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Final

Arroyo Grande Creek Erosion, Sedimentation and Flooding Alternatives Study

for

Coastal San Luis Resource Conservation District

January 4, 2006

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with funding from:

San Luis Obispo County Board of Supervisors,

State Coastal Conservancy

and

California Department of Parks & Recreation
(Off-Highway Vehicles Division)

January 4, 2006

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Definitions	
Aggradation	The raising of a stream-channel bed with time due to the deposition of sediment that was eroded and transported from the upstream watershed or the channel.
Bed Load	Sediment particles, which slide and roll along the bottom of a streambed. Constitutes the coarse material portion (typically > 2 millimeters) of sediment transport.
Bench/Terrace	An inactive floodplain that is located at a higher elevation than the current active floodplain.
Constant Loss	Describes the amount of water that is removed each time step from the soil water balance to account for loss to ground water or evapotranspiration. Constant loss is a parameter that is included in the HEC-HMS modeling program.
Cubic Feet Per Second	Cubic Feet Per Second (cfs): Units used to calculate the rate of water discharge, representing the volume of water (in cubic feet) passing a fixed point, over a period of time (one second). One cubic foot per second is equivalent to approximately 7.48 gallons per second, or 448.8 gallons per minute.
Flood Recurrence Interval	The probability floods of a particular magnitude are likely to occur. For example, a flood with a recurrence interval of 100 years has a 1 in 100 chance, or a 1% chance, of occurring during any single year.
Freeboard	The distance from the water's surface to the lowest levee crest. Freeboard increases overall channel capacity by providing surplus water storage above the height of the normal water level. Two feet of freeboard is a standard requirement of the Army Corps of Engineers to provide a level of protection beyond the design capacity.
Geo-RAS	A set of procedures, tools, and utilities, published by the Army Corps of Engineers, used for processing geospatial data in the Arc View computer software program.

HEC-HMS	Hydraulic Engineering Center's Hydrologic Modeling System. HEC-HMS software was developed at the Army Corps of Engineers to enable hydrologists and engineers to simulate the precipitation-runoff processes in a watershed using detailed hydrologic models. HEC-HMS software was used to develop hydrographs and total runoff volumes for the Arroyo Grande Creek Watershed.
HEC-RAS	Hydraulic Engineering Center's River Analysis System. HEC-RAS software was developed at the Army Corps of Engineers to enable hydrologists and engineers to conduct flow calculations (such as steady flow and unsteady flow simulations), as well as sediment transport computations, for natural and constructed channels. HEC-RAS software was used to develop an existing conditions model of the Arroyo Grande Creek Watershed and analyze potential alternatives.
Hydraulic	Pertaining to the mechanical properties of water and other liquids. In this study, hydaulic refers to the properties of discharge such as velocity, shear stress, etc.
Hydraulic Roughness	Resistance to flow as a function of channel roughness. A creek with a smooth bed surface, such as an aggraded flood control channel, will flow at a higher velocity than a creek with a rough bed surface, which creates hydraulic resistance.
Hydrologic	Pertaining to the hydrologic cycle, the cyclic transfer of water between the Earth's atmosphere, land cover, and oceans. In this study, hydrologic reference to the amount and timing of discharge rather than specific properties of that discharge.
Impervious Surface	A non-porous land cover, which has properties preventing the movement of water through it and causing water to runoff at a higher rate than natural conditions.
Incised Channel	A stream that has degraded and cut its bed into the valley bottom, indicating accelerated erosion.
Limb Up	Pruning or thinning of low-hanging tree branches and other riparian vegetation.
Low Flow Channel	A subset of a stream channel where water is confined to under baseflow conditions.

Manning's Roughness Coefficient (n)	A channel roughness value, and component of Manning's equation. Manning's n values range from .01 to .1. A Manning's coefficient value of .01 indicates extremely low channel roughness, such as a confined concrete channel. A value of .1 indicates high channel roughness, such as a boulder strewn mountain stream.
Manning's Equation	A hydraulic equation used to estimate in-channel velocity. $u = (1.49R^{2/3}S^{1/2})/n$, where u = velocity, R = hydraulic radius, s = slope, n = Manning's roughness coefficient.
Overflow Channel	A channel secondary to a main channel, which receives water flow when the main channel exceeds its capacity, such as during flood stage. Overflow channels occur naturally, but they can also be constructed for flood mitigation, in order to increase the total channel capacity of a stream or river. Lower Arroyo Grande Creek lacks natural overflow channels under existing conditions.
Sediment Budget	The quantification of the amount of sediment material being delivered and transported past a specific point in a watershed. If the amount of sediment being delivered exceeds the amount of sediment being transported, the channel is aggrading, or rising in elevation, due to sediment deposition over time. If the amount of sediment being transported exceeds the amount being delivered, the stream channel is incising, or experiencing accelerated erosion, due to sediment transport. If sediment delivery and transport are equal, the channel is in equilibrium.
Suspended Sediment Load	Finer-grained particles (typically less than 2 millimeters in diameter) carried in suspension by water flowing in a channel.
Steady Flow Model	A uniform flow model representing a discharge that remains constant over time and channel distance. Steady flow models are used by engineers to conduct hydraulic modeling in a controlled environment.

Stochastic	Random, or, non-deterministic. Involving or containing a random variable or variables. Involving chance or probability. For example, landslides can be considered stochastic because they cannot be predicted at any one location but instead occur irregularly across a landscape in reponse to heavy rainfall or other random events.
Unsteady Flow Model	A flow model that is non-uniform, representing a discharge that changes over time and channel distance. Unsteady flow models mimic natural channels.
Watershed	The land area drained by a particular river or stream, and all of its tributaries.

1. Introduction and Background

1.1. Location of Study Area

Arroyo Grande Creek drains a 157 square mile watershed located in west-central San Luis Obispo County. The mainstem of Arroyo Grande Creek flows through the cities of Arroyo Grande and Oceano and is an important regional waterway for the communities of Arroyo Grande, Grover Beach, Oceano, Pismo Beach, and Avila Beach. Lopez Reservoir, constructed in 1968, impounded approximately 70 square miles of the upper watershed. The construction of Lopez Dam affected downstream hydrology and sediment transport conditions, effectively dividing the watershed into the upper 70 square miles, most of which is contained within the Los Padres National Forest, and the lower 87 square miles, consisting of a mix of urban, rural residential, agricultural, and ranching uses.

The focus of this study is to evaluate alternatives to reduce flood risk in the mainstem Arroyo Grande and minimize accelerated, human-induced erosion in the watershed that may contribute to flooding. Existing and future impacts to aquatic habitat are also addressed through incorporation of habitat features that enhance riparian and aquatic function.

The areas of interest for the erosion and flooding portions of the study vary. In order to evaluate flooding and flood risk, the following areas of interest apply:

- *Hydrologic* Analysis (HEC-HMS Model): Hydrologic data was developed for all areas of the Arroyo Grande Creek watershed downstream of Lopez Reservoir (Figure 1.1) with the intent of providing necessary input parameters to the *hydraulic* model.

- Detailed Topographic Surveys: The topographic survey data collected for the study includes the flood control portion of Arroyo Grande and Los Berros Creeks and adjacent areas that would be impacted during a 100-year runoff event (Figure 1.2).

- Hydraulic Analysis (HEC-RAS Model): The HEC-RAS model was developed for the flood control portions of Arroyo Grande and Los Berros Creeks up to the Valley View Bridge (Figure 1.2).

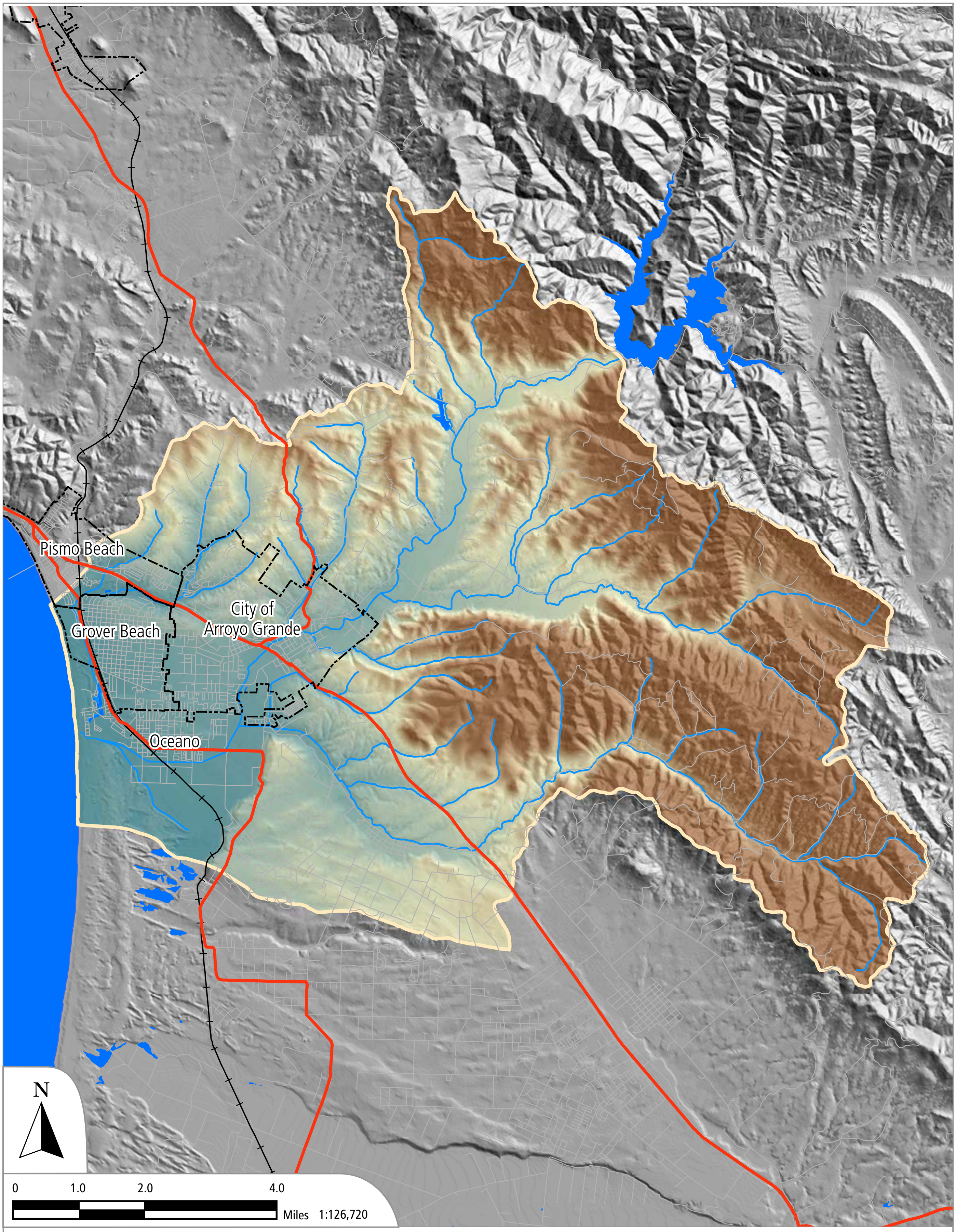

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FIGURE 1.1: Location map for the study area on Arroyo Grande Creek. The project area consists of the entire watershed downstream of Lopez Reservoir. The same study area was evaluated in the Arroyo Grande Creek Watershed Management Plan developed by Central Coast Salmon Enhancement (CCSE, 2005).

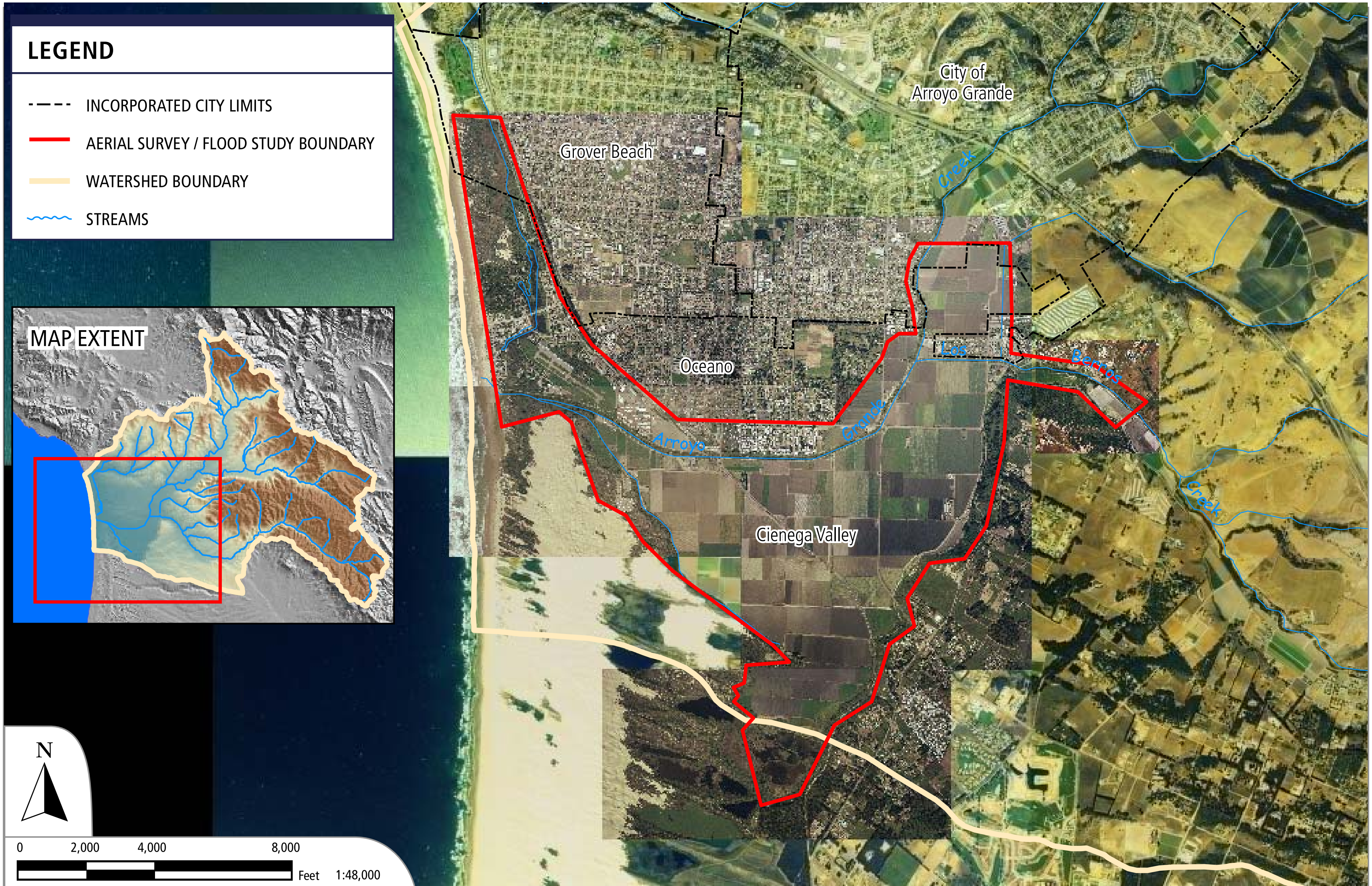

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FIGURE 1.2: Location map for the detailed hydraulic analysis. Hydraulic modeling focused on hydrologic conditions and impacts on lower Arroyo Grande Creek and lower Los Berros Creek within the Zone 1/1A Flood Control District.

In order to evaluate human induced erosion and sediment transport through the project area, the following areas of interest apply:

- *Sediment Budget*/Sediment Source Assessment: The sediment source assessment was developed for all areas of the Arroyo Grande Creek watershed downstream of Lopez Reservoir (Figure 1.1) with the intent of providing necessary input parameters to estimate sediment supply, transport, and deposition within the flood control portions of Arroyo Grande Creek.

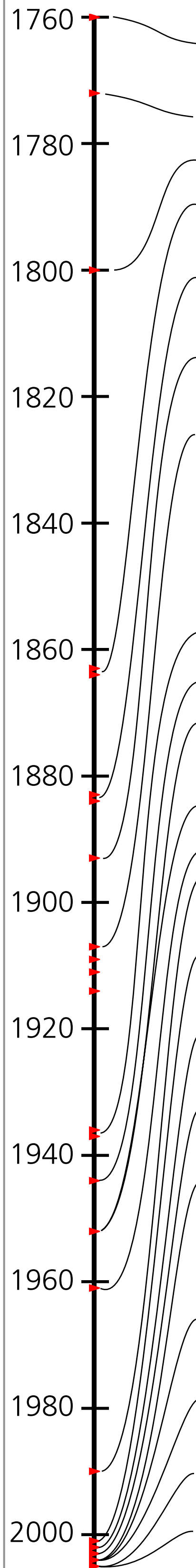
- Sediment Transport Analysis: Estimates of sediment flux, transport, and deposition were developed for the flood control portions of Arroyo Grande and Los Berros Creeks (Figure 1.2).

The sediment source assessment and development of the sediment budget for the lower watershed built on previous work conducted as part of the Arroyo Grande Creek Watershed Management Plan (CCSE, 2005).

1.2. History and Management

Arroyo Grande Creek has a long history of flood impacts to agriculture and human habitation that dates back to the time of the early settlements in the mid-19th century. Historical accounts and a geomorphic analysis of the lower watershed and Cienega Valley suggest that much of the valley floor was at grade with the Creek and consisted of a broad thicket of willows and other riparian trees (Dvorsky and Wingfield, 2004). From the time of the earliest settlements, use of the valley for homesteading, agricultural production, dairies, and cattle ranching required clearing of vegetation and active management of the channel and floodplain. Management, in those days, consisted primarily of ditching the channel to provide a predictable flow path, building levees, removing willow thickets, and leveling the land. Many of these activities were carried out by individual landowners with little to no coordinated efforts between adjacent property owners.

Despite the best intentions and well-laid plans of land owners to control Arroyo Grande Creek and reduce impacts to adjacent farmlands and infrastructure, the history of the creek, from settlement to present, has been a series of devastating floods that have greatly impacted the residents of the area. Severe flood damage was documented in the Arroyo Grande valley in 1883-84, 1893, 1895, 1907, 1909, 1911, 1914, 1936-37, 1943, 1952, and 2001 (Figure 1.3). The valley avoided the significant flood events that occurred elsewhere on the central and south coasts in 1969, 1983, and 1997, most likely due to flood storage provided by Lopez Reservoir.



Pre- 1760 Obispeno (Northern) Chumash Indian tribe inhabited Arroyo Grande Valley.

1760's Spanish soldier/explorer Gaspar de Portola with Catholic missionaries Father Junipero Sera and Father Juan Crespi were the first Euro-Americans to visit Arroyo Grande Valley.

1772 Mission San Luis Obispo was founded; most Native American villages were abandoned.

Early 1800's First Euro-American settlers began to appear along the Central Coast.

1863-1864 Devastating drought along Central Coast - many wetlands dried up, allowing for easier channelization of Arroyo Grande Creek.

1883-1884 Unexpected early heavy rains were diverted by an agricultural diversion dam. Channel permanently diverted through an agricultural ditch along the north side of town.

1893 Floods washed out a diversion dam, threatened the south approach to the bridge on Bridge Street, washed out the Central Pacific Railroad Bridge and flooded many local farms.

1907 Floods destroyed Southern Pacific and Pacific Coast Railroads track lines and washed out their original wooden bridges. Small bridges and culverts were washed out with notable damages to Corbett Canyon Rd. and other roads.

Floods in **1909, 1911** and **1914** washed out bridges, wrecked railroads and devastated the Arroyo Grande Valley.

1936-1937 A weekend storm in February caused flooding in Arroyo Grande and Oceano.

1944 San Luis Obispo County Flood Control and Water Conservation District (SLCFCWCD) organized.

1952 Flooding in January caused damage to roads and bridges in town, but also brought widespread devastation to farmers in the lower valley. Approximately 300 acres flooded, 100 of which drained quickly.

1952 The Arroyo Grande Soil Conservation District (AGSCD) founded.

1961 Arroyo Grande Creek Flood Control Project (AGSCD PL 566) completed.

Late 1990's Development boom. 625 new home sites were approved in the City of Arroyo Grande within a period of 5 years.

2001 March 5 - levee system failed on the south side during a moderately large storm. Hundreds of acres of farmland and several residences were flooded.

2002 SLOCFCWCD allocated $180,000 for a program Evaluation and Engineering Alternatives Analysis Study of lower Arroyo Grande Creek flood control channel. This funding was rescinded by SLOCFWCD in 2003.

2003 April 1st - SLOCFCWCD passed a "Resolution to Relinquish the Arroyo Grande and Los Berros Diversion Flood Control Channels to the State of California."

2004 June - SLOCFCWCD approved funding in the amount of $150,000 to the RCD to conduct "The Arroyo Grande Creek Watershed Assessment and Flooding Alternatives Analysis." The County grant was matched by the State Coastal Conservancy and augmented by $15,000 from the State Dept. of Parks and Recreation Off-Highway Vehicles Division for a total fund of $315,000.

2004 June 4 - Board of Supervisors requested a 1 year delay from Department of Water Resources to allow local groups the opportunity to develop other flood management options.

2004 Fall - The Division of Flood Management at the Department of Water Resources initiated the process of establishing a new Maintenance Area for flood control along the Arroyo Grande Creek.

2005 Feb. 14, DWR issued its Statement of Necessary work, and planned to begin work on the channel in July 2005.

2005 June 14, Board of Supervisors requested a 1 -year delay from DWR to allow local groups the opportunity to develop other flood management opportunities.

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FIGURE 1.3: Timeline of past management and flood history on lower Arroyo Grande Creek. Historic information was compiled from several references including: Chipping, 1989 and Brown, 2002.

The lower Arroyo Grande Creek floodplain, or Cienega Valley (Figure 1.2), is especially vulnerable to flooding because it lies at the downstream, lower gradient terminus of a highly erosive watershed. Much of the erosion occurring in the upper watershed results in sediment that is transported and delivered to the floodplains that make up the lower valley. Historically, much of the transported sediment was deposited onto broad floodplains of the lower alluvial valleys of Arroyo Grande Creek, Tar Springs Creek, and Los Berros Creek (Figure 1.4). Due to conversion of floodplain areas to agricultural and residential uses, and severe incision of Arroyo Grande Creek downstream of Lopez Dam, much of the sediment that was historically deposited on the floodplain ends up being deposited in backwater areas behind bridges, in small pocket floodplain areas, or in the lower gradient flood control reach.

In the 1950's severe flooding from Arroyo Grande Creek resulted in inundation of prime farmland in the Cienega Valley with significant impact to existing infrastructure. At the time, Arroyo Grande and adjacent communities were primarily rural with a combined population of fewer than 5,000 residents. To reduce future economic impacts to the agricultural economy and the growing urban and rural residential population, the community organized the Arroyo Grande Creek Flood Control Project (AGSCD PL 566). The proposed project, led jointly by the USDA-Soil Conservation Service and Arroyo Grande Resource Conservation District[1], was completed in 1961 in order to protect homes and farmland in the Cienega Valley.

As a component of the project design, a flood control channel maintenance plan and agreement was developed to assure operation and maintenance of the project to federal standards. Under a Watershed Protection Operation and Maintenance Agreement with the Natural Resources Conservation Service (NRCS) and the Coastal San Luis Obispo Resource Conservation District, dated May 15, 1959, the San Luis Obispo County Flood Control and Water Conservation District (SLOCFCWCD) was obligated to operate and maintain the Arroyo Grande Creek Flood Control Project. The project was designed and constructed by the former U.S. Soil Conservation Service and financed with federal, State, and local funds with a design capacity of 7,500 cubic feet per second believed to be (50 year flood capacity at the time) with two feet of freeboard.

The main feature of the project was a levee system and trapezoidal channel that confined Arroyo Grande Creek in levees from its confluence with Los Berros Creek downstream to the Pacific Ocean. In addition, the lower portion of Los Berros Creek from the Valley View Bridge to the confluence with Arroyo Grande Creek was diverted from its pre-1960 channel which ran along the southern edge of the Cienega Valley to its current confluence upstream of the Highway 1 Bridge. Runoff from the Meadow Creek watershed, which runs though Pismo Lake, was designed to enter Arroyo Grande Creek through a pair of flap gates near the Pismo Dunes State Vehicular Recreation Area (Chipping, 1989). Maintenance of the project, following construction, was the responsibility of San Luis Obispo County Flood Control District Zone 1/lA, under the purview of the County

[1] These organizations are now known as the USDA-Natural Resources Conservation Service and the Coastal San Luis Resource Conservation District (RCD), respectively.

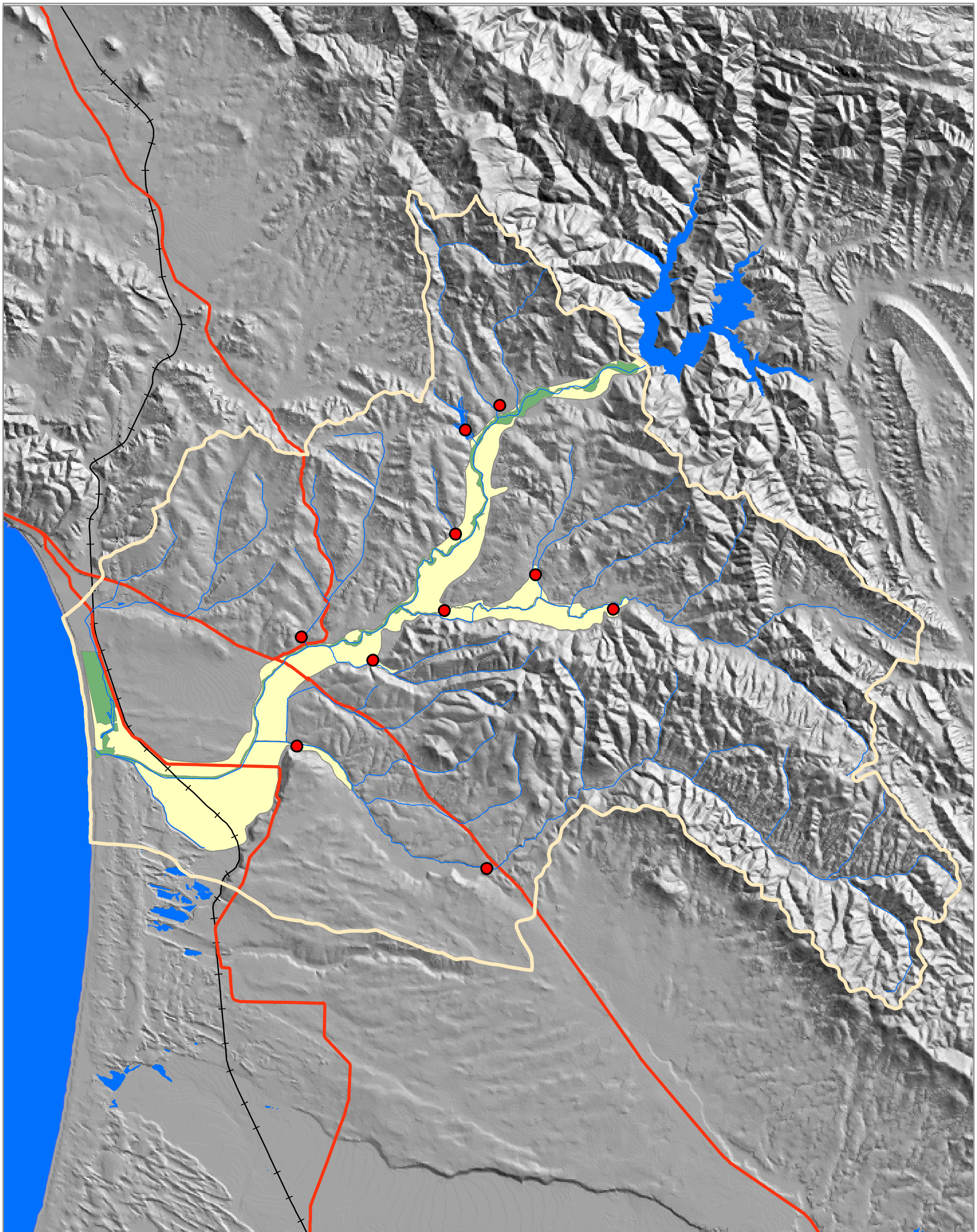

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FIGURE 1.4: Historic versus existing active channel areas on Arroyo Grande Creek and tributary channels downstream of Lopez Reservoir. Mapped surfaces represent areas of active deposition and storage of sediment delivered from the upper watershed. Loss of potential sediment storage in the lower valley results in transport and delivery of supplied sediment to the flood control reach.

Public Works Department. Landowners within the zone are assessed an annual fee to support management and maintenance of the flood control reach.

This original flood control channel was designed to carry a discharge of 7,500 cubic feet per second (cfs), which, at the time of the analysis, was determined to have a recurrence of once every 50 years. Maintenance of the flood control channel by the County since completion of the project in 1961 consisted primarily of vegetation and sediment removal to maintain the design geometry and capacity of the channel, and routine maintenance of the levee system and associated infrastructure. The frequency of maintenance varied depending on rainfall and runoff conditions that preceded maintenance. Maintenance activities in recent years were restricted by a combination of lack of funding[2] and environmental concerns about the impacts of vegetation and sediment maintenance on habitat conditions for sensitive species in the flood control reach.

Environmental concerns and restrictions on maintenance were exacerbated by the recent listing of the California red-legged frog[3] (Rana aurora draytonii) and steelhead[4] (Oncorhynchus mykiss) under the Federal Endangered Species Act (ESA). Protection of critical habitat for these two species meant that past maintenance activities, such as complete removal and dredging of the entire flood control channel were no longer feasible. In addition, tidewater goby (Eucyclogobius newberryi), listed as endangered under the ESA, were recently identified as occurring in the Arroyo Grande lagoon[5]. The agencies overseeing protection of endangered species, including the U.S. Fish and Wildlife Service, NOAA Fisheries, and the California Department of Fish and Game, requested that a more comprehensive strategy be prepared to manage the flood control reach through a maintenance program that specifically protects aquatic habitat.

During this period, Arroyo Grande was experiencing a development boom. During the late 1990's, 625 new home sites were approved in the City of Arroyo Grande in a period of 5 years. This number represents an increase of almost 10% in a city with only 6,750 housing units. Much of the development, both proposed and existing, provides little in the way of storm water management or Best Management Practices (BMP's) that limit runoff and reduce impacts to the hydrology of the watershed. Consequently, current development contributes increased runoff to the flood control reach with increased risk of flooding. A flood estimated to occur once every 50 years in 1955 is now estimated to have a recurrence interval of 15-20 years due to changes in the hydrology of the lower watershed. Development affects a watershed's hydrology by increasing the amount and timing of runoff through an increase in impervious surfaces. In addition, much of the development is occurring on steep, highly erodible soils. If adequate erosion controls are not implemented during construction, much of the sediment is transported to the flood control reach, reducing the capacity of the flood channel, resulting in impacts to low-lying agricultural land through increased flooding and flood risk.

[2] Zone 1/1A maintenance funds have not risen appreciably since creation of the special flood control district.
[3] California red-legged frog were listed as threatened under the Endangered Species Act in May 1996.
[4] Steelhead in Arroyo Grande Creek fall within the South-Central Coastal California ESU and were listed under the Endangered Species Act as threatened in August 1997.
[5] Tidewater goby were listed as endangered under the Endangered Species Act in February 1994.

In 1999, the US Army Corps of Engineers (USACE) conducted a study to assess the existing capacity of the flood control reach. The results suggested that the system currently has a reduced capacity of 1,700, cfs which equates to a recurrence interval of approximately 2- to 5-years (USACE, 2001). The capacity of the as-built channel (the channel as built in 1961), according to the USACE model, was determined to be 6,500 cfs with an associated level of protection between the 10-year and 20-year runoff event. These results show that even under 1961 geometry the capacity of the channel would be approximately 1,000 cfs less than was estimated when the channel was built, most likely due to changes in the levee geometry from settlement and erosion and inaccuracies in hydraulic modeling techniques used in the mid-1950's. The USACE study pointed to the need for a more detailed alternative assessment to define project opportunities and costs associated with improving overall capacity and flood protection.

On March 5, 2001, during a high intensity rain event, the Arroyo Grande levee system was breached on the south side between the mouth and the Union Pacific railroad bridge (Figure 1.5). It was estimated by observers in the field at the time of the levee breach that the levee would have overtopped upstream of the 22nd Street bridge, had the levee not breached and lowered the overall water surface. Hundreds of acres of farmland and several residences were flooded in the Cienega Valley. Impacts from the flooding persisted beyond the winter season as many of the areas with clay soils located in the southern portion of the valley remained saturated for many months. The northern levee remained intact, thereby protecting several residential developments, as well as the regional wastewater treatment plant that services the communities of Arroyo Grande, Oceano and Grover Beach.

In April 2003, the County Board of Supervisors passed a "Resolution to Relinquish the Arroyo Grande and Los Berros Diversion Flood Control Channels and Appurtenant Structures to the State of California". County Public Works Department staff recommended that maintenance responsibilities be turned over to the State Department of Water Resources (DWR) because the County had not been able to maintain the channel due to regulatory requirements, inadequate funding from the Zone 1/1A assessments, and the cost of liability insurance. The State is mandated to accept this responsibility under Water Code Section 12878. In fall 2004, the responsible entity, the Division of Flood Management at DWR, initiated the process of establishing a new Maintenance Area (referred to as MA-18) for flood control along lower Arroyo Grande Creek.

In February 2005, DWR issued a Statement of Necessary Work with the goal of initiating maintenance work on the channel in July 2005. The State Water Code mandates that DWR maintain the channel in accordance with the existing operation and maintenance agreement (Work Plan). This current Work Plan, developed as part of the 1955 Arroyo Grande Creek Flood Control Project, requires maintaining the channel by restoring it to its original 1958 design. To achieve this goal, DWR was faced with a difficult and expensive regulatory process in order to obtain the necessary environmental permits for this plan. Due to the presence of two federally listed species, restoring the original design would likely result in requirements to develop and

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FIGURE 1.5: A - Oblique photo of flooding in the Cienega Valley following the levee breach of March 2001 (looking south). B - Close-up view of the levee breach and flooding of farmland in March 2001 (looking at south levee from north levee).

implement costly mitigation measures to compensate for habitat loss that would be paid locally through the Zone 1/1A assessment process. There are no provisions in the Water Code that would permit DWR to study or implement other acceptable flood control designs or alternatives that would also be more environmentally acceptable.

During late 2002 the San Luis Obispo County Flood Control and Water Conservation District (SLOCFCWCD) allocated money for a Program Evaluation and Engineering Alternatives Analysis Study of the lower Arroyo Grande Creek flood control channel. This study was intended to evaluate a wide range of flood control alternative projects and provide a plan to manage flooding at the most downstream section of the creek. When the SLOCFCWCD began the process of relinquishing maintenance of the channel over to DWR, it also withdrew the funding for this critical study. The Zone 1/1A Advisory Committee, comprised of agriculturalists and other local residents, and various stakeholders, actively lobbied the County Board of Supervisors to restore this funding so that the plan could be developed. In June 2004, the SLOCFCWCD approved the release of $ 150,000 in funding to the RCD to conduct "The Erosion, Sedimentation, and Flooding Alternatives Study" (Alternatives Study). The County grant was matched by the State Coastal Conservancy, and augmented by $15,000 from the State Department of Parks and Recreation Off-Highway Vehicles Division.

1.3. Goals and Objectives of Study

The Alternatives Study is focused on an in-depth evaluation of erosion sources, sedimentation and hydrology as they relate to recurring flooding in the lower reaches of the creek. The Alternatives Study complements the Arroyo Grande Creek Watershed Management Plan (AGWMP) completed by Central Coast Salmon Enhancement (CCSE) in 2005. The AGWMP focused on developing a management plan for the lower reaches of the Arroyo Grande Creek watershed for the restoration of steelhead trout. The consulting firm of Swanson Hydrology and Geomorphology (SH+G) was contracted by the RCD to conduct the study, and began work in February 2005.

The initial task of the project team members, including the SH+G project manager, the RCD, and the NRCS, was to establish a goal that would define a threshold of success for a given alternative. Based on the history of flooding in the channel and the fact that the Watershed Protection Maintenance and Operation Agreement established in May 1959 was still in effect, the agreed-upon threshold for success was to equal or exceed the design capacity of 7,500 with two feet of freeboard. That goal would be achieved by evaluating potential flood and/or sediment reduction actions to reduce the frequency of levee overtopping along the flood control reach and to evaluate the expected cost of each proposed action.

To achieve the stated goal of the project, the Study includes the following tasks:

- Identify key sources of erosion in the lower watershed that contribute to excessive sediment loads and quantify sediment transport mechanisms within the Arroyo Grande Creek that contribute to sedimentation of the flood control reach.

- Create detailed topographic maps of the stream channel and surrounding flood prone areas based on a combination of aerial photography and ground surveys to provide input to hydraulic, hydrologic, and sediment transport models.

- Using existing and derived (HMS) hydrologic data to develop flood recurrence discharges ranging from 2.5 years to 100 years for input to the hydraulic modeling.

- Develop existing conditions HEC-RAS computer models based on channel topography, creek roughness, bridge geometry and representative flow conditions.

- With input from both a technical advisory team and from the general public, develop a list of potential actions and projects that would address the flooding and sedimentation impacts.

- Using HEC-RAS computer models, test feasible flood reduction alternatives, both singly and in combination, for their effectiveness in reducing flood risk.

- Evaluate environmental impacts of proposed actions and expected permitting process. Integrate habitat enhancement measures into proposed flood reduction actions to protect and restore aquatic habitat.

- Evaluate aquatic habitat and floodplain restoration potential in the Lower Arroyo Grande Creek watershed to improve habitat conditions for threatened and endangered species.

- Produce a draft and final report describing the process needed to implement the most cost-effective flood and sedimentation management actions, with proposed phasing based on expected future funding. The final report of the Arroyo Grande Creek Erosion, Sedimentation and Flooding Alternatives Study will provide the blueprint for successful long-term management of sedimentation and flood risk along the flood control channel.

2. General Approach

2.1. Overview

Modern society has been analyzing and assessing floods and the impact they have on property, infrastructure, agricultural lands, and communities for generations. Recent innovations in technology have allowed the science of flood estimation to advance through the creation of complex models that can not only determine maximum water surface elevations but can analyze potential flood impacts through time to assess flood volumes and the extent of potential impacts on areas inundated by flood flows. Similarly, modeling of sediment transport conditions in channel systems has improved significantly, though there is still considerable inherent error in attempts to understand sediment transport dynamics.

To evaluate flood reduction alternatives on the flood control reach of Arroyo Grande Creek and the degree to which sediment storage contributes to the flooding problems, we developed an assessment approach that relies heavily on modeling. Hydraulic modeling, in combination with high resolution topographic data, was used to assess existing conditions and potential flood reduction alternatives. This information, in turn, provided the raw data for use in the sediment transport analysis (Figure 2.1). The models are reasonably accurate at estimating channel capacity and associated water surface elevations. They also provide a way to compare the magnitude of change associated with a particular alternative. In addition, the relative speed with which a particular flood reduction scenario can be evaluated through computer modeling allows us to iteratively assess potential project options.

The primary hydraulic and hydrologic modeling tools used for this assessment are the HEC-RAS and HEC-HMS computer programs. These programs were developed by the U.S. Army Corps of Engineer's Hydrologic Engineering Center and represent an industry-wide standard for hydrologic and hydraulic modeling. More complicated 2-dimensional and 3-dimensional models are available today but they are proprietary software and require more time and effort to run. The analysis tools used for the sediment transport assessment consisted of a combination of traditional empirically-based tools and sediment transport models based on work conducted by Parker (1990). All of these tools were used iteratively to assess a range of flood and sediment reduction alternatives.

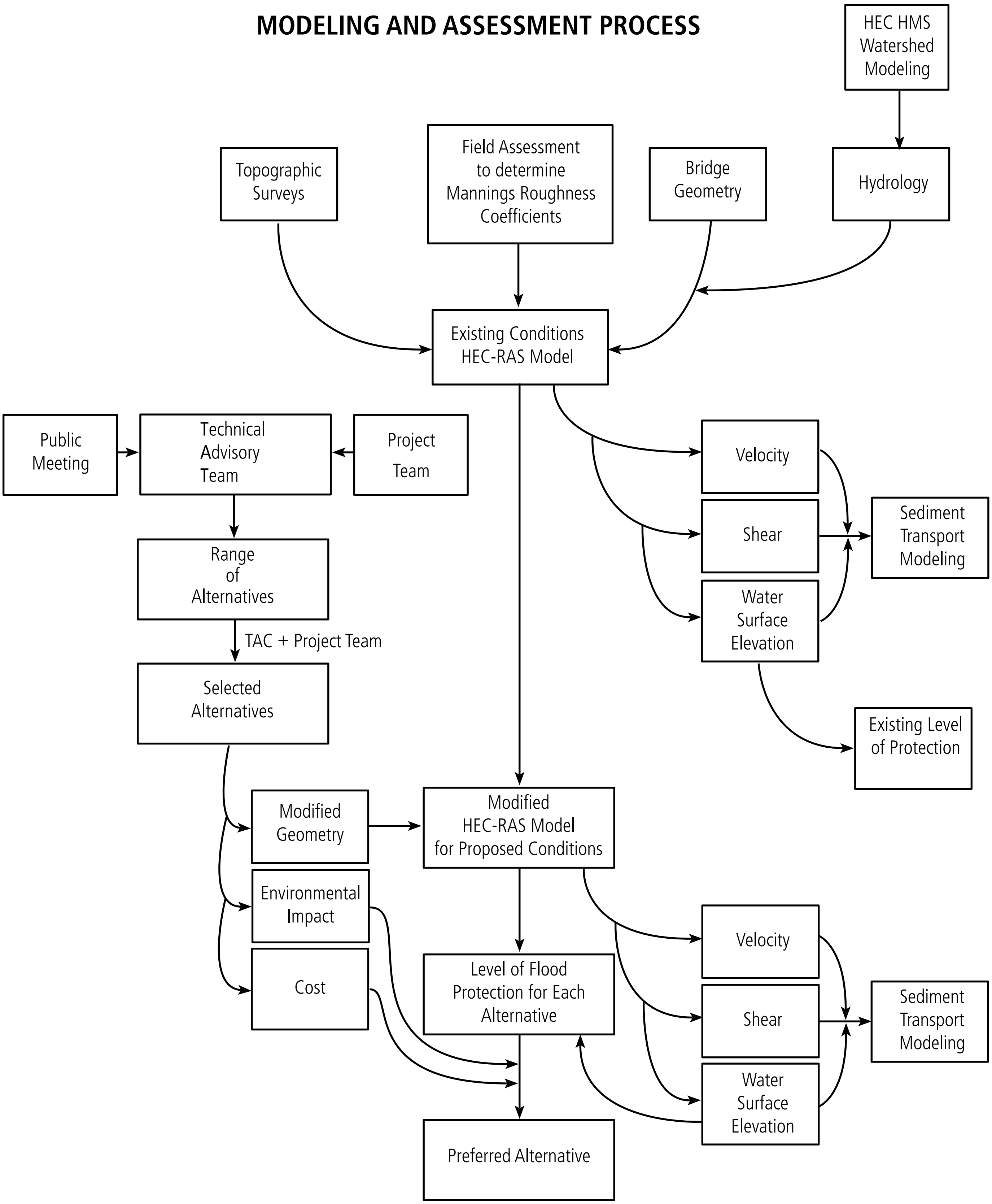

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FIGURE 2.1: Flowchart illustrating the modeling and assessment process used to evaluate existing conditions and proposed alternatives to reduce flood risk in the Zone 1/1A Flood Control District.

2.2. Hydrologic and Hydraulic Modeling

2.2.1. Topographic Surveys

An aerial photogrammetric survey of the project area was performed on March 10, 2005 by Central Coast Aerial Mapping, Inc., under subcontract with SH+G. The survey was tied to photo control points set by Cannon & Associates, Inc., using GPS survey equipment. The products of the aerial survey include a set of digital ortho-rectified color images of the project area as well as a topographic map showing two–foot contours in areas where the ground surface was not obscured by vegetation, standing water, or other obstructions.

To augment and improve upon topographic data collected remotely, SH+G conducted a ground-based survey that mapped cross sections along the project reach. Cross-section data was collected from the Valley Road Bridge on Los Berros Creek to the confluence with Arroyo Grande Creek and then extending from the confluence with Los Berros Creek on the Arroyo Grande mainstem downstream to the mouth of Arroyo Grande Creek at the Pacific Ocean. In addition, the ground survey extended approximately 200 feet up Arroyo Grande Creek from its confluence with Los Berros Creek to capture the remaining portion of the flood control reach and to establish boundary conditions. The survey was conducted using an electronic total station and data collector. A traverse was run along the levee crests, with periodic field ties made to the aerial photo control points set by Cannon & Associates, Inc. The purpose of the survey was to obtain detailed data at bridges and in locations where tree cover or other obstructions made aerial mapping impossible, including areas inundated with water at the time of the aerial mapping. Cross sections were surveyed approximately every 500 feet, with additional sections mapped at locations of hydraulic significance.

2.2.2. HEC-RAS Model Development

The existing-conditions HEC-RAS model was developed using *Geo-RAS* software to sample cross sections from the topographic base map. Sections were sampled approximately every 200 feet, with additional sections placed at locations of hydraulic significance.

Manning's roughness ("n") values for the model were determined from field observations and a review of aerial and ground photographs taken in March of 2005. Field data and photos for the roughness survey are included as an appendix to the digital version of this report (Appendix C). An average composite roughness value of 0.057 was calculated (Figure 2.2) for the project area, with composite roughness for individual cross sections varying between .037 and .07. Bridge geometry was input to the model from field survey measurements taken in March of 2005.

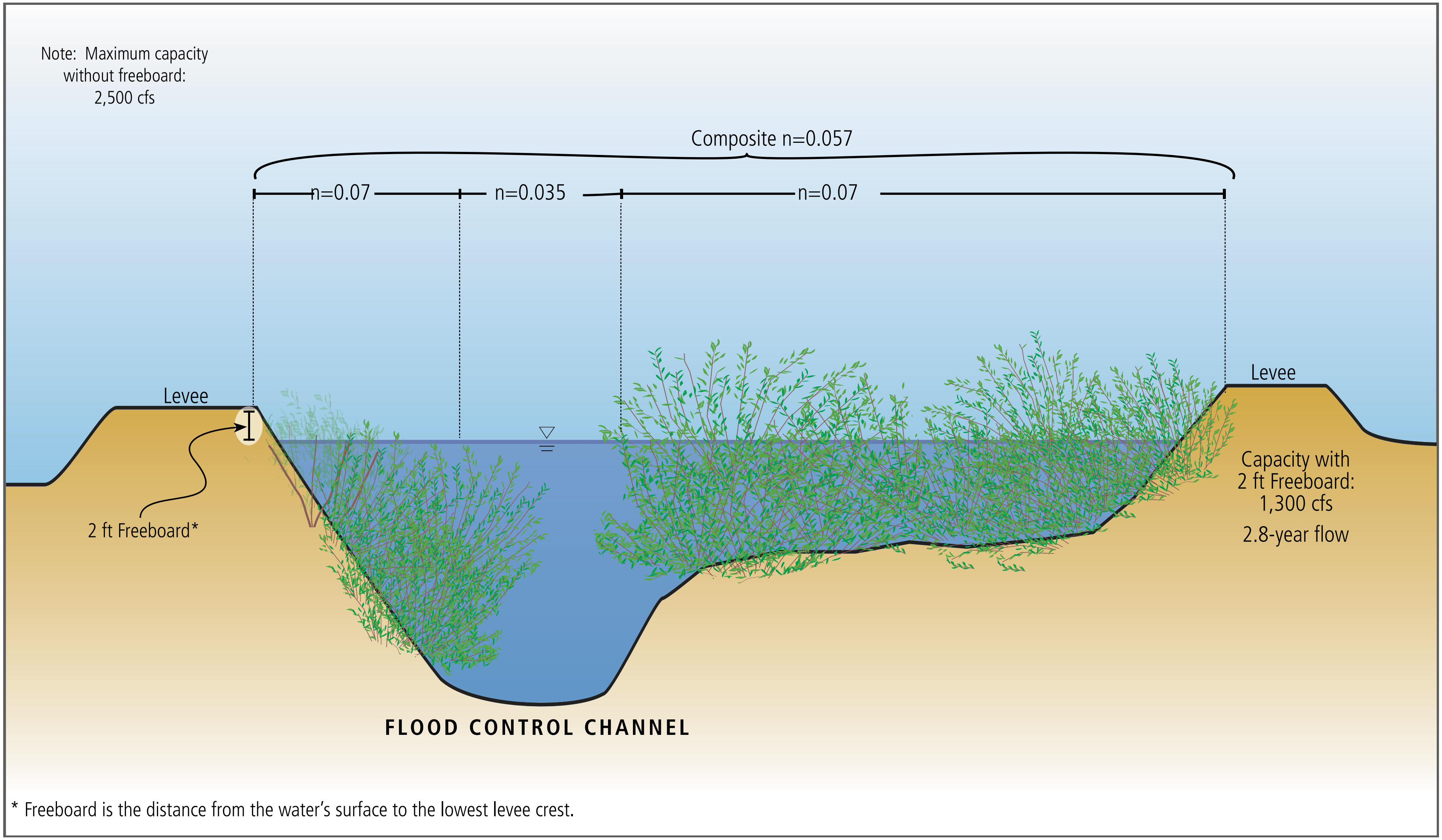

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FIGURE 2.2: Schematic diagram of existing conditions on the Arroyo Grande Creek flood control channel. A average composite Manning's roughness value (n) of 0.057 was estimated for the hydraulic modeling effort based on field observations in summer 2005.

2.2.3. HEC-HMS WATERSHED MODELING

A detailed hydrologic model of the *watershed* was developed to generate typical flood hydrographs for the 5-, 10-, 20-, 50-, and 100-year runoff events for use in analyzing proposed alternatives that required total runoff volumes. Our goal was to create an existing-conditions runoff model that matched the results of the USACE model, and that could be used as a foundation for modeling our proposed flood control alternatives. Our model was generated using HEC-HMS, Version 2.2.2, developed by USACE, with input data provided in the USACE report (USACE, 2001).

As part two of a two-part report on the hydrology of streams in San Luis Obispo County (USACE, 2001), the USACE developed a hydrologic model of Arroyo Grande Creek and its tributaries. The Corps study used HEC-1 rainfall-runoff modeling software to analyze hydrologic conditions in the watershed. Their final model was calibrated (by adjusting assumed values of *constant losses*) to provide peak flow values matching those determined from regional regression equations[6] that were developed during part one of their study (USACE, 1999).

Input parameters provided in the USACE report included:

- Sub-basin and channel geometry,
- Rainfall intensity, duration and frequency,
- Percent impervious areas,
- Transform and routing characteristics,
- Reservoir stage-storage-discharge relationship for Lopez Reservoir, and
- Assumptions of initial and constant losses.

Once the USACE values were entered into our model, the assumptions for constant losses were adjusted to obtain the desired output results. Hydrographs of the 5, 10, 20, 50, and 100-year recurrence interval storms were produced and are shown in Figure 2.3. These hydrographs were input into the *HEC-RAS unsteady flow model* and used to analyze Alternatives 5 and 6.

2.2.4. SEDIMENT BUDGET / TRANSPORT ANALYSIS

Recent flood impacts in the flood control reach of the Arroyo Grande not only relate to hydrologic and hydraulic conditions, but also to sediment supply, transport and storage conditions both in the contributing watershed and the flood control reach. Historically, solutions to improve flood capacity through the flood control reach have focused on maintenance programs without a clear understanding of the source of the sediment and the root causes of sedimentation.

[6] A total of 29 stream gages were used by the USACE to develop the regional regression equations. Gages were located in the Santa Maria watershed, Salinas watershed, Arroyo Grande watershed, and other smaller coastal drainages. All 29 gages were located in San Luis Obispo County.

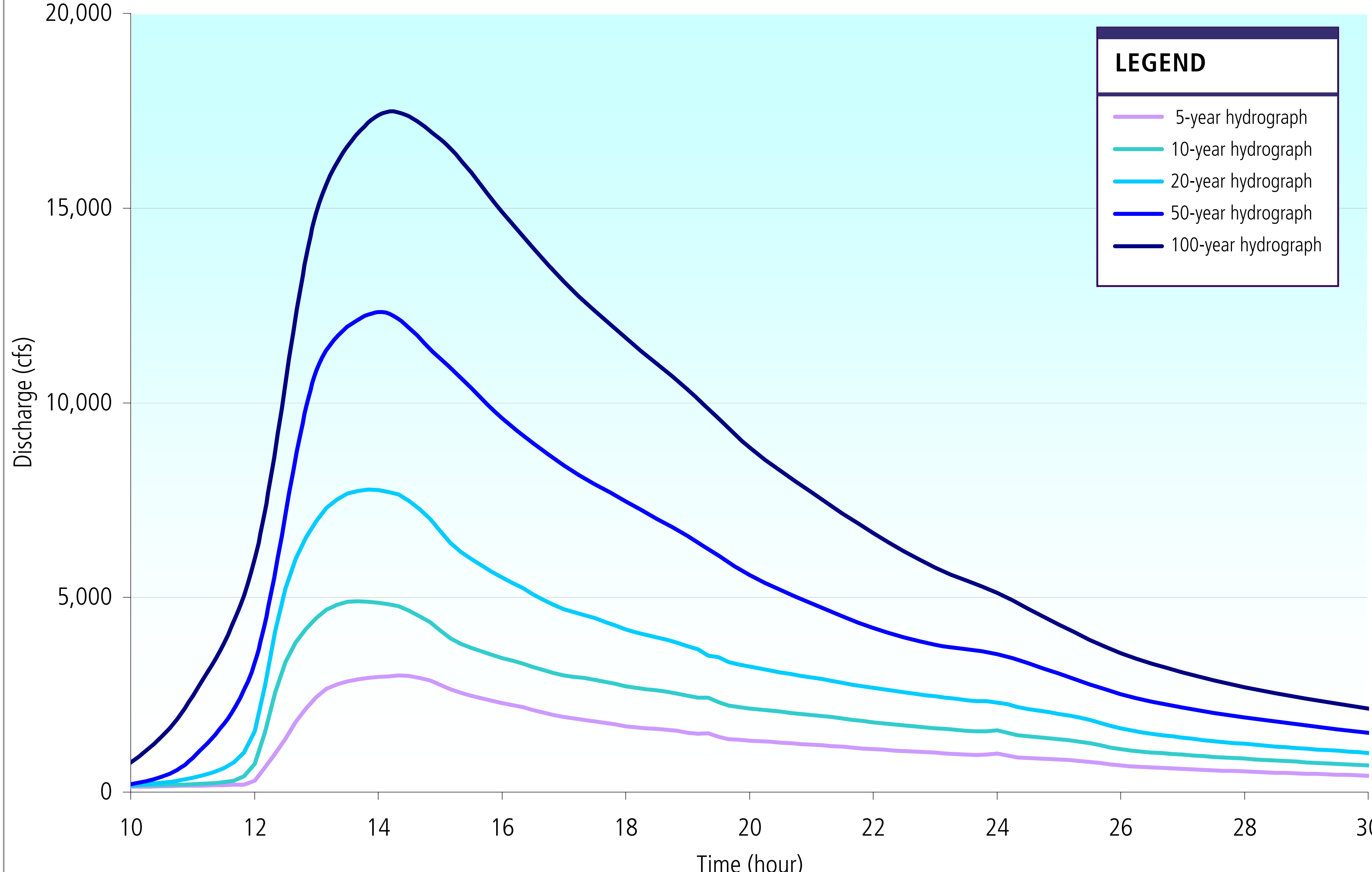

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FIGURE 2.3: Hydrologic modeling results (*HEC-HMS*) for the 5-year, 10-year, 20-year, 50-year, and 100-year recurrence interval storm events under existing conditions. The HMS model was developed from parameter data provided by the USACE to maintain consistency between the current modeling and modeling completed by USACE in 2001.

To answer these questions, we developed sediment supply and transport estimates for the lower Arroyo Grande Creek watershed in the form of a sediment budget. The supply side of the estimate was developed through a combination of focused field work and use of existing published rates of erosion based on land use and documented erosion processes occurring within the watershed (Reid and Dunne, 1996). The transport side of the sediment budget estimate was developed separately for suspended sediment and *bed load* transport. Suspended sediment estimates were generated using USGS suspended sediment concentration data combined with the long-term hydrologic record for Arroyo Grande Creek. Bed load transport quantities were estimated using Parker's (1990) bed load transport model. Sediment delivery and flux were compared to estimate storage within the flood control reach.

The sediment budget estimates provide a relative measure of the rates of sediment contribution to the lower watershed due to erosion processes occurring on the mainstem and in tributaries. Though there is likely to be significant error in the actual estimates, providing relative rates of erosion in the various subwatersheds of Arroyo Grande Creek can pinpoint problem areas that require attention. In addition to the sediment budget estimates, we also expanded on work completed in the Arroyo Grande Creek Watershed Management Plan by identifying specific actions and projects that could be implemented to reduce sediment delivery to the mainstem and flood control reach. Project identification and prioritization were directed by the results of the sediment budget which revealed which subwatersheds contributed the most sediment and therefore were targets for sediment reduction programs.

2.3. ALTERNATIVES ANALYSIS

The primary objective of this study was to evaluate potential projects or alternatives that could be implemented to reduce the frequency of flooding through the flood control reach of the Arroyo Grande Creek. To achieve that objective, the approach would be to either increase the hydraulic capacity of the channel and/or reduce the likelihood of excessive sedimentation. The number of potential alternatives available to achieve the project objectives was potentially limitless, yet the resources to analyze potential alternatives were finite.

To narrow the list of potential projects to a feasible set of alternatives, a series of meetings were held that involved a range of expertise and interests including the core project team members, regulatory agencies, local government entities, landowner representatives, and interested members of the public. The first meeting in March 2005 consisted of a brainstorming effort to identify the potential range of alternatives to be considered. A summary of the list generated from the brainstorming effort is shown in Table 2.1.

To narrow the alternatives down to a set of potential flood and sediment reduction actions that were feasible to implement within the goals and budgetary constraints of the Zone 1/1A flood district, each project identified in the brainstorming session was briefly reviewed to assess benefits, drawbacks, feasibility, potential community support, cost, and regulatory process associated with implementing the project. From this process, a total of six potential flood reduction alternatives and various other sediment reduction alternatives were reviewed and selected at a subsequent meeting. These six flood reduction alternatives and various sediment reduction alternatives were then analyzed using the hydrologic, hydraulic, and sediment transport tools described above.

Rejected alternatives (i.e. - those not selected for further analysis) were removed from the analysis for various reasons. The primary reason was the potential implementation cost associated with these alternatives or significant resistance to the alternative from the community. One of the assumptions in the analysis was that much of the infrastructure and maintenance of the selected alternative would be paid for through an annual assessment on the property owners that are within the boundaries of the special Zone1/1A district. That assumption limits the extent to which alternatives with large infrastructure costs could be evaluated. If grant funding became available or the funding pool was expanded beyond the current Zone 1/1A boundary, additional alternatives may become more feasible.

One such potential alternative that was not analyzed due to the high infrastructure cost is a levee setback scenario. A levee setback consists of shifting the location of the existing levee system to provide additional flood conveyance and/or storage within the flood control channel, thereby providing more flood protection. The advantages of a levee setback alternative include additional flood protection, potentially up to 100-year flood capacity, the potential to reduce maintenance needs (e.g. – vegetation and sediment maintenance) if the setback is adequate, and improved environmental conditions within the channel associated with a restored floodplain. The drawbacks of a levee setback include the high costs of the project (e.g. – new levee construction, removal of existing levees, three bridge replacements to accommodate increased capacity) and the loss of highly productive agricultural when the levee is set back. A preliminary evaluation of a proposed levee setback alternative will be undertaken in winter 2006 to address concerns about the existing set of alternatives raised by the Central Coast Regional Water Quality Control Board and NOAA Fisheries.

For each flood protection alternative analyzed as part of this study, preliminary project costs were developed to be used in a cost-benefit analysis. Costs for each project alternative were divided into up-front, first year infrastructure upgrades (e.g. – levee construction) and long-term annual maintenance costs. To provide a means of comparison for a cost-benefit analysis between the six proposed alternatives, total costs, including infrastructure and maintenance, were estimated over a ten year period. An annual inflation rate of 4% was applied to maintenance costs beyond Year 1 (i.e. – Year 2 through 10) to account for an increase in material and labor costs over the analysis period. Infrastructure upgrades (including Year 1 vegetation and sediment management options), proposed as part of each alternative, were assumed to be implemented in Year 1. A delay in implementing infrastructure upgrades would increase overall project costs.

Preliminary List of Potential Flood and Sediment Reduction Actions			
#	Action	Objective	Brief Description
1	Levee raise	Increase flood capacity	Includes raising the existing levees to obtain adequate flood protection along the Arroyo Grande Creek Flood Control Channel. The height of the levee will depend upon the level of flood protection required and existing infrastructure elements such as bridges. Levee raise could account for and allow for riparian vegetation and habitat with specific performance-based maintaince requirements.
2a	Levee setback and raise	Increase flood capacity	Includes all elements of the levee raise with the addition of a levee setback, where appropriate, to increase the overall capacity of the flood channel. Could create an additional floodplain within the channel and allow for integration of expanded wetlands. This option would require purchase of adjacent parcels to setback levee and restore floodplain.
2b	Retain existing levee and build second levee	Increase flood capacity	Would provide for additional conveyance and flood storage without dismantling the existing levee system. The floodplain could be managed differently in existing channel as compared to the overflow/bypass channel. This option would require purchase of adjacent parcels to setback levee.
3	Bridge modification or replacement	Increase flood capacity and reduce sedimentation in flood control channel	Preliminary observations suggest that existing bridges may constrict flow and result in backwatering, sediment deposition, and levee overtopping. This project will include modifications to exisitng constrictions to reduce potential flooding. May need to be combined with a levee raise to achieve desired flood protection.
4	High flow weirs and flood easements	Detain flood waters	This approach would consist of creating a low point in the levee where flood waters could be controlled with known consequences. This option would have to either include agricultural land purchase with potential lease-back option or payment guarantees in the case of crop failure on affected land (ie - flood easements).
5	Vegetation maintenance program	Increase flood capacity and reduce sedimentation in flood control channel	This alternative would most likely be bundled with other flood protection alternatives and would include an environmentally sound approach to vegetation maintenance with specific roughness targets identified for each reach.

TABLE 2.1: Summary table of potential range of alternatives. Grey highlighted rows represent actions that were evaluated, in detail, in the Alternatives Assessment. Non-highlighted actions were either evaluated at a cursory level or were deemed to be in-feasible given the project constraints.

Preliminary List of Potential Flood and Sediment Reduction Actions			
#	Action	Objective	Brief Description
6	Restoration of floodplain in vicinity of airport	Detain flood waters and restore habitat	Restoring floodplain may be a multiobjective approach that reduces flood risk and mitigates for habitat impacts associated with other flood reduction actions.
7	Restoring floodplain and flood capacity on tributary streams	Detain flood waters, restore habitat, reduce sedimentation in flood control channel	Opportunities may exist to expand floodplain and increase flood storage in several tributary areas such as Los Berros, Tar Springs, and Corbitt-Carpenter Creeks. This approach would have the added benefit of reducing sediment inputs to the flood control reach.
8	Restore floodplain on mainstem Arroyo Grande Creek above flood control channel	Detain flood waters, restore habitat, reduce sedimentation in flood control channel	There are several locations where there may be opportunities to restore floodplain and increase flood storage along the mainstem between Lopez Dam and the flood control channel. The approach could either be a passive or active approach to flood storage.
9a	Restore historic Los Berros Channel	Redirect portion of high flows away from main channel	Before the flood control project was built, Los Berros Creek entered Arroyo Grande Creek much further downstream. Reactivating this old channel as an *overflow channel* would reduce stresses on the upper portion of the flood control channel.
9b	Construct alternative bypass channel	Redirect portion of high flows away from main channel	Construct a new bypass channel as an overflow channel.
10	Alter Lopez Dam operations to provide flood detention	Detain flood waters	The current focus of operations at Lopez Dam are to maximize water storage. Operations could be adjusted to allow for flood detention, though this may impact storage in some years.
11	Reduce bank erosion on mainstem and gully formation in tributaries	Increase flood capacity and reduce sedimentation in flood control channel	Bank erosion, channel incision and gully formation have been identified as the most significant sources of erosion in the lower watershed. Reducing erosion would reduce the frequency of maintenance dredging required in the flood control reach to maintain flood capacity.
12	Excavate benches within channel	Increase flood capacity	Excavate benches to create geomorphically stable channel; allow vegetaiton on *low flow channel* banks.

TABLE 2.1 (cont.): Summary table of potential range of alternatives. Grey highlighted rows represent actions that were evaluated, in detail, in the Alternatives Assessment. Non-highlighted actions were either evaluated at a cursory level or were deemed to be in-feasible given the project constraints.

Preliminary List of Potential Flood and Sediment Reduction Actions			
#	Action	Objective	Brief Description
13	Sediment retention basin in channel	Reduce sedimentation downstream	Create a stilling basin in channel to settle sediments and reduce loss of channel capacity downstream - perhaps 20-75 acres total. May be especially useful around bridges.
14	Off-channel Sediment basin	Reduce sedimentation downstream	Create a stilling basin adjacent to the main channel to settle sediments and reduce loss of channel capacity downstream.
15	Flood Plain Management	Non-structural, site specific measures to eliminate and/or minimize flood damage to property or structures	Raise and flood-proof structures, install ring levees or floodwalls; move vulnerable structures; install overflow weirs and energy dissipators to contorl overflow, improve drainage network to drain floodplain quickly after floods.
16	Maintain/enlarge existing retention basins in housing developments	Detain flood waters	Several housing developments have been identified that have incorporated stormwater detention basins that appear to be poorly designed. Simple modifications could be made to these basins to make them more effective at capturing peak events.
17	Change county and/or local development codes	Reduce impermeable surfaces in developed areas; reduce erosion	Revise zoning and building regulations to reduce upslope impermeable surfaces, allowing for greater infiltration and diminishing flashiness of stream flows. Improve and enforce erosion control rules to reduce delivery of sediment to tributaries and main channel.
18	In off-season, rip benches/banks in flood control channel	Increase sediment mobility	Use machinery to loosen soil on upper benches/banks of flood control channel, making it easier for accumulated sediment to be entrained and moved downstream and flushed to ocean during high flows.

TABLE 2.1 (cont.): Summary table of potential range of alternatives. Grey highlighted rows represent actions that were evaluated, in detail, in the Alternatives Assessment. Non-highlighted actions were either evaluated at a cursory level or were deemed to be in-feasible given the project constraints.

In addition to providing infrastructure and maintenance costs, an attempt was made to estimate, for each alternative (including the "Do-Nothing" alternative), potential costs associated with flooding impacts (referred to as "indirect costs" in the cost spreadsheets for each alternative). This analysis was simplified by assuming the expected area of inundation due to flooding would be the same for each alternative and would be the result of a levee overtop rather than a levee failure. The levee overtop point was assumed to be the low point in the existing levee, located on the south levee between the Highway 1 and 22nd Street Bridges, with a total of 700 acres being flooded, consisting primarily of farmland. A simplified analysis of flood impacts is required in order to allow for direct comparison between alternatives.

3. Flood Reduction Alternatives Analysis

3.1. Existing Conditions – Setting

The existing flood control channel was completed in 1961 and consisted of approximately 3.5 miles of trapezoidal channel on the Arroyo Grande mainsteam and Los Berros Creek with an average width from levee edge to levee edge of approximately 70 feet. The proposed design included an estimated composite roughness of 0.035 with some vegetation proposed for the channel margins adjacent to the levees. Under the maintenance agreement carried out by San Luis Obispo County, sediment would be periodically removed from the channel to maintain the design capacity and geometry.

The need for constant dredging of the flood control channel to maintain design capacity is primarily rooted in two geomorphic principles that dictate sediment delivery and transport in the flood control reach. They include:

1. Much of the lower Arroyo Grande mainstem downstream of Lopez Dam consisted of broad floodplain characterized by an ephemeral active channel that migrated across the floodplain in response to sediment deposition and debris jams. The loss of the ability to migrate has resulted in excessive sediment deposition in the flood control reach. The flood control reach was historically part of a large lagoon complex. This complex was either actively filled when the area was developed, or filled as a result of excessive erosion in the upstream watershed.

2. The original design did not consider the concept of "bankfull" when sizing the flood control channel. Bankfull can be defined as the stage corresponding to the discharge at which channel maintenance is the most effective, that is, the discharge at which moving sediment, forming or removing bars, forming or changing bends and meanders, and generally doing work that results in the average morphologic characteristics of channels.

Field observations in the flood control reach, following an extended period of no dredging, suggest that a bankfull width of approximately 20-25 feet has developed in most areas (bankfull was difficult to evaluate in areas backwatered by beaver dams). The design bottom width of 60-70 feet resulted in excessive sediment deposition because flow was spread out, resulting in shallower water depths and less energy to move sediment (shear stress, a measure of the water's ability to do work, is a function of flow depth). Consequently, the geomorphic setting and design geometry are an important reason why there is a need to constantly remove sediment from the channel. Though there is only a limited amount of progress that could be made to improve upstream floodplain sedimentation (Item 1), enhancement and maintenance of bankfull and secondary channels could greatly improve sediment transport conditions in the flood control reach and reduce the need for constant maintenance of channel capacity (Item 2).

3.2. Existing Conditions - Results

The existing-conditions HEC-RAS model was used to evaluate the current channel capacity and to determine the locations where levee overtopping is likely to occur. The results of the existing-conditions HEC-RAS analysis determined that the channel will initially overtop the levee at river station 9068, between Highway 1 and the 22nd Street bridges (Figures 3.1, 3.1a and 3.2). Initial overtopping of the levees will occur under an estimated flow of 2,500 cfs, which offers 4.6 year protection. Using a 2-foot *freeboard* (distance from the water's surface to the lowest levee crest) criterion, the channel capacity under existing conditions is estimated to be 1,300 cfs, corresponding to a 2.8 year flow event.

Table 3.1: Arroyo Grande Creek discharge estimates from 1955, 1999, and current capacity studies.

	Composite Roughness	Estimated Discharge (in cfs)					
		Return Period (in years)					Calculated Level of Protection (w/2' freeboard)
		5 year	10 year	20 year	50 year	100 year	
1955* Study	0.035	NA	3,160	4,950	7,480	10,120	7,480
1999** Study	0.03	2,800	5,400	8,600	13,600	19,200	1,700
Current Study (2005)	0.057	2,800	5,400	8,600	13,600	19,200	1,300

* xxxxxxxxxx
** USAC 1999

A comparison of the hydrology of the flood control channel and associated level of flood protection is summarized in Table 3.1 for the 1955, 1999, and current studies, assuming a 2-foot freeboard criterion. Changes in current capacity of the Arroyo Grande Creek channel as compared

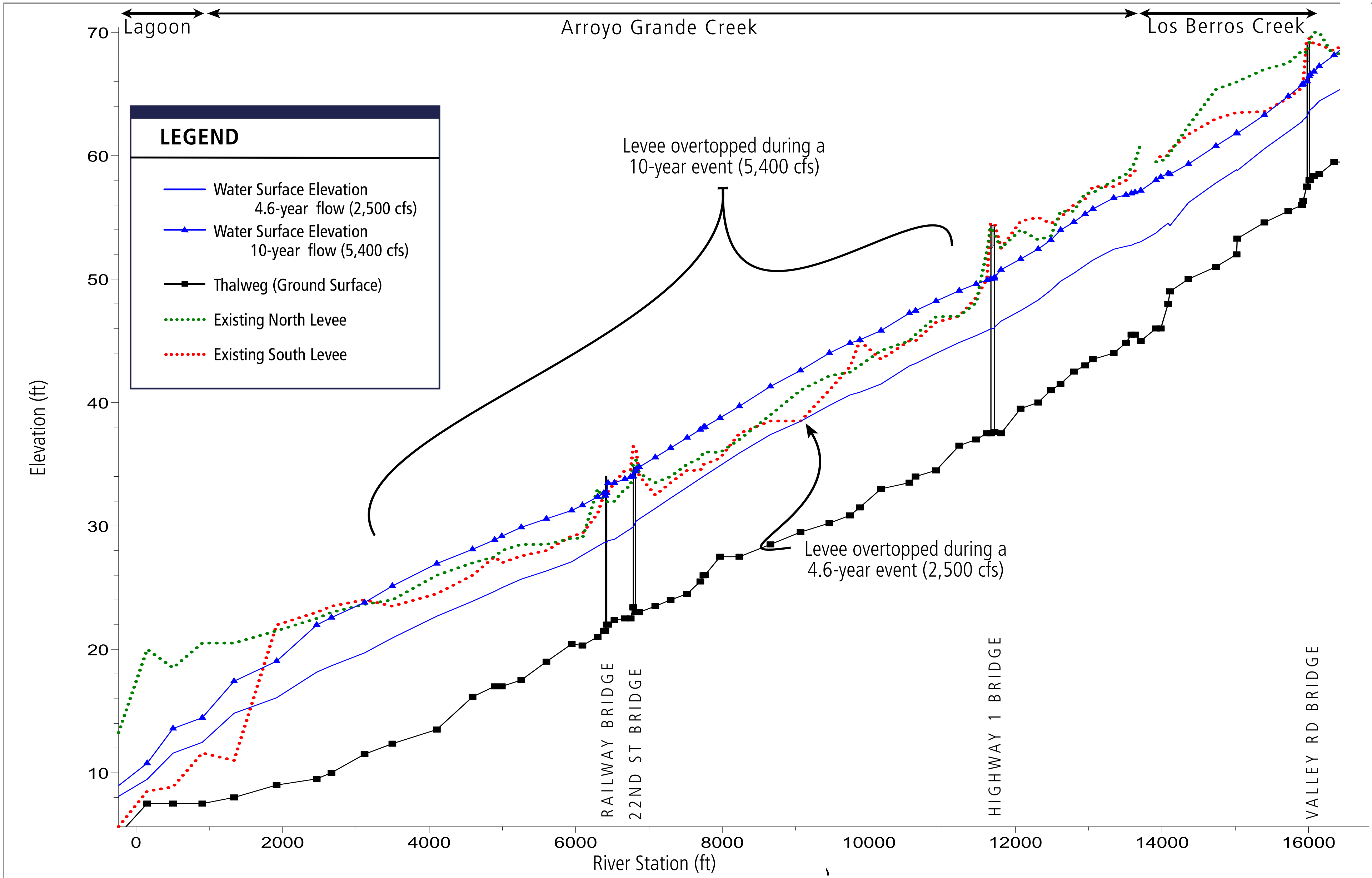

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FIGURE 3.1: Existing conditions water surface and levee profiles for the mainstem Arroyo Grande and Los Berros Creeks for the 5-year and 10-year event. Under existing conditions the levee is expected to overtop between the Highway 1 and 22nd Street Bridges in a 5-year event. Overtopping during a 10-year event would be widespread between Highway 1 and the lagoon.

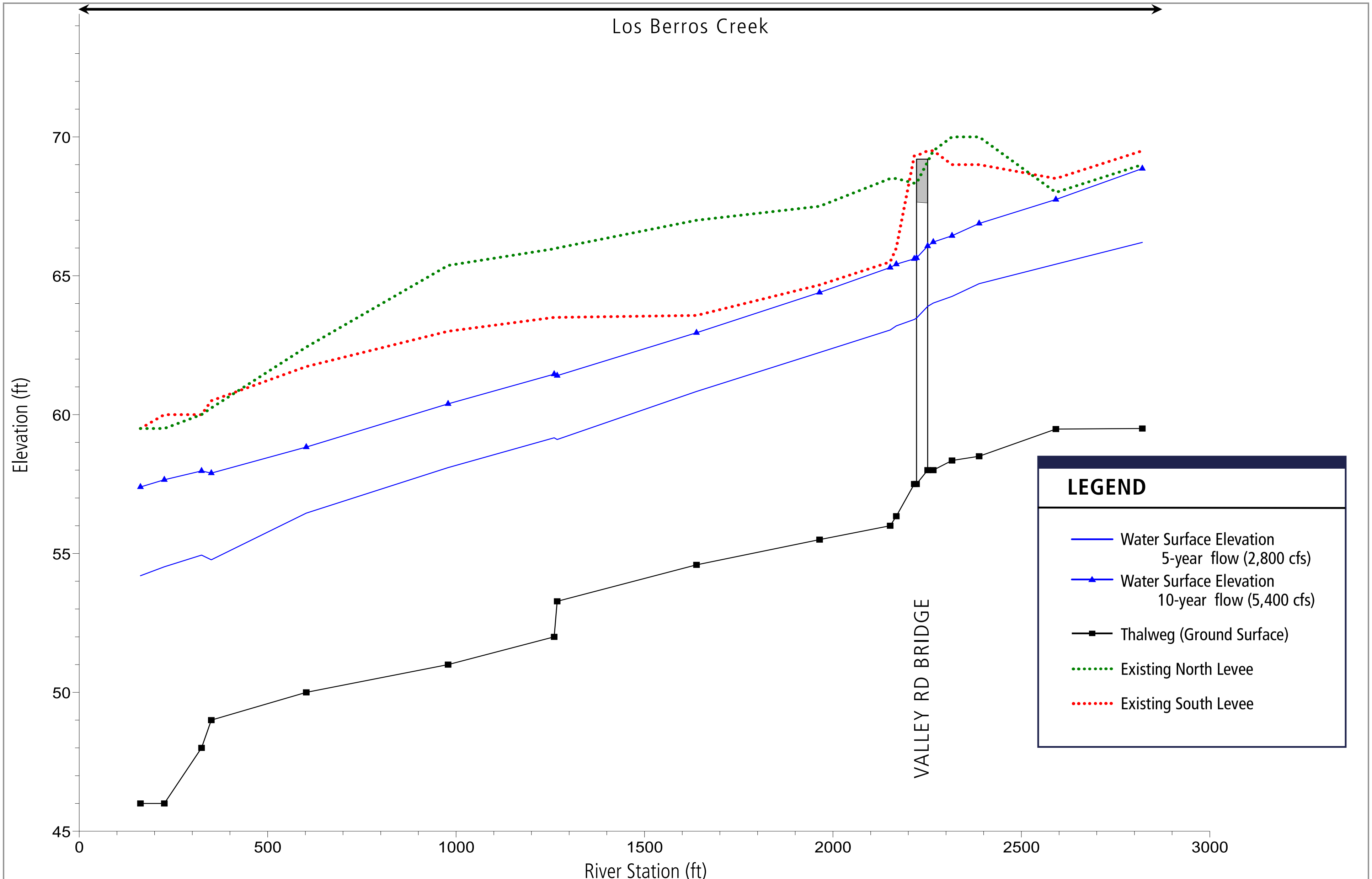

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FIGURE 3.1a: Existing conditions water surface and levee profiles for Los Berros Creek downstream of Valley Road for the 5-year and 10-year event. The Los Berros levees provide 10-year flood protection. A low point in the levee just downstream of Valley Road Bridge would be the likely overtop point at flows greater than the 10-year.

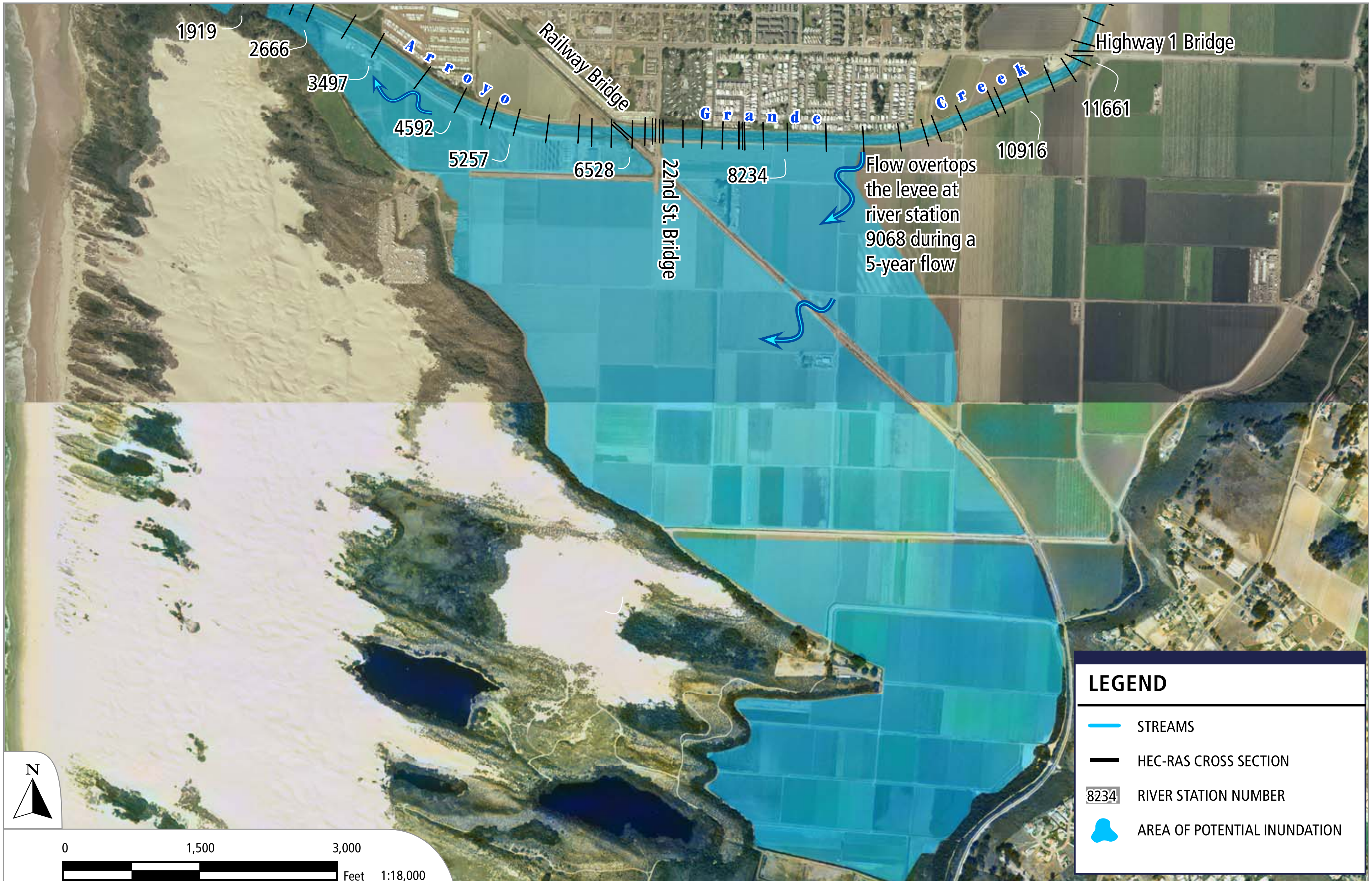

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FIGURE 3.2: Estimated area of flooding during a 5-year event assuming a levee overtop rather than a levee failure. Area of inundation was estimated to be approximately 700 acres. The area of inundation would differ under higher peak events or levee failure.

to the channel design proposed in 1955, and built in 1961, were postulated to be a result of the following factors:

- In 1955 the data used to estimate the 50 year design capacity flow were based on 14 years of stream flow records dating back to 1940 for the Arroyo Grande gage. Estimating a 50-year event with 14 years of data introduces considerable error. As the period of record lengthens (today we have approximately 64 years of data), the accuracy of predicting a 50-year recurrence increases,

- The hydrology of the watershed has been impacted by development which increases *impervious surfaces*. As a watershed urbanizes, it typically results in higher peak flows of shorter duration because the time it takes for the rain to run off of streets, sidewalks, and roofs is much shorter than the time it takes to run off, and be absorbed by, natural land (Anderson, 1970; Seaburn, 1969), and

- The channel does not have the same capacity it had in 1961 due to sediment accumulation and settlement along the levees.

3.3. Alternative 1 – Vegetation Management

3.3.1. Description

Alternative 1 considers vegetation management along the channel bed and banks to improve flood capacity by decreasing the *hydraulic roughness* of the channel (Figure 3.3). The vegetation management program would consist of maintaining a 10-foot riparian buffer on both sides of the low-flow channel to provide riparian habitat and streamside cover to protect aquatic habitat[7]. The riparian buffer would also act to maintain a bankfull channel that has developed over the last several years by providing root strength along the low flow channel margins. Vegetation outside of the buffer would be removed completely to allow for high flows to access secondary channels and provide for increased conveyance and flood capacity. Willows present within the buffer would be limbed up (only the lower limbs would be pruned) to reduce cross-sectional roughness but still provide adequate stream shading and riparian habitat. Cottonwood and sycamore trees present within the buffer would not be limbed up. Existing gaps in the riparian buffer would be revegetated with native riparian species including cottonwood, sycamore, and willow. In addition, cottonwood and sycamore will be planted at random along the length of the flood control channel to encourage long-term diversity in the riparian canopy.

[7] A hydraulic evaluation of a 15 foot vegetated buffer has been analyzed and is included in the discussion of Alternative 3c. The results show a slight, but less than significant decrease in flood conveyance.

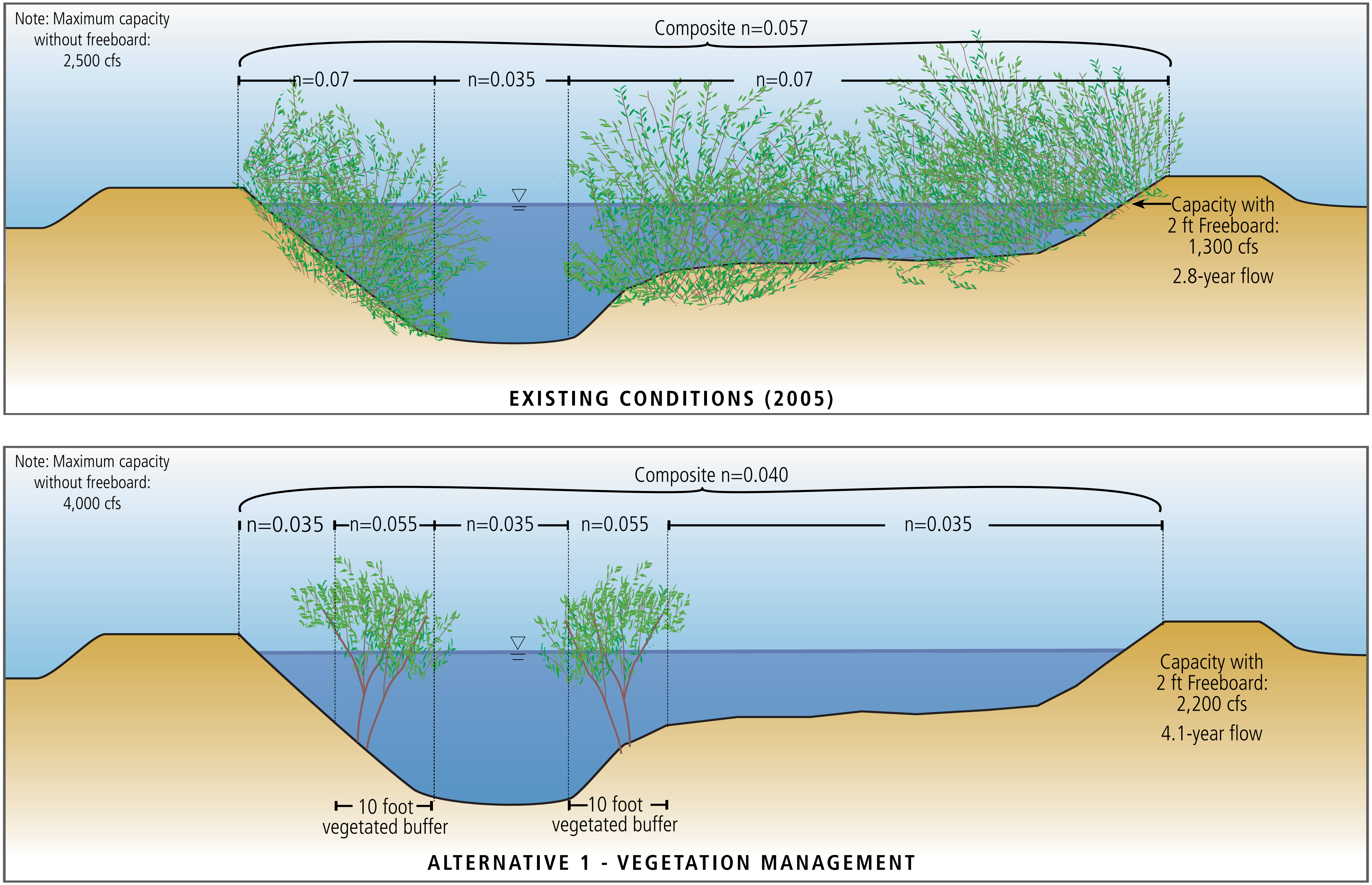

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FIGURE 3.3: Schematic diagram comparing existing conditions in 2005 and the Alternative 1 scenario (Vegetation Maintenance). This alternative increases the flood capacity of the channel from 1,300 cfs (2.8 year event) to 2,200 cfs (4.1 year event) by reducing the roughness of the channel. The roughness is reduced to a Manning's-n of 0.04 by managing vegetation in the channel.

Vegetation management would be conducted as often as necessary to maintain a roughness of 0.04 through an adaptive management approach that would include regular reconnaissance surveys, as well as site visits with regulatory agency staff as needed. Based on past experience, vegetation management would be repeated approximately every 1-3 years depending on the amount of re-growth. Based on past experience vegetation management would occur as late as possible in the summer and fall of each year to maximize stream shading during the warmer summer months. Vigorous regrowth of willow is expected in late winter and spring (Figure 3.4) providing low, overhanging vegetation during critical months for red-legged frog and steelhead rearing.[8]

3.3.2. Modeling Parameters / Assumptions

The HEC-RAS model developed for this alternative used the existing-conditions geometry with modified Manning's roughness values to represent vegetation management goals along the channel. A composite roughness value of 0.040 was used to simulate proposed channel roughness along all reaches of the channel, as shown in Figure 3.3.

3.3.3. Results / Discussion

The HEC-RAS model predicted that by implementing Alternative 1, channel capacity would be increased to 2,200 cfs (4.1 year event), with 2 feet of freeboard, and a capacity of 4,000 cfs (7.3 year event) with no freeboard. Under the Alternative 1 scenario, the levee is still overtopped between the Highway 1 and 22nd Street Bridges. Vegetation management alone has the potential to increase the existing conditions channel capacity by 900 cfs, with 2 feet of freeboard, and by 1,500 cfs with no freeboard.

3.3.4. Engineering Design / Implementation Cost Estimates

Vegetation management activities during the first year would be more extensive than in subsequent years due to the current density of vegetation in the channel. In addition, first year management would also focus on revegetating existing gaps in the riparian canopy and would include random planting of preferred riparian species such as cottonwood and sycamore. A total of 12 acres of existing riparian would be affected by the maintenance activities. To estimate an expected cost of vegetation management along the flood control reach, costs associated with vegetation and sediment management along the San Lorenzo River in Santa Cruz, California, and vegetation management activities completed on Arroyo Grande Creek in late-summer 2005, were considered.

[8]Existing biological conditions have been analyzed as part of a biological assessment for the selected alternative. The analysis suggests that the flood control reach lacks breeding habitat for red-legged frog and is therefore primarily habitat for rearing.

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FIGURE 3.4: Views of Arroyo Grande flood control channel looking upstream of 22nd Street Bridge. The three photos show the vegetation management sequence from Fall of 2004 before maintenance (A), after maintenance (B), and the level of regrowth over spring and summer 2005 (C).

Known costs for the San Lorenzo River and Arroyo Grande Creek vegetation management programs were converted to a per acre cost to estimate the yearly maintenance cost for the Arroyo Grande Creek flood control channel. Costs associated with vegetation management along the flood control reach were estimated at approximately $108,000 per year with a 10-year cost of approximately $1,360,000, assuming an annual inflation rate of 4% (Table 3.2). The estimated cost includes labor, as well as administration, permitting, and a contingency. The 10-year cost assumes that this alternative will require maintenance every year to achieve a roughness of approximately 0.04. The cost of vegetation management in Years 1-9 were assumed to be less than the Year 1 since achieving a roughness of 0.04 will require less labor. It is possible that maintenance could occur bi-annually without compromising hydraulic performance. However, unit costs of clearing would increase in proportion to the increased density and size of second-year vegetation.

Indirect costs associated with flood impacts beyond the expected level of protection provided by this alternative were calculated. The levee overtop scenario, assuming no freeboard, was used to calculate the expected frequency of flooding in farmland located to the south of the levee with an overtop point located approximately halfway between the Highway 1 and 22nd Street Bridges. A total of 700 acres was assumed to flood every 7.3 years. The estimated cost of crop loss and clean up was assumed to be $8,000 per acre. Based on these assumptions, the estimated 10-year indirect costs due to flooding beyond the protection level provided by Alternative 1 was calculated to be $11,400,000, assuming an annual inflation rate of 4% (Table 3.2).

3.4. Alternative 2 – Vegetation and Sediment Management

3.4.1. Description

Alternative 2 consists of adding sediment removal to the vegetation maintenance program outlined in Alternative 1. The first year of the sediment removal program includes removal of sediment on the levee side of the 10 foot riparian buffers established in Alternative 1. Sediment would be removed to depths of 1.5-feet above the bed of the Arroyo Grande Creek channel and 1-foot above the Los Berros Creek channel (Figure 3.5). These depths were estimated as the appropriate bankfull depth for the channel. The overflow channels will be excavated so as to mimic conditions found in natural river systems characterized by primary and secondary channels. In natural systems, the primary channel contains usual low flows throughout most of the year, whereas the secondary channel becomes activated during higher flows that, on average, occur once a year. The Arroyo Grande Creek flood control channel currently lacks the secondary channels that are found in more natural, low gradient stream environments. Under Alternative 2, the secondary, or overflow channels, will be excavated into areas in the channel that have accumulated excess sediment in bars and terraces and reduced flood capacity through the flood control reach. At strategic locations along the flood control reach, the excavated secondary channels will be connected with the primary channels to allow for complex flow conditions that will encourage scour and sediment transport, and reduce the need for future sediment removal.

ALTERNATIVE 1 - VEGETATION MANAGEMENT

ESTIMATED INFRASTRUCTURE COST

ITEM	UNIT	COST/UNIT	# UNITS	YEARS	INFLATION	TOTAL COST
1ST YEAR VEGETATION MANAGEMENT	AC	$7,500	11.56	1	--	$ 86,700
					SUBTOTAL	$ 86,700
				CONTINGENCY	20%	$ 17,340
				ADMINISTRATION AND PERMITTING	4%	$ 3,468
					TOTAL INFRASTRUCTURE COST	**$ 107,508**

10-YEAR ESTIMATED MAINTENANCE COST

ITEM	UNIT	COST/UNIT	# UNITS	YEARS	INFLATION	TOTAL COST
YEARLY VEGETATION MANAGEMENT	YR	$80,000	1	9	4%	$ 1,024,785
					SUBTOTAL	$ 1,024,785
				CONTINGENCY	20%	$ 204,957
				ADMINISTRATION AND PERMITTING	2%	$ 20,496
					TOTAL 10 YEAR MAINTENANCE COST	**$ 1,250,237**
					TOTAL 10 YEAR COST	**$ 1,357,745**

ESTIMATED INDIRECT COST DUE TO FLOODING

ITEM	UNIT	COST/UNIT	# UNITS	YEARS	INFLATION	**TOTAL COST**
FARMLAND INUNDATION (700 AC EVERY 7.3 YEARS)	AC/YR[1]	$8,000	96	10	4%	**$ 11,368,276**

[1] UNITS CALCULATED BY 700 ACRES / 7.3 YEARS

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TABLE 3.2: Estimated costs for Alternative 1 - Vegetation Maintenance. Costs are presented separately for infrastructure upgrades and maintenance. The total cost of the project over 10 years is also presented as a way to compare costs between alternatives to assist in selecting a preferred alternative.

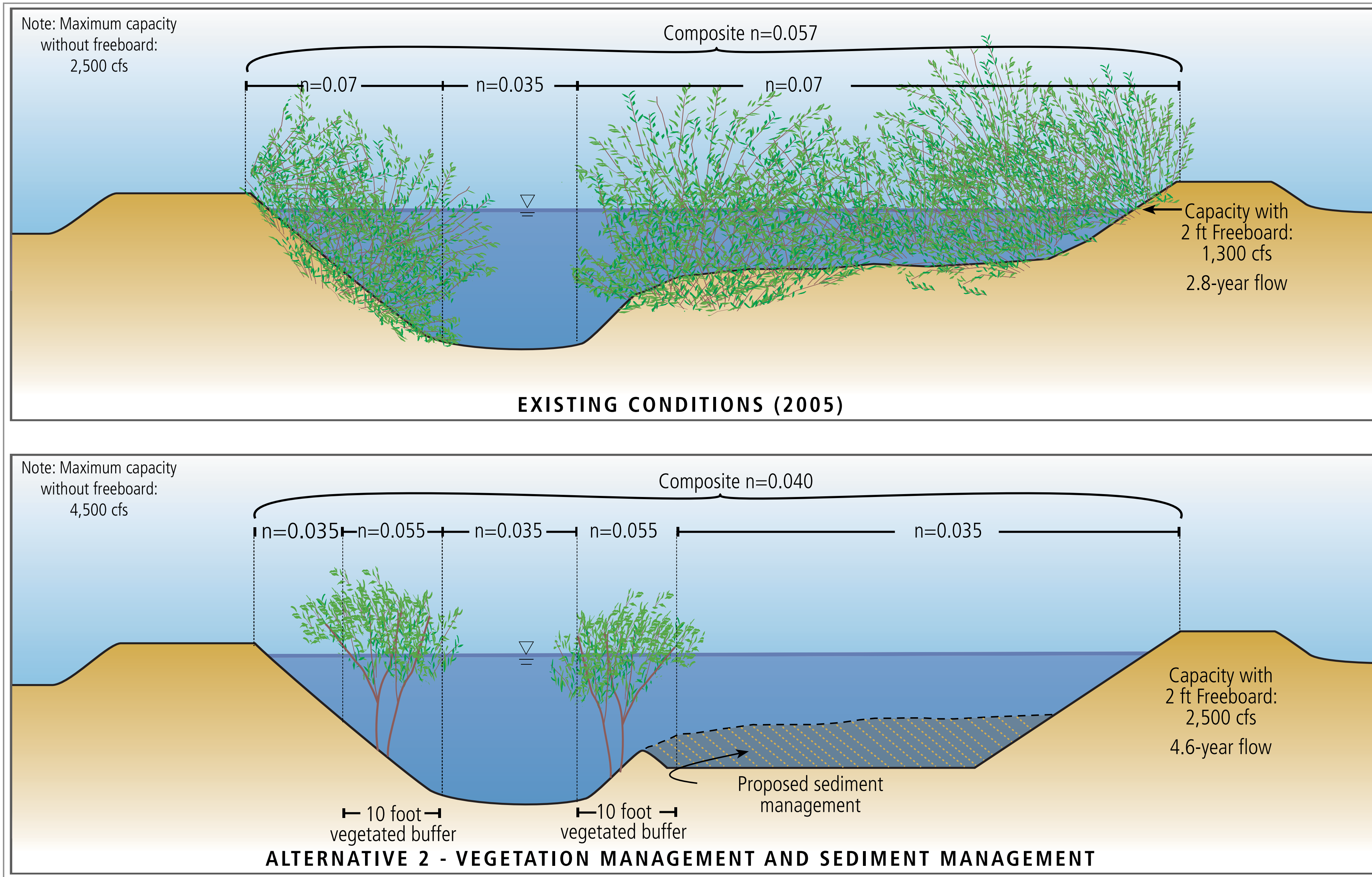

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FIGURE 3.5: Schematic diagram comparing existing conditions in 2005 and the Alternative 2 scenario (Vegetation and Sediment Maintenance). This alternative increases the flood capacity of the channel from 1,300 cfs (2.8 year event) to 2,500 cfs (4.6 year event) by reducing roughness and increasing channel capacity. Overflow channels would be established and maintained that would mimic bankfull and secondary channel conditions observed in natural systems.

Additionally, large woody debris (LWD) will be placed at strategic locations to protect the head of channel bars, promote pool scour, encourage sediment sorting, and provide cover habitat for steelhead and red-legged frog (Figure 3.6).

Some maintenance of the secondary channels is expected over the long-term. Annual cross-section monitoring will assess the performance of the channel in moving supplied sediment. The monitoring data will also provide information on the need to do spot removal of accumulated sediment to ensure that the project passes target flood flows. Annual maintenance will also be a component of the overall vegetation and sediment management program. Maintenance of the overflow channel will consist of "bar ripping", which breaks up roots and other debris to promote sediment transport to flush the channel during high flows. A similar program has been successfully implemented on the San Lorenzo River in Santa Cruz County despite concerns about steelhead, Coho salmon, and red-legged frogs (SH+G et al. 2002). The objective of the annual maintenance program is to keep the secondary channels open for flood flows. Vegetation maintenance alone would be unable to accomplish that goal since roots and debris would still persist.

3.4.2. Modeling Parameters / Assumptions

The HEC-RAS model developed for this alternative used the same Manning's roughness values as Alternative 1 (n=0.04), but with modified cross section geometry reflecting excavation of overflow channels, as shown in Figure 3.5. Alternative 2 assumes that bar ripping and spot removal of sediments will occur in subsequent years, as necessary to maintain channel capacity.

3.4.3. Results / Discussion

The results of the HEC-RAS modeling for Alternative 2 show that by implementing these measures the channel can have a capacity of 2,500 cfs (4.6 year event) with 2-feet of freeboard, and a capacity of 4,500 cfs (8.3 year event) with no freeboard. Alternative 2 has the ability to increase the existing channel capacity by 1,200 cfs with 2-feet of freeboard and by 2,000 cfs with no freeboard, as shown in Figure 3.5.

3.4.4. Engineering Design / Implementation Cost Estimates

Increasing the channel capacity and creation of secondary channels along Arroyo Grande Creek and Los Berros Creek would require removal of approximately 23,000 cubic yards (CY) of sediment from the channel in the first year. The total Year 1 cost for Alternative 2 was estimated to be approximately $810,000 (Table 3.3). In subsequent years, sediment management activities would be limited to "bar ripping" along the secondary channels. The frequency with which bar ripping would occur will be based on annual monitoring of the channel to assess deposition from past years and the extent to which bed armoring has occurred. Similar activities on the San

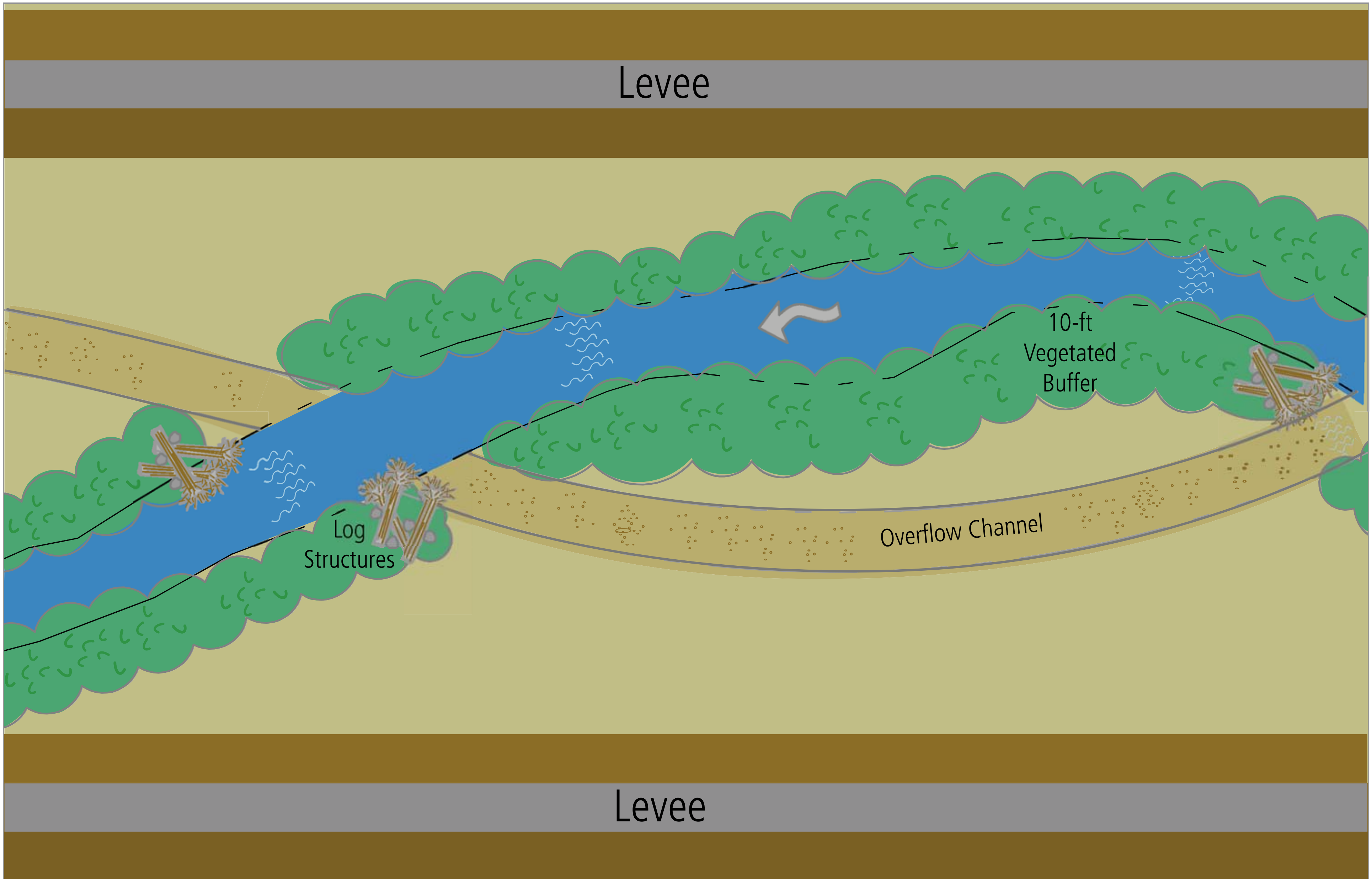

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FIGURE 3.6: Conceptual diagram of Alternative 2 showing primary and secondary channels following initial sediment management activities. The bottom of the secondary channel would be placed at the bankfull elevation to maintain the stability of the primary channel and provide an overflow channel under high flow conditions. Aquatic habitat enhancement elements, consisting primarily of engineered log structures (LWD), would be placed in strategic locations to encourage pool development and sediment sorting to improve conditions for steelhead.

ALTERNATIVE 2 - VEGETATION MANAGEMENT AND SEDIMENT MANAGEMENT

INFRASTRUCTURE COST

ITEM	UNIT	COST/UNIT	# UNITS	YEARS	INFLATION	TOTAL COST
1ST YEAR VEGETATION MANAGEMENT	ACRES	$7,500	11.56	1	--	$ 86,700
1ST YEAR SEDIMENT MANAGEMENT	CY	$20	22,626	1	--	$ 452,520
HABITAT ENHANCEMENT (LOG STRUCTURES)	EA	$2,500	20	1	--	$50,000
					SUBTOTAL	$589,220
				CONTINGENCY	20%	$117,844
				ADMINISTRATION AND PERMITTING	3%	$17,677
				ENGINEERING AND DESIGN	13%	$80,647
				TOTAL INFRASTRUCTURE COST		**$805,388**

10-YEAR ESTIMATED MAINTENANCE COST

ITEM	UNIT	COST/UNIT	# UNITS	YEARS	INFLATION	TOTAL COST
YEARLY VEG. MANAGEMENT	YR	$80,000	1	9	4%	$ 1,024,785
YEARLY SEDIMENT MANAGEMENT	YR	$140,000	1	9	4%	$ 1,793,373
					SUBTOTAL	$ 2,818,157
				CONTINGENCY	20%	$ 563,631
				ADMINISTRATION AND PERMITTING	3%	$ 84,545
				TOTAL 10 YEAR MAINTENANCE COST		**$ 3,466,334**
				TOTAL 10 YEAR COST		**$4,271,722**

ESTIMATED INDIRECT COST DUE TO FLOODING

ITEM	UNIT	COST/UNIT	# UNITS	YEARS	INFLATION	**TOTAL COST**
FARMLAND INUNDATION (700 ACRES EVERY 8.3YEARS)	ACRES/YR[1]	$8,000	84	10	4%	**$ 9,947,242**

[1] UNITS CALCULATED AS 700 ACRES / 8.3 YEARS

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TABLE 3.3: Estimated costs for Alternative 2 - Vegetation and Sediment Maintenance. Costs are presented separately for infrastructure upgrades and maintenance. The total cost of the project over 10 years is also presented as a way to compare costs between alternatives to assist in selecting a preferred alternative.

Lorenzo River in Santa Cruz, California have been successful in maintaining bed mobility while protecting habitat conditions and water quality. Costs associated with vegetation maintenance and bar ripping along the San Lorenzo River were incorporated on a per linear foot basis to estimate the yearly maintenance cost for the Arroyo Grande Creek channel. The 10-year cost assumes that bar ripping and vegetation maintenance will occur annually. The anticipated 10-year cost for Alternative 2 is estimated at $4,300,000 considering an annual inflation rate of 4% (Table 3.3). Costs for Year 2 through Year 10 will be less than the initial year because vegetation will be thinner and the channel will only require "bar ripping" and spot removal.

Indirect costs associated with flood impacts beyond the expected level of protection provided by this alternative were calculated. The levee overtop scenario, assuming no freeboard, was used to calculate the expected frequency of flooding in farmland located to the south of the levee with an overtop point located approximately halfway between the Highway 1 and 22nd Street Bridges. Under Alternative 2 a total of 700 acres would flood every 8.3 years or approximately 84 acres per year. The cost of crop loss and clean up was estimated at $8,000 per acre. Based on these assumptions, the estimated 10-year indirect cost due to flooding beyond the protection level provided by Alternative 1 was calculated to be $9,900,000 considering an annual inflation rate of 4% (Table 3.3).

3.5. Alternative 3 – Vegetation and Sediment Removal w/ Levee Raise Alternatives

3.5.1. Description

Alternative 3 raises the existing levees to increase channel capacity. Alternative 3 assumes implementation and maintenance of Alternatives 1 and 2. The existing levees will be raised while maintaining a 2h:1v slope on the levee sides and providing a minimum top width of 15-feet. To maintain a 2:1 levee side slope under a raised levee condition, the bottom width of the levee will increase, resulting in the potential loss of some farmland or adjustments to existing farm access roads. In addition, some areas along the north levee may require construction of retaining walls to accommodate a higher levee without impinging on existing infrastructure. In all levee raise alternatives, the north levee is raised approximately 4 inches above the south levee to provide additional protection to residential areas, as compared to the south levee, which is dominated by agriculture.

Alternative 3 is broken up into three potential options that differ by the extent to which the height of the levee is raised. Alternative 3a raises low spots in the levees in order to eliminate "high risk" locations where overtopping is likely to occur first. This alternative maintains 2-feet of freeboard above the 10-year flood event of 5,400 cfs. The average levee raise under Alternative 3a is 1.3 feet with a maximum raise of 2.4 feet. Alternative 3b raises the levees above the 15-year water surface to provide a channel capacity of 7,000 cfs, with 2-feet of freeboard. The average levee raise under Alternative 3b is 2.4 feet with a maximum raise of 3.8 feet. Alternative

3c raises the levees above the 20-year water surface to provide a channel capacity of 8,600 cfs, with 2-feet of freeboard. The average levee raise under Alternative 3c is 2.8 feet with a maximum raise of 4.4 feet.

The height of the levee raise under Alternatives 3b and 3c would potentially exacerbate debris build-up on the upstream side of the Union Pacific Railroad Bridge (UPRR). At the peak of the 2001 flood, prior to the levee failure, water and debris reached the deck elevation of the Bridge (Figure 3.7). To reduce the potential for failure of the UPRR Bridge, Alternative 3b and 3c were modeled assuming the UPRR Bridge will be raised to move the low chord of the Bridge above the 50-year water surface elevation. Union Pacific requires a 50-year water surface elevation for all of its bridges.

3.5.2. Modeling Parameters / Assumptions

The HEC-RAS model developed for Alternative 2 was also used to analyze Alternative 3 with the exception of the revised bridge geometry at the UPRR Bridge. The water surfaces generated with the Alternative 2 model were used to determine how high the levees would need to be raised in order to provide the required flood protection. Alternatives 3a, 3b, and 3c used the 10-year, 15-year, and 20-year water surfaces, respectively, to determine the required levee raises.

3.5.3. Results / Discussion

Alternative 3a raises the levees along Arroyo Grande Creek from approximately river station 3,300 through river station 11,400, just downstream of the Highway 1 Bridge (Figure 3.8). A short length of levee along Los Berros Creek, just downstream of the Valley Road Bridge would also be raised under this scenario (Figure 3.9). Approximately 12,000 cubic yards of fill material will be required to provide 10-year flood protection with 2-feet of freeboard. The channel capacity with no freeboard would be approximately 7,500 cfs and provide 16.6- year flood protection (Figure 3.10).

Alternative 3b raises the levees along Arroyo Grande Creek from river station 2,500 through river station 11,500, just downstream of the Highway 1 Bridge (Figure 3.11). A levee raise would also be required along approximately 2,300 linear feet of the south levee and 400 linear feet of the north levee of Los Berros Creek (Figure 3.12). 15-year flood protection with 2-feet of freeboard will require approximately 44,000 cubic yards of fill. The channel capacity with no freeboard would be approximately 9,000 cfs and provide 22.4-year flood protection (Figure 3.13).

Alternative 3c raises the levees along Arroyo Grande Creek from river station 2,000 through river station 14,000, providing protection against the 20-year flood of 8,600 cfs (Figure 3.14). A levee raise would also be required along approximately 2,300 linear feet of the south levee and 600

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FIGURE 3.7: Debris and drift accumulation upstream of the Union Pacific Railroad Bridge during the March 2001 flood. This photo illustrates the need to modify, raise, or strengthen this bridge if an alternative that recommends levee raising is pursued (e.g. - Alternatives 3b and 3c). If the levees are raised without modifications to this bridge, water would inundate the bridge with the potential for failure.

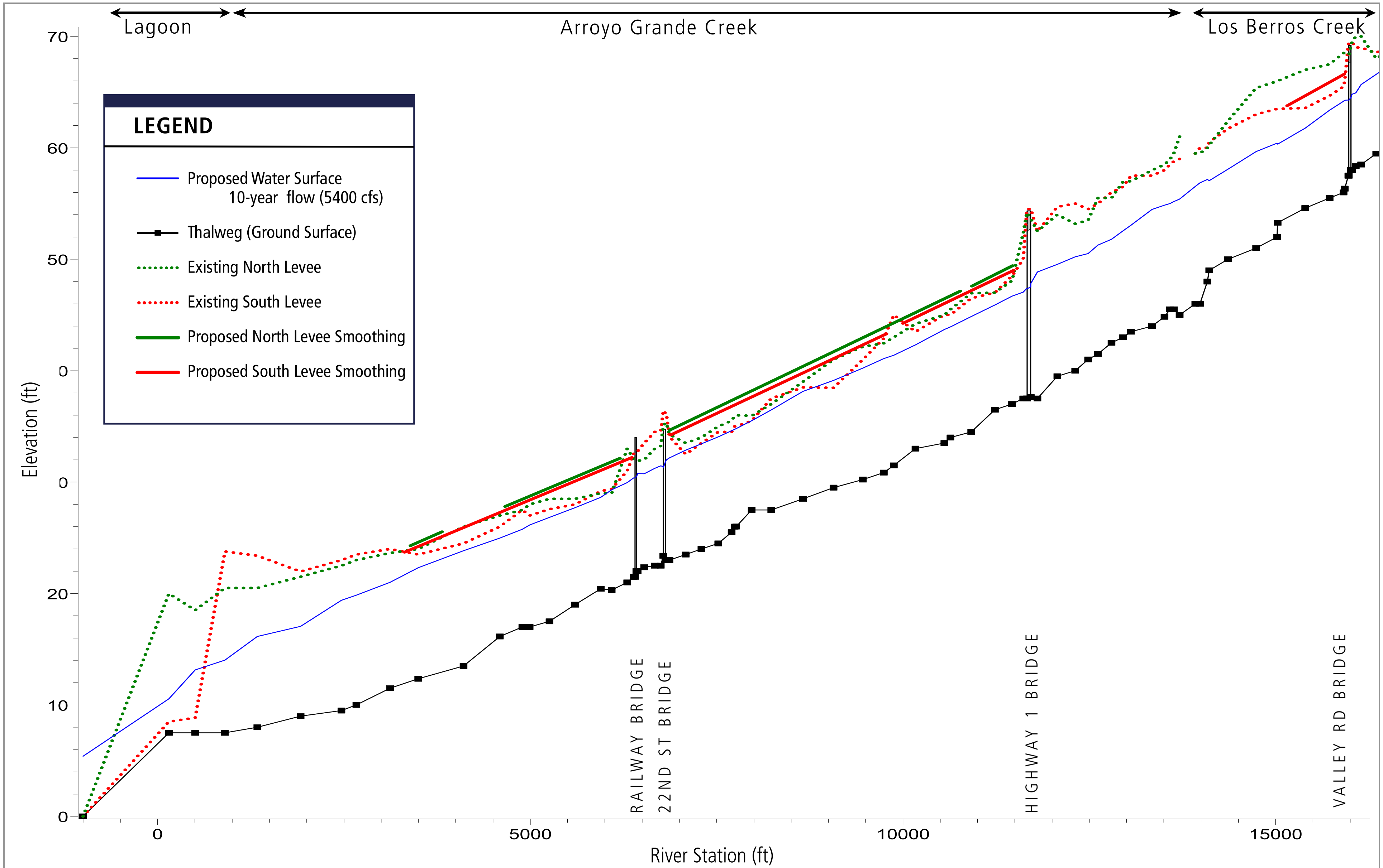

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FIGURE 3.8: Water surface and levee profiles for the mainstem Arroyo Grande and Los Berros for Alternative 3a - Levee Smoothing. Proposed levee smoothing locations are shown for the north and south levee separately. Portions of the north and south levees will be raised an average of 1.25 feet to achieve 10-year protection with 2 feet of freeboard.

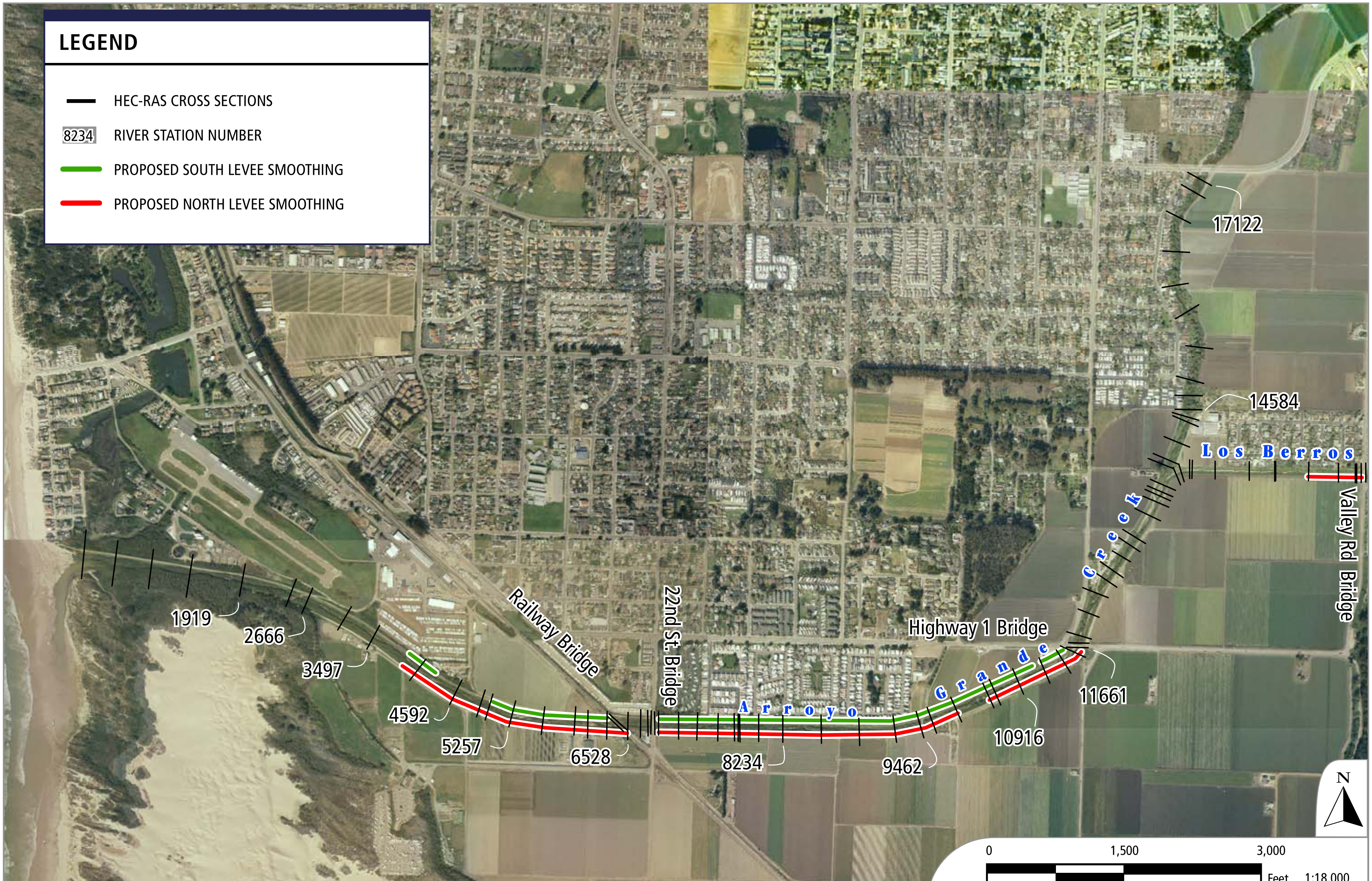

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FIGURE 3.9: Plan view of levee raise locations for Alternative 3a - Levee Smoothing. Under the levee raise alternatives, the north levee is raised approximately 4-inches above the south levee to provide additional protection to residential areas as compared to the south levee which is dominated by agricultural land uses.

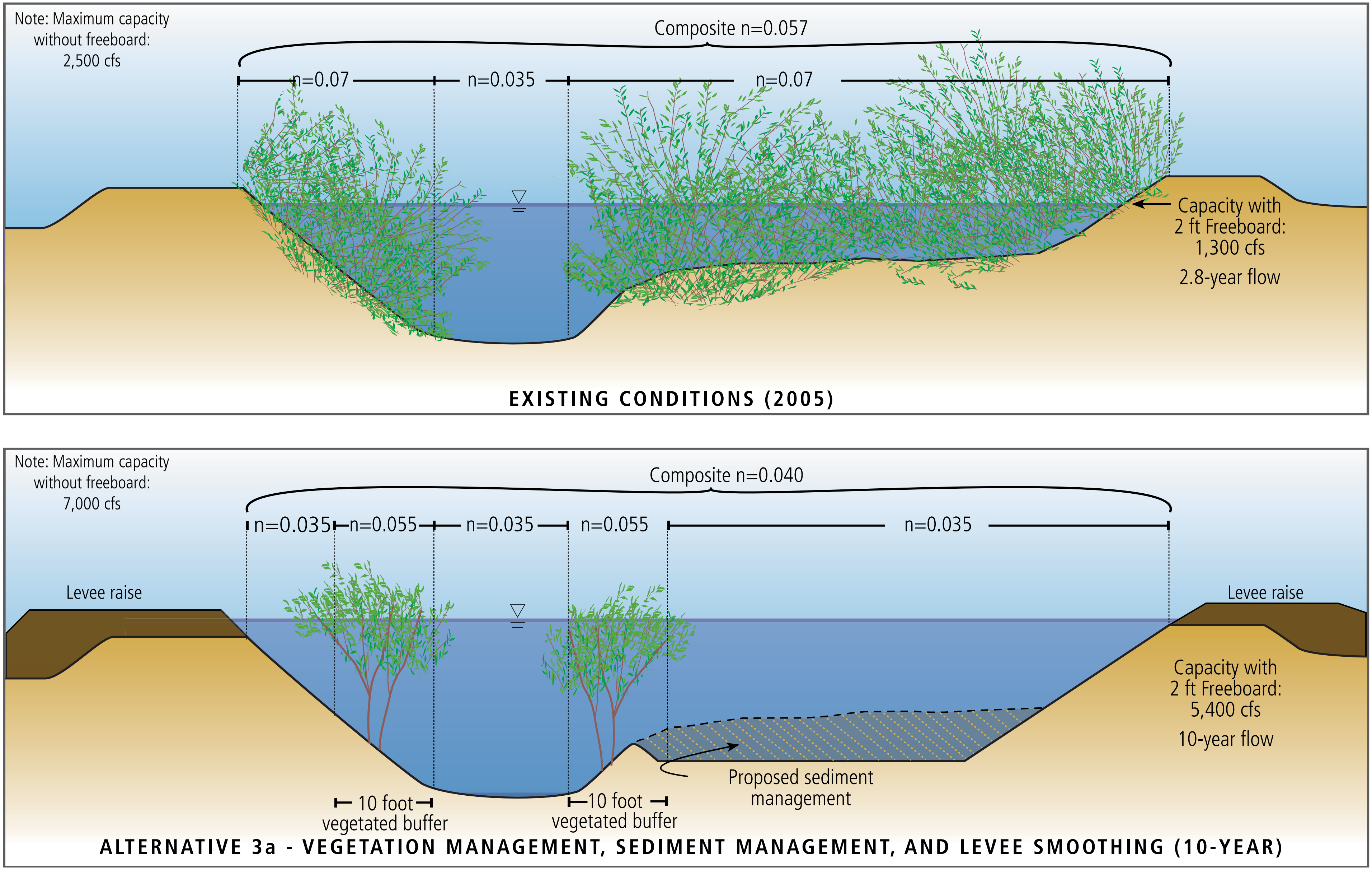

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FIGURE 3.10: Schematic diagram comparing existing conditions in 2005 and the Alternative 3a scenario (Levee Smoothing). This alternative increases the flood capacity of the channel from 1,300 cfs (2.8 year event) to 5,400 cfs (10-year event) by raising portions of the levee. Some areas are raised more than others due to past settlement or slumping associated with erosion and vehicle traffic.

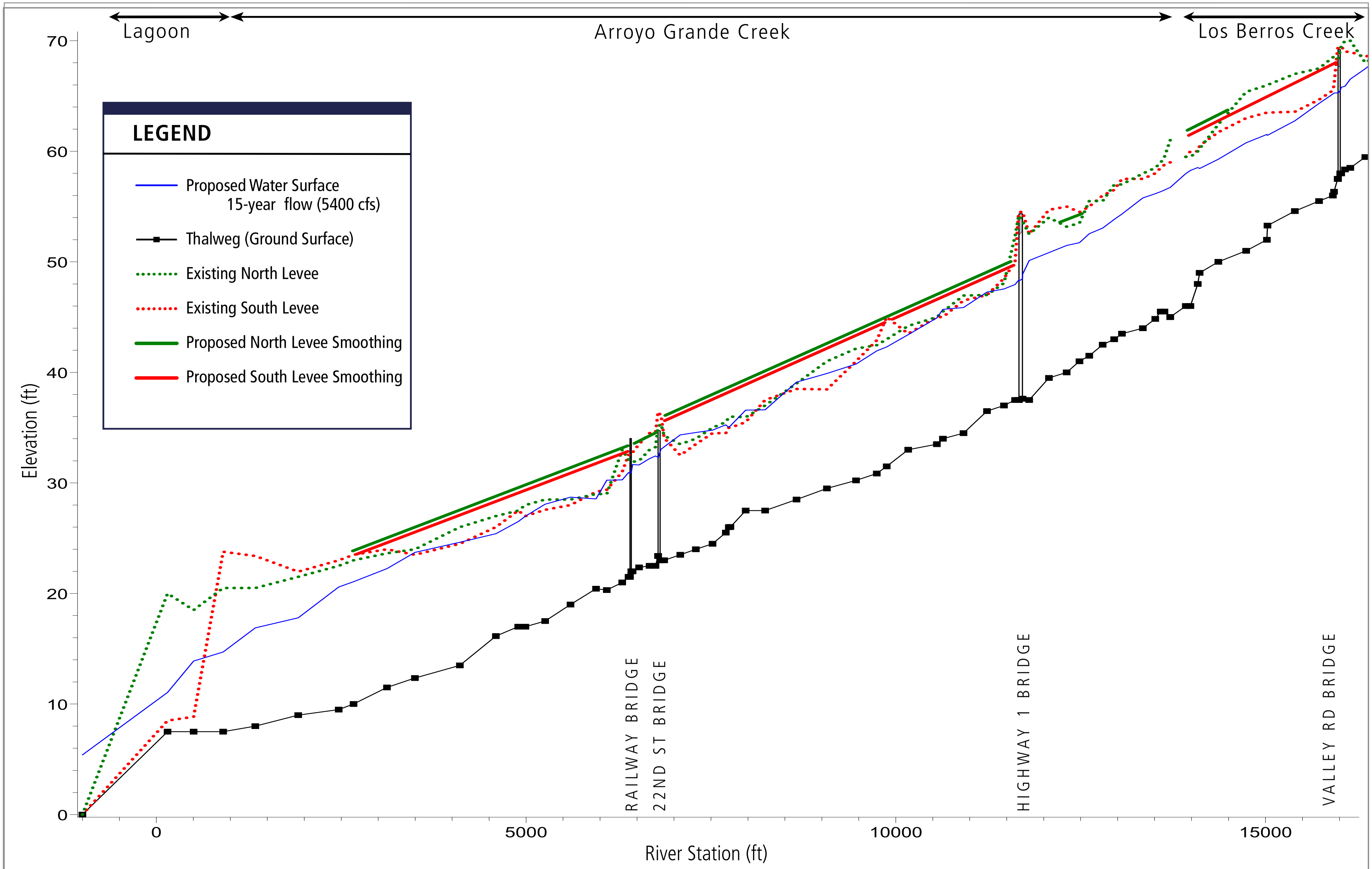

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FIGURE 3.11: Water surface and levee profiles for the mainstem Arroyo Grande and Los Berros Creeks for Alternative 3b - Levee Raise (15-year protection). Proposed levee smoothing locations are shown for the north and south levee separately. Portions of the north and south levees will be raised an average of 2.42 feet to achieve 15-year protection with 2 feet of freeboard.

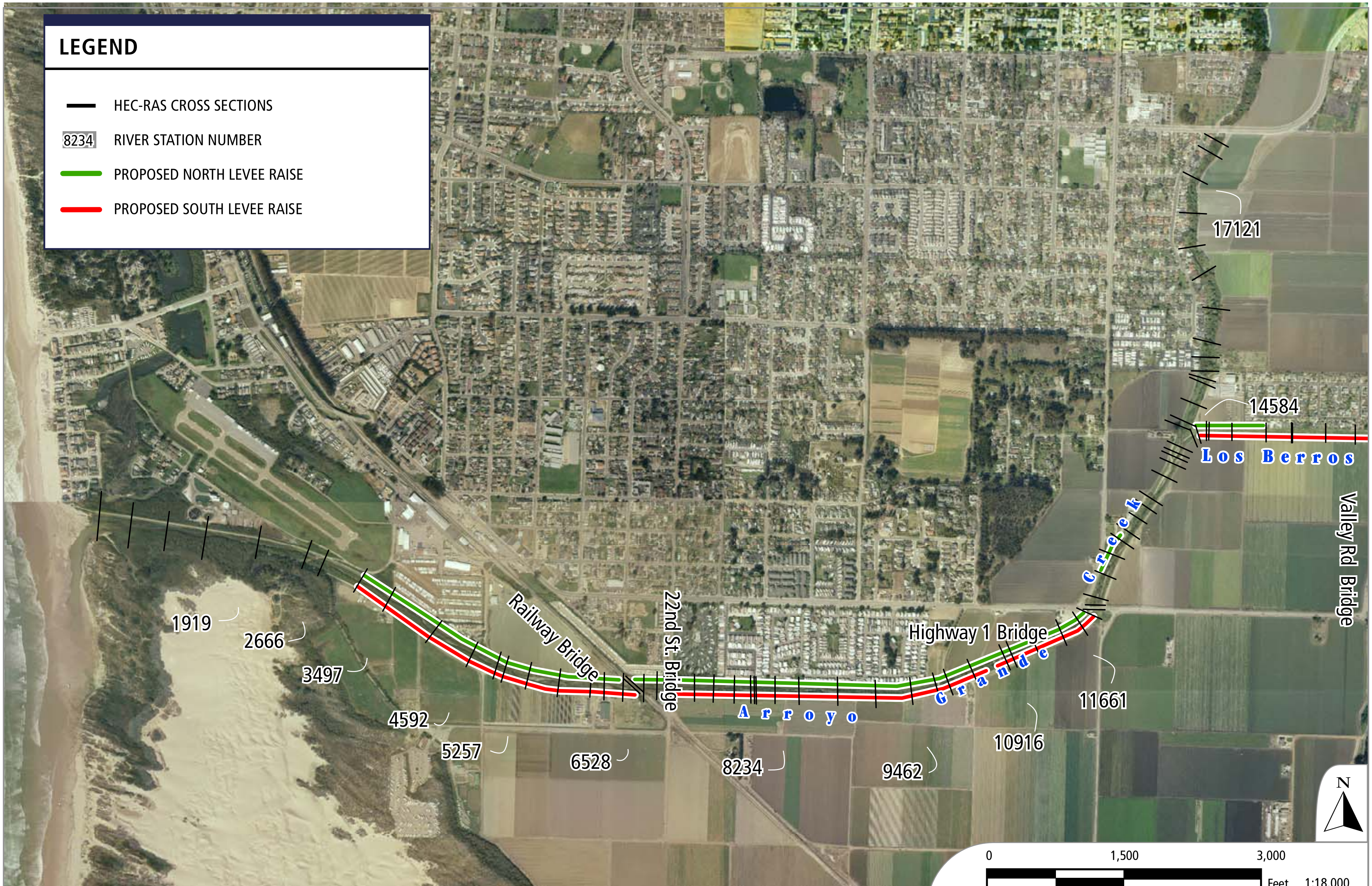

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FIGURE 3.12: Plan view of levee raise locations for Alternative 3b - Levee Raise (15-year protection). Under this alternative, levee raising occurs from the Highway 1 Bridge downstream to the airport on the mainstem Arroyo Grande with a portion of the Los Berros levee raised.

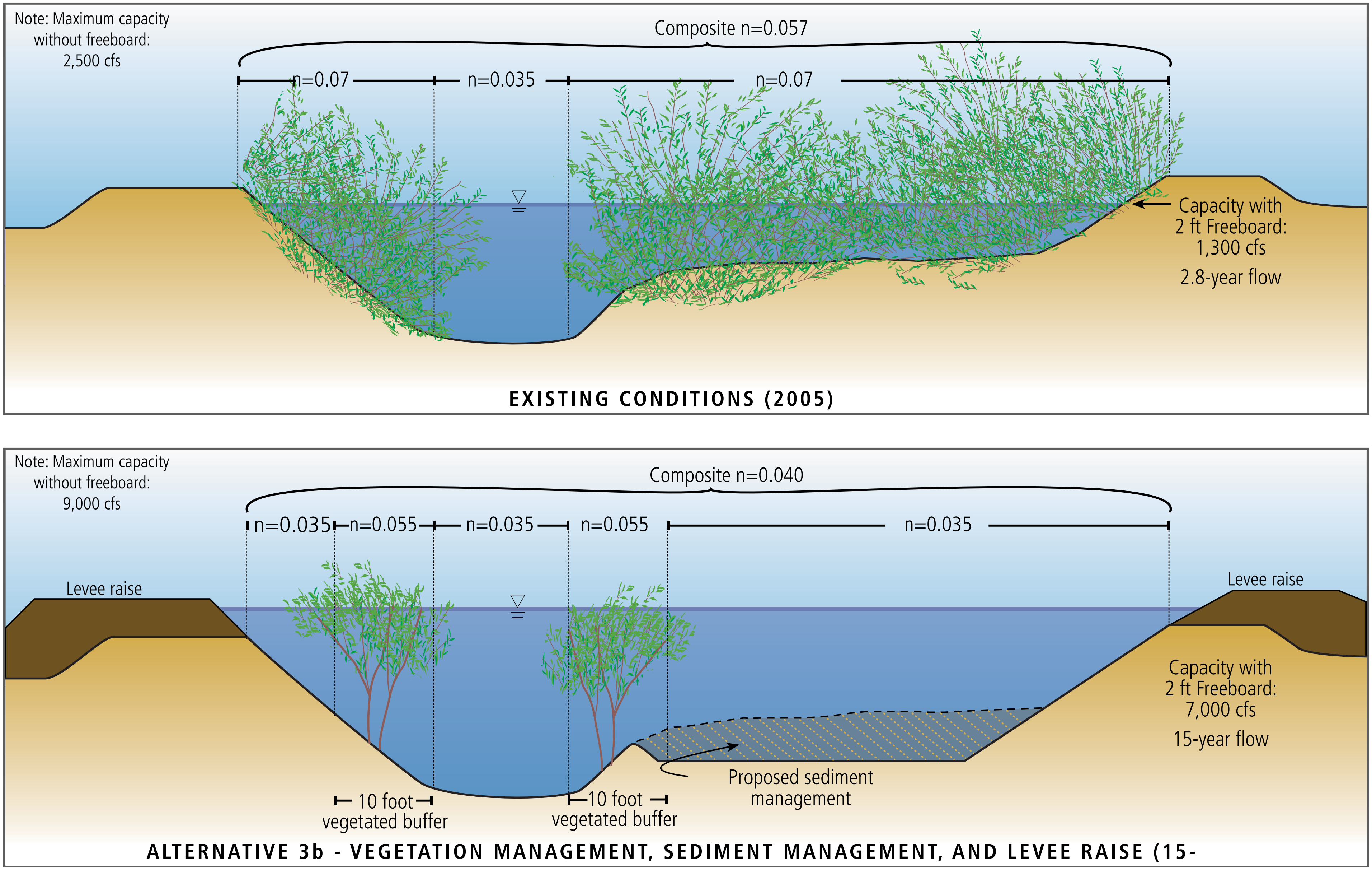

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FIGURE 3.13: Schematic diagram comparing existing conditions in 2005 and the Alternative 3b scenario (Levee Raise - 15-year protection). This alternative increases the flood capacity of the channel from 1,300 cfs (2.8 year event) to 7,000 cfs (15-year event) by raising portions of the levee.

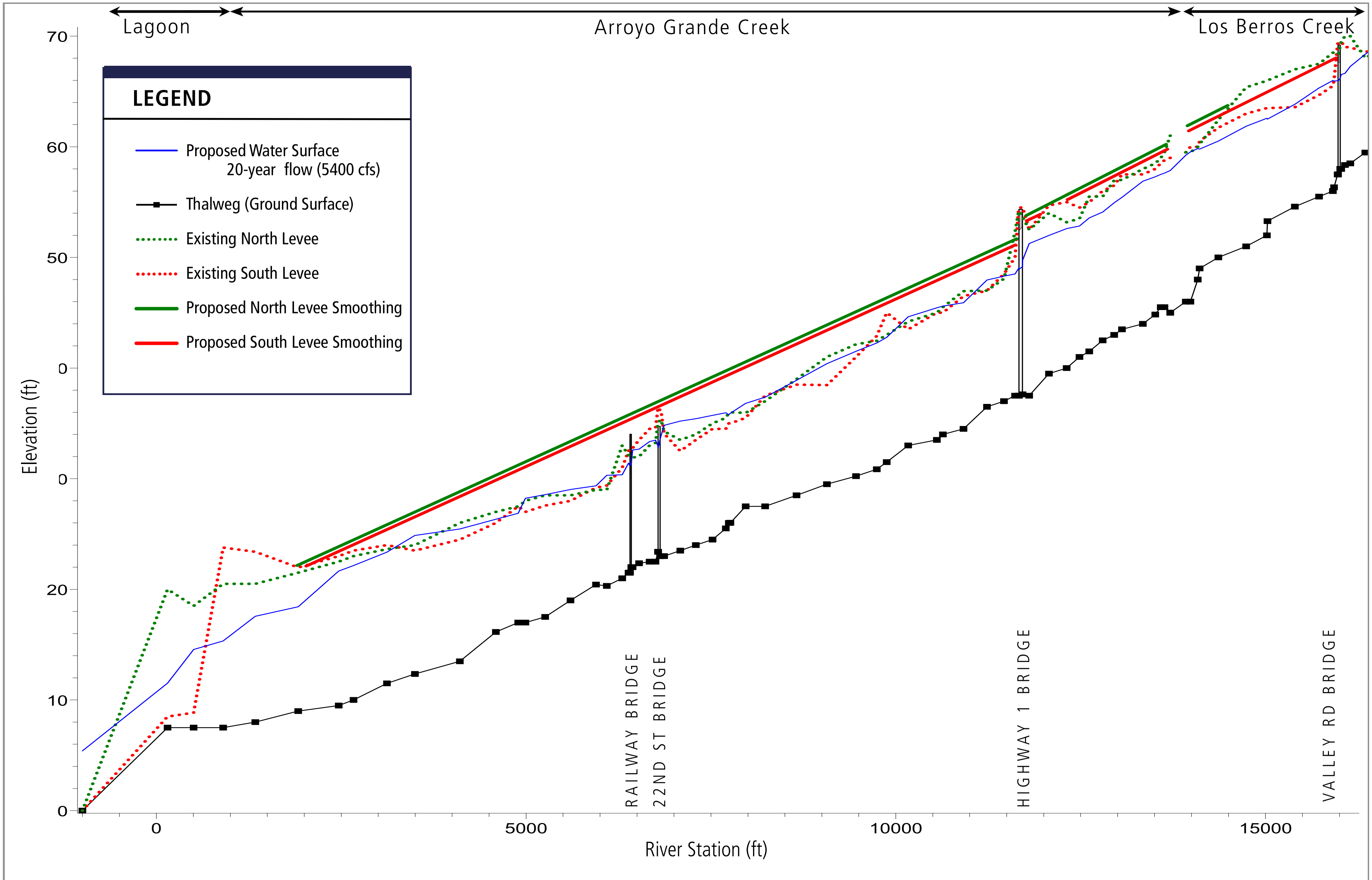

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FIGURE 3.14: Water surface and levee profiles for the mainstem Arroyo Grande and Los Berros for Alternative 3c - Levee Raise (20-year protection). Proposed levee smoothing locations are shown for the north and south levee separately. Portions of the north and south levees will be raised an average of 2.78 feet to achieve 20-year protection with 2 feet of freeboard.

linear feet of the north levee of Los Berros Creek (Figure 3.15). Approximately 79,000 cubic yards of fill will be required to meet the levee raise objectives of Alternative 3c. The 37.4-year flow of 11,500 cfs would be contained with no freeboard (Figure 3.16).

In response to concerns raised by the California Department of Fish and Game and the U.S. Fish and Wildlife Service, a variation of Alternative 3c was evaluated which included wider riparian buffer strips.[9] The revised model incorporated 15 foot riparian buffers instead of 10 foot, thereby widening the riparian corridor from an average of 45 feet to 55 feet in a channel that has an average bottom width of approximately 70 feet. The revised Alternative 3c assumes that pruning lower branch thinning would still occur within the riparian buffer to achieve a target roughness of 0.04. The results of this analysis, though not presented in detail here, show a water surface increase of approximately 1/10th of a foot. Consequently, widening of the riparian buffer could be incorporated into Alternative 3c without compromising the 7,500 cfs goal.

3.5.4. Engineering Design / Implementation Cost Estimates

Alternative 3 is broken down into 3 levels of protection, all of which assume implementation of Alternatives 1 and 2. A summary of the anticipated costs for Alternative 3 is provided in Table 3.4 through 3.6, with an estimate of the expected infrastructure and maintenance costs for the next ten years. Future costs beyond Year 1 assume an annual inflation rate of 4%. Costs to move utilities, construct retaining walls so that levees will not encroach on residential property, and modify existing culverts and flap gates, where appropriate, have been incorporated in the cost estimates under "Miscellaneous drainage and utility modifications". Estimates for the amount of retaining walls that may be required are based on a topographic analysis of the portion of the north levee between Highway 1 and the 22nd Street Bridge where residential development abuts the existing levee. The costs estimated to raise the levees are based on the assumption that all material will be imported and that a contractor will be selected to do the work. Overall costs may be reduced if sediment removed from the channel, or other sources of local material, could be mixed with competent material to raise the levees.

Alternative 3a is designed to provide 10-year flood protection with a channel capacity of 5,400 cfs. This alternative assumes that the levees can be raised in the lowest areas without requiring movement or replacement of any of the bridges along Arroyo Grande or Los Berros Creeks. However, UPRR regulations stating a requirement to pass the 50-year flood would not be met under Alternative 3a (the regulation currently is not met under existing conditions). This alternative does not include costs associated with land acquisition or easements they may be required to raise the levees. The Year 1 cost for Alternative 3a is estimated to be approximately $1,200,000 (Table 3.4). The cost over 10 years, including infrastructure and maintenance, is estimated to be $4,700,000.

[9] Concerns were also raised by regulatory agencies, particularly USFWS, regarding potential impacts to the lagoon associated with "bar ripping" to encourage sediment transport out of the flood control reach. This concern was evaluated through the use of hydraulic and sediment transport modeling tools and is discussed in Chapter 4.

ALTERNATIVE 3A - LEVEE RAISING (SMOOTHING LOW POINTS) W/ IMPORTED MATERIAL

ESTIMATED INFRASTRUCTURE COST

ITEM	UNIT	COST/UNIT	# UNITS	YEARS	INFLATION	TOTAL COST
1ST YEAR VEGETATION MANAGEMENT	AC	$7,500	11.56	1	--	$86,700
1ST YEAR SEDIMENT MANAGEMENT	CY	$20	22,626	1	--	$452,520
HABITAT ENHANCEMENT (LOG STRUCTURES)	EA	$2,500	20	1	--	$50,000
LEVEE RAISE (IMPORTED MATERIAL)	CY	$20	12,238	1	--	$244,760
MISCELLANEOUS DRAINAGE AND UTILITY MODIFICATIONS	LS	$50,000	1	1	--	$50,000

	SUBTOTAL	$883,980
CONTINGENCY	20%	$176,796
ADMINISTRATION AND PERMITTING	4%	$35,359
ENGINEERING AND DESIGN	13%	$126,630
	TOTAL INFRASTRUCTURE COST	**$1,222,765**

10-YEAR ESTIMATED MAINTENANCE COST

ITEM	UNIT	COST/UNIT	# UNITS	YEARS	INFLATION	TOTAL COST
YEARLY VEGETATION MANAGEMENT	YR	$80,000	1	9	4%	$1,024,785
YEARLY SEDIMENT MANAGEMENT	YR	$140,000	1	9	4%	$1,793,373

	SUBTOTAL	$2,818,157
CONTINGENCY	20%	$563,631
ADMINISTRATION AND PERMITTING	3%	$84,545
	TOTAL 10 YEAR MAINTENANCE COST	**$3,466,334**

TOTAL 10 YEAR COST	**$4,689,099**

ESTIMATED INDIRECT COST DUE TO FLOODING

ITEM	UNIT	COST/UNIT	# UNITS	YEARS	INFLATION	**TOTAL COST**
FARMLAND INUNDATION (700 AC EVERY 16.6 YR)	AC/YR[1]	$8,000	42	10	4%	**$4,973,621**

[1] UNITS CALCULATED BY 700 ACRES / 16.6 YEARS

TABLE 3.4: Estimated costs for Alternative 3a - Levee Smoothing (10-year protection). Costs are presented separately for infrastructure upgrades and maintenance. The total cost of the project over 10 years is also presented as a way to compare costs between alternatives to assist in selecting a preferred alternative.

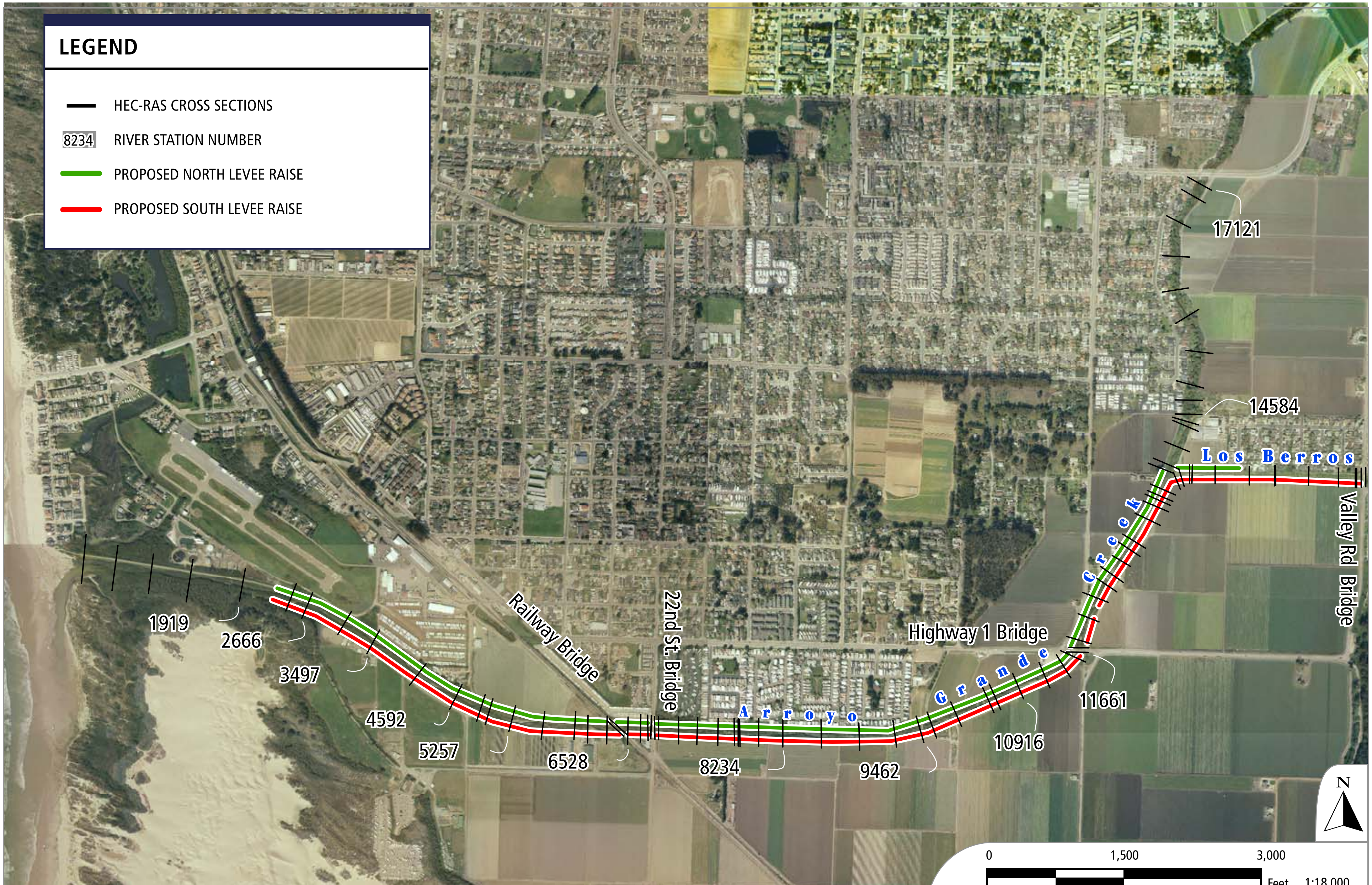

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FIGURE 3.15: Plan view of levee raise locations for Alternative 3c - Levee Raise (20-year protection). Under this alternative, levee raising would occur along most of the flood control reach including the Los Berros channel.

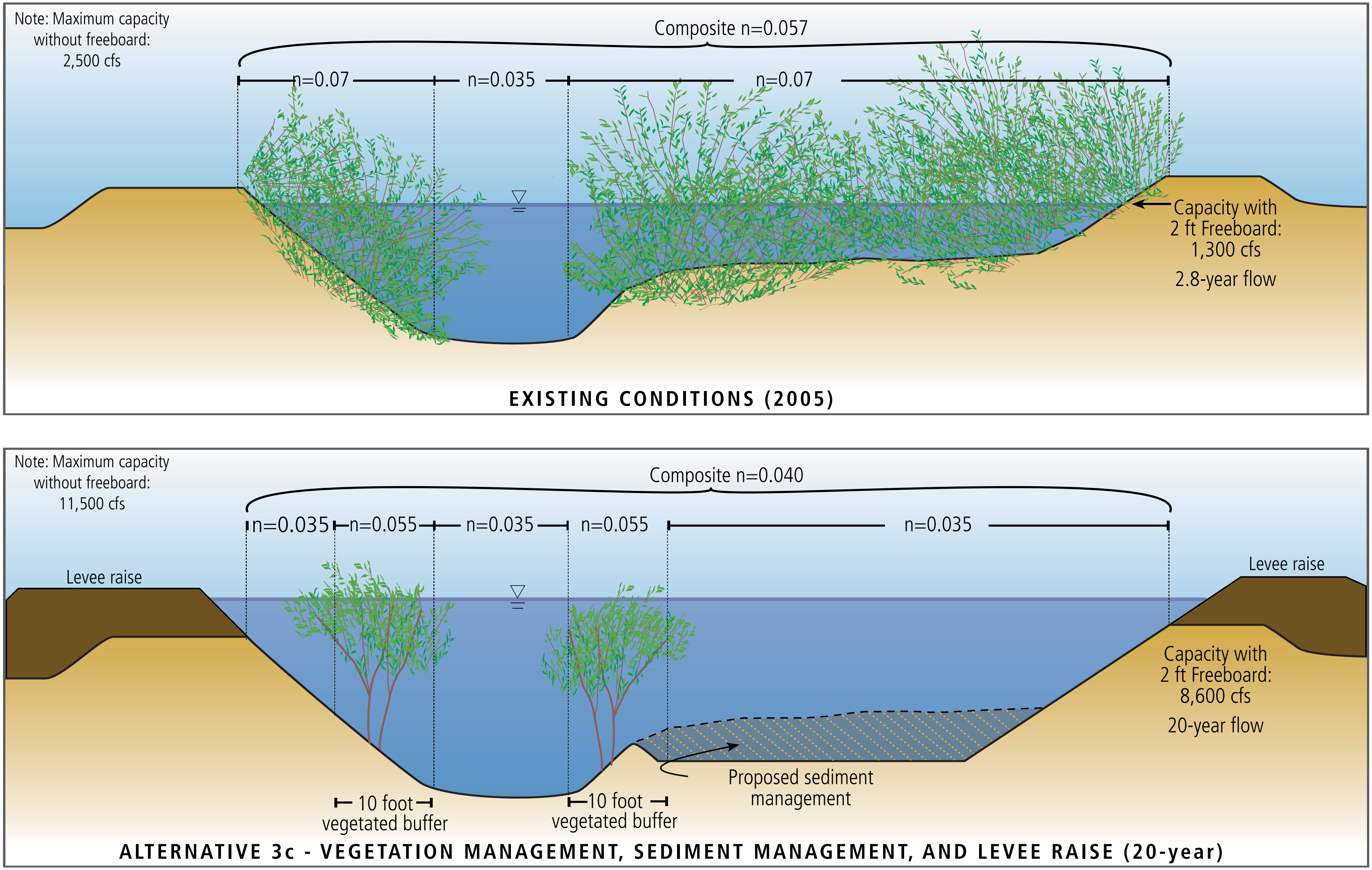

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FIGURE 3.16: Schematic diagram comparing existing conditions in 2005 and the Alternative 3c scenario (Levee Raise - 20-year protection). This alternative increases the flood capacity of the channel from 1,300 cfs (2.8 year event) to 8,600 cfs (20-year event) by raising portions of the levee.

Alternative 3b is designed to provide 15-year flood protection with a channel capacity of 7,000 cfs. This alternative assumes that the levees will be raised along a large portion of Arroyo Grande Creek, downstream of Highway 1. Due to concerns about higher levees resulting in higher water levels against the UPRR Bridge, this alternative, along with Alternative 3c, will require raising or modifying the UPRR Bridge[10]. The cost estimate assumes that the UPRR Bridge would be raised above the 50-year water surface elevation. The 50-yr water surface elevation was assumed to be 0.5 ft above the height of the levees. No costs associated with land acquisition or easement purchases that may be required to raise the levees were included in the cost estimate. The Year 1 cost for Alternative 3b is estimated to be approximately $6,200,000 (Table 3.5). The cost over 10 years, including infrastructure and maintenance, is estimated to be $9,700,000.

Alternative 3c is designed to give 20-year flood protection with a channel capacity of 8,600 cfs. This alternative raises the levees along most of Arroyo Grande and Los Berros Creeks, within the project area. However, this alternative also requires raising and/or retrofit of the UPRR Bridge along Arroyo Grande Creek. The cost estimate for this alternative assumes that the UPRR Bridge would be raised above the 50-year water surface elevation. The 50-yr water surface elevation was assumed to be 0.5 ft above the height of the levees. Costs associated with land acquisition or easements purchases required to raise the levees were not included in the cost estimate. The Year 1 cost for Alternative 3c is estimated to be approximately $7,500,000 (Table 3.6). The cost over 10 years, including infrastructure and maintenance, is estimated to be $11,000,000.

Indirect costs associated with flood impacts beyond the expected level of protection provided by this alternative were calculated. The levee overtop scenario, assuming no freeboard, was used to calculate the expected frequency of flooding in farmland located to the south of the levee with an overtop point located approximately halfway between the Highway 1 and 22nd Street Bridges. Under Alternative 3a a total of 700 acres would flood every 16.6 years or approximately 42 acres per year. The cost of crop loss and clean up was estimated at $8,000 per acre. Based on these assumptions, the estimated 10-year indirect cost due to flooding for Alternative 3a, beyond the protection level provided by Alternative 1, was calculated to be $5,000,000 considering an annual inflation rate of 4% (Table 3.4). Under Alternative 3b a total of 700 acres would flood every 22.4 years or approximately 31 acres per year. The estimated 10-year indirect cost due to flooding for Alternative 3b was calculated to be $3,700,000 (Table 3.5). Under Alternative 3c a total of 700 acres would flood every 37.4 years or approximately 19 acres per year. The estimated 10-year indirect cost due to flooding for Alternative 3c was calculated to be $2,200,000 (Table 3.6). Thus, as the level of flood protection increases, indirect costs due to flooding would decrease.

[10] Though this study incorporates the UPRR Bridge raise to remove the hydraulic constriction, other options may be available to increase capacity under the UPRR Bridge.

ALTERNATIVE 3B - LEVEE RAISING

ESTIMATED INFRASTRUCTURE COST

ITEM	UNIT	COST/UNIT	# UNITS	YEARS		TOTAL COST
1ST YEAR VEGETATION MANAGEMENT	AC	7,500	11.56	1	--	$86,700
1ST YEAR SEDIMENT MANAGEMENT	CY	20	22,626	1	--	$452,520
HABITAT ENHANCEMENT (LOG STRUCTURES)	EA	$2,500	20	1	--	$50,000
LEVEE RAISE (IMPORTED MATERIAL)	CY	20	44,418	1	--	$888,360
UPRR BRIDGE RAISE	LS	$2,800,000	1	1	--	$2,800,000
MISCELLANEOUS DRAINAGE AND UTILITY MODIFICATIONS	LS	$150,000	1	1	--	$150,000

SUBTOTAL		$4,427,580
CONTINGENCY	20%	$885,516
ADMINISTRATION AND PERMITTING	5%	$221,379
ENGINEERING AND DESIGN	13%	$679,431
TOTAL INFRASTRUCTURE COST		**$6,213,906**

10-YEAR ESTIMATED MAINTENANCE COST

ITEM	UNIT	COST/UNIT	# UNITS	YEARS		TOTAL COST
YEARLY VEGETATION MANAGEMENT	YR	80,000	1	9	4%	$1,024,785
YEARLY SEDIMENT MANAGEMENT	YR	140,000	1	9	4%	$1,793,373

SUBTOTAL		$2,818,157
CONTINGENCY	20%	$563,631
ADMINISTRATION AND PERMITTING	3%	$84,545
TOTAL 10 YEAR MAINTENANCE COST		**$3,466,334**
TOTAL 10 YEAR COST		**$9,680,240**

ESTIMATED INDIRECT COST DUE TO FLOODING

ITEM	UNIT	COST/UNIT	# UNITS	YEARS		**TOTAL COST**
FARMLAND INUNDATION (700 AC EVERY 22.4YR)	AC/YR[1]	8,000	31	10	4%	**$3,671,006**

[1] UNITS CALCULATED BY 700 ACRES / 22.4 YEARS

TABLE 3.5: Estimated costs for Alternative 3b - Levee Raise (15-year protection). Costs are presented separately for infrastructure upgrades and maintenance. The total cost of the project over 10 years is also presented as a way to compare costs between alternatives to assist in selecting a preferred alternative.

ALTERNATIVE 3C - LEVEE RAISING

ESTIMATED INFRASTRUCTURE COST

ITEM	UNIT	COST/UNIT	# UNITS	YEARS	INFLATION	TOTAL COST
1ST YEAR VEGETATION MANAGEMENT	AC	$7,500	11.56	1	--	$86,700
1ST YEAR SEDIMENT MANAGEMENT	CY	$20	22,626	1	--	$452,520
HABITAT ENHANCEMENT (LOG STRUCTURES)	EA	$2,500	20	1	--	$50,000
LEVEE RAISE (IMPORTED MATERIAL)	CY	$20	78,857	1	--	$1,577,140
UPRR BRIDGE RAISE	LS	$2,970,000	1	1	--	$2,970,000
MISCELLANEOUS DRAINAGE AND UTILITY MODIFICATIONS	LS	$210,000	1	1	--	$210,000

SUBTOTAL		$5,346,360
CONTINGENCY	20%	$1,069,272
ADMINISTRATION AND PERMITTING	5%	$267,318
ENGINEERING AND DESIGN	13%	$822,761
TOTAL INFRASTRUCTURE COST		**$7,505,711**

10-YEAR ESTIMATED MAINTENANCE COST

ITEM	UNIT	COST/UNIT	# UNITS	YEARS	INFLATION	TOTAL COST
YEARLY VEGETATION MANAGEMENT	YR	$80,000	1	9	4%	$1,024,785
YEARLY SEDIMENT MANAGEMENT	YR	$140,000	1	9	4%	$1,793,373

SUBTOTAL		$2,818,157
CONTINGENCY	20%	$563,631
ADMINISTRATION AND PERMITTING	3%	$84,545
TOTAL 10 YEAR MAINTENANCE COST		**$3,466,334**
TOTAL 10 YEAR COST		**$10,972,045**

ESTIMATED INDIRECT COST DUE TO FLOODING

ITEM	UNIT	COST/UNIT	# UNITS	YEARS	INFLATION	**TOTAL COST**
FARMLAND INUNDATION (700 AC EVERY 37.4 YEARS)	AC/YR[1]	$8,000	19	10	4%	**$2,249,971**

[1] UNITS CALCULATED BY 700 ACRES / 37.4 YEARS

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TABLE 3.6: Estimated costs for Alternative 3c - Levee Raise (20-year protection). Costs are presented separately for infrastructure upgrades and maintenance. The total cost of the project over 10 years is also presented as a way to compare costs between alternatives to assist in selecting a preferred alternative.

3.6. Alternative 4 – Vegetation Management w/ Levee Raise to Alternative 3c Height[11]

3.6.1. Description

Alternative 4 was developed in response to regulatory agency concerns about the impact of the sediment management program discussed in Alternative 2. Up to this point in the alternatives evaluation, new options have been added to the previous option to evaluate the net benefit of each action. Alternative 4 takes a step back and evaluates Alternative 3c, a levee raise to achieve 20-year flood protection, without inclusion of Alternative 2, the sediment management option (Figure 3.17). Alternative 4 raises the existing levees to the same height as Alternative 3c and assumes implementation and maintenance of the vegetation management program discussed in Alternative 1. The existing levees are assumed to be raised while maintaining a 2h:1v slope on the levee sides and providing a minimum top width of 15-feet. Alternative 4 also assumes the UPRR Bridge will be raised to move the low chord of the bridge above the 50-year water surface elevation, assumed to be 0.5 feet above the height of the levees.

3.6.2. Modeling Parameters / Assumptions

The HEC-RAS model developed for Alternative 1 was used to analyze Alternative 4, with the exception of revised bridge geometry at the UPRR Bridge. The flood protection was determined by matching a water surface elevation to the 20-yr water surface generated from the Alternative 3c.

3.6.3. Results / Discussion

Alternative 4 raises the levees along Arroyo Grande Creek from river station 2,000 through river station 14,000, providing protection against the 16.6-year flood of 7,500 cfs. An additional levee raise would also be required along approximately 2,300 linear feet of the south levee and 600 linear feet of the north levee of Los Berros Creek (see Alternative 3c). Approximately 76,000 cubic yards of fill will be required to meet the levee raising objectives of Alternative 4. The 34.4-year flood flow of 11,000 cfs would be contained with no freeboard (Figure 3.17).

3.6.4. Engineering Design / Implementation Cost Estimates

Alternative 4 is designed to provide 16.6-year flood protection with a channel capacity of 7,500 cfs. This alternative raises the levees along most of Arroyo Grande and Los Berros Creeks, within the project area. However, this alternative may also require raising and/or retrofit of the UPRR Bridge. The cost estimate for this alternative assumes that the UPRR Bridge will be raised above

[11] Alternative 4 was modified significantly from the one presented in the Draft Report. The original Alternative 4 focused on hydraulic effects associated with raising the UPRR and the 22nd Street Bridges. Because these elements are already incorporated into Alternatives 3b and 3c, Alternative 4 was replaced with an alternative that evaluates Alternative 3c without Alternative 2 incorporated.

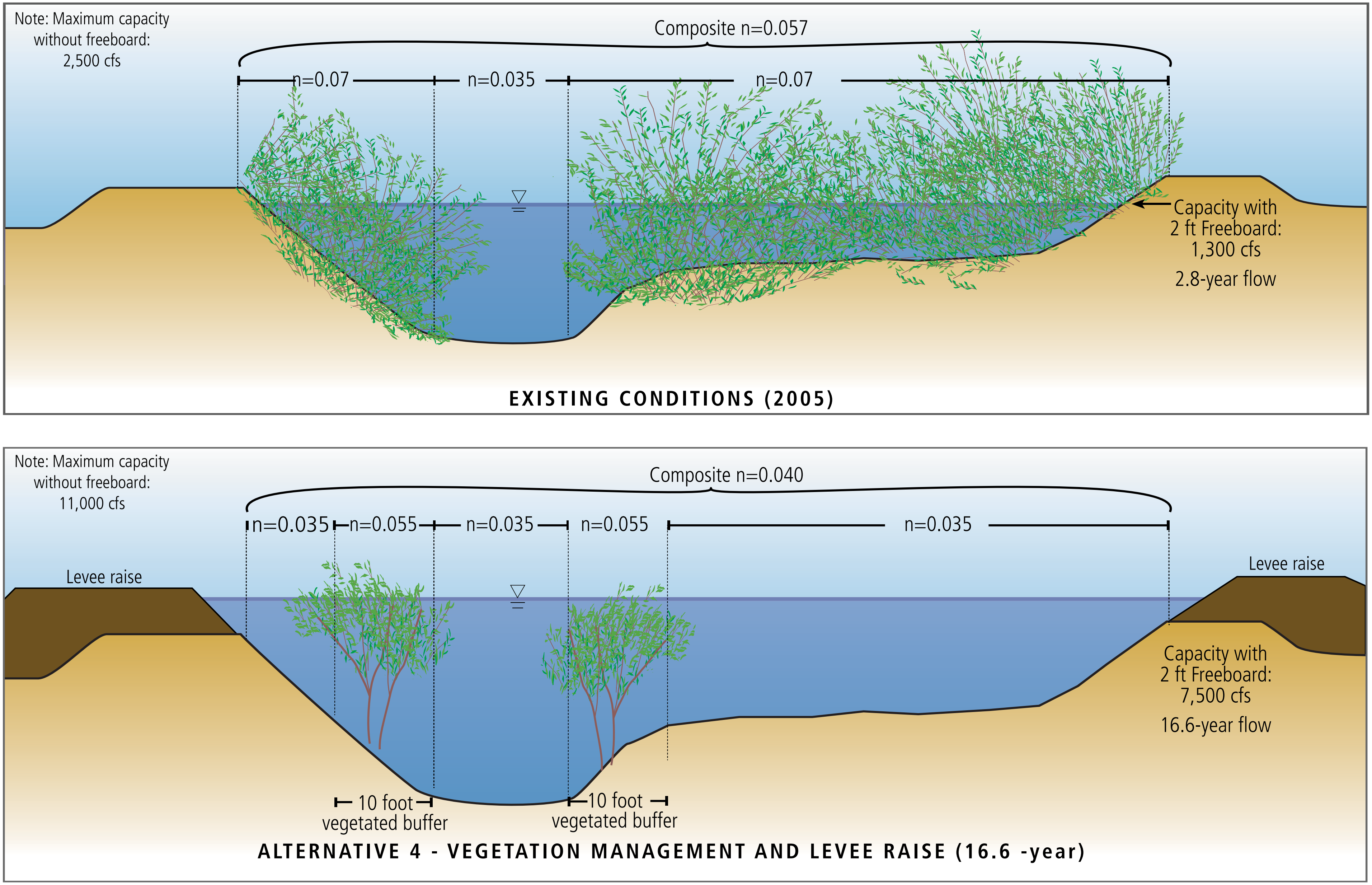

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FIGURE 3.17: Schematic diagram comparing existing conditions in 2005 and the Alternative 4 scenario (Levee raise without in channel sediment management). This alternative increases the flood capacity of the channel from 1,300 cfs (2.8 year event) to 7,500 cfs (16.6-year event) by raising portions of the levee.

the 50-year water surface elevation. The 50-yr water surface elevation was assumed to be 0.5 ft above the height of the levees. Costs associated with land acquisition or easement purchases required to raise the levees were not included in the cost estimate. The Year 1 cost for Alternative 4 is estimated to be approximately $6,800,000 (Table 3.7). The cost over ten years, including infrastructure and maintenance is estimated to be $8,000,000.

Indirect costs associated with flood impacts beyond the expected level of protection provided by this alternative were calculated. The levee overtop scenario, assuming no freeboard, was used to calculate the expected frequency of flooding in farmland located to the south of the levee with an overtop point located approximately halfway between the Highway 1 and 22nd Street Bridges. Under Alternative 4 a total of 700 acres would flood every 34.4 years or approximately 20 acres per year. The cost of crop loss and clean up was estimated at $8,000 per acre. Based on these assumptions, the estimated 10-year indirect cost due to flooding beyond the protection level provided by Alternative 1 was calculated to be $2,400,000 considering an annual inflation rate of 4% (Table 3.7).

3.7. ALTERNATIVE 5 – FLOOD EASEMENTS

3.7.1. DESCRIPTION

The objective of Alternative 5 is to integrate off-channel flood storage areas into the existing flood protection alternatives already analyzed in order to provide additional flood protection via a controlled overflow of flood waters. The areas proposed for off-channel storage are along the south bank of Arroyo Grande Creek, between the confluence of Los Berros Creek and the UPRR Bridge, in areas currently in agricultural use. The flood storage areas would be created by constructing 5-foot high levees around portions of existing agricultural fields (typically along existing access roads), to provide an average storage depth of 4 feet. (Flood storage along Los Berros Creek was considered but rejected because the elevation of the agricultural fields in relation to the tops of the Los Berros Creek levee would make it difficult to store water without significant excavation of prime farmland.) The property located within the off-channel storage areas would be protected through a flood easement. Flood easements would be negotiated with willing landowners prior to pursuing this alternative. Flood easements typically consist of a one-time payment to the landowner on a per acreage basis to offset potential impacts associated with future flooding and the loss of future development rights to the property (opportunity costs). We are currently in the process of determining appropriate flood easement options and costs for Arroyo Grande Creek. The flood easement would be negotiated to allow for continued farming of row crops on the property.

During a peak event, water would be diverted from the main channel through spillway weirs (Figure 3.18). The weirs would be designed to begin diverting flow from the main channel at the

ALTERNATIVE 4 - LEVEE RAISING WITHOUT SEDIMENT MANAGEMENT

ESTIMATED INFRASTRUCTURE COST

ITEM	UNIT	COST/UNIT	# UNITS	YEARS	INFLATION	TOTAL COST
1ST YEAR VEGETATION MANAGEMENT	AC	$7,500	11.56	1	--	$86,700
LEVEE RAISE (IMPORTED MATERIAL)	CY	$20	78,857	1	--	$1,577,140
UPRR BRIDGE RAISE	LS	$2,970,000	1	1	--	$2,970,000
MISCELLANEOUS DRAINAGE AND UTILITY MODIFICATIONS	LS	$210,000	1	1	--	$210,000

	SUBTOTAL	$4,843,840
CONTINGENCY	20%	$968,768
ADMINISTRATION AND PERMITTING	5%	$242,192
ENGINEERING AND DESIGN	13%	$744,368
	TOTAL INFRASTRUCTURE COST	**$6,799,168**

10-YEAR ESTIMATED MAINTENANCE COST

ITEM	UNIT	COST/UNIT	# UNITS	YEARS	INFLATION	TOTAL COST
YEARLY VEGETATION MANAGEMENT	YR	$80,000	1	9	4%	$1,024,785

	SUBTOTAL	$1,024,785
CONTINGENCY	20%	$204,957
ADMINISTRATION AND PERMITTING	2%	$20,496
	TOTAL 10 YEAR MAINTENANCE COST	**$1,250,237**
	TOTAL 10 YEAR COST	**$8,049,405**

ESTIMATED INDIRECT COST DUE TO FLOODING

ITEM	UNIT	COST/UNIT	# UNITS	YEARS	INFLATION	**TOTAL COST**
FARMLAND INUNDATION (700 AC EVERY 34.4 YEARS)	AC/YR[1]	$8,000	20	10	4%	**$2,368,391**

[1] UNITS CALCULATED BY 700 ACRES / 34.4 YEARS

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TABLE 3.7: Estimated costs for Alternative 4 - Levee Raise (20-year protection) without sediment management. Costs are presented separately for infrastructure upgrades and maintenance. The total cost of the project over 10 years is also presented as a way to compare costs between alternatives to assist in selecting a preferred alternative.

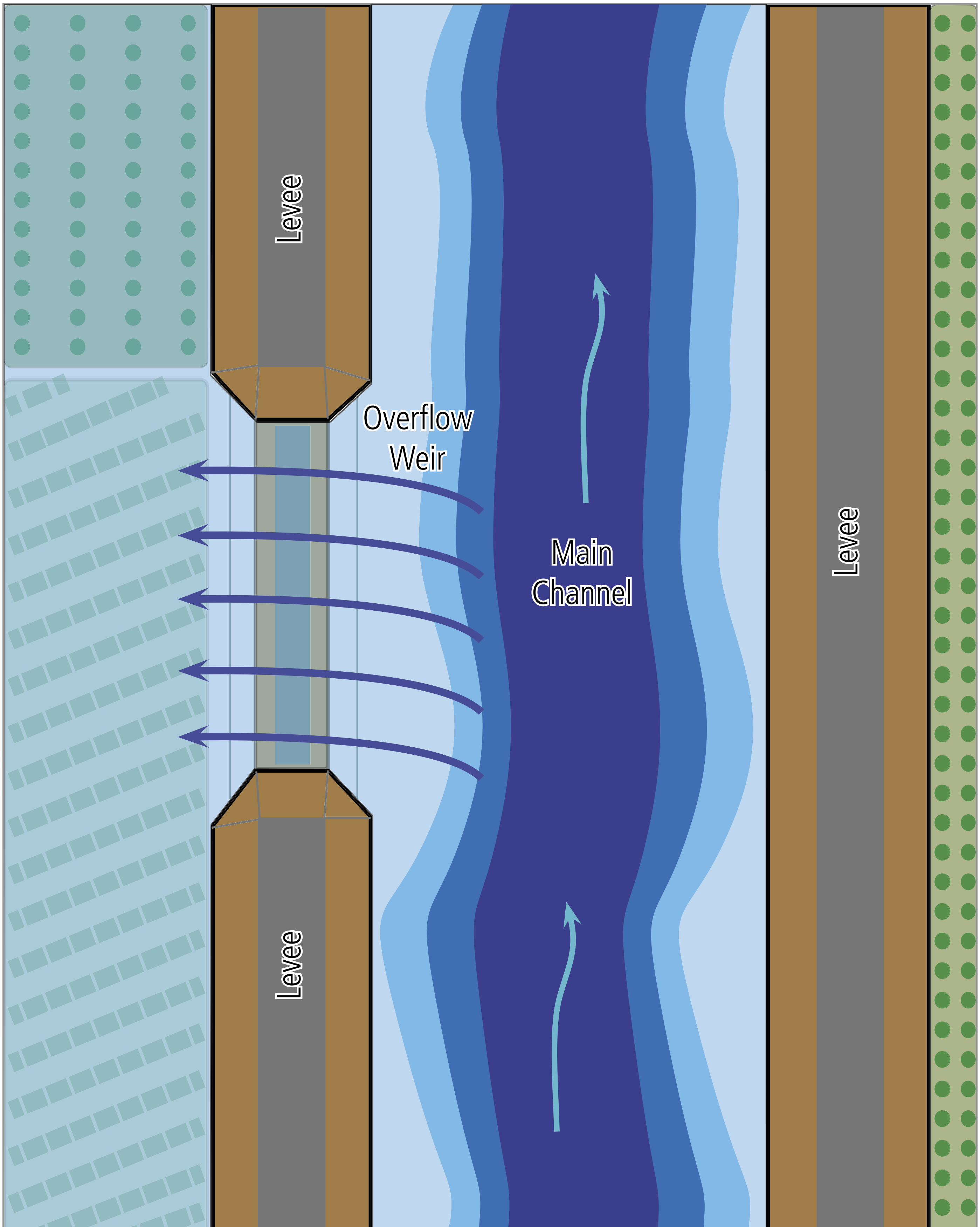

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FIGURE 3.18: Conceptual weir diagram for flood easements proposed under Alternative 5. The weir would act as a control structure that would allow safe overflow of water into off-channel storage areas. The off-channel storage areas would store water temporarily during a peak event. Following the peak, water would be pumped from the storage areas back into the channel using temporary or permanent pumps.

appropriate flow depth on the rising limb of the hydrograph based on output from the model. One concern about Alternative 5, raised by NOAA Fisheries, is that steelhead may be stranded in the off-channel storage areas when water spills over the weirs. Though there is the potential for that to occur, steelhead typically do not migrate during peak events due to the turbidity of the water and the risk associated with floating debris and bed load movement. In most cases, steelhead migrate on the declining limb of the hydrograph. Additionally, existing conditions in the flood control reach presents a similar hazard. Peak floods would overtop the levee with a higher frequency than what is proposed under Alternative 5. Consequently, steelhead would have a higher risk of being stranded under existing as compared to proposed conditions.[12]

Similarly to Alternative 3, Alternative 5 has been analyzed with three options that provide varying levels of flood protection. The goal of Alternative 5a is to provide 20-year flood protection and the goals of Alternative 5b and 5c are to provide 50-year flood protection. Alternatives 5a and 5b assume implementation of Alternative 3a, which provides 10-year flood protection. Therefore, Alternatives 5a and 5b must be capable of diverting and storing the portions of the 20-year and 50-year hydrographs, respectively, containing flows greater than the 10-year peak. Alternative 5a requires approximately 150 acres of flood easement (Figures 3.19 and 3.20) to store 600 acre-feet of flood waters and meet the 20-year flood protection requirement. Alternative 5b requires approximately 685 acres of flood easement (Figures 3.20 and 3.21) to store 2,740 acre-feet of flood waters and meet the 50-year flood protection requirement. Alternative 5c assumes implementation of Alternative 3c, which provides 20-year flood protection. Alternative 5c must be capable of diverting and storing the portion of the 50-year hydrograph containing flows greater than the 20-year peak. Alternative 5c requires approximately 155 acres of flood easement to store 620 acre-feet of flood waters and meet the 50-year flood protection requirements (Figures 3.20 and 3.22).

3.7.2. MODELING PARAMETERS / ASSUMPTIONS

The HEC-RAS model for Alternative 5 required unsteady flow analysis using the hydrographs derived from the rainfall-runoff modeling described in Chapter 2. The hydrographs were entered into the HEC-RAS model to simulate rising and falling river stage with respect to time, allowing for consideration of both stage and volume. Unsteady simulation could then be used to determine the amount of water removed from the channel during diversion to the storage areas.

For each of the Alternatives 5a-5c, the HEC-RAS model used in Alternative 3 was reconfigured with lateral weirs and storage areas capable of holding the required volume. The storage areas were assumed to hold an average depth of 4 feet of water and provide 1-foot of freeboard. In some locations, the storage areas would require internal levees to maintain depth while accommodating the natural slope of the land. These details were considered to be beyond the scope of this study.

[12]Impacts to steelhead are being analyzed in detail through a biological assessment. The assessment is being developed as a separate document that will be available in late December 2005/early January 2006.

FIGURE 3.19: Locations of possible flood easements proposed under Alternative 5a that would act as controlled overflow storage areas during a peak event. Alternative 5a would provide 10-year protection within the channel by implementing Alternative 3a with an additional 10 years of protection with the flood easements for 20-year protection. The flood easement area would total 150 acres and would be developed through cooperation with willing landowners.

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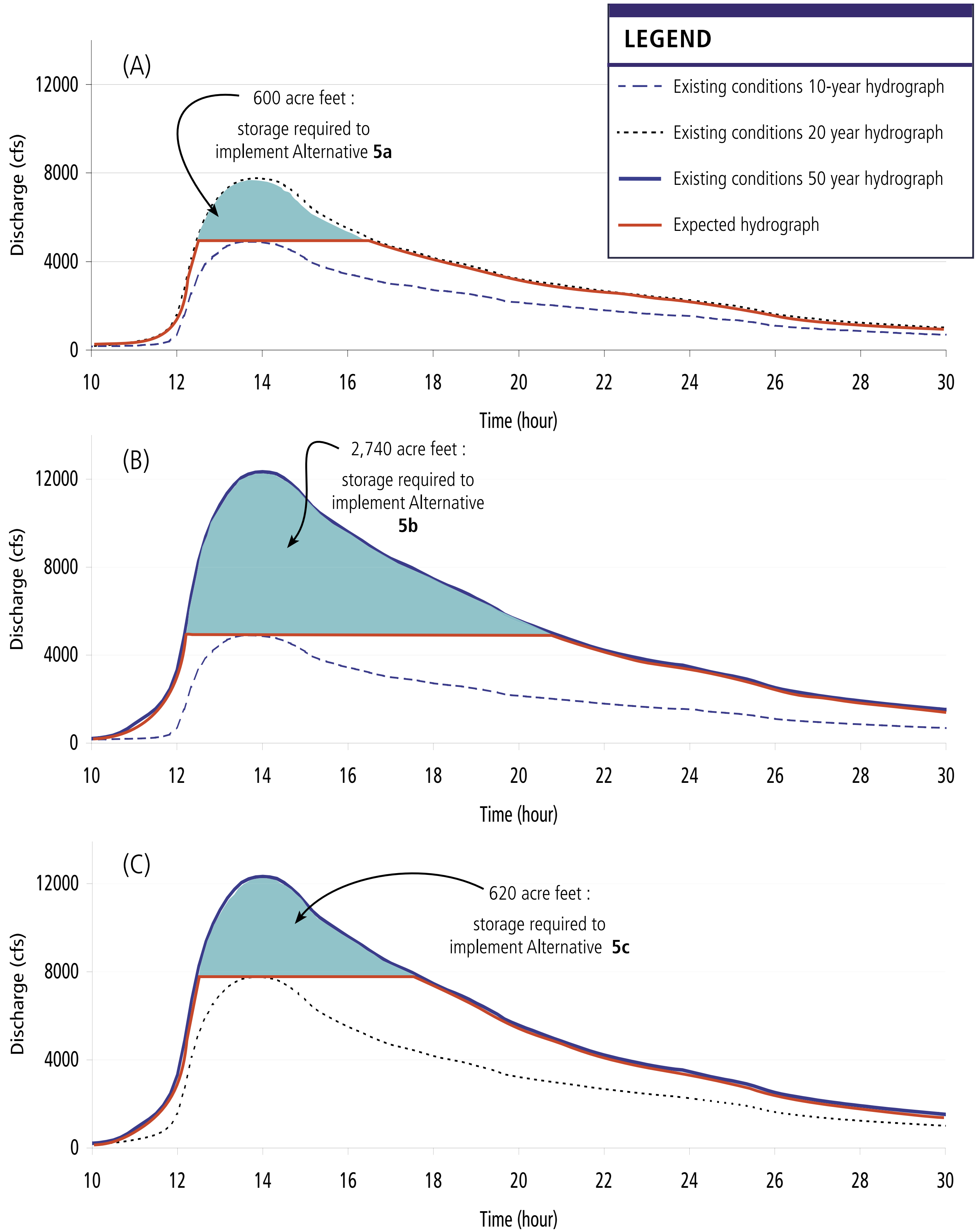

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FIGURE 3.20: Flood hydrographs under existing conditions and proposed Alternative 5 conditions. A - Alternative 5a would require 600 acre-feet of storage to provide 20-year protection; B - Alternative 5b would require 2,740 acre feet of storage to provide 50-year protection; C - Alternative 5c would require 500 acre feet of storage to provide 50-year protection.

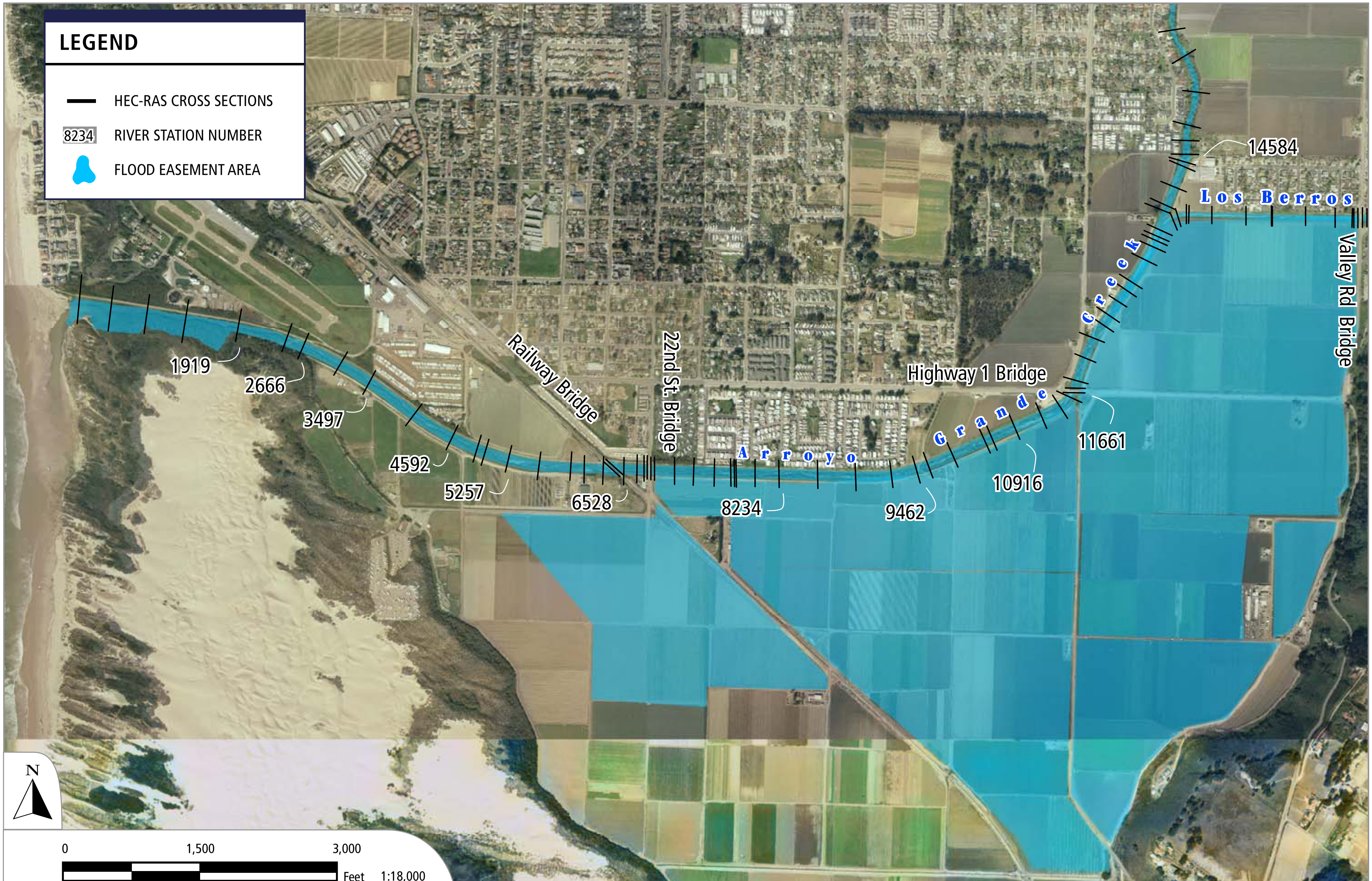

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FIGURE 3.21: Locations of possible flood easements proposed under Alternative 5b that would act as controlled overflow storage areas during a peak event. Alternative 5b would provide 10-year protection within the channel by implementing Alternative 3a

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FIGURE 3.22: Locations of possible flood easements proposed under Alternative 5c that would act as controlled overflow storage areas during a peak event. Alternative 5c would provide 20-year protection within the channel by implementing Alternative 3c with an additional 30 years of protection with the flood easements for 50-year protection. The flood easement area would total 125 acres and would be developed through cooperation with willing landowners.

3.7.3. RESULTS / DISCUSSION

The storage volume required to provide 20-year flood protection under Alternative 5a was calculated to be 600 acre-feet. An additional 2,140 acre-feet would be required to capture the 50-year flood. The storage volume required to provide 50-year flood protection under Alternative 5c was calculated to be 620 acre-feet (Figure 3.20). The unsteady HEC-RAS analysis determined that storage areas located along Arroyo Grande Creek between the UPRR Bridge and the confluence of Los Berros Creek could be configured to provide appropriate levels of protection for each Alternative.

Alternatives 5b and 5c were analyzed using the same approach as Alternative 5a. However, due to levee heights set below the 50-yr water surface along Los Berros Creek, overflows from Los Berros Creek would have to be diverted through a channel into storage areas along Arroyo Grande Creek that would have appropriate storage volume. Storage areas depicted in Figures 3.21 and 3.22 are probable locations where additional containment for the 50-year flood event could be achieved. It is unlikely that Alternative 5b would be pursued given the need to put much of the existing farmland into flood easements.

3.7.4. ENGINEERING DESIGN / IMPLEMENTATION COST ESTIMATES

The design of off channel storage areas assumes that the average levee height surrounding flood easements would be 5 feet. This assumption provides for 1-foot of freeboard when the flood storage areas are filled to the design depth of 4 feet. The levees constructed around the flood storage areas were assumed to have 3 to 1 side slopes. Potential storage areas along Los Berros Creek would have considerably less storage capacity because they would typically not provide 4 feet depth of storage. The cost estimate assumes that levees will have to be constructed along all sides of the storage areas except the side abutting the existing levee. The cost estimates also assume that Alternative 3a or Alternative 3c would be implemented. Costs associated with pumping the water out of the storage areas are not included due to the infrequency of the flood event. However, temporary or permanent pump stations may be required to remove water from storage areas.

The Year 1 cost for Alternative 5a is estimated to be approximately $6,200,000 (Table 3.8). The 10-year cost, including infrastructure and maintenance, is estimated to be $9,700,000. The Year 1 cost for Alternative 5b is estimated to be approximately $14,600,000 (Table 3.9). The 10-year cost, including infrastructure and maintenance is estimated to be $18,000,000. Alternative 5c is estimated to cost $12,000,000 in Year 1 and $15,500,000 over ten years (Table 3.10). All cost estimates assume an annual inflation rate of 4%.

Indirect costs associated with flood impacts beyond the expected level of protection provided by this alternative were calculated. Inundation of agricultural lands outside of the flood easement

ALTERNATIVE 5A - LEVEE SMOOTHING (ALT 3A) AND OFF CHANNEL STORAGE (20-YR)

ESTIMATED INFRASTRUCTURE COST

ITEM	UNIT	COST/UNIT	# UNITS	YEARS	INFLATION	TOTAL COST
1ST YEAR VEGETATION MANAGEMENT	AC	$7,500	11.56	1	--	$86,700
1ST YEAR SEDIMENT MANAGEMENT	CY	$20	22,626	1	--	$452,520
HABITAT ENHANCEMENT (LOG STRUCTURES)	EA	$2,500	20	1	--	$50,000
LEVEE RAISE (IMPORTED MATERIAL) ALT 3A	CY	$20	12,238	1	--	$244,760
GRADING FOR STORAGE LEVEES	CY	$20	106,944	1	--	$2,138,880
ROCK SLOPE PROTECTION	CY	$50	7,030	1	--	$351,500
SPILLWAY CONCRETE PROTECTION	CY	$300	420	1	--	$126,000
MISCELLANEOUS DRAINAGE STRUCTURES	LS	$300,000	1	1	--	$300,000
LAND PURCHASE/LEASE	AC	$15,000	20	1	--	$294,600
FLOOD EASEMENT COST	AC	$2,500	150	1	--	$375,000

	SUBTOTAL	$4,419,960
CONTINGENCY	20%	$883,992
ADMINISTRATION AND PERMITTING	6%	$265,198
ENGINEERING AND DESIGN	13%	$678,243
	TOTAL INFRASTRUCTURE COST	**$6,247,392**

10-YEAR ESTIMATED MAINTENANCE COST

ITEM	UNIT	COST/UNIT	# UNITS	YEARS	INFLATION	TOTAL COST
YEARLY VEGETATION MANAGEMENT	YR	$80,000	1	9	4%	$1,024,785
YEARLY SEDIMENT MANAGEMENT	YR	$140,000	1	9	4%	$1,793,373

	SUBTOTAL	$2,818,157
CONTINGENCY	20%	$563,631
ADMINISTRATION AND PERMITTING	3%	$84,545
	TOTAL 10 YEAR MAINTENANCE COST	**$3,466,334**
	TOTAL 10 YEAR COST	**$9,713,726**

ESTIMATED INDIRECT COST DUE TO FLOODING

ITEM	UNIT	COST/UNIT	# UNITS	YEARS	INFLATION	**TOTAL COST**
FARMLAND INUNDATION (662 AC EVERY 20YR)	AC/YR[1]	$8,000	27	10	4%	**$3,138,118**

[1] UNITS CALCULATED BY 662 ACRES / 20 YEARS

TABLE 3.8: Estimated costs for Alternative 5a - Flood Easements (20-year protection). Costs are presented separately for infrastructure upgrades and maintenance. The total cost of the project over 10 years is also presented as a way to compare costs between alternatives to assist in selecting a preferred alternative.

ALTERNATIVE 5B - LEVEE SMOOTHING (ALT 3A) AND OFF CHANNEL STORAGE (50-YR)

ESTIMATED INFRASTRUCTURE COST

ITEM	UNIT	COST/UNIT	# UNITS	YEARS	INFLATION	TOTAL COST
1ST YEAR VEGETATION MANAGEMENT	AC	$7,500	11.56	1	--	$86,700
1ST YEAR SEDIMENT MANAGEMENT	CY	$20	22,626	1	--	$452,520
HABITAT ENHANCEMENT (LOG STRUCTURES)	EA	$2,500	20	1	--	$50,000
LEVEE RAISE (IMPORTED MATERIAL) ALT 3A	CY	$20	12,238	1	--	$244,760
GRADING FOR STORAGE LEVEES	CY	$20	250,995	1	--	$5,019,900
ROCK SLOPE PROTECTION	CY	$50	7,861	1	--	$393,050
SPILLWAY CONCRETE PROTECTION	CY	$300	450	1	--	$135,000
MISCELLANEOUS DRAINAGE STRUCTURES	LS	$800,000	1	1	--	$800,000
LAND PURCHASE/LEASE	AC	$15,000	94	1	--	$1,410,000
FLOOD EASEMENT COST	AC	$2,500	685	1	--	$1,712,500

	SUBTOTAL	$10,304,430
CONTINGENCY	20%	$2,060,886
ADMINISTRATION AND PERMITTING	6%	$618,266
ENGINEERING AND DESIGN	13%	$1,596,220
	TOTAL INFRASTRUCTURE COST	**$14,579,802**

10-YEAR ESTIMATED MAINTENANCE COST

ITEM	UNIT	COST/UNIT	# UNITS	YEARS	INFLATION	TOTAL COST
YEARLY VEGETATION MANAGEMENT	YR	$80,000	1	9	4%	$1,024,785
YEARLY SEDIMENT MANAGEMENT	YR	$140,000	1	9	4%	$1,793,373

	SUBTOTAL	$2,818,157
CONTINGENCY	20%	$563,631
ADMINISTRATION AND PERMITTING	3%	$84,545
	TOTAL 10 YEAR MAINTENANCE COST	**$3,466,334**
	TOTAL 10 YEAR COST	**$18,046,135**

ESTIMATED INDIRECT COST DUE TO FLOODING

ITEM	UNIT	COST/UNIT	# UNITS	YEARS	INFLATION	**TOTAL COST**
FARMLAND INUNDATION (512 AC EVERY 50 YEARS)	AC/YR[1]	$8,000	10	10	4%	**$1,212,616**

[1] UNITS CALCULATED BY 512 ACRES / 50 YEARS

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TABLE 3.9: Estimated costs for Alternative 5b - Flood Easements (50-year protection). Costs are presented separately for infrastructure upgrades and maintenance. The total cost of the project over 10 years is also presented as a way to compare costs between alternatives to assist in selecting a preferred alternative.

ALTERNATIVE 5C - LEVEE RAISE (ALT 3C) AND OFF CHANNEL STORAGE (50-YR)

ESTIMATED INFRASTRUCTURE COST

ITEM	UNIT	COST/UNIT	# UNITS	YEARS	INFLATION	TOTAL COST
1ST YEAR VEGETATION MANAGEMENT	AC	$7,500	11.56	1	--	$86,700
1ST YEAR SEDIMENT MANAGEMENT	CY	$20	22,626	1	--	$452,520
HABITAT ENHANCEMENT (LOG STRUCTURES)	EA	$2,500	20	1	--	$50,000
LEVEE RAISE (IMPORTED MATERIAL) ALT 3C	CY	$20	78,857	1	--	$1,577,140
UPRR BRIDGE RAISE (5.25')	LS	$2,970,000	1	1	--	$2,970,000
GRADING FOR STORAGE LEVEES	CY	$20	93,592	1	--	$1,871,840
ROCK SLOPE PROTECTION	CY	$50	7,861	1	--	$393,050
SPILLWAY CONCRETE PROTECTION	CY	$300	450	1	--	$135,000
MISCELLANEOUS DRAINAGE STRUCTURES	LS	$310,000	1	1	--	$310,000
LAND PURCHASE/LEASE	AC	$15,000	17	1	--	$247,500
FLOOD EASEMENT COST	AC	$2,500	155	1	--	$387,500

	SUBTOTAL	$8,481,250
CONTINGENCY	20%	$1,696,250
ADMINISTRATION AND PERMITTING	6%	$508,875
ENGINEERING AND DESIGN	13%	$1,305,304
	TOTAL INFRASTRUCTURE COST	**$11,991,679**

10-YEAR ESTIMATED MAINTENANCE COST

ITEM	UNIT	COST/UNIT	# UNITS	YEARS	INFLATION	TOTAL COST
YEARLY VEGETATION MANAGEMENT	YR	$80,000	1	9	4%	$1,024,785
YEARLY SEDIMENT MANAGEMENT	YR	$140,000	1	9	4%	$1,793,373

	SUBTOTAL	$2,818,157
CONTINGENCY	20%	$563,631
ADMINISTRATION AND PERMITTING	3%	$84,545
	TOTAL 10 YEAR MAINTENANCE COST	**$3,466,334**
	TOTAL 10 YEAR COST	**$15,458,013**

ESTIMATED INDIRECT COST DUE TO FLOODING

ITEM	UNIT	COST/UNIT	# UNITS	YEARS	INFLATION	**TOTAL COST**
FARMLAND INUNDATION (662 AC EVERY 50 YEARS)	AC/YR[1]	$8,000	13.24	10	4%	**$1,567,875**

[1] UNITS CALCULATED BY 662 ACRES / 50 YEARS

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TABLE 3.10: Estimated costs for Alternative 5c - Flood Easements (50-year protection). Costs are presented separately for infrastructure upgrades and maintenance. The total cost of the project over 10 years is also presented as a way to compare costs between alternatives to assist in selecting a preferred alternative.

beyond the expected level of protection was used to estimate indirect costs. The area of farmland inundation was assumed to be the area of farmland within the original 700 acres of flood area (Figure 3.2) that was not contained within the proposed flood storage area for their respective alternatives. The cost of farmland inundation within the designated storage areas was assumed to be covered under the flood easement purchase. An annual inflation rate of 4% was used to calculate the 10-year cost.

Under Alternative 5a, a total of 662 acres was estimated to flood every 20 years, or approximately 27 acres per year. The estimated 10-year indirect cost due to flooding beyond the level of protection provided by Alternative 5a was calculated to be $3,100,000 (Table 3.8). Alternative 5b was estimated to flood 512 acres every 50 years or approximately 10 acres per year. The estimated 10-year indirect cost due to flooding beyond the level of protection provided by Alternative 5b was calculated to be $1,200,000 (Table 3.9). Alternative 5c was estimated to flood 662 acres every 50 years, or approximately 13 acres per year. The estimated 10-year indirect cost due to flooding beyond the level of protection provided by Alternative 5c was calculated to be $1,600,000 (Table 3.10).

3.8. Alternative 6 – Tributary Peak Detention Basins

3.8.1. Description

Alternative 6 investigates the potential flood-reduction benefits of constructing a number of stormwater detention basins on tributaries to Arroyo Grande Creek downstream of Lopez Dam. The basins would capture and store runoff during the peak of large storm events, thereby attenuating the downstream peak flows within the flood control reach. Existing land use on the proposed sites consists of either intensive agricultural, fallow land, or seasonal pastureland for horses. Riparian vegetation is non-existent on all the sites despite the fact that historically there were likely to be floodplain areas with vegetation. If stormwater detention is pursued on a particular site, there may be an opportunity to restore riparian vegetation and enhance other functions such as habitat for red-legged frog. Steelhead stranding concerns would need to be addressed if sites are selected on potential fish-bearing streams such as Los Berros, though it is more likely those sites would be used for floodplain restoration rather than stormwater detention.[13] Alternative 6 assumes implementation of Alternative 3a, which provides 10-year flood protection.

The locations for the proposed basins were identified during field visits attended by representatives of SH+G, Coastal San Luis RCD, NRCS, Central Coast Salmon Enhancement, the Zone 1/1Alandowners, and the City of Arroyo Grande (refer to Appendix B for a map of the potential basins). The sites were selected based on their proximity to tributaries, their size, current land use and geomorphic characteristics, with the goal of finding flat, low-lying, and

[13] Several of the potential stormwater detention sites included in Alternative 6 have also been recommended as sites for floodplain restoration due to their sediment retention potential. A detailed explanation of floodplain restoration options in the Lower Arroyo Grande Creek watershed along with a description of the sites are included in the recommendations section of Chapter 4.

vacant parcels that could be modified to receive and store runoff via a gravity-flow weir or similar means. The selected sites should be considered as representative of the opportunities, costs, and benefits associated with this type of approach. However, discussions still need to be held with landowners to determine whether there is interest in making these properties available for this purpose.

3.8.2. Modeling Parameters / Assumptions

Data collected during the field visits enabled us to calculate the approximate storage capacity available at each site and to make rough estimates of probable construction costs. The collected field data, which includes site geometry, accessibility, location and proximity to tributaries, is provided in Table 3.11.

Once the available storage volume of each of the proposed detention basins was determined from the site geometry, this value was compared to the flow volume that could feasibly be diverted into storage during a given storm event, based on the existing-conditions HEC-HMS model and the site's location relative to the nearest tributary. The lesser of the two volumes was considered to be the available storage volume for Alternative 6 modeling purposes.

The calculated storage volumes were then removed from the peak flow volume of each of the existing-conditions sub-basin hydrographs, to show the effects of the detention storage. The resulting hydrographs were inserted into a proposed-conditions HMS model to obtain the Alternative 6 design hydrographs for the various recurrence intervals under consideration.

For the purpose of this study, it was assumed that the basins would be designed to receive runoff through weirs, activated only during large storm events. The basins were independently optimized for each recurrence interval analyzed under this alternative. As such, the results should be considered independently. For instance, if the weirs were designed for maximum benefit during a 10-year recurrence interval event, they would likely not perform as well as shown for the 20-year event, because they would begin receiving water too early in the hydrograph.

As discussed above, each of the hydrographs was altered by removing a storm water volume that was centered about the peak of the storm event. It may later be determined, through more detailed analysis, that greater benefits could be achieved by diverting flows earlier in the storm, pending exact location and construction details associated with the sites ultimately selected for this type of treatment.

3.8.3. Results / Discussion

Site ID	Location	Area (acres)	Potential Storage Volume (acre feet)	Construction Notes	Estimated Costs for flow retention
4	Unnamed agricultural tributary - Site located between upper Arroyo Grande Rd and Arroyo Grande Creek	2.39	**9.6**	Would require routing of peak stormflows via concrete flume to parcel and development of outlet works and excavation or levee construction to allow for storage.	$ 237,879
5	Unnamed agricultural tributary - Parcel is isolated from main farm fields by creek and road	3.97	**15.9**	Would require inlet and outlet structures and excavation to capture flow from *incised channel*.	$ 243,317
6	Historic floodplain site on mainstem Arroyo Grande - Could be dual use flood detention for Arroyo Grande or agricultural tributary	6.03	**24.1**	Would require inlet and outlet structures. Modifications would depend on goal of capturing tributary inputs or mainstem inputs. Assume best approach would be tributary inputs since the site is so close to the dam. Alternatively this site could be a floodplain restoration area for mainstem Arroyo Grande.	$ 347,683
7	At mouth of Coralitos Creek	4.15	**16.6**	Would require excavation, inlet, outlet and levees.	$ 1,756,945
9	At mouth of Tar Springs Creek	6.80	**54.4**	Would require significant excavation due to highly incised condition of creek; construction of inlet and outlet structures.	$ 395,480
10	Mouth of Canyon de los Alisos, tributary to Tar Springs	1.54	**6.1**	May be able to acquire larger parcel; would require significant excavation for incised condition; inlet and outlet construction.	$ 155,594
14	Confluence of Carpenter and Corbitt Canyons	11.70	**46.8**	Urbanizing watershed; would require excavation, inlet, outlet, and levees.	$ 680,170
18	Mouth of Los Berros upstream of flood control reach	11.11	**88.9**	Would require inlet and outlet structures, excavation, and additional levees.	$ 900,871

TABLE 3.11: General description of tributary flood attenuation basins proposed under Alternative 6. Each site includes a general location description, size of the potential project area, general construction notes, and an estimated cost. Please refer to Appendix B for a map of potential stormwater detention basins.

As shown in Figure 3.23, full implementation of the proposed detention basins could result in a measurable reduction in peak flows for each of the events investigated. The most notable effect is seen in the 10-year event, where peak flows would be reduced by over 13% (670 cfs). The relative benefits to peak flow reduction are lessened as storm events become larger, with an approximate 2% potential reduction shown for the 50-year event. Viewed alone, these results do not appear to represent a significant improvement in flood protection in the flood control reach. However, if implemented in conjunction with one or more of the other alternatives, Alternative 6 may prove to be a key component of a cost-effective strategy.

3.8.4. ENGINEERING DESIGN / IMPLEMENTATION COST ESTIMATES

Since land purchase or lease is the single largest cost associated with implementing this alternative, total project cost will be dependent upon the willingness of landowners to make these parcels available for such a use. Our initial cost estimates were developed with assistance from local real estate professionals who provided estimated purchase costs on a per-acre basis. Actual purchase costs may vary substantially from those presented in our analysis due to development pressures or changing market conditions. The cost estimate assumes that Alternative 3a is implemented and that additional costs associated with land acquisition and construction-related activities are needed. Typical unit costs were assumed for grading, revegetation, and other construction-related activities, based on recent experience. In the absence of detailed topographic data for each site, only approximate estimates were possible for the cost of items like drainage details and site access, which were roughly tied to the size of the proposed basins. Year 1 costs for the project are estimated at $8,600,000, which includes $4,700,000 related to implementation of Alternative 3a. The 10-year cost, including infrastructure and maintenance, is estimated to be approximately $12,000,000 (Table 3.12).

Indirect costs associated with flood impacts beyond the expected level of protection provided by this alternative were calculated. The levee overtop scenario, assuming no freeboard, was used to calculate the expected frequency of flooding in farmland located to the south of the levee with an overtop point located approximately halfway between the Highway 1 and 22nd Street Bridges. The flood protection with 2 feet of freeboard was used to calculate the frequency of farmland inundation because a hydrograph required to overtop the levees could not be determined. Under Alternative 6, a total of 700 acres would flood every 12.1 years or approximately 58 acres per year. The cost of crop loss and clean up was estimated at $8,000 per acre. Based on these assumptions, the estimated 10-year indirect cost due to flooding beyond the protection level provided by Alternative 1 was calculated to be $6,900,000 considering an annual inflation rate of 4% (Table 3.12).

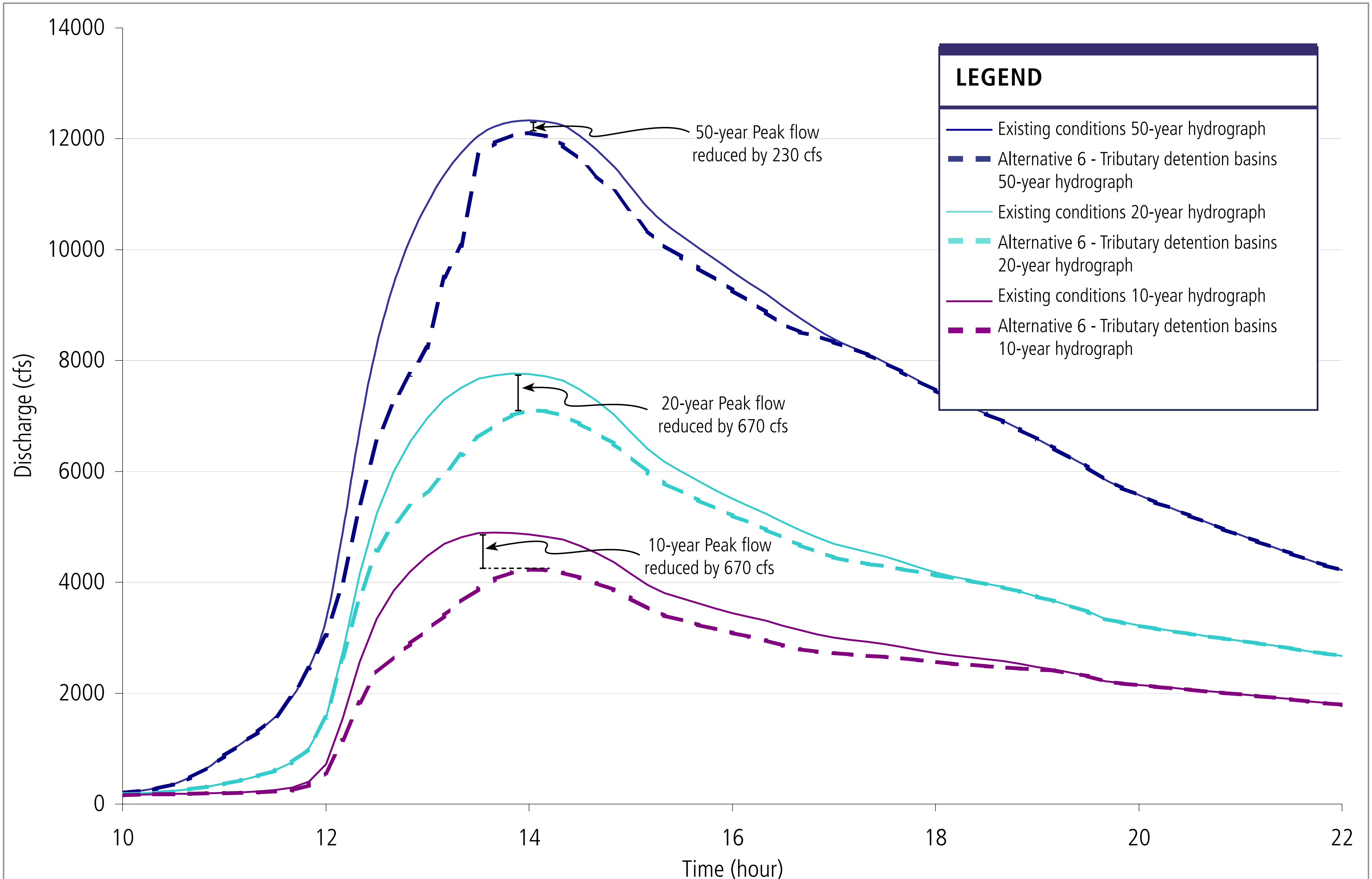

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FIGURE 3.23: Estimated flood attenuation benefit in the flood control reach using 50-year, 20-year, and 10-year hydrographs assuming all project sites proposed under Alternative 6 are developed for flood management. The modeling approach used the existing conditions HEC-HMS model to estimate changes to the flood hydrograph under proposed conditions.

ALTERNATIVE 6 - UPPER WATERSHED STORAGE

ESTIMATED INFRASTRUCTURE COST

ITEM	UNIT	COST/UNIT	# UNITS	TOTAL COST	SUBTOTAL
ALT 3A (INFRASTRUCTURE COST)	LS	$831,560	1	$1,222,765	$1,222,765
SITE ID#4 LOCATED BETWEEN UPPER ARROYO GRANDE RD AND ARROYO GRANDE CREEK					**$237,879**
LAND PURCHASE / LEASE[2]	AC	$25,000	2.39	$59,750	
TEMPORARY ACCESS ROADS	LS	$10,000	1	$10,000	
CLEARING AND GRUBBING	AC	$7,500	2.39	$17,925	
GRADING	CY	$20	4,580	$91,600	
REVEGETATION	AC	$3,600	2.39	$8,604	
MISCELLANEOUS DRAINAGE STRUCTURES	EA	$50,000	1	$50,000	
SITE ID#5 ISOLATED FROM MAIN FARMLAND BY CREEK AND ROAD					**$243,317**
LAND PURCHASE / LEASE[2]	AC	$25,000	3.97	$99,250	
TEMPORARY ACCESS ROADS	LS	$50,000	1	$50,000	
CLEARING AND GRUBBING	AC	$7,500	3.97	$29,775	
GRADING	CY	$20	1,000	$20,000	
REVEGETATION	AC	$3,600	3.97	$14,292	
MISCELLANEOUS DRAINAGE STRUCTURES	EA	$30,000	1	$30,000	
SITE ID#6 HISTORICAL FLOODPLAIN SITE ON MAINSTREAM ARROYO GRANDE CREEK					**$347,683**
LAND PURCHASE / LEASE[2]	AC	$25,000	6.03	$150,750	
TEMPORARY ACCESS ROADS	LS	$50,000	1	$50,000	
CLEARING AND GRUBBING	AC	$7,500	6.03	$45,225	
GRADING	CY	$20	4,000	$80,000	
REVEGETATION	AC	$3,600	6.03	$21,708	
MISCELLANEOUS DRAINAGE STRUCTURES	EA	$40,000	1	$40,000	
SITE ID#7 LOCATED AT MOUTH OF CORRALITOS CREEK					**$1,756,945**
LAND PURCHASE / LEASE[2]	EA	$750,000	2	$1,500,000	
TEMPORARY ACCESS ROADS	LS	$50,000	1	$50,000	
CLEARING AND GRUBBING	AC	$7,500	4.15	$31,125	
GRADING	CY	$20	6,044	$120,880	
REVEGETATION	AC	$3,600	4.15	$14,940	
MISCELLANEOUS DRAINAGE STRUCTURES	EA	$40,000	1	$40,000	
SITE ID#9 LOCATED AT MOUTH OF TAR SPRINGS CREEK					**$395,480**
LAND PURCHASE / LEASE[2]	AC	$25,000	6.80	$170,000	
TEMPORARY ACCESS ROADS	LS	$10,000	1	$10,000	
CLEARING AND GRUBBING	AC	$7,500	6.80	$51,000	
GRADING	CY	$20	5,000	$100,000	
REVEGETATION	AC	$3,600	6.80	$24,480	
MISCELLANEOUS DRAINAGE STRUCTURES	EA	$40,000	1	$40,000	

TABLE 3.12: Estimated costs for Alternative 6 - Tributary Flood Attenuation. Costs are presented separately for each alternative. The total cost of the project over 10 years is also presented as a way to compare costs between alternatives to assist in selecting a preferred alternative.

SITE ID#10 LOCATED AT MOUTH OF CANYON DE LOS ALISOS					**$155,594**
LAND PURCHASE / LEASE[2]	AC	$25,000	1.54	$38,500	
TEMPORARY ACCESS ROADS	LS	$30,000	1	$30,000	
CLEARING AND GRUBBING	AC	$7,500	1.54	$11,550	
GRADING	CY	$20	2,000	$40,000	
REVEGETATION	AC	$3,600	1.54	$5,544	
MISCELLANEOUS DRAINAGE STRUCTURES	EA	$30,000	1	$30,000	
SITE ID#14 LOCATED AT CONFLUENCE OF CARPENTER AND CORBITT					**$680,170**
LAND PURCHASE / LEASE[2]	AC	$25,000	11.70	$292,500	
TEMPORARY ACCESS ROADS	LS	$15,000	1	$15,000	
CLEARING AND GRUBBING	AC	$7,500	11.70	$87,750	
GRADING	CY	$20	10,140	$202,800	
REVEGETATION	AC	$3,600	11.70	$42,120	
MISCELLANEOUS DRAINAGE STRUCTURES	EA	$40,000	1	$40,000	
SITE ID#18 LOCATED AT MOUTH OF LOS BERROS U/S OF FLOOD CONTROL REACH					**$900,871**
LAND PURCHASE / LEASE[2]	AC	$25,000	11.11	$277,750	
TEMPORARY ACCESS ROADS	LS	$15,000	1	$15,000	
CLEARING AND GRUBBING	AC	$7,500	11.11	$83,325	
GRADING	CY	$20	22,240	$444,800	
REVEGETATION	AC	$3,600	11.11	$39,996	
MISCELLANEOUS DRAINAGE STRUCTURES	EA	$40,000	1	$40,000	
			SUBTOTAL	$5,980,704	
		CONTINGENCY	20%	$1,196,141	
		ADMINISTRATION AND PERMITTING	8%	$478,456	
		ENGINEERING AND DESIGN	13%	$932,990	
			TOTAL INFRASTRUCTURE COST	**$8,588,291**	

10-YEAR ESTIMATED MAINTENANCE COST

ITEM	UNIT	COST/UNIT	# UNITS	YEARS	INFLATION	TOTAL COST
YEARLY VEGETATION MANAGEMENT	YR	$80,000	1	9	4%	$1,024,785
YEARLY SEDIMENT MANAGEMENT	YR	$140,000	1	9	4%	$1,793,373
					SUBTOTAL	$2,818,157
				CONTINGENCY	20%	$563,631
				ADMINISTRATION AND PERMITTING	3%	$84,545
					TOTAL 10 YEAR MAINTENANCE COST	**$3,466,334**
					TOTAL 10 YEAR COST	**$12,054,625**

ESTIMATED INDIRECT COST DUE TO FLOODING

ITEM	UNIT	COST/UNIT	# UNITS	YEARS	INFLATION	**TOTAL COST**
FARMLAND INUNDATION (700 ACRES EVERY 12.1 YEARS)	AC/YR[1]	$8,000	58	10	4%	**$6,856,492**

[1] UNITS CALCULATED BY 700 ACRES / 12.1 YEARS

[2] UNIT COST OF LAND ASSUMES BASIN CONSTRUCTION WOULD NOT OCCUR ON OTHERWISE DEVELOPABLE SPACE

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TABLE 3.12 (cont.): Estimated costs for Alternative 6 - Tributary Flood Attenuation. Costs are presented separately for each alternative. The total cost of the project over 10 years is also presented as a way to compare costs between alternatives to assist in selecting a preferred alternative.

3.9. ADDITIONAL ALTERNATIVES[14]

3.9.1. STORAGE IN OLD LOS BERROS CHANNEL

As part of the Alternative 5 analysis, the old Los Berros channel was reviewed as a potential storage area for floodwaters emanating from the Los Berros Creek watershed. An existing flood gate located at the inlet of the old Los Berros channel would be retrofitted to allow flood flows to enter the old channel and bypass the flood control reach. This approach was considered infeasible for a number of reasons. First, the existing channel is overgrown and discontinuous, with structures and significant riparian vegetation already established along its alignment (these factors would cause the project to be expensive and have significant environmental impacts). Due to the location of the channel and locally high ground water table in the southern portion of the Cienega Valley, the area is also likely to be inundated with local drainage at the time the storage volume would be most needed, reducing its capacity to store additional flood waters. Further, the area's location and soil type make it very difficult to drain after a flood recedes, increasing the length of time during which there would be impacts on crop production.

3.9.2. STORAGE BASIN IN VICINITY OF AIRPORT

The existing airport is another area that was considered for temporary floodwater storage, similar to the concept proposed under Alternative 5. However, due to the airport's location downstream of the high-risk areas, flood reduction benefits would be minimal. These benefits would be overshadowed by the potential impacts to existing infrastructure. Levee construction would be required to minimize impacts to residents in the Meadow Creek drainage, an area that already experiences flooding during peak events (Chipping, 1989).

3.9.3. LEVEE SETBACK ALTERNATIVE

The levee setback alternative was considered and briefly evaluated to provide protection for the 50-year flood. This alternative was assumed to be paired with Alternative 3c, which provides 20-year protection. The difference between the 50-year and the 20-year recurrence interval flow is 5,000 cfs. To provide conveyance for 5,000 cfs with an average depth of 4 feet, an estimated channel width of 200 feet would be required. The existing channel is approximately 70 feet wide. Widening the channel to 200 feet in all areas would require rebuilding or retrofitting the UPRR Bridge, the 22nd Street Bridge, and the Highway 1 Bridge, redesigning the new Highway 1 Bridge, purchasing up to 100 acres of highly productive farmland on the south side of the existing levee, and relocating several residences and business to accommodate the new levee. In addition, the existing levee would have to be removed and a new one built and habitat restoration would be

[14] These alternatives were evaluated at a cursory level with some rough hydraulic modeling conducted to determine the feasibility of the project to meet the flood protection and financial objectives of the project.

required in the expanded channel area. A ballpark price tag for this alternative was estimated to be in the range of $30 million.

Due to the extensive impacts on existing infrastructure that would be associated with such an approach, the cost of the levee setback alternative was considered prohibitive within the framework of this alternative study. Further analysis of a levee setback alternative is possible outside of the framework of this study and will likely be pursued as a potential long-term option to reduce flood risk through the flood control reach.

3.10. Summary of Cost / Benefit for Proposed Alternatives

Assessing project costs in relation to potential benefits is a valuable tool when comparing alternatives. In the case of this study a cost/benefit analysis is complicated by the fact that many of the alternatives are bundled, and are therefore tied to the performance and cost of previous alternatives. In addition, each alternative was analyzed based on the initial, or one year investment costs, as well as by the long-term costs over a ten year period, which accounts for maintenance of the proposed project.

Table 3.13 and Figure 3.24 summarize the costs and flood control benefits for Alternatives 1 through 6. A rough cost/benefit is provided in Table 3.13 for each alternative and is presented as a ratio between the dollar amounts of the project compared to the improvement in flood protection that each alternative provides, in *cubic feet per second*. The results for the 1-year analysis of cost and benefit vary considerably from the results for the 10-year cost/benefit analysis. For example, Alternative 1, which consists only of vegetation maintenance, is the most cost effective alternative for the first year of implementation. However, extrapolated out over a ten year period, it ranks 6th out of 10 potential options because it requires similar expenditures year after year in order to maintain the project with no additional flood protection benefit. Over a ten year period, the most cost effective approach to flood reduction was calculated to be Alternative 3a because it provides 10-year protection at a relatively low cost. If the UPRR Bridge is added to Alternative 3a in response to concerns from Union Pacific that the 50-year flood protection requirement is not met, then Alternative 3a becomes a less attractive alternative because it only provides 10-year protection.

Alternative 5c was calculated to be the next best alternative because it provides 50-year protection. What is not considered in this analysis is the potential difficulty of implementing Alternative 5 because it requires flood easements to be negotiated and secured. Alternative 4 ranked 4th in this analysis and may be an interesting option to consider for implementation. Sediment management was removed from this alternative to address concerns from regulatory agencies about the possible impact to steelhead, red-legged, and tidewater goby due to recurring disturbance of the bed of the channel with heavy equipment. This option would become even

Parameter	Existing conditions	Alternative 1 Vegetation control	Alternative 2 Vegetation control and sediment management	Alternative 3a Levee smoothing (10-yr)	Alternative 3b Levee raise (15-yr)	Alternative 3c Levee raise (20-yr)	Alternative 4 Levee raise (20yr) w/o sediment management	Alternative 5a Overflow weir and storage	Alternative 5b Overflow weir and storage	Alternative 5c Overflow weir and storage	Alternative 6 Upper watershed storage
Infrastructure cost	$ 0	$ 107,508	$ 805,388	$ 1,222,765	$ 6,213,906	$ 7,505,711	$ 6,799,168	$ 6,247,392	$ 14,579,802	$ 11,991,679	$ 8,588,291
Maintenance cost	$ 0	$ 1,250,237	$ 3,466,334	$ 3,466,334	$ 3,466,334	$ 3,466,334	$ 1,250,237	$ 3,466,334	$ 3,466,334	$ 3,466,334	$ 3,466,334
Ten-year cost	$ 0	$ 1,357,745	$ 4,271,722	$ 4,689,099	$ 9,680,240	$ 10,972,045	$ 8,049,405	$ 9,713,726	$ 18,046,135	$ 15,458,013	$ 12,054,625
Indirect cost	$	$ 11,368,276	$ 9,947,242	$ 4,973,621	$ 3,671,006	$ 2,249,971	$ 2,368,391	$ 3,138,118	$ 1,212,616	$ 1,567,875	$ 6,856,492
Flood protection (with no freeboard)	4.6yr	7.3yr	8.3yr	16.6yr	22.4yr	37.4yr	34.4yr	--	--	--	--
Capacity (with no freeboard)	2500 cfs	4000 cfs	4500 cfs	7500 cfs	9000 cfs	11500 cfs	11000 cfs	--	--	--	--
Flood protection (with 2' of freeboard)	2.8yr	4.1yr	4.6yr	10yr	15yr	20yr	16.6yr	20yr	50yr	50yr	12.1YR
Capacity (with 2' of freeboard)	1300 cfs	2200 cfs	2500 cfs	5400 cfs	7000 cfs	8600 cfs	7500 cfs	8600 cfs	13600 cfs	13600 cfs	6070 CFS
Ten-year cost per increase in capacity	-	1509	3560	1144	1698	1503	1298	1331	1467	1257	2527
Rank	-	6	10	1	8	7	4	3	5	2	9
Year one cost per increase in capacity	-	119	671	298	1090	1028	1097	856	1185	975	1800

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TABLE 3.13: Cost benefit analysis table for Alternatives 1 through 6. The cost of each project per unit increase in channel capacity ($/cfs) is calculated for the first year (infrastructure) costs and the 10 year cost (infrastructure and maintenance). The cost/benefit of each alternative may change if analyzed over different time periods.

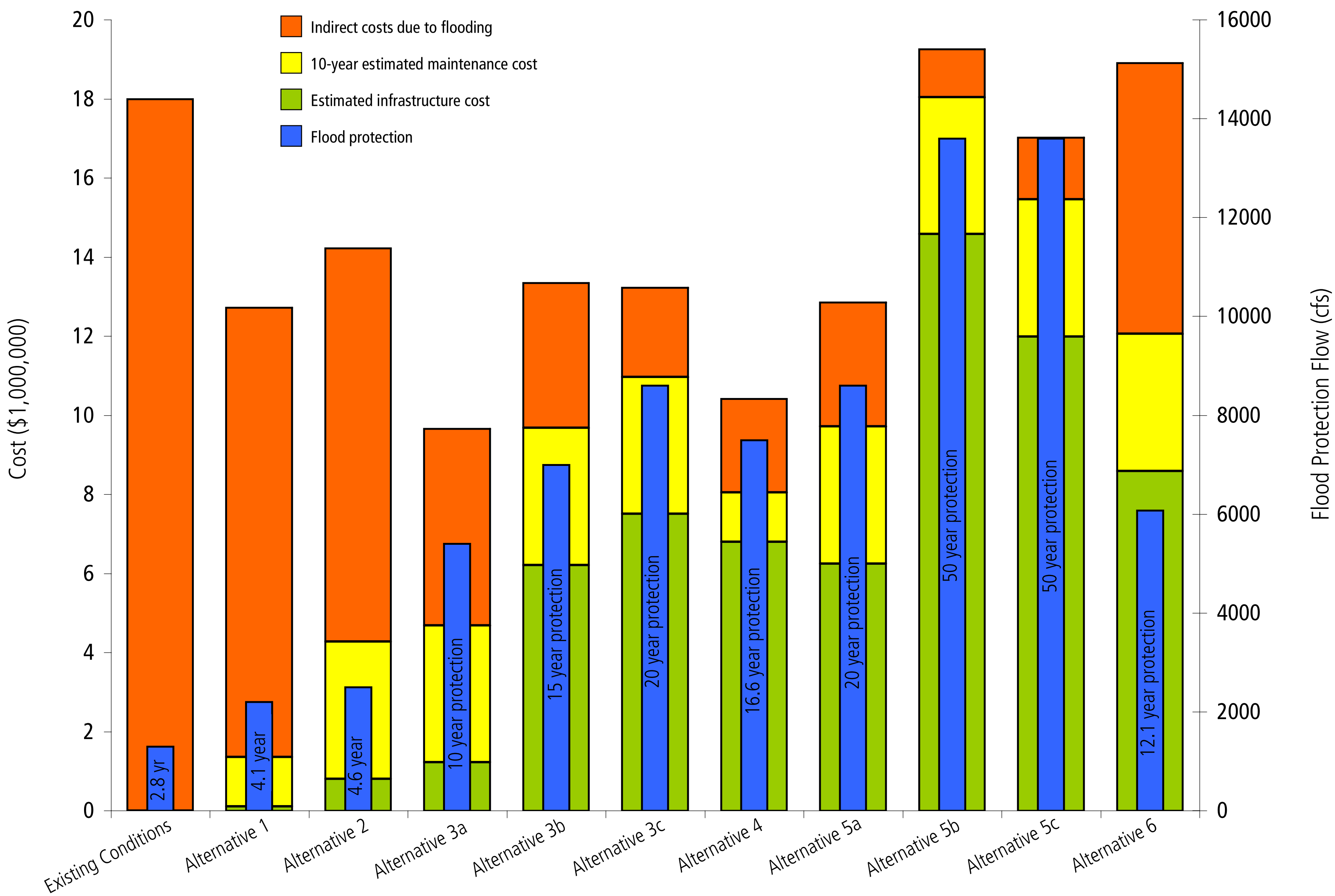

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FIGURE 3.24: Summary of project costs and level of flood protection for each proposed alternative. Estimated costs due to farmland inundation is also shown to illustrate flooding costs that are offset as additional flood protection is achieved.

more competitive if a grant or other sources of funding become available to raise the UPRR Bridge.

Project cost and benefit was also analyzed using a simple rating scale from 1 to 10 for three criteria, with a score of 10 given to the alternative with the best performance for the given criteria. The criteria analyzed were costs extrapolated over 10 years, level of flood protection, and expected regulatory requirements associated with getting the alternative implemented (Table 3.14). The regulatory requirement criteria considered the number of agencies that would be involved in the permitting process, the potential environmental impacts of the project, the permitting expense, and the potential for mitigation to be included in the project to offset potential environmental impacts.

Each criteria was weighted based on our understanding of the importance of each to the decision making process. Cost was given a weight of 40%, level of flood protection was given a weight of 50%, and the regulatory requirement criteria were given a weight of 10%. The weighting factor was applied to values from each category and the total was summed to produce a final rating for each alternative. As shown in Table 3.14, rating totals for the proposed alternatives ranged from 4.2 to 6.2 out of a total possible score of 10. The alternatives with the highest rankings were Alternatives 5c and 4. The alternative with the lowest ranking was Alternative 6. The approach used in the alternative analysis is subjective, but it provides a way to compare each alternative based on multiple criteria rather than through a simple cost/benefit ratio. Similarly to the analysis of cost/benefit discussed previously, including the costs for the UPRR Bridge raise skews the cost/benefit results, favoring those alternatives that do not include the bridge raise.

3.11. RECOMMENDATION

The stated goal of the flood reduction portion of this study is to analyze potential alternatives and provide a recommended alternative that would meet or exceed the 1955 design capacity of 7,500 cfs with 2 feet of freeboard. The most cost effective alternative that minimally meets the stated goal is Alternative 4. Alternative 4 consists of the following elements:

- Vegetation Management: Initial and annual vegetation management consisting of protection of a 10-foot riparian buffer on both sides of the low flow channel with vegetation removal elsewhere. Branches lower than 6 feet within the 10-foot buffer would be selectively thinned to provide adequate flood conveyance. Vegetation maintenance would occur in the Fall of each year with expected regrowth in late winter/ spring. Vegetation management would be done with hand crews and no work would be done in the wetted channel.
- Levee Raise: The existing levees would be raised to provide 20-year flood protection. All work would be conducted at the top and landward side of the levee to limit impacts

		Alternative 1	Alternative 2	Alternative 3a	Alternative 3b	Alternative 3c	Alternative 4	Alternative 5a	Alternative 5b	Alternative 5c	Alternative 6
Advantages	**Weight**	**Vegetation Control**	**Vegetation Control and Sediment Removal**	**Levee Smoothing**	**Levee Raise (15 year)**	**Levee Raise (20 year)**	**Levee raise (20-yr) without sedimetn management**	**Overflow and Weir Storage**	**Overflow and Weir Storage**	**Overflow and Weir Storage**	**Upper Watershed Storage**
Project Costs over 10-yrs	40%	10	8.5	8.5	6	5	6.5	5.5	1	2.5	4
Level of Flood Protection	50%	1	2	4	5	6.5	5.5	6.5	10	10	4.5
Regulatory Requirements	10%	10	6	6	4	4	8	5	5	2	3
Total Score	**100%**	**5.5**	**5.0**	**6.0**	**5.3**	**5.7**	**6.2**	**6.0**	**5.9**	**6.2**	**4.2**

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TABLE 3.14: Alternative analysis matrix for Alternatives 1 through 6. Project elements, including cost, level of protection, and regulatory requirements, are assigned a ranking from 1 to 10 and then weighted by the degree to which they would affect implementation. The result is a weighted score for each alternative that could be used to select a preferred alternatives.

within the channel. The levee raise would require that capacity be increased at the Union Pacific Railroad Bridge with one alternative being a bridge raise or replacement.

Sediment management was removed from Alternative 3c (to create Alternative 4) due to concerns about the environmental impacts associated with sediment removal and annual "bar-ripping". If the potential is there to allow the initial sediment removal operation without the annual "bar-ripping" option, then we feel that option should be pursued. We think it is important to remove the sediment that accumulated during the 2001 event and establish the recommended secondary channels to convey sediment more efficiently in the future. "Bar ripping" could be substituted with annual thinning of vegetation in the secondary channels.

In summary, our recommendation is to pursue an alternative that includes elements of Alternatives 3c and Alternative 4 to achieve 20-year flood protection. In the long-term it may be possible to pursue a levee setback option, but at the present time that option appears financially infeasible.

4. Sediment Budget / Transport Analysis

4.1. Constructing the Sediment Budget / Background

4.1.1. Description

Development of a sediment budget is an approach that considers the erosion processes occurring in a particular study area and attempts to quantify the amount of material being delivered and transported past a specific point of interest. If the amount of sediment being delivered exceeds the amount of sediment being transported, aggradation is the dominant process. If the amount of sediment being transported exceeds the amount being delivered, the stream channel is likely to be incising. If both delivery and transport of sediment are equal, the stream channel is said to be in equilibrium.

This simplified notion of a sediment budget is complicated because both sediment delivery and transport within a stream channel are *stochastic* processes (Benda and Dunne, 1997a; Benda and Dunne, 1997b). This means that sediment delivery to the channel occurs episodically through mass wasting events such as landslides, bank failure, or debris flows. Sediment transport is also a function of the magnitude, duration, and energy associated with streamflow, which can change significantly over time periods as short as a few hours. Sediment transport volumes during wet years can be orders of magnitude greater than those recorded in drought years. The same is true for sediment delivery. During wet years, a saturated hillslope in a steep inner gorge is much more likely to fail and deliver sediment to a stream channel than the same hillslope during a dry year. Over time, it is likely that episodic delivery and transport events even out, producing what is known as a system in dynamic equilibrium. The question often remains, over what time scale is the concept of dynamic equilibrium occurring within any given reach of stream?

The stochastic nature of sediment delivery and transport makes it very difficult to accurately estimate a sediment budget given limited data. Monitoring movement of suspended and bed load material passing a set location, such as a bridge, would require one to two decades of data to capture the range of flow and sediment events that characterize the stochastic nature of the process. It would not be uncommon for a single year, within a 20-year dataset, to represent over 50% of the total sediment load measured during that period. If that single year were removed, the average flux of sediment, per year, would be greatly underestimated.

There are also difficulties in estimating the supply side of the sediment budget equation that go beyond the stochastic nature of the process. In many cases it is very difficult to apply a rate to any particular erosion source. Sources of erosion can easily be identified in the field, and the volume of sediment being eroded and delivered to an adjacent stream channel can be estimated. The difficulty lies in estimating the rate at which the sediment is being delivered. Without information about how long ago a particular source began to erode, sediment volume information becomes meaningless.

In some cases this problem has been overcome through the use of aerial photo series. Several photo dates can be examined to constrain the date at which a particular erosion feature, such as a landslide, began delivering sediment. By estimating sediment volumes from many landslides throughout a particular watershed from a series of aerial photos, a landslide rate for the landscape of interest can be estimated (Reid and Dunne, 1996). Unfortunately, aerial photo interpretation of erosion features becomes problematic in a landscape with dense tree cover. Features such as landslides, debris flows, or gullies, are in most cases impossible to see, unless they are recent or very large. Mapping these features in a densely vegetated area with the intent of estimating a sediment budget can be very misleading.

The quality of the results generated from a sediment budget will ultimately be related to the quality of the input data and the amount of time and information that is available to accurately construct the budget (Reid and Dunne, 1996). To accurately quantify the rate at which sediment is being supplied to the channel would require years of intensive data collection and monitoring equipment, as well as access to all, or a statistically random subsample of potential sources. Since such an intensive approach is often not feasible, the best approach lies in identifying the most significant sources of sediment for a watershed and obtaining as much information as possible about the physical setting of the landscape that might help infer a certain rate of erosion, and applying published erosion rates from other watersheds that exhibit similar patterns of erosion.

Regardless of the difficulties in estimating sediment budgets, particularly in forested areas, the results can be a valuable dataset when attempting to understand the dominant erosion processes, and the sources of sediment that may be impairing aquatic habitat. The exercise of estimating a sediment budget requires careful consideration of each potential source, the magnitude of delivery by that source, a description of the grain-sizes being delivered, and a comprehensive understanding of the transport hydraulics within a stream channel. Even though the final sediment budget numbers may contain a significant amount of error, there is much to be understood from them. The magnitude to which each source contributes to the overall sediment budget and the location of those sources within the watershed, as a whole, are valuable pieces of information that can guide current and future management.

The first step in developing a sediment budget is to determine the location at which we are interested in quantifying the amount of sediment being transported through the system. Since we are concerned about the conditions of the entire watershed, and how those conditions affect sediment delivery to the flood control reach of Arroyo Grande Creek, the most logical location to calculate a sediment budget would be at the upstream end of the flood control reach, just downstream of the confluence with Los Berros. Upstream of this location lies a variety of subwatersheds that exhibit different morphologic, geologic, and land use conditions that must be considered to accurately estimate rates of erosion and sediment input to the stream channel.

To capture the variability in landscape and land use conditions in the watershed, while at the same time taking advantage of the dendritic nature of stream channels, we divided the watershed into subwatershed areas, as defined by the confluence of tributary inputs and/or significant changes in the geology or land use (Figure 4.1). Subwatersheds were delineated automatically using a USGS 30-meter digital elevation model (DEM) of the landscape based on points manually selected that represented the lowest "pour point" within each subwatershed. Standard GIS algorithms were used to derive the subwatershed boundaries from the input digital data source. In flatter areas, where the GIS-derived sub watersheds are less accurate, we manually delineated the subwatershed boundaries based on 7.5-minute USGS topographic maps.

The derived watersheds were the primary analysis units used to calculate erosion from the landscape and estimate sediment delivery to the channel, except for the bank erosion and channel incision components of the sediment budget, for which we used alluvial stream reach delineations (discussed later). A total of eight subwatersheds were delineated for the sediment budget analysis including the mainstem Arroyo Grande (includes minor subwatersheds not delineated separately), Los Berros, Newsom Canyon, Tar Springs, Canyon De Los Alisos (tributary to Tar Springs), the area defined as the Northern Subwatersheds (consisting of Corralitos Canyon and several other subwatersheds that drain the northwest portion of the analysis area), Corbitt/Carpenter Creeks, and the Meadow Creek subwatershed. Though a sediment budget was calculated for Meadow Creek, it was not added to the sediment budget estimate for the watershed since the outlet occurs downstream of the flood control reach, and much of the sediment delivered from the Meadow Creek watershed is stored in Pismo Lake and the lower lagoon reach, with little to no sediment reaching the mainstem Arroyo Grande.

4.1.2. MODEL PARAMETERS

As part of the preliminary fieldwork associated with development of the Arroyo Grande Creek Watershed Management Plan, we identified the primary erosion processes that dominate sediment production in the lower Arroyo Grande Creek watershed. The processes identified include headward expansion of drainage networks and associated gullying, bank erosion combined with long-term channel incision, erosion from roads, erosion associated with rilling and sheetwash from agricultural and natural lands, debris flows and landsliding, and erosion from bare areas resulting from urban development.

For this study, we took a thorough look at each of the dominant erosional processes and attempted to estimate rates of erosion, evaluated the potential for that sediment to be delivered and transported to the channel through a delivery efficiency calculation, and quantified total sediment delivery. These components of the sediment budget required an understanding of

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FIGURE 4.1: Subwatershed boundaries of the Lower Arroyo Grande Watershed. These subwatersheds were the primary analysis units used to develop the sediment budget.

conditions found in the watershed, focused field work to attempt to define specific erosion rates, and use of previously published rates of erosion for components of the sediment budget that were difficult, if not impossible, to measure directly.

Bank Erosion / Channel Incision

The mainstem of the Arroyo Grande Creek channel (downstream of Lopez Dam), under existing conditions, in no way resembles the channel in the late 1800's. A geomorphic analysis of how the channel looked and functioned historically is described in detail in "Appendix B – Geomorphic and Hydrologic Conditions Assessment" of the Arroyo Grande Creek Watershed Management Plan. In summary, the Creek was likely at grade with the valley prior to intensive agricultural development. Confinement and active entrenchment of the channel led to increased incision and bank erosion as all the flow and energy became focused in one distinct channel. Much of the channel incision was probably complete by the early to mid 1900's as the bed of the creek incised into bedrock, thereby resisting additional incision due to the presence of natural grade control. Following the rapid incision of the late 1800's and early 1900's, the creek transitioned into a phase where much of the excess energy resulted in bank erosion and widening of the stream bed in an effort to develop floodplain and sediment deposition areas.

While the mainstem of Arroyo Grande Creek was being modified and incised, the lower, alluvial dominated reaches (Figure 1.3) of the major tributaries, such as Los Berros, Tar Springs, and Corbitt/Carpenter, were being straightened and managed to increase agricultural land and provide for predictable flow paths. Incision of these creeks into confined channels was likely accelerated by incision in the mainstem, causing the tributaries to incise to match the new base level of the mainstem.

To estimate the rate of erosion and sediment delivery derived from historic and ongoing channel incision and bank erosion, we conducted surveys of each of the primary channels. A GPS unit was used to develop a longitudinal profile of the bed of the channel and a similar profile for the valley bottom, which functions as a terrace in most locations in the watershed. Bank to bank width at the GPS collection point was then either measured directly or estimated depending on the location. Points were taken at all publicly accessible locations on the mainstem and key tributaries where channel incision and bank erosion was determined to be an accelerated process, either through land use management or active means.

Channel geometry data collected in the field was then used to calculate the quantity of material excavated from the historic alluvial fill material via channel incision and bank erosion. This estimate produced a volume of material in cubic feet. In order to convert a sediment volume to a mass, we assumed a soil density of 123.5 pounds per cubic feet of material (lbs/ft^3) according to Holtz and Kovacs (1981). Conversion of the estimated volume to a mass assumes that the alluvial soils are dominated by sand and are fairly well consolidated. The estimated sediment mass was then converted to tons per year by dividing by 115, which assumes a starting point of incision occurring in approximately the year 1890. The final result was multiplied by a ratio of 0.6 to account for incision prior to 1890, active "ditching" of the channel to establish a predictable flow path (Brown, 2002), and the possibility that the channel was not at the elevation of the valley in 1890. A ratio of 0.6 assumes that 60% of the observed incision occurred since 1890 and resulted in sediment being transported downstream; 40% of the observed incision would be due to the factors previously mentioned. A ratio of 0.6 constitutes a rough estimate based on field observations and a general understanding of past conditions and the history of development.

Sheet and Rill Erosion (Includes General Surface Erosion)

Sheet and rill erosion describes the general process of erosion that occurs on the landscape when either rainfall rates exceed the capacity of the soil to absorb the rainfall (known as the soil infiltration rate) or the soil becomes saturated and is therefore unable to absorb any excess precipitation. The result is direct runoff over the surface of the land. Sheet erosion describes the runoff process whereby the flow is evenly distributed across the land surface and hillslope resulting in relatively even erosion. Rill erosion describes the process where minute streams of water cut separate channels. The concentration of runoff into rills causes an increase in the efficiency and intensity of soil removal and can eventually lead to gully formation.

The extent to which sheet and rill erosion becomes a significant component of sediment supply in a particular area is directly tied to the topography, cover type, and land use. To reflect different degrees of sediment delivery from a landscape due to sheeting and rilling, erosion rates were assigned by land use type according to the rates shown in Table 4.1.

Table 4.1: Erosion rates by land use due to sheeting and rilling. These rates were applied to a land use layer to estimate sediment contributions from different land use types

Land Use	Reference Source	Rate Source	Rate in tons/acre/year
Urban	Morro Bay TMDL	Chorro Creek - Urban	1.19
Rural Residential	Morro Bay TMDL	Chorro Creek – Average of Brush land and Urban	2.59
Cropland	Morro Bay TMDL	Chorro Creek - Cropland	3.31
Rangeland / Natural Land	County of San Luis Obispo	Upper Arroyo Grande Creek watershed upstream of Lopez	3.80

Urban, rural residential, and cropland rates of erosion due to sheeting and rilling were adopted from sediment budget work conducted for a Total Maximum Daily Load (TMDL) on Chorro Creek in the Morro Bay watershed. The Morro Bay watershed was used because it is nearby and has similar topography, cover types, and land use as the Lower Arroyo Grande Creek watershed. Differences do exist in soil types between Morro Bay and Arroyo Grande. Soil types in the northern portion of the Arroyo Grande watershed, particularly around the Corralitos and Corbitt-Carpenter drainages, are extremely sandy and unconsolidated. The Morro Bay watershed also contains more bedrock from the Franciscan mélange, whereas the Arroyo Grande contains more shale, particularly in the Los Berros and Tar Springs drainages. Despite their differences, Morro Bay presents the closest corollary to extrapolate measured rates of erosion to conditions found on the Lower Arroyo Grande. Other potential options would include a forested watershed in Santa Cruz County or a steep headwater stream in the Transverse Ranges in southern California.

Rates of erosion from rangeland and natural land were estimated based on sedimentation rates measured in Lopez Reservoir. Consequently, the rates used for rangeland and natural land reflect erosion not just from sheeting and rilling but other surface erosion processes such as dry raveling, shallow landsliding, and bank erosion in the upper watershed. Since lands designated as rangeland or natural land only occur in the headwaters, where other erosion rates applied as part of this sediment budget do not overlap, applying an all-inclusive rate does not result in the potential for overestimating sediment contribution.

The erosion rates shown in Table 4.1 were combined with a GIS layer representing the four land use types and their locations in the Arroyo Grande Creek watershed (Figure 4.2). The GIS layer used for this analysis was developed by synthesizing existing GIS layers available through various sources, such as land-use/land cover layers available through USGS, land use layers available through the County, and city boundary layers, into one layer that represented the four land use types. Average erosion rates for each subwatershed were calculated using the area weighted average method.[15]

Gully Erosion / Headward Expansion of Drainage Network

Gully erosion consists of rills in a landscape, which persists and enlarges over time into permanent features. Formally, a rill becomes a gully when the channel is engraved into the land surface to a depth greater than one foot. Headward expansion of an existing drainage network could be considered a type of gully when increased runoff, often due to impervious surfaces or land clearing, causes channel expansion to occur in headwater areas where flow concentration had not previously occurred.

[15] The area weighted average method is an approach used to calculate a spatial average within a defined map boundary where the data is not equally represented. Each value is first multiplied by the area it is represented in, the resulting totals are summed and then divided by the total area. It is a standard method used in spatial analysis.

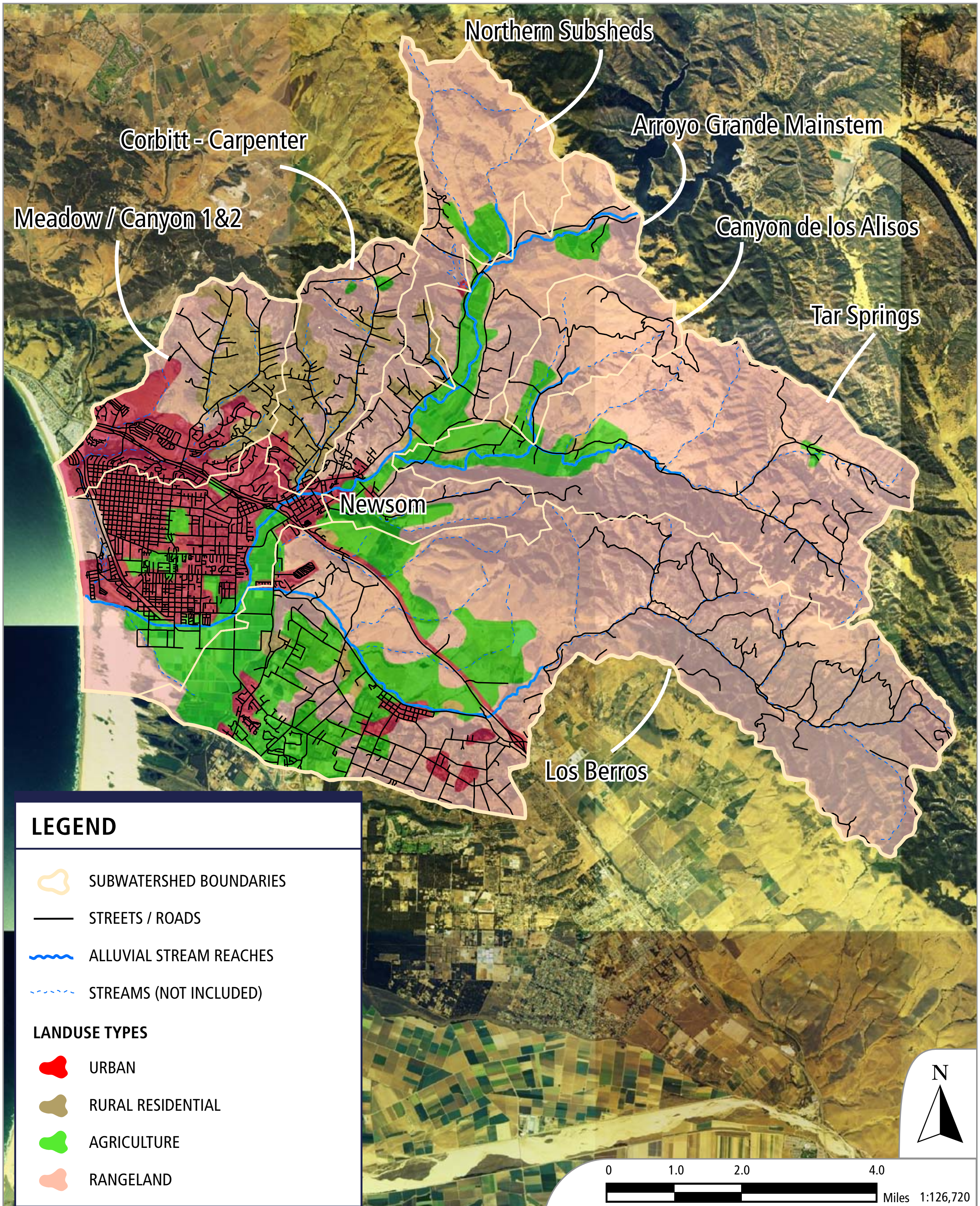

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FIGURE 4.2: Land use classification, roads, and alluvial stream reach data for the Lower Arroyo Grande Creek watershed. These data were used to generate length and area statistics for development of the sediment budget. Alluvial stream reaches were classified by SH+G staff based on field surveys. Road information and land use data were adopted from a GIS database developed by Cal Poly San Luis Obispo and San Luis Obispo County (GIS data source: SLO data finder).

In our original identification of the dominant erosion processes that were described in the Arroyo Grande Creek Watershed Management Plan (CCSE, 2005), we identified gully erosion and headward expansion of drainage networks as an important part of the overall sediment budget. Further analysis of the importance of this process in the watershed suggests that, although there may be localized areas of high sediment production, averaged across the landscape it is probably less of a factor than other erosion processes. This is supported by the literature where researchers found that gullying only represented between 1 and 4 percent of the total sediment budget in several studies (Leopold et al., 1966; Brune, 1950; Glymph, 1957). In addition, much of the headward expansion of channels in the watershed may have occurred historically, when land was originally converted from natural areas to orchards, agriculture, and rangeland. Current erosion associated with urban development is already being calculated as part of the channel incision analysis. Headward expansion is not likely to occur due to urban development since buildings and infrastructure would be threatened.

To estimate an erosion rate for the watershed due to gully formation and headward expansion, rates published for the Chorro Creek watershed as part of a USDA Soil Conservation Service (SCS) study entitled, "Erosion and Sediment Study – Morro Bay Watershed" (1989), were used. The Chorro Creek work consisted of a comprehensive mapping program that included measuring gullies throughout the watershed in order to estimate a rate of erosion. Recent sediment source assessment work conducted in the Morro Bay watershed by the National Estuary Program identified gully erosion and headward expansion as being a major source of erosion. That study did not identify erosion rates; therefore we relied solely on the 1989 study by the SCS. The SCS work produced an average gully erosion rate of 0.01 tons per acre per year (tons/ac/yr) for the entire Chorro Creek watershed. Though that rate appears to be extremely low compared to the rates for sheet and rill erosion, gully sites represent a small percentage of the total landscape, whereas sheet and rill erosion is calculated for the entire watershed.

Road Erosion

Road building is a common and often dominant theme in land use disturbance. From cattle ranching to driveways and public thoroughfares, roads are required for access to nearly every land use. Roads are by far the most destructive element in the landscape with regard to excessive fine sediment generation per unit area of land. Roads constructed along canyon floors and steep inner gorge slopes can result in channel realignment, causing direct delivery of sediment to streams. Erosion from road surfaces, ditches, and shoulders contribute mostly fine sediment. Paved and unpaved roads modify local hillslope drainage patterns, concentrate flow, and increase runoff rates. Runoff from roads concentrates over soils exposed on the roadbed and shoulder, drainage ditches, road cuts, sidecasts, and fills. Roads create chronic sources of erosion that contribute fine sediment to streams during most runoff events.

Erosion from roads in the lower Arroyo Grande watershed was estimated by applying measured erosion rates from the Chorro Creek work (USDA-SCS, 1989) to estimate an erosion rate per mile of road. The SCS estimated an erosion rate of 33.9 tons per mile per year by measuring sediment delivery from 189 miles of roads in the Chorro Creek watershed. This erosion rate was applied to approximately 385 miles of road in the Lower Arroyo Grande Creek watershed by subwatershed (Figure 4.2). Estimates of erosion were generated by using a GIS roads layer available through the SLO Data finder, a database developed through a joint venture between the San Luis Obispo County Planning Department and Cal Poly San Luis Obispo. A rate of 33.9 tons/mi/yr may overestimate the total contribution from roads, given the fact that the road network is more dense and urban in the lower Arroyo Grande watershed than roads located in the Chorro Creek watershed. No differentiation was made in the Chorro Creek study between paved urban, paved rural, and dirt roads. Comprehensive road surveys were not conducted as part of our analysis, though all roads were driven to identify significant point sources of erosion.

4.1.3. DELIVERY EFFICIENCY

Delivery efficiency is an important element of any sediment budget because it defines the proportion of sediment that actually makes it to the channel, as opposed to being deposited on the hillslope or the inside ditch of a road. The delivery efficiency of any specific grain is ultimately related to rainfall rates, length of drainage pathways, and proximity of the sediment source to a waterway. The precise fate of any single grain of sediment is difficult to know, but general assumptions can be made about the delivery efficiency of a particular source class of sediment.

Table 4.2 summarizes the delivery efficiencies used for the sediment budget analysis by erosion source class. The efficiency rates, listed as a percentage of the eroded material, are applied to the estimate of total erosion by source class and by subwatershed, to generate an estimate of the total sediment delivery rate to streams. Estimates of delivery efficiency are based on professional judgment and rates used in other published sediment budgets accepted by local Regional Water Quality Control Boards (Swanson and Dvorsky, 2001; Dvorsky and Wingfield, 2001).

Table 4.2: Delivery efficiencies to stream channels applied to sediment erosion rates.

Erosion Source Class	Delivery Efficiency
Streambank Erosion / Channel Incision	100%
Sheet and Rill Erosion	20%
Gully / Headward Erosion	80%
Road Erosion	40%

4.2. SEDIMENT BUDGET RESULTS

A sediment budget can be divided into three primary components that, when included together, comprise the "budget" portion of the analysis. The three components consist of the outflow (O) of sediment from the discharge point, the inflow (I) of sediment from the erosion sources (which are the components discussed in Section 4.1) and the change in storage (S) occurring at the point of interest. The equation, known as the sediment continuity equation, can be written as:

$$S = I - O$$

The storage component, S, in the case of the Arroyo Grande Creek flood control reach, is of particular importance because if the input (I) exceeds the output (O), the result will be storage within the flood control reach and loss of flood capacity. Because of the observed increase in sediment storage in the flood control reach, we know that sediment input (I) must exceed sediment output (O) resulting in positive storage (S). Lack of information about the quantity of sediment storage in the flood control reach due to past undocumented dredging, and lack of topographic data recording changes through time, means our focus is on estimating the input (I) and output (O) parameters of the continuity equation.

Sediment Yield from the Watershed (I)

Table 4.3 summarizes the results for the input portion of the sediment budget based on the approach outlined in Section 4.1. The results are presented by subwatershed and by sediment source type in order gain an understanding of what sources are contributing sediment to the channel. In addition, actual (tons/yr) and relative (tons/ac/yr) rates of erosion could be assessed in order to prioritize sediment reduction efforts per subwatershed (Figures 4.3 and 4.4).

The results present an estimated sediment yield from the entire watershed of approximately 105,000 tons per year, with a per acre average of 1.91 tons per year. Channel incision along the alluvial reaches of Arroyo Grande Creek and its tributaries accounted for approximately 79,600 tons/year or 76 percent of the total estimated yield. Sheet and rill erosion accounted for approximately 19,700 tons/year or 19%, while road erosion accounted for approximately 5,216 tons/year or 5%. Gully or headward erosion accounted for approximately 440 tons/year or 0.5% of the estimate annual sediment yield.

Sediment Flux Past the Point of Interest (O)

	Subwatershed	Feature Area (acres)	Erosion Rate (tons/acre/yr)	Erosion Volume (tons/yr)	Delivery Efficiency	Sediment Delivery Rate to Streams (tons/acre/yr)	Sediment Yield (tons/yr)	Total by Erosion Type (tons/yr)	Total Sediment Yield (tons/yr)	Total Sediment Yield (tons/ac/yr)
Sheet and Rill Erosion[1]	Arroyo Grande Mainstem	10,523	1.00	10,519	20%	0.20	2,104	19,719	105,003	1.91
	Los Berros	20,589	1.93	39,728	20%	0.39	7,946			
	Newsom	1,212	2.57	3,119	20%	0.51	624			
	Tar Springs	9,664	2.46	23,816	20%	0.49	4,763			
	Canyon de los Alisos	2,110	2.11	4,451	20%	0.42	890			
	Northern Subsheds	3,923	2.33	9,124	20%	0.47	1,825			
	Corbitt-Carpenter	2,986	1.46	4,371	20%	0.29	874			
	Meadow/Canyon 1&2	4,102	0.85	3,469	20%	0.17	694			
Gully Erosion	Arroyo Grande Mainstem	10,523	0.01	105.2	80%	0.008	84.2	441		
	Los Berros	20,589	0.01	205.9	80%	0.008	164.7			
	Newsom	1,212	0.01	12.1	80%	0.008	9.7			
	Tar Springs	9,664	0.01	96.6	80%	0.008	77.3			
	Canyon de los Alisos	2,110	0.01	21.1	80%	0.008	16.9			
	Northern Subsheds	3,923	0.01	39.2	80%	0.008	31.4			
	Corbitt-Carpenter	2,986	0.01	29.9	80%	0.008	23.9			
	Meadow/Canyon 1&2	4,102	0.01	41.0	80%	0.008	32.8			
	Subwatershed	Feature Length (miles)	Erosion Rate (tons/mi/yr)	Erosion Volume (tons/yr)	Delivery Efficiency	Sediment Delivery Rate to Streams (tons/mi/yr)	Sediment Yield (tons/yr)	Total by Erosion Type (tons/yr)		
Channel Incision[2] (alluvial reaches)	Arroyo Grande Mainstem	13.0	4,158	53,929	100%	4,158	53,929	79,627		
	Los Berros	5.8	2,247	13,079	100%	2,247	13,079			
	Newsom	0.0	0	0	100%	0	0			
	Tar Springs	5.0	2,018	10,112	100%	2,018	10,112			
	Canyon de los Alisos	1.5	482	743	100%	482	743			
	Northern Subsheds	1.5	72	108	100%	72	108			
	Corbitt-Carpenter	0.4	3,827	1,656	100%	3,827	1,656			
	Meadow/Canyon 1&2	0.0	0	0	100%	0	0			
Road Erosion	Arroyo Grande Mainstem	141.8	33.9	4,809	40%	13.56	1,923	5,216		
	Los Berros	114.7	33.9	3,887	40%	13.56	1,555			
	Newsom	4.2	33.9	143	40%	13.56	57			
	Tar Springs	27.4	33.9	930	40%	13.56	372			
	Canyon de los Alisos	8.6	33.9	291	40%	13.56	117			
	Northern Subsheds	6.7	33.9	228	40%	13.56	91			
	Corbitt-Carpenter	26.5	33.9	899	40%	13.56	360			
	Meadow/Canyon 1&2	54.6	33.9	1,852	40%	13.56	741			

1 - Sheet and Rill Erosion was determined to be the dominant process of erosion other than gully erosion, channel incision, or road erosion. To estimate the extent of sheet and rill erosion in each watershed, the following erosion rates were used according to land use: Urban = 1.19 tons/ac/yr; Rural Residential = 2.59 tons/ac/yr; Cropland = 3.51 tons/ac/yr; Rangeland and Natural Land = 3.83 tons/ac/yr

2 - Feature length for Channel Incision was only calcuated for stream reaches that were determined to be predominately alluvial where significant channel incision and/or bank erosion has occurred and is likely to continue to occur into the future. The length value was determined by calculating the stream length through alluvial sections. Though non-alluvial reaches may experience some incision and bank erosion, it was not considered to be a significant source of sediment.

TABLE 4.3: Estimated sediment budget for the Lower Arroyo Grande Creek watershed. Sediment budget results are presented by erosion type and by subwatershed based on measured and estimated erosion rates. Sediment erosion is then converted to a sediment yield delivered to stream channels through an estimate of the delivery efficiency. The result is a total sediment yield and a per unit area sediment yield for the study area.

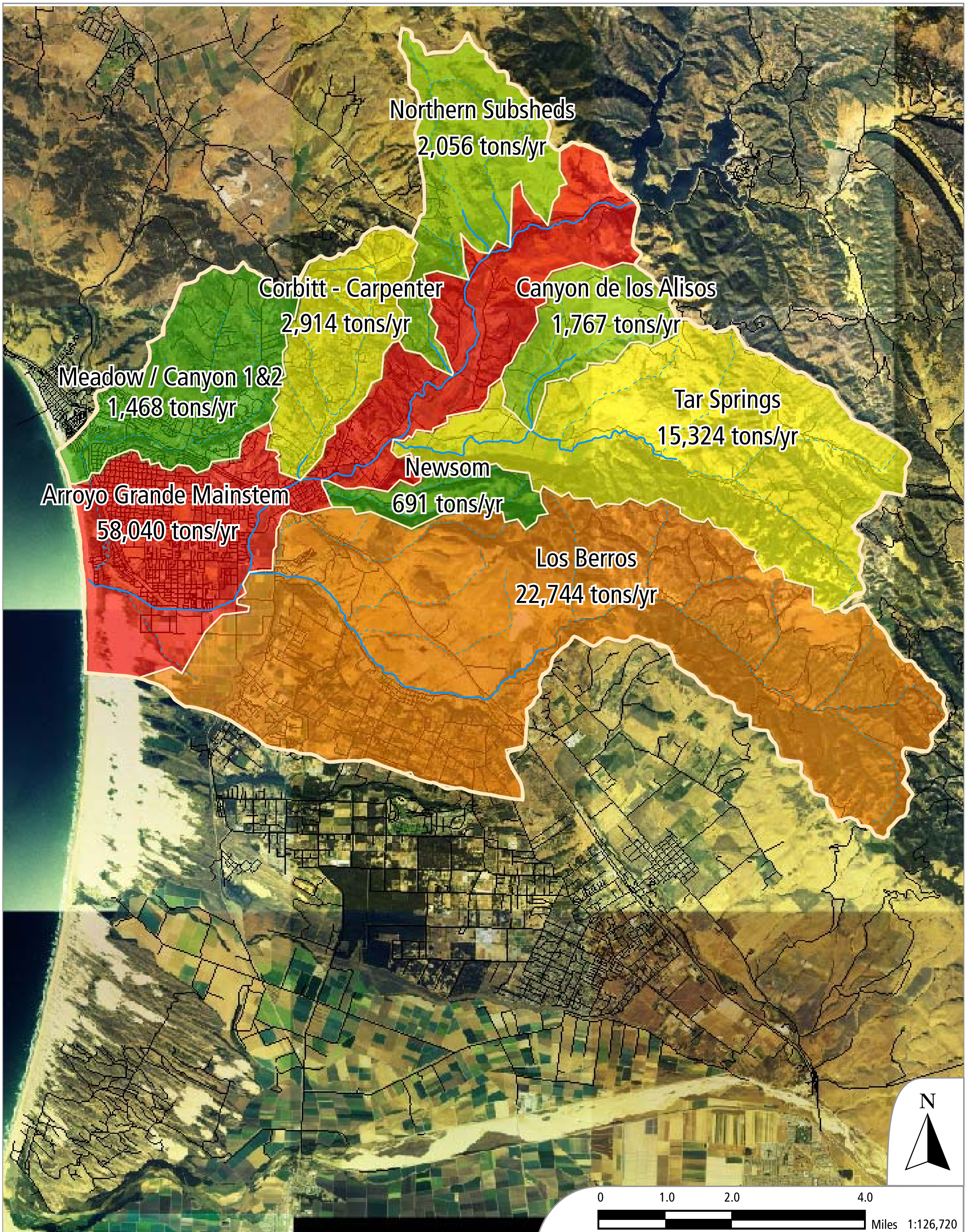

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FIGURE 4.3: Estimated total sediment yield (tons/year) by subwatershed based on the sediment budget calculated for the Lower Arroyo Grande Creek watershed. The subwatersheds with the highest estimated total sediment load are the Arroyo Grande mainstem, Los Berros Creek, and Tar Springs Creek.

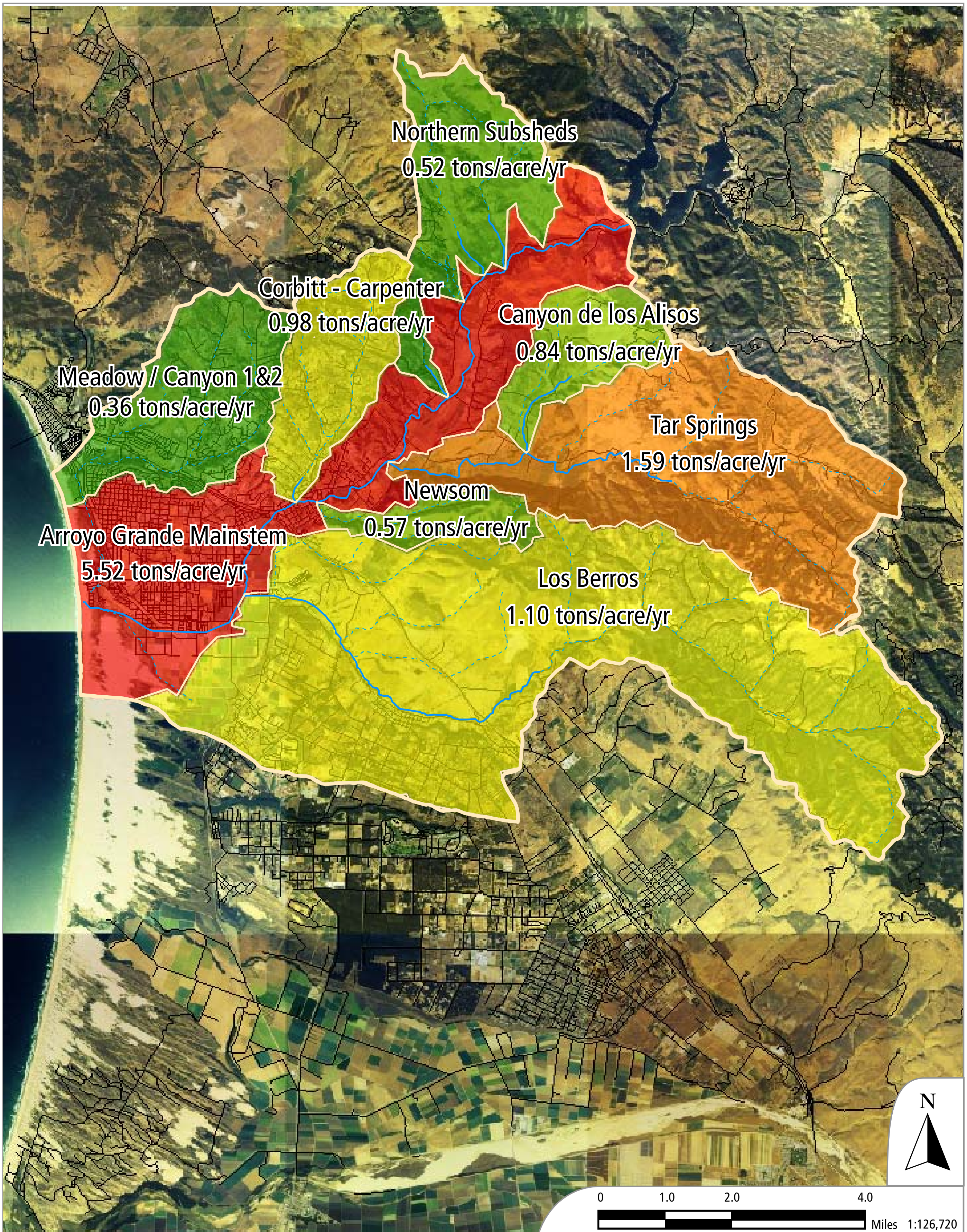

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FIGURE 4.4: Estimated relative sediment yield (tons/acre/year) by subwatershed based on the sediment budget calculated for the Lower Arroyo Grande Creek watershed. The subwatersheds with the highest estimated total sediment load are the Arroyo Grande mainstem, tar Springs Creek, Los Berros Creek, and Corbitt-Carpenter Creeks.

To accurately estimate sediment flux past a particular point of interest, in this case the flood control reach, requires many years of instream suspended sediment and bed load measurements in conjunction with a long-term stream flow record. Arroyo Grande Creek has a long-term streamflow record measured since 1940 through a combined effort from the USGS and the County of San Luis Obispo (Gage ID #11141500 – Figure 4.1). Unfortunately, we were unable to locate any suspended sediment or bed load measurements for Arroyo Grande Creek that would allow us to calculate a long-term record of sediment flux. To compensate for the lack of suspended sediment and bed load data we used two separate methods to develop an estimate.

There are two distinct components of the sediment load in Arroyo Grande Creek; these are gravel and sand/fines. Gravel (particles coarser than 2 mm diameter) generally move by sliding, rolling, or saltating (leaping or jumping) along the bed. Sand and fines (particles less than 2 mm diameter) can often be suspended by flow and kept in motion by turbulent eddies in the water column, being transported without significant grain-to-grain contact. These two components of the load are supplied from different sources, transported by different mechanisms, and deposited in different conditions. Thus our approach was to compute the two components of the load separately, using the most appropriate method for each.

This strategy consisted of the following steps:

(1) Compute relationships between mean daily discharge and the transport rate of sand and gravel, and

(2) Apply these relationships to the historical flow data available at the Arroyo Grande Gage (adjusted for drainage area to reflect flow conditions in the flood control reach).

The most appropriate method for computing gravel flux is the surface-based relation of Parker (1990). This bed load transport relationship is based on the best available data set on gravel transport from a real gravel river, collected by Milhous (1973) in Oak Creek, Oregon. Parker's analysis of the Oak Creek data set is based on the understanding that it is the surface material, rather than the subsurface material, that directly exchanges sediment with the bed load. The Parker (1990) relation specifically excludes material less than 2mm in diameter from the analysis because those grain sizes are considered to be transported by a different mechanism than gravel. The model has a rather complicated form but accounts for the entire particle size distribution of the bed surface and bed load, and thus accounts for surface armoring and predicts the composition of bed material and bed load. Details of this model are provided by Parker (1990) and are not elaborated here.

We chose to apply the model downstream of the confluence of Los Berros Creek at cross-section 13650, located close to pebble count ID #7 (Figure 4.5). Surface particle size data was collected from an adjacent bar deposit, representative of bed load transport conditions. Gravel flux was

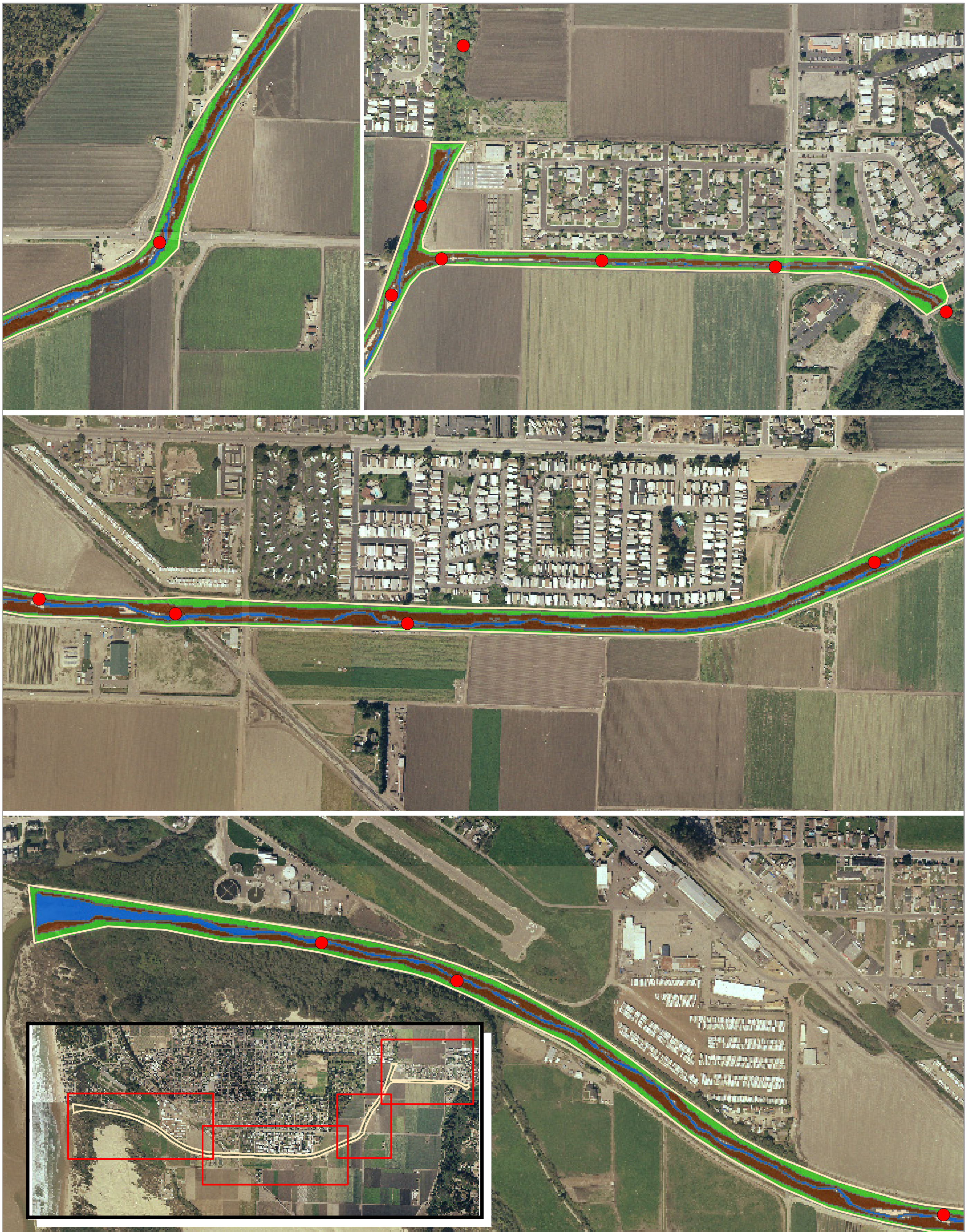

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FIGURE 4.5: Channel morphology and bed sediment sample sites on the Arroyo Grande and Los Berros flood control reach. Channel morphology was mapped using the 2005 high resolution aerial photos. Bed sediment samples were collected on bar features taken at regular intervals along the channel.

computed for a range of discharges to provide an estimate of mean daily gravel flux as it relates to mean daily discharge. We then fitted a regression to the data to compute gravel flux for flows between 50 – 3,000 cfs (Figure 4.6). The result of the regression was a power-law relationship producing an r-squared of 0.99[16]. Gravel flux was considered to be zero for flows less than 50 cfs.

The relationship presented in Figure 4.6 was then used to compute daily, annual, and long-term gravel flux using mean daily flow data for the Arroyo Grande gage adjusted for drainage area. Flow data was adjusted for drainage area to account for the input of Los Berros and Corbitt-Carpenter Creeks, which flow into the mainstem Arroyo Grande downstream of the stream gage. The results for years 1940-2002, presented in Table 4.4, shows that movement of bed load is low to nonexistent in most years. In high flow years, such as 1983 where 49,000 tons of bed load was estimated to move, transport of gravel is a significant proportion of the overall sediment flux.

An average annual bed load flux of approximately 3,400 tons per year was estimated using the Parker bed load transport equation with a range from 0 to 49,100 tons per year. Typically, all bed load is transported during one or two discrete storm runoff events that last on the order of a few hours. Consequently, most bed load is transported during years with one or more major floods, such as 1941, 1943, 1952, 1958, 1967, 1983, 1997, 1998, and 2001. Actual bed load flux may be higher given that our calculations used mean daily flow rather than flow hydrographs. Due to the flashy nature of the Arroyo Grande channel, daily peaks are likely to be much higher than daily means with significantly more sediment transport during peak events.

Because Parker's model specifically excludes suspended sediment flux from the calculations, we used a separate, empirical strategy to predict movement of sand and fine material in Arroyo Grande Creek. Since no suspended sediment data are available for Lower Arroyo Grande Creek, these calculations were made using suspended sediment data from a nearby watershed that most closely matched conditions in lower Arroyo Grande Creek (USGS Gage ID #11147070-Santa Rita Creek near Templeton). We evaluated suspended sediment data from the San Antonio River, the Naciamento River, the Carmel River, and Santa Rita Creek, and determined that data from Santa Rita Creek represented the longest period of record with conditions that are the most similar, geologically and topographically, to the Arroyo Grande Creek watershed.

The data collected at the Santa Rita gage consists of daily suspended sediment concentration measurements. These data were plotted against mean daily flow values to develop a statistical relationship that could be used to estimate suspended sediment flux for the Arroyo Grande Creek flood control channel using drainage area adjusted values from the Arroyo Grande gage. A regression was fitted to the results producing a linear relationship with an r-squared of 0.89 (Figure 4.7). This regression was then applied to the adjusted streamflow record for the Arroyo

[16] R-squared is a statistical measure of the ability of the relationship to explain trends in the data. An r-square of 1 means that 100% of the data can be explained by the statistical relationship. An r-square of 0.5 means that 50% of the data can be explained by the statistical relationship.

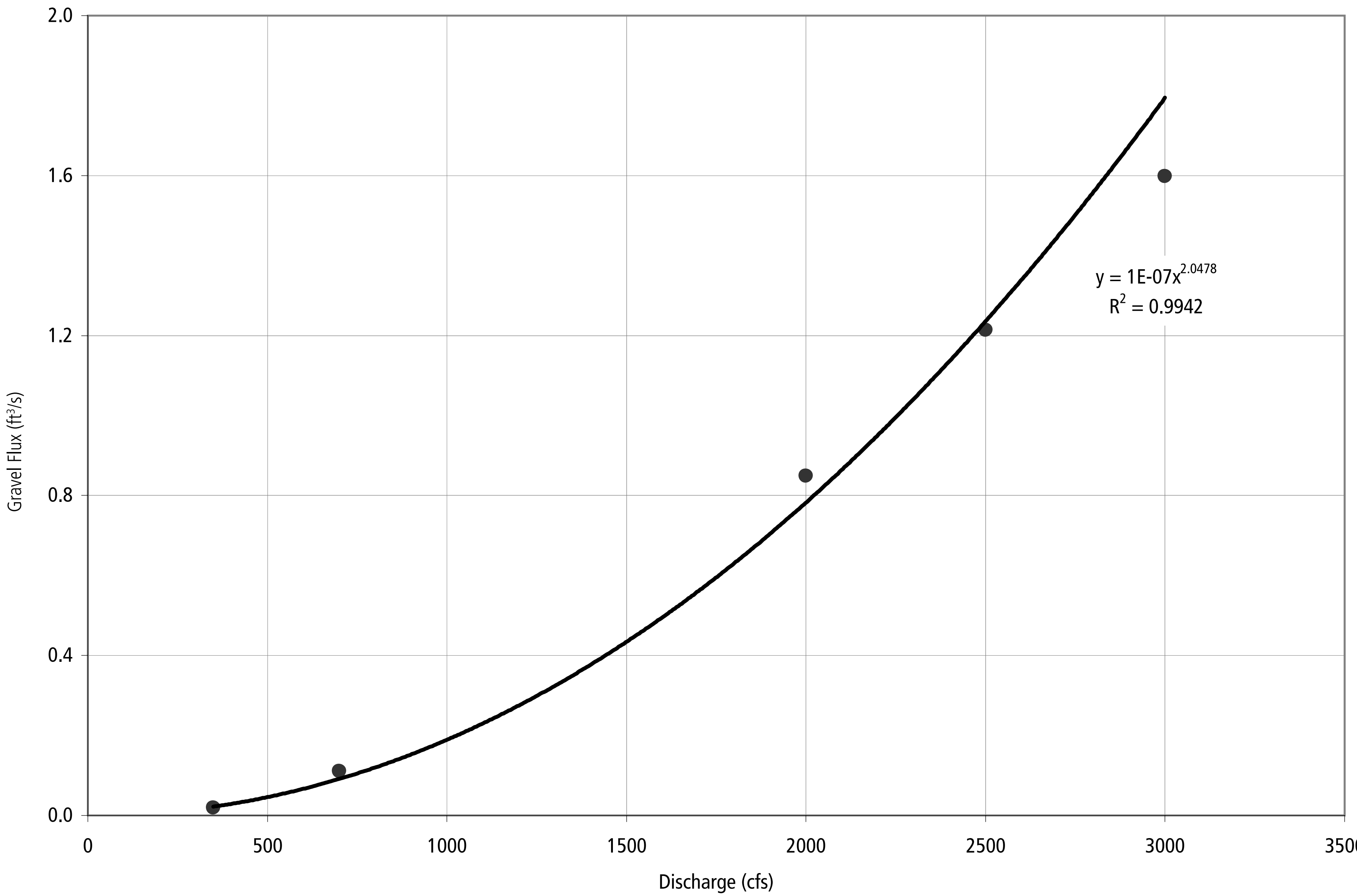

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FIGURE 4.6: Estimated bed load flux rating curve for the Arroyo Grande flood control reach. Bed load was estimated using Parker's (1990) surface based relationship and was modeled at River Station 13650, located just downstream of the Los Berros confluence, using bed information collected at sample PC-7.

Water Year	Estimated Annual Suspended Sediment Flux for Arroyo Grande Creek (tons/year)	Modeled Bedload Flux for Arroyo Grande Creek Flood Control Channel using Parker's Equation (tons/year)
1940	2,630	246
1941	173,317	22,511
1942	9,753	1,065
1943	152,430	20,243
1944	10,551	1,229
1945	5,789	646
1946	544	34
1947	146	0
1948	40	0
1949	107	0
1950	1,407	143
1951	181	0
1952	141,362	19,044
1953	2,286	198
1954	979	60
1955	232	0
1956	37,727	4,865
1957	123	0
1958	202,390	27,055
1959	448	6
1960	498	35
1961	71	0
1962	38,128	4,886
1963	456	5
1964	70	0
1965	945	75
1966	485	11
1967	134,823	18,302
1968	179	0
1969	42,205	5,375
1970	752	46
1971	228	5
1972	214	11
1973	5,431	609
1974	8,921	1,019
1975	158	0
1976	85	0
1977	64	0
1978	19,949	2,430
1979	739	66
1980	40,826	5,189
1981	638	56
1982	8,554	1,043
1983	370,416	49,111
1984	6,009	689
1985	78	0
1986	6,483	778
1987*	66	0
1988*	59	0
1989*	103	0
1990*	63	0
1991*	4,006	331
1992*	4,236	350
1993*	8,411	694
1994*	81	0
1995*	47,252	4,201
1996*	7,466	567
1997*	176,478	15,728
1998*	220,700	19,555
1999*	1,207	0
2000*	2,942	198
2001*	No Data	No Data
2002*	211	0

* Flow data from San Luis Obispo County Arroyo Grande Gage. All other data from USGS gages.

Average	30,696	3,689
Minimum	40	0
Maximum	370,416	49,111

[1] Estimated using the drainage area ratio from drainage area at flood control reach and drainage area at gage # 11141500.

TABLE 4.4: Long-term record of annual bed load and suspended load for Arroyo Grande Creek at the flood control reach. Bed load was estimated using the bed load flux relationship presented in Figure 4.6 and mean daily flow data recorded at the Arroyo Grande gage. (USGS Gage Id 11141500). Suspended load was estimated from the suspended load - discharge relationship developed for data collected by the USGS on Santa Rita Creek (Gage ID 11147070), as shown in Figure 4.7, and applied to mean daily flow data for the Arroyo Grande gage.

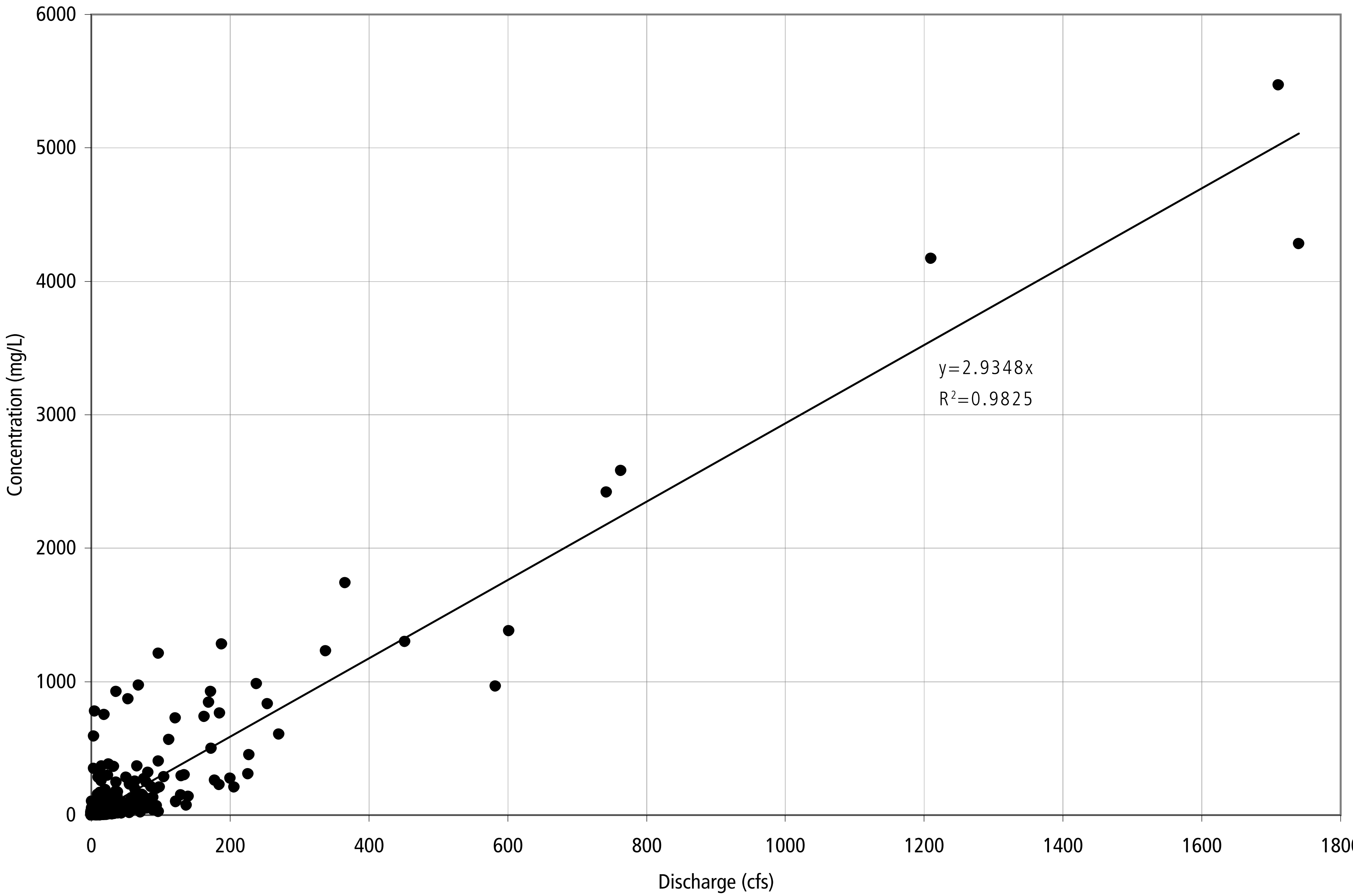

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FIGURE 4.7: Suspended sediment rating curve for data collected the by USGS on Santa Rita Creek near Templeton (USGS Gage #11147070). The rating curve was used to estimate annual suspended load flux for the Arroyo Grande flood control reach.

Grande gage. Computed average annual flux of suspended sediment through the flood control reach was estimated to be approximately 31,000 tons per year with a low of 40 tons in 1948 to a high of 370,000 tons in 1983 (Table 4.4). Similar to bed load transport, much of the suspended sediment flux for any given year typically occurs during one or two peak discharge events.

Years where suspended sediment flux is high mirror the years when bed load flux is high. The highest year on record is 1983 with suspended sediment flux estimated at 370,000 tons. Combined with bed load flux, the total sediment flux for 1983 is estimated to be 420,000 tons of sediment. This compares to the estimated average annual sediment flux for the period of record of 34,400 tons per year. Similarly to bed load flux, suspended sediment flux is likely to be underestimated since mean daily discharge values were used, thereby underestimating higher rates of suspended sediment discharge during peak events.

Storage Estimate (S)

The previous sections summarized the methods and results used to estimate a sediment budget for Arroyo Grande Creek with the intent of understanding delivery of sediment to the flood control reach, flux through the flood control reach, and sediment storage within the flood control reach. Input (I), or sediment delivery, was calculated based on land use characteristics, measured field data, and published estimates of erosion rates. Output (O), or flux, was estimated using both modeling and empirical approaches to estimate bed load and *suspended sediment load*. Both input and output estimates have a degree of error that is difficult to measure and built-in assumptions that influence the error. In addition, the input estimate is confounded by the fact that the material delivered to channels in each of the identified subwatersheds must travel downstream to the flood control reach, a process that is influenced by localized conditions that can result in deposition of sediment in long-term storage sites, such as floodplain or terraces, or be removed from the system by human activities, such as dredging.

Ideally, storage (S) would be the sum of the input term (positive value) and the output term (negative value), producing an estimate of the amount of sediment being deposited in channels and floodplains in the watershed. Our estimates suggest that average annual sediment delivery (I) is approximately 105,000 tons year. Average annual sediment flux through the flood control reach was estimated at 34,400 tons per year, producing storage of approximately 70,000 tons per year. Given the incised condition in many of the channels within the study area, much of the sediment storage is likely to occur in either in-channel bars or through *aggradation* of the bed of the channel.

Though the flood control reach is aggrading, 70,000 tons of sediment is far too much to be accounted for by aggradation. Sediment management, to control aggradation of the flood

[17] A ton of sediment can roughly be equated to a cubic yard of sediment depending upon the grain size of the material. For this analysis, we assumed that they were approximately equivalent.

control reach, as described in Alternative 2 of this study (Chapter 3), recommends removal of approximately 24,000 tons[17] of sediment. When compared to the estimate of storage, 24,000 tons of sediment removed from the channel would only represent 1/3rd of the average quantity of sediment being aggraded. A San Luis Obispo County plan to remove sediment from the flood control reach in 2002 proposed removal of only 9,600 tons of material. The apparent discrepancy between modeled estimates and actual rates of sedimentation within the flood control channel can be attributed to the following sources of error:

- Bed load and suspended load data are likely to be underestimated since they were developed from mean daily discharge data and don't represent peak event data. Peak events in Arroyo Grande typically only last 6-12 hours and move a considerable quantity of sediment. Assuming that the peak event carries a significant quantity of sediment, sediment flux through the flood control reach could be as high as approximately 51,000 tons per year, as apposed to the 34,400 tons per year estimated using mean daily discharge data.

- Sediment delivery due to bank erosion and channel incision may be significantly overestimated. Our assumption for channel incision was based on existing channel elevations as compared to conditions present in the late 1890's. What was not considered was the possibility that a significant portion of the observed incision was due to physical modifications to the historic channel, such as active dredging to increase channel capacity, with excess material being used to build levees adjacent to farm fields. Dredging and channelization activities could account for over half of the estimated sediment contribution that was calculated. If half of the incision is due to dredging, the adjusted annual average sediment load would be on the order of 68,000 tons per year, rather than 105,000 tons per year.

Adjusting for the potential sources of error in the both the delivered sediment and flux estimates suggests that sedimentation in the Arroyo Grande channel may be on the order of 5,000 to 15,000 tons of sediment per year, on average. Given the hydraulics of the flood control channel, there may be some self-regulation of aggradation whereby years with moderate discharge produce sediment deposition due to the lack of energy required to scour material and affect vegetation in the channel. During high flow years, when bed sediment and vegetation are scoured due to the velocity and duration of the flow, more sediment may be removed then is delivered. High rates of sediment accumulation would likely occur in the flood control reach following a major disturbance in the watershed, such as a fire, especially in the Los Berros and Tar Springs watersheds.

4.3. COMPARISONS TO EXISTING / REGIONAL SEDIMENT TRANSPORT ESTIMATES

To gain an understanding of the potential for error when developing a sediment budget, especially in the sediment delivery component, comparisons to past studies or regional estimates are an important tool. Several such estimates are available for Arroyo Grande Creek and are summarized in Table 4.5. These studies suggest that past estimates of sediment delivery and flux on Arroyo Grande Creek differ considerably depending on the methods used to make the estimate and the purpose of the study. The Willis (2002) and Inman (1998) estimates were developed to better understand sand flux to the beaches and littoral cells, and the effect dams are having on sand transport and coastal cliff erosion. The work done by Willis was more detailed, whereas Inman applied regional regression equations in an attempt to develop a rough estimate of sediment flux.

Estimates of sediment yield for watersheds along coastal California have also been made for studies of reservoir sedimentation rates, Total Maximum Daily Loads (TMDL), and scientific research projects. The rates cited in these published studies (other than those previously cited on Table 4.5) range from 1.06 tons per acre per year on the South Fork of Caspar Creek, a forested watershed in Mendocino County, to as high as 67.3 tons per acre per year on Pickens Creek, a small watershed in the steep Transverse Ranges of Los Angeles County (Table 4.6). This range of yields compares to the 1.9 tons per acre per year estimated for the Arroyo Grande Creek watershed (Table 4.3).

Table 4.5: Past estimates of sediment delivery and flux for Arroyo Grande Creek.

Location	Drainage Area (mi^2)	Description	Estimate from Source	Total Yield (tons/ year)	Relative Yield (tons/ac/yr)	Source
Arroyo Grande Creek tributary	13.5	1943 to 1972	380 tons/ mi^2/yr	5,130	0.59	Unavailable
Lopez Creek	21.6	1941-1972	1800 tons/mi^2/ yr	38,880	2.81	Lopez Dam Study
Arroyo Grande Creek	153	Pre-dam; sand and gravel portion	85,500 m^3/yr		1.84	Willis, 2002
Arroyo Grande Creek	86	Post-dam; sand and gravel portion	28,537 m^3/yr	60,333	1.10	Willis, 2002
Arroyo Grande Creek	153	Sediment flux to mouth; 1940-1995	300,000 tons/yr		3.06	Inman et. al., 1998
Lower Arroyo Grande Creek	86	Estimated sediment delivery	105,000 tons/yr		1.91	Current Study
		Estimated sediment flux (1940-2002)	35,000 – 50,000 tons/yr		0.64 – 0.91	

River/Stream	Sediment Yield (tons/ mi²)	Watershed Area (mi²)	Sediment Yield (tons/ ac/yr)	Period of Record	County	Source
Redwood Creek[1]	4750	278	7.42	1954-1997	Humboldt	USEPA and Knott, J.M. (1981)
Redwood Creek[1]	5485	278	8.57	1954-1997	Humboldt	Madej and others (unpublished)
Garcia River	1400	114	2.19	1952-1997	Mendocino	PWA (1997)
South Fork Caspar Creek[2]	680	1.83	1.06	1962-1998	Mendocino	PWA (1997)
North Fork Caspar Creek[2]	1111	1.64	1.73	1962-1998	Mendocino	PWA (1997)
Navarro River	1200	303	1.87	1980-1988	Mendocino	Trihey and Associates (1997)
Arroyo Grande Creek	380	13.5	0.59	1943-1972	San Luis Obispo	Knott, J.M. (1976)
Lopez Creek	1800	21.6	2.81	1943-1972	San Luis Obispo	Knott, J.M. (1976)
Santa Rita Creek	1100	18.2	1.72	1943-1972	San Luis Obispo	Knott, J.M. (1976)
Uvas Creek	1337	21	2.09	1967-1969	Santa Clara	Knott, J.M. (1973)
Coyote Creek	813	109	1.27	1967-1969	Santa Clara	Knott, J.M. (1973)
Arroyo Valle	1000	147	1.56	1967	Contra Costa	Knott, J.M. (1973)
Colma Creek	6768	10.8	10.6	1966-1970	San Mateo	Knott, J.M. (1973)
Little Santa Anita Canyon	22262	2.4	34.8	1938, 43, 52	Los Angeles	Tatum (1965)
Pickens Canyon	43069	1.7	67.3	1938, 43, 54	Los Angeles	Tatum (1965)

1. Researchers studying the same system reported different sediment yields. This outlines the uncertainty associated with estimating erosion rates and the potential range of assumptions made to arrive at a basin-averaged sediment yield.

2. Paired watershed study compared logged versus unlogged land.

TABLE 4.6: Published annual sediment yields for the coast ranges of California. Table adapted from Swanson and Dvorsky 2001.

4.4. Sediment Transport Along Flood Control Reach

4.4.1. Stream Energy and Bed Material Profiles

The analysis of sediment flux through the flood control reach, described in the previous section, focused solely on one location, namely cross-section 13650 (Figures 4.6 and 4.7), to provide an estimate of sediment transport through, and storage within, the flood control reach downstream of the Los Berros confluence. Though it is valuable to understand sediment flux past a single location, it is also important to understand longitudinal changes in parameters that affect flood control such as bed conditions, velocity, roughness, likelihood of aggradation, and presence of obstructions that may result in backwatering and a reduction in overall flood capacity.

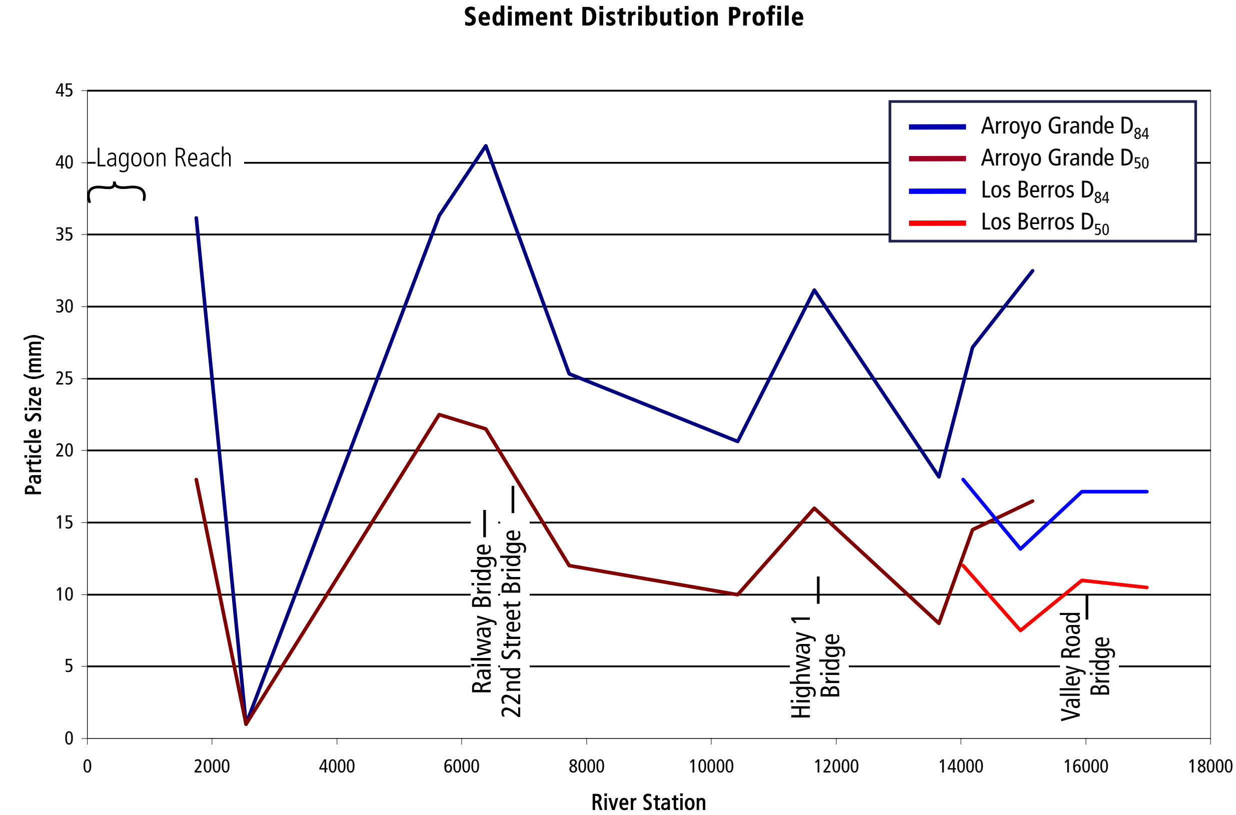
To understand these parameters within the context of the hydrologic and hydraulic modeling, we conducted a field survey to evaluate existing geomorphic conditions within the flood control channel. The first step consisted of developing a geomorphic map showing the low flow channel, and terrace deposits (Figure 4.5). Terrace deposits were considered aggradational surfaces that were stable and supported riparian vegetation. Bar deposits were considered to be ephemeral features inset within the low flow channel that are actively scoured and re-formed during high flow events.

The results of this analysis suggested to us that terrace deposits were widespread throughout the Los Berros and Arroyo Grande flood control reach, occurring at similar elevations above the channel. The presence of terrace deposits at consistent elevations above the low flow channel along the flood control reach suggests two things, 1) The terrace deposits are being formed during several discrete events rather than slowly being built up over time, and 2) The deposits are likely due to backwatering or slowing of flow associated with obstructions such as a bridge, channel confluences, or other obstructions such as beaver dams. Terrace deposits in Los Berros were especially pronounced as being related to backwatering from the mainstem Arroyo Grande. The Los Berros channel enters at an approximate 90 degree angle to Arroyo Grande Creek, resulting in a more pronounced backwater effect. The effect of the backwatering on Los Berros Creek is lessened in the upstream direction as evidenced by lower terracing.

To understand spatially how deposition is occurring within the Arroyo Grande channel, bed surface particle size data was collected along the Arroyo Grande and Los Berros flood control channels. The approach to assessing bed material size included bed surface sampling (Wolman, 1954) on representative bar deposits along the length of both channels. A total of 14 grain size samples were taken, 4 on Los Berros Creek and 10 on Arroyo Grande Creek (Table 4.7). Assessing the grain size data longitudinally in relation to the location of the bridges provides some insight into how existing infrastructure affects the hydraulics and depositional environment within the channel (Figure 4.8). The results show significant increases in the average grain size

Bed Sample ID (As shown in Figure 4.5)	Channel	River Station	D_{84} (mm)	D_{50} (mm)	D_{16} (mm)	Percent of Material in Bed Sample							
						(0-2mm)	(2-4mm)	(4-8mm)	(8-16mm)	(16-32mm)	(32-64mm)	(64-128mm)	(>128mm)
PC-1	Los Berros	16981	17	11	7	2	4	10	26	9	0	0	0
PC-2	Los Berros	15939	17	11	7	0	3	11	26	9	1	0	0
PC-3	Los Berros	14951	13	8	5	6	4	19	21	3	0	0	0
PC-4	Los Berros	14036	18	12	6	0	5	9	25	10	1	0	0
PC-5	Arroyo Grande	15149	32	17	9	0	2	5	18	17	8	0	0
PC-6	Arroyo Grande	14185	27	15	10	0	0	6	24	16	4	0	0
PC-7	Arroyo Grande	13650	18	8	1	24	5	10	13	10	0	0	0
PC-8	Arroyo Grande	11651	31	16	8	8	3	1	17	18	7	0	0
PC-9	Arroyo Grande	10425	21	10	5	12	1	12	19	11	1	0	0
PC-10	Arroyo Grande	7720	25	12	1	18	2	8	13	14	3	1	0
PC-11	Arroyo Grande	6385	41	22	9	2	1	3	14	13	17	1	0
PC-12	Arroyo Grande	5635	36	23	14	2	1	1	9	27	10	1	0
PC-13	Arroyo Grande	2540	1	1	1	100	0	0	0	0	0	0	0
PC-14	Arroyo Grande	1742	36	18	8	4	4	4	13	16	10	1	0

TABLE 4.7: Bed substrate results for the Arroyo Grande mainstem and Los Berros flood control channels. Bed substrate distributions was estimated using an approach developed by Wolman (1954). River station corresponds with the HEC-RAS model and represents distance, in feet, from the mouth of the Arroyo Grande. D_{84}, D_{50}, and D_{16} is the sediment particle size for which 84%, 50%, and 16% of the sediment sample, respectively, is finer (in millimeters).



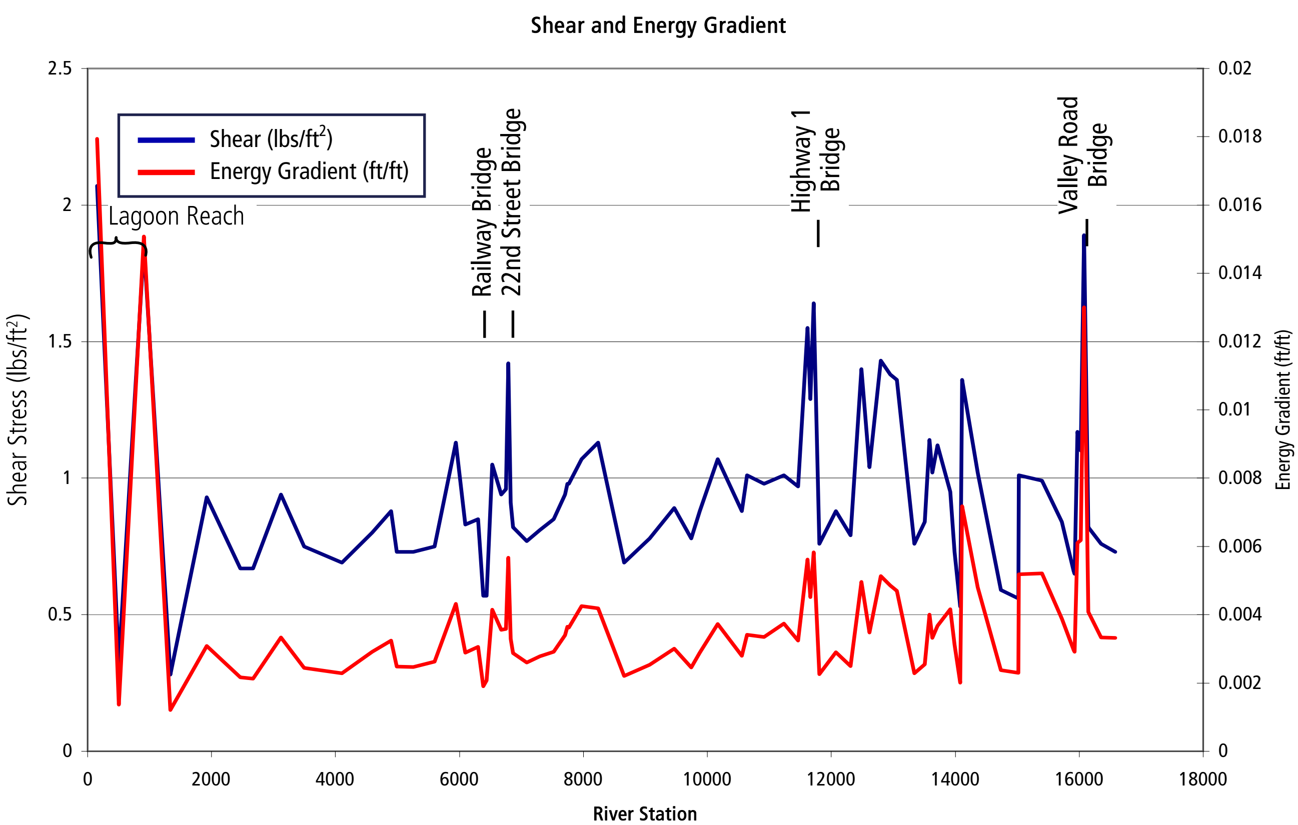


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FIGURE 4.8: A - Longitudinal profile of grain size (D84 and D50) for the flood control channel. B - Longitudinal profile of shear and energy gradient for the flood control channel under existing conditions (5-year discharge). Peaks in shear, energy gradient, and grain size appear to correspond with bridge constrictions. These constrictions appear to create a backwater during peak events resulting in deposition in fine sediment.

of sediment in the vicinity of the bridges with a reduction in grain size upstream of the bridges. This occurs both at the Highway 1 Bridge and at the 22nd Street/U.P Railroad Bridges. The effect is more significant at the 22nd Street/U.P Railroad Bridges reflecting their influence on channel hydraulics during high flow events. The phenomena observed is most likely due to the backwater effect that the bridges have on the flow due to their constricting or obstructing nature during high flow events. Backwatering results in reduced velocities upstream, causing sediment to deposit out when the water slows down. As water flows under a bridge, the velocity increases, causing scour which exposes larger bed and bar material on the downstream side of the bridge, while carrying away the finer sediments.

The results observed in the grain size data are similar to the longitudinal profile of the energy grade slope for the 5-year event, which is output from the HEC-RAS model (Fig. 3.1). The energy grade slope represents the slope of the water surface for the modeled discharge. A reduction in the energy grade slope indicates the potential for sediment deposition as flow becomes shallower and velocities decline. The results for the Arroyo Grande channel suggest a significant drop in the energy grade slope in the vicinity of the bridges (Figure 4.8).

4.4.2. Analysis of Potential Impacts to the Lagoon from Sediment Management Activities

Due to concerns raised by regulatory agencies about the potential for increased deposition within the lagoon due to sediment maintenance activities, a more detailed analysis of sediment transport conditions downstream of the UPRR Bridge was developed. Of particular interest was the potential that periodic "bar ripping", which is expected to increase the likelihood that accumulated sediment in the flood control reach will be mobilized, will result in movement of these materials into the lagoon and lead to a reduction in useable area for aquatic organisms that use the lagoon. The lagoon is home to the tidewater goby, an endangered species found in California's coastal wetlands, lagoons, and estuaries. Therefore, it was important to determine the effect of increased mobility of sediments in the Arroyo Grande Creek Channel and the potential impact that might have on the tidewater goby.

Sediment transport conditions from the UPRR Bridge to the Pacific Ocean were analyzed for existing conditions and for Alternative 3c. At this point in time, Alternative 3c is the preferred alternative and includes a plan to construct secondary/overflow channels that would improve flood capacity and reduce the need for long-term, invasive sediment removal activities by "ripping" the secondary channels to encourage sediment mobility and transport. Sediment mobility, for any particular runoff event, is primarily a function of grain size and shear stress in the channel. Longitudinal changes in shear stress and grain size were used to assess changes in bed mobility due to implementation of Alternative 3c using the following data:

- The sediment size distributions in Arroyo Grande Creek downstream of the UPRR Bridge were developed using the bed material samples collected along the flood control reach, as discussed in the previous section (Figure 4.5). Since only 4 samples were collected downstream of the UPRR Bridge, a linear relationships between was developed across these samples to generate continuous estimates of bed material conditions. This approach assumes continuity in bed conditions along the bed of the channel.
- Shear stress, a measure of per unit energy available to do work, was developed from the HEC-RAS model for flows ranging from 50 cfs to 8600 cfs.

The Shields Method (Simon and Senturk, 1992) was applied to determine a critical shear stress required to move the D_{84}, D_{50}, and D_{16} using two dimensionless parameters to relate shear stress and grain size. The dimensionless Boundary Reynolds Number can be calculated from the hydraulic radius and water surface slope that are provided as output in HEC-RAS model. The Boundary Reynolds Number is then related to a dimensionless shear stress using the Shields Curve. The dimensionless shear stress can then be used to calculate the critical shear stress required to move a particular grain size. Critical shear stresses were calculated for the D_{84}, D_{50}, and D_{16} at selected cross sections within the reach. The shear stresses determined in the HEC-RAS analysis were then compared to the calculated critical shear stresses to determine what proportion of the bed material is being mobilized.

The sediment mobility results along Arroyo Grande Creek from the UPRR Bridge to the Pacific Ocean are similar to the longitudinal profile of shear stress. For existing conditions and Alternative 3c the bed exhibits the same general pattern with peaks representing high mobility areas and valleys representing low mobility areas (Figure 4.9 and Figure 4.10). High mobility locations are present at the upper and lower end of the lagoon, River Stations 904 and 150 respectively, and a low mobility location is located in the middle of the lagoon (River Station 503). The low mobility location (River Station 503) will likely control the flushing of sediments through the lagoon reach.

The existing capacity of the channel is 2,500 cfs and the upper limit of sediment transport will occur at, or slightly above this discharge (Figure 4.10). The capacity of the proposed Alternative 3c channel is 11,500 cfs, which greatly increases the potential for sediment transport under higher discharges (Figure 4.11). A comparison between existing conditions and Alternative 3c of the amount of sediment flushing in the lagoon shows that:

1. At discharges below 2,800 cfs there is less sediment flushing occurring under Alternative 3c, as compared to existing conditions, due to lower water surface (i.e. – less shear) at equivalent flows,
2. At discharges above 4,000 cfs there is significantly more flushing of the lagoon under Alternative 3c than under existing conditions.

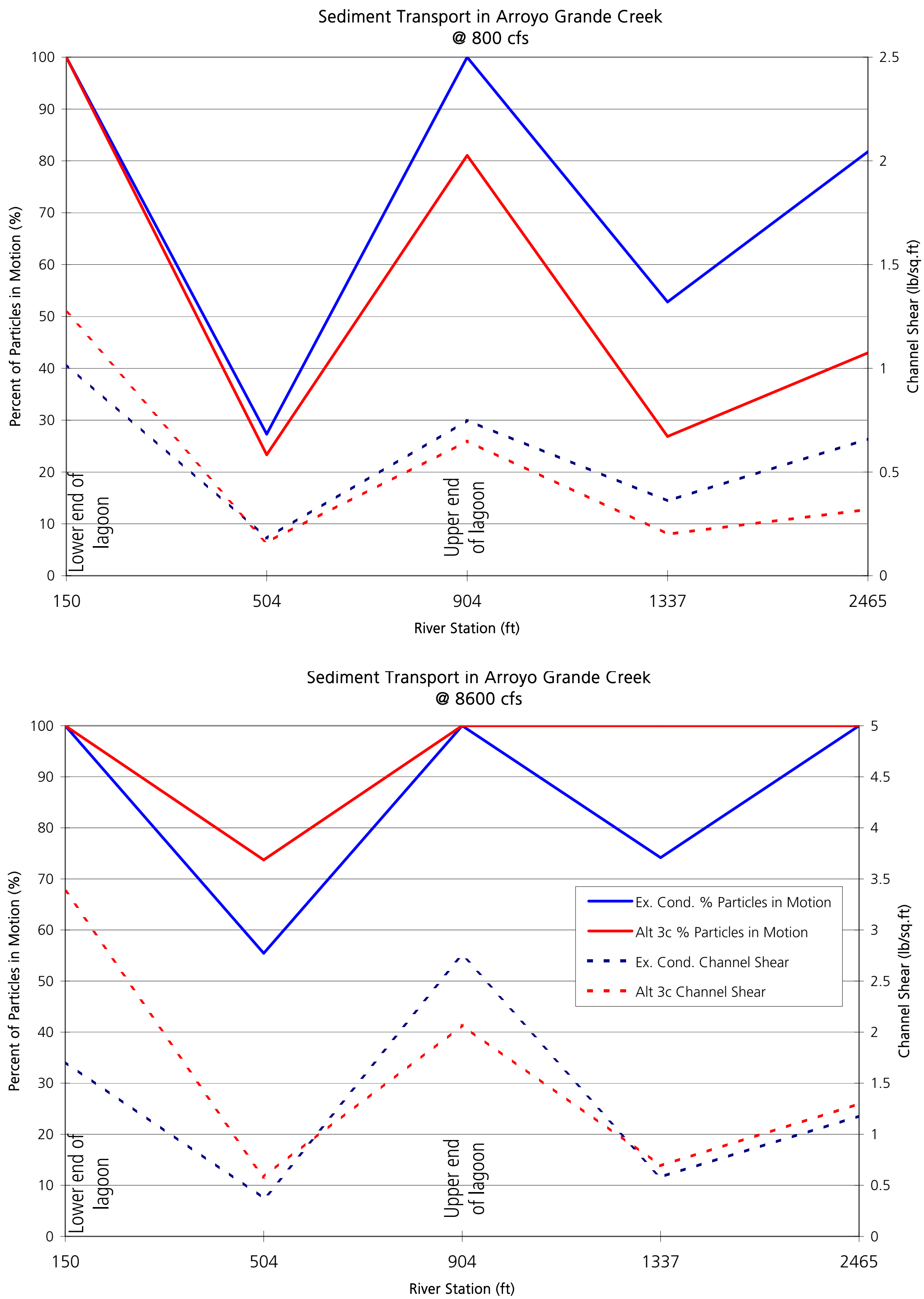

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FIGURE 4.9: Longitudinal profile of shear and bed mobility under existing and proposed (Alternative 3C) conditions from the Union Pacific Bridge to the mouth of Arroyo Grande Creek. Channel shear was generated from the HEC-RAS model. Bed mobility was developed using shear and the Shields equation (Simons and Senturk, 1992) to estimate the percent of bed material that would be in motion based on bed substrate samples. Results are shown for two flow conditions, 800 cfs (A) and 8600 cfs (B).

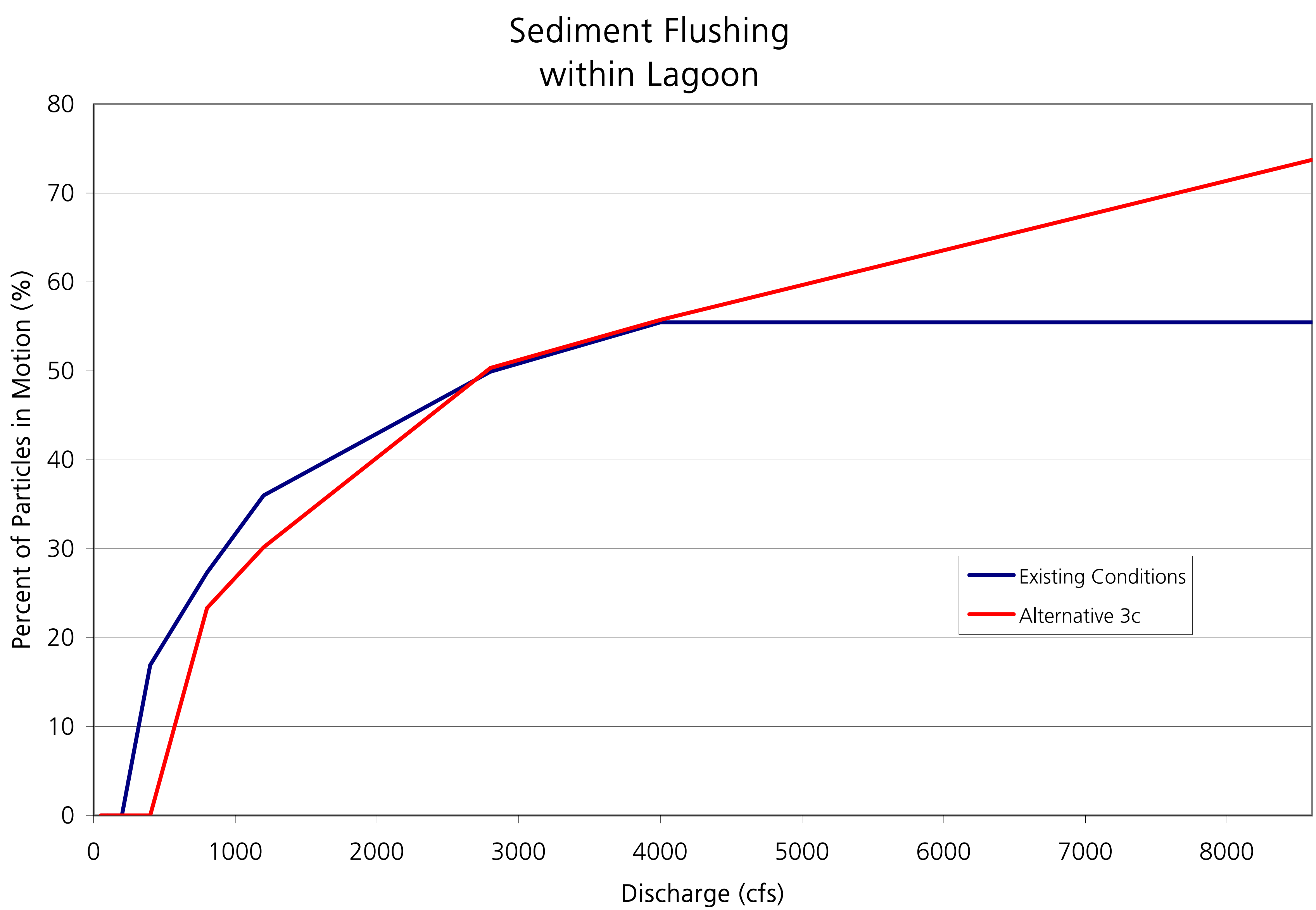

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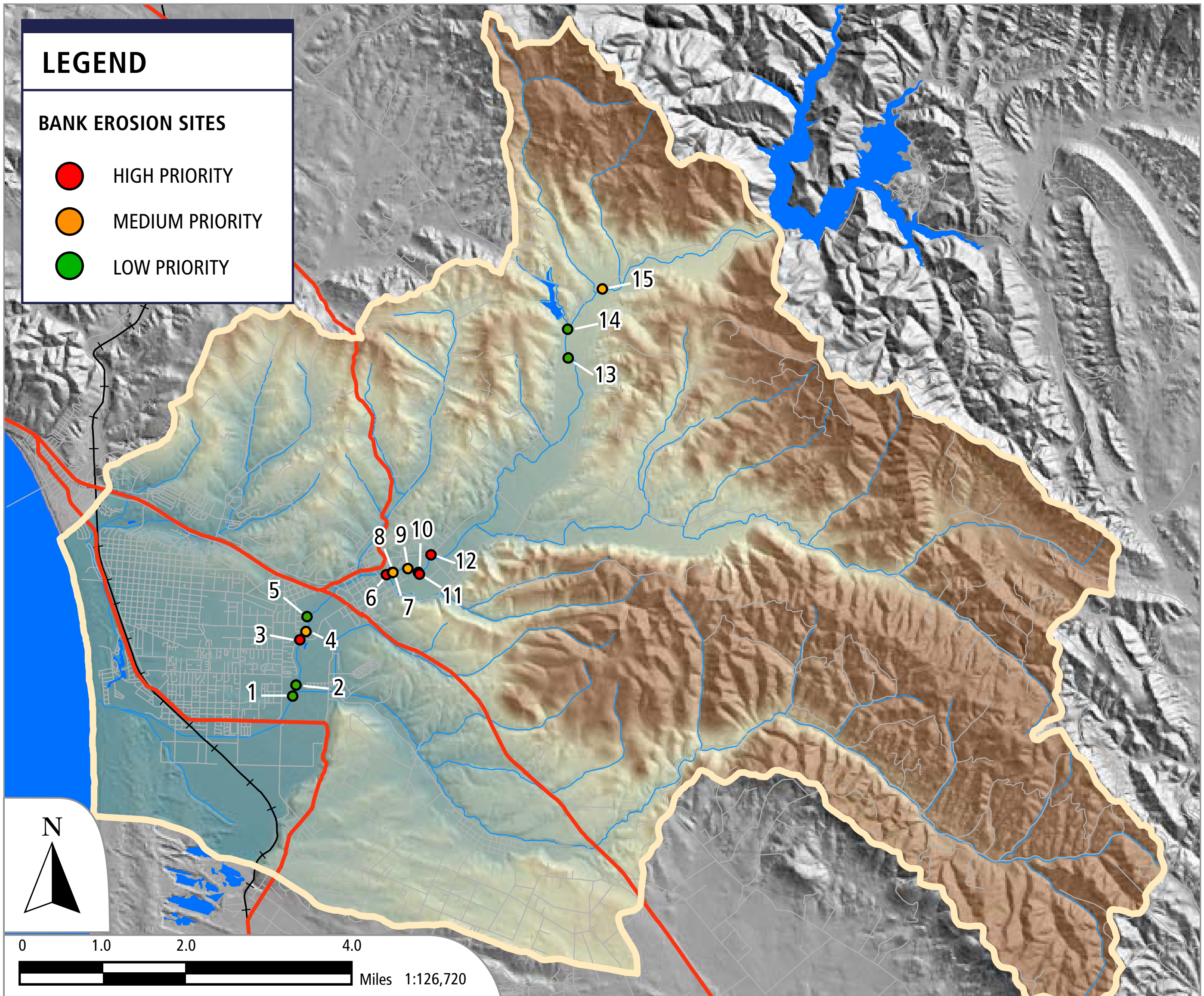
FIGURE 4.10: Relationship between discharge (in cfs) and bed mobility for a sample cross-section within the Arroyo Grande lagoon for existing and proposed conditions (Alternative 3C). The results suggest that under low to moderate flow conditions, the bed is less mobile under proposed conditions due lower water surface elevations (shear is a function of depth). At higher flows, the results suggest that there would be more flushing of the lagoon as more water is contained within the levee system, rather than flooding into existing farm fields.



ID	Feature Length (ft)	Feature Height (ft)	Bank	Feature Area (ft²)	Priority
11	198	40	left	7920	High
3	1308	6	both	7848	High
12	378	20	right	7560	High
6	308	22	left	6776	High
7	207	25	left	5175	High
9	361	12	right	4332	Medium
8	266	15	right	3990	Medium
15	323	10	right	3230	Medium
4	227	14	left	3178	Medium
10	372	8	right	2976	Medium
5	191	15	right	2865	Low
14	90	30	right	2700	Low
2	401	5	right	2005	Low
1	399	5	left	1995	Low
13	198	10	right	1980	Low

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FIGURE 4.11: Map and description of bank erosion sites that were selected for treatment to reduce sediment delivery to Arroyo Grande Creek. A total of fifteen sites were selected and prioritized based on the size of the feature. Sites were identified by the California Conservation Corps during an aquatic habitat assessment. Further site evaluation would be required to develop a potential options and cost for remediation.

The results of the sediment transport analysis suggest that under existing conditions sediments are mobilized at discharges greater than 200 cfs and under Alternative 3c sediments are mobilized at discharges greater than 400 cfs (Figure 4.11). However, due to the limited capacity of the existing channel, Alternative 3c is likely to be more efficient at flushing the lagoon at flows greater than 2,800 cfs.

4.5. Sediment Source Reduction Program: Priorities and Implementation

4.5.1. Site Specific Sediment Reduction Program

The sediment source analysis is a continuation of work that was conducted as part of the Arroyo Grande Creek Watershed Assessment. As part of that work, a combination of aerial photos and field based surveys were used to identify potential discrete point sources of erosion such as landslides, roads, and bank erosion. Potential erosion sources identified through that study were scattered throughout the watershed. These sites were prioritized based on the amount of information available about the source, the potential severity of the source, site accessibility, and the proximity of the source to streams or waterways that would deliver sediment directly to a stream channel.

For this phase of the sediment source analysis, the goal was to provide direction on specific sources of sediment, or treatment options, which would provide the most benefit. Benefit was defined as an erosion reduction measure or treatment option that would either, 1) Reduce sediment delivery to the flood control reach and thereby reduce the need for future sediment removal and maintenance activities, and 2) Reduce fine sediment delivery to the channel to improve aquatic habitat conditions.

Given the cost of treating discrete sediment sources and the shear number of sources that require treatment to reduce erosion and sediment delivery to natural background rates, any successful sediment reduction program requires a focus on key sources with a clear method of prioritization. We approached the development of a source reduction program by first assessing the sediment budget estimates to define what the key areas of source reduction are.

Bank Erosion and Incision on Mainstem Arroyo Grande Creek

Despite the difficulties of accurately measuring a sediment budget, the results still clearly point to the need for a reduction in the sediment loading from the mainstem Arroyo Grande Creek channel. The sediment budget, even if used as a relative measure of the quantity of sediment from different sources, suggests that a major component of sediment supply in the lower

Watershed is due to bank erosion on the mainstem Arroyo Grande Creek. As part of the Arroyo Grande Creek Watershed Management Plan (CCSE, 2005), the California Conservation Corps mapped known bank erosion sites along the entire mainstem Arroyo Grande Creek channel. From this database, which provided estimates of the length and height of the erosion source, we selected the top 10 sediment producers and prioritized them accordingly (Figure 4.11).

Bank erosion sites can be repaired in a variety of ways depending on funding available, the extent of existing buffers between the bank erosion site and adjacent land uses, and site accessibility. In an ideal situation, the scope of a bank repair project on the mainstem Arroyo Grande would include floodplain development, a reduction in the overall bank angle, riparian restoration, and implementation of instream habitat enhancement measures that provide toe protection for the bank as well. In most cases, channels are so constricted by adjacent land uses that stabilizing the slope through toe protection and revegetation of the slope is the only fix possible. Each site needs to be assessed individually to evaluate landowner cooperation, identify opportunities to achieve multiple objectives, and assess costs.

The project priorities listed in Figure 4.11 are meant to be a gage of the importance of each project in terms of source reduction potential and were designed with a timeline in mind. If a timetable is applied to the list of projects, high priority projects should be completed in a 1-3 year timeframe, projects assigned a medium priority should be completed within a 3-6 year timeframe, and projects assigned a low priority should be completed within 10 years. We recommend approaching the list of projects in phases. Phase I would consist of a more detailed evaluation of the high priority projects. The Coastal San Luis Resource Conservation District, Natural Resource Conservation Service, Central Coast Salmon Enhancement and San Luis Obispo County Land Conservancy are potential resources for identifying opportunities at each of the sites, recommending potential funding sources, and developing cost estimates for each project. If the opportunity exists, projects should be bundled for funding, permitting, and implementation purposes to reduce overall costs.

The level of permitting required at each site will depend on project scoping and access issues. If any work or activity is required below ordinary high water, the U.S. Army Corps of Engineers, including consultation with the U.S. Fish and Wildlife Service and National Marine Fisheries Service, will be required, along with input from the Regional Water Quality Control Board. If work is confined to areas above ordinary high water, the California Department of Fish and Game and other local jurisdictions should be contacted.

Transport of Suspended Sediment and Bed Load to the Mainstem

Erosion of sediment from the hillslope to the channel can often not be attributed to discrete point sources but instead is distributed across the landscape as erosion due to rilling, sheetwash, rainsplash, dry raveling, and a number of other erosion processes. Distributed sources of erosion can be treated through better land management practices or revegetation programs, but those often require long-term efforts to educate land managers and make necessary changes to policy. In the short-term, improvements or modifications could be made to conditions within stream channels to maximize sediment deposition prior to transport and delivery to more sensitive areas.

Potential options to reduce downstream sediment transport will vary depending upon the location of the treatment. The traditional approach would be to construct a sediment basin directly in the channel to capture sediment. A sediment basin consists of an enlarged portion of the channel with a constriction at the downstream end to reduce velocities within the basin and allow for deposition of material. Most sediment basins that are constructed directly in the channel are very efficient at capturing material, including bed load moving through the system. Their efficiency at capturing suspended load depends on their overall length, depth and volume relative to the flow rate entering the basin. Since sediment basins capture transported sediment, they must be maintained periodically by removing accumulated sediment in order to maximize their effectiveness. Sediment basins built in the channel are very intrusive and, consequently, have been discouraged in areas where sensitive biological habitats have been identified. By nature, they create barriers to free movement of aquatic species and should not be used in higher order channels (larger channels, lower in the watershed) where fish passage is a concern. They have the potential to provide a dual role for flood attenuation if designed correctly and should be considered in lower order tributary streams where excessive fine sediment loads are impacting conditions farther downstream, on higher order trunk streams.

Floodplain restoration offers an alternative to a traditional sediment basin that is more environmentally and aquatic habitat friendly. The first step is to identify locations in a watershed to restore floodplain areas that historically acted as sites for natural sediment retention. Floodplain restoration consists of modifying pieces of land that are adjacent to stream channels that historically may have been flood prone but are now protected from flooding due to past modification to the land or stream channel, or are protected by levees. Once a piece of land is restored as a floodplain and flood flows are allowed to access the site, natural sediment deposition will occur, reducing sediment delivery downstream. The efficiency with which a restored floodplain area retains sediment will depend upon the size of the restoration area, the relative elevation differences between the channel and the floodplain surface, and the amount of roughness present on the restored site. Floodplain restoration sites that are developed with the goal of retaining sediment typically require less maintenance over the long-term than traditional sediment basins, though they are typically not as efficient at removing supplied sediment. Restored floodplains typically are designed to remove suspended sediment while maintaining bed load continuity through the site.

Floodplain restoration also provides additional benefits beyond sediment retention. Sites restored for sediment retention can also provide a measure of flood attenuation. They can also significantly improve habitat conditions through riparian corridor restoration, increased roughness, and introduction of large woody material, and can be designed to restore habitat for amphibian species such as the California red-legged frog by constructing pocket wetlands on the floodplain surface. Floodplain restoration returns the land to its natural function and, with it, all the other benefits that a restored natural function provides. These types of projects can, therefore, be considered multi-objective projects with multiple benefits. They could also potentially be included as mitigation to offset impacts created by more intrusive flood or sediment reduction strategies elsewhere in the watershed.

In Table 4.8 we provide information on five potential sediment retention sites located on tributaries to the mainstem of Arroyo Grande Creek. These sites include a mix of floodplain restoration and traditional sediment basin sites with a description, size of the project area, estimated sediment load reduction, preliminary cost estimate, and priority ranking. Estimates of potential load reductions were based on the presumed sediment capture efficiency of the project and the sediment budget estimates for each subwatershed. The projects on Los Berros, Tar Springs, and Corbitt/Carpenter Creeks have been developed as floodplain restoration projects since aquatic habitat and fish passage may be of concern on these creeks (See Appendix B for a map of the sites). The other projects could be developed as either floodplain restoration projects or traditional sediment basins though the costs were developed assuming the latter.

Project implementation should proceed independently for each project, each of which should consist of two phases. Once the site is identified as a potential option, in terms of landowner cooperation or acquisition, the first phase can be started. The first phase should include project scoping, a brief analysis of alternatives, preliminary cost estimates based on the proposed alternatives, and efforts at land acquisition or easements. The first phase should also involve the regulatory agencies to assess their interest in seeing the project move forward and to solicit their involvement in the design. The regulatory agencies that should be contacted, depending on the particular site location, include the California Department of Fish and Game, Regional Water Quality Control Board, U.S. Army Corps of Engineers, San Luis Obispo County, U.S. Fish and Wildlife Service, National Marine Fisheries Service, and appropriate local agencies such as the City of Arroyo Grande. It is important to receive input from these agencies before proceeding. Their input will often dictate the project scope and how the project will be implemented, maintained and monitored. Phase I should also include efforts to acquire funding for Phase II which consists of administering, designing, and implementing the project.

Miscellaneous Point Source Erosion Sites and Priorities

A total of 11 additional erosion sites were selected throughout the watershed to include in a sediment source reduction program. These sites were considered miscellaneous because they occur outside of the high priority areas of bank erosion on the mainstem and sediment retention/floodplain restoration sites on the tributaries. The selected sites represent the most severe erosion sources from those listed in the Arroyo Grande Creek Watershed Assessment. A majority of the selected projects fall within the Los Berros, Tar Springs, or Corbitt/Carpenter subwatersheds.

Site #	Stream	Subwatershed	Site Description	Area (acres)	Project Description	Existing Sediment Load of Subwatershed (tons/yr)	Efficiency of Project to Reduce Sediment Load	Estimated Post Project Sediment Load for Subwatershed	Acquisition Cost	Project Implementation Cost	Maintenance Cost over 10 years	Total Estimated Cost	Priority
18	Los Berros	Los Berros	Property located at downstream end of the Los Berros canyon, upstream of the Valley Road Bridge. Property is currently used for hay production and is for sale. A low levee currently separates the property from Los Berros Creek. Flooding may already occur under high flow conditions.	11.1	Project would consist of a passive sediment detention basin whereby the existing levee and property would be modified to a restored flood-plain condition. Moderate to high flows would be allowed to flood the property and deposit sediment. Riparian vegetation would be restored to increase roughness and sediment deposition. The site would also have a flood attenuation benefit though focus would be on habitat improvement and floodplain restoration. The project would mainly reduce fine sediment loads though some bedload would be retained on upstream portions of the property where flood flows enter the site.	22,744	15%	19,332	$280,000	$600,000	$160,000	$1,040,000	High
9	Tar Springs	Tar Springs	Property located at lower end of Tar Springs on a property that appears to be currently fallow. Tar Springs is heavily incised at this location at the property sits approximately 8-10 feet above the bed of the channel.	6.9	Project would consist of a passive sediment detention basin whereby the property would be lowered to create a restored floodplain to capture primarily sand and fine sediment though some bedload would likely be deposited. Removed material could be used to construct flood reduction projects discussed in Chapter 3. Riparian vegetation would be restored to increase roughness. The site would also provide flood attenuation benefits for downstream areas on Arroyo Grande though the focus would be sediment retention. Periodic maintenance would be required to maintain sediment retention effectiveness.	17,091	15%	14,527	$170,000	$400,000	$120,000	$690,000	High
14	Corbitt/ Carpenter	Corbitt/ Carpenter	The site is located near the confluence of Corbitt and Carpenter Creeks. The site appears to currently be used as a seasonal grazing area for horses though we were unable to verify.	11.7	The project would consist of a passive sediment detention basin whereby the existing levee and property would be modified to a restored flood-plain conditions. The may already flood under high flow conditions. This project would increase the frequency of flooding and restore riparian vegetation to the site. The site is fairly large given the size of the water-shed. There may be potential to reduce the extent of the project, thereby maintaining the existing land use over a portion of the property.	2,914	30%	2,040	$292,500	$400,000	$120,000	$812,500	Medium
10	Canyon de los Alisos	Canyon de los Alisos	Property located at lower end of Canyon de los Alisos in heavily incised section of channel. Existing use of property is agriculture which may limit potential acquisition. Only a portion of the existing parcel would be used for project - division of existing parcel may be an option given willing landowner.	1.5	Project would potentially consist of an in-channel sediment basin that would be actively maintained to maximize sediment retention potential. If actively maintained on a 2-4 year time frame, this site would allow for dual use as a sediment retention and flow attenuation basin. As a sediment retention basin, the site would capture some suspended sediment and most of the bedload. Given a willing landowner, there is potential for the project to be expanded beyond 1.5 acres.	1,770	60%	708	$38,500	$120,000	$40,000	$198,500	Low
5	Unnamed	Northern Tributaries	The site is located on a tributary that is included with our Northern Tributaries designation. The site consists of agricultural land that is sandwiched in between the hillslope, the highway, and the creek channel and is cut off from the rest of the farming lands. Due to its isolation, the property owner may be willing to sell it.	4	The project would consist of constructing an in-line sediment basin to capture discharge and sediment from the tributary. The subwatershed is used intensively as agricultural land and the channel is incised with little to no buffer. The site would need to be lowered to act as a sediment basin. There is potential for the excess material to be used in the flood reduction projects proposed in Chapter 3. The site would capture a portion of the suspended load and all of the bedload. The watershed appears to have a high sand fraction.	617	70%	185	$99,250	$300,000	$60,000	$459,250	Low

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TABLE 4.8: Site summary for potential floodplain restoration / sediment retention projects identified as alternatives to reduce sediment contribution to the flood control reach, reduce fine sediment to improve aquatic habitat, and improve overall riparian and floodplain conditions on the Lower Arroyo Grande. These sites, along with associated costs and acreages, should be considered preliminary pending landowner interest and further evaluation.

Those areas were selected for treatment because they were identified as contributing the highest total and relative amounts of sediment to the mainstem (Figures 4.3 and 4.4).

Table 4.9 provides information on each of the proposed projects including potential treatment options and priority level (project locations are shown in Appendix B). The priorities are separated into high, medium, and low, based on their importance and timing of implementation. If a timetable is applied to the list of projects, high priority projects should be completed in a 1-3 year timeframe, projects assigned a medium priority should be completed within a 3-6 year timeframe, and projects assigned a low priority should be completed within 10 years. Costs are not provided for each of the projects because they require further development and scoping. We have provided recommendations on how to treat these sources but further site analysis is required in order to better define potential options based on landowner cooperation and potential funding.

The approach to the projects should be handled in a similar way to the recommendations we provided for the bank erosion sites on the mainstem Arroyo Grande. Sites should be bundled and analyzed according to priority. Phase I would consist of assessing the potential scope of project, the level of landowner cooperation, and cost estimating. The RCD, NRCS, and CCSE would be valuable resources toward achieving the information necessary to move the projects forward. They could also provide assistance in identifying funding resources. Phase II would consist of administration, design, permitting, and implementation of the projects carried forward from Phase I. The first phase should also involve the regulatory agencies to assess their interest in seeing the project move forward and to solicit their involvement in the design. The regulatory agencies that should be contacted, depending on the particular site location, include the California Department of Fish and Game, Regional Water Quality Control Board, U.S. Army Corps of Engineers, San Luis Obispo County, U.S. Fish and Wildlife Service, National Marine Fisheries Service, and appropriate local agencies such as the City of Arroyo Grande. It is important to receive input from these agencies before proceeding. Their input will often dictate the project scope and how the project will be implemented, maintained and monitored.

4.5.2. General Source Reduction Recommendation

General source reduction recommendations consist of programs or Best Management Practices (BMP) aimed at reducing long-term, chronic input of fine sediment from existing distributed sources of erosion and potential future point sources. The agencies or groups responsible for implementing, managing, or overseeing the recommendations vary from city governments, San Luis Obispo County, the NRCS, Coastal San Luis RCD, Central Coast Salmon Enhancement, to individual landowners. They are meant to be general recommendations that should be modified according to the specific application. Five recommendations are provided below. In addition, we have assembled a table outlining additional BMP's to reduce sediment input from rural and residential dirt roads, developed parcels, and agricultural land (Table 4.10).

Site #	Subwatershed Area	General Location	Arroyo Grande Watershed Assessment ID #	Description	Proposed Treatment	Priority
2	Corbitt/Carpenter	On Corbitt Creek, a short distance above confluence with Arroyo Grande Creek.	F-10	Headcut located on main channel.	Provide grade control to prevent further movement upstream.	high
3	Corbitt/Carpenter	Uppermost portion of subwatershed adjacent to main road.	49	Denuded stream channel passes through pasture area. Channel is devoid of vegetation, highly erodible and suceptible to impacts associated with livestock.	1) Isolate channel from livestock with fence and revegetate to reduce further erosion. or 2) Move channel outside of pasture area considering appropriate design measures ie. revegeation, channel morphology, constraints, etc.	high
8	Tar Springs	On Canyon de los Alisos near confluence with Tar Spring Creek.	122	Incised stream channel with little to no riparian buffer strip along channel. Subwatershed is highly erodible and well connected with Tar Spring Creek.	Widen stream corridor, including low benches to increase bank stability and allow for inchannel sediment storage.	high
9	Tar Springs	Middle alluvial portion of Tar Spring Creek main channel.	121	Stream channel is highly modified, confined between road and agricultural fields. Little to no ripairan buffer strip exists.	Widen stream corridor, including low benches to increase bank stability and allow for inchannel sediment storage.	high
1	Arroyo Grande Mainstem	Base of drainage located on left bank of Arroyo Grande Creek downstream of Biddle Park.	F-2	Debris flow - possibly the result of a failed agricultural retention pond. Large fresh sediment fan with headcut moving upstream.	Provide grade control to prevent further movement upstream. Revegetate stream channel areas to allow for sediment entrapment and storage.	medium
4	Northern Subsheds	Small subwatershed tributery to Arroyo Grande Creek near Lopez Dam.	81	Highly erodible subwatershed with little to no riparian buffer along tributary channel. Channel is well connected with Arroyo Grande Creek.	Widen riparian buffer strip along channel to reduce sediment input into the tributary stream.	medium

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TABLE 4.9: Site summary for miscellaneous erosion source reduction projects in the Lower Arroyo Grande watershed. These sites were selected from a preliminary list of potential projects identified in the Arroyo Grande Creek Watershed Management Plan. Each of the selected projects occurs within an area identified in the sediment budget to contribute disproportionately high sediment volumes to Arroyo Grande Creek. Further evaluation of each project area would be required to evaluate project scope, landowner interest, and costs. Locations of these sites are shown in Appendix B.

Site #	Subwatershed Area	General Location	Arroyo Grande Watershed Assessment ID #	Description	Proposed Treatment	Priority
5	Northern Subsheds	Small subwatershed tributery to Arroyo Grande Creek near Corralitos Creek.	22	Road cut into hillslope without proper design features.	1) Realign road to reduce erosive potential associated with road features ie cutslopes, road shoulders and roadside ditches. or 2) install appropriate BMP's to reduce erosion associated with road.	medium
10	Tar Springs	Middle alluvial portion of Tar Spring Creek Main Channel.	115	Stream channel is incised and flows through patures with no livestock exclusion. Little to no ripairan buffer strip exists.	Exclude livestock from riparian corridor and revegetate, widen stream channel including low benches to increase bank stability and allow for inchannel sediment storage.	medium
6	Northern Subsheds	Upper portion of subwatershed near Corralitos Creek.	23	Bare areas associated with development, area contains highly erodible soils.	Treat with BMP's appropriate for reducing erosion and trapping sediment. Revegetate to reduce erosion.	low
7	Tar Springs	Lower alluvial portion of Tar Spring Creek Main Channel.	124	Main channel passes through rural residential area and appears to be highly modified/lacking functional morphology.	Establish permanent channel alignment and appropriate riparian buffer throughout reach.	low
11	Los Berros	Upper portion of subwatershed.	131	Multiple untreated stream fords and livestock operation near channel.	Install appropriate culverts and exclude livestock from stream channel. Revegetate.	low

TABLE 4.9(cont): Site summary for miscellaneous erosion source reduction projects in the Lower Arroyo Grande watershed. These sites were selected from a preliminary list of potential projects identified in the Arroyo Grande Creek Watershed Management Plan. Each of the selected projects occurs within an area identified in the sediment budget to contribute disproportionately high sediment volumes to Arroyo Grande Creek. Further evaluation of each project area would be required to evaluate project scope, landowner interest, and costs. Locations of these sites are shown in Appendix B.

SITE LAND USE	TREATMENT STRATEGY	TREATMENT MEASURE	NOTES
Rural Residential and Dirt Roads	*Drainage Control*		
	Disperse/Slow Runoff	Grass-lined Swales	Application may be limited due to steep slopes
		Infiltration Trenches	May be limited due to saturated conditions
		Rolling Dips + Water Bars	Works well on unpaved roads and small paved roads in many terrains; must be installed correctly and maintained
		Outslope roads	Can be effective but reduces roads safety; should be applied to seasonal roads only.
		Pave roads with compacted gravel/decomposed Granite	Requires periodic replacement, re-compaction and Maintenance
	Control Concentrated Runoff	Place flow in culverts	Must be sized appropriately for runoff volume.
		Extend culvert outlets, fit with energy dissipaters	
		Use curbs to direct runoff on paved roads	
	Sediment/Erosion Control		
	Soil Stabilization	Pave road surfaces with asphalt	Must install drainage control systems to handle increases in concentrates runoff volume and peak flow
		Pave roads with compacted gravel/decomposed Granite	Requires periodic re-compaction/ Maintenance
		Rock line open drainage ditches	
		Install retaining/slough walls to stabilize road cuts and trap sediments.	Slough walls require periodic cleaning.
		Stabilize roadcuts and sidecast with vegetation	Should choose appropriate plant species and avoid exotic invasive plants.
	Sediment Retention	Install staged catch basins	Can handle only small volumes of sediment and runoff
		Install vegetated filter strips	May have limited application due to plant growth conditions
		Install organic debris filters.	May be difficult to hold in place; decays over time
		Install sediment retention basins	May have limited application due to steep terrain

Table 4.10: Programmatic and site specific strategies, measures, and Best Management Practices (BMP's) recommended to reduce erosion and chronic fine sediment delivery to Arroyo Grande Creek. Recommendation apply to rural residential and dirt roads, developed parcels, and agricultural land.

Developed Parcels	*Drainage Control*		
	Control runoff from impervious surfaces	Install roof gutter and downspout systems and control discharge in pipe	
		Install pipe extensions and energy dissipaters to safe outlet	
	Disperse runoff	Direct runoff to infiltration trenches	Application may be limited in areas of high saturation; may create landslide hazard.
		Direct runoff into grass lined swales and/or open flat vegetated areas	Application may be limited due to steep terrain
	Sediment/Erosion Control		
	Soil Stabilization	Mulch and plant vegetation on exposed soils	
		Install retaining structures to support fill slopes	
		Install retaining / slough walls on cut slopes	
	Sediment Retention	Install vegetated filter strips in drainage paths and/or in flow dispersion areas	Application may be limited due to steep terrain
		Install catch basins at inlets or culvert discharge points, control outflow by dispersion and/or energy dissipation.	
Agricultural Land	*Sediment/Erosion Control*		
	Ditch Management	Seed ditches and swales with grass	Use appropriate seed mixture approved through NRCS
		Re-seed ditches following periodic maintenance	
		Perch cross-culverts to allow for sediment deposition and reduce culvert clogging	
		Maintain ditch sideslopes at no greater than 3:1	
	Sediment Retention	Create small sediment basins periodically along length of ditch and prior to discharging into streams to capture sediment	Will require periodic maintenance. Consult with NRCS for appropriate sizing and spacing
		Plant riparian buffers along contact between agricultural land and stream channels	

FIGURE 4.10 (cont): Programmatic and site specific strategies, measures, and Best Management Practices (BMP's) recommended to reduce erosion and chronic fine sediment delivery to Arroyo Grande Creek. Recommendation apply to rural residential and dirt roads, developed parcels, and agricultural land.

Recommendation 1: Establish and Maintain Channel Monitoring Programs to Measure Sediment Impairment and the Effectiveness of Sediment Control Measures

Stream channel conditions have a great influence over habitat quality and impairment by fine sediment. The key habitat factors are: streamflow, sediment, nutrients and riparian corridor quality and these are interrelated (e.g. riparian vegetation influences bank erosion and stream temperature). Following implementation of specific erosion control projects, channel monitoring should be conducted to document changes in fine sediments in the streambed and the relationship to habitat quality and fish populations. A network of cross-section and bed substrate condition monitoring stations should be established to document potential benefits from project implementation. In addition, periodic habitat assessments should be funded with a focus on assessing pool depth, spawning substrate quality, and presence of cover habitat since these appear to be the limiting factors affecting steelhead in Arroyo Grande Creek.

Recommendation 2: Public Agency Measures to Reduce Sediment from Private Lands

A common non-point source of fine sediments results from drainage modifications and/or soil disturbances on private lands. Parcel development often involves removal of stabilizing vegetation, grading and exposure of soils, increased runoff rates from impervious cover (i.e. roofs, roads, etc.) and concentration of runoff in efficient drainage collection systems (roof gutters, curbs, streets and culverts). Storm runoff on private parcels is often discharged into private and/or public road drainage systems, which, in combination with steep terrain, easily erodible soils, and high intensity rainfall, often creates significant challenges for road agencies to control drainage and erosion. Local government agencies can affect management of sediment and runoff on new private developments by creating ordinances, defining the requirements and expectations. Some of the common measures used to reduce impacts of private land development on public facilities and storm water management systems are as follows:

- Require new developments to install water detention devices,
- Require new roads to incorporate water retention into infrastructure (such as a reverse French drain, grease and oil traps),
- Create best management opportunities for single-family residences, housing developments and roads, and
- Coordinate with County of San Luis Obispo and other local government agencies to create permitting changes that incorporate best management practices.

In addition, existing developments can be targeted for sediment reduction and storm water management through outreach and incentive programs including:

- Develop outreach and incentive programs for residential water detention such as roof runoff cisterns for irrigation purposes,
- Coordinate with the County of San Luis Obispo or other local government agencies to develop a rebate program for roof runoff cisterns, and
- Provide education and outreach for better land use practices (including brochures, public service announcements, workshops, etc.). Make sure to include why better management practices will benefit landowners.

Recommendation 3: Develop and Analyze Alternatives to Hard Bank Protection Structures

Bank erosion is often difficult and expensive to fix, especially in areas with poor access to the channel. Often, installing new bank protection structures that are hard (e.g. rip rap, gabions, walls etc.) may cause more erosion when flow energy deflects to an unprotected bank. In many cases, structural bank erosion fixes address the eroding bank and do not consider reach hydraulics or geomorphic stability. Hard structures alone can lead to more erosion.

Recommendation 3 seeks to analyze bank protection structure impacts and investigate whether non-structural solutions such as securing riparian buffers or restoring stable channel geometry and using re-vegetation are applicable. The County, NRCS, or local government agencies should provide public and agency education and assistance for streamside landowners to prevent accelerated erosion due to placement of hard structures along banks. Proposed projects should incorporate "bioengineering" into bank protection structures to address wildlife habitat issues.

Recommendation 4: Develop A Road Maintenance BMP Program and Develop Spoils Disposal Sites

Road maintenance on public (and private) roads often involves removing sediment from the road surfaces and ditches and placing in areas where it is susceptible to erosion and delivery to a waterway. The objective of the Public Road BMP Program is to ensure that all feasible measures are taken to reduce erosion and prevent road maintenance sediments from entering waterways.

A common source of fine sediments found along roads are the spoils generated during emergency repairs or normal maintenance grading. This sediment is often placed on the road shoulder or in a sidecast area where it is susceptible to erosion and delivery to a waterway. Spoils often remain barren of stabilizing vegetation cover and persist for many years after placement.

Recommendation 4 is to develop road maintenance Best Management Practices (BMPs), and emergency and permanent spoil disposal sites for road maintenance work to stabilize, store, or otherwise contain fine sediments permanently and prevent erosion and delivery to waterways.

This recommendation seeks to incorporate BMPs into regular maintenance activities with emergency work and development of spoils disposal sites that service both activities.

To initiate a BMP program, maintenance practices, equipment, and techniques should be examined and compared to those conducted during a construction project that involves earth grading under an established construction sediment control program such as a Storm Water Pollution Prevention Plan (SWPPP). Any resource gaps in terms of personnel, equipment, training, spoils storage and disposal, and revegetation needs should be addressed in a BMP program document, the guide for implementation.

A first order BMP would be to move excavated spoils material to safe, long-term disposal sites. The County, or other responsible agency, should acquire suitable disposal sites such as old quarry pits. During winter emergencies or as part of the practicality of operations, immediate delivery of spoils to a permanent disposal site may be difficult to accomplish given the priority of opening roads. For emergency work, interim safe storage practices should be employed such as installing runoff detention swales, straw bales and/or mulching, etc. to temporarily stored spoils. Other possible BMP's would include spreading, mulching and seeding spoils.

Recommendation 5: Encourage Ranchers to Erect Riparian Fencing for Controlled Cattle Access on Primary Stream Channels

Cattle can cause extensive damage to streambanks and young riparian vegetation resulting in chronic delivery of fine sediment directly to stream channel. In addition, cattle spending time in stream channels during hot summer days can cause water quality problems. Controlled access through the use of riparian fencing would provide protection for riparian areas and allow for management of localized erosion while at the same time providing cattle with a refuge from high summer temperatures, a local source of water, and access to grazing land on either side of the stream. Off-channel watering troughs can also be developed to provide additional water sources away from the stream channel. Protection of the riparian corridor is a vital element in reducing bank erosion and minimizing impacts from high water temperatures on habitat conditions in the mainstem Arroyo Grande. Riparian fencing should be set back a reasonable distance to allow for expansion of narrow riparian corridors impacted by past encroachment.

5. Preliminary Environmental Review of Proposed Alternatives

Environmental review and permitting of projects located within or adjacent to stream channels or wetlands are often complicated due to overlapping regulatory agency jurisdictions, presence of threatened or endangered species, and concerns about the potential the project might have on flooding and water quality. Rivers, streams, and wetlands are typically one of the most impacted habitats because they are often sources of competing uses (e.g. – water supply, irrigation supply, waste discharge, etc) and in many cases present a danger through flooding and bank erosion, requiring communities to modify their channels to attempt to minimize impacts.

Because of these competing uses and the important value that rivers, streams and wetlands provide to the community, regulatory jurisdictions often overlap. For Arroyo Grande Creek, the following agencies will often claim jurisdiction when a project is considered:

- California Department of Fish and Game – state wildlife resource protection
- U.S. Army Corps of Engineers – 404 Clean Water Act
- National Marine Fisheries Service (NOAA Fisheries) – Endangered Species Act
- U.S. Fish and Wildlife Service – Endangered Species Act
- Regional Water Quality Control Board – 401 Certification; NPDES Permits
- San Luis Obispo County or alternative local agency – local grading and building permits
- State Coastal Commission (downstream of the Union Pacific Railroad Bridge) – Coastal Protection Act
- Private entities such as Union Pacific

In addition to the regulatory requirements, any project built within the State of California, except for federal projects, is subjected to environmental review under the California Environmental Quality Act (CEQA)[18]. CEQA evaluates potential environmental impacts due to a project, not only to biological communities but to human communities. An assessment of impacts within each of the impact categories are meant to be evaluated with baseline conditions considered. So, for example, in the case of a levee raise, the impacts that need to be evaluated under CEQA would not be the impact of having a levee, but the impact of raising the levee. This is an important distinction to make. Determinations are then made based on the results of an impact analysis to evaluate the suitability of implementing the project. If impacts are expected to occur when the project is implemented, those impacts could be mitigated to a less than significant level.

[18] Our analysis assumed that CEQA would apply to each Alternative considered. If a federal agency is involved in implementing the project or is acting as the project proponent, such as the NRCS, NEPA, the National Environmental Protection Act, would apply instead of CEQA. Though the process would be different, the approach to analyzing environmental impacts and requirements to lessen those impacts through mitigation would be similar.

To preliminarily assess potential impacts associated with Alternatives 1 through 6, we prepared an Initial Study Checklist for each of the alternatives (Appendix A)[19]. The checklists provide a first look at what the impacts might be, what level of mitigation might be required to lessen potential impacts, and whether or not the project could receive the determination of a Negative Declaration with Mitigation or if a full analysis of impacts would be required through preparation of an Environmental Impact Report.

For most of the projects considered in the Alternative Analysis, it appears that a Mitigated Negative Declaration would be the most appropriate approach, though increasing the heights of the 22nd and/or Union Pacific Bridges and construction of flood and sediment detention basins on the tributaries may require further analysis. The most significant impact associated with most of the projects is protection of three ESA listed species: steelhead, California red-legged frog, and tidewater goby. Fortunately, most projects within or adjacent to streams on the Central Coast have encountered these species so there is a wealth of information about how to provide mitigation to reduce impacts. The other prime area of concern is protection of water quality. Again, appropriate construction-related Best Management Practices are well-documented to provide for water quality protection when activities are within or adjacent to live stream channels.

The remaining issues that would require further analysis under CEQA for many of the alternatives would be cultural resources, construction related impacts to traffic and noise, for Alternatives that propose levee construction or sediment removal, and the level of impact on the channel associated with the alternatives that include a bridge raise.

[19] A biological report is currently being prepared to evaluate potential impacts and adverse effects on the biology of the Arroyo Grande and Los Berros flood control channel if Alternative 3c were to be implemented. The biological report will also provide recommendations to mitigate for any potential impacts. This document would support the CEQA or NEPA analysis and will be available for review in January, 2006.

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Appendix A.

CEQA Initial Study Checklist for each Proposed Alternative

Arroyo Grande Flood Control Project, Alternative 1
CEQA
Environmental Checklist Form

1. Project title: **Arroyo Grande Flood Control Project, Alternative 1**

2. Lead agency name and address:

   "to be completed"

3. Contact person and phone number:

   Julie Thomas
   (805) 772-4391

4. Project location:

   Arroyo Grande Creek, San Luis Obispo County.

5. Project sponsor's name and address:

   "to be completed"

6. General plan designation: ________________________ 7. Zoning: ____________________

8. Description of project: (Describe the whole action involved, including but not limited to later phases of the project, and any secondary, support, or off-site features necessary for its implementation. Attach additional sheets if necessary.)

   Alternative 1 consists of vegetation maintenance along the Arroyo Grande and Los Berros flood control channel to improve channel flood capacity by decreasing the channel roughness. Vegetation maintenance would maintain a 10 foot vegetated buffer around the low flow channel to maintain riparian habitat and canopy cover. Vegetation within the 10 foot buffer would be managed by thinning branches lower than 6' to reduce overall channel roughness while maintaining adequate canopy cover for stream shading and other environmental benefits. Vegetation outside of the buffer would be removed. Vegetation management would be conducted as often as necessary to maintain a roughness of 0.04, and is assumed to be necessary approximately every 2 to 3 years.

9. Surrounding land uses and setting: Briefly describe the project's surroundings:

   Arroyo Grande Creek is a 157 square mile coastal watershed located in west San Luis

Obispo County and mainly drains agricultural and urban areas including the cities of Arroyo Grande and Oceano. This project focuses on the 3.8 mile reach from the Pacific Ocean to just upstream of Los Berros Creek and up Los Berros Creek to Valley View Rd, both reaches entirely contained by flood levees. The reach of interest is surrounded by farmland on the south and a mix of farmland and suburban residential areas on the north.

10. Other public agencies whose approval is required (e.g., permits, financing approval, or participation agreement.)

    California Department of Fish and Game
    U.S. Army Corps of Engineers
    National Marine Fisheries Service (NOAA Fisheries)
    U.S. Fish and Wildlife Service
    Regional Water Quality Control Board
    San Luis Obispo County
    State Coastal Commission (lower portion)

ENVIRONMENTAL FACTORS POTENTIALLY AFFECTED:

The environmental factors checked below would be potentially affected by this project, involving at least one impact that is a "Potentially Significant Impact" as indicated by the checklist on the following pages.

	Aesthetics		Agriculture Resources		Air Quality
X	Biological Resources		Cultural Resources		Geology /Soils
	Hazards & Hazardous Materials		Hydrology / Water Quality		Land Use / Planning
	Mineral Resources		Noise		Population / Housing
	Public Services		Recreation		Transportation/Traffic
	Utilities / Service Systems		Mandatory Findings of Significance		

DETERMINATION: (To be completed by the Lead Agency)

On the basis of this initial evaluation:

I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared.

I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.

I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.

I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.

I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier EIR or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier EIR or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required.

______________________________ ______________
Signature Date

______________________________ ______________
Signature Date

EVALUATION OF ENVIRONMENTAL IMPACTS:

1) A brief explanation is required for all answers except "No Impact" answers that are adequately supported by the information sources a lead agency cites in the parentheses following each question. A "No Impact" answer is adequately supported if the referenced information sources show that the impact simply does not apply to projects like the one involved (e.g., the project falls outside a fault rupture zone). A "No Impact" answer should be explained where it is based on project-specific factors as well as general standards (e.g., the project will not expose sensitive receptors to pollutants, based on a project-specific screening analysis).

2) All answers must take account of the whole action involved, including off-site as well as on-site, cumulative as well as project-level, indirect as well as direct, and construction as well as operational impacts.

3) Once the lead agency has determined that a particular physical impact may occur, then the checklist answers must indicate whether the impact is potentially significant, less than significant with mitigation, or less than significant. "Potentially Significant Impact" is appropriate if there is substantial evidence that an effect may be significant. If there are one or more "Potentially Significant Impact" entries when the determination is made, an EIR is required.

4) "Negative Declaration: Less Than Significant With Mitigation Incorporated" applies where the incorporation of mitigation measures has reduced an effect from "Potentially Significant Impact" to a "Less Than Significant Impact." The lead agency must describe the mitigation measures, and briefly explain how they reduce the effect to a less than significant level (mitigation measures from Section XVII, "Earlier Analyses," may be cross-referenced).

5) Earlier analyses may be used where, pursuant to the tiering, program EIR, or other CEQA process, an effect has been adequately analyzed in an earlier EIR or negative declaration. Section 15063(c)(3)(D). In this case, a brief discussion should identify the following:
   a) Earlier Analysis Used. Identify and state where they are available for review.
   b) Impacts Adequately Addressed. Identify which effects from the above checklist were within the scope of and adequately analyzed in an earlier document pursuant to applicable legal standards, and state whether such effects were addressed by mitigation measures based on the earlier analysis.
   c) Mitigation Measures. For effects that are "Less than Significant with Mitigation Measures Incorporated," describe the mitigation measures which were incorporated or refined from the earlier document and the extent to which they address site-specific conditions for the project.

6) Lead agencies are encouraged to incorporate into the checklist references to information sources for potential impacts (e.g., general plans, zoning ordinances). Reference to a previously prepared or outside document should, where appropriate, include a reference to the page or pages where the statement is substantiated.

7) Supporting Information Sources: A source list should be attached, and other sources used or individuals contacted should be cited in the discussion.

8) This is only a suggested form, and lead agencies are free to use different formats; however, lead agencies should normally address the questions from this checklist that are relevant to a project's environmental effects in whatever format is selected.

9) The explanation of each issue should identify:
   a) the significance criteria or threshold, if any, used to evaluate each question; and
   b) the mitigation measure identified, if any, to reduce the impact to less than significance

SAMPLE QUESTION

Issues:

	Potentially Significant Impact	**Less Than Significant with Mitigation Incorporation**	**Less Than Significant Impact**	**No Impact**
I. AESTHETICS -- Would the project:				
a) Have a substantial adverse effect on a scenic vista?				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?				X
c) Substantially degrade the existing visual character or quality of the site and its surroundings?				X
d) Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area?				X
II. AGRICULTURE RESOURCES: In determining whether impacts to agricultural resources are significant environmental effects, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (1997) prepared by the California Dept. of Conservation as an optional model to use in assessing impacts on agriculture and farmland. Would the project:				
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?				X
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?				X
c) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use?				X
III. AIR QUALITY -- Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:				X
a) Conflict with or obstruct implementation of the applicable air quality plan?				X
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors)?				X
d) Expose sensitive receptors to substantial pollutant concentrations?				X
e) Create objectionable odors affecting a substantial number of people?				X
IV. BIOLOGICAL RESOURCES -- Would the project:				
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?		X		
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or US Fish and Wildlife Service?		X		
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?				X
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?				X
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?				X
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local,				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
regional, or state habitat conservation plan?				
V. CULTURAL RESOURCES -- Would the project:				
a) Cause a substantial adverse change in the significance of a historical resource as defined in '15064.5?				X
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to '15064.5?				X
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?				X
d) Disturb any human remains, including those interred outside of formal cemeteries?				X
VI. GEOLOGY AND SOILS -- Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				X
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.				X
ii) Strong seismic ground shaking?				X
iii) Seismic-related ground failure, including liquefaction?				X
iv) Landslides?				X
b) Result in substantial soil erosion or the loss of topsoil?				X
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?				X
d) Be located on expansive soil, as defined in Table				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?				
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?				X
VII. HAZARDS AND HAZARDOUS MATERIALS B Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?				X
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?				X
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?				X
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?				X
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?				X
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?				X
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?				X
h) Expose people or structures to a significant risk of loss, injury or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
VIII. HYDROLOGY AND WATER QUALITY -- Would the project:				
a) Violate any water quality standards or waste discharge requirements?				X
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?				X
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?				X
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?				X
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?				X
f) Otherwise substantially degrade water quality?				X
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?				X
h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?				X
i) Expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam?				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
j) Inundation by seiche, tsunami, or mudflow?				X
IX. LAND USE AND PLANNING - Would the project:				
a) Physically divide an established community?				X
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?				X
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?				X
X. MINERAL RESOURCES -- Would the project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?				X
b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?				X
XI. NOISE B Would the project result in:				
a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?				X
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels?				X
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?				X
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?			X	
e) For a project located within an airport land use				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?				
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?				X
XII. POPULATION AND HOUSING -- Would the project:				
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?				X
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?				X
c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?				X
XIII. PUBLIC SERVICES				
a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services:				
Fire protection?				X
Police protection?				X
Schools?				X
Parks?				X
				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
Other public facilities?				
XIV. RECREATION --				
a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?				X
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?				X
XV. TRANSPORTATION/TRAFFIC -- Would the project:				
a) Cause an increase in traffic which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)?				X
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?				X
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?				
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?				X
e) Result in inadequate emergency access?				X
f) Result in inadequate parking capacity?				X
g) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?				X
XVI. UTILITIES AND SERVICE SYSTEMS B				

Would the project:	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?				X
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?				X
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?				X
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?				X
e) Result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project=s projected demand in addition to the provider=s existing commitments?				X
f) Be served by a landfill with sufficient permitted capacity to accommodate the project=s solid waste disposal needs?				X
g) Comply with federal, state, and local statutes and regulations related to solid waste?				X
XVII. MANDATORY FINDINGS OF SIGNIFICANCE --				
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?		X		
b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?				
c) Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?				X

I. AESTHETICS:

This project does not have adverse effects on scenic vistas. The project locations do not fall within view of scenic highway areas. The proposed project involves the removal of riparian vegetation. The modifications are minimal and would not offer a significant impact to the visual character and quality of the sites. No additional sources of light or glare would be created due to these projects. Based on these considerations less than significant aesthetical impacts are anticipated due to the proposed projects.

II. AGRICULTURAL RESOURCES:

The proposed project will not impact prime or unique farmlands and there will be no conflicts with current zoning for agricultural uses or Williamson act contracts. No changes in regard to the conversion of farmland to non-agricultural uses will occur due to the changes in the environment due to the proposed projects. Considering these factors no agricultural resources impacts are foreseen due to the implementation of the proposed projects.

III. AIR QUALITY:

No conflicts or violations with applicable air quality plans will occur due to the proposed projects. The projects being considered will not contribute to pollutants which fit criteria for designation as non-attainment under the applicable state and federal clean air guidelines. The vegetation removal process will not contribute to particulate matter nor will it expose sensitive receptors to substantial pollutant concentrations or create objectionable odors affecting a substantial number of people. No air quality impacts are expected due to the proposed projects.

IV. BIOLOGICAL RESOURCES:

This project proposes to thin riparian vegetation from Arroyo Grande and Los Berros Creek to improve the passage of flood waters. This project may have an adverse impact on the two listed species, Steelhead (*Oncorhynchus mykiss*) and the California red-legged frog (*Rana aurora draytonii*) but will be less than significant with mitigation. The proposed work will consist of temporary, project implementation-related impacts. All work will be done during the low flow season and no work will be done in the wetted channel, thus minimizing any direct impact on steelhead or juvenile red-legged frogs in the channel. An on-site biological monitor will be present to temporarily relocate red-legged frogs if they are found during vegetation thinning activities. The 2004 habitat conservation plan (HCP) (Stetson 2004) found no breeding or incubating red-legged frog habitat directly in the channel due to lack of slow water areas. It was believed that all red-legged frogs found in the area were dispersed from other off channel incubation areas. This HCP also found no rare or endangered plants within the 100-year flood plain. There will be a less than significant impact on the riparian habitat since a 10 foot riparian buffer is being maintained with vegetation growing back quickly in the late-winter/spring months. This will preserve sufficient riparian habitat, provide stream shading for steelhead in the channel and preserve any potential breeding or foraging habitat for the red-legged frogs. This project will not directly impact on any federally protected wetlands as defined by Section 404 of the Clean Water Act since vegetation will only be thinned. This project will not interfere with the movement of any fish or wildlife species or impede the use of native wildlife nursery sites. This project does not conflict with any local policies or ordinances protecting biological resources or with any adopted HCP. The previously mentioned HCP has yet to be adopted and does not include the lower flood control reaches. There is no impact to biological resources foreseen following completion of the projects.

V. CULTURAL RESOURCES:

No impact is foreseen in this area. There are no historical, archeological or paleontological resources in the flood channel and the existing bed of the channel is not being disturbed.

VI. GEOLOGY AND SOILS

No impacts in this category are foreseen as construction of the proposed projects will not compromise any geologic or soil stability associated with the surrounding areas.

VII. HAZARDS AND HAZARDOUS MATERIALS:

Impacts are not anticipated in this category because no hazardous materials will be necessary in the construction of the proposed projects.

VIII. HYDROLOGY AND WATER QUALITY:

No impacts to water quality are foreseen as all work will be done during low flows and no work will be done in the wetted channel. The proposed project will not affect groundwater recharge, alter the drainage pattern resulting in erosion, or contribute to increased runoff affecting drainage networks within the area.

IX. LAND USE AND PLANNING:

No impact is anticipated to land use and planning since the proposed project will not physically divide any established communities, conflict with land use plans, or conflict with conservation plans.

X. MINERAL RESOURCES:

No losses in the availability of any locally, state or federally important mineral resources will result due to the construction of the proposed project.

XI. NOISE:

Due to the equipment necessary for the construction of the proposed project, mostly chain saws and wood chippers, there will be less than significant impacts expected due to temporary increases in ambient noise levels in the project vicinity. No other impacts in regard to increased noise levels are expected due to the proposed projects.

XII. POPULATION AND HOUSING:

No impacts are anticipated concerning population growth, the displacement of people or houses necessitating the construction of housing elsewhere.

XIII. PUBLIC SERVICES:

No impacts are anticipated concerning any public services or facilities.

XIV. RECREATION:

This project would have no impact on existing recreational facilities.

XV. TRANSPORTATION/TRAFFIC

This project would have no impact on traffic as the number of vehicle trips required to carry away cleared vegetation is expected to be minimal.

XVI. UTILITIES AND SERVICE SYSTEMS:

No effect on utilities and service systems is expected since the proposed project in no way affects waste water systems, landfills, drainage systems, or water supplies.

XVI. MANDATORY FINDINGS OF SIGNIFICANCE:

This project will not substantially impact steelhead, red-legged frogs, rare plants or their habitats. The project will have no impact that are individually limited but cumulatively considerable and does not have any environmental effects which will cause substantial adverse effects on human beings. Mitigations for protection of red-legged frog and steelhead are being incorporated into the project by maintaining a 10 foot buffer around the low flow channel and having on-site biological monitors present during vegetation removal activities.

Arroyo Grande Flood Control Project, Alternative 2
CEQA
Environmental Checklist Form

1. Project title: **Arroyo Grande Flood Control Project, Alternative 2**

2. Lead agency name and address:

   “to be completed”

3. Contact person and phone number:

   Julie Thomas
   (805) 772-4391

4. Project location:

   Arroyo Grande Creek, San Luis Obispo County.

5. Project sponsor's name and address:

   “to be completed”

6. General plan designation: ________________________ 7. Zoning: ____________________

8. Description of project: (Describe the whole action involved, including but not limited to later phases of the project, and any secondary, support, or off-site features necessary for its implementation. Attach additional sheets if necessary.)

   Alternative 2 proposes to remove built up sediment along the flood control channel to increase the channel flood capacity. Excavation of overflow channels will occur on the levee side of a 10 foot vegetated buffer. Excavation will occur to a depth of 1.5 ft above the existing low flow bed on Arroyo Grande Creek and 1 foot above the existing bed on Los Berros Creek. Connections will be made between the existing low flow channel and the excavated areas to encourage flood flows to enter and exit the overflow channel, increase overall capacity, and provide channels that would mimic natural bed scour conditions. Future maintenance of the overflow channel will be accomplished by “bar ripping”, which breaks up roots and other debris to encourage sediment transport and flushing of the overflow channels. The channel will be maintained in this condition through spot removal of accumulated sediments based on monitoring results at permanent cross section established along the length of the channel. Monitoring cross-sections will be surveyed annually.

9. Surrounding land uses and setting: Briefly describe the project's surroundings:

   Arroyo Grande Creek is a 157 square mile coastal watershed located in west San Luis Obispo County and mainly drains agricultural and urban areas including the cities of Arroyo Grande and Oceano. This project focuses on the 3.8 mile reach from the Pacific Ocean to just upstream of Los Berros Creek and up Los Berros Creek to Valley View Rd, both reaches entirely contained by flood levees. The reach of interest is surrounded by farmland on the south and a mix of farmland and suburban residential areas on the north.

10. Other public agencies whose approval is required (e.g., permits, financing approval, or participation agreement.)

    California Department of Fish and Game
    National Marine Fisheries Service (NOAA Fisheries)
    U.S. Fish and Wildlife Service
    Regional Water Quality Control Board
    San Luis Obispo County
    State Coastal Commission (where appropriate)

ENVIRONMENTAL FACTORS POTENTIALLY AFFECTED:

The environmental factors checked below would be potentially affected by this project, involving at least one impact that is a "Potentially Significant Impact" as indicated by the checklist on the following pages.

	Aesthetics		Agriculture Resources		Air Quality
X	Biological Resources	**X**	Cultural Resources		Geology /Soils
	Hazards & Hazardous Materials	**X**	Hydrology / Water Quality		Land Use / Planning
	Mineral Resources		Noise		Population / Housing
	Public Services		Recreation	____	Transportation/Traffic
	Utilities / Service Systems		Mandatory Findings of Significance		

DETERMINATION: (To be completed by the Lead Agency)

On the basis of this initial evaluation:

I find that the proposed project COULD NOT have a significant effect on the environment, and a

NEGATIVE DECLARATION will be prepared.

I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.

I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.

I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.

I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier EIR or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier EIR or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required.

Signature ______________________ Date __________

Signature ______________________ Date __________

EVALUATION OF ENVIRONMENTAL IMPACTS:

1) A brief explanation is required for all answers except "No Impact" answers that are adequately supported by the information sources a lead agency cites in the parentheses following each question. A "No Impact" answer is adequately supported if the referenced information sources show that the impact simply does not apply to projects like the one involved (e.g., the project falls outside a fault rupture zone). A "No Impact" answer should be explained where it is based on project-specific factors as well as general standards (e.g., the project will not expose sensitive receptors to pollutants, based on a project-specific screening analysis).

2) All answers must take account of the whole action involved, including off-site as well as on-site, cumulative as well as project-level, indirect as well as direct, and construction as well as operational impacts.

3) Once the lead agency has determined that a particular physical impact may occur, then the checklist answers must indicate whether the impact is potentially significant, less than significant with

mitigation, or less than significant. "Potentially Significant Impact" is appropriate if there is substantial evidence that an effect may be significant. If there are one or more "Potentially Significant Impact" entries when the determination is made, an EIR is required.

4) "Negative Declaration: Less Than Significant With Mitigation Incorporated" applies where the incorporation of mitigation measures has reduced an effect from "Potentially Significant Impact" to a "Less Than Significant Impact." The lead agency must describe the mitigation measures, and briefly explain how they reduce the effect to a less than significant level (mitigation measures from Section XVII, "Earlier Analyses," may be cross-referenced).

5) Earlier analyses may be used where, pursuant to the tiering, program EIR, or other CEQA process, an effect has been adequately analyzed in an earlier EIR or negative declaration. Section 15063(c)(3)(D). In this case, a brief discussion should identify the following:
   a) Earlier Analysis Used. Identify and state where they are available for review.
   b) Impacts Adequately Addressed. Identify which effects from the above checklist were within the scope of and adequately analyzed in an earlier document pursuant to applicable legal standards, and state whether such effects were addressed by mitigation measures based on the earlier analysis.
   c) Mitigation Measures. For effects that are "Less than Significant with Mitigation Measures Incorporated," describe the mitigation measures which were incorporated or refined from the earlier document and the extent to which they address site-specific conditions for the project.

6) Lead agencies are encouraged to incorporate into the checklist references to information sources for potential impacts (e.g., general plans, zoning ordinances). Reference to a previously prepared or outside document should, where appropriate, include a reference to the page or pages where the statement is substantiated.

7) Supporting Information Sources: A source list should be attached, and other sources used or individuals contacted should be cited in the discussion.

8) This is only a suggested form, and lead agencies are free to use different formats; however, lead agencies should normally address the questions from this checklist that are relevant to a project's environmental effects in whatever format is selected.

9) The explanation of each issue should identify:
   a) the significance criteria or threshold, if any, used to evaluate each question; and
   b) the mitigation measure identified, if any, to reduce the impact to less than significance

SAMPLE QUESTION

Issues:

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
I. AESTHETICS -- Would the project:				
a) Have a substantial adverse effect on a scenic vista?				X
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?				X
c) Substantially degrade the existing visual character or quality of the site and its surroundings?				X
d) Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area?				X
II. AGRICULTURE RESOURCES: In determining whether impacts to agricultural resources are significant environmental effects, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (1997) prepared by the California Dept. of Conservation as an optional model to use in assessing impacts on agriculture and farmland. Would the project:				
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?				X
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?				X
c) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use?				X
III. AIR QUALITY -- Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:				X
a) Conflict with or obstruct implementation of the				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
applicable air quality plan?				
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?				X
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors)?				X
d) Expose sensitive receptors to substantial pollutant concentrations?				X
e) Create objectionable odors affecting a substantial number of people?				X
IV. BIOLOGICAL RESOURCES -- Would the project:				
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?		X		
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or US Fish and Wildlife Service?		X		
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?		X		
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?				X
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
preservation policy or ordinance?				
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?				X
V. CULTURAL RESOURCES -- Would the project:				
a) Cause a substantial adverse change in the significance of a historical resource as defined in '15064.5?				X
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to '15064.5?			X	
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?				X
d) Disturb any human remains, including those interred outside of formal cemeteries?				X
VI. GEOLOGY AND SOILS -- Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				X
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.				X
ii) Strong seismic ground shaking?				X
iii) Seismic-related ground failure, including liquefaction?				X
iv) Landslides?				X
b) Result in substantial soil erosion or the loss of topsoil?				X
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?				
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?				X
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?				X
VII. HAZARDS AND HAZARDOUS MATERIALS B Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?				X
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?				X
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?				X
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?				X
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?				X
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?				X
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?				X
h) Expose people or structures to a significant risk				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
of loss, injury or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?				
VIII. HYDROLOGY AND WATER QUALITY -- Would the project:				
a) Violate any water quality standards or waste discharge requirements?		X		
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?				X
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?			X	
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?				X
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?				X
f) Otherwise substantially degrade water quality?			X	
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?				X
h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
i) Expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam?				X
j) Inundation by seiche, tsunami, or mudflow?				X
IX. LAND USE AND PLANNING - Would the project:				
a) Physically divide an established community?				X
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?				X
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?				X
X. MINERAL RESOURCES -- Would the project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?				X
b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?				X
XI. NOISE B Would the project result in:				
a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?				X
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels?				X
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?			X	
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?				X
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?				X
XII. POPULATION AND HOUSING -- Would the project:				
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?				X
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?				X
c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?				X
XIII. PUBLIC SERVICES				
a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services:				
Fire protection?				X
Police protection?				X
				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
Schools?				
Parks?				X
Other public facilities?				X
XIV. RECREATION --				
a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?				X
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?				X
XV. TRANSPORTATION/TRAFFIC -- Would the project:				
a) Cause an increase in traffic which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)?				X
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?				X
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?				
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?				X
e) Result in inadequate emergency access?				X
f) Result in inadequate parking capacity?				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
g) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?				X
XVI. UTILITIES AND SERVICE SYSTEMS B Would the project:				
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?				X
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?				X
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?				X
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?				X
e) Result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project=s projected demand in addition to the provider=s existing commitments?				X
f) Be served by a landfill with sufficient permitted capacity to accommodate the project=s solid waste disposal needs?				X
g) Comply with federal, state, and local statutes and regulations related to solid waste?				X
XVII. MANDATORY FINDINGS OF SIGNIFICANCE --				
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate		X		

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
important examples of the major periods of California history or prehistory?				
b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?				X
c) Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?				X

I. AESTHETICS:

This project does not have adverse effects on scenic vistas. The project locations do not fall within view of scenic highway areas. The proposed project involves the removal of sediment. The modifications are minimal and would not offer a significant impact to the visual character and quality of the sites. No additional sources of light or glare would be created due to these projects. Based on these considerations less than significant aesthetical impacts are anticipated due to the proposed projects.

II. AGRICULTURAL RESOURCES:

The proposed project will not impact prime or unique farmlands and there will be no conflicts with current zoning for agricultural uses or Williamson Act contracts. No changes in regard to the conversion of farmland to non-agricultural uses will occur due to the changes in the environment due to the proposed projects. Considering these factors no agricultural resources impacts are foreseen due to the implementation of the proposed projects.

III. AIR QUALITY:

No conflicts or violations with applicable air quality plans will occur due to the proposed projects. The projects being considered will not contribute to pollutants which fit criteria for designation as non-attainment under the applicable state and federal clean air guidelines. The sediment removal process will not contribute to particulate matter nor will it expose sensitive receptors to substantial pollutant concentrations or create objectionable odors affecting a substantial number of people. No air quality impacts are expected due to the proposed projects.

IV. BIOLOGICAL RESOURCES:

This project proposes to remove sediment from Arroyo Grande and Los Berros Creek to improve flood capacity and reduce the need for future sediment removal by maintaining secondary channels that would flush sediment and reduce aggradation. This project may have an adverse impact on three listed species, Steelhead (*Oncorhynchus mykiss*), California red-legged frog (*Rana aurora draytonii*), and tidewater goby

(*Eucyclogobius newberryi*) but will be less than significant with mitigation. The proposed work will consist of temporary, construction-related impacts. All work will be done during the low flow season and no work will be done in the wetted channel, thus minimizing any direct impact on steelhead or juvenile red-legged frogs in the channel. An on-site biological monitor will be present to temporarily relocate red-legged frogs if they are found during sediment removal activities. The 2004 habitat conservation plan (HCP) (Stetson 2004) found no breeding or incubating red-legged frog habitat directly in the channel due to lack of slow water areas. It was believed that all red-legged frogs found in the area were dispersed from other off channel incubation areas. This HCP also found no rare or endangered plants within the 100-year flood plain. There will be a less than significant impact on the riparian habitat with the mitigation of a 10 foot riparian buffer. This will preserve sufficient riparian habitat, provide necessary cover for steelhead in the channel and preserve any potential breeding or foraging habitat for the red-legged frogs. This project will not directly impact on any federally protected wetlands as defined by Section 404 of the Clean Water Act since vegetation will only be thinned. This project will not interfere with the movement of any fish or wildlife species or impede the use of native wildlife nursery sites. This project does not conflict with any local policies or ordinances protecting biological resources or with any adopted HCP. The previously mentioned HCP has yet to be adopted and does not include the lower flood control reaches. There is no impact to biological resources foreseen following completion of the projects.

V. CULTURAL RESOURCES:

The project occurs within an existing flood control channel constructed in the 1961. The current sediment removal proposal will adequately protect archaeological resources because maintenance sediment removal activities will not approach the bottom of the constructed channels original depth. In the event that archaeological resources are found, all work in the vicinity will stop and the disposition of any artifacts will be accomplished in accordance with state and federal law by a qualified archaeologist.

VI. GEOLOGY AND SOILS

No impacts in this category are foreseen as construction of the proposed projects will not compromise any geologic or soil stability associated with the surrounding areas.

VII. HAZARDS AND HAZARDOUS MATERIALS:

Impacts are not anticipated in this category because no hazardous materials will be necessary in the construction of the proposed projects.

VIII. HYDROLOGY AND WATER QUALITY:

Potential construction-related impacts to water quality will be minimized by doing all grading work during low flows with no work being done in the wetted channel. A 10 foot buffer will be maintained between sediment removal activities and the low flow channel except in areas where connections are being made between the two. Appropriate BMP's will be in place to reduce impacts associated with construction equipment being near flowing water. The proposed project will not affect groundwater recharge, alter the drainage pattern resulting in erosion, or contribute to increased runoff affecting drainage networks within the area. Long-term, the project is not expected to substantially impact water quality. Some additionally sediment will be mobilized as a result of maintaining the overflow channels but increased turbidity is only expected during high runoff events when turbidity is already high. Much of the increase in sediment transport will be associated with fine sediment that will be mobilized and transported all the way to the ocean. A rough analysis of potential impacts to the lagoon suggests that the proposed project will increase lagoon flushing at higher flows due to increased channel capacity.

IX. LAND USE AND PLANNING:

No impact is anticipated to land use and planning since the proposed project will not physically divide any established communities, conflict with land use plans, or conflict with conservation plans.

X. MINERAL RESOURCES:

No losses in the availability of any locally, state or federally important mineral resources will result due to the construction of the proposed project.

XI. NOISE:

Due to the equipment necessary for the construction of the proposed project, mostly trucks, tractors and front loaders, there will be less than significant impacts expected due to temporary increases in ambient noise levels in the project vicinity. Potential impacts are temporary and construction related. No other impacts in regard to increased noise levels are expected due to the proposed projects.

XII. POPULATION AND HOUSING:

No impacts are anticipated concerning population growth, the displacement of people or houses necessitating the construction of housing elsewhere.

XIII. PUBLIC SERVICES:

No impacts are anticipated concerning any public services or facilities.

XIV. RECREATION:

This project would have no impact on existing recreational facilities.

XV. TRANSPORTATION/TRAFFIC

This project would have no impact on traffic as the number of vehicle trips required to carry away removed sediment is expected to be minimal.

XVI. UTILITIES AND SERVICE SYSTEMS:

No effect on utilities and service systems is expected since the proposed project in no way affects waste water systems, landfills, drainage systems, or water supplies.

XVI. MANDATORY FINDINGS OF SIGNIFICANCE:

This project will not substantially impact steelhead, red-legged frogs, rare plants or their habitats. The project will have no impact that are individually limited but cumulatively considerable and does not have any environmental effects which will cause substantial adverse effects on human beings. Mitigations for protection of red-legged frog and steelhead are being incorporated into the project by maintaining a 10 foot buffer around the low flow channel and having on-site biological monitors present during sediment removal activities.

Arroyo Grande Flood Control Project Alternative 3
CEQA
Environmental Checklist Form

1. Project title: **Arroyo Grande Flood Control Project, Alternative 3**

2. Lead agency name and address:

   “to be completed”

3. Contact person and phone number:

   Julie Thomas
   (805) 772-4391

4. Project location:

   Arroyo Grande Creek, San Luis Obispo County.

5. Project sponsor's name and address:

   “to be completed”

6. General plan designation: ________________________ 7. Zoning: ____________________

8. Description of project: (Describe the whole action involved, including but not limited to later phases of the project, and any secondary, support, or off-site features necessary for its implementation. Attach additional sheets if necessary.)

   Alternative 3 assumes that the components of Alternative 1 and 2 are being implemented concurrently. The additional project proposed as part of Alternative 3 consists of a series of options that aims to raise existing flood control levees to increase channel capacity and reduce the frequency of flooding to adjacent agricultural land. Alternative 3a consists of raising uneven portions of the levee that have been compromised due to natural settlement. Approximately 12,000 cubic yards of fill material would be required to raise portions of the existing levee to an elevation that would contain a 10-year discharge event. The fill would be used to raise elevations at the top of the levee and to maintain a 2:1 slope on the outer edge of the levee with a 15-foot levee top. Sediment removed from the channel as part of Alternative 2 could potentially be used for a portion of the fill required to implement Alternative 3a. Alternatives 3b and 3c consist of a similar approach to 3a with additional levee height added to protect against floods of a higher magnitude (15-year and 20-year protection respectively). Alternative 3b would require 44,000 cubic yards of material and Alternative 3c would

require 79,000 cubic yards. Because of the significant increase in the levee height associated with Alternative 3b and 3c, the Union Pacific Railroad Bridge would need to be raised to pass increased flood flows. Conceptually, a bridge raise would not require modifications to the existing in-channel abutments though some work would likely be required in the channel with a temporary diversion.

9. Surrounding land uses and setting: Briefly describe the project's surroundings:

   Arroyo Grande Creek is a 157 square mile coastal watershed located in west San Luis Obispo County and mainly drains agricultural and urban areas including the cities of Arroyo Grande and Oceano. This project focuses on the 3.8 mile reach from the Pacific Ocean to just upstream of Los Berros Creek and up Los Berros Creek to Valley View Rd, both reaches entirely contained by flood levees. The reach of interest is surrounded by farmland on the south and a mix of farmland and suburban residential areas on the north.

10. Other public agencies whose approval is required (e.g., permits, financing approval, or participation agreement.)

    California Department of Fish and Game
    U.S. Army Corps of Engineers
    National Marine Fisheries Service (NOAA Fisheries)
    U.S. Fish and Wildlife Service
    Regional Water Quality Control Board
    San Luis Obispo County
    State Coastal Commission

ENVIRONMENTAL FACTORS POTENTIALLY AFFECTED:

The environmental factors checked below would be potentially affected by this project, involving at least one impact that is a "Potentially Significant Impact" as indicated by the checklist on the following pages.

	Aesthetics		Agriculture Resources		Air Quality
X	Biological Resources	X	Cultural Resources		Geology /Soils
	Hazards & Hazardous Materials	X	Hydrology / Water Quality		Land Use / Planning
	Mineral Resources		Noise		Population / Housing
	Public Services		Recreation	_____	Transportation/Traffic
	Utilities / Service Systems		Mandatory Findings of Significance		

DETERMINATION: (To be completed by the Lead Agency)

On the basis of this initial evaluation:

I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared.

I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.

I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.

I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.

I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier EIR or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier EIR or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required.

__________________________________ _______________

Signature Date

__________________________________ _______________

Signature Date

EVALUATION OF ENVIRONMENTAL IMPACTS:

1) A brief explanation is required for all answers except "No Impact" answers that are adequately supported by the information sources a lead agency cites in the parentheses following each question. A "No Impact" answer is adequately supported if the referenced information sources show that the impact simply does not apply to projects like the one involved (e.g., the project falls outside a fault rupture zone). A "No Impact" answer should be explained where it is based on project-specific factors as well as general standards (e.g., the project will not expose sensitive receptors to pollutants, based on a project-specific screening analysis).

2) All answers must take account of the whole action involved, including off-site as well as on-site, cumulative as well as project-level, indirect as well as direct, and construction as well as operational impacts.

3) Once the lead agency has determined that a particular physical impact may occur, then the checklist answers must indicate whether the impact is potentially significant, less than significant with mitigation, or less than significant. "Potentially Significant Impact" is appropriate if there is substantial evidence that an effect may be significant. If there are one or more "Potentially Significant Impact" entries when the determination is made, an EIR is required.

4) "Negative Declaration: Less Than Significant With Mitigation Incorporated" applies where the incorporation of mitigation measures has reduced an effect from "Potentially Significant Impact" to a "Less Than Significant Impact." The lead agency must describe the mitigation measures, and briefly explain how they reduce the effect to a less than significant level (mitigation measures from Section XVII, "Earlier Analyses," may be cross-referenced).

5) Earlier analyses may be used where, pursuant to the tiering, program EIR, or other CEQA process, an effect has been adequately analyzed in an earlier EIR or negative declaration. Section 15063(c)(3)(D). In this case, a brief discussion should identify the following:
   a) Earlier Analysis Used. Identify and state where they are available for review.
   b) Impacts Adequately Addressed. Identify which effects from the above checklist were within the scope of and adequately analyzed in an earlier document pursuant to applicable legal standards, and state whether such effects were addressed by mitigation measures based on the earlier analysis.
   c) Mitigation Measures. For effects that are "Less than Significant with Mitigation Measures Incorporated," describe the mitigation measures which were incorporated or refined from the earlier document and the extent to which they address site-specific conditions for the project.

6) Lead agencies are encouraged to incorporate into the checklist references to information sources for potential impacts (e.g., general plans, zoning ordinances). Reference to a previously prepared or outside document should, where appropriate, include a reference to the page or pages where the statement is substantiated.

7) Supporting Information Sources: A source list should be attached, and other sources used or individuals contacted should be cited in the discussion.

8) This is only a suggested form, and lead agencies are free to use different formats; however, lead agencies should normally address the questions from this checklist that are relevant to a project's environmental effects in whatever format is selected.

9) The explanation of each issue should identify:
   a) the significance criteria or threshold, if any, used to evaluate each question; and
   b) the mitigation measure identified, if any, to reduce the impact to less than significance

SAMPLE QUESTION

Issues:

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
I. AESTHETICS -- Would the project:				
a) Have a substantial adverse effect on a scenic vista?				X
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?				X
c) Substantially degrade the existing visual character or quality of the site and its surroundings?				X
d) Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area?				X
II. AGRICULTURE RESOURCES: In determining whether impacts to agricultural resources are significant environmental effects, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (1997) prepared by the California Dept. of Conservation as an optional model to use in assessing impacts on agriculture and farmland. Would the project:				
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?			X	
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?				X
c) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use?				X
III. AIR QUALITY -- Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
a) Conflict with or obstruct implementation of the applicable air quality plan?				X
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?				X
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors)?				X
d) Expose sensitive receptors to substantial pollutant concentrations?				X
e) Create objectionable odors affecting a substantial number of people?				X
IV. BIOLOGICAL RESOURCES -- Would the project:				
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?		X		
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or US Fish and Wildlife Service?		X		
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?		X		
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?				X
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?				X
V. CULTURAL RESOURCES -- Would the project:				
a) Cause a substantial adverse change in the significance of a historical resource as defined in '15064.5?				X
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to '15064.5?			X	
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?				X
d) Disturb any human remains, including those interred outside of formal cemeteries?				X
VI. GEOLOGY AND SOILS -- Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				X
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.				X
ii) Strong seismic ground shaking?				X
iii) Seismic-related ground failure, including liquefaction?				X
iv) Landslides?				X
b) Result in substantial soil erosion or the loss of topsoil?				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?				X
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?				X
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?				X
VII. HAZARDS AND HAZARDOUS MATERIALS B Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?				X
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?				X
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?				X
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?				X
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?				X
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?				X
g) Impair implementation of or physically interfere with an adopted emergency response plan or				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
emergency evacuation plan?				
h) Expose people or structures to a significant risk of loss, injury or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?				X
VIII. HYDROLOGY AND WATER QUALITY -- Would the project:				
a) Violate any water quality standards or waste discharge requirements?		X		
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?				X
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?				X
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?				X
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?				X
f) Otherwise substantially degrade water quality?			X	
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?				X
h) Place within a 100-year flood hazard area				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
structures which would impede or redirect flood flows?				
i) Expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam?				X
j) Inundation by seiche, tsunami, or mudflow?				X
IX. LAND USE AND PLANNING - Would the project:				
a) Physically divide an established community?				X
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?				X
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?				X
X. MINERAL RESOURCES -- Would the project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?				X
b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?				X
XI. NOISE B Would the project result in:				
a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?				X
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels?				X
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
existing without the project?				
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?			X	
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?				X
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?				X
XII. POPULATION AND HOUSING -- Would the project:				
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?				X
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?				X
c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?				X
XIII. PUBLIC SERVICES				
a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services:				
Fire protection?				X
Police protection?				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
Schools?				X
Parks?				X
Other public facilities?				X
XIV. RECREATION --				
a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?				X
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?				X
XV. TRANSPORTATION/TRAFFIC -- Would the project:				
a) Cause an increase in traffic which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)?				X
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?				X
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?				
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?				X
e) Result in inadequate emergency access?				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
f) Result in inadequate parking capacity?				X
g) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?				X
XVI. UTILITIES AND SERVICE SYSTEMS B Would the project:				
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?				X
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?				X
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?				X
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?				X
e) Result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project=s projected demand in addition to the provider=s existing commitments?				X
f) Be served by a landfill with sufficient permitted capacity to accommodate the project=s solid waste disposal needs?				X
g) Comply with federal, state, and local statutes and regulations related to solid waste?				X
XVII. MANDATORY FINDINGS OF SIGNIFICANCE --				
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal		X		

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?				
b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?				X
c) Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?				X

I. AESTHETICS:

This project does not have adverse effects on scenic vistas. The project locations do not fall within view of scenic highway areas. The proposed project involves the raising of channel levees. The modifications are minimal and would not offer a significant impact to the visual character and quality of the sites. No additional sources of light or glare would be created due to these projects. Based on these considerations less than significant aesthetical impacts are anticipated due to the proposed projects.

II. AGRICULTURAL RESOURCES:

The proposed projects will not impact prime or unique farmlands and there will be no conflicts with current zoning for agricultural uses or Williamson act contracts. No changes in regard to the conversion of farmland to non-agricultural uses will occur due to the changes in the environment due to the proposed projects. Considering these factors no agricultural resources impacts are foreseen due to the implementation of the proposed projects.

III. AIR QUALITY:

No conflicts or violations with applicable air quality plans will occur due to the proposed projects. The projects being considered will not contribute to pollutants which fit criteria for designation as non-attainment under the applicable state and federal clean air guidelines. The levee raising process will not contribute to particulate matter nor will it expose sensitive receptors to substantial pollutant concentrations or create objectionable odors affecting a substantial number of people. No air quality impacts are expected due to the proposed projects.

IV. BIOLOGICAL RESOURCES:

This project proposes to raise the levees on Arroyo Grande and Los Berros Creek to increase channel capacity and reduce flood impacts on adjacent farmland and residential housing. This project may have an adverse impact on the three listed species, Steelhead (*Oncorhynchus mykiss*), California red-legged frog

(*Rana aurora draytonii*), and tidewater goby (*Eucyclogobius newberryi*) but will be less than significant with mitigation. The proposed work will consist of temporary, construction-related impacts. The levee raise portion of the project will be conducted completely outside of the channel. Alternative 3b and 3c, which require raising the Union Pacific Bridge will likely require temporary, construction-related diversion of the creek to facilitate use of equipment within the channel. Installation of the temporary diversion would require temporary relocation of fish and amphibians under consultation with NOAA Fisheries and USFWS. An on-site biological monitor will be present to temporarily relocate red-legged frogs if they are found during construction activities. The 2004 habitat conservation plan (HCP) (Stetson 2004) found no breeding or incubating red-legged frog habitat directly in the channel due to lack of slow water areas. It was believed that all red-legged frogs found in the area were dispersed from other off channel incubation areas. This HCP also found no rare or endangered plants within the 100-year flood plain. . This project will not directly impact on any federally protected wetlands as defined by Section 404 of the Clean Water Act since vegetation will only be thinned. This project will not interfere with the movement of any fish since the project will be conducted during non-migratory season, nor will it affect wildlife species or impede the use of native wildlife nursery sites. This project does not conflict with any local policies or ordinances protecting biological resources or with any adopted HCP. The previously mentioned HCP has yet to be adopted and does not include the lower flood control reaches. There is no impact to biological resources foreseen following completion of the projects.

V. CULTURAL RESOURCES:

The project occurs within an existing flood control channel constructed in the 1961. The current sediment removal proposal will adequately protect archaeological resources because maintenance sediment removal activities will not approach the bottom of the constructed channels original depth. In the event that archaeological resources are found, all work in the vicinity will stop and the disposition of any artifacts will be accomplished in accordance with state and federal law by a qualified archaeologist.

VI. GEOLOGY AND SOILS

No impacts in this category are foreseen as construction of the proposed projects will not compromise any geologic or soil stability associated with the surrounding areas.

VII. HAZARDS AND HAZARDOUS MATERIALS:

Impacts are not anticipated in this category because no hazardous materials will be necessary in the construction of the proposed projects.

VIII. HYDROLOGY AND WATER QUALITY:

Much of the work being conducted as part of Alternative 3 would occur outside of the wetted channel, respecting a 10 foot riparian buffer established as part of Alternative 1 and 2. Appropriate BMP's will be in place to reduce impacts associated with construction equipment being near flowing water. The only exception is for Alternatives 3b and 3c which would require in channel work in the vicinity of the Union Pacific Bridge. The work would likely require a temporary diversion of Arroyo Grande Creek around the project area to reduce water quality impacts. BMP measures would be in place to protect water quality associated with temporary construction related impacts. No long-term impacts to the site hydrology or water quality would be anticipated. The proposed project will not affect groundwater recharge, alter the drainage pattern resulting in erosion, or contribute to increased runoff affecting drainage networks within the area.

IX. LAND USE AND PLANNING:

No impact is anticipated to land use and planning since the proposed project will not physically divide any established communities, conflict with land use plans, or conflict with conservation plans.

X. MINERAL RESOURCES:

No losses in the availability of any locally, state or federally important mineral resources will result due to the construction of the proposed project.

XI. NOISE:

Due to the equipment necessary for the construction of the proposed project, mostly trucks, tractors and front loaders, there will be less than significant impacts expected due to temporary increases in ambient noise levels in the project vicinity. No other impacts in regard to increased noise levels are expected due to the proposed projects.

XII. POPULATION AND HOUSING:

No impacts are anticipated concerning population growth, the displacement of people or houses necessitating the construction of housing elsewhere.

XIII. PUBLIC SERVICES:

No impacts are anticipated concerning any public services or facilities.

XIV. RECREATION:

This project would have no impact on existing recreational facilities.

XV. TRANSPORTATION/TRAFFIC

This project would have no impact on traffic as the number of vehicle trips required to construct the levees is expected to be minimal. Passenger train service may temporarily be interrupted during construction, which may require buses to provide transportation while the bridge is out of service. Details regarding the transportation plan will be determined later but mitigations are available to limit potential impacts associated with disruption of train service.

XVI. UTILITIES AND SERVICE SYSTEMS:

No effect on utilities and service systems is expected since the proposed project in no way affects waste water systems, landfills, drainage systems, or water supplies.

XVI. MANDATORY FINDINGS OF SIGNIFICANCE:

This project will not substantially impact steelhead, red-legged frogs, rare plants or their habitats. The project will have no impact that are individually limited but cumulatively considerable and does not have any environmental effects which will cause substantial adverse effects on human beings. Mitigations for protection of red-legged frog and steelhead are being incorporated into the project by maintaining a 10 foot buffer around the low flow channel and having on-site biological monitors present during sediment removal activities. BMP's will be implemented, where appropriate, to minimize impacts to biological resources and water quality.

Arroyo Grande Flood Control Project, Alternative 4
CEQA
Environmental Checklist Form

1. Project title: **Arroyo Grande Flood Control Project, Alternative 4**

2. Lead agency name and address:

   "to be completed"

3. Contact person and phone number:

   Julie Thomas
   (805) 772-4391

4. Project location:

   Arroyo Grande Creek, San Luis Obispo County.

5. Project sponsor's name and address:

   "to be completed"

6. General plan designation: ________________________ 7. Zoning: ____________________

8. Description of project: (Describe the whole action involved, including but not limited to later phases of the project, and any secondary, support, or off-site features necessary for its implementation. Attach additional sheets if necessary.)

   Alternative 4 assumes implementation of all the measures associated with Alternative 3c except for creation of overflow channels and long-term sediment management activities. Alternative 4 still proposes raising the UPRR Bridge above the 50 year flood water surface.

9. Surrounding land uses and setting: Briefly describe the project's surroundings:

   Arroyo Grande Creek is a 157 square mile coastal watershed located in west San Luis Obispo County and mainly drains agricultural and urban areas including the cities of Arroyo Grande and Oceano. This project focuses on the 3.8 mile reach from the Pacific Ocean to just upstream of Los Berros Creek and up Los Berros Creek to Valley View Rd, both reaches entirely contained by flood levees. The reach of interest is surrounded by farmland on the south and a mix of farmland and suburban residential areas on the north.

10. Other public agencies whose approval is required (e.g., permits, financing approval, or participation agreement.)

    California Department of Fish and Game
    U.S. Army Corps of Engineers
    National Marine Fisheries Service (NOAA Fisheries)
    U.S. Fish and Wildlife Service
    Regional Water Quality Control Board
    San Luis Obispo County
    State Coastal Commission

ENVIRONMENTAL FACTORS POTENTIALLY AFFECTED:

The environmental factors checked below would be potentially affected by this project, involving at least one impact that is a "Potentially Significant Impact" as indicated by the checklist on the following pages.

	Aesthetics		Agriculture Resources		Air Quality
X	Biological Resources	**X**	Cultural Resources		Geology /Soils
	Hazards & Hazardous Materials	**X**	Hydrology / Water Quality		Land Use / Planning
	Mineral Resources		Noise		Population / Housing
	Public Services		Recreation	_____	Transportation/Traffic
	Utilities / Service Systems		Mandatory Findings of Significance		

DETERMINATION: (To be completed by the Lead Agency)

On the basis of this initial evaluation:

I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared.

I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.

I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.

I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.

I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier EIR or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier EIR or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required.

Signature ____________________ Date __________

Signature ____________________ Date __________

EVALUATION OF ENVIRONMENTAL IMPACTS:

1) A brief explanation is required for all answers except "No Impact" answers that are adequately supported by the information sources a lead agency cites in the parentheses following each question. A "No Impact" answer is adequately supported if the referenced information sources show that the impact simply does not apply to projects like the one involved (e.g., the project falls outside a fault rupture zone). A "No Impact" answer should be explained where it is based on project-specific factors as well as general standards (e.g., the project will not expose sensitive receptors to pollutants, based on a project-specific screening analysis).

2) All answers must take account of the whole action involved, including off-site as well as on-site, cumulative as well as project-level, indirect as well as direct, and construction as well as operational impacts.

3) Once the lead agency has determined that a particular physical impact may occur, then the checklist answers must indicate whether the impact is potentially significant, less than significant with mitigation, or less than significant. "Potentially Significant Impact" is appropriate if there is substantial evidence that an effect may be significant. If there are one or more "Potentially Significant Impact" entries when the determination is made, an EIR is required.

4) "Negative Declaration: Less Than Significant With Mitigation Incorporated" applies where the incorporation of mitigation measures has reduced an effect from "Potentially Significant Impact" to a "Less Than Significant Impact." The lead agency must describe the mitigation measures, and briefly explain how they reduce the effect to a less than significant level (mitigation measures from Section XVII, "Earlier Analyses," may be cross-referenced).

5) Earlier analyses may be used where, pursuant to the tiering, program EIR, or other CEQA process, an effect has been adequately analyzed in an earlier EIR or negative declaration. Section 15063(c)(3)(D). In this case, a brief discussion should identify the following:
   a) Earlier Analysis Used. Identify and state where they are available for review.
   b) Impacts Adequately Addressed. Identify which effects from the above checklist were within the scope of and adequately analyzed in an earlier document pursuant to applicable legal standards, and state whether such effects were addressed by mitigation measures based on the earlier analysis.
   c) Mitigation Measures. For effects that are "Less than Significant with Mitigation Measures Incorporated," describe the mitigation measures which were incorporated or refined from the earlier document and the extent to which they address site-specific conditions for the project.

6) Lead agencies are encouraged to incorporate into the checklist references to information sources for potential impacts (e.g., general plans, zoning ordinances). Reference to a previously prepared or outside document should, where appropriate, include a reference to the page or pages where the statement is substantiated.

7) Supporting Information Sources: A source list should be attached, and other sources used or individuals contacted should be cited in the discussion.

8) This is only a suggested form, and lead agencies are free to use different formats; however, lead agencies should normally address the questions from this checklist that are relevant to a project's environmental effects in whatever format is selected.

9) The explanation of each issue should identify:
   a) the significance criteria or threshold, if any, used to evaluate each question; and
   b) the mitigation measure identified, if any, to reduce the impact to less than significance

SAMPLE QUESTION

Issues:

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
I. AESTHETICS -- Would the project:				
a) Have a substantial adverse effect on a scenic vista?				X
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?				X
c) Substantially degrade the existing visual				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
character or quality of the site and its surroundings?				
d) Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area?				X
II. AGRICULTURE RESOURCES: In determining whether impacts to agricultural resources are significant environmental effects, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (1997) prepared by the California Dept. of Conservation as an optional model to use in assessing impacts on agriculture and farmland. Would the project:				
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?			X	
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?				X
c) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use?				X
III. AIR QUALITY -- Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:				X
a) Conflict with or obstruct implementation of the applicable air quality plan?				X
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?				X
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
exceed quantitative thresholds for ozone precursors)?				
d) Expose sensitive receptors to substantial pollutant concentrations?				X
e) Create objectionable odors affecting a substantial number of people?				X
IV. BIOLOGICAL RESOURCES -- Would the project:				
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?		X		
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or US Fish and Wildlife Service?			X	
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?			X	
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?				X
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?				X
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?				X
V. CULTURAL RESOURCES -- Would the project:				
a) Cause a substantial adverse change in the				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
significance of a historical resource as defined in '15064.5?				
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to '15064.5?				X
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?				X
d) Disturb any human remains, including those interred outside of formal cemeteries?				X
VI. GEOLOGY AND SOILS -- Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				X
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.				X
ii) Strong seismic ground shaking?				X
iii) Seismic-related ground failure, including liquefaction?				X
iv) Landslides?				X
b) Result in substantial soil erosion or the loss of topsoil?				X
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?				X
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?				X
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
the disposal of waste water?				
VII. HAZARDS AND HAZARDOUS MATERIALS B Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?				X
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?				X
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?				X
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?				X
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?				X
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?				X
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?				X
h) Expose people or structures to a significant risk of loss, injury or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?				X
VIII. HYDROLOGY AND WATER QUALITY -- Would the project:				
a) Violate any water quality standards or waste discharge requirements?		X		

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?				X
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?				X
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?				X
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?				X
f) Otherwise substantially degrade water quality?			X	
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?				X
h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?				X
i) Expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam?				X
j) Inundation by seiche, tsunami, or mudflow?				X

IX. LAND USE AND PLANNING - Would the project:

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
a) Physically divide an established community?				X
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?				X
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?				X
X. MINERAL RESOURCES -- Would the project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?				X
b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?				X
XI. NOISE B Would the project result in:				
a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?				X
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels?				X
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?				X
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?			X	
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?				X
XII. POPULATION AND HOUSING -- Would the project:				
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?				X
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?				X
c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?				X
XIII. PUBLIC SERVICES				
a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services:				
Fire protection?				X
Police protection?				X
Schools?				X
Parks?				X
Other public facilities?				X
XIV. RECREATION --				
a) Would the project increase the use of existing				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?				
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?				X
XV. TRANSPORTATION/TRAFFIC -- Would the project:				
a) Cause an increase in traffic which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)?			X	
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?				X
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?				
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?				X
e) Result in inadequate emergency access?				X
f) Result in inadequate parking capacity?				X
g) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?				X
XVI. UTILITIES AND SERVICE SYSTEMS B Would the project:				
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?				X
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?				X
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?				X
e) Result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project=s projected demand in addition to the provider=s existing commitments?				X
f) Be served by a landfill with sufficient permitted capacity to accommodate the project=s solid waste disposal needs?				X
g) Comply with federal, state, and local statutes and regulations related to solid waste?				X
XVII. MANDATORY FINDINGS OF SIGNIFICANCE --				
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?		X		
b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
probable future projects)?				
c) Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?				X

I. AESTHETICS:

This project does not have adverse effects on scenic vistas. The project locations do not fall within view of scenic highway areas. The proposed project involves the raising of two bridges. The modifications would not offer a significant impact to the visual character and quality of the sites. No additional sources of light or glare would be created due to these projects. Based on these considerations less than significant aesthetical impacts are anticipated due to the proposed projects.

II. AGRICULTURAL RESOURCES:

The proposed projects will not impact prime or unique farmlands and there will be no conflicts with current zoning for agricultural uses or Williamson act contracts. No changes in regard to the conversion of farmland to non-agricultural uses will occur due to the changes in the environment due to the proposed projects. Considering these factors no agricultural resources impacts are foreseen due to the implementation of the proposed projects.

III. AIR QUALITY:

No conflicts or violations with applicable air quality plans will occur due to the proposed projects. The projects being considered will not contribute to pollutants which fit criteria for designation as non-attainment under the applicable state and federal clean air guidelines. The construction process will not contribute to particulate matter nor will it expose sensitive receptors to substantial pollutant concentrations or create objectionable odors affecting a substantial number of people. No air quality impacts are expected due to the proposed projects.

IV. BIOLOGICAL RESOURCES:

This project proposes to raise the levees on Arroyo Grande and Los Berros Creek to increase channel capacity and reduce flood impacts on adjacent farmland and residential housing. This project may have an adverse impact on the two listed species, Steelhead (*Oncorhynchus mykiss*) and California red-legged frog (*Rana aurora draytonii*) but will be less than significant with mitigation. The proposed work will consist of temporary, construction-related impacts. The levee raise portion of the project will be conducted completely outside of the channel. Raising the Union Pacific Bridge will likely require temporary, construction-related diversion of the creek to facilitate use of equipment within the channel. Installation of the temporary diversion would require temporary relocation of fish and amphibians under consultation with NOAA Fisheries and USFWS. An on-site biological monitor will be present to temporarily relocate red-legged frogs if they are found during construction activities. The 2004 habitat conservation plan (HCP) (Stetson 2004) found no breeding or incubating red-legged frog habitat directly in the channel due to lack of slow water areas. It was believed that all red-legged frogs found in the area were dispersed from other off channel incubation areas. This HCP also found no rare or endangered plants within the 100-year flood plain. . This project will not directly impact on any federally protected wetlands as defined by Section 404 of the Clean Water Act since vegetation will only be thinned. This project will not interfere with the movement of any fish since the project will be conducted during non-migratory season, nor will it affect wildlife species or impede the use of native wildlife nursery sites. This project does not conflict with any local policies or ordinances protecting biological resources or with any adopted HCP. The previously mentioned HCP has yet to be adopted and does not include the lower flood control reaches. There is no impact to biological resources foreseen following completion of the projects.

V. CULTURAL RESOURCES:

No impact is foreseen in this area. There are no historical, archeological or paleontological resources in the flood channel and the existing bed of the channel is not being disturbed.

VI. GEOLOGY AND SOILS

No impacts in this category are foreseen as construction of the proposed projects will not compromise any geologic or soil stability associated with the surrounding areas.

VII. HAZARDS AND HAZARDOUS MATERIALS:

Impacts are not anticipated in this category because no hazardous materials will be necessary in the construction of the proposed projects.

VIII. HYDROLOGY AND WATER QUALITY:

Much of the work being conducted as part of Alternative 4 would occur outside of the wetted channel, respecting a 10 foot riparian buffer established as part of Alternative 1. Appropriate BMP's will be in place to reduce impacts associated with construction equipment being near flowing water. The only exception is in the vicinity of the Union Pacific Bridge. The work around the bridges would likely require a temporary diversion of Arroyo Grande Creek around the project area to reduce water quality impacts. BMP measures would be in place to protect water quality associated with temporary construction related impacts. No long-term impacts to the site hydrology or water quality would be anticipated. The proposed project will not affect groundwater recharge, alter the drainage pattern resulting in erosion, or contribute to increased runoff affecting drainage networks within the area.

IX. LAND USE AND PLANNING:

No impact is anticipated to land use and planning since the proposed project will not physically divide any established communities, conflict with land use plans, or conflict with conservation plans.

X. MINERAL RESOURCES:

No losses in the availability of any locally, state or federally important mineral resources will result due to the construction of the proposed project.

XI. NOISE:

Due to the equipment necessary for the construction of the proposed project, mostly trucks, tractors and front loaders, there will be less than significant impacts expected due to temporary increases in ambient noise levels in the project vicinity. No other impacts in regard to increased noise levels are expected due to the proposed projects.

XII. POPULATION AND HOUSING:

No impacts are anticipated concerning population growth, the displacement of people or houses necessitating the construction of housing elsewhere.

XIII. PUBLIC SERVICES:

No impacts are anticipated concerning any public services or facilities.

XIV. RECREATION:

This project would have no impact on existing recreational facilities.

XV. TRANSPORTATION/TRAFFIC

This project would have no impact on traffic as the number of vehicle trips required to construct the levees is expected to be minimal. Passenger train service may temporarily be interrupted during construction, which may require buses to provide transportation while the bridge is out of service. Details regarding the transportation plan will be determined later but mitigations are available to limit potential impacts associated with disruption of train service.

XVI. UTILITIES AND SERVICE SYSTEMS:

No effect on utilities and service systems is expected since the proposed project in no way affects waste water systems, landfills, drainage systems, or water supplies.

XVI. MANDATORY FINDINGS OF SIGNIFICANCE:

This project will not substantially impact steelhead, red-legged frogs, rare plants or their habitats. The project will have no impact that are individually limited but cumulatively considerable and does not have any environmental effects which will cause substantial adverse effects on human beings. Mitigations for protection of red-legged frog and steelhead are being incorporated into the project by maintaining a 10 foot buffer around the low flow channel and having on-site biological monitors present during sediment removal activities.

Arroyo Grande Flood Control Project, Alternative 5
CEQA
Environmental Checklist Form

1. Project title: **Arroyo Grande Flood Control Project, Alternative 5**

2. Lead agency name and address:

   “to be completed”

3. Contact person and phone number:

   Julie Thomas
   (805) 772-4391

4. Project location:

   Arroyo Grande Creek, San Luis Obispo County.

5. Project sponsor's name and address:

   “to be completed”

6. General plan designation: ________________________ 7. Zoning: ____________________

8. Description of project: (Describe the whole action involved, including but not limited to later phases of the project, and any secondary, support, or off-site features necessary for its implementation. Attach additional sheets if necessary.)

   Alternative 5 proposes off channel storage areas along the south bank of Arroyo Grande Creek between the confluence of Los Berros Creek and the UPRR bridge. The storage areas would be constructed in existing agricultural fields with 5 foot high levees providing for an average flood depth of 4 feet. Flood easements would be placed on the affected lands allowing agriculture to continue except in years when the off channel storage areas are activated due to a high flow event. The purpose of Alternative 5 is to manage flooding in agricultural areas adjacent to the levee as opposed to spreading flood flows across a larger area and causing more impact. Standing water would be pumped back into the Arroyo Grande following passage of the flood using mobile pump systems. Alternative 5 consists of three options. Option 5a assumes Alternative 3a would be implemented, providing 20 year flood protection with approximately 150 acres in flood easements. Option 5b assumes Alternative 3a would be implemented, providing 50 year flood protection with approximately 685 acres of flood easements. Option 5c assumes that Alternative 3c would be implemented

which includes raising the UPRR bridge. Option 5c provides 50 years of protection with approximately 155 acres of flood easement.

9. Surrounding land uses and setting: Briefly describe the project's surroundings:

   Arroyo Grande Creek is a 157 square mile coastal watershed located in west San Luis Obispo County and mainly drains agricultural and urban areas including the cities of Arroyo Grande and Oceano. This project focuses on the 3.8 mile reach from the Pacific Ocean to just upstream of Los Berros Creek and up Los Berros Creek to Valley Rd, both reaches entirely contained by flood levees. The reach of interest is surrounded by farmland on the south and a mix of farmland and suburban residential areas on the north.

10. Other public agencies whose approval is required (e.g., permits, financing approval, or participation agreement.)

    California Department of Fish and Game
    U.S. Army Corps of Engineers
    National Marine Fisheries Service (NOAA Fisheries)
    U.S. Fish and Wildlife Service
    Regional Water Quality Control Board
    San Luis Obispo County
    State Coastal Commission

ENVIRONMENTAL FACTORS POTENTIALLY AFFECTED:

The environmental factors checked below would be potentially affected by this project, involving at least one impact that is a "Potentially Significant Impact" as indicated by the checklist on the following pages.

	Aesthetics		Agriculture Resources		Air Quality
X	Biological Resources	**X**	Cultural Resources		Geology /Soils
	Hazards & Hazardous Materials	**X**	Hydrology / Water Quality		Land Use / Planning
	Mineral Resources		Noise		Population / Housing
	Public Services		Recreation	_____	Transportation/Traffic
	Utilities / Service Systems		Mandatory Findings of Significance		

DETERMINATION: (To be completed by the Lead Agency)

On the basis of this initial evaluation:

I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared.

I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.

I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.

I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.

I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier EIR or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier EIR or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required.

Signature	Date
Signature	Date

EVALUATION OF ENVIRONMENTAL IMPACTS:

1) A brief explanation is required for all answers except "No Impact" answers that are adequately supported by the information sources a lead agency cites in the parentheses following each question. A "No Impact" answer is adequately supported if the referenced information sources show that the impact simply does not apply to projects like the one involved (e.g., the project falls outside a fault rupture zone). A "No Impact" answer should be explained where it is based on project-specific factors as well as general standards (e.g., the project will not expose sensitive receptors to pollutants, based on a project-specific screening analysis).

2) All answers must take account of the whole action involved, including off-site as well as on-site, cumulative as well as project-level, indirect as well as direct, and construction as well as operational impacts.

3) Once the lead agency has determined that a particular physical impact may occur, then the checklist answers must indicate whether the impact is potentially significant, less than significant with mitigation, or less than significant. "Potentially Significant Impact" is appropriate if there is substantial evidence that an effect may be significant. If there are one or more "Potentially Significant Impact" entries when the determination is made, an EIR is required.

4) "Negative Declaration: Less Than Significant With Mitigation Incorporated" applies where the incorporation of mitigation measures has reduced an effect from "Potentially Significant Impact" to a "Less Than Significant Impact." The lead agency must describe the mitigation measures, and briefly explain how they reduce the effect to a less than significant level (mitigation measures from Section XVII, "Earlier Analyses," may be cross-referenced).

5) Earlier analyses may be used where, pursuant to the tiering, program EIR, or other CEQA process, an effect has been adequately analyzed in an earlier EIR or negative declaration. Section 15063(c)(3)(D). In this case, a brief discussion should identify the following:
   a) Earlier Analysis Used. Identify and state where they are available for review.
   b) Impacts Adequately Addressed. Identify which effects from the above checklist were within the scope of and adequately analyzed in an earlier document pursuant to applicable legal standards, and state whether such effects were addressed by mitigation measures based on the earlier analysis.
   c) Mitigation Measures. For effects that are "Less than Significant with Mitigation Measures Incorporated," describe the mitigation measures which were incorporated or refined from the earlier document and the extent to which they address site-specific conditions for the project.

6) Lead agencies are encouraged to incorporate into the checklist references to information sources for potential impacts (e.g., general plans, zoning ordinances). Reference to a previously prepared or outside document should, where appropriate, include a reference to the page or pages where the statement is substantiated.

7) Supporting Information Sources: A source list should be attached, and other sources used or individuals contacted should be cited in the discussion.

8) This is only a suggested form, and lead agencies are free to use different formats; however, lead agencies should normally address the questions from this checklist that are relevant to a project's environmental effects in whatever format is selected.

9) The explanation of each issue should identify:
   a) the significance criteria or threshold, if any, used to evaluate each question; and
   b) the mitigation measure identified, if any, to reduce the impact to less than significance

SAMPLE QUESTION

Issues:

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
I. AESTHETICS -- Would the project:				
a) Have a substantial adverse effect on a scenic vista?				X
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?				X
c) Substantially degrade the existing visual character or quality of the site and its surroundings?				X
d) Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area?				X
II. AGRICULTURE RESOURCES: In determining whether impacts to agricultural resources are significant environmental effects, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (1997) prepared by the California Dept. of Conservation as an optional model to use in assessing impacts on agriculture and farmland. Would the project:				
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?			X	
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?				X
c) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use?				X
III. AIR QUALITY -- Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:				X
a) Conflict with or obstruct implementation of the				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
applicable air quality plan?				
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?				X
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors)?				X
d) Expose sensitive receptors to substantial pollutant concentrations?				X
e) Create objectionable odors affecting a substantial number of people?				X
IV. BIOLOGICAL RESOURCES -- Would the project:				
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?		X		
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or US Fish and Wildlife Service?		X		
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?		X		
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?				X
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
preservation policy or ordinance?				
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?				X
V. CULTURAL RESOURCES -- Would the project:				
a) Cause a substantial adverse change in the significance of a historical resource as defined in '15064.5?			X	
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to '15064.5?				X
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?				X
d) Disturb any human remains, including those interred outside of formal cemeteries?				X
VI. GEOLOGY AND SOILS -- Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				X
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.				X
ii) Strong seismic ground shaking?				X
iii) Seismic-related ground failure, including liquefaction?				X
iv) Landslides?				X
b) Result in substantial soil erosion or the loss of topsoil?				X
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?				
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?				X
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?				X
VII. HAZARDS AND HAZARDOUS MATERIALS B Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?				X
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?				X
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?				X
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?				X
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?				X
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?				X
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?				X
h) Expose people or structures to a significant risk				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
of loss, injury or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?				
VIII. HYDROLOGY AND WATER QUALITY -- Would the project:				
a) Violate any water quality standards or waste discharge requirements?		X		
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?				X
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?				X
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?				X
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?				X
f) Otherwise substantially degrade water quality?			X	
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?				X
h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
i) Expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam?				X
j) Inundation by seiche, tsunami, or mudflow?				X
IX. LAND USE AND PLANNING - Would the project:				
a) Physically divide an established community?				X
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?				X
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?				X
X. MINERAL RESOURCES -- Would the project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?				X
b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?				X
XI. NOISE B Would the project result in:				
a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?				X
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels?				X
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?			X	
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?				X
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?				X
XII. POPULATION AND HOUSING -- Would the project:				
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?				X
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?				X
c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?				X
XIII. PUBLIC SERVICES				
a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services:				
Fire protection?				X
Police protection?				X
				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
Schools?				
Parks?				X
Other public facilities?				X
XIV. RECREATION --				
a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?				X
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?				X
XV. TRANSPORTATION/TRAFFIC -- Would the project:				
a) Cause an increase in traffic which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)?				X
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?				X
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?				
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?				X
e) Result in inadequate emergency access?				X
f) Result in inadequate parking capacity?				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
g) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?				X
XVI. UTILITIES AND SERVICE SYSTEMS B Would the project:				
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?				X
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?				X
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?				X
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?				X
e) Result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project=s projected demand in addition to the provider=s existing commitments?				X
f) Be served by a landfill with sufficient permitted capacity to accommodate the project=s solid waste disposal needs?				X
g) Comply with federal, state, and local statutes and regulations related to solid waste?				X
XVII. MANDATORY FINDINGS OF SIGNIFICANCE --				
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate		X		

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
important examples of the major periods of California history or prehistory?				
b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?				X
c) Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?				X

I. AESTHETICS:

This project does not have adverse effects on scenic vistas. The project locations do not fall within view of scenic highway areas. The proposed project involves the construction of overflow weirs along Arroyo Grande flood levees. The modifications would not offer a significant impact to the visual character and quality of the sites. No additional sources of light or glare would be created due to these projects. Based on these considerations less than significant aesthetical impacts are anticipated due to the proposed projects.

II. AGRICULTURAL RESOURCES:

The proposed project will allow farmland to occasionally flood and will require up to 94 acres of farmland to be converted to levees. We do not foresee levee construction as an impact to existing agricultural resources since much of the land that would be acquired to construct the levees is situated on existing farm roads. The tops of the new levees can potentially be used as farm access roads with some agricultural land impacted by access routes from the levee tops down to the farm field. Considering these factors, significant impacts to agricultural resources are not foreseen due to the implementation of the proposed projects.

III. AIR QUALITY:

No conflicts or violations with applicable air quality plans will occur due to the proposed projects. The projects being considered will not contribute to pollutants which fit criteria for designation as non-attainment under the applicable state and federal clean air guidelines. The construction process will not contribute to particulate matter nor will it expose sensitive receptors to substantial pollutant concentrations or create objectionable odors affecting a substantial number of people. No air quality impacts are expected due to the proposed projects.

IV. BIOLOGICAL RESOURCES:

This project proposes to raise the levees on Arroyo Grande and Los Berros Creek to increase channel capacity and reduce flood impacts on adjacent farmland and residential housing. This project may have an adverse impact on the three listed species, Steelhead (*Oncorhynchus mykiss*), California red-legged frog

(*Rana aurora draytonii*), and tidewater goby (*Eucyclogobius newberryi*) but will be less than significant with mitigation. The proposed work will consist of temporary, construction-related impacts. The levee raise portion of the project will be conducted completely outside of the channel. Alternative 3b and 3c, which require raising the Union Pacific Bridge will likely require temporary, construction-related diversion of the creek to facilitate use of equipment within the channel. Installation of the temporary diversion would require temporary relocation of fish and amphibians under consultation with NOAA Fisheries and USFWS. An on-site biological monitor will be present to temporarily relocate red-legged frogs if they are found during construction activities. The remaining work would be conducted outside the existing channel on adjacent farmland that, under baseline conditions, floods regularly. The 2004 habitat conservation plan (HCP) (Stetson 2004) found no breeding or incubating red-legged frog habitat directly in the channel due to lack of slow water areas. It was believed that all red-legged frogs found in the area were dispersed from other off channel incubation areas. This HCP also found no rare or endangered plants within the 100-year flood plain. . This project will not directly impact on any federally protected wetlands as defined by Section 404 of the Clean Water Act since vegetation will only be thinned. This project will not interfere with the movement of any fish since the project will be conducted during non-migratory season, nor will it affect wildlife species or impede the use of native wildlife nursery sites. This project does not conflict with any local policies or ordinances protecting biological resources or with any adopted HCP. The previously mentioned HCP has yet to be adopted and does not include the lower flood control reaches. There is no impact to biological resources foreseen following completion of the projects.

V. CULTURAL RESOURCES:

The project occurs within an existing flood control channel constructed in the 1961. The current sediment removal proposal will adequately protect archaeological resources because maintenance sediment removal activities will not approach the bottom of the constructed channels original depth. In the event that archaeological resources are found, all work in the vicinity will stop and the disposition of any artifacts will be accomplished in accordance with state and federal law by a qualified archaeologist.

VI. GEOLOGY AND SOILS

No impacts in this category are foreseen as construction of the proposed projects will not compromise any geologic or soil stability associated with the surrounding areas.

VII. HAZARDS AND HAZARDOUS MATERIALS:

Impacts are not anticipated in this category because no hazardous materials will be necessary in the construction of the proposed projects.

VIII. HYDROLOGY AND WATER QUALITY:

Much of the work being conducted as part of Alternative 5 would occur outside of the wetted channel, respecting a 10 foot riparian buffer established as part of Alternative 1 and 2. Appropriate BMP's will be in place to reduce impacts associated with construction equipment being near flowing water. The only exception is for Alternatives 3b and 3c which would require in channel work in the vicinity of the Union Pacific Bridge. The work would likely require a temporary diversion of Arroyo Grande Creek around the project area to reduce water quality impacts. BMP measures would be in place to protect water quality associated with temporary construction related impacts. No long-term impacts to the site hydrology or water quality would be anticipated. The proposed project will not affect groundwater recharge, alter the drainage pattern resulting in erosion, or contribute to increased runoff affecting drainage networks within the area.

IX. LAND USE AND PLANNING:

No impact is anticipated to land use and planning since the proposed project will not physically divide any

established communities, conflict with land use plans, or conflict with conservation plans.

X. MINERAL RESOURCES:

No losses in the availability of any locally, state or federally important mineral resources will result due to the construction of the proposed project.

XI. NOISE:

Due to the equipment necessary for the construction of the proposed project, mostly trucks, tractors and front loaders, there will be less than significant impacts expected due to temporary increases in ambient noise levels in the project vicinity. No other impacts in regard to increased noise levels are expected due to the proposed projects.

XII. POPULATION AND HOUSING:

No impacts are anticipated concerning population growth, the displacement of people or houses necessitating the construction of housing elsewhere.

XIII. PUBLIC SERVICES:

No impacts are anticipated concerning any public services or facilities.

XIV. RECREATION:

This project would have no impact on existing recreational facilities.

XV. TRANSPORTATION/TRAFFIC

This project would have no impact on traffic as the number of vehicle trips required to construct the levees is expected to be minimal. Passenger train service may temporarily be interrupted during construction, which may require buses to provide transportation while the bridge is out of service. Details regarding the transportation plan will be determined later but mitigations are available to limit potential impacts associated with disruption of train service.

XVI. UTILITIES AND SERVICE SYSTEMS:

No effect on utilities and service systems is expected since the proposed project in no way affects waste water systems, landfills, drainage systems, or water supplies.

XVI. MANDATORY FINDINGS OF SIGNIFICANCE:

This project will not substantially impact steelhead, red-legged frogs, rare plants or their habitats. The project will have no impact that are individually limited but cumulatively considerable and does not have any environmental effects which will cause substantial adverse effects on human beings. Mitigations for protection of red-legged frog and steelhead are being incorporated into the project by maintaining a 10 foot buffer around the low flow channel and having on-site biological monitors present during sediment removal activities.

Arroyo Grande Flood Control Project, Alternative 6
CEQA
Environmental Checklist Form

1. Project title: **Arroyo Grande Flood Control Project, Alternative 6**

2. Lead agency name and address:

   "to be completed"

3. Contact person and phone number:

   Julie Thomas
   (805) 772-4391

4. Project location:

   Arroyo Grande Creek, San Luis Obispo County.

5. Project sponsor's name and address:

   "to be completed"

6. General plan designation: ________________________ 7. Zoning: ____________________

8. Description of project: (Describe the whole action involved, including but not limited to later phases of the project, and any secondary, support, or off-site features necessary for its implementation. Attach additional sheets if necessary.)

   Alternative 6 proposes to reduce the effects of potential floods by constructing a number of storm water detention basins on selected parcels within the upper watershed, below Lake Lopez Dam.

9. Surrounding land uses and setting: Briefly describe the project's surroundings:

   Arroyo Grande Creek is a 157 square mile coastal watershed located in west San Luis Obispo County and mainly drains agricultural and urban areas including the cities of Arroyo Grande and Oceano. This project focuses on the 3.8 mile reach from the Pacific Ocean to just upstream of Los Berros Creek and up Los Berros Creek to Valley Rd, both reaches entirely contained by flood levees. The reach of interest is surrounded by farmland on the south and a mix of farmland and suburban residential areas on the north.

10. Other public agencies whose approval is required (e.g., permits, financing approval, or participation agreement.)

    California Department of Fish and Game
    U.S. Army Corps of Engineers
    National Marine Fisheries Service (NOAA Fisheries)
    U.S. Fish and Wildlife Service
    Regional Water Quality Control Board
    San Luis Obispo County
    State Coastal Commission

ENVIRONMENTAL FACTORS POTENTIALLY AFFECTED:

The environmental factors checked below would be potentially affected by this project, involving at least one impact that is a "Potentially Significant Impact" as indicated by the checklist on the following pages.

	Aesthetics		Agriculture Resources		Air Quality
X	Biological Resources		Cultural Resources		Geology /Soils
	Hazards & Hazardous Materials	**X**	Hydrology / Water Quality		Land Use / Planning
	Mineral Resources		Noise		Population / Housing
	Public Services		Recreation	_____	Transportation/Traffic
	Utilities / Service Systems		Mandatory Findings of Significance		

DETERMINATION: (To be completed by the Lead Agency)

On the basis of this initial evaluation:

I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared.

I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.

I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.

I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.

I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier EIR or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier EIR or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required.

______________________________ ____________
Signature Date

______________________________ ____________
Signature Date

EVALUATION OF ENVIRONMENTAL IMPACTS:

1) A brief explanation is required for all answers except "No Impact" answers that are adequately supported by the information sources a lead agency cites in the parentheses following each question. A "No Impact" answer is adequately supported if the referenced information sources show that the impact simply does not apply to projects like the one involved (e.g., the project falls outside a fault rupture zone). A "No Impact" answer should be explained where it is based on project-specific factors as well as general standards (e.g., the project will not expose sensitive receptors to pollutants, based on a project-specific screening analysis).

2) All answers must take account of the whole action involved, including off-site as well as on-site, cumulative as well as project-level, indirect as well as direct, and construction as well as operational impacts.

3) Once the lead agency has determined that a particular physical impact may occur, then the checklist answers must indicate whether the impact is potentially significant, less than significant with mitigation, or less than significant. "Potentially Significant Impact" is appropriate if there is substantial evidence that an effect may be significant. If there are one or more "Potentially Significant Impact" entries when the determination is made, an EIR is required.

4) "Negative Declaration: Less Than Significant With Mitigation Incorporated" applies where the incorporation of mitigation measures has reduced an effect from "Potentially Significant Impact" to a "Less Than Significant Impact." The lead agency must describe the mitigation measures, and briefly explain how they reduce the effect to a less than significant level (mitigation measures from Section XVII, "Earlier Analyses," may be cross-referenced).

5) Earlier analyses may be used where, pursuant to the tiering, program EIR, or other CEQA process, an effect has been adequately analyzed in an earlier EIR or negative declaration. Section 15063(c)(3)(D). In this case, a brief discussion should identify the following:
   a) Earlier Analysis Used. Identify and state where they are available for review.
   b) Impacts Adequately Addressed. Identify which effects from the above checklist were within the scope of and adequately analyzed in an earlier document pursuant to applicable legal standards, and state whether such effects were addressed by mitigation measures based on the earlier analysis.
   c) Mitigation Measures. For effects that are "Less than Significant with Mitigation Measures Incorporated," describe the mitigation measures which were incorporated or refined from the earlier document and the extent to which they address site-specific conditions for the project.

6) Lead agencies are encouraged to incorporate into the checklist references to information sources for potential impacts (e.g., general plans, zoning ordinances). Reference to a previously prepared or outside document should, where appropriate, include a reference to the page or pages where the statement is substantiated.

7) Supporting Information Sources: A source list should be attached, and other sources used or individuals contacted should be cited in the discussion.

8) This is only a suggested form, and lead agencies are free to use different formats; however, lead agencies should normally address the questions from this checklist that are relevant to a project's environmental effects in whatever format is selected.

9) The explanation of each issue should identify:
   a) the significance criteria or threshold, if any, used to evaluate each question; and
   b) the mitigation measure identified, if any, to reduce the impact to less than significance

SAMPLE QUESTION

Issues:

	Potentially Significant Impact	**Less Than Significant with Mitigation Incorporation**	**Less Than Significant Impact**	**No Impact**
I. AESTHETICS -- Would the project:				
a) Have a substantial adverse effect on a scenic vista?				X
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?				X
c) Substantially degrade the existing visual				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
character or quality of the site and its surroundings?				
d) Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area?				X
II. AGRICULTURE RESOURCES: In determining whether impacts to agricultural resources are significant environmental effects, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (1997) prepared by the California Dept. of Conservation as an optional model to use in assessing impacts on agriculture and farmland. Would the project:				
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?			X	
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?			X	
c) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use?			X	
III. AIR QUALITY -- Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:				X
a) Conflict with or obstruct implementation of the applicable air quality plan?				X
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?				X
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
exceed quantitative thresholds for ozone precursors)?				
d) Expose sensitive receptors to substantial pollutant concentrations?				X
e) Create objectionable odors affecting a substantial number of people?				X
IV. BIOLOGICAL RESOURCES -- Would the project:				
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?		X		
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or US Fish and Wildlife Service?		X		
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?			X	
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?			X	
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?				X
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?				X
V. CULTURAL RESOURCES -- Would the project:				
a) Cause a substantial adverse change in the				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
significance of a historical resource as defined in '15064.5?				
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to '15064.5?			X	
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?				X
d) Disturb any human remains, including those interred outside of formal cemeteries?				X
VI. GEOLOGY AND SOILS -- Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				X
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.				X
ii) Strong seismic ground shaking?				X
iii) Seismic-related ground failure, including liquefaction?				X
iv) Landslides?				X
b) Result in substantial soil erosion or the loss of topsoil?				X
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?				X
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?				X
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
the disposal of waste water?				
VII. HAZARDS AND HAZARDOUS MATERIALS B Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?				X
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?				X
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?				X
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?				X
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?				X
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?				X
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?				X
h) Expose people or structures to a significant risk of loss, injury or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?				X
VIII. HYDROLOGY AND WATER QUALITY -- Would the project:				
a) Violate any water quality standards or waste discharge requirements?		X		

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?				X
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?			X	
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?			X	
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?				X
f) Otherwise substantially degrade water quality?			X	
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?				X
h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?				X
i) Expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam?				X
j) Inundation by seiche, tsunami, or mudflow?				X
IX. LAND USE AND PLANNING - Would the project:				

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
a) Physically divide an established community?				X
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?				X
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?				X
X. MINERAL RESOURCES -- Would the project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?				X
b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?				X
XI. NOISE B Would the project result in:				
a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?				X
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels?				X
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?				X
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?			X	
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?				X
XII. POPULATION AND HOUSING -- Would the project:				
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?				X
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?				X
c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?				X
XIII. PUBLIC SERVICES				
a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services:				
Fire protection?				X
Police protection?				X
Schools?				X
Parks?				X
Other public facilities?				X
XIV. RECREATION --				
a) Would the project increase the use of existing				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?				
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?				X
XV. TRANSPORTATION/TRAFFIC -- Would the project:				
a) Cause an increase in traffic which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)?				X
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?				X
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?				
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?				X
e) Result in inadequate emergency access?				X
f) Result in inadequate parking capacity?				X
g) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?				X
XVI. UTILITIES AND SERVICE SYSTEMS B Would the project:				
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?				X
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?				X
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?				X
e) Result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project=s projected demand in addition to the provider=s existing commitments?				X
f) Be served by a landfill with sufficient permitted capacity to accommodate the project=s solid waste disposal needs?				X
g) Comply with federal, state, and local statutes and regulations related to solid waste?				X
XVII. MANDATORY FINDINGS OF SIGNIFICANCE --				
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?		X		
b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of				X

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	Less Than Significant Impact	No Impact
probable future projects)?				
c) Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?				X

I. AESTHETICS:

This project does not have adverse effects on scenic vistas. The project locations do not fall within view of scenic highway areas. The proposed project involves the construction of overflow weirs along Arroyo Grande flood levees. The modifications would not offer a significant impact to the visual character and quality of the sites. No additional sources of light or glare would be created due to these projects. Based on these considerations less than significant aesthetical impacts are anticipated due to the proposed projects.

II. AGRICULTURAL RESOURCES:

The proposed project entails removing some farmland from production but will not impact prime or unique farmlands. There may be conflicts with current zoning for agricultural uses or Williamson act contracts. No changes in regard to the conversion of farmland to non-agricultural uses will occur due to the changes in the environment due to the proposed projects. Considering these factors no agricultural resources impacts are foreseen due to the implementation of the proposed projects.

III. AIR QUALITY:

No conflicts or violations with applicable air quality plans will occur due to the proposed projects. The projects being considered will not contribute to pollutants which fit criteria for designation as non-attainment under the applicable state and federal clean air guidelines. The construction process will not contribute to particulate matter nor will it expose sensitive receptors to substantial pollutant concentrations or create objectionable odors affecting a substantial number of people. No air quality impacts are expected due to the proposed projects.

IV. BIOLOGICAL RESOURCES:

This project assumes implementation of Alternative 3a which would include vegetation and sediment management activities in the flood control reach. In addition, the project proposes adding flood retention basins to tributaries to reduce flood impacts downstream. This would require modifying existing farmland or vacant land. Any removal of existing riparian vegetation would be minimized to reduce impacts to existing riparian corridors and the species that are supported by it. This project may have an adverse impact on the three listed species, Steelhead (*Oncorhynchus mykiss*), California red-legged frog (*Rana aurora draytonii*), and tidewater goby (*Eucyclogobius newberryi*) but will be less than significant with mitigation. The proposed work will consist of temporary, construction-related impacts. An on-site biological monitor will be present to temporarily relocate red-legged frogs if they are found during construction activities. The remaining work would be conducted outside the existing channel on adjacent farmland that, under baseline conditions, floods regularly. The 2004 habitat conservation plan (HCP) (Stetson 2004) found no breeding or incubating red-legged frog habitat directly in the channel due to lack of slow water areas. It was believed that all red-legged frogs found in the area were dispersed from other off channel incubation areas. This HCP also found no rare or endangered plants within the 100-year flood plain. . This project will not directly impact on any federally protected wetlands as defined by Section 404 of the Clean Water Act since vegetation will only be thinned. This project will not interfere with the movement of any fish since the project will be conducted during non-migratory season, nor will it affect wildlife species or impede the use of native wildlife nursery sites. This project does not conflict with any local policies or ordinances protecting biological resources or with any adopted HCP. The previously mentioned HCP has yet to be adopted and does not include the lower flood control reaches. There is no impact to biological resources foreseen following completion of the projects.

V. CULTURAL RESOURCES:
The project occurs within an existing flood control channel constructed in the 1961. The current sediment removal proposal will adequately protect archaeological resources because maintenance sediment removal activities will not approach the bottom of the constructed channels original depth. Archaeological resources are not expected to be found in the flood detention sites due to past disturbance that has occurred there associated with intensive farming practices. In the event that archaeological resources are found, all work in the vicinity will stop and the disposition of any artifacts will be accomplished in accordance with state and federal law by a qualified archaeologist.

VI. GEOLOGY AND SOILS
No impacts in this category are foreseen as construction of the proposed projects will not compromise any geologic or soil stability associated with the surrounding areas.

VII. HAZARDS AND HAZARDOUS MATERIALS:
Impacts are not anticipated in this category because no hazardous materials will be necessary in the construction of the proposed projects.

VIII. HYDROLOGY AND WATER QUALITY:
Much of the work being conducted as part of Alternative 6 would occur outside of the wetted channel, respecting a 10 foot riparian buffer established as part of Alternative 1 and 2 and avoiding impacts to the existing channel in the flood detention areas. Some modification of the bank around the potential inlet and outlet weirs would be required but would be conducted during the dry season when flow is either low or non-existent. Appropriate BMP's will be in place to reduce impacts associated with construction equipment being near flowing water. No long-term impacts to the site hydrology or water quality would be anticipated since only flood flows would be diverted. The proposed project will not negatively affect groundwater recharge, alter the drainage pattern resulting in erosion, or contribute to increased runoff affecting drainage networks within the area.

IX. LAND USE AND PLANNING:
No impact is anticipated to land use and planning since the proposed project will not physically divide any established communities, conflict with land use plans, or conflict with conservation plans.

X. MINERAL RESOURCES:
No losses in the availability of any locally, state or federally important mineral resources will result due to the construction of the proposed project.

XI. NOISE:
Due to the equipment necessary for the construction of the proposed project, mostly trucks, tractors and front loaders, there will be less than significant impacts expected due to temporary increases in ambient noise

levels in the project vicinity. No other impacts in regard to increased noise levels are expected due to the proposed projects.

XII. POPULATION AND HOUSING:
No impacts are anticipated concerning population growth, the displacement of people or houses necessitating the construction of housing elsewhere.

XIII. PUBLIC SERVICES:
No impacts are anticipated concerning any public services or facilities.

XIV. RECREATION:
This project would have no impact on existing recreational facilities.

XV. TRANSPORTATION/TRAFFIC
This project would have no impact on traffic as the number of vehicle trips required to construct the detention basins is expected to be minimal.

XVI. UTILITIES AND SERVICE SYSTEMS:
No effect on utilities and service systems is expected since the proposed project in no way affects waste water systems, landfills, drainage systems, or water supplies.

XVI. MANDATORY FINDINGS OF SIGNIFICANCE:
This project will not substantially impact steelhead, red-legged frogs, rare plants or their habitats. The project will have no impact that are individually limited but cumulatively considerable and does not have any environmental effects which will cause substantial adverse effects on human beings. Mitigations for protection of red-legged frog and steelhead are being incorporated into the project by avoiding any construction in the low flow channel and having on-site biological monitors present during sediment removal activities.

Appendix B.

Sediment Source Reduction Project Sites
(To obtain this information please contact Julie Thomas at the Coastal San Luis Resource Conservation District)

Appendix C.

Roughness Database with Fieldnotes and Photos
(Included with Digital Media)