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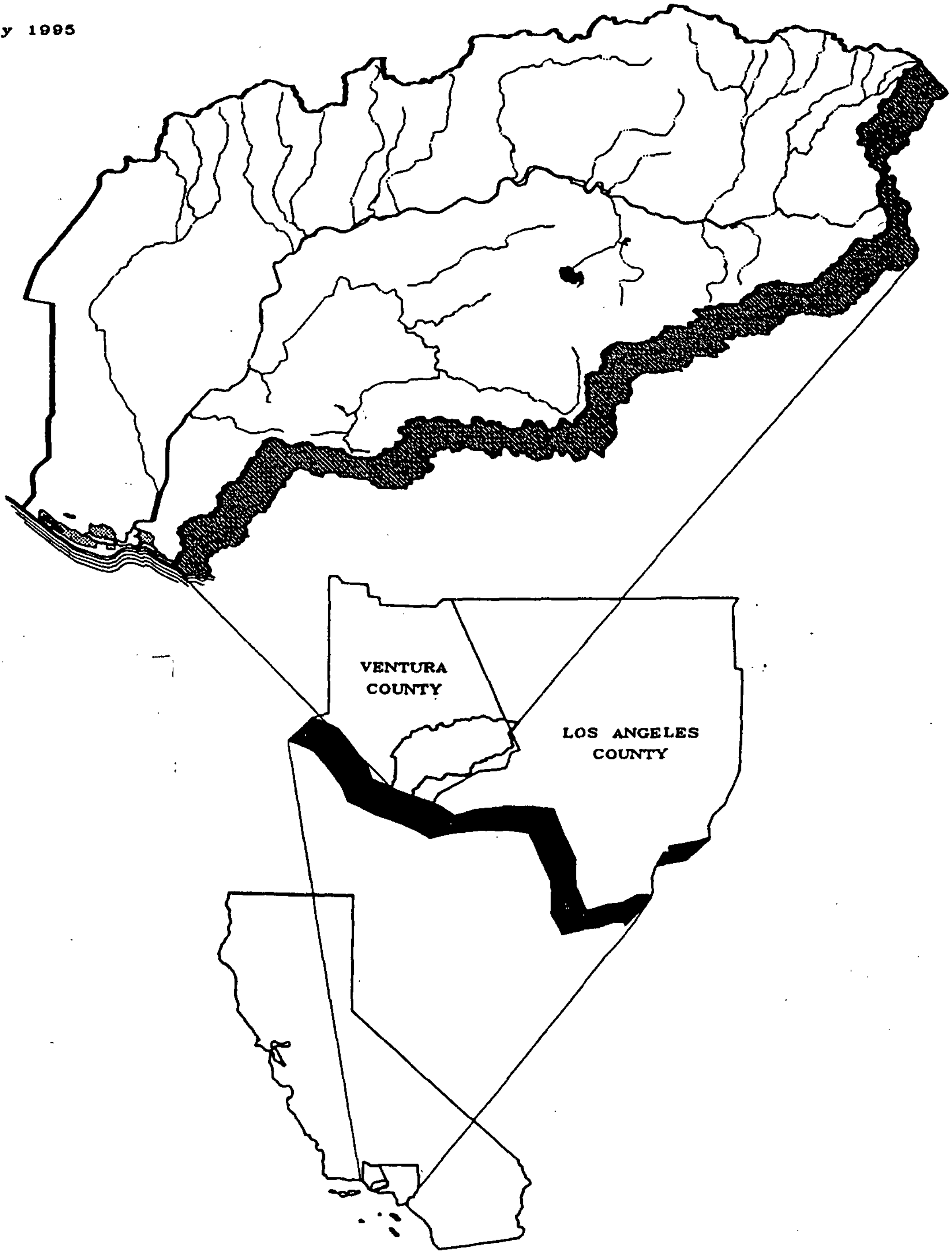
CALLEGUAS CREEK WATERSHED EROSION AND SEDIMENT CONTROL PLAN FOR MUGU LAGOON

VENTURA & LOS ANGELES COUNTIES,
CALIFORNIA



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Calleguas Creek Watershed
Erosion and Sediment Control Plan
for Mugu Lagoon

MAY 1995

Prepared for and in cooperation with
Ventura County Resource Conservation District
and the
California State Coastal Conservancy

A Cooperative
River Basin Study

Prepared by
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Davis, California

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EROSION AND SEDIMENT CONTROL PLAN FOR MUGU LAGOON

Purpose Of The Study

The purpose of this study is to identify and quantify erosion sources and sediment transport in the Calleguas Creek Watershed and to formulate a plan to address present and future erosion and sediment impacts. The plan is to serve as a guide to help local, state, and federal decision makers ascertain a reasonable approach to maximize the benefits of investments made to reduce accelerated erosion and sedimentation, given limited technical and financial resources.

Consideration of all current and past land uses in the watershed is necessary in order to understand the problems in the watershed. This report summarizes the current resource conditions in the watershed and the history of actions leading to the present status of erosion and sediment deposition problems in the watershed.

An important objective of the plan is to identify ways to slow down the potential rapid conversion of habitats in Mugu Lagoon caused by sedimentation. Further filling of the lagoon will convert intertidal habitat and reduce tidal flushing which is essential to the health of the estuarine system.

The recommended plan identifies projects for immediate implementation as well as long-term actions that should be undertaken to reduce sediment deposition in Mugu Lagoon. To varying degrees these alternatives will also minimize land loss and property damage, maintain agricultural productivity, and protect the biological and water resources throughout the watershed.

The Watershed and Lagoon

Mugu Lagoon in Ventura County is one of the largest remaining relatively undisturbed salt marsh areas in southern California along the Pacific Flyway, a nursery ground for many marine fish and mammals, and vital habitat for several threatened and endangered species. The effects of agriculture and urbanization have resulted in a rapid change of habitats, increased runoff and freshwater flows into the lagoon, accelerated erosion and sedimentation, and transport of agricultural chemicals and urban pollutants to the lagoon.

The Calleguas Creek Watershed study area is 30 miles long and 14 miles wide and drains an area of 343 square miles. The principal tributaries to Mugu Lagoon are Calleguas Creek and the Beardsley Wash/Revolon Slough. The upper reaches of Calleguas Creek are named Arroyo Simi and Arroyo Las Posas. The tributaries of Calleguas Creek include Conejo Creek and Arroyo Santa Rosa. The adjacent Beardsley Wash/Revolon Slough drainage has been included in this study.

The salicornia marsh and intertidal mudflats of Mugu Lagoon are important habitats for species using the lagoon and offshore area. Mugu Lagoon is vital habitat for nine threatened and/or endangered species, three protected marine mammals, 30 species which are candidates for listing, and 36 state species of special concern (US Navy data, 1993). Some of the endangered species in the area are American peregrine falcon, California least tern, light-footed clapper rail, California brown pelican, and Belding savanna sparrow. The lagoon is also one of the last remaining places in southern California where the harbor seals pup.

During the last fifty years, several changes in the watershed have altered the ecology of the central portion of the lagoon. Sediment was formerly collected largely in a vast estuarine network that meandered across the Oxnard Plain. Prior to 1884, the Calleguas Creek emptied onto the Oxnard Plain near Somis with no defined channel from there to the ocean. At that time the Mugu Lagoon covered 3,000 acres (now it is an estuary of about 1,130 acres). In 1884, local landowners began channelizing the creek effectively draining the plain and shunting flows directly to the lagoon. By 1889, local residents had cleared a straight channel from river mile 9.6 (State Highway 101) to the mouth of Conejo Creek. Cycles of channel downcutting (degradation) have been followed by cycles of channel filling (aggradation) and are still continuing. Channel straightening in the uplands has aggravated this condition. The construction of the Naval Air Station filled more of the wetlands. Numerous drop structures, channel bed stabilizers, dams, and debris basins have since been constructed to compensate for the loss of flood plain.

In 1946, Pt. Mugu Naval Air Station dredged the central portion of the lagoon and filled some of the surrounding wetlands. Extensive urban development, farmland conversion, and the resulting redevelopment of orchards on steeper slopes has changed the hydrology of the area and led to accelerated erosion rates. Freshwater now flows from the creek into the lagoon all year long due to (1) urban runoff, (2) discharge from wastewater treatment plants, and (3) water importation.

Accelerated erosion rates in the Calleguas Creek Watershed have contributed to flooding and sedimentation of the Oxnard Plain and Mugu Lagoon. Sedimentation, primarily from private lands in the upper watershed, and erosion from urban runoff has forced both farmers and public agencies into major annual expenditures to repair their property and mitigate future losses. The total annual erosion, sediment, and flood damage expense is estimated at $2.7 million. Projected sedimentation estimates indicate that 430 acres of lagoon intertidal salt marsh, approximately 40 percent, will be converted to upland habitat by the year 2030 (Steffen, 1982).

Findings

Erosion and Sediment:

* Total estimated gross erosion based on 1990 land use is 1,197,000 tons per year. Sheet and rill erosion accounts for 42 percent of the gross erosion. The present average annual estimate of sediment delivered to the main channel is 412,000 tons. Of the 412,000 tons of sediment yield, 240,000 tons are delivered to Mugu Lagoon and the ocean.

* The top five erosion producing areas (or where the initial detachment and transport of soil occurs) are: natural areas (240,000 tons/year), soil slips (188,000 tons/year), orchards (184,000 tons/year), streambanks (178,000 tons/year), and construction (106,000 tons/year).

* In terms of sediment yield, however, the ranking becomes: streambanks (152,000 tons/year), orchards (74,000 tons/year), construction (53,000 tons/year), natural areas (45,000 tons/year), and roads other than orchard roads (23,000 tons/year). Eleven subwatersheds stand out as contributing, per acre, a disproportionate share of the total sediment yield.

* In 1982, Steffen estimated the average annual sediment deposited in Mugu Lagoon to be 94,000 tons per year. Taking into account a reduction in trap efficiency of the lagoon, Steffen estimated the future rate of sediment deposition will decline. Steffen projected that in year 2036 the lagoon would be filled to the elevation of 5 feet with sediment.

* Scott and Williams (1978) noted that the Calleguas Creek area is highly susceptible to minor changes in hydrologic or land use factors because of the widespread occurrence of alluvial fill material.

* If all of the watershed were in a natural state, the gross erosion rate would be 182,000 tons/year; a tenth of the rate that has been estimated for current land use conditions. ✓

* Since 1950s, erosion has shifted from severely eroding bean fields and barrancas to erosion of streambanks, orchards, and roads.

* The time period 1968 to 1978 (the urbanization period), may have been the most erosive period in historical times. More acres under roofs and pavements at least partially explains the higher runoff. Extensive construction during the 1960s and 1970s associated with 5 years of drought prior to the rains of the 1970s set the stage for excessive erosion and transport of sediment.

* Urban development in cities such as Simi Valley, Moorpark, and Camarillo has converted prime agricultural land and pushed orchard development out of the valley floors onto the hill slopes. From 1968 to 1988 approximately 13,120 acres of new agricultural acreage came into production. Most of that new acreage (90 percent) is avocado and lemon orchards established on hillsides in the upper Calleguas Creek Watershed. Seventy-five percent of the converted lands are avocados which are typically planted on steep or very steep slopes (Steffen, 1982). Any further conversion of the remaining, even steeper slopes to orchard is considered unlikely.

* Steep hillslope orchards require landowners to spend up to $70/acre/year to repair and replace irrigation equipment, to regrade the field roads, and fill gullies in the roads.

* The Ventura County Flood Control District (VCFCD) has made significant progress in reducing flooding problems. Many stream improvements and sediment basins have been installed and are being maintained. A recent SCS report (USDA, 1992) summarizes the successes that the SCS/RCD have had in getting resources directed to this region. The SCS works closely with the RCD and landowners in the review of planned agricultural developments to ensure proper erosion control measures are included.

* Urban and rural residential development is expected to continue to expand in the watershed based on the county and city general plans. No significant changes in the hillside orchard growers' erosion and sediment problems are anticipated. Erosion rates and sediment yield calculations made for the year 2010 indicate that sedimentation will continue to be a severe problem due to natural conditions as well as land use activities. The sediment yield to the main channel is calculated to decrease from 412,000 tons/year in 1990 to 403,000 tons in 2010.

* Eleven priority subwatersheds have been identified as logical treatment areas, given the strategy is to reduce the production and delivery of sediment reaching the lagoon from the major sources. These subwatersheds contribute nearly 55 percent or 223,000 tons/year of the sediment reaching the main channel system. Implementation of the land treatment component of the recommended plan would reduce the total sediment yield to the main channel by 8 percent.

- If the VCFCD Arroyo Las Posas channel work and VCFCD large sediment basin above the lagoon are installed, these two projects alone would reduce the sediment reaching the lagoon by 54 percent at a construction cost of $44 million dollars.

- If the county intends to devise a strategy to reduce urban water runoff and pollution, flooding in the main channel, and increased bank erosion, a different list of subwatersheds should be targeted. These twelve subwatersheds account for 75 percent of the total projected expansion of urban land use to the year 2010 and are associated with the growth in Thousand Oaks, Simi Valley, Moorpark, and Camarillo.

Flooding and Water Runoff:

- Ventura County is one of the fastest growing areas in California. The population more than tripled from 1960 to 1990. The projection for 2010 is population growth from 675,000 to 894,000. The majority of the future urban expansion in the Calleguas Creek Watershed is projected to occur through the conversion of natural areas, though acreage in orchards and field crops will also decline. If the County General plan is implemented, urban land use in this watershed will increase from 45,010 acres to 81,900 acres, almost a twofold increase in only fifteen years.

- Converting a valley into urban subdivisions creates greater potential for runoff from small storms because there is no opportunity for the water to infiltrate into the soil. Urban developments are designed to direct and concentrate runoff in the roadways and drainage ways so that the runoff can be released to a main drainage as quickly as possible. This prevents localized infiltration and flooding but increases the peak flow in the main drainage system, causing additional streambank erosion and flooding downstream.

- Urbanization in the Calleguas Creek Watershed has clearly increased runoff. Studies demonstrate the extent of the change over time in yield of acre-feet of water passing Simi stream gage. The yield/volume of water has increased almost 10 times from the period of record 1935-1963 (agricultural changes) to 1964-1990 (urbanization).

- Flooding problems in the lower reaches of the Calleguas system will continue. In the subwatersheds that experience significant urbanization, the peak flows from smaller storms will increase and create the potential for more frequent flooding problems. Studies indicate that a 2-year event in the Calleguas Creek Watershed will discharge 20 percent (400 cfs) more water under future urbanized conditions as compared with present conditions. The impacts of the increased peak discharges include the potential for increased bank erosion and flooding problems. Although it is difficult to accurately estimate the specific change in bank erosion and flood damage due to future increases in peak discharges, the impact would likely be an increase in the sediment delivered to the lagoon.

- Land owners in the Oxnard Plain face problems with agriculture crop damage, land loss, and added maintenance expense as a result of flooding. Flooding in the Oxnard Plain causes $1,267,000 in damage on an average annual basis. A 10-year event is estimated to cause $5,045,000. In 1992, in another part of the watershed where sediment collects, a grower spent about $5,000 per acre to remove sediment from a small orchard.

- For the Calleguas Creek Watershed, the cost to the County for road maintenance after storms, repair and cleanout of flood control infrastructure, as well as routine maintenance of this infrastructure can be significant. The 1992 flooding resulted in over $500,000 in storm damage, debris removal, and storm protection expense in the watershed.

* Runoff from urbanized areas during abnormally rainy years (resulting in 100-year floods) would not be substantially greater compared to runoff from pristine natural areas because the runoff over hard surfaces mimics runoff over already saturated soils. Thus, for the Calleguas Creek Watershed, despite substantial new urban conversion, the data indicate that the 100-year discharge for future development condition is only 2 to 4 percent higher than that computed for the existing conditions. Projected urban development in the watershed will result in increased water flows of 20 percent during the typical rainy season (2-year floods/small events). A 20 percent increase in flows in the streams and main channel could result in an increase of 15-20 percent in sediment yield from bank erosion.

Water Quality:

* The 1992 Water Quality Assessment published by the California State Water Resources Control Board (State Board) lists Mugu Lagoon, Calleguas Creek, Beardsley Slough, and Revolon Slough as impaired water bodies. Impaired waters are water bodies that cannot reasonably be expected to attain or maintain applicable water quality standards. Water bodies with impairments do not generally support the beneficial uses (such as water-contact recreation or water for wildlife habitat) designated by the State Board for that water body.

* Mugu Lagoon received its classification as an impaired water body due to the presence of sediment and the elevated levels of pesticides found in the fish and shellfish of its waters. The tributaries to Mugu Lagoon contain pesticides no longer in use including the DDT family, toxaphene, dieldrin, and chlordane. These pesticides are typically carried with sediment. Also found in these surface water bodies is a high total dissolved solids (TDS) content and high concentrations of ions capable of forming salts harmful to irrigation, aquatic life, and drinking water. Nitrate levels have been detected at concentrations over the allowed maximum limit and some of the groundwater bodies have been impaired by nitrate.

* A 1982 study by the Soil Conservation Service concluded that one source of the nonpoint pollution is agriculture including over application of nitrogen fertilizers; over application of irrigation water; sedimentation; and leaching of salts, pesticides, and herbicides. The July 1993 Draft Ventura County Water Management Plan concludes that "agricultural runoff appears to be one of the most significant sources of pollution to Mugu Lagoon, a vital and rare wetland".

* It is unknown at this time how much of the overall water quality problem in Mugu Lagoon may be due to urban influences. Two of the major pollutants found in urban runoff are sediment and nutrients. Pesticides have been commonly used along the streambanks and in the urban setting as well. As urban development continues, water quality issues pertaining to surface runoff will be associated with urban-based contaminants rather than agricultural type contaminants. Due to the scope and implementation of the National Pollution Discharge Elimination System program, however, many of the typical urban pollutants should be kept to manageable levels.

* Prior to the expansion of the cities, continuous (year-round) streamflow conditions did not occur, except during and immediately following rainfall. Today, significant reaches of the main channel have continuous flows due to the following: wastewater treatment plants are discharging into the creek; water is now imported into the region; and the valleys no longer serve as infiltration areas as they did before development. These year-long freshwater flows may influence the ecology of Mugu Lagoon. However, the City of Thousand Oaks, Ventura County, and several water districts have proposed to withdraw about 11,000 acre-feet of water from Conejo Creek at Highway 101 to be used for agricultural purposes. If this project is approved, base flows in Calleguas Creek below State Highway 101 would be significantly reduced (approximate base flow, 2 cfs). This project would reduce freshwater to Mugu Lagoon.

Habitat Issues:

* U.S. Navy biologists report several listed endangered species, threatened species, candidate 1 species, candidate 2 species, and species of special concern in the Mugu Lagoon area. Accelerated sedimentation of the lagoon will result in a conversion of habitats used by these species. The outflow from Mugu Lagoon has the potential to negatively impact the marine habitat Area of Special Biological Significance located directly outside the mouth of the lagoon.

* Riparian and wetland plant communities are natural filters for trapping fine sediment and contaminants. Present vegetative management practices associated with the riparian corridors require the use of pesticides, herbicides, and mechanical equipment.

* By the 1950s, many of the stream channels in the upper watershed were already channelized and stripped of vegetation. At least fifty percent of the stream channels in the watershed have been altered in some fashion, which accounts for the severe loss of wetland and riparian vegetation. Less than 0.2 percent of the watershed is riparian habitat. This is a very low amount; Los Angeles County has about 1 percent of its area as riparian habitat and the statewide average is 10 percent in undisturbed areas.

* Immediate steps should be taken to protect the remaining islands of significant habitat values. The present areas with significant habitat values were mapped in this plan and then linked together where the potential for restoration still exists. Many of these existing habitat areas have clusters of threatened and endangered species. The goal of this concept is to establish linkages or corridors between a variety of habitats from the Pacific Ocean to the upper watershed. Riparian corridors provide excellent links between areas. These corridors can be used for wildlife and recreation purposes. The southeast border of the watershed currently adjoins protected state and federal parklands, thus providing linkages to other watersheds to maximize habitat values. Efforts to establish or enhance riparian habitat may be best accomplished in specific portions of the watershed such as Arroyo Santa Rosa and Conejo stream corridors. While segments of the main channel may still contain significant riparian habitat to protect, the Calleguas Creek/Arroyo Las Posas/Arroyo Simi reaches might also be developed as an urban recreation corridor for such uses as bikeways.

* Future development will continue to replace native plant communities with manmade habitats, unless land use policies, regulations, and landowner management practices change. The loss of native plant communities and change in habitat diversity may effect threatened and endangered species. In the upper watershed oak savanna, oak woodland, and riparian corridors are the most likely habitat types that will be impacted by land use changes. Channel modifications will further reduce the number of native birds, fish, and amphibians in the watershed. The fish and wildlife resources in Mugu Lagoon will continue to be impacted by accelerated erosion, nonpoint source pollution, and possibly freshwater flows. Transport of sediment-attached pollutants to offshore areas may degrade marine species diversity.

IMPLEMENTATION STRATEGIES AND OPTIONS

Sediment Storage and Transport Areas: Main Channel

The VCFCD has already embarked on two projects that will, if they are both constructed, substantially address the symptoms of erosion and sedimentation in the Calleguas Creek Watershed. Jointly, these projects would reduce sedimentation by approximately 54 percent. One, the Arroyo Las Posas Project, which deals with the middle reach of the main channel, is approved and proceeding to implementation. The second, the Calleguas Creek Project, is proposed to replace a project initiated by the U.S. Army Corps of Engineers (COE). The COE completed a study in 1993 to determine the feasibility of installing large flood/sediment basins on the Oxnard Plain to provide flood protection and reduce sediment to the lagoon. The VCFCD, as local sponsors, determined that a locally-funded version of this proposal would be more viable; asked the Corps to put their proposal in hiatus; and developed a preliminary plan for a locally-funded version of the sediment basin project just above the lagoon that has been conceptually endorsed by the adjoining landowners. The VCFCD version of the Calleguas Creek Project would require acquisition and conversion of less farmland than the Corps project, could potentially be completed sooner, and the total cost would be considerably less. The two VCFCD projects will address the priority sediment storage and transport areas.

Sediment Production Areas: The Grimes Canyon Model

The Grimes Canyon subwatershed was chosen to be analyzed in greater detail than other subwatersheds in this report in order to demonstrate the impacts of various treatments on the priority sediment production regions. The reasons for this selection were that all of the typical land uses are present in Grimes Canyon, the sediment yield from the canyon is significant, and there is some indication of landowner interest.

Based on the major sediment contributing sources in the Grimes Canyon subwatershed, certain treatment options were identified (See Appendix C). Identified practices include sediment basins, water management, bank protection, grade stabilization, road improvements, critical area planting, orchard drainage systems, cover crops, filter strips, riparian corridor planting, education, and enforcement of ordinances.

Based on the acres or miles of each sediment source that needs treatment, a maximum potential amount of each practice that could be installed in the watershed was estimated. This information was then used to estimate the maximum sediment reduction that is possible as well as an estimate of other resource impacts.

Because there are many potential treatment options, criteria were developed to prioritize the possibilities. The emphasis was placed on the control of sediment washload rather than bedload. Washload material was defined for this report to be less than .0625 mm in size and bedload defined as greater than .0625 mm. Several criteria were chosen including treatment cost per ton of sediment reduction; washload reduction; damage reduction; positive environmental benefits; and total sediment reduction.

Using this criteria, it was determined that the sediment basin option and grade stabilization structures (with the riparian improvement option) are top ranked in four out of five of the criteria. Bank protection ranked third and the practice of cover crops ranked fourth.

Two treatment options for the priority sediment production areas were selected. Option 1 consists of installing a sediment basin at the outlet of the subwatershed. Option 2 is a combination of the following practices: bank protection, riparian improvements, and cover crops on orchards.

Sediment Production Areas: All Priority Subwatersheds

These treatment options were then expanded to the other priority subwatersheds. The installation of appropriate sediment basins shows an estimated potential reduction in sediment of 52,400 tons per year. The installation cost is $3.2 million with an additional $533,000 per year required to maintain the structures. The average annual cost for each ton of reduced washload plus bedload is $17.

The second option combines three practices (bank protection, riparian improvements, and orchard cover crops) and is estimated to reduce sediment yield by 41,400 tons per year. The installation cost is $7.3 million with an additional $490,000 a year required to maintain the practices. The average annual cost for each ton of reduced washload and bedload is $76 and $50 respectively.

Alternative Plans For Erosion And Sedimentation Control

The plan compares alternative project combinations starting with the Arroyo Las Posas Project which is now proceeding to implementation. The tributary and revegetation projects are calculated only for the eleven worst sediment production subwatersheds:

Alternative 1 - Arroyo Las Posas Project only.
Alternative 2 - VCFCD Arroyo Las Posas and Lower Calleguas Sediment Basin Projects.
Alternative 3 - Arroyo Las Posas and the small tributary sediment basins.
Alternative 4 - Arroyo Las Posas and the vegetative stabilization practices in the upper drainages.
Alternative 5 - Both VCFCD Projects (alternative 2) and the small tributary sediment basins.
Alternative 6 - Both VCFCD Projects (alternative 2) and the vegetative stabilization practices in the upper drainages.

When comparing the various alternatives, numbers 2, 5, and 6 stand out as providing a reasonable cost per ton of sediment reduction while also having positive impacts on habitat and water quality. Numbers 5 and 6, however, provide about 20 percent greater washload reduction for approximately the same cost per ton. A reduction of the washload provides more significant benefits to the lagoon than a corresponding reduction in bedload. Diminished washload results in a slower conversion of habitat types in the lagoon.

Recommended Plan And Funding

Alternative 6, the recommended plan, provides the best combination of total sediment control, washload reduction, landowner options and control, urban water runoff, and long-term streambank stability. This alternative addresses the need to reduce the sediment washload and, in addition, the need to provide significant flood protection, on-farm erosion control, and enhancement of the lagoon ecosystem with increased riparian habitat throughout different portions of the watershed.

The recommended plan has five components. Although the focus of the plan is on control of sediment, a more holistic approach requires that other resource issues such as urban water runoff changes due to urbanization and wildlife habitat/recreation enhancement in the watershed be considered. Therefore, components #4 and #5 listed below are strongly recommended but have only been conceptually developed in this study due to the original limitations in the plan scope.

The recommended plan components are:

1. Arroyo Las Posas Channel Improvements.
2. Lower Calleguas Creek Project.
3. Land Treatment and Tributary Channel Stabilization in the Priority Sediment Source Subwatersheds.
4. Watershed Level Coordinated Urban Development Water Runoff Plan.
5. Watershed Level Coordinated Wildlife Habitat/Recreation Enhancement Plan.

The recommended plan, Alternative 6, has a total cost of $51 million and will result in a 62 percent reduction in sediment yield in Calleguas Creek Watershed. Computed as an average annual cost, implementation will cost $5 million per year and will reduce erosion, sedimentation, and flood expense by $2 million per year.

The two VCFCD projects would cost $44 million and would be paid for by assessments to the watershed landowners. The Land Treatment and Tributary improvements would cost approximately $7 million and would largely require funding and cooperative initiatives by the local landowners.

Policy And Planning Recommendations

Implementation action items are discussed and tasks are suggested for different agencies and groups. It is recommended that consensus be reached concerning the erosion and sediment concerns, long-term objectives be verified for the lagoon as an ecological system and as a community resource, methods be investigated to establish riparian mitigation areas in the watershed, and steps be taken to minimize flooding concerns.

The results of this study highlight the fact that the source of a specific resource concern cannot easily be pinpointed to one cause or location within the watershed. Therefore, it is critical that local community decision makers consider the consequences not only of erosion and sedimentation, which is the focus of the report, but at the same time flooding, urbanization, habitat restoration, and recreation. This is emphasized in two of the action items which indicate a need to evaluate urban water runoff, riparian habitat enhancement, and recreation opportunities throughout the watershed rather than community by community.

This study has also identified the need to target treatment efforts in specific subwatersheds so as to achieve the greatest positive benefits, given that there is limited restoration funds to address resource concerns. This provides an opportunity to more efficiently use public and private resources by pooling the technical and financial resources of the various interest groups.

The Calleguas Creek Watershed is relatively large and complex. Therefore, successful resource enhancement will require the long-term commitment and coordination between the various interest groups. All efforts that facilitate this expanding communication among interest groups needs to be encouraged.

1. PURPOSE AND ORGANIZATION OF STUDY

1.1 Purpose of the Study

The primary purpose of this study is two-fold:

1. Identify and quantify erosion sources and sediment transport in the Calleguas Creek Watershed.
2. Formulate a plan to address impacts from present and future erosion and accelerated sediment in the Calleguas Creek Watershed.

These impacts are interrelated with the past and present uses of the resources throughout the watershed. Therefore, consideration of all resources in the watershed is necessary in order to address the problems. The changes in land use that have occurred in the watershed over time are equally important. This report summarizes the current resource conditions in the watershed and the history of actions leading to the present status of accelerated sediment deposition in Mugu Lagoon.

Mugu Lagoon is one of the largest remaining relatively undisturbed salt marshes in southern California. It is a vital stop over site along the Pacific Flyway, a nursery ground for many marine fish and mammals, and vital habitat for threatened and/or endangered species (US Navy data, 1993). Some of the endangered species in the area are American peregrine falcon, California least tern, light-footed clapper rail, California brown pelican, and Belding savanna sparrow. The lagoon is also one of the last remaining places in southern California where the harbor seals pup.

Even though the lagoon is without many of the common alterations seen in most of the southern California lagoons and estuaries, it has not been left unaltered. In the Native American settlement period, freshwater wetlands surrounded the coastal marine embayment which was primarily influenced by the ocean, sunlight, and temperature. The tidal prism kept it open at all times. Shell midden sites attest to the high biotic productivity (Onuf, 1987 and Odum, 1970).

In 1884, Calleguas Creek was channelized and the flows shunted through the lagoon, creating an estuarine environment which is primarily influenced by freshwater. In 1946, Pt. Mugu Naval Air Station dredged the central portion of the lagoon and filled some of the surrounding wetlands (Onuf, 1987).

After the 1978 and 1980 storm events the depth of the lagoon had been reduced by 40 percent from upper watershed sediments (Onuf, 1981). This dramatic decrease in depth from these storm events was due to four factors: 1) spring tides which have the greatest rise and fall, allowing more sediment deposition; 2) drought conditions reducing vegetative cover; 3) development activities in the watershed; and 4) dredged area in the lagoon filled with sediment, reducing the buffering effect on the eastern arm (Onuf, 1981).

The factors that change and increase sediment deposition patterns in the lagoon are watershed development and lagoon dredging. The effects of development from agriculture and urbanization have resulted in a change of habitats, increased runoff and freshwater flows into the lagoon, accelerated erosion and sedimentation, and the transport of agricultural chemicals and urban pollutants to the lagoon. Dredging disrupts the food chain, decreases oxygen concentrations, disturbs sediment essential to normal nutrient cycling, and changes the dynamics of estuarine hydrology.

The present habitat diversity is valuable. It consists of barrier beach, tidal inlet/tidal delta system, tidal channels, ponds, tidal flats, tidal creeks, marsh, and salt pans (Warme, 1969). Further infilling of the lagoon would change this habitat diversity and reduce the tidal flushing which is essential to the health of the estuarine system.

Based on the identification of the erosion and sediment sources, alternative measures to reduce the amount of sediment reaching Mugu Lagoon are identified. To varying degrees these alternatives will also minimize land loss and property damage, maintain agricultural productivity, and protect the biological and water resources throughout the watershed. The recommended plan identifies projects that should be undertaken now to reduce the accelerated sediment deposition in Mugu Lagoon, as well as long-term actions that need to occur.

This report integrates known on-going and proposed activities of local, state, and federal agencies that have programs to address sedimentation and water quality issues in the watershed. Previously completed studies and additional research by the planning team were used to develop the plan.

The goal identified in this report is to maintain existing habitat values in the lagoon, while respecting the value of other ecosystems, as well as present land uses and future needs. The plan is to serve as a guide to help local, state, and federal decision makers to ascertain a reasonable approach to maximize the benefits of investments made in the protection of Mugu Lagoon, given limited technical and financial resources. The success of the plan depends heavily on the acceptance by and involvement of the many local agencies/interest groups and individuals.

1.2 Organization of Study Report

In addition to Section 1, there are five sections to this report. Section 2 of the study summarizes the results of a resources data inventory. The results of the analysis of resource problems and opportunities in the watershed are described in Section 3. Section 4 of the study focuses on identification of treatment options and quantification of the impacts. Alternative plans are developed for comparison in Section 5. Section 6 summarizes the recommended action plan and implementation strategy.

2. RESOURCE DATA INVENTORY

2.1 Purpose of Resource Data Inventory Section

The purpose of this section is to describe for the reader the natural resources in the watershed and provide an overview of how land uses and the population in the area have changed over time. This information is important in the development of an understanding of the resource problems and opportunities pertaining to accelerated delivery of sediment to Calleguas Stream system. This section includes the following topics:

2.2 Study Area

The Calleguas Creek Watershed is about 30 miles long and 14 miles wide. It is located in southern Ventura County and includes a small portion of Los Angeles County (Figure 2-a). Calleguas Creek and its upper reaches named Arroyo Simi and Arroyo Las Posas drain an area of 343 square miles. The tributaries of Calleguas Creek include Conejo Creek and Arroyo Santa Rosa. The adjacent Beardsley Wash/Revolon Slough drainage has been included in this study. The watershed was divided into 37 subwatersheds for the purposes of this study (Figure 2-b).

The Calleguas drainage is surrounded by rugged mountains reaching 3,700 feet in elevation in the northeastern portion of the watershed. The northern boundary of the watershed is formed by the Santa Susana Mountains, South Mountain, and Oat Ridge. The southern boundary is formed by the Simi Hills and the Santa Monica Mountains. The main Calleguas Creek system drains towards the southwestern portion of the basin where the mountain ranges disappear into a flat expansive plain, the Oxnard Plain, that extends to the Pacific Ocean. Calleguas Creek flows across the Oxnard Plain, contained between man-made levees, into Mugu Lagoon, and then empties into the Pacific Ocean.

2.3 Mugu Lagoon Sediment Deposition History

In a study completed by Sadd (1994) the depositional history of Mugu Lagoon is described. Between 1857 and 1901 the Mugu Lagoon/wetlands appeared to have been in dynamic equilibrium. Since 1900, a trend of net infilling began. In the middle of the century infilling accelerated significantly. This parallels a period of changing land use from agriculture to urban uses as well as the channelization of the lower Calleguas Creek. Dredging, construction, and maintenance activities between 1945 and 1970 resulted in significant changes with Mugu Lagoon. Since 1970, the primary effects to the lagoon have been the sedimentation associated with the increased annual water discharge to the watershed streams.

The barrier shoreline on both sides of Mugu Lagoon inlet showed little change between 1857 and 1901. In 1901 shoreline migration increased, perhaps due to the change in supply of sediment with the increasing agricultural development and channelization of lower Calleguas Creek. Since 1972, the shoreline segment updrift of the inlet has been eroding more rapidly than anytime since 1857. This eroding shoreline has recently resulted in the loss of some structures associated with the military base and has raised questions about how the lagoon will be impacted in the future.

2.4 Fish, Wildlife, and Plant Resources

The habitats within the watershed are summarized in Table 2-a.

Table 2-a: Habitats within the Watershed

Habitats within the watershed include the following:
(comprises about 50 percent of the total watershed area)

Coastal Scrub with inclusions of chaparral	48%
Annual Grassland with inclusions of Oak Savanna	1%
Riparian (0.2%) with inclusions of Freshwater Marsh	0.4%
Saltwater marsh	0.7%
Marine	

Other habitats less than 0.5%
Southern Oak Woodlands, Riverine, Eucalyptus, Estuarine, and Lacustrine

Each habitat within the watershed is described below, and the distribution of these habitats is shown in Figure 2-c.

Coastal Scrub (CS):

Over 90 percent of the vegetation in the non-urban/non-agricultural areas of the watershed is coastal scrub, which is typified by low to moderate-sized shrubs with shallow root systems. In southern California, the coastal scrub type is typically dominated by California sagebrush (*Artemisia californica*), black sage (*Salvia mellifera*), purple sage (*Salvia leucophyla*), and buckwheat (*Eriogonum cincera, E. elongatum* and *E. fasciculatum*). Golden yarrow, chaparral yucca, lupines, and monkeyflower are also typical. Prickly pear cactus (*Opuntia littoralis*) is found along the coast. Coastal scrub is a complex mosaic which includes maritime succulent scrub near Pt. Mugu to Venturan coastal sage scrub in the areas farther inland which are interspersed with annual grasslands, oak savanna, and chaparral.

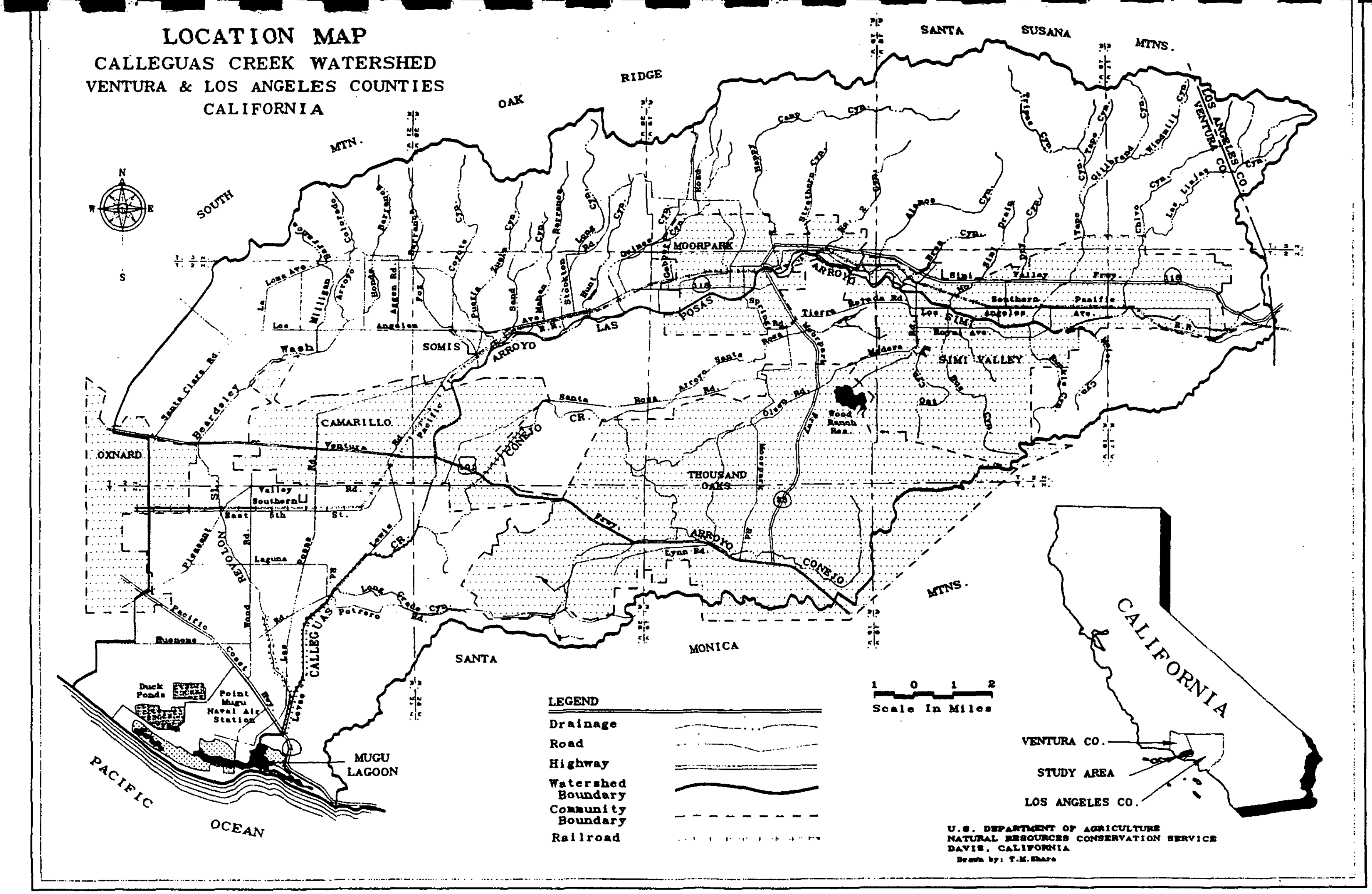
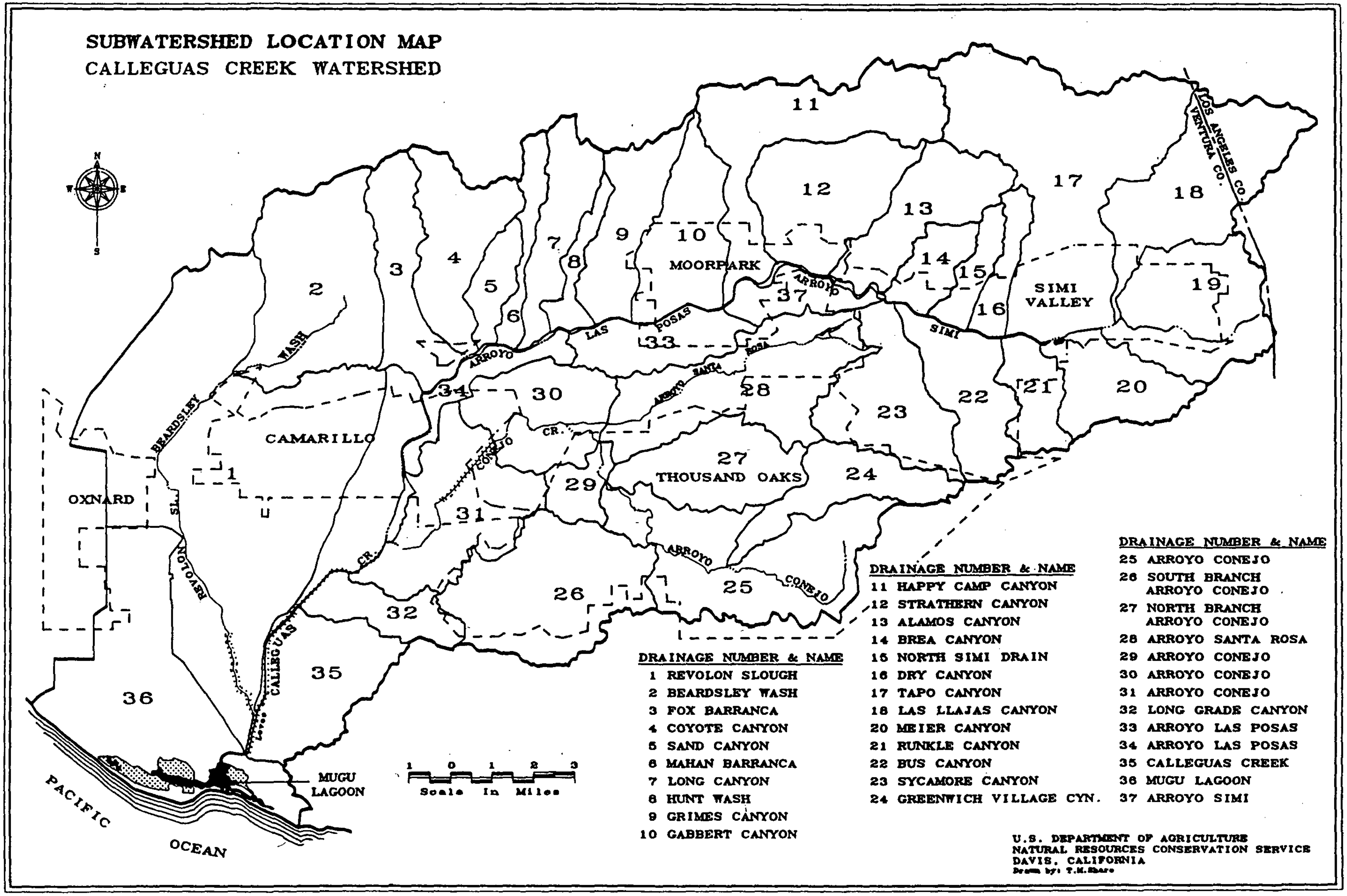

LOCATION MAP
CALLEGUAS CREEK WATERSHED
VENTURA & LOS ANGELES COUNTIES
CALIFORNIA
N
S
E
W
SOUTH
MTN.
OAK
RIDGE
SANTA
SUSANA
MTNS.
VENTURA CO.
LOS ANGELES CO.
MOORPARK
SOMIS
CAMARILLO
OXNARD
THOUSAND OAKS
SIMI VALLEY
ARROYO
LAS
POSAS
ARROYO SIMI
CONEJO
ARROYO CONEJO
CALLEGUAS
CR.
Santa Rosa
Wood Ranch Res.
Camp Cyn.
Happy
Strathern Cyn.
Alamos Cyn.
Tapo Cyn.
Gillibrand Cyn.
Windmill Cyn.
Chivo Cyn.
Las Llajas Cyn.
Dry Cyn.
Brea Cyn.
Oak Cyn.
Long Cyn.
Erringer Rd.
Gabbert Cyn.
Grimes Cyn.
Fox Cyn.
Coyote Cyn.
Sand Cyn.
Beardsley Wash
Santa Clara Rd.
Los Angeles Ave.
La Loma Ave.
Milligan
Pacific
Ventura Frwy.
Simi Valley Frwy.
Southern Pacific R.R.
Tierra Rejada Rd.
Madera Rd.
Royal Ave.
Olsen Rd.
Moorpark Rd.
Lynn Rd.
Lewis Rd.
Valley Rd.
Southern
East 5th St.
Laguna
Pleasant Valley
REVOLON SL.
Wood Rd.
Hueneme
Las Posas
Long Grade Cyn.
Potrero Rd.
Pacific Coast Hwy.
Levee
Duck Ponds
Point Mugu Naval Air Station
MUGU LAGOON
PACIFIC OCEAN
SANTA MONICA MTNS.
118
23
101
LEGEND
Drainage
Road
Highway
Watershed Boundary
Community Boundary
Railroad
1 0 1 2
Scale In Miles
CALIFORNIA
VENTURA CO.
STUDY AREA
LOS ANGELES CO.
U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
DAVIS, CALIFORNIA
Drawn by: T.M.Share

Figure 2-a

SUBWATERSHED LOCATION MAP
CALLEGUAS CREEK WATERSHED



DRAINAGE NUMBER & NAME	
1	REVOLON SLOUGH
2	BEARDSLEY WASH
3	FOX BARRANCA
4	COYOTE CANYON
5	SAND CANYON
6	MAHAN BARRANCA
7	LONG CANYON
8	HUNT WASH
9	GRIMES CANYON
10	GABBERT CANYON

DRAINAGE NUMBER & NAME	
11	HAPPY CAMP CANYON
12	STRATHERN CANYON
13	ALAMOS CANYON
14	BREA CANYON
15	NORTH SIMI DRAIN
16	DRY CANYON
17	TAPO CANYON
18	LAS LLAJAS CANYON
20	MEIER CANYON
21	RUNKLE CANYON
22	BUS CANYON
23	SYCAMORE CANYON
24	GREENWICH VILLAGE CYN.

DRAINAGE NUMBER & NAME	
25	ARROYO CONEJO
26	SOUTH BRANCH ARROYO CONEJO
27	NORTH BRANCH ARROYO CONEJO
28	ARROYO SANTA ROSA
29	ARROYO CONEJO
30	ARROYO CONEJO
31	ARROYO CONEJO
32	LONG GRADE CANYON
33	ARROYO LAS POSAS
34	ARROYO LAS POSAS
35	CALLEGUAS CREEK
36	MUGU LAGOON
37	ARROYO SIMI

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Figure 2-b

Oak savanna (10 percent to 30 percent tree cover) and oak woodland (greater than 30 percent tree cover) occur as a minor element within the more widespread coastal scrub vegetation type. Annual grasses are the predominate understory vegetation; and elderberry, baccharis, California sagebrush, and black sage can be locally abundant. Valley oak and, to a lesser extent, coast live oak are the overstory trees in this type. These inclusions are normally limited to the north and east facing slopes or deeper soil types where moisture is more abundant. The present distribution reflects a long term trend of converting habitat types to grazing, agricultural, and urban uses. The oak woodlands and savannas are important habitats as they add vertical structure and diversity to the surrounding habitat types.

Annual Grassland (G):

Extensive historical grazing and range improvement practices have allowed introduced Mediterranean annual grasses (*Bromus spp* and *Avena spp*) to replace much of the southern coastal sage scrub. Annual grassland now occupies about two percent of the watershed, most of it in the Simi Valley area. Native grassland areas have been replaced by agriculture, except in the adjacent watershed in the Point Mugu State Park where some native perennial bunch grasses (*Stipa pulchra*) have survived.

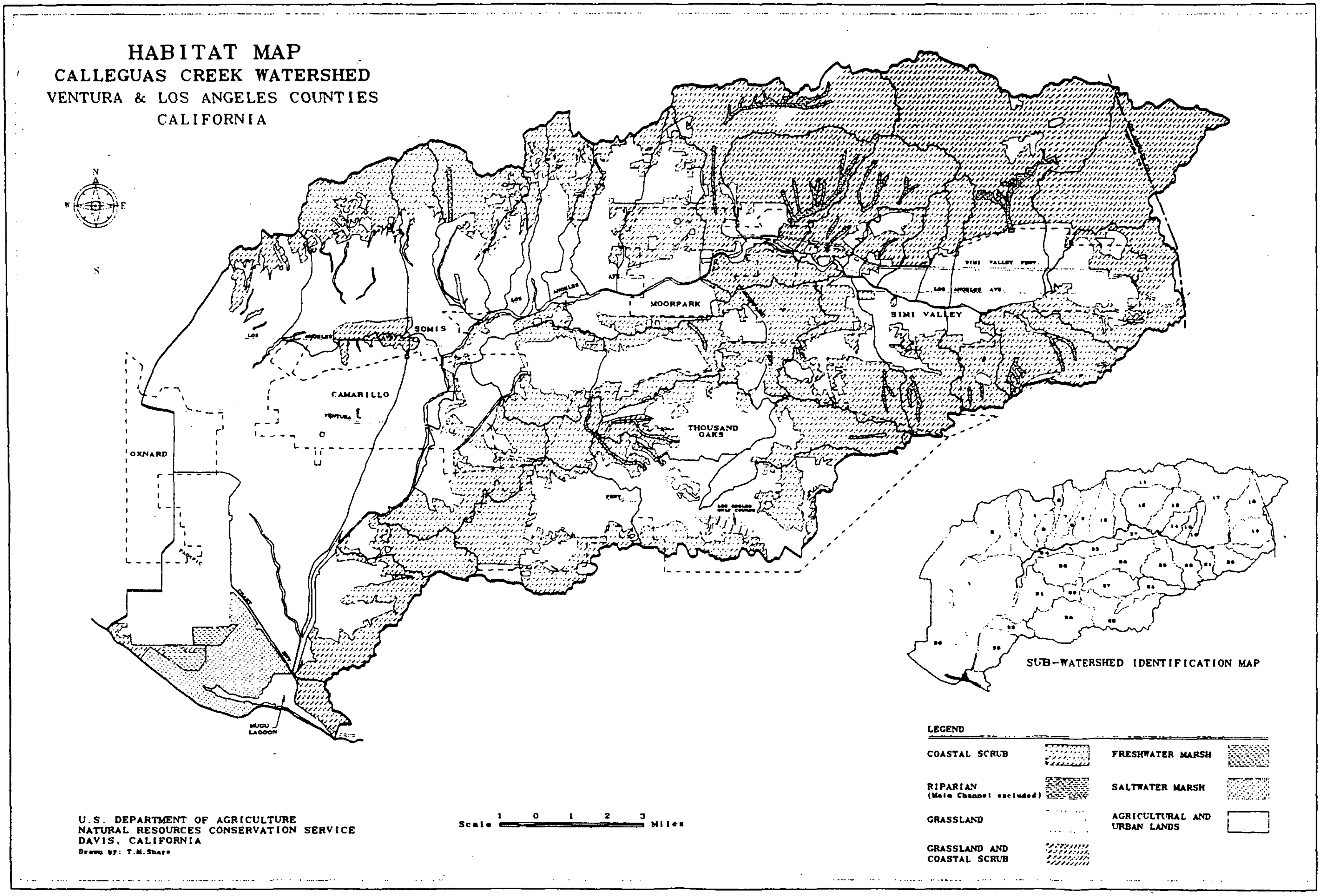
Riparian (RP):

The banks of permanent streams are characterized by willow (*Salix sp.*), Western sycamore (*Platanus racemosa*), Fremont cottonwood (*Populus fremontii*), Valley Oak (*Quercus lobata*), and Coast Live Oak (*Quercus agrifolia*). The Natural Diversity Database has identified several special riparian community types within the watershed; these are Southern Coast Live Oak Riparian Forest, Southern Riparian Forest, Southern Sycamore Alder Riparian Woodland, Southern Riparian Scrub, and Southern Willow Scrub.
Only about half a percent (0.5 percent) of the watershed is riparian habitat which includes the inclusions of freshwater marsh along the edges of the streams (characterized by sedges, tules, and cattails). Most of the riparian areas have been replaced with grouted rock, concrete lining, rock rip-rap, bare dirt banks, orchards, or crops. Many of the streambeds have bare vertical banks which are apparently unstable or have been channelized.

Virtually all of the freshwater emergent wetland that once covered most of the Oxnard Plain has been put into agricultural production. The only remaining wetland sites are about 900 acres of freshwater marsh set aside as game preserves and small fragmented instream areas along the various watercourses in the watershed.

Saltwater marsh (SM):

Saltwater marsh or saline emergent wetlands are characterized as salt or brackish marshes consisting of zones of plants in intertidal and upper marsh areas (tidal marsh, salt pannes, etc.). The dominant lower marsh specie is pickleweed (*Salicornia virginica*). The upper marsh areas are a mixture of pickleweed, sea lavender (*Limonium californicum*), alkali heath (*Frankenia grandifolia*), juamea (*Juamea carnosa*), salt grass (*Batis maritima*), and arrowgrass (*Triglochin concinnum*) (Onuf, 1987).



HABITAT MAP
CALLEGUAS CREEK WATERSHED
VENTURA & LOS ANGELES COUNTIES
CALIFORNIA

Figure 2-c

Saltwater marsh habitats are highly productive areas which provide food, cover, and nesting areas for a variety of species. The saltwater marsh habitat in Mugu Lagoon is composed of approximately 950 acres of tidal marsh, 128 acres of tidal flats, and 76 acres of salt panne (Onuf, 1987). Currently, the distribution of these habitats provide the most diversity for the greatest number of species (pers. comm. R. Dow, Mugu Naval Base).

Estuarine:

Estuaries are semi-enclosed coastal waters where tidal seawater is diluted by flowing freshwater. This mix of fresh and saline water creates a horizontal salinity gradient (Mayer, 1988). Before Calleguas Creek was diverted into the lagoon, Mugu Lagoon was a true lagoon with vertical salinity gradients (Warme, 1967). Within the estuarine habitat in Mugu Lagoon are subtidal zones (where light normally penetrates easily), intertidal zones (where the substrate is periodically exposed), and shoreline zone. In 1987 Onuf reported 12 acres of tidal inlet, 12 acres of subtidal channel, and 274 acres of subtidal ponds and open water comprising the estuarine habitat.

Apart from salinity gradients, substrate is the most important local factor in determining the nature of the benthos, an important component of the food chain. Three major substrate types are found in Mugu Lagoon (Warme, 1967): vegetation; rock, shell and wood; and unconsolidated sediment such as gravel, sand, and mud.

The wide ranges of salinity result in natural communities that are low in species richness but high in density. Most of the organisms are benthic which attach to the bottom substrate, burrow in the mud, or live in crevasses. These include worms and various mollusks. In the open water the primary organisms are phytoplankton and zooplankton which are the basis of the food chain. Eelgrass grows in the subtidal areas and is especially good fish habitat. The most common fish species found in Mugu Lagoon are arrow goby, topsmelt, staghorn sculpin, and shiner surfperch.

Marine:

The marine environment off the coast of Mugu Lagoon and to the south is a remnant of native rock shoreline that once occurred in Ventura, Los Angeles, and Orange Counties. Because the biota is both rich and diverse in this area, the Regional Water Quality Control Board, Los Angeles Region, has designated it as an Area of Special Biological Significance (ASBS) (State Water Resources Control Board, 1979). The area designated is from Laguna Point (Mugu Lagoon) to Latigo Point (just north of the beginning of Santa Monica Bay).

Five major habitats occurring in this coastal marine environment are barrier beach, open coast kelp beds, open coast sandy beaches, semi-protected kelp beds, and submarine canyons. Some of the most important organisms that occur in these habitats are giant kelp, surf grass, gray tube worm, sand dollar, pismo clam, sand tube worm, and halibut.

2.5 Soils

The soils of the Calleguas Creek Watershed are broadly described in soil associations, which are groupings of soils found together in the same area. Twelve soil associations are identified in the Calleguas Creek Watershed (Figure 2-d). The associations have been grouped into three landform divisions: (1) alluvial fans, plains, and basins; (2) terraces; and (3) uplands as shown on the block diagram (Figure 2-e).

Soils of the alluvial fans, plains and basins occupy about 25 percent of the watershed. Slopes range from 0 to 9 percent. In basins, soils are poorly drained loamy sands to silty clay loams. The soils formed in alluvium are derived predominantly from sedimentary rocks and to a lesser extent from basic igneous rocks.

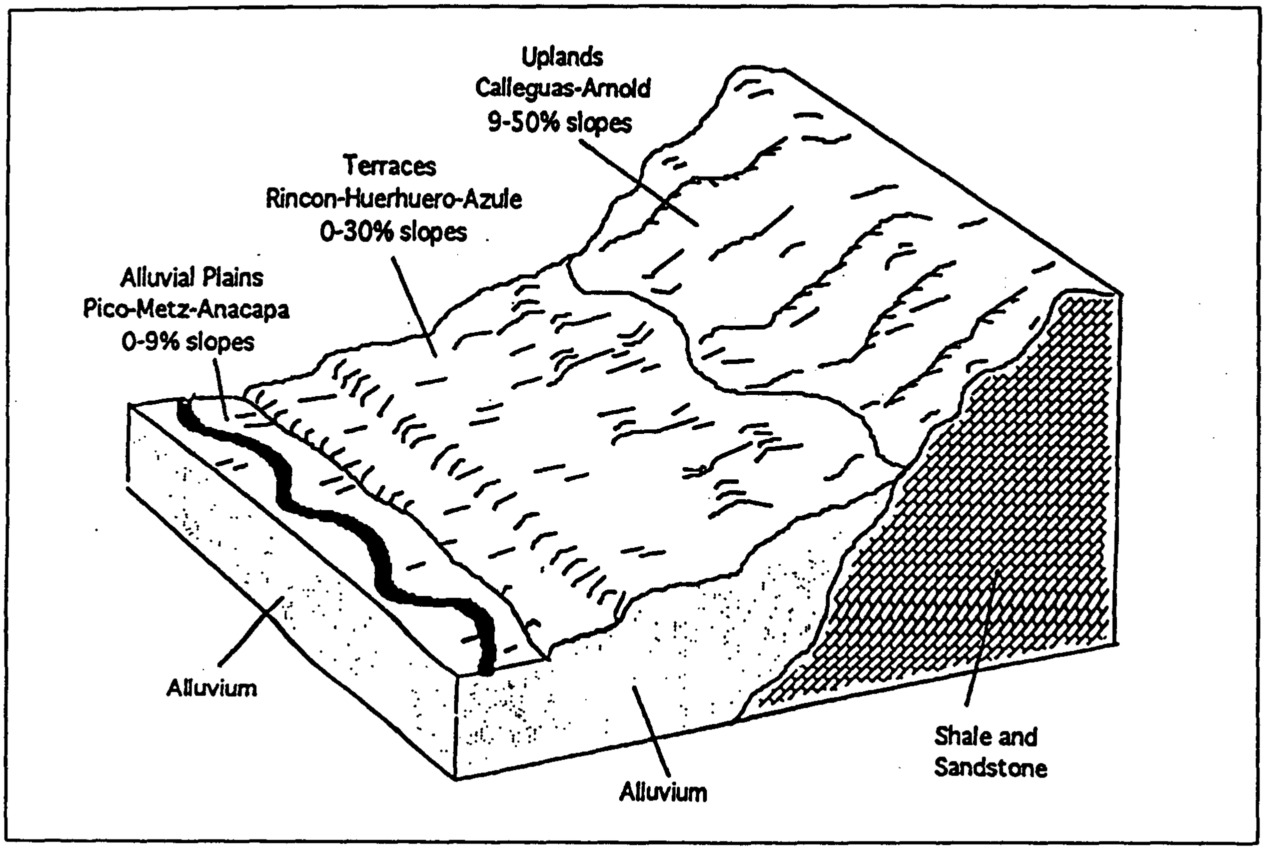
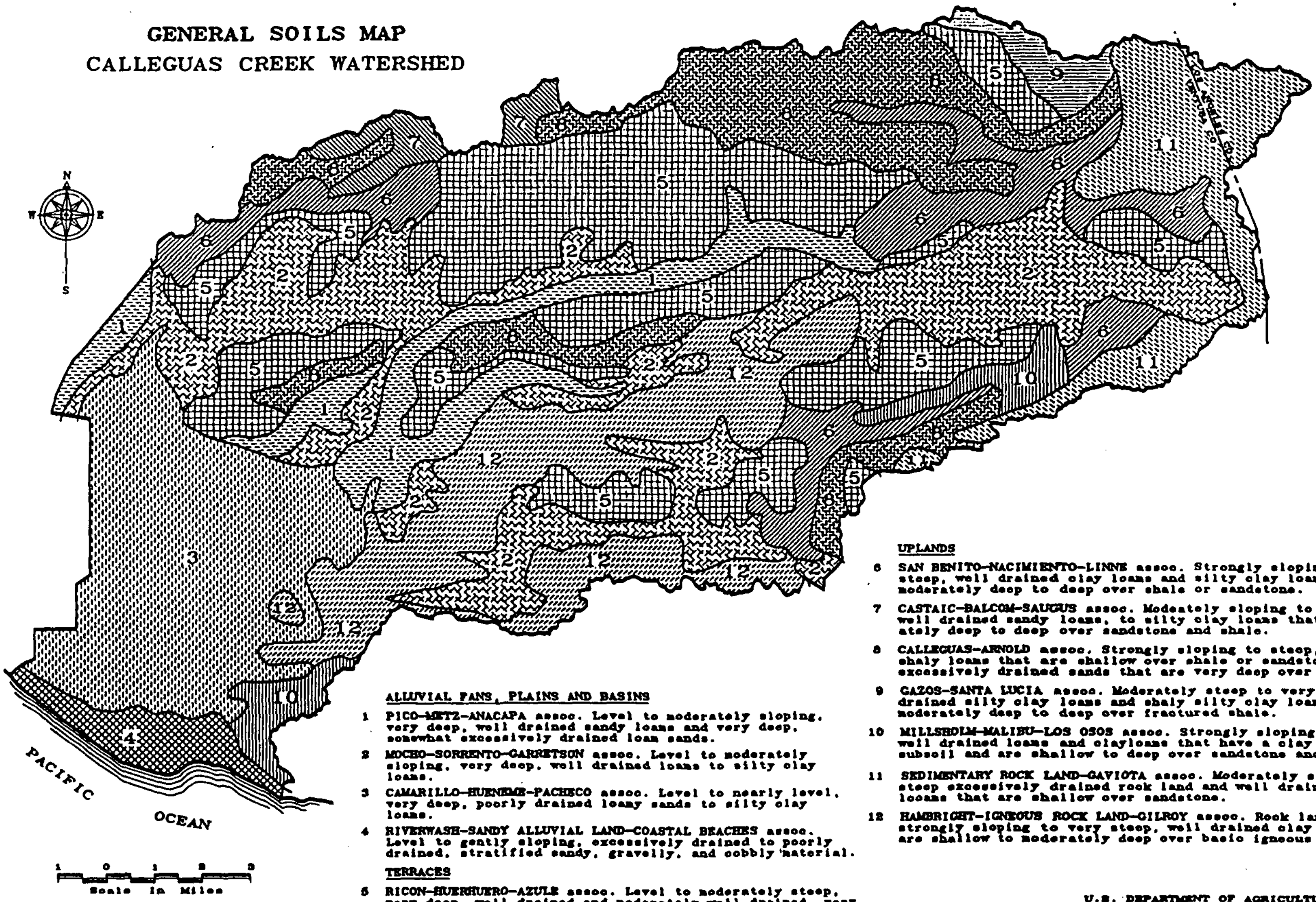


Figure 2-e: Block Diagram Showing the Typical Soil Associations on the Landscape in the Calleguas Creek Watershed.

Soils of the terraces occupy about 35 percent of the watershed. These soils are well drained and moderately well drained, very fine sandy loams to silty clay loams that have a slowly to very slowly permeable sandy clay subsoil. Slopes range from 0 to 30 percent. Most of these soils formed on old terraces, in alluvium derived from sedimentary rocks. A few formed on old alluvial fans.

Soils of the uplands occupy about 35 percent of the watershed. These soils are well drained to excessively drained sands to silty clay loams. They are shallow to very deep over softly consolidated sediments-sandstone, shale, or basic igneous rocks. Slopes range from 9 to 75 percent.

GENERAL SOILS MAP
CALLEGUAS CREEK WATERSHED



ALLUVIAL FANS, PLAINS AND BASINS

1 PICO-METZ-ANACAPA assoc. Level to moderately sloping, very deep, well drained sandy loams and very deep, somewhat excessively drained loam sands.

2 MOCHO-SORRENTO-GARRETSON assoc. Level to moderately sloping, very deep, well drained loams to silty clay loams.

3 CAMARILLO-HUENEME-PACHECO assoc. Level to nearly level, very deep, poorly drained loamy sands to silty clay loams.

4 RIVERWASH-SANDY ALLUVIAL LAND-COASTAL BEACHES assoc. Level to gently sloping, excessively drained to poorly drained, stratified sandy, gravelly, and cobbly material.

TERRACES

5 RICON-HUERHUERO-AZULE assoc. Level to moderately steep, very deep, well drained and moderately well drained, very fine sandy loams that have a slowly and very slowly permeable sandy clay subsoil.

UPLANDS

6 SAN BENITO-NACIMIENTO-LINNE assoc. Strongly sloping to very steep, well drained clay loams and silty clay loams that are moderately deep to deep over shale or sandstone.

7 CASTAIC-BALCOM-SAUGUS assoc. Modeately sloping to very steep, well drained sandy loams, to silty clay loams that are moderately deep to deep over sandstone and shale.

8 CALLEGUAS-ARNOLD assoc. Strongly sloping to steep, well drained shaly loams that are shallow over shale or sandstone, somewhat excessively drained sands that are very deep over sandstone.

9 GAZOS-SANTA LUCIA assoc. Moderately steep to very steep, well drained silty clay loams and shaly silty clay loams that are moderately deep to deep over fractured shale.

10 MILLSHOLM-MALIBU-LOS OSOS assoc. Strongly sloping to very steep, well drained loams and clayloams that have a clay loam and clay subsoil and are shallow to deep over sandstone and shale.

11 SEDIMENTARY ROCK LAND-GAVIOTA assoc. Moderately steep to very steep excessively drained rock land and well drained sandy looams that are shallow over sandstone.

12 HAMBRIGHT-IGNEOUS ROCK LAND-GILROY assoc. Rock land and strongly sloping to very steep, well drained clay loams that are shallow to moderately deep over basic igneous rock.

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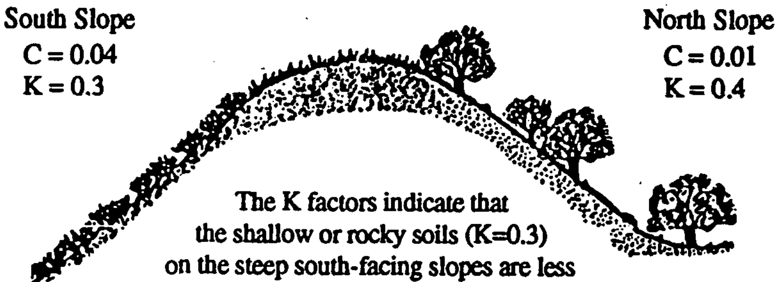
Figure 2-d

Mineralogy of soils affects soil texture and soil structure. Clay mineralogy is especially important to soil erosivity and the capacity of soils to sorb contaminants. The predominant clay mineralogy in the watershed is montmorillonitic. Montmorillonite, an expanding clay, has the highest sorptive capacity of the clay minerals. The subsoil of the Ricon-Huerhuero-Azule association (Number 5 in Figure 2-d) has high sorptive capacity and thus high potential to store contaminants. Soils that form aggregates more easily retain fine fractions, clays, and colloids in place. In this watershed, soil associations 6, 9, and 12 (Figure 2-d) are most likely to erode as soil aggregates.

Erodibility of soils is a function of slope orientation, soil depth, and texture. The schematic (Figure 2-f) shows typical distribution of soil erodibility (K-factors) as well as undisturbed cover conditions (C-factors) that influence erosion. Using the universal soil loss equation (USLE) soil erodibility factor 'K' as the indicator of potential erodibility, the soil associations in figure 2-d show the rank of the most severe erosion potential to least severe to be 7, 5, 10, 2, 6, 9, 3, 1, 11, 8, 12, and 4. In general, soil textural classed as silts and silt loams are the most erodible.



The K factors indicate that the shallow or rocky soils (K=0.3) on the steep south-facing slopes are less erosive than the deeper soils (K=0.4) on the north-facing slopes.
The C factor indicates that the scrubby chaparral (C=0.04) on the south-facing slopes provide less ground cover than the grasslands and oak woodlands (C=0.01) on the north-facing slopes.

Figure 2-f: Soil and Vegetation Relationship

Erosion takes many forms. The three largest erosion contributors in this watershed, in order of magnitude are: (1) sheet and rill, (2) soil slips, and (3) streambank. The combined effects of high erodibility 'K', the cover 'C', and slope length 'L' result in sheet and rill erosion to be highest on terraces. Soil slip erosion is highest on the uplands and streambank erosion is most severe on the alluvial plains (Figure 2-e).

2.6 Geology

Calleguas Creek Watershed is part of the Transverse Range geomorphic province of California. Geologic structures generally trend west to east. The major geologic structures in the watershed are the Oxnard Plain, Simi Anticline, Las Posas Anticline, Santa Rosa Fault, Springville Fault Zone, and the Santa Rosa Syncline.

Surficial geology is highly correlated with soil associations (Figure 2-d). Hard sedimentary deposits (Cretaceous, Paleocene, and Eocene marine shale; sandstone and conglomerate; and nonmarine Oligocene) correlate with soil associations 6, 9, and 10; soft sedimentary deposits (Miocene, Pliocene, and lower Pleistocene marine deposits) correlate with soil associations 7, 8, and 11; igneous rocks of Miocene age correlate with soil association 12; and alluvium (Quaternary alluvial and terrace deposits, mainly nonmarine) correlate with soil associations, 1, 2, 3, 4, and 5. The Hambright-Igneous rock land-Gilroy soil association overlying basic igneous rock has the lowest upland erosion potential.

A high degree of tectonic activity exists in the area, and local watersheds have been uplifted by as much as 7.6 meters per 1000 years. In the 1994 Northridge earthquake, Oat Mountain was uplifted 18 inches (46 cm). The maximum extrapolated rate of denudation measured over the largest available period of record is 2.3 meters per 1000 years adjusted to a drainage area of 1.3 square kilometers (Scott & Williams, 1978).

Tectonic activity rejuvenates the surrounding mountain ranges. As a result, the erosion processes have not kept pace with uplift, but occur in dramatic forms such as landslides, soil slips, etc. These erosion processes lumped as "mass wasting" are delivered to the stream valleys and floodplains where they are deposited. Accumulation of valley fill over geologic time has created wide, deep deposits that act as a continual source of sediment.

The following epochs in geologic time are discussed to provide background for present erosion and sediment problems.

Middle Pleistocene - Holocene epochs: The Oxnard Plain was built up by flood deposits of the Santa Clara River during Middle Pleistocene (300,000 Before Present {B.P.}). Sedimentation rates on the Oxnard Plain were almost 6 feet per century. Sea level was at its lowest about 18,000 B.P. In Holocene time, 3000 B.P., sea level rose 6 feet. It was at about this time that Mugu Lagoon was formed.

Post Holocene epoch - Pre-Historic period: Valley fill deposits in the Calleguas Creek valley document periods of fill and cutting. At times during the Pleistocene epoch, Calleguas Creek undoubtedly connected with off-shore Mugu Canyon. At the close of the Holocene epoch and into Pre-historic times, Calleguas Creek, its tributaries and the Beardsley Wash and Revolon Slough drainages flowed as distributary streams onto the Oxnard Plain. The Oxnard Plain is the product of coalescing fans dropped by these streams.

2.7 Climatology and Meteorology

The climate in the watershed is typical of the southern California coastal region. Summers are relatively warm and dry and the winters are mild and wet. Eighty-five percent of rainfall occurs in the winter season from November to March. Mean annual precipitation varies from about 13 inches on the Oxnard Plain to 14 inches in the interim valleys, with a maximum of 20 inches in the higher elevations.

Table 2-d: Comparison of Measured Chemical Concentrations in Calleguas Creek Watershed Tributaries to Recommended Objectives

Constituents	Recommended Objective mg/l	Calleguas Creek mg/l	Revolon Slough mg/l	Beardsley Wash mg/l	Arroyo Las Posas mg/l	Arroyo Simi mg/l
Sodium	100	10-126	372-600	9-155	180	9-270
Calcium	50-150	56+	225-466	21-185	130	24-300
Magnesium	50-200	2-33	73-180	6-58	43	4-100
Chloride	250	20-200	131-835	18-96	5-190	9-205
Sulfate	250	54-1550	1083-2325	45-627	20-440	18-1100
Nitrate	45	N.D.-35	0.4-248.	39-57	N.D.-50	6-20
pH	6.5-8.5	7.0-8.2	7-8.1	-	-	6.6-8.4
Total Dissolved Solids	500	118-702	2160-4623	49-1370	1180	156-2275
DDT, DDD, DDE	1.0	2.0	2.0	-	-	-
Toxaphene	0.5	-	-	-	-	-
Dieldrin	1.9	2.0	2.0	-	-	-
Endosulfan	5.6	5.0	5.0	-	-	-
PCB	14	30	30	-	-	-

2.10 Threatened and Endangered Species

Sixteen threatened and/or endangered (T&E) species are found in the Calleguas Creek Watershed and at least 37 other species are candidates for listing. Table 2-e lists the threatened and endangered species in the entire watershed. Many other species are of special concern and considered rare. Most of these species depend on either the saltwater marsh/estuarine system (40 percent) or the freshwater marsh/riparian habitats (29 percent) and to a lesser degree the coastal sage habitat (19 percent).

2.11 Settlement History and Land Use Changes Over Time

The history of settlement of people and development of agriculture in the region is important to this study because many of the resource concerns today can be linked to activities from the past. This information provides a historical account of the changes that have occurred in the watershed over time. Understanding the past is important in order to address the resource issues today, such as accelerated sediment impacts to Mugu Lagoon.

For the purpose of this study the settlement history is divided into four periods: Native American, Spanish-Mexican Settlement, Agricultural Expansion, and Modern Urbanization. Each period and the primary land uses are briefly described.

TABLE 2-e: Federal and State listed and candidate species for Mugu Lagoon and Calleguas Creek Watershed. Compiled using information from: U.S. Navy, Natural Diversity database, and U.S. Fish & Wildlife Service.

NAME	FEDERAL STATUS	STATE STATUS	HABITAT
AMPHIBIANS			
California red-legged frog *Rana aurora draytoni*	candidate 1	special concern	R,F
BIRDS			
tricolored blackbird *Agelaius tricolor*	candidate 2	special concern	F,G
S.C. rufous-crowned sparrow *Aimophila ruficeps canescens*	candidate 2		CS
Bell's sage sparrow *Amphispiza belli belli*	candidate 2		CS
ferruginous hawk *Buteo regalis*	candidate 2	special concern	G,F
Swainson's hawk *Buteo swainsoni*		threatened	RP
Western snowy plover Charadrius alexandrinus nivosus	threatened	special concern	E,S,R,L
mountain plover *Charadrius montanus*	candidate 2	special concern	G
black tern *Chlidonias niger*	candidate 2		E,S,F,L
Western yellow-billed cuckoo *Coccyzus americanus occidentalis*	category 3B	endangered	RP
fulvous whistling-duck *Dendrocygna bicolor*	candidate 2	special concern	F
reddish egret *Egretta rufescens dickeyii*	candidate 2	special concern	S
willow flycatcher *Empidonax traillii*		endangered	RP
California horned lark *Eremophila alpestris actia*	candidate 2		G,CS
American peregrine falcon *Falco peregrinus anatum*	endangered	endangered	F,S,L, R,RP
Peale's falcon *Falco peregrinus pealei*	endangered		F,S,L, R,RP
greater sandhill crane *Grus canadensis tabida*		threatened	G,F
bald eagle *Haliaeetus leucocephalus*	endangered		E,L,R
harlequin duck *Histrionicus histrionicus*	candidate 2	special concern	E,R
Western least bittern Ixobrychus exilis hesperis	candidate 2	special concern	F
loggerhead shrike *Lanius ludovicianus*	candidate 2		RP,G,CS
California black rail *Laterallus jamaicensis coturniculus*	candidate 2	threatened	S,F
Belding's savannah sparrow *Passerculus sandwichensis beldingi*	candidate 2	endangered	S,G
large-billed savannah sparrow *Passerculus sandwichensis rostratus*	candidate 2	special concern	S,G
California brown pelican *Pelecanus occidentalis californicus*	endangered	endangered	M,E
white-faced ibis *Plegadis chihi*	candidate 2	special concern	F
light-footed clapper rail *Rallus longirostris levipes*	endangered	endangered	S,F
bank swallow *Riparia riparia*		threatened	R coastal cliffs
California least tern *Sterna antillarum browni*	endangered	endangered	E beaches
elegant tern *Sterna elegans*	candidate 2	special concern	E sand/mud
Least Bell's vireo *Vireo bellii pusillus*	endangered	endangered	RP

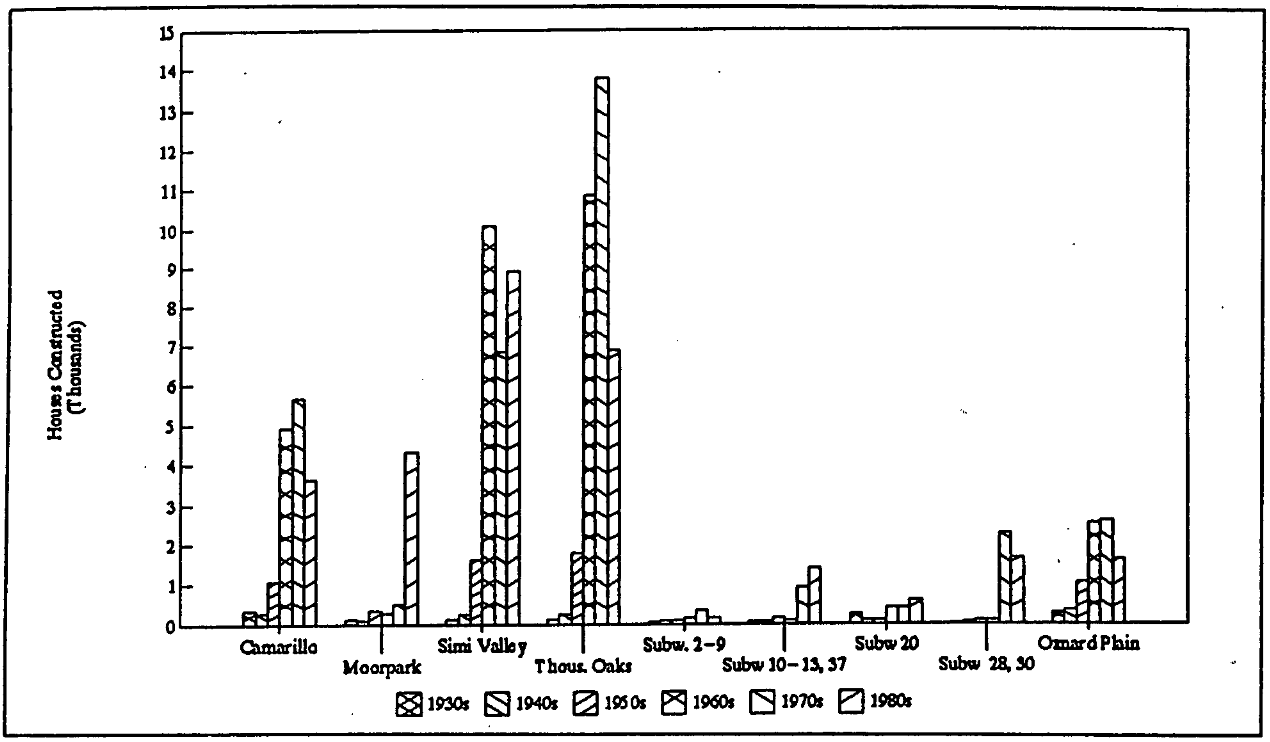


Figure 2-i: Construction of Housing Units in the Watershed, 1930s through 1980s.

Table 2-g: Summary of Current (1990) and Projected (2010) Land Uses

Land Use	Current (acres)[1]	Projected (acres) [2]
Orchards	25,425	24,500
Field Crops	32,075	30,100
Urban	45,010	81,900
Open Space	108,715	75,200
Other	8,760	8,285
	---------	-------
Total	219,985	219,985

[1] - Compiled using Dept. of Water Resources land use maps and aerial photography interpretation.

[2] - Compiled using county and city General Plan Projections.

Following are examples of the urbanization that is expected to continue through the 1990s and into the twenty-first century. Several new construction projects are in the planning stages.

- Adjacent to Calleguas Creek, the City of Camarillo plans to allow development of a 127-acre parcel (agricultural) for residential use.
- Adjacent to Calleguas Creek, the City of Camarillo plans to allow development of a 210-acre parcel (agricultural) to residential, industrial and park uses.
- The City of Simi Valley is projected (General Plan) to grow tremendously over the next 20 years; residential dwellings to double; commercial to more than double; and industrial to expand to five times as much as there is today.
- The City of Moorpark is projected to have similar development as Simi Valley over the next 20 years.

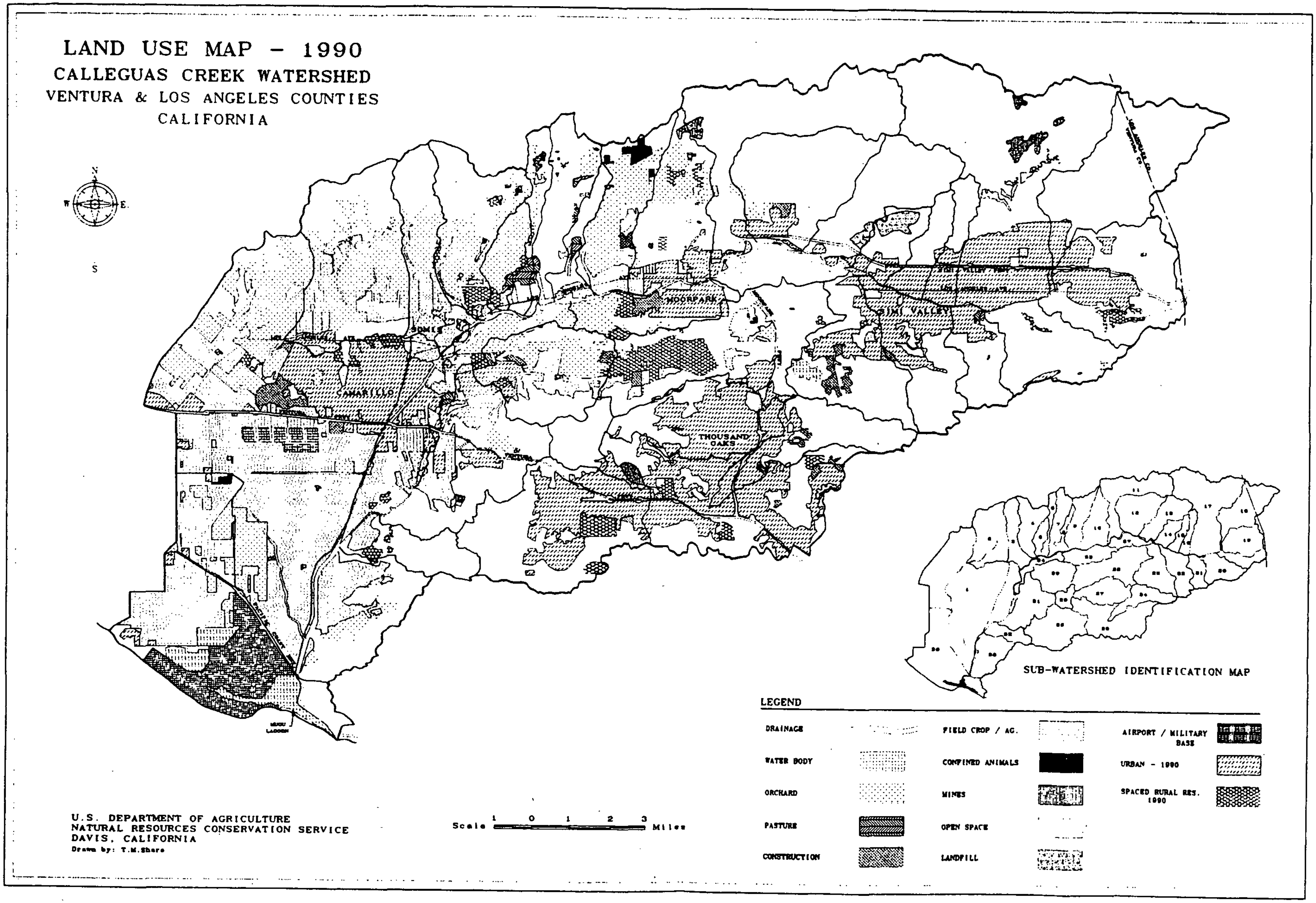

LAND USE MAP - 1990
CALLEGUAS CREEK WATERSHED
VENTURA & LOS ANGELES COUNTIES
CALIFORNIA
N
W
E
S
MOORPARK
SIMI VALLEY
SOMIS
CAMARILLO
THOUSAND OAKS
MUGU LAGOON
SUB-WATERSHED IDENTIFICATION MAP
LEGEND
DRAINAGE
WATER BODY
ORCHARD
PASTURE
CONSTRUCTION
FIELD CROP / AG.
CONFINED ANIMALS
MINES
OPEN SPACE
LANDFILL
AIRPORT / MILITARY BASE
URBAN - 1990
SPACED RURAL RES. 1990
U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
DAVIS, CALIFORNIA
Drawn by: T.M.Shore
Scale 1 0 1 2 3 Miles

Figure 2-j

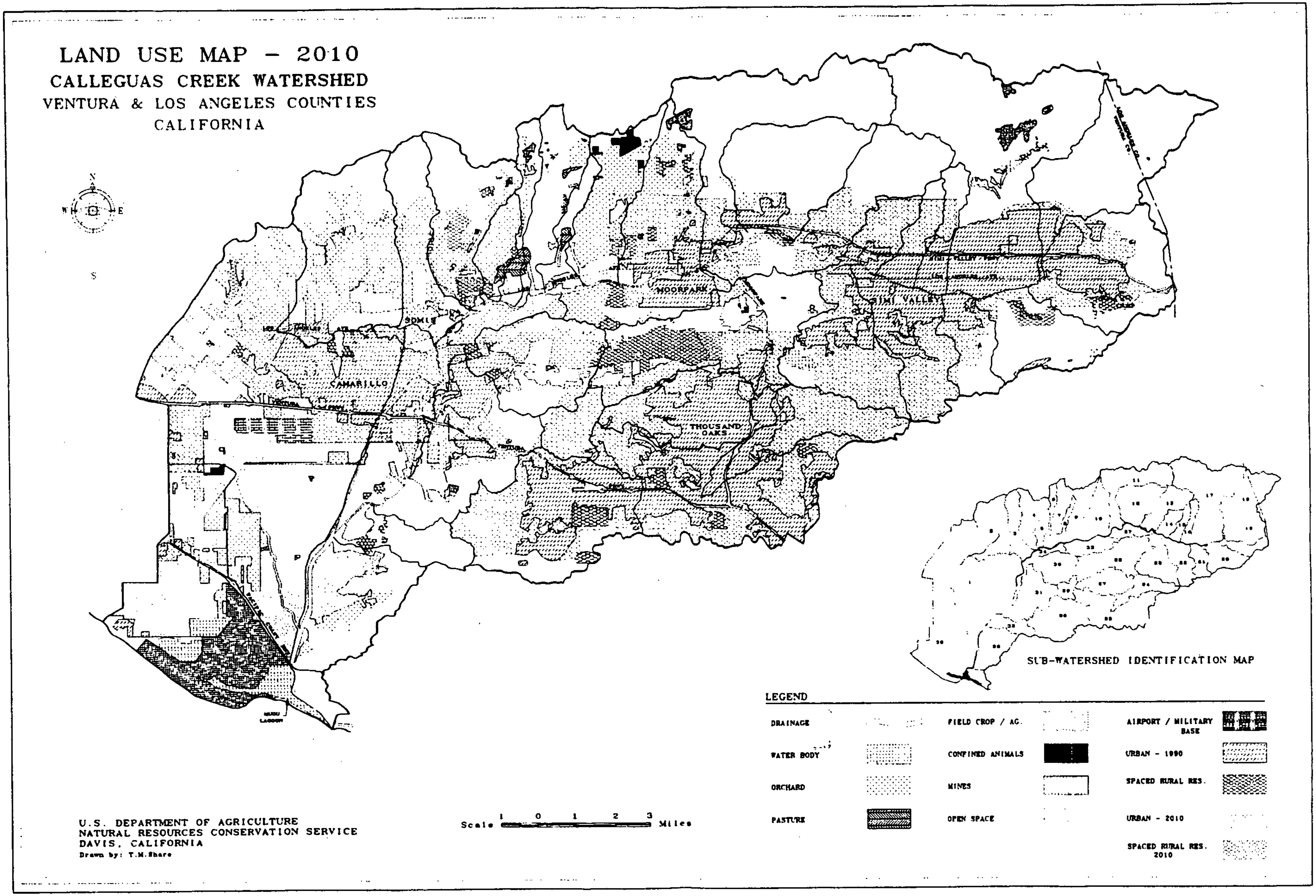

LAND USE MAP - 2010
CALLEGUAS CREEK WATERSHED
VENTURA & LOS ANGELES COUNTIES
CALIFORNIA
N
W
E
S
SOMIS
MOORPARK
SIMI VALLEY
CAMARILLO
THOUSAND OAKS
MUGU LAGOON
SUB-WATERSHED IDENTIFICATION MAP
LEGEND
DRAINAGE
WATER BODY
ORCHARD
PASTURE
FIELD CROP / AG.
CONFINED ANIMALS
MINES
OPEN SPACE
AIRPORT / MILITARY BASE
URBAN - 1990
SPACED RURAL RES.
URBAN - 2010
SPACED RURAL RES. 2010
Scale 1 0 1 2 3 Miles
U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
DAVIS, CALIFORNIA
Drawn by: T.M.Share

Figure 2-k

3. RESOURCE PROBLEMS AND OPPORTUNITIES

3.1 Purpose of Resource Problems and Opportunities Section

As has previously been stated, the primary objective of this study is to develop an implemention plan to reduce the accelerated delivery of sediment to the Calleguas Creek system and Mugu Lagoon. The development of this plan requires the consideration and knowledge of many interrelated resource issues and human activities throughout the watershed.

Inventory data is included in this section of the report to quantify the resource problems and opportunities that directly and/or indirectly influence erosion and sedimentation.

A variety of resource issues and human activities were touched upon in the previous section. The Calleguas Creek Watershed is large and in order to be able to effectively confront the problems, the focus must be narrowed. Resource issues that are most significantly interrelated with Mugu Lagoon are further evaluated in order to identify where the greatest erosion and accelerated sediment control treatment in the watershed is possible.

3.2 Overview of Water Runoff Issues
3.3 Changes in Peak Flow Over Time
3.4 Addressing Urban Water Runoff Issues
3.5 Flooding
3.6 Addressing Flooding Issues
3.7 Erosion and Sedimentation Over Time
3.8 Prioritizing Erosion and Sedimentation Control Efforts
3.9 Economic Impacts of Erosion, Sedimentation, and Flooding
3.10 Water Quality Contaminant Concerns
3.11 Addressing Water Quality Issues
3.12 Habitat Issues
3.13 Addressing Habitat Issues
3.14 Previous and Ongoing Efforts to Manage Resource Problems/Opportunities
3.15 Forecasted Conditions

3.2 Overview of Water Runoff Issues

The rapidly increasing population growth has contributed to profound changes in the creeks in the watershed. These impacts can be grouped into four categories: stream hydrology, geomorphology, water quality, and aquatic ecology. Table 3-a is a summary of the major impacts by category (US EPA, 1991).

Prior to the expansion of the cities, continuous streamflow conditions did not occur, except during and immediately following rainfall. Today, significant reaches of the main channel have continuous flows due to the following: wastewater treatment plants are discharging into the creek; water is now imported into the region; and the valleys no longer serve as infiltration areas as they did before development.

Today, periods of high intensity rainfall in combination with the effects of sparse vegetation, denudation, and steep channel gradients result in sediment-laden floodwater, and debris in the form of trees and shrubs. Higher velocity flows cause channel scouring in areas upstream of Camarillo, and a resulting sediment deposition problem in the lower portion of Calleguas Creek.

Urbanization in this watershed began along the flatter lands associated with the streams. These flat areas at one time were infiltration beds for the storm water to enter the groundwater basin. Urban developments are usually designed to direct and concentrate the runoff in roadways and drainage ways so that runoff can be released to an outlet to a main drainage way as quickly as possible. This prevents localized infiltration and flooding but increases peak flows in the main drainage system, and increases the potential for streambank erosion.

Table 3-a: Population Impacts on Stream Systems

Changes in Stream Hydrology:
- -Increase in Magnitude & Frequency of Floods.
- -Increased Frequency of Erosive Bankfull Floods.
- -Increase in Annual Volume of Surface Runoff.
- -Increased Stream Velocities.

Changes in Stream Morphology:
- -Stream Channel Widening and Downcutting.
- -Increased Streambank Erosion.
- -Shifting Bars of Coarse Grained Sediment.
- -Elimination of Pool/Riffle Structure.
- -Imbedding of Stream Sediments.
- -Stream Relocation/Enclosure or Channelization.

Changes in Water Quality:
- -Pulses of Sediment During Construction.
- -Increased Pollutants.
- -Nutrient Enrichment.
- -Increased Bacteria.
- -Increased Organic Carbon Loads.
- -Increased Levels of Toxics, Trace Metals, & Hydrocarbons.
- -Elevated Water Temperature.
- -Trash and Debris.

Changes in Stream Habitat and Ecology:
- -Reduction in Diversity of Aquatic Insects.
- -Reduction in Diversity & of Fish Abundance.
- -Loss of Wetlands, Riparian Buffers, & Springs.

Table 3-b demonstrates the extent of the change over time in yield of acre-feet of water passing Simi stream gage. The yield has increased almost 10 times from the period of record 1935-1963 to 1964-1990. The 1935-1963 period represents a time before significant urbanization began and the 1964-1990 period represents a time of rapid urbanization.

Table 3-b: Change in Yield of Acre-Feet of Water for the Time Periods 1934-1963 and 1964-1990 at Simi Stream Gage

Time Period	Average Annual Yield in Acre-Feet
1934-1963	698.5
1964-1990	6750.1

The increased yield in acre-feet per year is due to three major reasons:

1. Water is now imported into the urban areas of Simi Valley. In addition, the agricultural wells are not being used and the ground water table is rising. Five dewatering wells were developed and are delivering 2.5 cfs mean daily flow to the stream.

2. Wastewater treatment plants are discharging into the creek.

3. Two-year return period events produce increased runoff because the sandy valleys are now covered with houses and paved streets preventing them from serving as infiltration areas. In times past, little or no runoff would have occurred.

Studies indicate that a 2-year event in the Calleguas Creek Watershed will discharge 20 percent (400 cfs) more water under future urbanized conditions as compared with present conditions. However, future urbanization will result in only a 2 to 4 percent (700 to 1,400 cfs) increase in discharge from a 100-year event. With a 100-year event the soil is usually saturated by prior smaller storms, which usually result in nearly 100 percent runoff. Therefore, the land use and cover conditions do not significantly change the yield from a 100-year event. (Simons, Li, and Associates, 12-89).

3.3 Changes in Peak Flow Over Time

To demonstrate the impact of land use changes on peak flows, cover conditions for five time periods in history were estimated. The periods are Native American, Spanish-Mexican, Agricultural Expansion, Modern Urbanization, and year 2010 conditions. The estimated peak discharges for all 37 subwatersheds were estimated.

Overall, the data for all subwatersheds show that there is no significant change in the 100-year peak discharge. The discharge from a smaller event increases due to changes in land use. Converting a valley into urban subdivisions creates greater potential for runoff from small events because there is no opportunity for the water to infiltrate into the soil. The water runs off of roofs and streets and into storm drains which typically discharge directly to stream channels.

Two subwatersheds with significantly different projected future land uses are discussed in order to show how peak flows change as land uses are modified. Grimes Canyon (#9) is a subwatershed that has significant orchard land and is projected to stay in agriculture; Gabbert Canyon (#10) is an adjacent subwatershed that is currently primarily open space but is projected to be heavily urbanized over the next 20 years.

Table 3-c displays peak discharges corresponding to the different periods for the Grimes Canyon and Gabbert Canyon subwatersheds. It should be remembered that these numbers only show relative differences in subwatersheds as a result of changes in land use conditions.

As can be seen by the comparison of the two subwatersheds, the discharges in Gabbert Canyon will likely increase with projected development. The 2-year discharge increase from the 1990 period to 2010 is relatively greater than the change in 100-year event discharge for the same period (15 percent increase versus 5 percent). In the Grimes Canyon subwatershed major land use changes are not projected and the discharges are not expected to substantially increase for the 2010 period.

Table 3-c: Peak Discharges (cfs) Over Time
(Grimes and Gabbert Canyons)

Grimes Canyon (#9) - (Little Urban Development Anticipated)

Return Period (Years)	Native American (period)	Spanish-Mexican (period)	1932 (period)	1990 (period)	2010 (period)
2	90	200	610	610	610
5	210	480	1000	1000	1000
10	330	680	1280	1280	1280
25	740	1220	1890	1890	1890
50	840	1350	2020	2020	2020
100	1160	1740	2430	2430	2430

Gabbert Canyon (#10) - (Significant Urban Development Anticipated)

Return Period (Years)	Native American (period)	Spanish-Mexican (period)	1932 (period)	1990 (period)	2010 (period)
2	120	320	620	890	1020
5	300	750	1160	1500	1620
10	500	1040	1530	1850	1980
25	1070	1810	2370	2700	2850
50	1210	2000	2550	2890	3040
100	1650	2550	3090	3450	3610

In addition to the potential changes in peak flows as land use changes occur in the subwatersheds, several studies have been completed to estimate the peak discharge for different return periods associated with the main channel. Future watershed condition flows, as determined by the Ventura County Flood Control District (VCFCD, 1989), are generally about 20 percent higher than those computed by the Corps of Engineers (US Army COE, 1985). A reason for this is that the VCFCD (1989) study assumed maximum development would occur in the foothill areas of the watershed as well as on the relatively flat, low-lying areas. The US Army COE (1985) study did not estimate intensive urbanization in the foothills (Table 3-d).

As was found for the individual subwatersheds, the data indicates that the 100-year event discharge to the main channel for future development conditions is only 2 to 4 percent higher than the discharge computed for the existing development condition. For the 2-year event, the discharges are as much as 20 percent higher for the future condition case.

The impacts of the increased peak discharges include the potential for increased bank erosion and increased flooding problems. Although it would be very difficult to accurately estimate the specific change in bank erosion and flood damage due to a potential increase in peak discharges, the impact could be significant. In order to roughly gauge the potential increased bank erosion resulting from urbanization, an assessment of the change in transport capacity was made. The change was assumed to directly relate to a change in average annual sediment yield from bank erosion. Results of this evaluation determined a potential increase of 15-20 percent in sediment yield from bank erosion. It is important to note that the current streambank erosion is significant; therefore, regardless of the amount of future development streambank treatment measures will be needed. These treatment measures may very well minimize future bank erosion problems due to urbanization.

Table 3-d: Return Period versus Peak Discharge Estimates
by the COE and VCFCD
(middle reach of Arroyo Las Posas)

Return Period (Years)	COE Discharge (cfs) Present	COE Discharge (cfs) Future	VCFCD Discharge (cfs) Future
2	----	----	1,800
5	3,200	3,800	5,200
10	6,000	6,800	8,500
25	12,000	13,000	14,000
50	18,000	19,000	19,400
100	25,000	26,000	26,500

3.4 Addressing Urban Water Runoff Issues

Future water runoff changes in the watershed will primarily be a result of increased urbanization. Table 3-e summarizes the projected urbanization that is expected to occur over the next 20 years, by subwatershed. Subwatershed 25, Arroyo Conejo is expected to have the greatest amount of acreage converted to urban use (4,200 acres), and includes 11 percent of the total urban land expansion in the Calleguas Creek Watershed. According to Table 3-e, over 75 percent of the total projected expansion of urban land use is within 12 of the 37 subwatersheds. These subwatersheds are associated with the growth in Thousand Oaks, Simi Valley, Moorpark, and Camarillo.

Summary: Overall, it could be argued that, after any urban development is completed and the construction site is revegetated, a reduction of sediment reaching the lagoon would be the result. However, there are other issues associated with runoff, such as the potential pollutants, the impacts to the stability of the stream banks due to changing peak flows, and the overall health of the ecosystem.

Any proposed plans to address urban runoff must be developed closely with the cities, county, and the development interest groups.

3.5 Flooding

Precipitation records indicate that moderate to heavy storms have occurred in the area in: 1891, 1905, 1907, 1911, 1913-1916, 1918, 1921, 1926, 1927, 1931, 1934, 1937, 1938, 1941, 1943, 1944, 1947, 1958, 1962, 1966, 1967, 1969, 1971-1975, 1978, 1980, 1983, and 1992. Local residents indicate that prior to 1918 major floods occurred in 1862, 1884, 1889, 1914, and 1916. Of these, the floods of 1862 and 1884 were probably the largest. A comparison of these floods with recorded flows is not possible since historic floods are usually remembered by the damage rather than by an estimate of peak discharge. Brief descriptions of the recent storms and floods (1969, 1978, 1980, and 1983) are provided below. Typical problems associated with flood waters include damage to homes and the contents, crops, roads, and other infrastructure.

TABLE 3-e: Projected Change in Urban Land Use: 1990 to 2010

Subwatershed Name	Total Subwtrshd (acres)	1990 Urban Land (acres)	2010 Urban Land (acres)	% of Urban Land: Year 2010	Net Change in Urban Acres: 1990 to 2010	Cumulative % of Total Change in Urban Acres
25 Arroyo Conejo	10,050	5,440	9,613	96%	4,173	11.3%
23 Sycamore Canyon	5,675	1,275	4,601	81%	3,326	20.3%
26 S. Branch Arr. Conejo	8,615	3,665	6,780	79%	3,115	28.8%
24 Greenwich Village Can.	3,925	1,130	3,812	97%	2,682	36.0%
28 Arroyo Santa Rosa	8,950	2,305	4,798	54%	2,493	42.8%
22 Bus Canyon	4,565	1,955	4,295	94%	2,340	49.1%
10 Gabbert Canyon	5,395	1,010	3,032	56%	2,022	54.6%
1 Revolon Slough	29,180	5,110	7,074	24%	1,964	59.9%
19 Arroyo Simi	6,895	2,185	3,986	58%	1,801	64.8%
27 N. Branch Arr. Conejo	5,210	3,540	5,048	97%	1,508	68.9%
13 Alamos Canyon	4,765	220	1,531	32%	1,311	72.5%
29 Arroyo Conejo	1,460	35	1,322	91%	1,287	75.9%
34 Arroyo Las Posas	6,600	1,445	2,608	40%	1,163	79.1%
37 Arroyo Simi	1,975	20	1,053	53%	1,033	81.9%
21 Runkle Canyon	2,420	560	1,418	59%	858	84.2%
15 North Simi Drain	1,620	620	1,367	84%	747	86.2%
20 Meier Canyon	3,970	175	782	20%	607	87.9%
11 Happy Camp Canyon	8,275	360	934	11%	574	89.4%
14 Brea Canyon	1,880	430	972	52%	542	90.9%
30 Arroyo Conejo	5,080	735	1,251	25%	516	92.3%
12 Strathern Canyon	6,450	530	1,028	16%	498	93.7%
33 Arroyo Las Posas	3,430	1,265	1,661	48%	396	94.7%
31 Arroyo Conejo	7,345	1,585	1,955	27%	370	95.7%
4 Coyote Canyon	5,015	410	735	15%	325	96.6%
36 Mugu Lagoon	13,165	4,390	4,704	36%	314	97.5%
16 Dry Canyon	1,790	890	1,192	67%	302	98.3%
18 Las Llajas Canyon	7,565	420	650	9%	230	98.9%
17 Tapo Canyon	15,525	3,610	3,825	25%	215	99.5%
2 Beardsley Wash	8,850	650	747	8%	97	99.8%
9 Grimes Canyon	4,115	50	141	3%	91	100.0%
5 Sand Canyon	1,590	100	100	6%	0	100.0%
35 Calleguas Creek	5,360	50	50	1%	0	100.0%
32 Long Grade Canyon	2,520	165	165	7%	0	100.0%
6 Mahan Barranca	1,595	45	45	3%	0	100.0%
3 Fox Barranca	4,310	175	175	4%	0	100.0%
7 Long Canyon	3,505	60	60	2%	0	100.0%
8 Hunt Wash	1,350	10	10	1%	0	100.0%
Total Watershed	219,985	46,620	83,520	38%	36,900	

1. Storm of January 18-27, 1969: Nine-day totals ranged from 10 to 20 inches in the lowlands and from 25 to more than 50 inches over mountain areas of southern California. Along Calleguas Creek, a peak discharge of 12,800 cfs was recorded at the Camarillo State Hospital gage, which has a drainage area of 243 square miles. The peak discharge for the Arroyo Simi gage was 5,040 cfs.

2. Storm and flood of February 22-25, 1969. The late February 1969 storm series was the climax of more than a month of extremely heavy, recurring rainfall in southern California. The maximum peak discharge at Camarillo State Hospital gage was 13,100 cfs, while the Arroyo Simi gage recorded 6,330 cfs and the Moorpark gage recorded 6,500 cfs.

3. Storms and floods of February 28 - March 5, 1978: The storms and floods of February 28 - March 5, 1978, were preceded by a series of storms in early February 1978. The maximum peak discharge at Camarillo State Hospital gage was 18,700 cfs, 7,730 cfs at Arroyo Simi and 8,600 cfs at Moorpark on March 4, 1978.

4. Storm and flood of February 13-22, 1980: A series of varying intensity fronts coming from the west soaked southern California with eight days of nearly continuous rain. The strongest front passed the area midday Saturday, February 16, producing the second highest peak discharge of record of 25,300 cfs at the State Hospital and 9,310 cfs near Simi. This storm caused a breach of the west levee of Calleguas Creek below Hueneme Road with an estimated total of 24,000 acre-ft of water flowing through the breach before it was repaired.

5. Storm and flood of February 25 - March 3, 1983: This storm was characterized by two periods of moderate to heavy precipitation. With the ground wet from a January storm, heavy precipitation produced high flows in most creeks in southern California. At the Camarillo State Hospital gage the highest maximum recorded peak discharge, for the gage's period of record, was 26,600 cfs. As in 1980, the Calleguas Creek levee was severely overtopped near Broome Ranch road crossing (Dames & Moore, Sept. 1992).

3.6 Addressing Flooding Issues

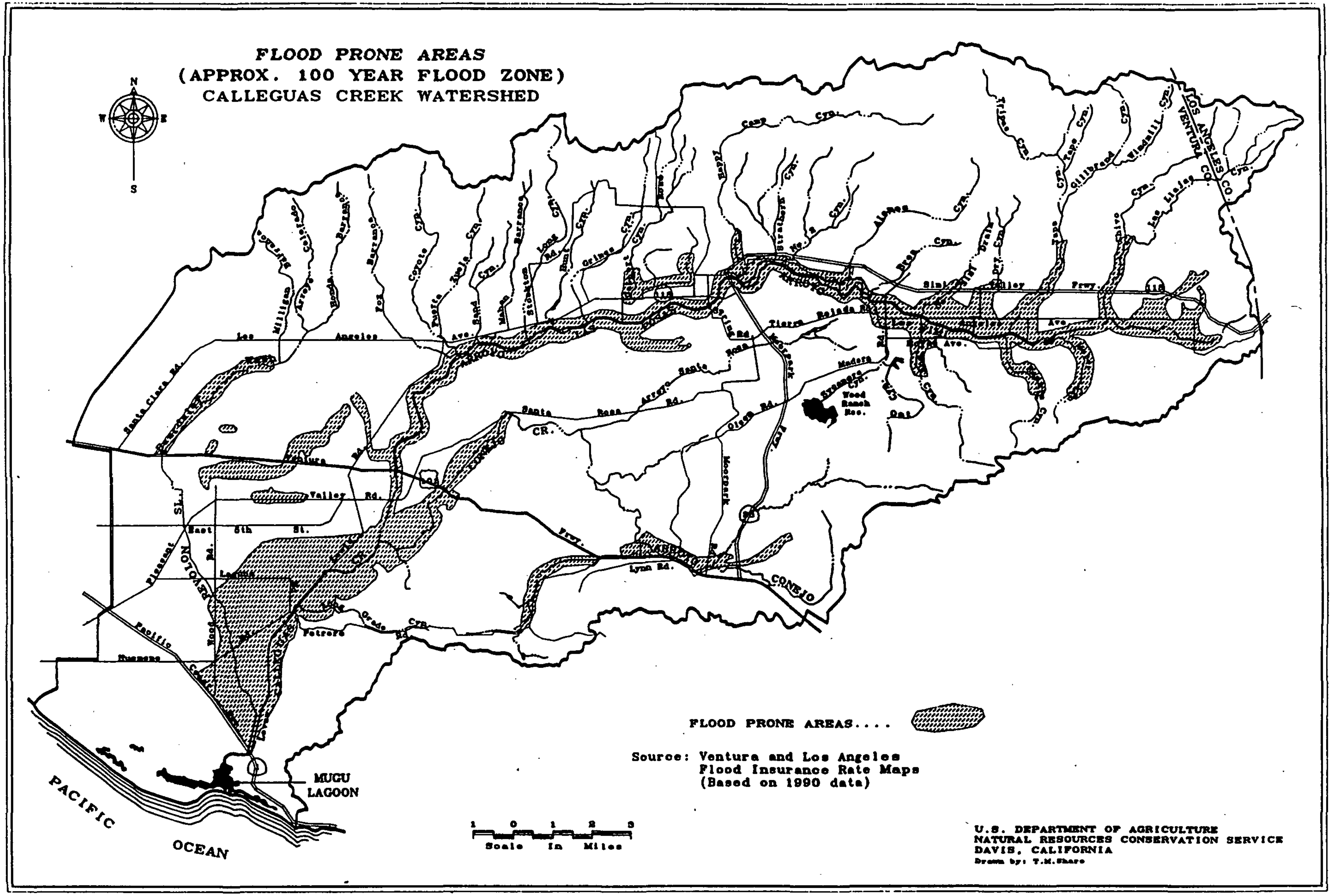
Sediment deposition clearly contributes to the flooding problems in the lower reaches of the watershed. Figure 3-a identifies the primary flood areas in the watershed. The very significant flooding problems are associated with the reduced stream capacity due to sedimentation at the lower end of the watershed and increased peak flows due to urbanization.

Summary: Although flooding is a significant problem in the Calleguas Creek Watershed, this plan will not directly identify treatment measures to reduce the problem. However, the flooding problems will indirectly be addressed as a result of treatment of other resource issues such as erosion and sediment.

3.7 Erosion and Sedimentation Over Time

The following section describes how human activity over time has impacted the erosion and sediment processes in the watershed. Erosion and sedimentation that occurred during the Native American period in the watershed was accelerated by European settlement. The impact of actions carried out by European settlement has not yet culminated.

Figure 3-a



FLOOD PRONE AREAS
(APPROX. 100 YEAR FLOOD ZONE)
CALLEGUAS CREEK WATERSHED

FLOOD PRONE AREAS.... ▨

Source: Ventura and Los Angeles Flood Insurance Rate Maps (Based on 1990 data)

U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
DAVIS, CALIFORNIA
Drawn by: T.M.Share

Scott and Williams (1978) characterized the Calleguas Creek drainage as an area of low sediment yields in the Transverse Ranges of Southern California. However, they also documented the presence of easily erodible alluvial fill material adjacent to active stream channels and historical evidence of several episodes of channel cutting in Tapo Canyon. Scott and Williams (1978) go on to say that the alluvial fill material will continue to be highly susceptible to erosion due to minor hydrologic or land use changes.

In the early years of agricultural development in the region, sediment deposits were considered a mixed blessing on the Oxnard Plain. Along with inconvenience and damages, the deposition of light textured sediment enhanced the tilth of the heavy marsh land. In some instances, it was valued so highly that considerable effort was spent to direct flood flows onto fields. In time, the inconvenience of flooding and additional damages caused by sediment deposits outweighed diminishing soil productivity benefits.

Land use changes, commencing with conversion of the riparian and Valley Oak Savanna plant communities to annual grass land and subsequently to present agricultural and urban land uses have caused increased runoff and accelerated erosion.

Figure 3-b compares the gross erosion and sediment yield calculations for the different time periods (Finney, 1993 b-e). Present soil loss calculations (Finney, 1993 b-e) are 6.8 and 3.2 times calculations for the Native American and Spanish/Mexican periods respectively. Present sediment yield calculations are 7.8 and 4.8 times those calculated for the Native American and Spanish/Mexican periods respectively. Prior to Pre-European intervention, sediment carried by Calleguas Creek was deposited on the Oxnard Plain and not directly delivered to Mugu Lagoon.

Comparing the gross erosion and sediment yield of different subwatersheds for different time periods shows how land use changes dramatically influence erosion and sediment rates. Las Llajas Canyon (Subwatershed #18) is still in a relatively natural condition and, as would be expected, the erosion and sediment yield estimates for current conditions (erosion, 7,000 tons/year: sediment, 2,000 tons/year) are similar to the rates estimated for the Native American period (erosion, 6,900 tons/year; sediment, 1,500 tons/year). Sand Canyon (Subwatershed #5) is predominently in agriculture and the erosion and sediment yield estimates for current conditions (erosion 14,300 tons/year; sediment, 6,000 tons/year) are ten times the rates estimated for the Native American period (erosion, 1,800 tons/year; sediment, 600 tons/year).

About one third of the Calleguas Creek Watershed was documented as severely or very severely eroded by the 1950s (USDA-SCS, 1954). Bean farming on steeply sloping lands was blamed as a primary cause of accelerated erosion. The era of the 1930s is shown as being one of the highest erosion periods in written history for the area (Figure 3-b). Severely eroded fields and barrancas are documented in the 1954 SCS report.

The most dramatic change to erosion and sedimentation rates in the watershed has been the channelization of Calleguas Creek to the Pacific Ocean. According to the Corps of Engineers Flood Control Survey Report of 1942, there was no definite channel downstream of State Highway 101 near Camarillo in 1862. By 1889 local residents had cleared a straight channel from river mile 9.6 (State Highway 101) to the mouth of Conejo Creek (USDA-SCS, 1954). Channel straightening increases velocities. As a rule of thumb, doubling stream velocity increases erosive power four fold and sediment carrying capacity sixty-four fold (Leopold, 1964).

The effects of wildfires on erosion rates in southern California is also important (Scott & Williams, 1978). Fires are a function of the characteristic summer dry season and dry fire-fanning winds caused by periodic reversal of the normal onshore flow pattern. Chaparral vegetation is rich in flammable resins and waxy leaf coatings which are consumed with an intensity that has been described as one of the most difficult wildland fire-control problems in the world. Although fires of human origin have tripled in 15 years, the overall rate of watershed burn has remained relatively constant in Los Angeles County since 1907 at about 1 percent per year, with a recurrence interval of approximately 26 years (Scott & Williams, 1978). Calleguas Creek Watershed is thought to have similar characteristics to those given above for Los Angeles County.

The effects of fire on sediment yield are important. Unfortunately, an analysis of the impacts of fires on sediment yield was not completed for this study. However, Finney, et al, (1994f) calculated the impacts of fire on sediment yield for the Malibu Basin, a nearby watershed. A 4.3 inch, 6 hour duration storm event was used to calculate the impacts of the 1993 "Old Topanga Fire" on sediment yield from the Malibu Basin. Cold Creek watershed, the primary burn area in the Malibu Basin, comprises approximately 7 percent of the drainage area. Sediment yield from the Malibu Basin was calculated to have increased 6,000 tons or 13 percent due to the fire.

Although no direct correlation of the Malibu basin to the Calleguas Creek Watershed can be made, it is clear that fires do have impacts on erosion rates. Therefore, any treatment alternatives that are identified for implementation will require some consideration of the effect of fire on erosion rates and the potential impacts on the success of treatment measures.

3.8 Prioritizing Erosion and Sedimentation Control Efforts

Based on 1990 land use data, the present average annual sediment yield from the 37 subwatersheds to the main channel system in Calleguas Creek Watershed is about 412,000 tons. The estimated average annual sediment yield to Mugu Lagoon from Calleguas Creek is 240,000 tons.

The major objective of this study is to identify potential sediment control opportunities and to reduce off-site damages. Simons, Li & Associates (1989) divided the Calleguas Creek Watershed sedimentation problem into three components: (1) sediment production, (2) sediment transport, and (3) sediment deposition. For purposes of problem prioritization the following discussions address components (1) and (2) since they are the sources of materials affecting component (3) or sediment in Mugu Lagoon.

(1) Sediment production region: Table 3-f displays erosion and sediment by source for the Calleguas Creek Watershed. The top five erosion producing areas are:

1-natural areas, 240,000 tons/year;
2-soil slips, 188,000 tons/year;
3-orchards, 184,000 tons/year;
4-streambanks, 178,000 tons/year;
and 5-construction, 106,000 tons/year.

Table 3-f: Erosion and Sediment by Erosion Source

		TOTAL VOLUME		RANKING ACCORDING TO	
EROSION SOURCES	ACRES	EROSION TONS/YEAR	SEDIMENT YIELD* TONS/YEAR	EROSION	SEDIMENT YIELD*
CITRUS-NEW	10,555	52,000	19,000	-	-
CITRUS-OLD	6,960	11,000	3,000	-	-
AVOCADO-NEW	3,471	30,000	12,000	-	-
AVOCADO-OLD	4,439	10,000	2,000	-	-
ORCHARD ROADS	N.A.	81,000	38,000	-	-
TOTAL ORCHARDS	25,425	184,000	74,000	3	2
PASTURE	385	1,000	1,000	14	13
CONFINED ANIMALS	485	4,000	1,000	13	13
URBAN	37,069	19,000	3,000	11	10
RURAL RESIDENTIAL	5,769	9,000	2,000	12	12
FIELD CROPS	32,123	97,000	14,000	6	7
NATURAL AREAS	108,548	240,000	45,000	1	4
OTHER	5,130	30,000	3,000	10	10
MINES	860	90,000	7,000	7	9
CONSTRUCTION	2,200	106,000	53,000	5	3
GULLIES	N.A.	32,000	11,000	9	8
STREAMBANKS	N.A.	178,000	152,000	4	1
SOILSLIPS	N.A.	188,000	22,000	2	6
OTHER ROADS	N.A.	47,000	23,000	8	5
WATER	1,900	0	0		15
TOTAL	219,894	1,225,000	411,000		

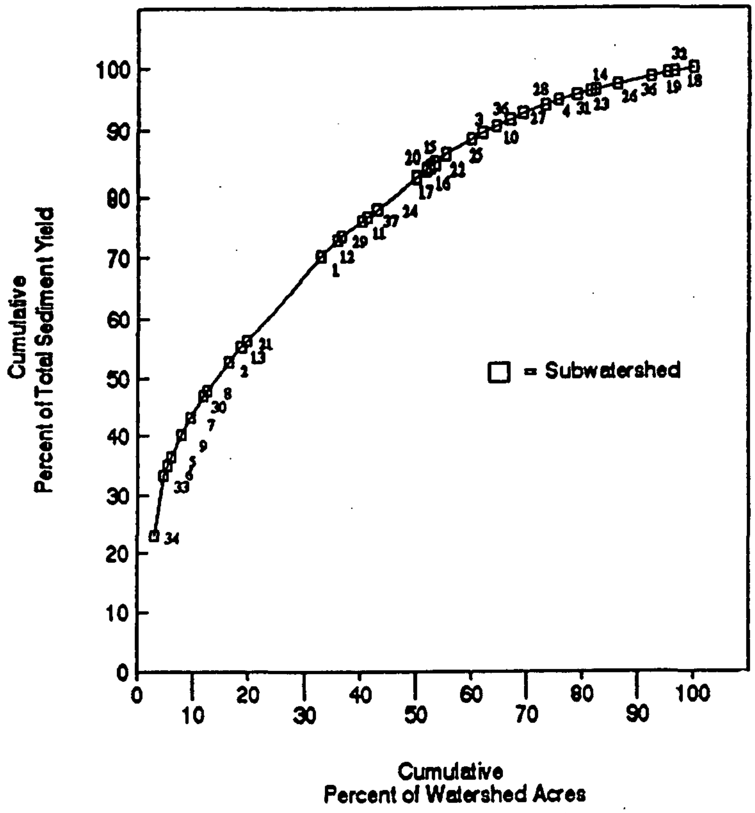
* Sediment yield to the stream. Includes only sediment passing through debris basins.

However, in terms of sediment yield the ranking is:

1-streambanks, 152,000 tons/year;
2-orchards, 74,000 tons/year;
3-construction, 53,000 tons/year;
4-natural areas, 45,000 tons/year;
and 5-other roads, 23,000 tons/year.

In addition to ranking by erosion sources, Table 3-g displays the sediment yield for the 37 subwatersheds and ranks them by total sediment yield per square mile, from highest to lowest. The top five sources of sediment yield for each subwatershed are summarized in Table 3-h.

With the data in Table 3-g for sediment yield per square mile, Figure 3-c was plotted to graphically show each subwatersheds incremental contribution of sediment to the total basin sediment yield. Eleven subwatersheds stand out in Figure 3-d as contributing, per square mile, a disproportionate share of the total sediment yield.



As an example, this figure shows that Subwatershed No. 34 accounts for about 5 percent of the total study area acreage, but accounts for about 22 percent of the total sediment yield.

Figure 3-c: Ranking of Subwatersheds Based on Highest to Lowest Sediment Contribution on a Per Acre Basis.

(2) Sediment Transport Region: Of the eleven priority subwatersheds, numbers 33 and 34 are primarily sediment transport rather than sediment production subwatersheds. Ninety-one percent and sixty-nine percent of the sediment yield from subwatersheds 34 and 33 respectively comes from streambanks.

Summary: The eleven priority subwatersheds are logical treatment areas if the strategy is to reduce the production and delivery of sediment reaching the lagoon from the major sources. These areas contribute nearly 55 percent or 223,000 tons/year of the sediment reaching the main channel system (Figure 3-d). Another strategy that will be considered in the alternative development section will be the trapping of the sediment before it reaches the lagoon.

Table 3-g: Present Average Annual Sediment Yield for Subwatersheds of Calleguas Creek Watershed To The Main Channel – Sediment Yield Per Square Mile.

SEDIMENT YIELD PER SQUARE MILE

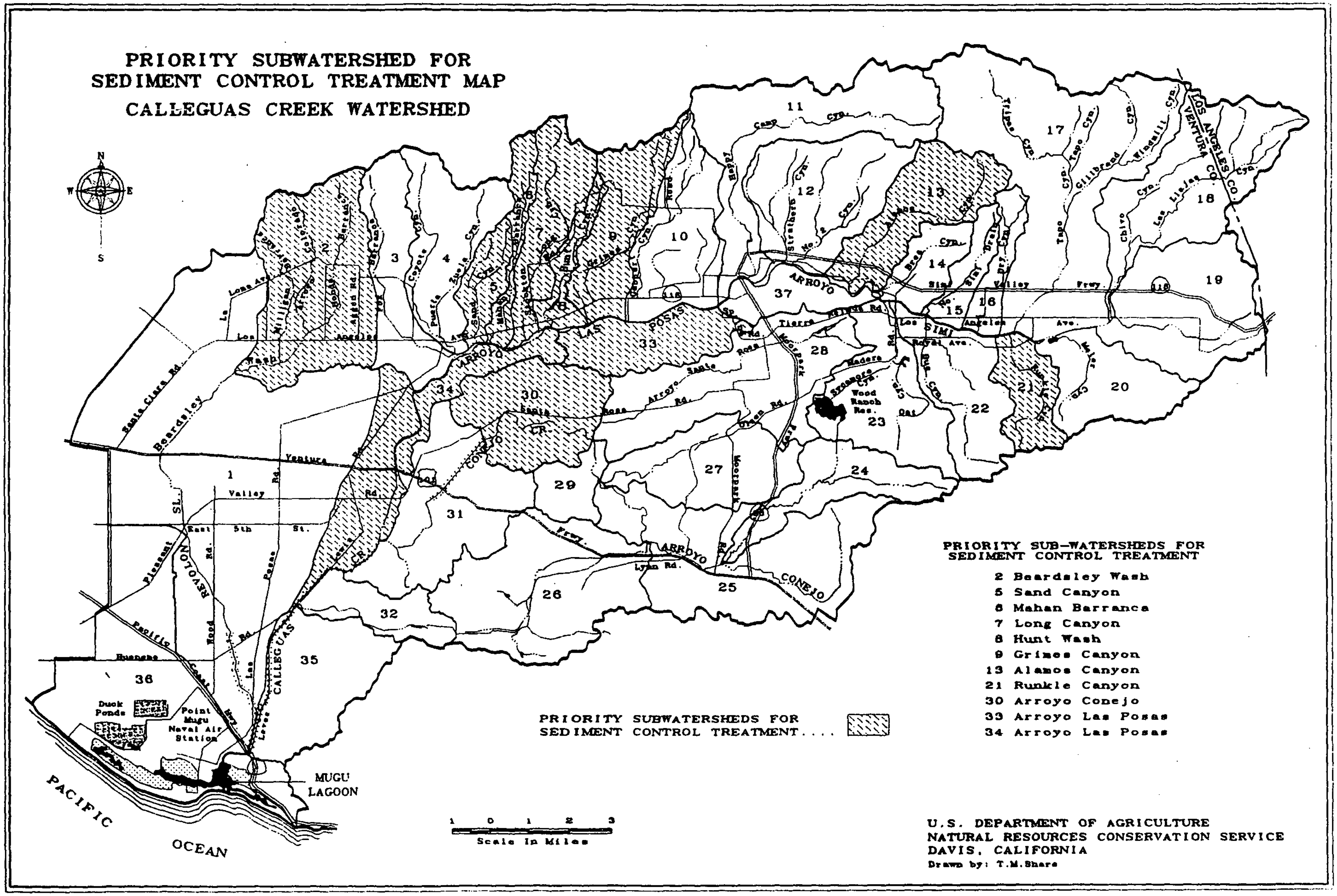
	Drainage Area	Sediment (tons)*			Tons Per
Tributary Name	(Square Miles)	Wash Load	Bed Load	Total Load	Sq. Mile
Arroyo Las Posas (34) **	10.3	38,219	56,407	94,626	9,176
Peach Hill Wash (33)	5.4	20,061	21,890	41,951	7,828
Mahan Barranca (6)	2.5	4,490	2,928	7,418	2,977
Sand Canyon (5)	2.5	3,566	2,422	5,988	2,410
Grimes Canyon (9)	6.4	7,615	7,555	15,170	2,359
Long Canyon (7)	5.5	7,354	4,995	12,349	2,255
Arroyo Conejo (30)	7.9	9,281	5,984	15,265	1,923
Hunt Wash (8)	2.1	2,224	1,519	3,743	1,774
Beardsley Wash (2) **	13.8	12,995	8,746	21,741	1,572
Alamos Canyon (13)	7.4	4,970	4,948	9,918	1,332
Runkle Canyon (21) **	3.8	3,425	556	3,981	1,053
Revolon Slough (1) **	45.6	33,937	23,016	56,953	1,249
Strathern Canyon (12)	10.1	5,955	5,449	11,404	1,132
Arroyo Conejo (29)	2.3	1,280	825	2,105	923
Happy Camp Canyon (11) **	12.9	5,691	5,826	11,517	891
Arroyo Simi (37)	3.1	1,968	723	2,691	872
Greenwich Village Canyon (24)	6.1	3,106	2,003	5,109	833
Tapo Canyon (17) **	24.3	10,860	8,629	19,489	803
Meier Canyon/Los Alisos (20)	6.2	2,276	2,445	4,721	761
North Simi Drain (15)	2.5	900	902	1,802	712
Dry Canyon (16)	2.8	1,065	864	1,929	690
Bus Canyon (22) **	7.1	2,433	2,461	4,894	686
Arroyo Conejo (25)	15.7	5,875	3,523	9,398	598
Fox Barranca (3) **	6.7	2,670	1,312	3,982	591
Gabbert Canyon (10) **	8.4	2,534	2,334	4,868	577
Calleguas Creek (35)	8.4	3,274	1,202	4,476	534
North Branch Arroyo Conejo(27)	8.1	2,400	1,548	3,948	485
Arroyo Santa Rosa (28) **	14.0	3,350	2,149	5,499	393
Coyote Canyon (4) **	7.8	1,956	961	2,917	372
Arroyo Conejo (31)	11.5	2,399	1,489	3,888	339
Sycamore Canyon (23) **	8.9	2,062	504	2,566	289
Brea Canyon (14) **	2.9	1,100	195	1,295	441
South Branch Arroyo Conejo(26)	13.5	2,186	1,410	3,596	267
Oxnard Plain (36)	20.6	3,951	1,450	5,401	263
Arroyo Simi Headwaters (19)	10.8	1,135	1,640	2,775	258
Long Grade Canyon (32)	3.9	457	295	752	191
Las Llajas Canyon/Chivo (18) **	11.8	1,054	926	1,980	168
MUGU WATERSHED	343.7	220,074	192,031	412,105	

* Wash load estimates were made by the Soil Conservation Service (1993).
Wash load is less than .0625 mm, Bed load is greater than .0625 mm
Bedload was modified from Simons & Li (1989) and rounded to the nearest hundred.

** Canyons with debris basins.

TABLE 3-h: Top Five Sediment Yield Sources for Each Subwatershed
(Subwatershed are in order of highest total sediment yield to lowest.

SUBWATERSHED NAME	SEDIMENT SOURCE	SEDIMENT BY SOURCE (tons/year)	SUBWATERSHED NAME	SEDIMENT SOURCE	SEDIMENT BY SOURCE (tons/year)	SUBWATERSHED NAME	SEDIMENT SOURCE	SEDIMENT BY SOURCE (tons/year)
Arroyo Las Posas	STREAM	85,624	Mahan Barranca	ORCH+RD	2,040	Arroyo Conejo	ORCH+RD	1093
34 (6,600 ac.)	ORCH+RD	4,164	6 (1,595 ac.)	NAT. AREA	1,475	31 (7,345 ac.)	FIELD CRP	517
	CONST	1,650		STREAM	976		URBAN	461
	FIELD CR	1,423		OTHER RD	848		NAT. AREA	445
	NAT. AREA	698		SOIL SLIPS	804		STREAM	334
		93,559			6,143			2,850
Revolon Slough	CONST	19950	Sand Canyon	ORCH+RD	4,213	Arroyo Simi	NAT. AREA	1290
1 (29,180 ac.)	ORCH+RD	15836	5 (1,590 ac.)	STREAM	806	37 (1,975 ac.)	STREAM	684
	STREAM	7780		OTHER RD	293		SOIL SLIPS	356
	FIELD CRP	7754		SOIL SLIPS	207		OTHER RD	182
	GULLIES	2626		NAT. AREA	178		GULLIES	178
		53,946			5,697			2,690
Peach Hill Wash	STREAM	28,772	Greenwich Vill. Cr.	CONST	3600	Arroyo Simi Hdwat	STREAM	1110
33 (3,430 ac.)	CONST	7,650	24 (3,925 ac.)	SOIL SLIPS	589	19 (6,895 ac.)	NAT. AREA	706
	ORCH+RD	3,054		OTHER RD	312		OTHER RD	358
	OTHER RD	822		NAT. AREA	269		STREAM	228
	NAT. AREA	683		STREAM	221		GULLIES	146
		40,981			4,991			2,548
Beardsley Wash	ORCH+RD	12,487	Oxnard Plain	ORCH RD	3093	Arroyo Conejo	SOIL SLIPS	876
2 (8,850 ac.)	STREAM	3,660	36 (13,165 ac.)	NAT. AREA	683	29 (1,460 ac.)	STREAM	473
	NAT. AREA	1,817		CONF. ANML	390		OTHER RD	363
	OTHER RD	1,262		STREAM	360		NAT. AREA	214
	SOIL SLIPS	843		OTHER MIL	285		GULLIES	175
		20,069			4,811			2,101
Tapo Canyon	NAT. AREA	7383	MeierCyn/Los Alisos	NAT. AREA	3722	Dry Canyon	NAT. AREA	891
17 (15,525 ac.)	MINES	3760	20 (3,970 ac.)	OTHER RD	486	16 (1,790 ac.)	STREAM	446
	STREAM	3228		STREAM	190		SOIL SLIPS	317
	SOIL SLIPS	2515		ORCH RD	131		OTHER RD	106
	OTHER RD	1379		SOIL SLIPS	91		URBAN	89
		18,285			4,620			1,849
Arroyo Conejo	CONST	5,775	Arroyo Santa Rosa	CONST	2400	North Simi Drain	NAT. AREA	825
30 (5,080 ac.)	ORCH+RD	4,817	28 (8,950 ac.)	SOIL SLIPS	877	15 (1,620 ac.)	STREAM	425
	SOIL SLIPS	1,544		NAT. AREA	498		SOIL SLIPS	301
	OTHER RD	1,541		RURAL RES	485		OTHER RD	118
	FIELD CR	658		STREAM	294		GULLIES	85
		14,335			4,554			1,754
Grimes Canyon	ORCH+RD	5,348	Bus Canyon	NAT. AREA	1,630	Las Llajas/Chivo Cy	SOIL SLIPS	776
9 (4,115 ac.)	STREAM	2,981	22 (4,565 ac.)	CONST	1,050	18 (7,565 ac.)	NAT. AREA	447
	OTHER RD	2,083		STREAM	798		OTHER RD	218
	CONST	1,920		SOIL SLIPS	548		STREAM	215
	SOIL SLIPS	1,264		GULLIES	401		GULLIES	61
		13,596			4,427			1,717
Gabbert Canyon	NAT. AREA	5544	Calleguas Creek	ORCH+RD	1,911	Coyote Canyon	ORCH+RD	595
10 (5,395 ac.)	SOIL SLIPS	3690	35 (5,360 ac.)	FIELD CRP	950	4 (5,015 ac.)	GULLIES	451
	STREAM	1640		OTHER RD	644		STREAM	244
	FIELD CRP	1330		SOIL SLIPS	375		OTHER RD	199
	ORCH+RD	1036		NAT. AREA	288		SOIL SLIPS	78
		13,240			4,168			1,567
Long Canyon	ORCH+RD	6652	Runkle Canyon	GULLIES	1,960	Sycamore Canyon	NAT. AREA	670
7 (3,505 ac.)	STREAM	2291	21 (2,240 ac.)	SOIL SLIPS	635	23 (5,675 ac.)	SOIL SLIPS	277
	OTHER RD	1230		CONST	600		STREAM	274
	NAT. AREA	941		NAT. AREA	375		GULLIES	136
	SOIL SLIPS	547		OTHER RD	189		OTHER RD	65
		11,661			3,759			1,422
Happy Camp	NAT. AREA	4831	N.B. Arroyo Conejo	STREAM	1110	Long Grade Canyon	NAT. AREA	199
11 (8,275 ac.)	SOIL SLIPS	2284	27 (5,210 ac)	NAT. AREA	1102	32 (2,520 ac.)	FIELD CRP	194
	STREAM	1938		SOIL SLIPS	677		STREAM	181
	OTHER RD	1240		GULLIES	469		OTHER RD	85
	MINES	585		OTHER RD	323		RURAL RES	48
		10,878			3,681			707
Strathern Canyon	NAT. AREA	3739	Hunt Wash	ORCH+RD	1,865	Brea Canyon	SOIL SLIPS	165
12 (6,450 ac.)	CONST	3000	8 (1,350 ac.)	STREAM	858	14 (1,880 ac.)	NAT. AREA	142
	STREAM	2010		NAT. AREA	317		OTHER RD	88
	OTHER RD	1308		SOIL SLIPS	197		STREAM	87
	ORCH RD	620		OTHER RD	161		URBAN	29
		10,677			3,398			511
Alamos Canyon	NAT. AREA	4,336	Fox Barranca	ORCH+RD	1388			
13 (4,765 ac.)	STREAM	2,010	3 (4,310 ac.)	STREAM	798			
	SOIL SLIPS	1,868		GULLIES	388			
	OTHER RD	1,308		FIELD CRP	344			
	GULLIES	214		OTHER RD	244			
		9,736			3,162			
Arroyo Conejo	CONST	4950	S.B. Arroyo Conejo	CONST	1050			
25 (10,050 ac.)	MINES	1440	26 (8,615 ac.)	SOIL SLIPS	758			
	SOIL SLIPS	905		NAT. AREA	491			
	STREAM	531		OTHER RD	380			
	OTHER RD	476		STREAM	379			
		8,302			3,058			


PRIORITY SUBWATERSHED FOR SEDIMENT CONTROL TREATMENT MAP
CALLEGUAS CREEK WATERSHED
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PRIORITY SUB-WATERSHEDS FOR SEDIMENT CONTROL TREATMENT
2 Beardsley Wash
5 Sand Canyon
6 Mahan Barranca
7 Long Canyon
8 Hunt Wash
9 Grimes Canyon
13 Alamos Canyon
21 Runkle Canyon
30 Arroyo Conejo
33 Arroyo Las Posas
34 Arroyo Las Posas
PRIORITY SUBWATERSHEDS FOR SEDIMENT CONTROL TREATMENT....
1 0 1 2 3
Scale in Miles
U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
DAVIS, CALIFORNIA
Drawn by: T.M.Share
PACIFIC OCEAN
MUGU LAGOON
Duck Ponds
Point Mugu Naval Air Station
CALLEGUAS CR.
ARROYO LAS POSAS
ARROYO SIMI
ARROYO CONEJO
CONEJO CR.
Wood Ranch Res.
LOS ANGELES CO.
VENTURA CO.
Simi Valley Frwy.
Los Angeles Ave.
Ventura Frwy.
Pacific Coast Hwy.
Santa Clara Rd.
Beardsley Wash
Pleasant Valley Rd.
Lewis Rd.
Revolon SL.
East 5th St.
Hueneme Rd.
Wood Rd.
Pesos Rd.
Lynn Rd.
Moorpark Rd.
Tierra Rejada Rd.
Santa Rosa Rd.
Madera Rd.
Royal Ave.
Camp Cyn.
Happy Cyn.
Tapo Cyn.
Chivo Cyn.
Las Llajas Cyn.
Gillibrand Cyn.
Windmill Cyn.
Strathern Cyn.
Coyote Cyn.
Fox Cyn.
Long Cyn.
Grimes Cyn.
Sycamore Cyn.
Oak Cyn.
Runkle Cyn.
Meier Cyn.
Bus Cyn.
Dry Cyn.
Brea Cyn.
Alamos Cyn.
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Figure 3-d

3.9 Economic Impacts of Erosion, Flooding, and Sedimentation

Hillside orchard land operators face problems with productive land loss, access road damage and maintenance expenses. According to a SCS study of the Calleguas Creek Watershed (USDA-SCS, 1983), up to half of the acres of steep hillslope orchards require landowners to spend an average of $29 per acre per year (current dollars) repairing and replacing irrigation equipment. In addition, a small percentage (10 percent) of the steep sloped and new orchards require an additional $205 per acre per year to replace soil around tree roots and to fill in rills.

Hillside orchard road erosion, rilling and gullying, is another significant problem. Sediment accumulates in the orchard roads from upslope erosion areas and rilling of the cutbanks. Runoff is concentrated on the major orchard roads causing erosion to the roads. An estimated $35 to $41 per acre of hillside orchard (less than 50 percent of all orchards) is spent each year to regrade the field roads and haul dirt from the orchards to fill gullies in the roads.

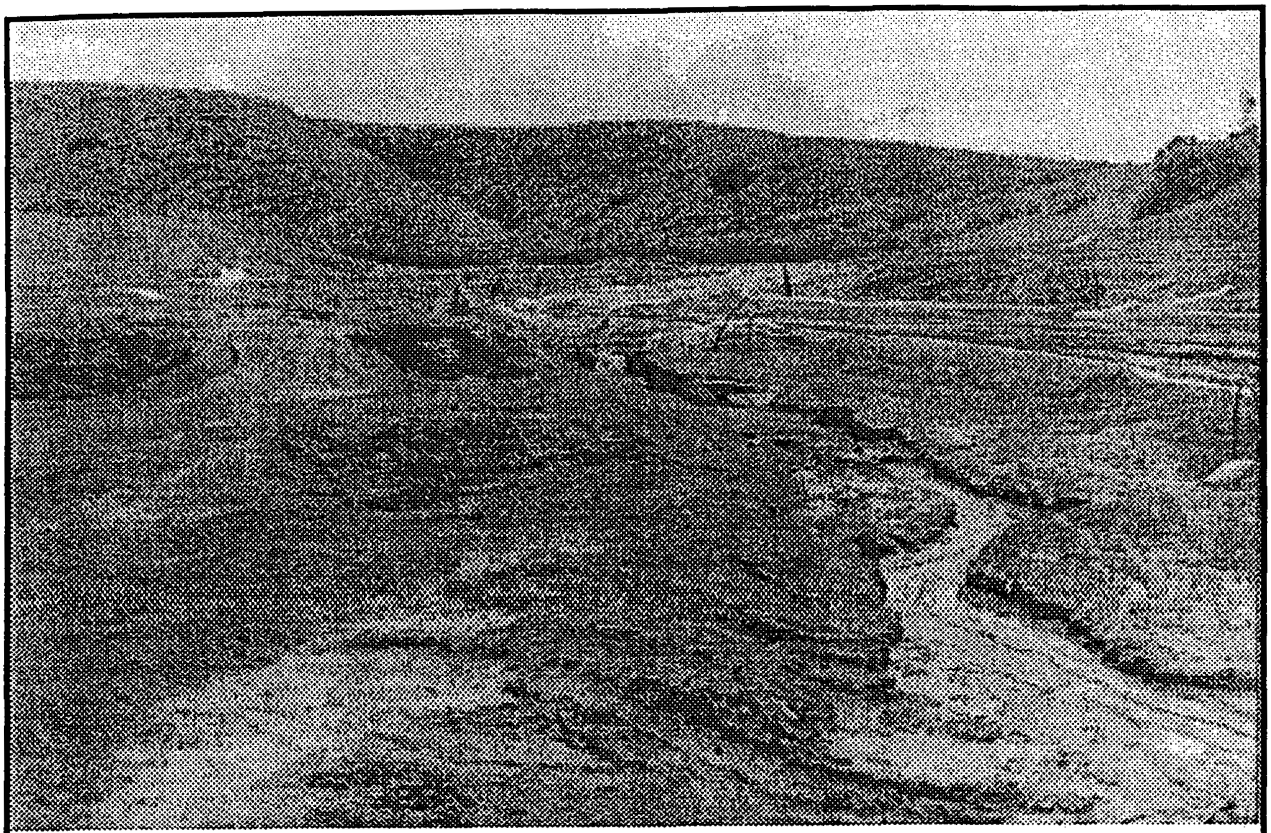
The University of California Cooperative Extension has estimated that orchard growers typically spend on average of about $20 per acre per year to address erosion problems (UC Extension, 1992). This estimate is an average for all orchards regardless of the age of the trees. In comparison, the Cooperative Extension damage estimate is about half the Natural Resources Conservation Service (NRCS) damage estimate. Additional data is needed in order to more accurately determine the actual orchard grower costs due to erosion and sedimentation.

Streambank erosion is another problem. Streambank erosion damages farm roads, county roads, bridges, utilities, cropland, and other public and private property. In 1992 the Ventura County road maintenance division spent over $530,000 to remove storm debris, to provide storm protection, and repair storm damage in the watershed.

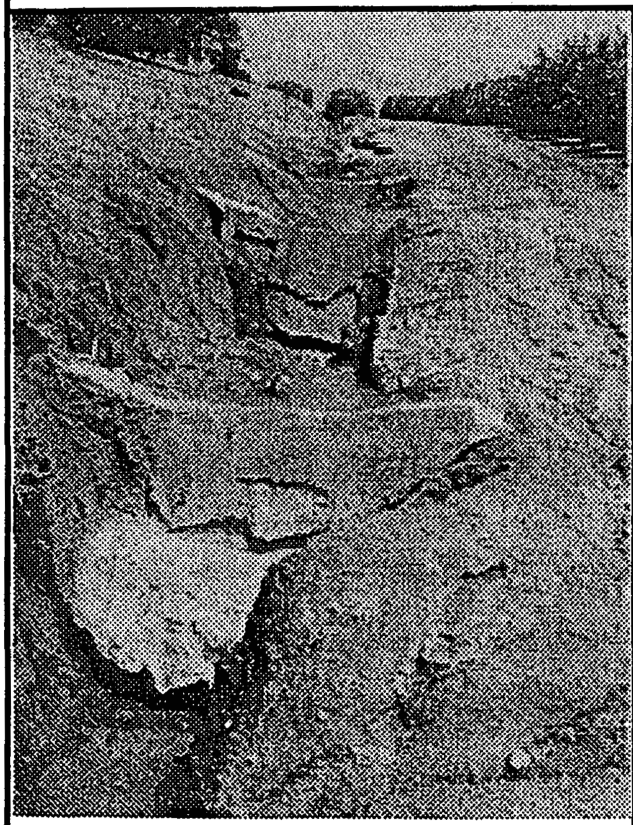
Other county divisions are faced with continual damage and maintenance expenses due to flooding and sedimentation. In addition to the road department, the Ventura County Flood Control District spends a tremendous amount of money to maintain existing infrastructure and to clean out sediment basins and channels. Cleanout records for County debris basins in the Calleguas Creek Watershed indicate that about 50,000 tons of sediment is cleaned out on an annual basis (this is in addition to 412,000 tons/year reaching the main channel). In 1992, debris basin cleanout cost was $703,600. Work at the lower end of the watershed just above the lagoon required 180,000 cubic yards of soil to be removed at an estimated cost of $1 million. A similar cleanout operation was also required in 1979, 1981, 1984 and 1989. In average annual dollars, the cleanout cost is estimated to equal $220,000. ✓

Routine maintenance of the channels and flood control infrastructure in the watershed, by the VCFCD, is another major expense. In 1991, about $2,326,000 of maintenance work in general was required in the Calleguas Creek Watershed; the records indicate that over $670,000 of this amount is related to flood control that addressses sediment problems. ✓

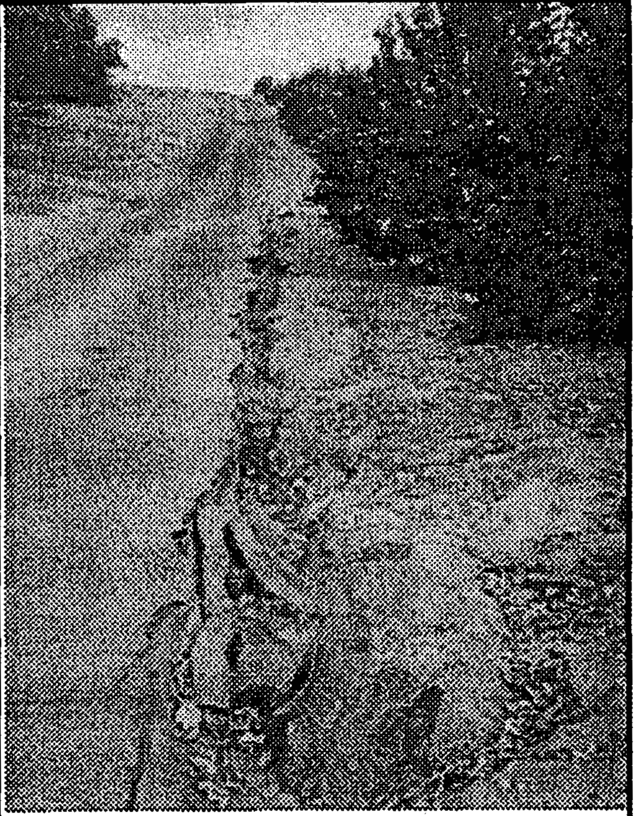
Land owners in the Oxnard Plain face problems with agriculture crop damage, land loss and added maintenance expense as a result of flooding. In a study of this problem by the Corps of Engineers (US Army COE, 1992), it was found that damages in the Oxnard Plain cause $1,269,300 in damage on an average annual basis. A 10-year event is estimated to cause $5,045,000, a 25-year event would cause $11,402,000, and a 100-year event would cause about $24,000,000 in damages.



New Construction Erosion and Sediment



Deteriorating Grade Control Sections



Orchard Road Erosion

In addition to major flooding problems in the Oxnard Plain flood plain, there are some floodwater problems in the tributary drainages such as Grimes Canyon. The 1983 flood caused problems in the lower portion of Grimes Canyon. Sand-sized and larger sediment particles deposited in the lower reach of this drainage caused the channel bottom to raise, and when storm flows occurred weak channel banks eroded and out of bank flows occurred. Up to 40 acres of agriculture land were severely impacted causing a loss of some trees, and the need to reshape, regrade and relevel fields, and remove sediment and debris. The estimated expense in current dollars was $249,000. In 1992, in another part of the watershed where sediment collects, a grower spent about $5,000 per acre to remove sediment from a small orchard.

3.10 Water Quality Contaminant Concerns

Though there are many documented benefits associated with the use of pesticides, these same chemicals may cause impairments to surface and ground water bodies. The types of pesticides found in the water of the Calleguas Creek Watershed are particularly resistant to degradation and may persist and accumulate in aquatic systems. These pesticides generally sorb to sediment and are carried along with the sediment. Mugu Lagoon, Calleguas Creek, and Revolon Slough have been classified as impaired water bodies by the State of California due to high levels of pesticides being found in the sediment and fish tissue of these surface water bodies.

DDT was declared to be an environmental hazard due to its long residual life and accumulation properties in food chains where it is detrimental to certain forms of wildlife. Though banned in 1973, DDT is still showing up in water bodies such as Mugu Lagoon and its tributaries.

Dieldrin, toxaphene and chlordane are toxic to fish and are also found in the waters of this study area. Most agricultural uses of chlordane were cancelled by US EPA. Most registered uses for toxaphene were cancelled by US EPA in 1983, but until then it was the most used single insecticide in agriculture. Toxaphene is very persistent in soil and is the most toxic to fish of the three pesticides.

Levels of DDT and toxaphene in the tissue of fish taken from Mugu Lagoon, Calleguas Creek, and Revolon Slough exceed the National Academy of Sciences guidelines. Mugu Lagoon received its impaired classification in part due to the elevated levels of pesticides found in the fish and shellfish in the lagoon's waters.

Also found in these surface water bodies is a high total dissolved solids content and ions capable of forming salts harmful for irrigation, aquatic life and drinking water. Some test results show levels of sulfate eight times higher than recommended for the beneficial uses.

Levels of PCBs two times higher than the state water quality objective have been detected in Calleguas Creek and Revolon Slough. The exact source of the PCBs is unknown but there is speculation that PCBs found in the lagoon itself may have come from past military activities.

Nitrate has been detected at concentrations over the allowed maximum limit and at least two of the groundwater bodies in the area have been impaired by nitrate. These various contaminants affect the designated beneficial uses of the water bodies. Table 3-i illustrates the effects of these substances on the beneficial uses.

Table 3-i: Effects of Contaminants on Beneficial Uses

Primary Beneficial Uses [1]	Pesticides	Sodium	Calcium	Sulfate	Nitrate	Chloride	TDS
AGR		May be toxic to plants. When in irrigation water, causes leaf burn, impairs soil intake.	Desirable in irrigation water. Needed for plant growth and for soil tilth.	Levels over 1000 mg/l may be toxic and unsuitable to plants.	Excess tends to reduce intake, but generally desirable for fertilizing value.	May be toxic, may be harmful to crops.	High salinities
MUN	Presence above certain levels may be harmful	In excess, may be harmful to people suffering from cardiac, renal or circulatory disease.	Extreme levels may cause kidney and bladder stones. Causes crusting on utensils and water heaters.	Has laxative effect. Causes bad taste in water.	Excess causes irritation of bladder and GI tract. Can cause death in infants.	Usually restricted due to decrease in water palatability. Imparts salty taste.	Has laxative effect. Does not quench thirst.
GWR	Presence above certain levels may be harmful	Same as AGR and MUN.	Same as AGR and MUN.	Same as AGR and MUN.	Same as AGR and MUN.	Same as AGR and MUN.	Same as AGR and MUN.
WARM, WILD, REC	Toxic to aquatic life. Bioaccumulates.	High levels of sodium sulfate salts result in fish mortality.	High levels of some salts are toxic to fish.	Sodium and Calcium sulfates are toxic to fish.	Stimulates plant growth so may increase food supply. Extreme levels cause too much algae and reduces dissolved oxygen.	Mixtures of chlorides and salts must be evaluated separately. Cannot generalize.	Fish may slowly adapt to high salinities. TDS may reduce toxicity of heavy metals and organic compounds.

[1] Refer to Section 2 for definition of beneficial uses.

Generally, the source of these water quality concerns can be categorized as either agriculture or urban.

Agricultural Sources: With close to 100,000 acres of irrigated farmland in the county, runoff from fields and orchards is finding its way into surface channels and eventually the ocean. Agricultural runoff is recognized as a nonpoint pollution source due to the pesticides and fertilizers carried with sediment from farm land to receiving water bodies. Contaminated runoff can degrade ground as well as surface water.

A 1982 study by the Soil Conservation Service concluded that possible sources of the nonpoint pollution included overapplication of nitrogen fertilizers, overapplication of irrigation water, and sedimentation and leaching of salts, pesticides, and herbicides. The use of too much irrigation water or the effect of precipitation hitting bare ground increases erosion, sediment, and levels of total dissolved solids. Unabsorbed water runs off site, carrying sediment, pesticides, and fertilizers. Too much water causes soil constituents and minerals to leach out of the soil. This has been cited as one of the causes for the high levels of sodium, calcium, magnesium, chloride, and sulfate found in the drainage area.

The July 1993 Draft Ventura County Water Management Plan concludes that "agricultural runoff appears to be one of the most significant sources of pollution to Mugu Lagoon, a vital and rare wetland. Agricultural runoff also poses potential degradation to Ventura County's limited water resources, specifically groundwater resources which can be threatened by the percolation of agricultural runoff into underground aquifers."

There has been an increase in horse boarding and training facilities and some sand and gravel operations. The horse facilities are frequently located directly on the creeks with the animals having access to the stream channel and manure often being found piled in the creek. It is likely that the number of horse boarding facilities will continue to expand in this watershed. As a result, water quality concerns relating to horse operations may also increase.

A large scale poultry ranch is located in the watershed and the manure produced is used locally to fertilize vegetable crops. Agricultural tailwater ditches and urban storm drains discharge into the surface streams.

Urban Sources: In recent years studies have indicated that in most urbanized areas urban stormwater runoff is one of the most significant sources of water pollution. Two of the major pollutants found in urban runoff are sediment and nutrients. For instance, a study by the Aquatic Habitat Institute suggests that urban runoff accounts for one-third of the PCBs found in San Francisco Bay.

It is unknown at this time how much of the overall water quality problem in Mugu Lagoon may be due to urban influences. Besides urban runoff through storm drains, there are urban wastewater treatment plants in the watershed contributing flow to the stream channels. In addition, many of the areas on septic systems in the past which had been identified as failing on a regular basis or causing some degree of off-site pollution have now been sewered.

Pesticides have been commonly used along the streambanks and in the urban setting as well. Streambanks show little sign of vegetation and even streets and sidewalks in the cities are frequently sprayed with an herbicide to eliminate weeds. It is not known what specific pesticides are used.

The 208 Water Quality Plan adopted by Ventura County in 1980 did not find a significant countywide problem with urban stormwater runoff. When the plan was prepared, a small portion of the total drainage area of the county was urban. The recent update of the 208 Water Quality Plan notes that, since that time, urban areas have increased and urban runoff is now considered one of the most significant sources of water pollution.

3.11 Addressing Water Quality Issues

Many of the pesticides found in the surface water of the Calleguas Creek Watershed have been banned for some time and are the result of past agricultural use. It is unknown exactly when the contaminated sediments found their way into the stream system or where they originated from. Generally pesticides will attach themselves to the smaller soil particles rather than sand type particles. The best solution to reduce these pesticides from the surface water bodies is to keep the soil in place and prevent it from eroding into the water bodies.

Of concern in the future may be the effect of urbanization on the watershed's water bodies. Increases in sediment occur during construction, but once developed erosion from urbanized areas is lower than other land uses. Increased nutrients, bacteria, oil and grease, trace metals, and temperature changes are the most common water quality results of urbanization. Continued decrease in aquatic species diversity and numbers are also common. Minimizing these effects in the future as the population of cities such as Moorpark, Simi Valley, Thousand Oaks, and Camarillo continues to expand will remain a challenge.

3.12 Habitat Issues

Aerial photos of the Calleguas Creek Watershed from the early 1950s display that significant habitat alteration had taken place by then. Many of the stream channels in the upper watershed were already channelized and stripped of vegetation.

Within the watershed, areas of oak savanna and chaparral have been almost completely lost and replaced with annual grassland, agriculture, and urban areas. Proportions of each habitat type are displayed in Figure 3-e. Most of the "natural habitat" is now coastal scrub.

According to the NRCS habitat map developed for this study, at least fifty percent of the stream channels in the watershed have been altered in some fashion, which accounts for the severe loss of wetland and riparian vegetation. Less than 0.2 percent of the watershed is riparian habitat.

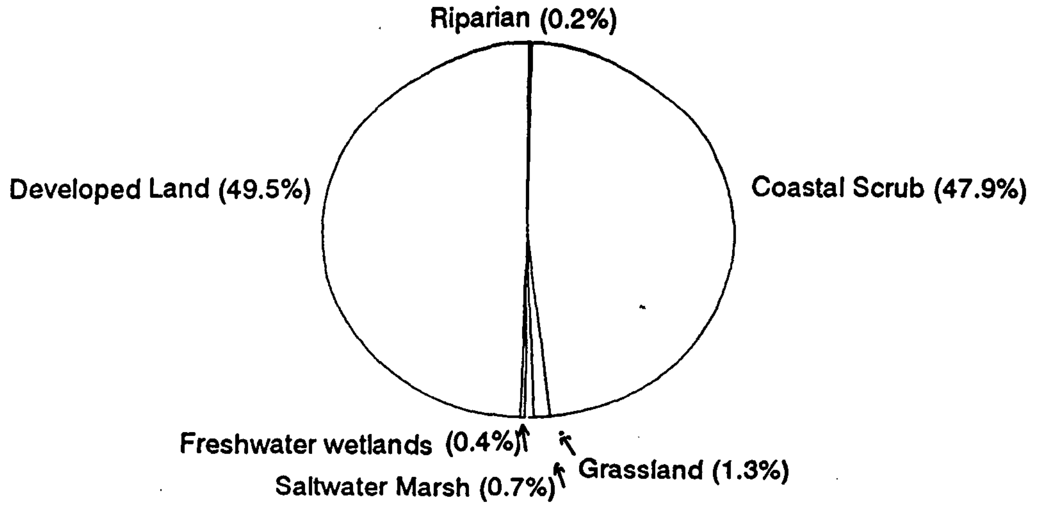


Figure 3-e: Habitat Type Distribution

Overall, the oak woodlands, oak savannas and wetland habitats were the areas developed into urban and agricultural land (flat, fertile ground). This trend is not unique to this watershed; it is seen throughout the state.

Since the mid 1900s, Mugu Lagoon has been dredged periodically which has resulted in deep areas refilling with sediment. This "hydraulic dredge cycle" many times results in areas of high turbidity, constantly shifting sediments and limiting primary production (basis of food chain) (Odum, 1970). The current habitats may not be the most natural but do provide quality habitat for threatened and endangered species. Therefore, it appears that it is desirable to manage for the present conditions (briefly described in current conditions section) that exist in Mugu Lagoon.

U.S. Navy biologists report nine listed endangered species, five threatened species, four candidate 1 species, twenty-six candidate 2 species, and thirty-eight species of special concern in the Mugu Lagoon area. Excessive sedimentation of the lagoon would result in a loss of habitat necessary for the survival and reproduction of these species. Filling of the lagoon would reduce tidal flushing which degrades the affected wetland. Tidal flushing is essential to the establishment of a broad spectrum of substrates, produces a wide variety of exposure-inundation regimes, assures marine influence (physical and biological inputs), moves around material necessary for productivity, and removes wastes that may accumulate to harmful levels (Onuf, 1987).

Another problem associated with sediment to Mugu Lagoon is the mobilization of sediment-attached contaminants (see discussion in water quality section) that may affect fish and wildlife directly or indirectly through the food chain.

Riparian and wetland plant communities are natural filters for trapping fine sediment and contaminants. Present vegetative management practices require the use of pesticides, herbicides, and mechanical equipment to control these vital riparian and wetland plant communities. These practices combined with high contaminant levels in the water have also negatively impacted the freshwater aquatic habitat which once supported a variety of fish and amphibians.

The outflow (including sediments) from Mugu Lagoon has the potential to negatively impact the marine habitat Area of Special Biological Significance with various contaminants associated with agriculture and urbanization, such as sediment, septic tank leachate, freshwater outflow, and pesticides.

3.13 Addressing Habitat Issues

The habitats most impacted by changes in land use in the watershed (past and possibly in the future) are: riparian, oak woodland, oak savanna, freshwater wetland, freshwater aquatic, salt marsh, and estuarine.

Remnants of these habitats are found in the southeastern portion of the watershed. Most of the native vegetation in the western portion of the watershed has been replaced with orchard and cropland, urban uses, or removed as channel modifications were completed.

An area that is an important refuge of the native plants and animals of the region is located northwest of Thousand Oaks in the Wildwood-Mountclef Park. This area contains relatively undisturbed grassland, coastal sage scrub, and mixed riparian vegetation types. Wildlife is abundant and includes some species of concern to both state and federal agencies.

3.14 Previous and Ongoing Efforts to Manage Resource Problems/Opportunities

There has been a long history of efforts to reduce the problems associated with flooding and sedimentation in the Calleguas Creek Watershed. Following is a summary of this history.

As documented in the Soil Conservation Service Watershed Plan (USDA-SCS, 1954), the Corps of Engineers Flood Control Survey Report of 1942 noted that there was no definite channel below Highway 101 just below Camarillo until the 1880s when local residents initiated the development of a straight and defined channel for the water to outlet into the ocean. In the 1920s a drainage district was formed to establish and maintain a drainage system for the Oxnard Plain. The Revolon Slough was constructed as the main drainage channel and landowners began installing their own on-farm tile drain systems.

Beginning in the 1930s, the watershed benefitted from the operation of a soil conservation demonstration project and other government programs. In the 1940s conservation districts were formed to more effectively work throughout the watershed. The Ventura County Flood Control District, state and county highway agencies, and the railroad company also were very active and by the 1950s more than $2.3 million (1954 dollars) in channel improvement work had been completed (USDA-SCS, 1954).

In 1954, the SCS completed a study that investigated the resource problems throughout the watershed and identified structural and land treatment measures to reduce flood damages and conserve the soil and water resources. The plan identified the need for over a hundred sediment control structures, miles of stream channel improvement, and a tremendous amount of land treatment measures including canal lining, range management practices, and on-farm sediment basins. Due to cost constraints, this plan was scaled back in 1958. By 1964, the structural measures identified in the revised plan were installed for an estimated $2.6 million (1964 dollars).

In 1965, the Revolon and Beardsley PL-566 flood control project developed by SCS was authorized by Congress. The project is intended to provide flood control for 38,200 acres through channel work and land treatment measures. Although the primary purpose of the project was to prevent flooding, the sediment reaching the lagoon has also been reduced as a result of upper watershed treatment. The Revolon portion of this project was completed in 1986 and the Beardsley system is projected to be completed by the year 2000. To date, approximately $55 million has been spent to install the necessary measures.

The Ventura County Flood Control District has made significant progress in reducing flooding problems and sedimentation. Many stream improvements and sediment basins have been installed and are being maintained.

Major storm events have also led to major road restoration work. According to the Ventura County Road Maintenance Department, the 1992 flood event resulted in over $500,000 in storm damage repair, storm damage debris removal, and storm protection in the Calleguas Creek Watershed.

The VCFCD has completed a plan for the Arroyo Las Posas reach of the creek. This plan includes the installation of stream stabilization measures and sediment basins at a cost of $5.8 million. This project will stabilize the creek from Upland Road to Hitch Boulevard and significantly reduce the amount of sediment reaching the lagoon. Figure 3-f displays this and other projects as well as areas that have already been modified. The typical channel work is described in Figure 3-g.

The County, Natural Resources Conservation Service (NRCS), and the local communities have taken the initiative to attempt to control erosion from new urban and agriculture development. The county has ordinances such as the grading and hillside erosion control ordinances which require developers to develop an erosion control plan for new construction and have it approved before construction. Depending on jurisdiction, the city or county attempts to ensure that an effective grading plan is developed before any urban construction project is initiated. The county hillside erosion ordinance for new agriculture developments requires landowners that are developing new agriculture lands to develop an erosion control plan. Before the planting takes place, the RCD works with the landowner in developing an erosion control plan to ensure that there will not be significant erosion problems. The NRCS assists the RCD and landowner in the site review and plan preparation.

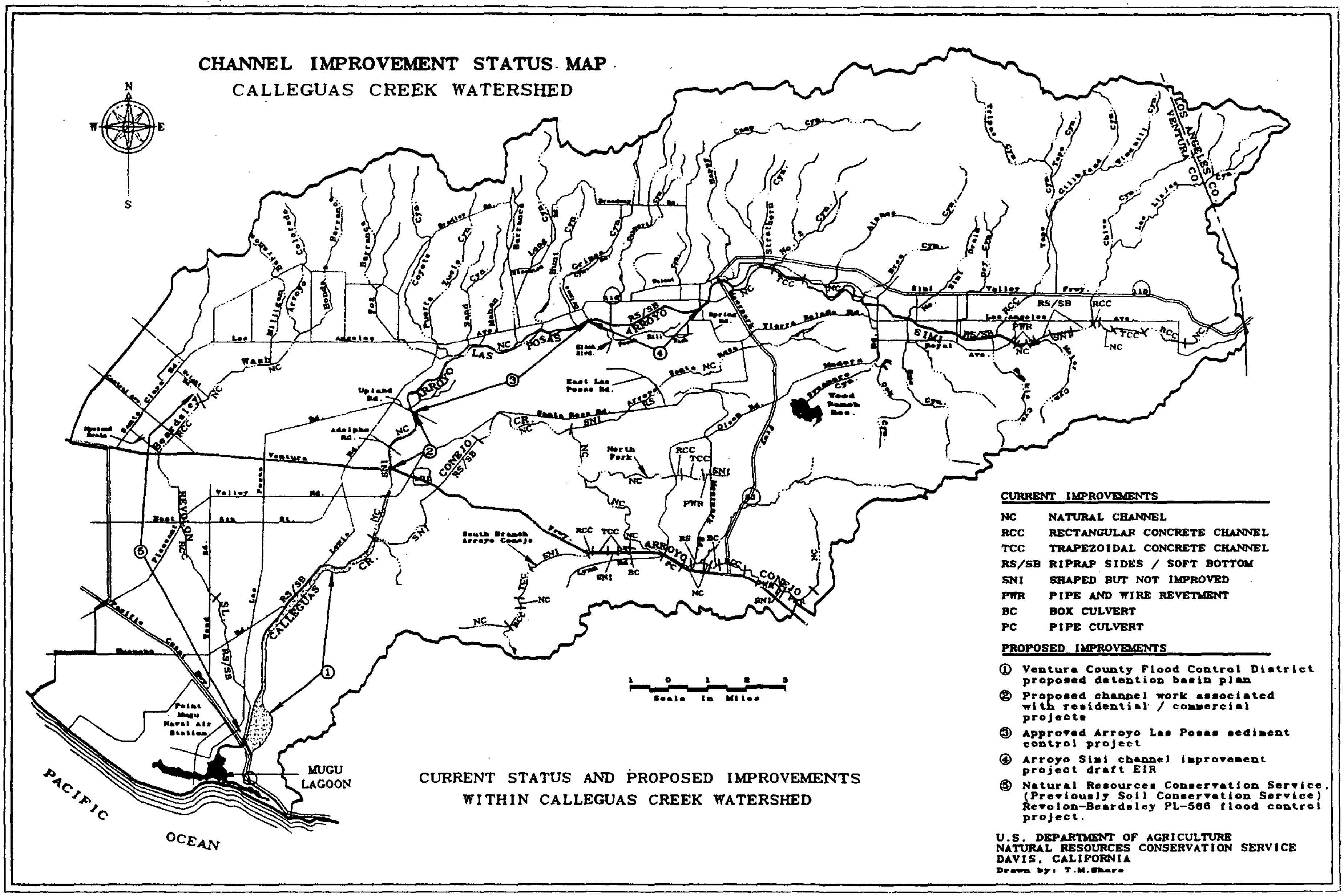
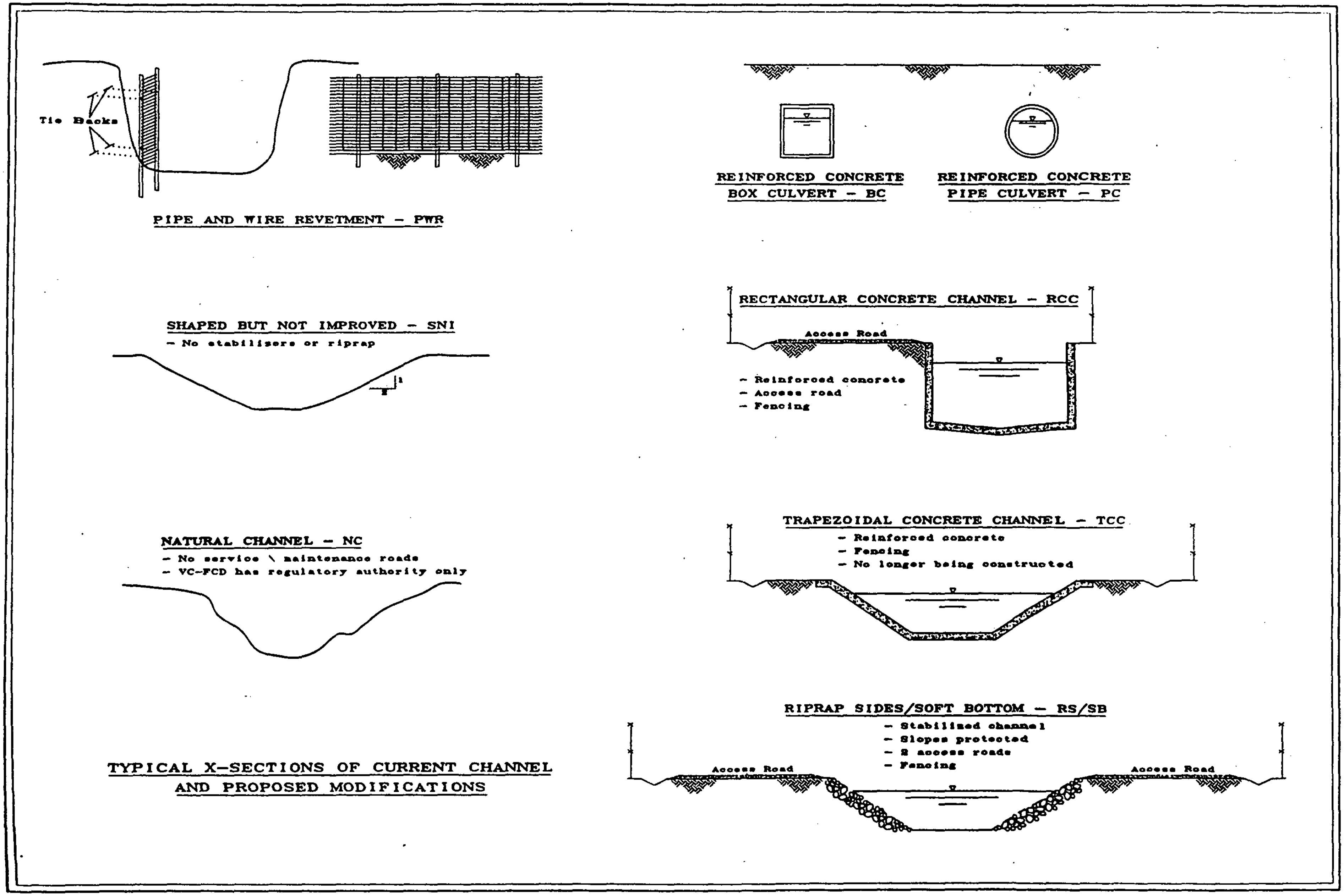

CHANNEL IMPROVEMENT STATUS MAP
CALLEGUAS CREEK WATERSHED
N
S
E
W
CURRENT IMPROVEMENTS
NC NATURAL CHANNEL
RCC RECTANGULAR CONCRETE CHANNEL
TCC TRAPEZOIDAL CONCRETE CHANNEL
RS/SB RIPRAP SIDES / SOFT BOTTOM
SNI SHAPED BUT NOT IMPROVED
PWR PIPE AND WIRE REVETMENT
BC BOX CULVERT
PC PIPE CULVERT
PROPOSED IMPROVEMENTS
① Ventura County Flood Control District proposed detention basin plan
② Proposed channel work associated with residential / commercial projects
③ Approved Arroyo Las Posas sediment control project
④ Arroyo Simi channel improvement project draft EIR
⑤ Natural Resources Conservation Service (Previously Soil Conservation Service) Revolon-Beardsley PL-566 flood control project.
U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
DAVIS, CALIFORNIA
Drawn by: T.M.Share
CURRENT STATUS AND PROPOSED IMPROVEMENTS
WITHIN CALLEGUAS CREEK WATERSHED
1 0 1 2 3
Scale In Miles
PACIFIC
OCEAN
MUGU
LAGOON
Point Mugu Naval Air Station
CALLEGUAS
CR.
CONEJO
ARROYO
LAS POSAS
ARROYO
SIMI
REVOLON
Beardsley
Wash
LOS ANGELES CO.
VENTURA CO.
Wood Ranch Res.
Simi Valley Frwy.
Ventura Frwy.
Pacific Coast Hwy.
South Branch Arroyo Conejo
North Fork
East Las Posas Rd.
Santa Rosa Rd.
Tierra Rejada Rd.
Los Angeles Ave.
Royal Ave.
Upland Rd.
Adolpho Rd.
Valley Rd.
East 5th St.
Hueneme
Pleasant
Lewis
Madera
Olsen Rd.
Moorpark
Somis
Las Posas

Figure 3-1



TYPICAL X-SECTIONS OF CURRENT CHANNEL AND PROPOSED MODIFICATIONS

Figure 3-g

In addition, some land owners have attempted to stabilize stream channel banks and erosion problems on their own. The NRCS field office has consistently worked with many of these people by providing technical assistance. Some financial assistance has been made available through the Consolidated Farm Services Agency (CFSA). The NRCS field office and the Ventura County Resource Conservation District involvement in the region has been extremely valuable in assisting landowners with their resource problems. A recent SCS report (USDA-SCS, 1992) summarizes the successes that SCS/RCD have had in getting resources directed to this region.

Even with all the successful efforts to reduce the resource problems in the Calleguas Creek watershed, additional work requiring financial and technical resources is still needed.

3.15 Forecasted Conditions

Erosion and Sediment:

Urban and rural residential development is expected to continue to expand in the watershed based on the county and city general plans. Soil loss and sediment yield calculations were made for the year 2010 (Table 3-j) and indicate continued sediment problems.

Table 3-j: Soil Loss and Sediment Yield (Tons/Yr) to the Main Channel
Under Buildout Conditions

	1990 SED. YIELD	2010 SOIL LOSS w/o VCFCD PROJ	2010 SED. YIELD w/o VCFCD PROJ	2010 SED. YIELD w/ VCFCD PROJ
TOTAL	412,101	1,134,985	403,890	325,599 [1]

[1] The sediment yield to the main channel would be reduced an additional 57,000 tons/yr if the cleanout of the new VCFCD basins is included (total continuing yield equal to 268,600 tns/yr).

With the installation of the approved VCFCD project along Arroyo Las Posas channel, future conditions are projected to result in a reduction in the annual rate of sedimentation to the lagoon. Additional reduction in sediment will occur with the VCFCD removing sediment from these sediment basins. This project will also limit any increase in streambank erosion due to urbanization because the design of the project accounts for future development.

Flooding:

Flooding problems in the lower reaches of the Calleguas system will continue. In the subwatersheds that experience significant urbanization, the peak flows from smaller storms will increase by as much as 20 percent. This may create more frequent flooding problems.

Water Runoff:

The City of Thousand Oaks, Ventura County, and several water districts have proposed to withdraw about 11,000 acre-feet per year of water from Conejo Creek at Highway 101 to be used for agricultural purposes. If this project is approved, base flows in Calleguas Creek below State Highway 101 would be significantly reduced (approximate base flow, 2 cfs). This project would reduce freshwater to Mugu Lagoon. The Mugu Lagoon hydraulic system would revert toward those that prevailed before wastewater discharges increased freshwater inflows (CH2M Hill, May 1991). This project would have little impact on sediment delivery to Mugu Lagoon because most of the sediment is transported during major storms.

Water Quality:

As urban development continues the quality of surface runoff should change from agricultural-type contaminants to urban based contaminants. Due to the scope and implementation of the National Pollution Discharge Elimination System program, however, many of the typical urban pollutants should be kept to manageable levels.

Habitat Issues:

Future development will continue to replace native plant communities with manmade habitats. The loss of native plant communities and change in habitat diversity may effect threatened and endangered species. In the upper watershed oak savanna, oak woodland, and riparian corridors are the most likely habitat types that will be impacted by land use changes. Channel modifications will further reduce the number of native birds, fish, and amphibians in the watershed. The vital fish and wildlife resources in Mugu Lagoon will continue to be impacted by accelerated erosion, nonpoint source pollution, and possibly freshwater flows. Transport of sediment-attached pollutants to offshore areas may degrade marine species diversity.

4. WATERSHED TREATMENT ALTERNATIVES

4.1 Purpose of Watershed Treatment Alternatives Development Section

In the previous sections resource concerns that impact the Callequas Creek system and Mugu Lagoon were identified and prioritized. The purpose of this section is to describe the potential treatment options to address the priority resource issues. There are currently several projects proposed throughout the Calleguas Creek Watershed that would have some impact on the creek system and lagoon. These proposed projects as well as other potential treatment options will be discussed in this section. A primary purpose of this study is to identify ways to reduce the sediment delivered to the Calleguas Creek system and Mugu Lagoon, therefore, the treatment options that are discussed will focus on addressing this concern. However, other resource concerns have also been identified such as urban water runoff, flooding, water quality, and habitat degradation, so some discussion of treating these concerns is included. This section is divided as follows:

4.2 Current Plans to Address Resource Concerns
4.3 Overview of Treatment Options for Sediment Control
4.4 Urban Water Runoff Treatment Options
4.5 Flood Control
4.6 Water Quality Treatment
4.7 Habitat Enhancement Opportunities

4.2 Current Plans to Address Resource Concerns

Various projects that would have an impact on flooding, sedimentation, and other water quality concerns are currently proposed in the Calleguas Creek Watershed. The types of proposed projects involve the VCFCD and their efforts along the main channel to reduce flooding, as components of urban developments, and to meet the requirements of the NPDES regulations.

The Corps of Engineers completed a study to determine the feasibility of installing large flood/sediment basins just above the Mugu Lagoon to provide flood protection. The local sponsors of that study have determined that a locally funded version of the COE proposal is more viable. As a result, the VCFCD has begun investigating and planning a locally funded flood control project upstream of Highway 1.

The VCFCD has also identified in their 5-year capital projects financing plan the need to spend over $26 million (including the Arroyo Las Posas Project and other portions along the main drainage) for flood and sediment control improvement measures in this watershed. Some of the measures include sediment/flood storage basins, increasing the capacity of certain reaches of the creeks, and enhancing existing improvements.

As with any proposed project, design tradeoffs exist with the proposed VCFCD channel work. Modifications to the Arroyo Las Posas channel work that is about to be constructed, are designed to minimize negative environmental impacts. Other projects, such as the one proposed just below the VCFCD Arroyo Las Posas project and associated with urban development projects, are planned to use more riprap and require channel reconstruction in order to provide the developers with maximum land development, and flood protection. A wider, more natural channel design would require additional right-of-way and thus allow for less land to be developed. In addition, there are uncertainties as to what can be done with the sediment removed from the basins and for what cost. The VCFCD-proposed Arroyo Simi project is designed to improve existing flood control channels that were not designed for urban conditions when they were constructed. The creation of riparian wetland habitat along the channel is included as mitigation.

Overall, the proposed VCFCD flood control measures will provide sediment reduction benefits to the Mugu Lagoon, which is the primary goal of this study. Although portions of the proposed projects will eliminate riparian habitat, mitigation efforts are proposed that will create new wetlands in certain areas. A more natural channel throughout the system will require purchasing right-of-way. The stream channel itself is manmade and any riparian habitat that can be preserved or restored would be beneficial but not as significant as the lagoon itself. The U.S. Fish and Wildlife Service has indicated that enhancement efforts along the stream channels would be beneficial; however, primary attention should be focused on the protection and enhancement of Mugu Lagoon.

There are many proposed residential and commercial developments and road improvements associated with the four major cities in the watershed and, although erosion control measures are required of developers and others, proper timing of implementation of erosion control measures is still a concern. As development occurs there will likely be increased runoff reaching the main stream system which in turn will increase the peak flows by as much as 20 percent. In some cases the developer will be required to retain the runoff onsite. Even with these measures, increased runoff will reach the main channel.

4.3 Overview of Treatment Options for Sediment Control

In this section, different methods of sediment control are discussed and the tradeoffs of the treatment options are described. In order to reduce the sediment yield to the main channel and/or Mugu Lagoon, one or more of these methods of sediment control are required. The types of sediment control fall into the following categories:

1) Treatment of the sediment production regions in the highest contributing priority subwatersheds identified in Section 3 of this report.
2) Treatment of the sediment transport, production, and storage regions associated with the main channel.
3) Sediment trap for controlled storage at the lower end of the main channel.
4) Dredging of Mugu Lagoon in order to remove sediment.

Nearly 55 percent of sediment delivered to the lagoon and main channel is associated with the eleven subwatersheds identified in the previous chapter. These eleven subwatersheds can either be categorized as significant sediment production regions and/or sediment delivery regions. Reducing sediment production or delivery associated with these subwatersheds requires conservation practices that focus on preventing erosion and/or stabilizing or controlling sediment movement.

The impacts of each of the sediment control options are summarized below:

1. Treatment of the sediment production regions in the Highest Contributing Priority Subwatersheds

Nine of the eleven priority subwatersheds are sediment production subwatersheds. They are subwatersheds 2, 5, 6, 7, 8, 9, 13, 21, and 30. Based on the typical land uses and what was observed in these subwatersheds, a list of potentially effective erosion control practices was identified. These practices, either singly or in combination, will reduce erosion and/or sediment delivery. Impacts on other resource issues such as surface water runoff or water quality may also be realized.

Table 4-a shows the general effects of each of the conservation practices on the major land types in the watershed. Each practice is identified as to whether it influences erosion (E), sedimentation (S), excess runoff water (R), or water quality (Q). Table 4-b provides an estimate of the percent effectiveness of practices, as well as a typical installation cost. The purpose of Tables 4-a and 4-b is to provide the reader an understanding of the general practice information used to identify and analyze treatment options for the sediment production areas within these specific subwatersheds.

In these priority subwatersheds, the typical land types that contribute the most to the sediment yield per acre are: new and steeply sloped orchards and their associated roads; streambank erosion; new construction sites; other roads such as county; sheet and rill erosion from the open space/natural land; and sources such as soilslips and gullies.

With the knowledge of these priority sediment contributing land types and where they are located in the Calleguas Creek Watershed, it would be possible to treat them separately. However, there are some concerns with that approach. They are:

a) Such an approach ignores the interrelationship of the causes and sources of sediment within each subwatershed.
b) Many of the long-term solutions require neighbor cooperation and coordination within the same subwatersheds. Improvement on one person's property could result in new problems associated with a neighbor's property if the treatment is not properly coordinated.
c) Treatment measures that are implemented and scattered throughout such a large watershed make it difficult to document reductions in sediment yields.
d) Treatment impacts to other resource issues such as water quality or urban water runoff cannot easily be measured.

Table 4-a: Recommended Practices to Reduce Erosion, Sedimentation and Runoff in the Calleguas Creek Watershed

Page 1 Of 2

	Access Road A. Orchard B. Other (560)	Conserv. Tillage (329)	Contour Farming (330)	Cover Crop (340)	Critical Area Planting (342)	Crop Residue Use (344)	Deferred Grazing (352)	Diversion (362)	Fencing (382)	Filter Strip (393)	Grade Stabilization Structure (410)	Grassed Waterway (412)	Hillside Bench/Terrace (192/600)	Irrigation System Sprinkler, Drip or Trickle (441/442)
Orchards														
-Citrus														
New														
0 to 6% slopes	E,R	E, S, R	E, S, R	E, S, R	E, S	E, S, R		E, S, R		E, S, R, Q	E, S	E, S, R, Q		E, S, R, Q
> 6 % Slopes	E,R	E, S, R	E, S, R	E, S, R	E, S	E, S, R		E, S, R		E, S, R, Q	E, S	E, S, R, Q	E, S, R	E, S, R, Q
Old														
0 to 6% slopes	E,R	E, S, R		E, S, R	E, S	E, S, R		E, S, R		E, S, R, Q	E, S	E, S, R, Q		E, S, R, Q
> 6 % Slopes	E,R	E, S, R		E, S, R	E, S	E, S, R		E, S, R		E, S, R, Q	E, S	E, S, R, Q	E, S, R	E, S, R, Q
-Avocado														
New														
0 to 6% slopes	ER	E, S, R	E, S, R	E, S, R	E, S	E, S, R		E, S, R		E, S, R, Q	E, S	E, S, R, Q		E, S, R, Q
> 6 % Slopes	E,R	E, S, R	E, S, R	E, S, R	E, S	E, S, R		E, S, R		E, S, R, Q	E, S	E, S, R, Q	E, S, R	E, S, R, Q
Old														
0 to 6% slopes	E,R	E, S, R		E, S, R	E, S	E, S, R		E, S, R		E, S, R, Q	E, S	E, S, R, Q		E, S, R, Q
> 6 % Slopes	E,R	E, S, R		E, S, R	E, S	E, S, R		E, S, R		E, S, R, Q	E, S	E, S, R, Q	E, S, R	E, S, R, Q
Orchard Roads														
Steep Paved (>7%)	E,R				E, S						E, S		E, S, R	
Flat Paved					E, S									
Steep Unpaved (>7%)	E,R				E, S						E, S		E, S, R	
Flat Unpaved	E,R				E, S									
Pasture	E,R				E, S		E, S, R, Q		E, S		E, S			E, S, R, Q
Confined Animals					E, S		E, S, R, Q	E, S, R	E, S	E, S, R, Q	E, S			
Urban	E,R							R		R, Q	E, S		E, S, R	R
Rural Residential	E,R	E, S, R			E, S			E, S, R		E, S, R	E, S	E, S, R, Q	E, S, R	E, S, R, Q
Field Crops	E,R	E, S, R	E, S, R	E, S, R	E, S	E, S, R		E, S, R		E, S, R, Q	E, S	E, S, R, Q	E, S, R	E, S, R, Q
Natural Areas	E,R				E, S				E, S		E, S			
Other					E, S						E, S			
Mines	E,R				E, S			E, S, R		E, S, Q				
Construction	E,R				E, S			E, S, R		E, S, Q	E, S	E, S, R	E, S, R	
Gullies		E, S	E, S		E, S			E, S				E, S, R		
Streambanks							E, S, R, Q		E, S					
Soil Slips			E, S		E, S			E, S						
Other Roads	E,R				E, S						E, S		E, S, R	
Water			R											

REDUCED PROBLEM
E = EROSION
S = SEDIMENT
R = EXCESS RUNOFF WATER
Q = WATER QUALITY

Table 4-a: Recommended Practices to Reduce Erosion, Sedimentation and Runoff in the Calleguas Creek Watershed

Continued: Page 2 Of 2

	Irrigation Water Conveyance (ditch) (428)	Irrigation Water Management (449)	Irrigation Water Conveyance (pipeline) (430)	Livestock Exclusion (472)	Proper Grazing Use (528)	Runoff Mgt. System (570)	Sediment Basin (350)	Streambank Protection (580)	Stream Corridor Improvement (204)	Underground Outlet (620)	Wildlife Upland Habitat Mgt. (645)	Wildlife Wetland Habitat Mgt. (465)	Ordinances and Education	Operation and Maintenance
Orchards														
-Citrus													E, S, R, Q	E, S, R, Q
New							E, S	E, S			E, Q		E, S, R, Q	E, S, R, Q
0 to 6% slopes		E, S, R, Q	E, S			E, S, R, Q							E, S, R, Q	E, S, R, Q
> 6 % Slopes		E, S, R, Q	E, S			E, S, R, Q			E, S	E, S			E, S, R, Q	E, S, R, Q
Old							E, S	E, S			E, Q		E, S, R, Q	E, S, R, Q
0 to 6% slopes		E, S, R, Q	E, S			E, S, R, Q							E, S, R, Q	E, S, R, Q
> 6 % Slopes		E, S, R, Q	E, S			E, S, R, Q			E, S	E, S			E, S, R, Q	E, S, R, Q
-Avocado													E, S, R, Q	E, S, R, Q
New							E, S	E, S			E, Q		E, S, R, Q	E, S, R, Q
0 to 6% slopes		E, S, R, Q	E, S			E, S, R, Q							E, S, R, Q	E, S, R, Q
> 6 % Slopes		E, S, R, Q				E, S, R, Q				E, S			E, S, R, Q	E, S, R, Q
Old			E, S				E, S	E, S			E, Q		E, S, R, Q	E, S, R, Q
0 to 6% slopes		E, S, R, Q	E, S			E, S, R, Q							E, S, R, Q	E, S, R, Q
> 6 % Slopes		E, S, R, Q				E, S, R, Q				E, S			E, S, R, Q	E, S, R, Q
Orchard Roads										E, S			E, S, R, Q	E, S, R, Q
Steep Paved (>7%)						E, S, R, Q							E, S, R, Q	E, S, R, Q
Flat Paved													E, S, R, Q	E, S, R, Q
Steep Unpaved (>7%)						E, S, R, Q							E, S, R, Q	E, S, R, Q
Flat Unpaved													E, S, R, Q	E, S, R, Q
Pasture	E, S	E, S, R, Q	E, S	E, S, R	E, S, R	E, S, R, Q		E, S	E, S		E, Q		E, S, R, Q	E, S, R, Q
Confined Animals	E, S		E, S	E, S, R, Q	E, S, R	E, S, R, Q		E, S	E, S	E, S			E, S, R, Q	E, S, R, Q
Urban		R				E, S, R, Q	E, S	E, S	E, S	E, S	E, Q		E, S, R, Q	E, S, R, Q
Rural Residential		E, S, R, Q				E, S, R, Q	E, S	E, S	E, S	E, S	E, Q		E, S, R, Q	E, S, R, Q
Field Crops	E, S	E, S, R, Q	E, S			E, S, R, Q	E, S	E, S	E, S	E, S	E, Q		E, S, R, Q	E, S, R, Q
Natural Areas				E, S, R	E, S, R	E, S, R, Q		E, S	E, S		E, Q		E, S, R, Q	E, S, R, Q
Other								E, S	E, S		E, Q		E, S, R, Q	E, S, R, Q
Mines						E, S, R, Q	E, S	E, S	E, S	E, S	E, Q		E, S, R, Q	E, S, R, Q
Construction						E, S, R, Q	E, S	E, S	E, S	E, S	E, Q		E, S, R, Q	E, S, R, Q
Gullies													E, S, R, Q	E, S, R, Q
Streambanks				E, S, R, N	E, S, R		E, S	E, S	E, S			E, Q	E, S, R, Q	E, S, R, Q
Soil Slips													E, S, R, Q	E, S, R, Q
Other Roads						E, S, R, Q							E, S, R, Q	E, S, R, Q
Water													E, S, R, Q	E, S, R, Q

REDUCED PROBLEM
E = EROSION
S = SEDIMENT
R = EXCESS RUNOFF WATER
Q = WATER QUALITY

Table 4-b: Typical Practices, Effectiveness, and Cost Range
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Practice	Units	Erosion Control Effectiveness (percent)	Nutrient Mgt. Effectiveness (percent)	Water Mgt. Effectiveness (percent)	Pollution Control Effectiveness (percent)	Sediment Control Effectiveness (percent)	Habitat Improv. Effectiveness (percent)	Cost Range Per Unit	
								low	high
Access Road (560)									
Road Paving	sq yd	95-100					(-20--30)	$2.15	$4.30
Rolling Dips	ea	15-20		55-60			(-20--30)	$15.00	$135.00
Cross-sloping	LF road	15-20		45-55			(-20--30)	$0.75	$3.50
Added R/W	ft. ea side	10-15					(-20--30)	$3.50	$8.00
Water Bars	ea	15-20		55-60			(-20--30)	$5.00	$35.00
Paved Orchards Rds	sq yd	90-95		85-90			(-20--30)	$2.15	$4.30
Paved Drives	sq yd	90-95		55-60			(-20--30)	$1.70	$4.00
Paved Parking	sq yd	90-95		80-85			(-40--80)	$0.85	$1.95
Curb & Gutter	LF	10-15		80-85			(-5--20)	$1.85	$4.15
Conservation Tillage (329)									
No Till	acre	5-25	5-10	5-10		10-15		($10)	$5.00
Mulch Till	acre	10-35	5-10	5-15		10-15		$10.00	$20.00
Contour Farming (330)	acre	15-20	5-10	5-10	0-5	5-10		$8.00	$100.00
Contour Orchard and Other Fruit Area (331)	acre	15-20	5-10	5-10	0-5	5-10		$100.00	$130.00
Cover and Green Manure Crop (340)									
Cover Crop (between rows)	acre	10-20				5-10	5-10	$10.00	$230.00
Erosion Control Planting	acre	30-35				10-20	5-35	$425.00	$1,700.00
Summer Filter Strip or Travelway Protection	acre	5-10				5-10		$60.00	$150.00
Cover Crop (area)	acre	30-35				15-25	5-35	$100.00	$230.00
Critical Area Planting (342)									
Erosion Control Planting	acre	25-30			3-5	5-10	5-15	$425.00	$1,700.00
Landscaping	acre	30-35			5-10	15-20	15-20	$450.00	$3,500.00
Crop Residue Use (344)									
Chopping and Chopping Waste	acre	15-25	5-10	5-10		5-0		$25.00	$60.00
Mulching using min. Tillage	acre	15-25	10-15	5-10		5-15		$10.00	$25.00
Deferred Grazing (352)	acre	15-30	2-5			5-10		$1.00	$8.00
Diversion (362)									
Diversion (earth ditch)	LF	15-45		75-85				$0.65	$6.50
Lined ditch	LF	85-90		80-85			(-10--20)	$3.50	$65.00
Fencing (382)	acre	(2)	(2)			(2)		$340.00	$1,360.00
Filter Strip (393)									
Filter Strip (10-20 ft wide)	acre	40-65	5-10		2-10	15-20	5-20	$375	$12,500
Filter Strip (20-40 ft wide)	acre	45-70	5-15		5-15	20-35	5-25	$375	$12,500
Filter Strip (40-60 ft wide)	acre	60-85	10-25		10-25	30-60	5-25	$375	$12,500
Buffer Strip (20-30 ft wide)	acre	40-65	10-20		10-20	25-60	15-45	$425	$1,700
Landscaping (20-30 ft wide)	acre	35-60	5-15		5-15	15-35	5-25	$450	$3,500
Grade Stabilization Structure (410)									
Ditch Grade Stabilizers	ea	15-35		20-55		5-20		$125	$12,500
Drop Structure	ea	15-45		20-40		15-45		$750	$250,000
Sills	ea	5-25		10-15		5-20		$125	$6,000
Ford	ea	10-30		10-40		5-20		$7,500	$160,000
Earth formed; outdoor		30-40 (1)	20-25			5-10 (2)		$15	$75
Carpet or filter fabric or wood fiber matting cover									
Steel Sheet		30-40 (1)		20-25		5-10 (2)		$100	$130
Rock Riprap		30-40 (1)		25-30		5-10 (2)		$35	$150
Straw Bales		30-40 (1)		25-30		5-10 (2)		$15	$60
Sandbags		30-40 (1)		25-30		5-10 (2)		$20	$80
Silt Fence		20-35 (1)		15-25		10-15 (2)		$70	$350
Grassed Waterway (412)	acre	30-45	5-10	80-85	5-15	5-20	5-20	$375	$12,500
Hillside Bench (192)	acre	20-60	5-10	10-15		10-40		$35.00	$1,850.00
Irrigation System: Sprinkler (442)	acre	15-30	15-25	40-65	15-20			$350.00	$1,100.00
Irrigation System: Trickle (441)									
Microspray System	acre	35-40	20-25	60-85	25-35			$850.00	$3,200.00
Drip Irrigation	acre	40-45	30-35	70-85	25-35			$1,850.00	$3,600.00
Irrigation System Tailwater Recovery (447)	ea		5-15	40-45	5-10	5-35		$4,500.00	$25,000.00
Irrigation Water Conveyance Lined Ditch (428)	per foot	85-90 (3)		80-85			(10-20)	$7.50	$140.00
Irrigation Water Conveyance Pipeline (430)	per foot	85-90 (3)		85-90				$6.00	$25.00
Irrigation Water Management (449)	acre	15-45	20-35	45-60	15-35			$50.00	$750.00
Livestock Exclusion (472)	LF	35-40			50-65		45-55	$0.65	$7.50

Table 4-b: Typical Practices, Effectiveness, and Cost Range
Continued: Page 2 of 2

Practice	Units	Erosion Control Effectiveness (percent)	Nutrient Mgt. Effectiveness (percent)	Water Mgt. Effectiveness (percent)	Pollution Control Effectiveness (percent)	Sediment Control Effectiveness (percent)	Habitat Improv. Effectiveness (percent)	Cost Range Unit Cost	
								low	high
Proper Grazing Use (528)	acre	10-20				5-15	5-10	$1.00	$5.00
Runoff Management System (570)									
Sediment Basin (350)	each			5-70	5-15	(5)-100 (4)	(3-10) (5)	$700	$1,000,000
Infiltration Trench	per foot			5-10	(5-10)	5-10		$15	$75
Parking Lot Water Retention	each			5-10	(5-10)	5-10		$150	$1,500
Rooftop Storage	sq. ft. roof			5-10				$3	$45
Underground Tanks	each			5-10				$1,500	$17,500
Filter Strips	acre	45-70 (1)	5-15		5-15	20-35	5-25	$375	$12,500
Sediment Trap, Box Inlet	each			0-2	0-5	5-15		$185	$850
Filter Trap	acre	60-85 (1)	10-25		10-25	30-60	5-25	$375	$12,500
Sediment Basin (350)	each			5-70	5-15	-5-100(4)	(3-10)(5)	$700	$1,000,000
Streambank and Shoreline Prot. (580)									
Erosion Control Planting	acre	30-35					5-35	$425	$1,700
Rock Riprap Revetment	foot	25-50					5-10	$40	$375
Stream Corridor Improvement (204)	acre	20-35		60-75	5-15		5-35	$700	$5,500
Underground Outlet (620)									
Culvert	LF	45-70		75-85				$6	$160
Culvert Inlet	ea	15-30		60-75				$115	$1,500
Culvert Outlet	ea	40-60		35-40				$85	$2,600
Drop Inlet Box	ea			60-75				$240	$1,450
Drop Inlet w/sed. stor	ea			60-75		2-10		$650	$3,100
Down Drain	LF	45-65		60-75				$4.50	$85.00
Storm Drain	LF	45-65		75-85				$6.00	$160.00
Storm Drain Inlet	ea			60-75				$450	$2,100
Wildlife Upland Habitat Mgt. (645)	acre	5-10	0-5		0-5	10-15	10-50	$15	$280
Wildlife Wetland Habitat Mgt. (644)	acre		0-10	5-20	5-10	5-30	10-50	$5	$750

Footnotes for Table:

1. Access Road-cut and fill slopes erode at original rates after construction period.
2. With added Right-of-Way bank stability would be increased 40%+ per year.
3. Mainly for bank stability.
4. Sediment reduction depends on basin size, flow, construction, maintenance, and residence time.
5. Habitat improvement depends on "wetlands" that may develop.

For sediment production sources such as those in the priority subwatersheds in the Calleguas Creek Watershed, it is more appropriate to address the resource concerns on a subwatershed basis. This will insure that the interrelationship of all of the resource problems will be considered. It will also provide the opportunity to include all land operators in the development of solutions to the identified problems in the subwatershed. See Appendix A for additional discussion of the watershed approach.

Treatment of Grimes Canyon - An Example: Grimes Canyon (#9) is one of the nine subwatersheds that has been identified as needing measures to reduce sediment production. If it is determined that treatment of these sediment production subwatersheds is an effective component of reducing sediment reaching Mugu Lagoon, then Grimes Canyon would be a good subwatershed to start with. This is because the typical land uses in all of the nine subwatersheds are present in Grimes Canyon, the sediment yield is significant, and there is some indication of land operator interest.

Based on these reasons, the Grimes Canyon subwatershed was chosen to be analyzed in further detail in order to demonstrate the impacts of treatment. This same process could then be followed in the other priority subwatersheds. Although sedimentation is the focus of this study, other resource issues will also be considered in this analysis. It should be remembered that at the time implementation occurs each priority subwatershed will need to be analyzed separately.

Table 4-c shows that sedimentation rates in Grimes Canyon have changed over time. As agriculture replaced the natural vegetation in the area, sedimentation rates have increased. These high sedimentation rates are projected to continue into the future as well.

There are four main sediment contributing sources in the Grimes Canyon subwatershed. They are orchards and associated roads, streambanks, other roads not associated with orchards, and new construction. Therefore, the treatment of the entire subwatershed will focus on these priority sediment sources.

Based on the major sediment contributing sources in the Grimes Canyon watershed, certain treatment options were identified. Practices that were identified include: sediment basins, water management, bank protection, grade stabilization, road improvements, critical area planting, cover crops, filter strips, riparian corridor planting, education, and enforcement of ordinances.

Based on the acres or miles of each land type that needs treatment, a maximum potential amount of each practice that could be installed in the watershed was estimated. This information is then used to estimate the maximum sediment reduction that is possible as well as an estimate of other resource impacts. Appendix C provides information about these practices and how the necessary quantities of each practice in the subwatershed were determined. A map of Grimes Canyon subwatershed that delineates the treatment areas is also included in Appendix C (Figure C-2).

Table 4-d is a summary of the net impacts if each of the treatment measures were implemented. More complete information on the impacts of each practice is included in Appendix C.

Table 4-c: Sources of Erosion and Estimated Sediment Yield for Different Periods in Grimes Canyon (#9)

Time Period/ Erosion Sources	Grimes Canyon Sediment Yield (tons/year)	Total
Native American Period:		
Oak Woodland	41	
Gullies	123	
Streambanks	701	
Soilslips	527	
		1,392
Spanish/Mexican Period:		
Scrub/grass	453	
Gullies	173	
Streambanks	934	
Soilslips	737	
		2,297
Expansion of Agriculture (1932):		
Orchards	1,311	
Beans	1,806	
Field Crops	29	
Natural Area	2,275	
Gullies	720	
Streambanks	4,471	
Soilslips	1,264	
Other Roads	2,084	
		13,960
Current Period:		
Orchards	5,348	
Confined Animals	32	
Rural Resident.	12	
Field Crops	244	
Natural Area	565	
Construction	1,920	
Gullies	720	
Streambanks	2,981	
Soilslips	1,264	
Other Roads	2,084	
Urban		
		15,170
Buildout Conditions:		
Orchards	5,348	
Confined Animals	32	
Rural Resident.	51	
Field Crops	244	
Natural Area	511	
Construction	120	
Gullies	720	
Streambanks	3,167	
Soilslips	1,264	
Other Roads	2,084	
Urban		
		13,541

Table 4-d: Summary of Practice Net Impacts on the High Priority Erosion Sources--Grimes Canyon

Subwatershed: Grimes Canyon

Treatment Impacts	Sediment Basin Net Change 1/	Grade Stab. Natural Net Change	Grade Stab. Replant Orch. Net Change	Grade Stab Riparian Net Change	Other Roads Net Change	Bank Protection Net Change	Orchard Drainage Net Change	Orchard Cover Crop(Zorro) Net Change	Orchard Cover Crop(Blando) Net Change	Filter Strip (Zorro) Net Change	Filter Strip (Blando) Net Change
a. Install. Cost ($)(includes land cost, if any)	$470,000	$1,250,000	$1,819,000	$2,025,600	$2,530,000	$20,400	$3,898,000	$132,200	$79,800	$2,600	$1,600
Life of Practice (yrs)	50	50	50	50	50	20	20	20	20	20	20
Avg. Ann. Install. Cost($/year) =	$37,000	$98,400	$143,000	$159,500	$199,200	$1,050	$397,000	$23,650	$8,000	$260	$165
b. Project Maintenance Cost ($/year) =	$92,000	$37,000	$37,000	$37,000	$0	$200	$78,900	$46,700	$38,800	$890	$750
Total Avg. Annual Cost=	$129,000	$135,400	$180,000	$196,500	$199,200	$1,250	$475,900	$70,350	$46,800	$1,150	$915
c. Erosion (tons/year)	0	-500	-2900	-4200	-3000	-2900	-2800	-3450	-3450	0	0
d. Sediment(tons/year)	-12200	-7700	-7600	-8300	-1500	-1800	-1400	-1090	-1090	-400	-400
Washload (tons)	-4600	-100	-700	-1300	-750	-800	-600	-540	-540	-100	-100
Bedload (tons)	-7600	-7600	-6900	-7000	-750	-1000	-800	-550	-550	-300	-300
Avg. Ann. Cost Per Ton of Sed. Reduction	$11	$18	$24	$24	$133	$1	$340	$65	$43	$3	$2
Avg. Ann. Cost Per Ton of Washload Reduct	$28	$1,354	$257	$151	$266	$2	$793	$130	$87	$12	$9
Avg. Ann. Cost Per Ton of Bedload Reduct.	$17	$18	$26	$28	$266	$1	$595	$128	$85	$4	$3
e.1 Crop Land Acres Required for. Project	10.5	28	17 replanted	19	0	0	0	0	0	0	0
e.2 Crop land (change in lost acres from eros.)	0	0	-0.04	-0.04	0	-0.04	0	0	0	0	0
f. Crop Yields, any sign. impact? (+,-,0)	0	0	0	0	0	0	0	0	0	0	0
g. Effect on Lagoon Habitat(+,-,0)	+	0	0	+	0	+	0	0	0	0	0
h. Onsite Hab. Value(WHR)&(+ or - change)	(112) +44	(121) +16	(70) -32	(111) +10	n/a	(116) +10	(84) +34	(79) +9	(78) +7	(69) +13	(69) +13
i. Water Quality(qual. +,-,0)	+	+	+/-	+	+/-	+	+	+	+	+	+
j. Water Runoff 100-yr Peak(cfs),below project	0	0	0	0	0	0	0	-50	-50	0	0
Erosion, Sediment, Flood Damage, Expense:											
k. On-farm Land Damage(erosion)($/year)	$0	$0	$0	$0	$0	$0	($18,000)	($13,300)	($13,300)	($2,000)	($2,000)
l. On-farm Road Dam(eros./flood)($/year)	$0	$0	$0	$0	$0	$0	($34,200)	($3,800)	($3,800)	($3,800)	($3,800)
m. On-farm equip. Damage(erosion)($/year)	$0	$0	$0	$0	$0	$0	($24,200)	($18,800)	($18,800)	($2,700)	($2,700)
n. County Road Damage(flood)($/year)	$0	($9,000)	($9,000)	($9,000)	($13,500)	($3,000)	($1,500)	$0	$0	$0	$0
o. On-farm Land Protect. Expense(flood)($/yr)	($400)	($2,400)	($2,400)	($2,400)	$0	($2,400)	$0	$0	$0	$0	$0
p. Stream Restoration Expense(flood)($/year) & Existing Structure Repair Cost(flood)($/year)	($600)	($5,700)	($5,700)	($5,700)	$0	($1,200)	$0	$0	$0	$0	$0
q. Change in County Road Maintenance	n/a	n/a	n/a	n/a	($90,000)	n/a	n/a	n/a	n/a	n/a	n/a
r. Change in Total Damage:	($1,000)	($17,100)	($17,100)	($17,100)	($103,500)	($6,600)	($77,900)	($35,900)	($35,900)	($8,500)	($8,500)
s. Management Skills Required (more, less, same)	same	more	more	more	same	more	less	more	more	more	more

1/ Sediment disposal cost will vary significantly cepending on the available disposal options.

Table 4-d shows that the overall objective(s) of treatment will determine what practices are the most appropriate. For example, if the goal is solely to maximize sediment control, then certain practices such as the sediment basin in the lower subwatershed will be most appropriate. If the goal is sediment reduction and the lowering of on-farm erosion and flood damages, then stream channel improvements with on-farm drainage improvements may be more appropriate.

Table 4-e summarizes the major potential combinations of treatments identified in this study for the Grimes Canyon subwatershed. Each of these treatment combinations will lead to significantly different results. Therefore, before a treatment plan for a subwatershed can be developed, all interested parties must agree on the treatment objective(s). This can only be done after significant coordination and communication among the interested parties.

Table 4-e: Grimes Canyon Sediment Sources
and Treatment Measure Combinations to be Considered.

Sediment Source	Treatment Measure Combinations
Orchard & Orchard Roads	1. Orchard drainage improvements including orchard road work, cover crops, and proper maintenance.
	2. Orchard drainage improvements including orchard road work, filter strips, and proper maintenance.
	3. For new orchards or replanted orchards ensure that contour planting, cover crop, and proper drainage system is included with proper maintenance.
Streambanks	1. Grade stabilization only w/ proper maintenance.
	2. Grade Stabilization, bank reshaping, replant orchards adjacent to stream w/ proper maintenance.
	3. Grade Stabilization, bank reshaping, develop riparian corridor along stream w/ proper maintenance.
	4. Spot bank protection work with proper maintenance.
Other Roads, Ditches	1. Road improvements, critical area treatment, drainage improvements w/ proper maintenance.
New Construction	1. Follow existing ordinances and maintain practices throughout construction period.
All Sediment Sources	1. Debris basin at lower end of watershed with proper maintenance.

Because there are many potential treatment options, it was determined that some criteria were necessary in order to limit the possibilities. Since the primary purpose of this study is to identify sediment reduction possibilities for Mugu Lagoon, the emphasis was placed on the control of sediment washload. Overall, five criteria were chosen based on the potential range of impacts that are possible and summarized in Table 4-d. The criteria are:

Treatment Impacts	Criteria: Based on Table 4-d
Cost/Ton	Maximum $200/ton
Amount washload reduced	Min. reduction 800 tons/yr
Damage reduction	Min. $30,000 reduction
On-site environmental benefits and benefits to lagoon	Lines G and H - both positive
Total sediment reduced	Min. reduction 6,000 tons/yr.

Using these criteria, it was determined that the sediment basin option and grade stabilization structures with the riparian improvement option are top ranked in four out of five of the criteria. The bank protection practice was third, meeting three of the criteria, and the practice of cover crops met two of the criteria.

Further narrowing of options was required in order to demonstrate the type of impacts treatment would have on the lagoon. Two treatment options were developed using these four practices. Option 1 consists of installing a sediment basin at the outlet of the subwatershed. Option 2 is a combination of practices: bank protection, riparian improvements, and cover crops on orchards. While Option 1 effectively prevents sediment from being transported further downstream, Option 2 provides additional on-site erosion reduction benefits.

Grimes Canyon Sediment Basin Option (Option 1): The information summarized in Table 4-e shows that the most effective way to reduce sediment reaching Arroyo Las Posas is the installation of a sediment basin. It has been estimated that a sediment basin will trap 4,600 tons/year of washload and 7,555 tons/year of bedload. The per ton cost to control this amount of sediment is relatively low ($13/ton) compared to other practices.

This practice would not require landowners to modify their management methods. Unfortunately, this type of practice does little to reduce the on-site erosion and flood problems that some landowners currently experience. The Grimes Canyon stream system would remain unstable.

Because of the sediment trapping ability of this practice, it is believed that some of the pesticides and chemicals associated with agriculture and roads would also be contained. Besides sediment control, a basin may provide some positive water quality impacts downstream. It has been shown in the past that sediment basins can also provide good wildlife habitat.

One concern is the potential lack of available sediment disposal options. Available disposal options will greatly influence disposal costs. It has been estimated in this analysis that sediment disposal will cost $12 per cubic yard.

Grimes Canyon Bank Protection, Riparian Grade Stabilization and Cover Crop Option (Option 2): Reducing on-site erosion and flood damages and reducing the sediment reaching Arroyo Las Posas from Grimes Canyon is less straightforward. Any objective to benefit the Mugu Lagoon will focus on decreasing washload. Unfortunately, many practices that reduce on-site damages do not significantly reduce sediment washload. Washload is derived from the finer textured soils.

The practices required to significantly reduce washload and reduce on-site damages are costly. As an example, due to the soil and erosion types found in Grimes Canyon, applying more orchard cover crops would reduce field erosion and gullying problems, but not significantly reduce sediment washload. Adding the grade stabilization measure that allows for reshaping and expanding the riparian corridor reduces sediment yield, but at a significant price. Bank protection practices further reduces sediment. The three practices in combination would reduce washload by about 2,600 tons/year and bedload 8,500 tons/year with an average annual cost of about $246,000. An added benefit of these practices is that the estimated annual cost of erosion and flood damages would be reduced by about $50,000.

Overall, this combination of measures would stabilize the Grimes Canyon stream system and potentially improve water quality leaving the subwatershed, and improve habitat in the subwatershed as well as the lagoon. These measures would unfortunately require the removal of about 19 acres of orchard land along the stream in order to reshape the slopes for riparian vegetation.

The options discussed above are only two of a myriad of combinations of practices that could be considered. The above examples provide two relatively different directions that could be taken. The primary purpose for these two options is to develop effects data that can be expanded to the other priority subwatersheds. This expansion of the data is not to indicate specific treatments for the other subwatersheds but to provide the decisionmakers with a general understanding of the overall impacts (positive and negative) of these types of treatments in the nine priority sediment production subwatersheds.

As is discussed in Appendix A, what is most appropriate for each subwatershed must be determined by the local landowners and other interested entities.

Expansion of Grimes Canyon Type of Treatment to Other Priority Sediment Production Subwatersheds: Earlier in this section, eleven subwatersheds, (including Grimes Canyon) were identified as priority treatment areas. Nine of these priority subwatersheds are discharging sediment to the main channel and eventually Mugu Lagoon. The other two subwatersheds contribute significant sedimentation to Mugu Lagoon, primarily because of stored sediment periodically delivered, and streambank erosion problems in the main channel.

The next question to answer is what the overall impacts would be, particularly in the reduction of sediment washload, if all similar land types in the other priority subwatersheds were treated with the same practices described in the Grimes Canyon options. The purpose of answering this question is to provide information on the overall impacts, particularly the reduction in sediment to Mugu Lagoon, after treating the priority sediment production subwatersheds. This information will be useful when developing alternatives for the entire watershed and determining the viability of treating these sediment production areas versus other options such as a large sediment basin just above Mugu Lagoon that the VCFCD has proposed.

Table 4-f summarizes the estimated acres or miles for each land type that needs to be treated in the other priority subwatersheds. This information is used to expand treatment options identified for Grimes Canyon to other priority subwatersheds. Tables 4-g and 4-h summarizes the impacts of expanding the two treatment options, developed for Grimes Canyon, to all priority subwatersheds. An impacts sheet for each subwatershed that the two treatment options were expanded to is included in Appendix C.

The summary table for the sediment basin expansion option shows that the estimated potential reduction in sediment yield is 52,400 tons per year. The installation cost is $3.2 million and an additional $533,000 per year is required to maintain the structures. The average annual cost for each ton of reduced washload and bedload is $34 and $27 respectively. This includes a sediment disposal cost of $12 per cubic yard.

The second option that combines three practices is estimated to reduce sediment yield by 41,400 tons per year. The installation cost is $7.3 million and an additional $490,000 a year is required to maintain the practices. The average annual cost for each ton of reduced washload and bedload is $76 and $50 respectively.

TABLE 4–1: Units of Each Sediment Source Needing Treatment (Top 11 Subwatersheds)

SW#	SUBWATERSHED NAME	SEDIMENT SOURCE TO BE TREATED	TOTAL UNITS	UNITS NEEDING TREATMENT
34	Arroyo Los Posas	Stream (Main Channel)	16.2 Miles	Treated By County
		Roads In Steep Orchard	695 acres	487 acres
		New Orchard	520 acres	470 acres
		Construction	55 acres	55 acres
		Field Crop	2710 acres	Undetermined
		Natural Area	1057 acres	1057 acres
33	Peach Hill Wash	Stream (Main Channel)	26.9 Miles	Treated By County
		Roads In Steep Orchard	645 acres	450 acres
		New Orchard	370 acres	330 acres
		Construction	255 acres	255 acres
		Other Roads	5.6 miles–sec.	5.6 Miles
			2.4 miles–prim.	2.4 Miles
		Natural Area	1035 acres	1035 acres
9	Grimes Canyon	Roads In Steep Orchard	1325 acres	928 acres
		New Orchard	630 acres	570 acres
		Stream	14.6 mi. (1 Sed. Basin)	1 Basin
		Stream	14.6 mi. (74 Structures)	59 Struct.
		Stream	14.6 miles	1.5 miles
		Natural Area	1070 acres	1070 acres
		Other Roads	11.6 miles–sec.	11.6 Miles
			6.4 miles–prim.	6.4 Miles
		Soil Slips	Undetermined	Undetermined
		Gullies	Undetermined	Undetermined
		Construction	80 acres	80 acres
2	Beardsley Wash	Roads In Steep Orchard	757 acres	530 acres
		New Orchard	2427 acres	2180 acres
		Stream	31.2 miles	1 Basin
		Stream	31.2 miles	0.13 miles/ 2 structures
		Stream	31.2 miles	3.1 miles
		Natural Area	2753 acres	2753 acres
		Other Roads	11.6 miles–sec.	11.6 Miles
			8 miles–prim.	8 Miles
		Soil Slips	Undetermined	Undetermined
30	Arroyo Conejo	Construction	165 acres	165 acres
		Roads In Steep Orchard	570 acres	400 acres
		New Orchard	780 acres	702 acres
		Soil Slips	– None	None
		Other Roads	9.2 miles–sec.	9.2 miles
			3.2 miles–prim.	3.2 miles
		Field Crops	658 acres	Undetermined
7	Long Canyon	Roads In Steep Orchard	810 acres	570 acres
		New Orchard	1045 acres	940 acres
		Stream	17.9 miles	1 Basin
		Stream	17.9 miles	3.1 miles/54 structures
		Stream	17.9 miles	1.8 miles
		Natural Area	1425 acres	1425 acres
		Other Roads	15.6 miles–sec.	15.6 Miles
			3.8 miles–prim.	3.8 Miles
		Soil Slips	Undetermined	Undetermined
13	Alamos Canyon	Natural Areas	4390 acres	4390 acres
		Stream	22 miles	1 Basin
		Stream	22 miles	1.7 miles/72 structures
		Stream	22 miles	1.1 Miles
		Other Roads	13.6 miles–sec.	13.6 Miles
		Soil Slips	Undetermined	Undetermined
		Gullies	Undetermined	Undetermined
6	Mahan Barranca	Roads In Steep Orchard	120 acres	84 acres
		New Orchard	280 acres	250 acres
		Stream	6.1 miles	1 Basin
		Stream	6.1 miles	0.23 miles/7 structures
		Stream	6.1 miles	0.6 Miles
		Natural Area	745 acres	745 acres
		Other Roads	3.8 miles–sec.	3.8 Miles
			2.2 miles–prim.	2.2 Miles
		Soil Slips	Undetermined	Undetermined
5	Sand Canyon	Roads In Steep Orchard	665 acres	466 acres
		New Orchard	665 acres	599 acres
		Stream	6.3 miles	no treatment
		Stream	6.3 miles	2.4 miles/72 structures
		Stream	6.3 miles	0.6 Miles
		Natural Area	270 acres	270 acres
		Other Roads	5.8 miles–sec.	5.8 Miles
		Soil Slips	Undetermined	Undetermined
21	Runkle Canyon	Soil Slips	Undetermined	Undetermined
		Construction	20 acres	20 acres
		Natural Areas	882 acres	882 acres
		Other Roads	4.4 Miles–sec.	4.4 Miles
			0.6 Miles–prim.	0.6 Miles
		Stream		1 Structure
8	Hunt Wash	Roads In Steep Orchard	360 acres	252 acres
		New Orchard	210 acres	190 acres
		Stream	6.7 miles	1 Basin
		Stream	6.7 miles	1.1 miles/24 structures
		Stream	6.7 miles	0.67 Miles
		Natural Area	480 acres	480 acres
		Other Roads	3.2 miles–sec.	3.2 Miles
		Soil Slips	Undetermined	Undetermined

ASSUMPTIONS

1. Ninety percent of young orchards (Up to 7 years) need to be planted to cover crops and filter strips to reduce sheet and rill erosion until trees produce enough litter to cover most of the soil. Cover crop/filter strip plantings will reduce sediment by 90 percent. Four–tenths of an acre of filter strips alone should be planted on every 20 acres of young orchard and will reduce sediment by 30 percent.
2. Seventy percent of roads in new orchards on steep slopes above 6 percent need to be treated with orchard drainage system practices. Drainage system practices on steep unpaved and flat unpaved roads in orchards on steep slopes will reduce sediment by 60 percent.
3. Vegetative Streambank Protection (shaping and planting) is needed on 10 percent of the streambank channels in subwatersheds 2 thru 9, on 5 percent of the stream bank channel in subwatershed 13 and on 1 percent of the stream channel banks in subwatershed 21. This is in addition to vegetative planting included as part of stream channel grade stabilization.
4. Natural Areas can be protected by using brush management to reduce the age of cover. Increased erosion resulting from fire can be reduced by emergency seeding of critical erosion areas, brush management, firebreak installation, and prescribed burning.

Table 4-g. Summary of Impacts of Construction of Sediment Basins In High Priority Subwatersheds

1. Subwatershed: All priority subwatersheds with potential sites (#2, #6, #7, #8, #9, #13, and #21).

2. Practices: Sediment Basins

3. Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a.1 Install. Cost ($): Project Sediment Basins		$3,180,000	$3,180,000
a.2 Life of Practice is: 50 years			
a.3 Average Annual Cost: Project		$260,000	$260,000
a.4 Total Average Annual Maintenance Cost=		$614,000	$614,000
b.1 Total Average Annual Cost Project		$874,000	$874,000
c. Erosion (tons/year)	1219100	1219100	0
d. Sediment(tons/year)	410400	358100	−52300
Washload (tons)	219200	196100	−23100
Bedload (tons)	191200	162000	−29200
Avg. Ann. Cost Per Ton of Sed. Reduction			$17
Avg. Ann. Cost Per Ton of Washload Reduct			$38
Avg. Ann. Cost Per Ton of Bedload Reduct			$30
e. Crop land Acres Required for Project			61
f. Effect on Lagoon Habitat (+,−,0)	−	+	+
g. On−site Hab. Value (WHR Value)	68	112	44
h. Water Quality (qual. +,−,0)	−	+	+
Erosion, Sediment, Flood Damage, Expense: **			
i. On−farm Land Damage(erosion)($/year)	$58,100	$58,100	$0
j. On−farm Road Dam(eros./flood)($/year)	$115,998	$115,998	$0
k. On−farm equip. Damage(erosion)($/year)	$82,012	$82,012	$0
l. County Road Damage(flood)($/year)	$69,450	$69,450	$0
m. On−farm Land Protect. Expense(flood)($/yr)	$11,600	$10,600	($1,000)
n. Stream Restoration Expense ($/year) & Existing Structure Repair Cost ($/year)	$30,800	$28,600	($2,200)
o.Total Damage:	$367,960	$364,760	($3,200)
p.			
q. Management Skills Required (more, less, same)		More	
r. Other Soil, Water, Animal, Plants, Air and Human Considerations:			
** Damages are associated with areas where work is proposed.			
− Some basin locations may negatively impact endangered/threatened species.			
− Basin cleanout is expected after large events or 15% loss of capacity at $12 per cubic yard.			

Table 4-h. Summary of Watershed Practice Impacts on the High Priority Erosion Sources

1. Subwatershed: All the Target Subwatersheds (#2, #5, #6, #7, #8, #9, #13, #30, #33, and #34).
2. Practices: Orchard Cover Crop(Blando) + Bank Protection + Riparian Grade Stab (for more detailed practice descriptions see Appendix C)
3. Total Acres or Miles of Erosion Source In The Subwatershed:
   Cover Crop: 6767 acres
   Bank Protection: 104.8 miles
   Riparian Corridor Grade Stabilization: 104.8 miles
4. Total Acres or Miles of Erosion Source In The Subwatershed to Treat:
   Cover Crop: 5932 acres
   Bank Protection: 8.4 miles
   Riparian Corridor Grade Stabilization: 290 Str 12.6 miles

5. Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a.1 Install. Cost ($): Cover Crop($145/ac) =		$857,600	$857,600
Bank Prot.($6,800/mi) =		$64,100	$64,100
290 Grade Stabilization Structures @ $22,000		$6,357,000	$6,357,000
a.2 Life of Practice is: Cover Crop= 20yr & Bank Prot.=20yr & Grade=50yr			
a.3 Average Annual Cost: Cover Crop=		$87,300	$87,300
Bank Prot.=		$6,500	$6,500
Grade Stab.=		$519,600	$519,600
a.4 Total Average Annual Installation Cost		$613,400	$613,400
b.1 Maintenance Cost:Cover Crop ($/year)		$481,100	$481,100
b.2 Maintenance Cost:Bank Prot.($/year)		$1,500	$1,500
b.3 Maintenance Cost:Grade Stab.($/year)		$153,000	$153,000
b.4 Total Maintenance Cost ($/year)		$635,600	$635,600
b.5 Total Avg. Ann. Inst. & Main. Cost ($/yr.)		$1,249,000	$1,249,000
c. Erosion (tons/year)	1219100	1120600	-98500
d. Sediment(tons/year)	410400	369100	-41300
Washload (tons)	219200	202850	-16350
Bedload (tons)	191200	166250	-24950
Avg. Ann. Cost Per Ton of Sed. Reduction			$30
Avg. Ann. Cost Per Ton of Washload Reduct			$76
Avg. Ann. Cost Per Ton of Bedload Reduct			$50
e. Crop land Acres Required for Project			50
g. Effect on Lagoon Habitat(+,-,0)	-	+	0
h. On-site Hab. Value(WHR Value)	96	102	6
i. Water Quality(qual. +,-,0)	-	+	+
Erosion, Sediment, Flood Damage, Expense: **			
k. On-farm Land Damage(erosion)($/year)	$85,300	$25,600	($59,700)
l. On-farm Road Dam(eros./flood)($/year)	$170,850	$153,650	($17,200)
m. On-farm equip. Damage(erosion)($/year)	$120,750	$36,250	($84,500)
n. County Road Damage(flood)($/year)	$119,700	$80,350	($39,350)
o. On-farm Land Protect. Expense(flood)($/yr)	$17,000	$9,200	($7,800)
p. Stream Restoration Expense(flood)($/year) & Existing Structure Repair Cost(flood)($/year)	$30,800	$1,550	($29,250)
q.Total Damage:	$544,400	$306,600	($237,800)

2. Treatment of Sediment Storage and Delivery Subwatersheds Associated with Arroyo Las Posas

In addition to treating the highest contributing sediment production subwatersheds, treatment associated with the Arroyo Las Posas is also an option.

According to work completed by Simons, Li & Associates (1989) sediment transport imbalances along the mainstem of the channel (portions of subwatersheds 33 and 34) significantly contribute to the sedimentation problems that currently exist in the Calleguas Creek Watershed. In their study they identified and evaluated several alternatives to stabilize the mainstem and reduce sediment deposition in the lower reach of Calleguas Creek. Sedimentation control measures that they recommended in this preliminary analysis include the stabilization of the channel between Sand Canyon and Hitch Boulevard, and the construction of sediment basins just above Seminary Road. Additional measures include bank protection, levee realignment, groin structures, and rubble placed along areas of obvious bank loss.

In the future, other channel improvements such as drop structures upstream of Upland Road bridge and additional grade modification structures upstream of Hitch Boulevard are recommended. The Ventura County Flood Control District has identified several locations to modify the existing channel over the next five years as funds are available.

Table 4-i summarizes the overall impacts of this treatment along the main channel. The local office of the US Fish and Wildlife Service has reviewed the plans and has indicated support for this type of work in this watershed. Any impacts to existing wetlands will be mitigated. It is anticipated that additional wetlands will be created in the channel system while reducing the amount of sediment reaching the lagoon.

The recommended improvement alternative would decrease the average annual loading of sediment to Mugu Lagoon. With reduced transport capacities through the upstream portions of the creek, sediment to the lower stream reaches would be reduced. Therefore, a reduction in average annual cleanout costs for lower Calleguas Creek is estimated to equal about $256,000. Although not quantified, there may be some reduction in flood damages to the adjacent agricultural land due to reduced sedimentation in the channel.

This option was estimated to cost about $5.8 million dollars to install and $155,000 in average annual maintenance cost. Due to the uncertainty of sediment disposal sites, it is possible that the maintenance costs are understated, and could actually cost more than twice as much.

Table 4-i. Summary of the Impacts of Arroyo Las Posas Channel Projects by VCFCD

1. Subwatershed: Peach Hill Wash (33), and Arroyo Las Posas (#34)

2. Practices: Bank Protection, In Stream Sediment Basins, Grade Stabilization Structures, Rock Groins, Low-flow Channel, and Channel Re-alignment

3. Total Feet of Erosion Source In The Subwatershed:
Arroyo Las Posas 22,400 feet, Peach Hill Wash 45,700 feet

4. Untreated Feet of Erosion Source In The Subwatershed:
Arroyo Las Posas 16,800 feet, Peach Hill Wash 26,600 feet

5. Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a.1 Install. Cost ($): VCFCD Project		$5,800,000	$5,800,000
a.2 Life of Practice is: 50 years			
a.3 Average Annual Cost: VCFCD Project		$475,000	$475,000
a.4 Total Average Annual Maintenance Cost=		$155,000	$155,000
b.1 Total Average Annual Cost VCFCD Project		$630,000	$630,000
c. Erosion (tons/year)	1219100	1152000	-67100
d. Sediment(tons/year)	410400	343300	-67100
Washload (tons)	219200	195100	-24100
Bedload (tons)	191200	148200	-43000
Avg. Ann. Cost Per Ton of Sed. Reduction			$9
Avg. Ann. Cost Per Ton of Washload Reduct			$26
Avg. Ann. Cost Per Ton of Bedload Reduct			$15
e. Crop land Acres Required for Project			0
g. Effect on Lagoon Habitat(+,-,0)	-	+	+
h. On-site Hab. Value (+,-,0)	+	-	0
i. Water Quality(qual. +,-,0)	-	+	+
Erosion, Sediment, Flood Damage, Expense:			
k. On-farm Land Damage(erosion)($/year)	$85,300	$85,300	$0
l. On-farm Road Dam(eros./flood)($/year)	$170,850	$170,850	$0
m. On-farm equip. Damage(erosion)($/year)	$120,750	$120,750	$0
n. County Road Damage(flood)($/year)	$119,700	$119,700	$0
o. On-farm Land Protect. Expense(flood)($/yr)	$17,000	$17,000	$0
p. Stream Restoration Expense ($/year) & Existing Structure Repair Cost ($/year)	$30,800	$30,800	$0
q. Flood Damages to Oxnard Plain ($/yr)	$1,267,700	$1,267,700	$0
r. VCFCD Sed. Rem. & Restoration Cost($/yr)	$890,000	$634,000	($256,000)
Total Damages:	$2,702,100	$2,446,100	($256,000)
s. Management Skills Required (more, less, same)		More	
t. Other Soil, Water, Animal, Plants, Air and Human Considerations:			
- Some reduction in flood damages (not quantified).			
- 457 acres of riparian corridor will be purchased.			
- Upper basin cleanout is expected every 5 years (actural cost unknown).			
- Reduced VCFCD maintenance above and below project site.			
- Items k through p are damages in the upper subwatersheds.			

3. Sediment Basin(s) Just Above Mugu Lagoon

The following large sediment retention basin option was developed by the VCFCD as an alternative to a proposal developed by the U.S. Army Corps of Engineers as described in the Calleguas Creek Reconnaissance Report (1992). The VCFCD staff has determined that their modified flood plan would provide similar flood protection with fewer impacts to the adjacent land owners.

Major features of the VCFCD proposed project include the following (VCFCD, April 1993): a sediment retention basin just above State Route 1 (SR1) and from the west levee of Calleguas Creek to the hills on the east; a dam 5.9 feet above the current downstream bed elevation with the axis parallel to SR1 to retain floodwaters; the west levee of Calleguas Creek would be elevated to prevent overflow into Revolon Slough; stabilizers would be constructed in the existing channel and the channel bottom would be lowered five feet to trap coarse sediment; existing levees would also be raised three feet and extend up to Hueneme Road; channel modifications would extend from Hueneme Road up to the existing channel improvements 800 feet upstream of the State Hospital bridge to upstream of Pleasant Valley Road with 2 to 1 slopes and rock riprap.

Both the VCFCD and US Army COE projects include sediment basins to capture coarse and fine sediments before reaching Mugu Lagoon and thereby extending the life of the lagoon. Both projects provide flood protection to the adjacent lands; however, the VCFCD proposal requires significantly less farmland conversion. Costs of the VCFCD project are also less than the COE plan ($38 million versus $85 million).

Because the proposed sediment retention basin is to be located just upstream of Mugu Lagoon, it could provide valuable riparian habitat and serve as an extension of Mugu Lagoon. A significant reduction in the sediment delivery to Mugu Lagoon may preserve the lagoon. Some valuable agricultural land would be taken out of production but, compared to the COE proposal, it would be significantly less (80 acres versus several hundred acres). Table 4-j summarizes the impacts of the VCFCD proposal.

Based on the initial economic analysis, the current average annual damages are equal to $1,267,700 (US Army COE, 1992). Under current conditions, a 10-year flood event would cause about $5 million in damages whereas a 100-year event would result in $24 million in damages.

The preliminary estimate of the benefits of this project, in average annual dollars, is estimated to be $1,207,000 in reduced flood damages (US Army COE, 1992).

The estimated cost of installing this project is $38 million and the average annual cost is equal to $3 million. An estimate of the operation and maintenance cost has not been determined and, therefore, is not included (VCFCD, 1993). The maintenance cost could be significant depending on the sediment disposal options available. Some options include ocean beach use, land fill disposal, or clean fill for development.

Table 4-j. Summary of Impacts of Lower Calleguas Creek Retention Basin Project by VCFCD

1. Subwatershed: All of Calleguas Creek Watershed

2. Practices: Retention Basin, Including small dam, channel work and wetland enhancement areas

3. Total Drainage Area Controlled By Project: 168,800 Acres

4. Untreated Drainage Area In Watershed: 51,200 Acres

5. Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a.1 Install. Cost ($): (Prelim. estimate)		$38,000,000	$38,000,000
a.2 Life of Practice is: 50 years			
a.3 Average Annual Cost: VCFCD Project		$3,100,000	$3,100,000
a.4 Total Average Annual Maintenance Cost=		unknown	unknown
b.1 Total Average Annual Cost VCFCD Project		$3,100,000	$3,100,000
c. Erosion (tons/year)	1219100	1219100	0
d. Sediment(tons/year)	410400	222300	−188100
Washload (tons)	219200	135600	−83600
Bedload (tons)	191200	86700	−104500
Avg. Ann. Cost Per Ton of Sed. Reduction			16
Avg. Ann. Cost Per Ton of Washload Reduct			37
Avg. Ann. Cost Per Ton of Bedload Reduct			30
e. Crop land Acres Required for Project			80
g. Effect on Lagoon Habitat(+,−,0)	−	+	+
h. On−site Hab. Value(+,−,0)	−	+	+
i. Water Quality(qual. +,−,0)	−	+	+
Erosion, Sediment, Flood Damage, Expense:			
k. On−farm Land Damage(erosion)($/year)	$85,300	$85,300	$0
l. On−farm Road Dam(eros./flood)($/year)	$170,850	$170,850	$0
m. On−farm equip. Damage(erosion)($/year)	$120,750	$120,750	$0
n. County Road Damage(flood)($/year)	$119,700	$119,700	$0
o. On−farm Land Protect. Expense(flood)($/yr)	$17,000	$17,000	$0
p. Stream Restoration Expense ($/year) & Existing Structure Repair Cost ($/year)	$30,800	$30,800	$0
q.1 VCFCD Sed. Rem. & Restoration ($/yr)	$890,000	$670,000	($220,000)
q.2 Flood Damages to Oxnard Plain ($/yr)	$1,267,700	$60,700	($1,207,000)
Total Damage:	$2,702,100	$1,275,100	($1,427,000)
r.			
s. Management Skills Required (more, less, same)		More	
t. Sediment disposal cost could be sidnificant depending on available disposal options.			
− Item q.2 includes crop, irrig. equip., roads, home & utility damage; cleanup expense.			
− Sediment and damage reduction estimates are based on COE analysis (1992).			
− Items k through p are damages associated with the upper subwatersheds.			

4. Dredging to Enhance the Mugu Lagoon Tidal Prism

Another option to address the potential future problem of sediment building up in the lagoon is to dredge the lagoon.

Mean tidal prism is the average of the Mean Low Low Water and Mean High High Water for a tidal water body. In 1857, mean tidal prism was 120 million cubic feet (M. cu. ft) (Williams, 1994). By 1976, the volume had changed to 19 M. cu. ft.

Using data on the change in tidal prism from the present condition (1980) and projected future condition (2030), indicates that the lagoon is moving toward a closed lagoon condition (USDA-SCS, 1982). The tidal prism was estimated to be 10.6 M.cu.ft. for the 1980 condition and projected to be 7.2 M.cu.ft. under the 2030 condition. Williams (1994) data concurs with the projection that the declining tidal prism for Mugu Lagoon means that the lagoon is moving toward a condition in which the lagoon may be more frequently closed.

A more frequently closed lagoon may result in rapid habitat conversions. One option to avoid this rapid conversion is to increase the tidal prism by dredging the lagoon. Two scenarios are described. The first is to recreate the conditions similar to those in 1857 with a mean tidal prism of 120 M. cu. ft. If the predicted future condition is 7.2 M. cu. ft., 2.8 M. cu. yards of material would need to be removed. If it is assumed that the typical dredging cost is $5.00 per cubic yard, then this project would cost $14,000,000. A less drastic proposal would be to develop enough storage in the lagoon to handle the future amount of sediment that is anticipated. This scenario would require 126,000 cubic yards of material removed in 2030. It is estimated that this project would cost $630,000 in todays dollars. Neither scenario addresses the area above Mean High High Water, the existing upland habitat.

Dredging as an option has many unanswered questions. Where would the dredged material be placed? Would the disturbances to the lagoon ecosystem during dredging result in new problems? In addition, the resource problems in the rest of the watershed are not addressed with this type of option.

Sediment Control Summary

The previous discussion shows that there clearly are several approaches that could be taken to address the accelerated rate of sediment impacting Mugu Lagoon. Later in Section 5 of this report, different alternatives will be presented and the projected impacts of each discussed.

4.4 Urban Water Runoff Treatment Options

Urban expansion results in changes in runoff which can result in increased base stream flows, increased duration of bank flows, and increased flooding. As development continues in the watershed, the bank erosion problem could be expanded. Practices that retain runoff on-site of developing areas is one way to potentially prevent future bank erosion problems. Coordination of the on-site runoff retention throughout the watershed is critical when determining effectiveness. As an example, if all new developments incorporated retention facilities into their projects, it could result in the same increased bank erosion problems if these retention facilities discharged at the same time even though later.

Some runoff retaining practices that could be considered are infiltration ponds, constructed wetlands, media filtration, biofilters, detention basins and multiple systems. Many of these options provide opportunities to integrate storm water management objectives with passive recreation needs, wildlife habitat, and groundwater recharge. Some of the factors that need to be considered include: slope of area, area that would be required, soils, water availability, aesthetics, safety, and environmental side effects. A copy of the summary of each of these practices is included in Appendix C (Source is California Storm Water Best Management Practice Handbooks; Camp, Dresser & McKee et al, March 1993). Additional details are included in the referenced handbook. Table 4-k summarizes the requirements of each practice and the general benefit of the practice.

Table 4-k: Urban Runoff Control Practice Features -- Practice Requirements versus Benefits

Media Filtration	Infiltration	Biofilter (Swales & Filter Strips	Wet Ponds & Wetlands	Extended Detention
REQUIREMENTS:				
Moderate Available Space	Basins: available space; Trenches/permeable pavement: limited space available	Moderate to limited space available	Available space	Available space
Well-designed Filter System	Water Table >3 ft below pond bottom	Water Table >3 ft swale bottom	Water table at or near pond normal pool level	
Frequent maintenance otherwise systems will clog	Permeable soils (SCS Group A or B)	Relatively permeable soils (SCS Group A or B) moderate slopes	Relatively impermeable soils (SCS Group D)	
BENEFITS:				
Peak discharge reduction for small storms	Peak discharge reduction for small storms	Peak discharge reduction for small storms	Peak discharge control	Peak discharge control
Pollutant load reduction off-line or on-line, high suspended solids removal	Volume discharge control	Volume discharge control	Load reduction for dissolved and suspended pollutants	Load reduction for suspended pollutants
Multiple-use park areas	Aquifer recharge	Aquifer recharge	Aesthetic permanent pool	Multiple use pool area
	Pollutant load removed from runoff off-line or on-line for dissolved and suspended pollutants by infiltration	Pollutant load reduction off-line or one-line by infiltration or sedimentation	Wildlife Habitat	
	Multiple use park areas		Multiple use park areas	

4.5 Flood Control

The development of flood control measures is not a purpose of this report. The VCFCD has and is continuing to address flooding problems in the watershed. As was noted earlier in this report several of the proposed flood control measures will have an impact on sediment reaching the lagoon and will be discussed in the alternative section for that reason.

4.6 Water Quality Treatment

The following information was summarized from Volume Two of the Ventura Countywide NPDES Storm Water Permit Application document published in 1994 under the Ventura Countywide Stormwater Quality Management Program as it relates to water quality treatments from urban sources.

Ventura County was designated a 208 planning area in 1974 under Section 208 of the 1972 Clean Water Act. The County adopted its original 208 Water Quality Management Plan in 1978. By continuing to update water quality issues and population and land use forecasts and reevaluating goals and policies, the original plan was updated, revised, and adopted by the County Board of Supervisors in 1980 as the 208 Areawide Water Quality Management Plan.

In 1993 the County was still updating the plan to include water management developments. The plan tries to comply with current legislation, updates technical information, provide consistency with other regional plans, and perfects the format for referencing and updating. Though much of this plan was not implemented due to lack of funding and the need to address more pressing issues, the recommendations to reduce nonpoint source pollution are still applicable and have been incorporated into the Ventura County National Pollution Discharge Elimination System (NPDES) permit.

The Ventura County storm water NPDES permit requires each co-permittee to implement appropriate storm water management programs within their jurisdiction. In Ventura County the county is the lead agency and the cities are the co-permittees. A two-phase implementation plan has been developed:

1. Phase I is the initial implementation phase and begins when the permit is issued. During this phase co-permittees will begin to implement select storm water management programs.
2. Phase II is the full implementation phase and begins 18 months after the permit is issued. Co-permittees implement the remaining programs during this time.

The management plan must meet federal regulations by consisting of "management practices, control techniques, and system, design, and engineering methods" needed to control pollutant discharges from storm drains to the "maximum extent possible". The plan must also include a comprehensive planning process, a coordination mechanism between the co-permittees and other government agencies, a public participation process, and an assessment and reporting mechanism. Co-permittees must also have the proper staff, equipment, legal authority, and fiscal resources during implementation. Compliance is judged by how successfully the programs reduce pollutant discharges from the municipal drainage systems.

The NPDES plan provides measures for six programs: residential, businesses, municipal infrastructure, illicit discharges, land development, and construction sites. Specific preventative steps may include information campaigns; material disposal practices; maintenance programs; collection, disposal, and reuse programs; and planning and inspection programs.

The steps the co-permittees must follow include:
1. Prioritize programs.
2. Prepare plans and select management practices.
3. Initiate implementation.
4. Develop-county-wide approach.
5. Implement specific programs.
6. Evaluate program effectiveness and revise programs.

A Management Committee has been formed by the Ventura County co-permittees for coordination. Advisory committees are being formed to advise the Management Committee on program implementation. Three advisory committees are already formed: Public Outreach, Development and Construction, and Business and Illicit Discharge Control. The Public Infrastructure Committee will be formed by the time the permit is issued.

A tentative list of management practices has been formulated for each program. Practices include educational programs, ordinances and restrictions, recycling programs, and treatment controls.

Monitoring will be conducted to identify pollutant sources, determine the impacts of discharges on receiving water quality, and evaluate management program effectiveness. The key elements of the monitoring plan will be to monitor six outfall sites during three storm events per year to characterize storm water runoff from different land uses; use the results of this monitoring to identify suspected pollutant sources; conduct receiving water monitoring at two sites in a major tributary during three events per year; collect indirect monitoring data regarding the effectiveness of source control management practices; and analyze the information to produce load estimates and identify long term water quality trends.

4.7 Habitat Enhancement Opportunities

A variety of opportunities exist to improve the habitats within the watershed. Some of the measures include:

a. Reconstruct wetlands.

b. Restoration, enhancement, and preservation of riparian habitats.

c. Land treatment practices (vegetative filter strips, cover crops, plantings, etc.) to reduce input and application of pesticides.

d. Long range goal for habitat preservation and restoration tied to planning and zoning for the purpose of: mitigation banking, protection of threatened and endangered species, habitat linkages and wildlife corridors, improved water quality, maximized biodiversity, and recreational and educational opportunities.

This can be accomplished with a plan for linking the habitat areas together (using gap analysis). Gap analysis is a valuable tool for land planners. Areas can be identified for preservation and recreational areas, and then can be purchased with mitigation funds. Instead of developers spending large amounts of money on small fragmented pieces of habitat, it may be more valuable to work towards a common effort that will have far more benefits ecologically. Efforts to establish or enhance riparian habitat may be best accomplished in specific portions of the watershed such as Arroyo Santa Rosa and Conejo stream corridor. The Calleguas stream system may be more appropriate as an urban recreation corridor for such uses as bikeways.

An example of a potential habitat enhancement/linkage map is shown in Figure 4-a. This map was developed using Natural Diversity Database (NDDB) information, field observations, and the habitat land use map. The present areas with significant habitat values were mapped and then linked together where the potential for restoration still exists. Many of these existing habitat areas have clusters of threatened and endangered species. The goal of this concept is to establish linkages or corridors between a variety of habitats from the Pacific Ocean to the upper watershed. Riparian corridors provide excellent links between areas. These corridors can be used for wildlife and recreation purposes. The southeast border of the watershed currently adjoins protected state and federal parklands, thus providing linkages to other watersheds to maximize habitat values.

e. To improve fish and wildlife habitat conditions, specific objectives must be developed and agreed upon by the local community. Immediate steps should be taken to preserve and protect the islands of habitat still remaining.

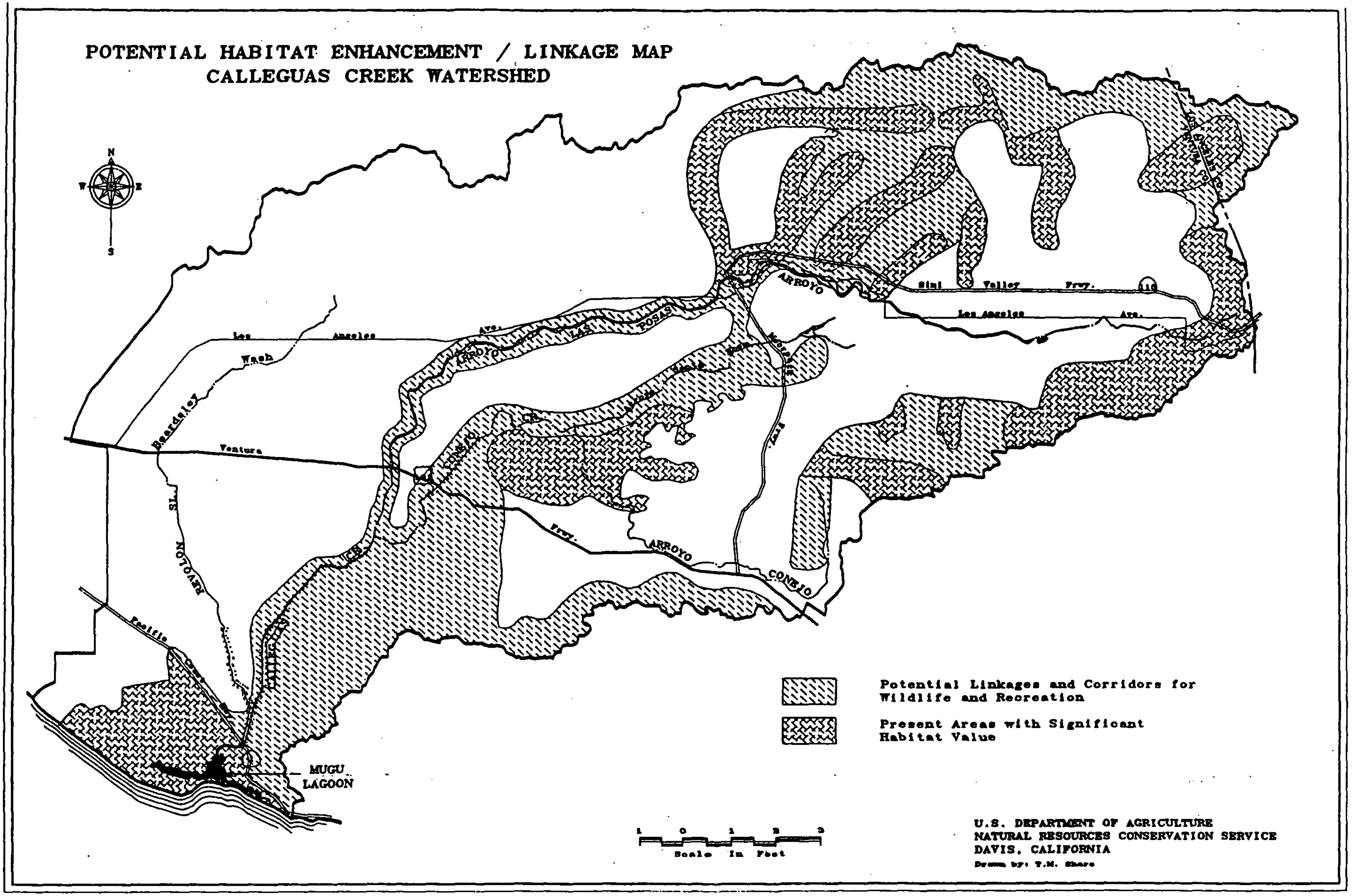
POTENTIAL HABITAT ENHANCEMENT / LINKAGE MAP
CALLEGUAS CREEK WATERSHED
N
W
E
S
Los Angeles
Wash
Beardsley
Ventura
Fwy.
REVOLON SL.
Pacific Coast Hwy
CALLEGUAS CR.
CONEJO CR.
ARROYO LAS POSAS
Ave.
ARROYO SIMI
Simi Valley Fwy.
118
Los Angeles Ave.
Moorpark
23
ARROYO CONEJO
MUGU LAGOON
▨ Potential Linkages and Corridors for Wildlife and Recreation
▩ Present Areas with Significant Habitat Value
1 0 1 2 3
Scale In Feet
U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
DAVIS, CALIFORNIA
Drawn by: T.M. Share

Figure 4-a

5. ALTERNATIVE PLANS DEVELOPMENT

5.1 Purpose of Alternative Plans Development Section

The previous section described several approaches for controlling sediment from reaching the Calleguas Creek system and Mugu Lagoon, and also touched on some other associated resources.

In this section, probable combinations of these sediment control measures are evaluated. In all combinations, it is assumed that the VCFCD Arroyo Las Posas channel work will be completed because it has already been approved. This section of the report is divided as follows:

- 5.2 Alternative 1: Assume VCFCD Arroyo Las Posas channel work is completed.
- 5.3 Alternative 2: VCFCD Arroyo Las Posas channel work and VCFCD large sediment basin above the lagoon is installed.
- 5.4 Alternative 3: VCFCD Arroyo Las Posas channel work and installation of sediment basins in the appropriate priority subwatersheds.
- 5.5 Alternative 4: VCFCD Arroyo Las Posas channel work with vegetative practices in high priority subwatersheds using cover crops, stream bank stabilization, and riparian corridor grade stabilization structures.
- 5.6 Alternative 5: Alternative 2 plus installation of small sediment basins in the appropriate priority subwatersheds.
- 5.7 Alternative 6: Alternative 2 plus vegetative practices in high priority subwatersheds using cover crops, streambank stabilization, and grade stabilization of the streams and restoration of the riparian corridor.
- 5.8 Summary and Comparison of Impacts for Different Alternatives.
- 5.9 Additional Components to Erosion and Sediment Alternatives.

5.2 Alternative 1: Assume VCFCD Arroyo Las Posas channel work is completed.

Alternative 1 - Do nothing but assume that the Ventura County Flood Control District (VCFCD) project on the Arroyo Las Posas position of the main channel is installed. The impacts of this alternative are summarized in Table 4-i. This alternative reduces the sediment originating in the Calleguas Creek Watershed by about 16 percent and costs $5.8 million dollars to install.

Water quality will improve as sediment is collected in the sediment basins and removed and deposited off-site.

Diminished washload (fine sediment) will result in a slower conversion of habitat types in the lagoon. This diminished washload will benefit the aquatic-dependent wildlife due to reduced sediment-associated contaminants.

The modification of a somewhat natural channel may have some adverse on-site impacts to wildlife and threatened and endangered species. Mitigation measures should off-set adverse effects.

Although the project will require annual maintenance, some reduction in overall sediment removal and flood restoration expenses will occur.

5.3 Alternative 2: VCFCD Arroyo Las Posas channel work and VCFCD large sediment basin upstream of the lagoon is installed.

Alternative 2 - Combines VCFCD channel improvements and the VCFCD large sediment trap just upstream of the lagoon. The impacts are summarized in Table 5-a. This alternative reduces the sediment in the Calleguas Creek Watershed by 54 percent and costs $44 million dollars to install. In addition to the installation cost there will be a sediment removal expense ranging from $6 to $28 per cubic yard.

Overall water quality impacts are positive due to significant reductions in sediment from the installation of sediment basins and a wetland. The wetland may also take up some contaminants found in the water.

Diminished washload will result in a slower conversion of habitat types in the lagoon. This diminished washload will benefit the aquatic dependent wildlife due to reduced sediment-associated contaminants. The wetland aspect of the project will provide additional aquatic benefits and important habitat.

The modification of a somewhat natural channel (VCFCD) may have some adverse on-site impacts to wildlife and threatened and endangered species. Mitigation measures should off-set any adverse effects in both cases.

This project would result in some reduction in VCFCD sediment removal and restoration expense. In addition, flood damages to properties adjacent to the lower Calleguas Creek would be significantly reduced.

Table 5–a. Alternative 2: Summary of Impacts of VCFCD Arroyo Las Posas and Calleguas Creek Retention Basin Projects

Practice & Description: This VCFCD Arroyo Las Posas project includes: Two sediment basins, several grade or drop structures, a pilot channel, rock groins and some channel re–alignment. The project includes 25% of streambank length in subwatershed # 33 and 55% of subwatershed # 34. The Calleguas Creek Project is a large flood control basin & wetland project upstrearr of Mugu Lagoon in subwatershed #1.

Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a. Install. Cost Arroyo Las Posas Project($)	▨	$5,800,000	$5,800,000
Install. Cost Calleguas Cr. Basin Proj.($)	▨	$38,000,000	$38,000,000
Total Installation Cost	▨	$43,800,000	$43,800,000
Average Annual Cost Arroyo Las Posas Proj.	▨	$474,000	$474,000
Average Annual Cost Basin Project	▨	$3,106,000	$3,106,000
b. Arroyo Las Posas Maintenance Cost ($/year)	▨	$155,000	$155,000
Calleguas Basin Maintenance Cost ($/year)	▨	Unknown	Unknown
Total Maintenance Cost	▨	$155,000	$155,000
Total Average Annual Cost	▨	$3,735,000	$3,735,000
c. Erosion (tons/yr)	1219100	1152000	–67100
d. Sediment(tons/year)	410400	189700	–220700
Washload (tons)	219200	111500	–107700
Bedload (tons)	191200	78200	–113000
Avg. Ann. Cost Per Ton Sed. Reduction	▨	▨	$17
Avg. Ann. Cost Per Ton Washload Reduct.	▨	▨	$35
Avg. Ann. Cost Per Ton Bedload Reduct.	▨	▨	$33
e. Crop land required for project	▨	▨	80
f. Lagoon Habitat Quality (+,–,0)	–	+	+
g. Site Habitat Quality (+,–,0)	0	+	+
h. Water Quality (+,–,0)	–	+	+
Erosion, Sediment, Flood Damage, Expense:			
i. On–farm Land Damage(erosion)($/year)	$85,300	$85,300	$0
j. On–farm Road Dam(eros./flood)($/year)	$170,850	$170,850	$0
k. On–farm equip. Damage(erosion)($/year)	$120,750	$120,750	$0
l. County Road Damage(flood)($/year)	$119,700	$119,700	$0
m. On–farm Land Protect. Expense(flood)($/yr)	$17,000	$17,000	$0
n. Stream Restoration Expense(flood)($/year) & Existing Structure Repair Cost(flood)($/year)	$30,800	$30,800	$0
o. VCFCD Sed. Rem. & Restoration ($/yr.) **	$890,000	$414,000	($476,000)
p. Flood Damages to Oxnard Plain ($/yr.)	$1,267,700	$60,700	($1,207,000)
Total Damage:	$2,702,100	$1,019,100	($1,683,000)
r.			
s. Management Skills Required (more, less, same)	▨	More	
t. Sediment removal expense will depend on disposal options (costs $6 to $28 per cubic yard).			
** Main Channel Restoration			

5.4 Alternative 3: VCFCD Arroyo Las Posas channel work and installation of sediment basins in the appropriate priority subwatersheds.

Alternative 3 - Combines VCFCD channel improvements with small sediment basin treatments in the upper drainages of the Calleguas Creek Watershed. The impacts of this alternative are summarized in Table 5-b. This alternative will reduce sediment originating in the watershed by 29 percent and cost $9 million dollars to install. The sediment removal expense will range from $6 to $28 per cubic yard.

There is an overall positive impact on water quality due to significant reduction of sediment trapped by the installed sediment basins.

Diminished washload will result in a slower conversion of habitat types in the lagoon. This diminished washload will benefit the aquatic-dependent wildlife due to reduced sediment-associated contaminants.

In some areas habitat conditions will improve over current conditions with the installation of sediment basins, in other areas it may adversely impact the habitat. The modification of a somewhat natural channel (VCFCD) may have some adverse on-site impacts to wildlife and threatened and endangered species. Mitigation measures should off-set adverse effects in both cases.

This project would result in some reduction in VCFCD sediment removal and restoration expense. In addition, a minor amount of on-farm erosion and flood restoration associated expenses will be reduced.

Table 5–b. Alternative 3: Summary of Impacts of VCFCD Arroyo Las Posas Project and Small Sediment Basins

Practice & Description: The VCFCD Arroyo Las Posas project includes: Two sediment basins, several grade or drop structures, a pilot channel, rock groins and some channel re–alignment. The project includes 25% of streambank length in subwatershed # 33 and 55% of subwatershed # 34. The NRCS sediment basins are located in the priority subwatersheds #2, #6, #7, #8, #9, #13, and #21. See Appendix C for practice details.

Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a. Install. Cost Arroyo Las Posas Project($)		$5,800,000	$5,800,000
Install. Cost NRCS Sed. Basins Project ($)		$3,203,000	$3,203,000
Total Installation Cost		$9,003,000	$9,003,000
Average Annual Cost Arroyo Las Posas Proj.		$474,000	$474,000
Average Annual Cost NRCS Project		$262,000	$262,000
b. Arroyo Las Posas Maintenance Cost ($/year)		$155,000	$155,000
SCS Basin Maintenance Cost ($/year)		$533,000	$533,000
Total Maintenance Cost		$688,000	$688,000
Total Average Annual Cost		$1,424,000	$1,424,000
c. Erosion (tons/yr)	1219100	1152000	–67100
d. Sediment(tons/year)	410400	290900	–119500
Washload (tons)	219200	172000	–47200
Bedload (tons)	191200	118900	–72300
Avg. Ann. Cost Per Ton Sed. Reduction			$12
Avg. Ann. Cost Per Ton Washload Reduct.			$30
Avg. Ann. Cost Per Ton Bedload Reduct.			$20
e. Crop land required for project			61
f. Lagoon Habitat Quality (+,–,0)	–	+	+
g. Site Habitat Quality (+,–,0)	+	–	0
h. Water Quality (+,–,0)	–	+	+
Erosion, Sediment, Flood Damage, Expense:			
i. On–farm Land Damage (erosion)($/year)	$85,300	$85,300	$0
j. On–farm Road Dam. (eros./flood)($/year)	$170,850	$170,850	$0
k. On–farm equip. Damage (erosion)($/year)	$120,750	$120,750	$0
l. County Road Damage (flood)($/year)	$119,700	$119,700	$0
m. On–farm Land Prot. Expense (flood)($/yr)	$17,000	$16,000	($1,000)
n. Stream Restoration Expense (flood)($/year) & Existing Structure Repair Cost (flood)($/year)	$30,800	$28,600	($2,200)
o. VCFCD Sed. Rem. & Restoration ($/yr.) **	$890,000	$634,000	($256,000)
p. Flood Damage to Oxnard Plain ($/yr.)	$1,267,700	$1,267,700	$0
Total Damage:	$2,702,100	$2,442,900	($259,200)
s. Management Skills Required (more, less, same)		More	
t. Sediment removal expense will depend on disposal options (cost $6 to $28 per cubic yard).			
** Main Channel Restoration			

5.5 Alternative 4: VCFCD Arroyo Las Posas channel work with vegetative practices in high priority subwatersheds using cover crops, stream bank stabilization, and riparian corridor grade stabilization structures.

Alternative 4 - Combines VCFCD channel improvements with vegetative practices in the upper drainages using Cover Crop with Bank Protection and Riparian Corridor Grade Stabilization Structures. The impacts of this alternative are summarized in Table 5-c. This alternative will reduce sediment originating in the Calleguas Creek Watershed by 26 percent and cost $13 million dollars to install. The sediment removal expense will range from $6 to $28 per cubic yard.

The overall impact on water quality is positive due to reduced erosion and sediment being delivered to surface water bodies.

Diminished washload will result in a slower conversion of habitat types in the lagoon. This diminished washload will benefit the aquatic dependent wildlife due to reduced sediment associated contaminants. Vegetation treatment results in trapping and keeping fine soil from the lagoon which is beneficial.

Overall, the vegetative treatment has the most habitat benefits. In some areas habitat conditions will improve over current conditions; in other areas the habitat may be temporarily disturbed, potentially affecting threatened and endangered species. The modification of a somewhat natural channel (VCFCD) may have some adverse on-site impacts to wildlife and threatened and endangered species. Mitigation measures should off-set adverse effects in both cases.

This project would result in some reduction in VCFCD sediment removal and restoration expense. In addition, a significant amount of on-farm erosion and flood restoration associated expenses will be reduced.

Table 5–c. Alternative 4: Summary of Impacts of VCFCD Arroyo Las Posas Project and Tributary Channel Improvement and Land Treatment

Practices: Orchard Cover Crop (Blando) + Bank Protection + Riparian Corridor Grade Stab.
The NRCS treatments are located in the priority subwatersheds #2, #5, #6, #7, #8, #9, #13, #30, #33, and #34. See Appendix C for practice details.
The VCFCD Arroyo Las Posas Project is described in Tables 5a and 5b.

Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a.1 Install. Cost ($): Cover Crop($145/ac)=		$857,600	$857,600
Bank Prot..($6,800/mi)=		$64,100	$64,100
290 Grade Stabilization Structures @ $22,000		$6,357,000	$6,357,000
VCFCD Arroyo Las Project		$5,800,000	$5,800,000
a.2 Total Installation Cost		$13,078,700	$13,078,700
a.3 Average Annual Cost: Cover Crop=		$87,300	$87,300
Bank Prot.=		$6,500	$6,500
Grade Stab.=		$520,000	$520,000
Arroyo Las Posas Project=		$474,000	$474,000
a.4 Total Average Annual Installation Cost		$1,087,800	$1,087,800
b.1 Maintenance Cost:Cover Crop ($/year)		$480,700	$480,700
b.2 Maintenance Cost:Bank Prot.($/year)		$1,500	$1,500
b.3 Maintenance Cost:Grade Stab.($/year)		$153,000	$153,000
b.4 Maintenance Cost: VCFCD Arroyo Project ($/yr)		$155,000	$155,000
b.5 Total Maintenance Cost ($/year)		$790,200	$790,200
b.6 Total Avg. Ann. Inst. & Main. Cost ($/yr.)		$1,878,000	$1,878,000
c. Erosion (tons/year)	1219100	1053300	−165800
d. Sediment(tons/year)	410400	301900	−108500
Washload (tons)	219200	178700	−40500
Bedload (tons)	191200	123200	−68000
Avg. Ann. Cost Per Ton of Sed. Reduction			$17
Avg. Ann. Cost Per Ton of Washload Reduct			$46
Avg. Ann. Cost Per Ton of Bedload Reduct			$28
e. Crop land Acres Required for Project			50
f. Lagoon Habitat Quality (+,−,0)	−	+	+
g. Site Habitat Quality (+,−,0)	+	+/−	+
h. Water Quality (+,−,0)	−	+	+
Erosion, Sediment, Flood Damage, Expense:			
i. On−farm Land Damage (erosion)($/year)	$85,300	$25,600	($59,700)
j. On−farm Road Dam (eros./flood)($/year)	$170,850	$153,650	($17,200)
k. On−farm equip. Damage (erosion)($/year)	$120,750	$36,250	($84,500)
l. County Road Damage (flood)($/year)	$119,700	$80,350	($39,350)
m. On−farm Land Protect. Expense (flood)($/yr)	$17,000	$9,200	($7,800)
n. Stream Restoration Expense (flood)($/year) & Existing Structure Repair Cost (flood)($/year)	$30,800	$1,550	($29,250)
o. VCFCD Sed. Rem. and Restoration ($/yr.) **	$890,000	$634,000	($256,000)
p. Flood Damages to Oxnard Plain ($/yr)	$1,267,700	$1,267,700	$0
Total Damage:	$2,702,100	$2,208,300	($493,800)
r.			
s. Management Skills Required (more, less, same)		More	
t. Sediment removal expense will depend on disposal options (cost $6 to $28 per cubic yard).			
** Main Channel Restoration			

5.6 Alternative 5: VCFCD Arroyo Las Posas channel work and VCFCD large sediment basin upstream of the lagoon plus installation of small sediment basins in the appropriate priority subwatersheds.

Alternative 5 - Combines the VCFCD Arroyo Las Posas channel improvements with the VCFCD's sediment basin above Mugu Lagoon plus the NRCS practices in the upper watersheds which use sediment basins on subwatershed drainages. The impacts of this alternative are summarized in Table 5-d. This alternative reduces sediment originating in the Calleguas Creek Watershed by 67 percent and costs $47 million dollars to install. The sediment removal expense will range from $6 to $28 per cubic yard.

Overall positive impacts to water quality are expected from a reduction in sediment reaching surface water bodies with the installation of sediment basins. The wetland may also take up some contaminants found in the water.

Diminished washload will result in a slower conversion of habitat types in the lagoon. This diminished washload will benefit the aquatic-dependent wildlife due to reduced sediment associated contaminants. With a significant reduction (60 percent) in washload, the conversion of a silt/clay substrata in the channels to a sand substrata can be expected. This reduction in sediment will increase tidal flushing. The estimated 74 percent reduction in bedload will occur throughout the stream system. The combined effects of reduced washload and bedload may accelerate the headcutting of the underwater Mugu Canyon at the outlet of the lagoon.

The wetland aspect of the VCFCD sediment basin project above Mugu Lagoon will provide additional aquatic benefits and important habitat. In some areas habitat conditions will improve over current conditions; in other areas sediment basins may adversely impact the habitat. The modification of a somewhat natural channel (VCFCD) may have some adverse on-site impacts to wildlife and threatened and endangered species. Mitigation measures should off-set adverse effects in all cases.

This project would result in some reduction in VCFCD sediment removal and restoration expense. Flood damages to properties adjacent to the lower Calleguas Creek would be significantly reduced. In addition, a minor amount of on-farm erosion and flood restoration associated expenses would be reduced.

Table 5-d. Alternative 5: Summary of Impacts of VCFCD Arroyo Las Posas and Calleguas Creek Retention Basin Projects and Small Sediment Basins

Practice & Description: This VCFCD Arroyo Las Posas project includes: Two basins, several grade or drop structures, a pilot channel, rock groins and some channel re-alignment. The project includes 25% of streambank length in subwatershed # 33 and 55% of subwatershed # 34. The Calleguas Creek project is a large basin and wetland project in subwatershed # 1. The NRCS sediment basins are located in the priority subwatersheds #2, #6, #7, #8, #9, #13, and #21. See Appendix C for practice details.

Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a. Install. Cost Arroyo Las Posas Project($)		$5,800,000	$5,800,000
Install. Cost NRCS Sed. Basins Project ($)		$3,180,000	$3,180,000
Install. Cost Calleguas Creek Project ($)		$38,000,000	$38,000,000
Total Installation Cost		$46,980,000	$46,980,000
Average Annual Cost Arroyo Las Posas Proj.		$474,000	$474,000
Average Annual Cost SCS Project		$260,000	$260,000
Average Annual Cost Calleguas Creek Proj.		$3,106,000	$155,000
b. Arroyo Las Posas Maintenance Cost ($/year)		$155,000	$155,000
Small Basin Maintenance Cost ($/year) =		$614,000	$614,000
Calleguas Creek Project Maint. Cost ($/year)		unknown	unknown
Total Maintenance Cost		$769,000	$769,000
Total Average Annual Cost		$4,609,000	$4,609,000
c. Erosion (tons/yr)	1219100	1152000	-67100
d. Sediment(tons/year)	410400	137300	-273100
Washload (tons)	219200	88400	-130800
Bedload (tons)	191200	48900	-142300
Avg. Ann. Cost Per Ton Sed. Reduction			$17
Avg. Ann. Cost Per Ton Washload Reduct.			$35
Avg. Ann. Cost Per Ton Bedload Reduct.			$32
e. Crop land required for project			141
f. Lagoon Habitat Quality (+,-,0)	-	+	+
g. Site Habitat Quality (+,-,0)	+	-	0
h. Water Quality (+,-,0)	-	+	+
Erosion, Sediment, Flood Damage, Expense:			
i. On-farm Land Damage (erosion)($/year)	$85,300	$85,300	$0
j. On-farm Road Dam (eros./flood)($/year)	$170,850	$170,850	$0
k. On-farm equip. Damage (erosion)($/year)	$120,750	$120,750	$0
l. County Road Damage (flood)($/year)	$119,700	$119,700	$0
m. On-farm Land Protect. Expense (flood)($/yr	$17,000	$16,000	($1,000)
n. Stream Restoration Expense (flood)($/year) & Existing Structure Repair Cost (flood)($/year)	$30,800	$28,600	($2,200)
o. VCFCD Sed. Rem. & Restoration ($/yr) **	$890,000	$405,000	($485,000)
p. Flood Damage To Oxnard Plain	$1,267,700	$60,700	($1,207,000)
Total Damage:	$2,702,100	$1,006,900	($1,695,200)
r.			
s. Management Skills Required (more, less, same)		More	
t. Sediment removal expense will depend on disposal options, (cost $6 to $28 per cubic yard)			
** Main Channel Restoration			

5.7 Alternative 6: VCFCD Arroyo Las Posas channel work and VCFCD large sediment basin upstream of the lagoon plus vegetative practices in high priority subwatersheds using cover crops, streambank stabilization, and riparian corridor grade stabilization structures.

Alternative 6 - Combines the VCFCD channel improvements, VCFCD sediment basin, and the NRCS upper drainage treatments with Riparian Corridor Grade Stabilization Structures and Cover Crop with Bank Protection. The impacts of this alternative are summarized in Table 5-e. This alternative reduces sediment from the Calleguas Creek Watershed by 62 percent and costs $52 million dollars to install. The sediment removal expense will range from $6 to $28 per cubic yard.

Diminished washload will result in a slower conversion of habitat types in the lagoon. This diminished washload will benefit the aquatic dependent wildlife due to reduced sediment associated contaminants. With the significant reduction (57 percent) in washload the conversion of a silt/clay substrata in the channels to a sand substrata can be expected. This reduction in sediment will increase tidal flushing. The estimated 68 percent reduction in bedload will occur throughout the stream system. The combined effects of reduced washload and bedload may cause accelerated headcutting of the underwater Mugu Canyon at the outlet of the lagoon.

In most areas habitat conditions will improve over current conditions, in other areas the habitat may be temporarily disturbed, potentially affecting threatened and endangered species. The modification of a somewhat natural channel (VCFCD) may have some adverse on-site impacts to wildlife and threatened and endangered species. Mitigation measures should off-set adverse effects in both cases.

This project would result in some reduction in VCFCD sediment removal and restoration expense. Flood damages to properties adjacent to the lower Calleguas Creek would be significantly reduced. In addition, the majority of on-farm erosion and flood restoration associated expenses would be reduced in the priority upper watersheds.

Table 5-e. Alternative 6: Summary of Impacts of VCFCD Arroyo Las Posas and Calleguas Creek Retention Basin Projects and Tributary Channel Improvement

Practices: Orchard Cover Crop (Blando) + Bank Protection + Riparian Corridor Grade Stab.
The NRCS treatments are located in the priority subwatersheds #2, #5, #6, #7, #8, #9, #13, #30, #33, and #34. See Appendix C for practice details.
The VCFCD Projects are described in Table 5-a.

5. Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a.1 Install. Cost ($): Cover Crop($145/ac)=		$857,600	$857,600
Bank Prot.($6,800/mi)=		$64,100	$64,100
290 Grade Stabilization Structures @ $22,000		$6,357,000	$6,357,000
Arroyo Las Posas Project		$5,800,000	$5,800,000
Calleguas Creek Project		$38,000,000	$38,000,000
a.2 Total Installation Cost		$51,078,700	$51,078,700
a.3 Average Annual Cost: Cover Crop=		$87,300	$87,300
Bank Prot.=		$6,500	$6,500
Grade Stab.=		$520,000	$520,000
Arroyo Las Posas=		$474,000	$474,000
Calleguas Creek Project=		$3,106,000	$3,106,000
a.4 Total Average Annual Installation Cost		$4,193,800	$4,193,800
b.1 Maintenance Cost:Cover Crop ($/year)		$480,700	$480,700
b.2 Maintenance Cost:Bank Prot.($/year)		$1,500	$1,500
b.3 Maintenance Cost:Grade Stab.($/year)		$153,000	$153,000
b.4 Maintenance Cost: Arroyo Las Posas Proj.($/yr)		$155,000	$155,000
b.5 Maintenance Cost: Calleguas Cr Proj. ($/year)		unknown	unknown
b.6 Total Maintenance Cost ($/year)		$790,200	$790,200
b.7: Total Avg. Ann. Inst. & Main. Cost ($/yr.)		$4,984,000	$4,984,000
c. Erosion (tons/year)	1219100	1053300	-165800
d. Sediment(tons/year)	410400	156300	-254100
Washload (tons)	219200	95100	-124100
Bedload (tons)	191200	61200	-130000
Avg. Ann. Cost Per Ton of Sed. Reduction			$20
Avg. Ann. Cost Per Ton of Washload Reduct			$40
Avg. Ann. Cost Per Ton of Bedload Reduct			$38
e. Crop land Acres Required for Project			130
f. Lagoon Habitat Quality (+,-,0)	-	+	+
g. Site Habitat Quality (+,-,0)	+	+	+
h. Water Quality (+,-,0)	-	+	+
Erosion, Sediment, Flood Damage, Expense:			
i. On-farm Land Damage (erosion)($/year)	$85,300	$25,600	($59,700)
j. On-farm Road Dam (eros./flood)($/year)	$170,850	$153,650	($17,200)
k. On-farm equip. Damage (erosion)($/year)	$120,750	$36,250	($84,500)
l. County Road Damage (flood)($/year)	$119,700	$80,350	($39,350)
m. On-farm Land Protect. Expense (flood)($/yr)	$17,000	$9,230	($7,770)
n. Stream Restoration Expense (flood)($/year) & Existing Structure Repair Cost (flood)($/year)	$30,800	$1,550	($29,250)
o. VCFCD Sed. Rem. and Restoration ($/yr.) **	$890,000	$414,000	($476,000)
p. Flood Damages to Oxnard Plain ($/yr)	$1,267,700	$60,700	($1,207,000)
Total Damage:	$2,702,100	$781,330	($1,920,770)
r.			
s. Management Skills Required (more, less, same)		More	
t. Sediment removal expense will depend on disposal options (cost $6 to $28 per cubic yard)			
** Main Channel Restoration			

5.8 Summary and Comparison of Impacts for Different Alternatives.

Table 5-f summarizes the impacts of each of the alternatives. Although not included, dredging of the lagoon could be added to any of these alternatives. How often dredging would be required and how much material would need to be removed depends on which alternative is being considered and what habitat mixture is wanted in the lagoon.

As seen in Table 5-f, it becomes apparent that many factors need to be considered when comparing alternative solutions to reduce sedimentation in Mugu Lagoon. The alternatives with positive impacts on habitat and water quality are numbers 2, 5, and 6. The constructed wetlands in the Calleguas Creek project favorably impacts the quantity of wildlife habitat while the land treatment option provides additional habitat values in the form of riparian habitat and cover crops.

These three alternatives also provide a reasonable cost per ton of sediment reduction. More important is the relatively low cost per ton reduction in sediment washload. A reduction of washload provides more significant benefits to the lagoon than a corresponding reduction in bedload. Diminished washload results in a slower conversion of habitat types in the lagoon and benefits the aquatic wildlife due to reduced sediment associated contaminants. Sediment borne contaminants can typically be found more frequently on the smaller, ionically charged particles of sediment than the larger particles which make up the bedload fraction of the sediment.

For this reason, Alternatives 5 and 6 can be separated from Alternative 2 as they provide more washload reduction for approximately the same cost per ton. Alternatives 5 and 6 will also provide significant reductions, 60 percent and 57 percent respectively, of washload to the lagoon. This will allow the conversion of a silt/clay substrata in the channels to a sand substrata. This reduction in sediment will increase tidal flushing in the lagoon, allowing the lagoon to be kept cleaner and under more natural conditions.

It is difficult to further compare Alternatives 5 and 6 because of the nature of their components.

The third component of Alternative 5 is relatively small sediment basins to be installed at the mouth of canyons in the priority subwatersheds, while the third component of Alternative 6 is on-farm improvements with land treatment. Alternative 5 is therefore considered to be an off-farm option while Alternative 6 can be installed by landowners on-farm and allows more control of the solution by the individual landowners.

It should be remembered that these treatment options apply to those subwatersheds which have been prioritized. Other previously mentioned treatments such as filter strips for orchards or urban management practices may actually be the preferred treatment under some conditions or in some subwatersheds. During the planning stage with the landowners in each subwatershed, the appropriate specific practices should be identified.

5.9 Additional Components of Erosion and Sediment Alternatives.

The focus of alternative development in this report has been on reducing sediment reaching Mugu Lagoon. However, through the evaluation process additional items were identified. Water runoff management, habitat corridor enhancement, and recreation opportunity enhancement are additional components of any alternative to address erosion and sediment. Many of the recommended actions consider these components.

Table 5–f. Summary and Comparison of Impacts for Different Options.

TREATMENT IMPACTS	Alternative 1 Arroyo Las Posas Project Only	Alternative 2 Arroyo Las Posas Project Plus Calleguas Creek Project	Alternative 3 Arroyo Las Posas Project Plus Small Sediment Basins	Alternative 4 Arroyo Las Posas Project Plus Tributary Channel Work with Land Treatment	Alternative 5 Arroyo Las Posas Project Plus Calleguas Cr. Project & Small Sediment Basins	Alternative 6 Arroyo Las Posas Project Plus Calleguas Cr. Project & Tributary Channel w/ Land Treatment
Total installation cost ($)	$5,800,000	$43,800,000	$9,003,000	$13,078,700	$46,980,000	$51,078,700
Total maintenance cost ($/yr)	$155,000	$155,000	$688,000	$790,200	$769,000	$790,200
Total average annual cost	$630,000	$3,106,000	$1,424,000	$1,878,000	$4,609,000	$4,984,000
Erosion (tons/yr)	–67100	–67100	–67100	–165800	–67100	–165800
Sediment (tons/yr)	–67100	–220700	–119500	–108500	–273100	–254100
Washload (tons)	–24100	–107700	–47200	–40500	–130800	–124100
Bedload (tons)	–43000	–113000	–72300	–68000	–142300	–130000
Avg. annual cost / ton sediment reduction	$9	$14	$12	$17	$17	$20
Avg. annual cost / ton washload reduction	$26	$29	$30	$46	$35	$40
Avg. annual cost / ton bedload reduction	$15	$27	$20	$28	$32	$38
Lagoon habitat quality (+,–,0)	+	+	+	+	+	+
On–site habitat quality (+,–,0)	0	+	0	+	0	+
Water quality (+,–,0)	+	+	+	+	+	+
Avg. ann. eros., sed., flood, expense reduction	$256,000	$1,683,000	$259,000	$494,000	$1,695,000	$1,921,000

6. RECOMMENDED ACTION PLAN AND IMPLEMENTATION STRATEGY

6.1 Purpose of Recommended Action Plan and Implementation Strategy Section

In the previous section of this report, several alternatives to address sedimentation concerns were presented. The impacts of each of these alternatives were summarized.

In this section of the report, an action plan to address the sedimentation concerns and related resource concerns is presented. Although the focus of the plan is on control of accelerated sediment, a more holistic approach incorporating other resource issues in the watershed is presented.

A strategy to implement the plan is also presented. Portions of this plan reflect activities that are currently taking place in the watershed. Other portions provide specific activities that should be initiated. In addition, there are portions of the plan that provide conceptual ideas that appear necessary but require further analysis beyond the scope of this study before initiating.

This section of the report includes the following topics:

6.2 Recommended Action Plan
6.3 Implementation Strategy--Action Items
6.4 Implementation Steps and Possible Funding Sources

6.2 Recommended Action Plan

Total sediment control and costs are not the only criteria that should be used when considering the best solution(s) to maintain the Mugu Lagoon ecosystem. As mentioned previously, focusing on a reduction of washload may provide more overall benefits to the lagoon compared to a reduction in bedload. It may also be important to include on-farm land treatment measures to allow private landowners more options and control rather than solely relying on off-site treatment measures. Related resource issues such as urban water runoff and the potential long-term impacts on the stability of the streambanks may need to be incorporated. In addition, there are potential water quality factors to consider. Opportunities to enhance other resources throughout the watershed should also be considered.

Considering the above factors, the core components of the recommended plan are presented in Alternative 6 described in the previous section. This plan addresses the need to reduce the sediment washload and in addition provide significant flood protection, on-farm erosion control, and enhancement of the lagoon ecosystem and increase riparian habitat throughout different portions of the watershed.

In terms of the most cost effective approach to control washload (cost/ton of sediment control) Alternative 2 is the most effective plan. However, Alternative 6 includes treatment measures that incorporates areas outside of the lagoon and main channel portions of the watershed. Treatment in the sediment source areas of the watershed provides a reduction in on-site damages associated with erosion and attempts to provide some long-term solutions. The other components of Alternative 6 do not address the sediment source but rather treat the symptoms.

The recommended plan recognizes the need to both develop cost effective treatments to preserve the lagoon and at the same time identify more long-term treatments that address the source(s) of the sediment reaching the Calleguas Creek system and Mugu Lagoon.

A more long-term treatment perspective that looks beyond just treating the symptoms requires that other components be added to Alternative 6. Additional components to be added are treatment measures to address urban water runoff changes due to urbanization, and wildlife habitat/recreation enhancement measures. These additional components are included but have only been conceptually developed due to the limitations of this study.

Following is a summary of the recommended plan components:

1. Arroyo Las Posas Channel Improvements.
2. Large Flood Water/Sediment Basin just above Mugu Lagoon.
3. Land Treatment and Tributary Channel Stabilization in the Priority Sediment Source Subwatersheds.
4. Watershed Level Coordinated Urban Development Water Runoff Plan.
5. Watershed Level Coordinated Wildlife Habitat/Recreation Enhancement Plan.

6.3 Implementation Strategy--Action Items

This report documents the present status of erosion and sediment and the associated resource issues in the watershed. The effects of potential alternative treatment concepts have been presented. Based on this information, task force members, individuals, and other public agency representatives have identified the need for a coordinated effort in the pursuit of resource enhancement opportunities associated with the Calleguas Creek Watershed.

Following are action items that have been identified to assist in the implementation of the recommended plan.

Action Item 1: Establish consensus specifically pertaining to erosion and sediment concerns in the watershed. Initiate and/or accelerate the implementation of treatment.

Different approaches to addressing the erosion and sediment issues and the varying results are described in this report. Through a continued public involvement process it is important that the long-term direction for treatment be solidified. The current direction is to pursue a combination of treatment efforts such as is described in the recommended alternative.

Implementing Groups and Actions:

Erosion and Sediment Control Task Force: Establish key agency task force to help coordinate, identify implementation funds, and monitor progress.

VCFCD: Main channel stabilization efforts, lower channel sediment storage.

NRCS/Cooperative Extension/CFSA: Tributary enhancement efforts focusing on working with landowners. The approach should be at the subwatershed level. Focus on treatment of the targeted subwatersheds one at a time.

Ventura County/Cities/NRCS: Enhance existing ordinances pertaining to construction activities to control erosion and sedimentation. Enhance existing hillside erosion ordinance and develop procedures to ensure consistent enforcement.

Resource Agencies: Play an active role on the task force.

Action Item 2: Verify what are the long-term objectives for Mugu Lagoon as an ecological system.

This document notes that the lagoon, although it is a valuable resource, is by no means in a natural state, nor is there any expectation that it could be returned to a natural condition. It is generally agreed that the continued filling of the lagoon is not desirable. There is, however, a myriad of other potential scenarios for the future of the lagoon. The goal identified in this report is to establish and manage a dynamic balance between sediment production, transport, and deposition to enhance habitat values in the lagoon, while respecting the value of other ecosystems, as well as present land uses and future needs. The implementors and actions to accomplish this are described in Action Item 1.

There is a need to explore other resource issues besides sedimentation. Land use activities adjacent to the lagoon need to be considered. Adjacent land uses such as the existing duck clubs or activities like the proposed public airport may enhance or degrade the habitat values of the lagoon. Other resource issues that need to be better understood include the quantity of freshwater passing through the lagoon and the quality of this water.

Implementing Groups and Actions:
Interagency Mugu Lagoon Task Force: Establish interagency task force to reiterate the long-term objectives of the lagoon and adjacent lands and identify other studies needed concerning water quality and quantity issues.

Action Item 3: Verify what are the long-term objectives and potential for expanded use of Mugu Lagoon by the regional community.

An associated issue is the potential accessibility and use by the regional population. Currently, there is limited public awareness of the lagoon because there is limited access. In order for the community to develop an appreciation and understanding of the value of the lagoon, there is a need to expand public outreach and education.

Implementing Groups and Actions:
Mugu Lagoon Task Force: Establish key agency task force to develop and implement an expanded community outreach and education program about the resources of the Mugu Lagoon. The task force could also initiate efforts to establish public access opportunities such as a visitor center, and identify funding opportunities.
  Navy Base: Provide educational information to schools; expand educational tour opportunities.
  National Park Service: Participate in the task force efforts.
  State Park Service: Participate in the task force efforts.
  City and County Parks: Participate in the task force efforts.
  Resource Agencies: Participate in the task force efforts.

Action Item 4: There are significant riparian habitat and potential riparian corridor recreation resources in the watershed. These sites are identified, in general terms, in this report. Currently, development projects are required to mitigate site by site. There is the potential to provide additional benefits by establishing more extensive mitigation areas in specific regions of the watershed.

The current community recreation area opportunities along the riparian corridors in the watershed are limited. There is the potential to develop inter-city (regional) recreation opportunities, such as bikepaths and parkways.

<u>Implementing Groups and Actions:</u>

Riparian Corridor Task Force: Establish a riparian corridor habitat task force to address methods to protect and enhance the existing resources. This task force could develop a regional plan that targets areas to be used for mitigation sites. Another role of the task force would be to coordinate the development of a regional recreation use plan along the riparian corridors that would involve the cities, county and local interest groups. Implementation funding sources would also be identified.

Developers: Provide input to the task force on reasonable mitigation options and measures designed to protect and enhance the riparian corridors.

Cities and Counties: Play an active role on the task force to identify long-term regional goals of riparian corridor enhancement and development of recreation opportunities.

VCFCD: Play an active role on the task force.

Interested Local Groups: Play an active role on the task force.

Resource Agencies: Play an active role on the task force.

Action Item 5: Urban water runoff and flooding have been concerns in the watershed for a long time. The VCFCD, cities, and other agencies have taken major steps to limit flood problems. Flooding is still a concern.

There are opportunities to prevent additional flood problems by limiting increased runoff from future development sites. Even without future increased runoff, there are existing flood problems that need to be addressed.

<u>Implementing Groups and Actions:</u>

Water Management Task force: Establish a task force to coordinate different agency/city water management efforts. Develop appropriate guidelines/ordinances to ensure runoff to the main channel system from future developments will not negatively impact downstream improvements or ecosystems.

VCFCD: Continue efforts to implement flood control measures. Work with cities, landowners, and developers on measures to prevent increased future runoff and reduce flooding problems. Coordinate the task force.

Impacted Agriculture Landowners: Work with agencies on alternative flood control measures.

Cities: Provide input into task force on guidelines that would prevent increased future runoff.

Developers: Provide input into guidelines that would prevent increased future runoff.

Resource Agencies: Play an active role on the task force.

6.4 Implementation Steps and Possible Funding Sources

The following components require implementation schedules.

1. Land Treatment and Tributary Stabilization
2. Arroyo Las Posas Channel Improvements.
3. Large Flood Water/Sediment Basin just above Mugu Lagoon.
4. Watershed Level Coordinated Urban Water Runoff Plan.
5. Watershed Level Coordinated Wildlife Habitat/Recreation Enhancement Plan.

The implementation of the above recommended plan may have different stages and may be phased in over several years. Appendix A describes some important characteristics for different populations and how the differences could impact the implementation of the plan. Landowners must be directly involved in the land treatment work. Therefore, implementation should be carried-out in phases.

The following table is one suggestion as to how implementation may proceed on the land treatment and tributary stabilization component of the recommended plan (Table 6-a). As specific implementation efforts are initiated for each priority subwatershed, certain issues will need to be considered by the local project teams (summarized in Table 6-b). As specific implementation measures are identified, funding sources will be needed.

Table 6-c summarizes many of the potential sources of funding for the recommended projects. Appendix B provides additional information on these funding sources.

Steps that could be considered in the potential staging of implementation of Arroyo Las Posas channel improvements and a large flood water/sediment basin just upstream of Mugu Lagoon include:

1. Involve all interested agencies and groups in the refinement of the designs in order to meet as many objectives as possible. This may include recreation needs as well as resource enhancement opportunities.

2. Clearly communicate these projects to the people living in the watershed.

3. Indentify potential construction funding and long term maintenance, and identify the groups involved in maintenance.

4. Develop a way to monitor the project's effectiveness after completion.

In addition, it has been identified that there is a need to coordinate at the watershed level, future development and the associated urban water runoff and wildlife habitat/recreation enhancement planning. This may include:

1. Developing additional watershed level information.
2. Prioritizing treatment needs and opportunities.
3. Developing task forces to address specific treatment needs and opportunities.
4. Initiate demonstration projects
5. Identify potential funding sources.
6. Identify a monitoring program.

Table 6-a: Potential Staging of Implementation of Land Treatment Component

STAGE I

1. Priority subwatersheds identified.
2. Advisory committee for watershed needs to set priorities.
3. Task force formed in one priority subwatershed. Task force begins to work with groups of landowners to determine what physically can be done and that is acceptable to landowners.
4. Begin intensive information program to inform regional population on the resource values of the watershed such as the lagoon, creeks, etc.
5. Identify potential funding sources.

STAGE II

1. Form task forces in other priority subwatersheds and begin targeting groups of landowners in those subwatersheds.
2. Initiate monitoring program to track implementation of conservation practices.
3. Install demonstration projects in priority subwatersheds.
4. Continue and expand education program to include schools and homeowners groups. Complete local and areawide brochure for mail out in utility bills.

STAGE III

1. Include landowners from throughout the watershed in solutions.
2. Continue monitoring program.
3. Continue education program and provide results of demonstration project to landowners.
4. Highlight and reward successful community efforts.

Table 6-b: Issues to Consider as Specific Implementation Efforts are Initiated [1/]

1. Implement processes for getting people to work together.
   Five crucial steps that could be taken are:
   a) Develop a written statement of group's beliefs that are relevant to the project.
   b) Determine wants/needs of group members relative to the resource issues and prioritize them.
   c) Develop and agree on obtainable, measurable written objectives for priority wants/needs.
   d) Develop plan of implementation for the most significant objectives including necessary resources of persons, finances, equipment, time and space, and appropriate techniques (committees, meetings, training sessions, newsletters, tours, demonstration projects, etc.)
   e) Periodically evaluate group's performance against the plan of implementation and make adjustments to plan or to written beliefs, if necessary.

2. Recognize existing accomplishments of landowners. Don't incriminate; instead, say "Let's build and do better."

3. Develop and agree upon at the start of the project a written set of limitations about what the project can't do.

4. Staff for adequate one-to-one educational and technical assistance with landowners who choose to change practices.

5. Refine BMP's to the local situation or objective.

6. Make producers aware, up front, of both the positive and negative economic potentials of every BMP. Positive economic benefits, coupled with environmental effectiveness, are very powerful motivational forces.

7. Be an interagency and interdisciplinary effort.

8. Include a local coordinating committee of no more than seven to eleven members. Landowners should compose at least 1/3 to 1/2 of the committee.

9. Have a project coordinator who is retained for the life of project.

10. Do things designed to bring the team together, such as:
    a) Post a large 6'X 7' map or aerial photo in the central meeting room or "war room" for the group
    b) Have some "fun" meetings every once in a while (tours, barbecues).
    c) Give awards and public recognition to those who adopt BMP's

11. Develop an information and education program including regular newsletters, printed information, and fact sheets.

12. Keep everyone updated on progress (successes and failures) of the project, and

13. Develop a plan to generate local media coverage including news releases.

[1/] Information compiled by American Farm Bureau Federation.

Table 6–c: Matrix of Possible Funding Sources by Project

Recommended Watershed Projects:

Possible Funding Sources [1]:	Arroyo Las Posas Channel Improvements	Sediment Basin Above Mugu Lagoon	Land Treatment & Tributary Channel Improvements	Urban Water Runoff	Habitat Enhancement/ Recreation Opportunities
Calif. Dept. of Education					X
Calif. Dept. of Fish & Game	X	X			X
Calif. Dept. of Forestry			X		
Calif. Dept. of Water Resources	X	X	X		X
Calif. State Coastal Conserv.	X	X			X
Calif. State Wat. Res. Control Board			X	X	
Community Assessment Districts	X	X		X	X
Consolidated Farm Serv. Agency (CFSA) (formerly ASCS)			X		
Local City/County Dept. Funds	X	X		X	X
NOAA				X	X
NRCS (formerly Soil Conser. Ser.)			X		
Pt. Mugu Naval Air Station					X
U.S. Army Corps of Engineers		X			X
U.S. Environ. Protection Agency			X	X	X
U.S. Fish & Wildlife Service					X
U.S. National Park Service					X

[1] Additional details about these funding sources are described in Appendix B.

7. LIST OF PREPARERS

Technical studies and participation leading to the publication of this report were performed by the following:

USDA-Natural Resources Conservation Service:
  Water Resources Planning Staff:
    Monte J. Collins, Assistant State Conservationist (Water Resources)
    Romeo Rivera, Director, Water Resources Planning (Retired)
    Walter Sykes, Acting Director, Water Resources Planning
    Timothy Kuhn, Team Leader and Agricultural Economist
    Thomas Benson, Hydraulic Engineer
    Rebecca Challender, Water Quality Specialist
    Mark Cocke, Civil Engineer
    William Cunningham, Resource Conservationist
    Vernon Finney, Geologist (Planning)
    Patricia Grover, Administrative Assistant
    David Krietemeyer, Agricultural Engineer
    Stanley Moorhead, Civil Engineer (Retired)
    Thomas Share, Civil Engineering Technician
    Betty Shatto, Program Specialist
    Bianca Streif, Biologist

  Salinas Area Office Staff:
    Kenneth Oster, Area Soil Scientist
    Glenn Wilcox, Resource Conservationist

  Somis Field Office Staff:
    Steve Jewett, District Conservationist
    Sheri Klittich, Soil Conservationist
    Peggy Rose, Civil Engineer
    Guy Trohon, Soil Conservationist

USDA-Forest Service:
    Randall Godden, Forester/Biologist

VENTURA COUNTY RESOURCE CONSERVATION DISTRICT:
    Richard Campbell, Consultant
    Pat Oliver, RCD Office Manager
    Mike Simmons, Engineer

CALIFORNIA STATE COASTAL CONSERVANCY:
    Carol Arnold, Program Manager
    Peter Brand, Project Manager
    Mike Fischer, Executive Officer

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APPENDIX A

A STRATEGY FOR ACTION

The Watershed Approach

Mugu Lagoon is one of the few remaining high quality wetlands in southern California. It provides habitat and breeding grounds for several endangered, sensitive, and rare species. This productive wetland is threatened by sediment loads transported during periods of heavy rains.

The multiple sources of sediment into the lagoon include urban developments, agriculture, and public services such as roads and recreation facilities. Controlling sediment will require a long-term commitment and a combination of structural and management measures.

When it comes to water quality, the use of a "watershed approach" is now being emphasized by the Department of Agriculture, the Environmental Protection Agency, and others. This approach involves looking at the bigger picture, or the entire landscape within a drainage basin. Critical to assessing the bigger picture is the involvement of the residents living in the watershed.

Overall Impressions for a Successful Implementation

Information from landowners, local agency personnel, and data from previous studies provide common components of a successful implementation plan.

1. Voluntary programs are important: Involvement of landowners and local government agencies at the outset can lead to local ownership and solutions.
2. Information distribution and education efforts are essential.
3. Cost share funding is important to the success.
4. Lengthy lag time to resource improvement is probable and needs to be understood.
5. A reasonable monitoring program is crucial to any resource improvement effort.
6. A follow-up evaluation several years after a "project" is completed should be done to determine if the practices are still performing well, and if not, why.

Importance of Local Involvement

Land use alone is not the source of contaminants to the lagoon, and the activities of the people using the land must also be addressed. Local residents familiarity with the region in which they live and awareness of the resource problems is important. A key ingredient is for each resident to be aware that their actions and activities can and do affect others.

Table A-1: Comparison of Recommended Practices to Factors that Influence Voluntary Implementation

Recommended Practices	Practice Factors				
	Relative Advantage	Compatibility	Low Complexity	Trialability	Observability
Grade Stabilizers	+/-	+	-	-	+
Debris Basins	+/-	+	-	-	+
Cover Crops	+/-	+/-	+	+	-
Road Work	+/-	+/-	-	-	-
Water Management	+/-	+	+/-	+	-
Critical Area Planting	+/-	+/-	+/-	+	+
Contour Planting	+/-	+	+/-	+/-	+
Filter Strips	+/-	-	+	+	+
Grassed Waterway	+/-	-	+	+	+
Riparian Corridor Management	+/-	-	+/-	-	-
Streambank Protection	+/-	+/-	-	-	+
Education/Ordinance Enforcement	+/-	+/-	+	+	-
Maintenance	+/-	+/-	+/-	+	-

NOTE: A "+" indicates a positive factor, a "-" indicates a negative factor, and "+/- " indicates that it could be a positive or negative factor depending on the specific situation.

Estimating Public Participation Rate

Adoption of Solutions versus Non-Adoption:

Research has resulted in the development of methods to gauge what level of involvement of people can be expected in a voluntary approach program. These methods rely on the evaluation of specific targeted landowner characteristics, characteristics of the agricultural land, characteristics of the practices the landowners are being asked to implement, and an evaluation of community-wide characteristics. A primary source of information for procedures to estimate landowner participation was developed by the National and Regional USDA Soil Conservation Service sociologists and is documented in a SCS Social Science Technical Note titled: Guide For Estimating Participation in Conservation Operations and Hydrologic Area Protection Projects, Feb. 3, 1989. Table A-2 summarizes the major characteristics that previous research studies have shown to be important in whether or not landowners will be receptive to implement pollution control measures.

Table A-2: Important Conservation Adoption Characteristics [1]

I. Characteristics associated with landowner adoption of practices:

- High Income.
- High Use of Mass Media.
- High Education.
- High Number of Contacts With Private Organizations.
- Full-Time Farmers (if agriculture).
- Desire to Pass Farm to Children (if agriculture).
- High Number of Contacts with Government Agencies.
- Willingness to Take Risks.
- High Awareness of Resource Problems.

II. If agriculture, farm/ranch structural characteristics associated with adoption of practices:

- Large Scale Farms.
- Corporate Farms.
- Full Ownership.
- High Gross Farm Sales.
- Low Debt Level.

III. Characteristics of conservation practices/management systems that are associated with adoption of practices:

- Inexpensive.
- Simple and Easy to Use.
- Results are Easy to See.
- Can Implement on a Small Scale.
- Consistent with Existing Ideas, Beliefs & Mgmt. Styles.
- Flexible Enough to Fit into Existing System.
- Installed/Managed by Readily Available Equipment.

IV. Community characteristics that are likely factors of importance associated with conservation adoption:

- Existence of Conservation Clubs/Organizations.
- Healthy Local Economy.
- High Support of District Activities & High Use of Services.
- High Level of Cooperation Between Private/Public Organizations.
- Consistently High Use of Cost-sharing Funds.
- High Support of Educational Activities.
- High Requests for Technical Assistance.
- High Number of Volunteers.
- Existence of District-Paid Employees.

[1] The primary source of this information was compiled by the National and Regional USDA Soil Conservation Service sociologists, and is documented in a SCS social science technical note titled: Guide For Estimating Participation In Conservation Operations and Hydrologic area Protection Projects, Feb. 3, 1989.

It is unrealistic to expect that 100 percent of the landowners can or would be willing to install all of the necessary practices or change their management style to obtain the maximum sediment reduction to the lagoon. A reduction of sediment from the targeted subwatersheds and land uses will be dependent on how acceptable the recommended solutions are to the people who live on or use the land.

The participation estimation procedure is based on an evaluation of the adoption characteristics of the targeted landowners in specific subwatersheds. To determine the viability of successfully targeting particular land uses or groups of landowners, the acceptability by the landowners to voluntarily participate, perhaps with technical and/or financial assistance, can be estimated. The variation of the range generally found in the estimate reflects differences in landowner acceptability of the treatment or treatments for different land uses and locations.

Also important is identifying the reasons for non-adoption. Dr. Pete Nowak in Why Farmers Adopt Technologies points out two categories of reasons for non-adoption: 1) the landowner is unable to adopt the practices or 2) the landowner is unwilling to adopt the practices. Table A-3 summarizes the major reasons for non-adoption under these two categories.

Table A-3: Reasons For Non-Adoption [1]

I. Unable to Adopt Because:
  - Information is lacking.
  - Cost of obtaining information is too high.
  - Complexity of system is too great.
  - Too expensive a management system.
  - Labor requirements are considered excessive.
  - Planning horizon is too short.
  - Limited availability and accessibility of supporting resources.
  - Inadequate managerial skills.
  - Little or no control over the adoption decision.

II. Unwilling to Adopt Because:
  - Information conflicts or is inconsistent.
  - Poor applicability and relevance of information.
  - Conflicts between current goals and the new technology.
  - Lack of knowledge on the part of landowner or sponsor of contaminant reduction practices or technology.
  - Practice is inappropriate for the physical setting.
  - Practice increases risk of negative outcomes.
  - Belief in traditional practices.
  - Limited capital.

[1] Summarized from a paper presented at "Crop Residue Management For Conservation" conference Aug, 9, 1991 in Lexington, KY; author is Dr. Pete Nowak, Dept. of Rural Sociology, Environmental Resources Center, University of Wisconsin-Madison.

Ideally, the promoter of the technology should first identify those landowners that cannot adopt the practices and attempt to remove the barriers, then work with those landowners that have been identified as unwilling. With a good understanding of the reasons for non-adoption, delivery of more accurate and necessary information is possible.

Table A-4 is a checklist of issues that the implementation team should consider before implementation.

Goals/Policies

At some point it may be essential to set a goal or standard for the landowners to meet. The goal may be a voluntary or regulatory policy. The goal might be to achieve a set participation rate or to establish the number of practices implemented during a certain period of time.

As goals are set, management measures or conservation practices should be tracked as they are applied. Tracking will provide the information needed to determine whether the practices have been implemented, operated, and maintained adequately. This information will supplement and assist in fully interpreting available water quality data.

The local task forces may want to set goals or policies on a subwatershed basis. Ideally policies should be based on the following principles:

1. Sediment control policies need to be determined through a planning process between growers, the beneficiaries of water quality improvements, and the responsible local, state and federal agencies. Growers should be given some incentive to implement the control policies;
2. Regulations or policies should be addressed at the watershed level;
3. There must be a long-term local, state, and federal commitment to non-point source pollution control and watershed management. Flexibility for solutions, monitoring progress, and a time schedule needs to be allowed for in local watershed management in order to successfully implement control strategies; and
4. Long-term monitoring and enforcement to achieve explicit water quality improvements consistent with local, state, and federal objectives should be required.

The problem needs to be solved locally. As in any implementation strategy, one of the most important and cost-effective steps is to work with the individual grower and provide information about the sedimentation problem and low cost solutions. Positive steps in erosion and sediment reduction can be taken to reduce the impacts of eroding soils by promoting cost-effective implementation strategies consistent with long-term local, state, and federal watershed objectives.

Table A-4: Checklist of Issues to Consider before Implementation

Checklist of Ideas	Status With this Project	
	Yes	No
* Have a clearly stated goal, supported by realistic assessment of the problem, and the feasibility of solving it;	______	______
* Stress voluntary participation through education, technical assistance, and incentives, and emphasize project benefits;	______	______
* Stress target-audience involvement at project initiation;	______	______
* Target areas where realistic water quality benefits can be maintained and/or obtained; it should be recognized that, because of forces of nature or the natural environment, some areas may not respond to water quality treatments;	______	______
* Concentrate on one-to-one education and demonstration programs;	______	______
* Have full funding for the project committed up front;	______	______
* Include necessary cost-share funds;	______	______
* Be long-term (10 years) in order to understand causes of nonpoint source pollution and the effects BMP's have on water quality;	______	______
* Have a clear understanding of BMPs already in place prior to the study;	______	______
* Have adequate pre-implementation assessment and monitoring;	______	______
* Have a written, agreed upon, plan and time lines;	______	______
* Have sufficient funding to accomplish scientific assessment and evaluation;	______	______
* Have a separate, independent group of recognized experts/ professionals overseeing design and implementation of monitoring and analyses procedures, and evaluation of data; and	______	______
* Measure participating and non-participating landowners' and and other interested groups' attitudes and perceptions pre- and post-project.	______	______

APPENDIX B

POTENTIAL FUNDING SOURCES FOR IMPLEMENTATION

Appendix B includes the program title, objectives, type of assistance/available funds, requirements/limitations, eligibility, and contact for further information for potential funding sources.

Program Title	Agricultural Conservation Program
Objectives	Control erosion and sedimentation and to encourage voluntary compliance with federal/state requirements to solve point and nonpoint source pollution. Water quality improvement is an allowable purpose and is presently receiving special emphasis.
Type of Assistance/ Available Funds	Financial assistance. Direct payments for specified uses.
Requirements/Limitations	The County ASCS Committee sets conservation need priorities. The local Soi and Water Conservation District identifies appropriate conservation practices. Technical assistance is provided by SCS Field Office staff. ASCS provides financial assistance upon certification by SCS of practice installation.
Eligibility	Farmers, ranchers, owners and associated groups who bear a part of a cost of an approved conservation practice are eligible for cost share assistance.
Further Information	State and local ASCS office or. Agricultural Stabilization and Conservation Service U. S. Department of Agriculture P.O. Box 2415 Washington, D.C. 20013 (202) 447-6221

Program Title	Agriculture Preservation Projects
Objectives	Work with property owners, local governments, and state agencies within the coastal zone to establish long-term protection of agricultural lands threatened by development. Tools such as transfer of development rights, purchase of development rights, and realization of supplemental land uses are used to implement this goal. Funding also provides for the purchase of easements.
Type of Assistance/ Available Funds	Grants, loans, land acuisitions, project/program development assistance
Requirements/Limitations	Sites must be in the coastal zone or in the jurisdiction of the San Francisco Bay Conservation And Development Commission.
Eligibility	State, local or federal public agencies or nonprofit organizations.
Further Information	State Coastal Conservancy Carol Arnold 1330 Broadway, Suite 1100 Oakland, CA 94612-2530 (510) 286-4173

Program Title	Assessment and Watershed Protection Support
Objectives	Assessment and watershed protection support activities, can include all levels of government and private organizations.
Type of Assistance/ Available Funds	Grants - Part of Clean Water Act
Requirements/Limitations	Grants - Funds determined annually
Further Information	US Environmental Protection Agency Region IX Mike Schulz, Chief 1235 Missouri Street Grants and Policy Branch San Francisco, CA 94105 (415) 744-1623

Program Title	California Traffic Safety Programs
Objectives	Assist state and local agencies in implementing programs to reduce traffic accidents and/or improve traffic safety-related activities.
Type of Assistance/ Available Funds	Grants
Requirements/Limitations	Funds to supplement not substitue for ongoing expenditures.
Eligibility	Any state agency or local political subdivision.
Examples	Complete program manuals are available upon request.
Further Information	Office of Traffic Safety Marilyn Sabin, Planning & Operations Manager 7000 Franklin Blvd, Suite 440 Sacramento, CA 95823 (916) 445-9734

Program Title	Capitalization Grants for State Revolving Funds
Objectives	Create State Revolving Fund for local financing of municipal wastewater treatment facilities.
Type of Assistance/ Available Funds	Grants
Requirements/Limitations	To provide loans to local governments
Eligibility	States
Further Information	US Environmental Protection Agency Region IX Mike Schulz, Chief 1235 Missouri Street Grants and Policy Branch San Francisco, CA 94105 (415) 744-1623

Program Title	Civil Works Projects
Objectives	To provide help to communities with a variety of water resource problems and opportunities including flood control, coastal and shoreline erosion, outdoor recreation, environmental restoration and water quality control.
Type of Assistance/ Available Funds	Planning, engineering, and other technical assistance and financial assistance with cost sharing. Cost sharing percentages vary by type.
Requirements/Limitations	Six steps for projects. Local sponsors enter into two agreements with the CORPS.
Eligibility	State and local agencies
Further Information	Corps District and Division Office U.S. Army Crops of Engineer Washington D.C. 20314-1000 (202) 272-0144

Program Title	Clean Lakes
Objectives	Prepare identification and classification surveys of all publicly owned lakes.
Type of Assistance/ Available Funds	Grants
Requirements/Limitations	Matching funds required.
Eligibility	States
Further Information	US Environmental Protection Agneyc Region IX Mike Schulz, Chief 1235 Missouri Street Grants and Policy Branch San Francisco, CA 94105 (415) 744-1623

Program Title	Coastal Restoration Projects
Objectives	The Conservancy may award grants to restore areas that are adversely affecting the coastal environment or are impeding orderly development because of scattered ownerships, poor lot layout, inadequate parks and open spaces, incompatible land uses, or other conditions. Up to $100,000 is available to prepare a required coastal restoration plan.
Type of Assistance/ Available Funds	Grants
Requirements/Limitations	Sites must be in the coastal zone or in the jurisdiction of the San Francisco Bay Conservation And Development Commission.
Eligibility	Local public agencies or nonprofit organization.
Examples	Reports of funded projects are available for review.
Further Information	State Coastal Conservancy Steve Horn, Program Manager 1330 Broadway, Suite 1100 Oakland Ca 94612-2530 (510) 286-1015

Program Title	Coastal Wetlands Planning, Protection and Restoration Act
Objectives	Funds are used for acquistion of interests in coastal lands or waters, and for restoration, enhancement, or management of coastal wetland ecosystems. Projects must provide for the long-term conservation of such lands or waters and the hydrology, water quality, and the fish and wildlife dependent on them.
Type of Assistance/ Available Funds	Project Grants
Requirements/Limitations	Project must provide for long-term conservation of coastal lands or waters and the hydrology, water quality, and fish and wildlife dependent on them. Additional requirements are a performance report, audits, and cost records maintained separately for each project.
Eligibility	Available to states bordering on the Pacific.
Examples	New Program
Further Information	Colombus H. Brown Fish and Wildlife Service Division of Federal Aid 4401 Fairfax Dr. Room 322 Arlington, VA (703) 358-2156

Program Title	Coastal Zone Management Program
Objectives	Assist federally approved coastal states in promoting the effective management of the Nation's coastal zone by balancing competing demands of resource protection, protection of public health and safety, provision for public access, and economic development.
Type of Assistance/ Available Funds	Formula grants and oversight of stat CZMA programs.
Requirements/Limitations	Funds must go toward implementing state Coastal Zone Management Programs or toward develoment of management plans.
Eligibility	Coastal states with an approved Coastal Zone Management Program.
Examples	Kings County, WA has used CZM funds in a multiphased research program to investigate the viability of using freshwater wetlands for urban surface water management and nonpoint source pollution control. The project involves collecting baseline data, sampling, analyzing, and monitoring the wetlands and interpreting the results to devise policy and management guidelines that protect wetlands and downstream waterbodies.
Further Information	Chief, Coastal Programs Division Office of Ocean and Coastal Resource Managment National Oceanic and Atmospheric Administration U.S. Department of Commerce 1825 Connecticut Ave., NW Washington, D.C. 20235

Program Title	Conservancy Nonprofit Organization Assistance Program
Objectives	Technical assistance to nonprofit organizations and land trusts for the promotion of public access restoration of coastal wetlands, or agricultural and viewshed protection.
Type of Assistance/ Available Funds	Technical Assistance
Requirements/Limitations	Organization must have obtained tax-exempt status and have articles of incorporation that identify the purposes of organization as being the preservation of land for scientific, historic, educational, ecological, recreational, agricultural, scenic or open space opportunities. Sites must be in the coastal zaone or in the jurisdiction of the San Franscisco Bay Conservation and Development Commission.
Eligibility	Qualified nonprofit organizations.
Examples	Reports of funded projects are available for review.
Further Information	State Coastal Conservancy Joan Cardellino, Program Manager 1330 Broadway, Suite 1100 Oakland, CA 94612-2530 (510) 268-4093

Program Title	Emergency Conservation Program
Objectives	Enables farmers to perform emergency conservation measures to rehabilitate farmlands damaged by natural disasters and to carry out emergency water conservation or water enhancing measures during periods of drought, also wind erosion on farmlands.
Type of Assistance/ Available Funds	SCS provides technical assistance to plan and construct the measures, and ASCS provides the payments.
Further Information	County or state ASCS offices. Agricultural Stabilization and Conservation Service U.S. Department of Agriculture P.O. Box 2415 Washington D.C. 20013 (202) 720-6221

Program Title	Enhancement
Objectives	Enhance and restore coastal habitat through a variety of measures and physical enhancement of the sites either through grants or directly by the Conservancy.
Type of Assistance/ Available Funds	Grants, loans, project development by the Conservancy *Note: Plan preparation is 50% match, funding for implementation varies.
Requirements/Limitations	Sites must be in the coastal zone or in the jurisdiction of the San Francisco Bay Conservation And Development Commission, or a coastal watershed that directly affects a significant downstream coastal resource or relates to the environmental quality or public enjoyment of San Francisco Bay.
Eligibility	State or local public agencies and nonprofit organizations
Examples	Reports of funded projects and annual reports available upon request.
Further Information	State Coastal Conservancy Reed Holderman, Program Manager 1330 Broadway, Suite 1100 Oakland, CA 94612-2530 (510) 268-4183

Program Title	Environmental Education
Objectives	Educational programs for students K-12 relating to the wise use of natural resources and protection of environmental quality.
Type of Assistance/ Available Funds	Grants
Requirements/Limitations	Applicant must contribute matching funds or other equivalent in-kind services and materials. They must also use community resources such as volunteers, free materials, and services available from various government and private agencies.
Eligibility	School districts, county offices of education, local or state governments, nonprofit associations, colleges and universities that maintain teacher training programs, and Univ. of California and California state colleges and universities.
Examples	
Further Information	California Department of Education Environmental Education Coordinator P.O. Box 944272 Sacramento, CA 94244-2720 (916) 657-5374

Program Title	Environmental Enhancement and Mitigation Program (EEM)
Objectives	Provides additional mitigation and natural resources enhancement to offset the environmental impact of new or modified public transportation facilities.
Type of Assistance/ Available Funds	Grants
Requirements/Limitations	Government agencies and nonprofit organizations for Highway Landscape and Urban Forestry, Resource Lands, or Roadside Recreational projects.
Eligibility	Local, state, federal agencies and nonprofit entities.
Further Information	Resources Agency MaryLou Shurteff, EEM Program Coordinator 1416 9th Street, Suite 1311 Sacramento, CA 95814 (916) 344-3596

Program Title	Environmental License Plate Fund
Objectives	Suppports a variety of projects that help to preserve or protect California's environment.
Requirements/Limitations	Projects are funded in one-year increments; projects must be separate, distinct with a clearly defined benefit.
Eligibility	State Agencies, boards, or commissions; city or county agencies; University of California, private nonprofit environmental and land acquisition organization, and private research organizations.
Further Information	Resource Agency Donna Gonder, Secretary to Harold Waraas 1416 9th Street, Room 1311 Sacramento, CA 95814 (916) 653-9709

Program Title	Financial Assistance for Ocean Resources Conservation and Asssessment Program
Objectives	To determine the long-term consequences of human activities that affect the coastal and marine environmen; to assess the consequences of these activites in terms of ecological, economic, and social impacts on human, physical and biotic environments, and to define and evaluate management alternatives that minimize adverse consequences of human use of coastal and marine environments and resources.
Type of Assistance/ Available Funds	Project grants (cooperative agreements)
Eligibility	Universities, colleges, technical schools, institutes, laboratories, state and local government agencies, public and private, profit and nonprofit entities, or individuals are eligible for these funds.
Examples	Development of a data set of characteristics of the Nation's coasts and oceans including erosion rates, coastal vulnerability indices, and coastal hazards for incorporation into a geographic information system and other microcomputer desktop information systems for further analyses.
Further Information	National Ocean Service Office of Ocean Resources Conservation and Assessment (N/ORCA) 1305 East-West Highway Silver Springs, MD 20910

Program Title	Flood Control Projects (Small Flood Control Projects)
Objectives	Reduction of flood damages through projects not specifically authorized by Congress. The Corps of Engineers designs and constructs the project. The local sponsor shares equally in the cost of feasibility studies and project costs and provides a cash contribution for project features other than flood control.
Type of Assistance/ Available Funds	Provision of specialized services. Limit of $5 million.
Further Information	Corps and Division Offices. U. S. Army Corps of Engineers Attn: CECW-PM Washington, D.C. 20314-1000 (202) 272-0144

Program Title	National Pollutant Discharge Elinimation System Related State Program Grants
Objectives	Implement new requirements relating to NPDES program.
Type of Assistance/ Available Funds	Grants
Eligibility	States
Further Information	US Environmental Protection Agency Region IX Mike Schulz, Chief 1235 Missouri Street Grants and Policy Branch San Francisco, CA 94105 (415) 744-1623

Program Title	National Water Quality Asssessment Program (NAWQA)
Objectives	Investigations of surface water and groundwater resources of major regional hydrologic systems will be conducted on a rotating basis for 60 key areas located throughout the nation. The program will address a wide range of major water-quality issues.
Type of Assistance/ Available Funds	Provides water resources information.
Requirements/Limitations	Work must be consistent with the mission of the Water Resources Division of USGS.
Eligibility	Information available to anyone interested.
Examples	Study showed elevated levels of the pesticide DDT in fish in the Yakima River which prompted the Washington Department of Public Health to begin additional studies to determine whether a public health advisory is warranted.
Further Information	Office of the Deputy Assistant Chief Hydrologist for the Nation Water-Quality Assessment Program, Water Resources Division Geological Survey 407 National Center Reston, VA. 22092 (703) 648-5716

Program Title	Near Coastal Waters
Objectives	Improving the environmental condition of near coastal waters.
Type of Assistance/ Available Funds	Grants and Cooperative Agreements
Eligibility	States, other public and nonprofit agencies, institutions, organizations, and individuals.
Further Information	US Environmental Protection Agency Region IX Mike Schulz, Chief 1235 Missouri Street Grants and Policy Branch San Francisco, CA 94105 (415) 744-1623

Program Title	Nonpoint Source (NPS) Water Quality Implementation Grant
Objectives	Controlling nonpoint source pollution in California water bodies.
Type of Assistance/ Available Funds	Grants *Note: 319 Funding - Federal
Requirements/Limitations	40% Match, Three years maximum
Eligibility	Public agencies, nonprofit organizations, and universities.
Examples	Erosion, sedimentation, hydrologic modification, etc.
Further Information	State Water Resources Control Board Division of Water Quality and Water Rights Nonpoint Source Unit Pablo Gutierrez P.O. Box 944213 Sacramento, CA 94244-2130 (916) 322-8342

Program Title	Plant Materials for Conservation
Objectives	Assemble, evaluate, select, release, introduce into commerce, and promote the use of new and improved plant materials for soil, water, and related resource conservation and environmental improvement programs both internationally and domestically.
Type of Assistance/ Available Funds	Provision of specialized services.
Further Information	National Technical Centers, state and field SCS offices Deputy Chief for Technology Soil Conservation Service U. S. Department of Agriculture P.O. Box 2890 Washington D.C. 20013 (202) 720-3905

Program Title	Public Access Program
Objectives	Provide facilities that are suitable for wildlife associated recreational purposes.
Requirements/Limitations	Program to develop state projects in cooperation with local governmental agencies.
Eligibility	Any public agency of the state, or other state or federal agencies.
Examples	Fishing piers and floats, access roads, parking areas, etc.
Further Information	Department of Fish and Game Wildlife Conservation Board W. John Schmidt, Executive Director 801 K Street, Suite 806 Sacramento, CA 95814 (916) 445-8448

Program Title	Public Water System Supervision
Objectives	Carry out public water systems supervision programs.
Type of Assistance/ Available Funds	Fomula Grants - 25 % Match
Program Title	Public Water System Supervision
Objectives	Carry out public water systems supervision programs.
Type of Assistance/ Available Funds	Fomula Grants - 25 % Match
Eligibility	States and Indian Tribes
Further Information	Region IX Mike Schulz, Chief 1235 Missouri Street Grants and Policy Branch San Francisco, CA 94105 (415) 744-1623

Program Title	River Basin Surveys and Investigations (River Basin Planning)
Objectives	SCS provides planning assistance to federal/state/local agencies for development of coordinated water and related land resources programs.
Type of Assistance/ Available Funds	Provision of specialized services.
Further Information	State SCS offices. Deputy Chief for Programs Soil Conservation Service U.S. Department of Agriculture P.O. Box 2890 Washington D.C 20013 (202) 720-4527

Program Title	Rivers, Trails and Conservation Programs
Objectives	Assist citizens to conserve rivers and establish trails on lands outside national parks and forests. The Park Service, in cooperation with citizens and government agencies is involved in the early phases of projects in setting up goals.
Type of Assistance/ Available Funds	Resource and planning expertise to help state and local partners.
Further Information	Recreation Resources and Assistance Division National Park Service U.S Department of the Interior P.O. Box 37127 Washington, D.C. 20013

Program Title	Soil and Water Conservation
Objectives	Plan and carry out a national soil and water conservation program, and to provide leadership in conservation, development, and productive use of the Nation's soil, water, and related resources.
Type of Assistance/ Available Funds	Advisory services and counseling to provide technical assistance to the general public throught total resource planning and management to improve water quality and natural resources and to reduce point and nonpoint source pollution. Technical soil and water conservation resource assistance is provided to state and local governments.
Requirements/Limitations	Resource assistance needed is usually reviewed with the conservation district governing body.
Eligibility	General public, state governments, and local governments.
Further Information	State and field SCS offices. Deputy Chief for Program Soil Conservation Service U. S. Department of Agriculture P.O. Box 2890 Washington D.C. 20013 (202) 720-4527

Program Title	Stewardship Incentives Program
Objectives	Encourage individual landowners to improve the long term management and condition of their lands.
Type of Assistance/ Available Funds	Up to 75 percent cost share with a $10,000 limit per landowner per year.
Requirements/Limitations	Either 10 percent tree cover of capable of growing trees
Eligibility	Landowners with less than 1,000 acres (up to 5,000 with waiver)
Examples	Windbreak/Shelter break plantings, fish and wildlife improvement, agroforestry, riparian plantings, streambank stabilization, erosion reduction projects, woodland improvements
Further Information	Local California Department of Forestry and Fire Protection Forestry Advising Specialist

Program Title	Underground Injection Control
Objectives	Carry out underground injection control programs.
Type of Assistance/ Available Funds	Formula Grant - 25% Match
Eligibility	States and Indian Tribes
Further Information	US Environmental Protection Agency Region IX Mike Schulz, Chief 1235 Missouri Street Grants and Policy Branch San Francisco, CA 94105 (415) 744-1623

Program Title	Urban Forestry Grant Program
Objectives	Planting treets along streets, dedicated open spaces, public parking lots, and school yards.
Type of Assistance/ Available Funds	Grants
Requirements/Limitations	90% of funds must be used for trees. 10% for public awareness and education.
Eligibility	Cities, counties, districts, and nonprofit organizations.
Examples	
Further Information	Department of Forestry and Fire Protection Resource Management Division James R. Geiger, Urban Forester 1416 9th Street, Room 1540-36 Sacramento, CA 95814 (916) 653-9448

Program Title	Urban Streams Restoration Grants
Objectives	Assist local goverment agecies and citizens groups to solve flooding and bank erosion problems in urban areas, using techniques which help restore the natural environmental value of the stream.
Type of Assistance/ Available Funds	Grants, Technical Assistance
Requirements/Limitations	Maximum grant of $200,000
Eligibility	Joint applications only from cooperating citizens groups and local government agencies.
Further Information	Department of Water Resources Division of Local Assistance Earle Cummings, Sara Denzler, Terrie Brown-Resse 1025 P Street P.O. Box 942836 Sacramento, CA. 94236-0001 (916) 327-1656, 327-1664, 323-9544

Program Title	Water Pollution Control State and Interstate Program Support
Objectives	To assist states, tribes, and interstate agencies in establishing and maintaining adequate measures for prevention and control of surface and groundwater pollution.
Type of Assistance/ Available Funds	Formula Grants
Requirements/Limitations	Funds cannot be used for construction, operation, or maintenance of waste treatment plants, nor can they be used for costs financed by other Federal grants.
Eligibility	States
Examples	Grants to states for the prevention, reduction, and control of pollution.
Further Information	US Environmental Protection Agency Region IX Mike Schulz, Chief 1235 Missouri Street Grants and Policy Branch San Francisco, CA 94105 (415) 744-1623

Program Title	Water Quality Management Planning
Objectives	Provide water quality management planning to correct/prevent a wide variety of surface and groundwater problems. Agencies must have the capacity to perform and complete the proposed work.
Type of Assistance/ Available Funds	Grants
Requirements/Limitations	Funding for planning only and requires 25% non-federal match.
Eligibility	State, local or regional agencies.
Further Information	State Water Resources Control Board Division of Water Quality Water Quality Planning Program Paul Lillebo, Chief 901 P Street P.O. Box 100 Sacramento, CA 95801-0100 (916) 657-1031

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Type of Assistance/ Available Funds	Grants
Requirements/Limitations	90% of funds must be used for trees. 10% for public awareness and education.
Eligibility	Cities, counties, districts, and nonprofit organizations.
Examples	
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Type of Assistance/ Available Funds	Grants, Technical Assistance
Requirements/Limitations	Maximum grant of $200,000
Eligibility	Joint applications only from cooperating citizens groups and local government agencies.
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Type of Assistance/ Available Funds	Formula Grants
Requirements/Limitations	Funds cannot be used for construction, operation, or maintenance of waste treatment plants, nor can they be used for costs financed by other Federal grants.
Eligibility	States
Examples	Grants to states for the prevention, reduction, and control of pollution.
Further Information	US Environmental Protection Agency Region IX Mike Schulz, Chief 1235 Missouri Street Grants and Policy Branch San Francisco, CA 94105 (415) 744-1623

Program Title	Water Quality Management Planning
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Type of Assistance/ Available Funds	Grants
Requirements/Limitations	Funding for planning only and requires 25% non-federal match.
Eligibility	State, local or regional agencies.
Further Information	State Water Resources Control Board Division of Water Quality Water Quality Planning Program Paul Lillebo, Chief 901 P Street P.O. Box 100 Sacramento, CA 95801-0100 (916) 657-1031

Program Title	Watershed Protection and Flood Prevention (Small Watershed Program, PL-566 Program)
Objectives	Provide technical and financial assistance to state agencies and units of local governments in planning and carrying out works of improvement and to protect, develop and utilitize the land and water resources in small watersheds, less than 250,000 acres, including total resources managment and planning to improve water quality and solve problems caused by flooding, erosion and sediment damage, conservation, development, utilization, and disposal of water.
Type of Assistance/ Available Funds	Project grants, advisory services, counseling
Requirements/Limitations	Must meet set criteria.
Eligibility	State agencies, counties, municipality, soil and water conservation districts, flood prevention or flood control district, Indian tribe or tribal organization, or any other nonprofit agency with authority under state law to carry out, maintain, and operate watershed works of improvement.
Examples	Development of multipupose facilities for such uses as recreation, improvement of fish and wildlife habitat, irrigation, and water supply to municipal and industrial users.
Further Information	State SCS Offices Deputy Chief for Programs Soil Conservation Service U.S Department of Agriculture P.O. Box 2890 Washington D.C. 20013 (202) 720-4527

Program Title	Wetlands Protection Program
Objectives	Wetland protection activities, can involve other federal agencies, state agenices
Type of Assistance/ Available Funds	Grants - Part of the Clean Water Act
Eligibility	Other Federal Agencies, State Agencies
Further Information	US Environmental Protection Agency Region IX Mike Schulz, Chief 1235 Missouri Street Grants and Policy Branch San Francisco, CA 94105 (415) 744-1623

Program Title	*Wetland Protection - State Development Grants*
Objectives	Grant funds can be used to develop new wetland protection programs or refine existing wetland protection programs.
Type of Assistance/ Available Funds	Grants
Requirements/Limitations	Cost Share Program
Eligibility	States
Examples	
Further Information	US Environmenal Protection Agency Region IX Mike Schulz, Chief 1235 Missouri Street Grants and Policy Branch San Francisco, CA 94105 (415) 744-1623

APPENDIX C

INFORMATION USED TO DEVELOP TREATMENT OPTIONS

Appendix C includes information used to develop the treatment options. Specific impacts of these treatment options is also included.

Part 1. Treatment Options for Typical Land Use Conditions.

Part 2. Maintenance Considerations.

Part 3. Ordinances.

Part 4. Practice Impacts for High Priority Erosion Sources,
Grimes Canyon Subwatershed.

Part 5. Impacts of Selected Practices for High Erosion Sources
in All Priority Subwatersheds.

Part 1. Treatment Options for Typical Land Use Conditions.

TREATMENT OPTIONS FOR TYPICAL LAND USE CONDITIONS

Brief Description of Land Types:

The following are brief descriptions of the land types identified for this study to evaluate erosion and sediment problems.

Orchards: Citrus and avocado are the predominant orchard types. Avocado trees are frequently grown on the steep slopes greater than 6 percent. Most citrus trees are typically grown on slopes less than 6 percent. Subcategories which are the most dominant influences on sheet and rill erosion in orchards are (1) tree type, (2) tree age and (3) slope of ground. New orchards will usually have a higher erosion rate than older more mature orchards because they have less canopy cover and ground cover from litter and mulch from cuttings.

Orchard roads: Orchard roads were separated out from other roads in the study area because they are an integral part of the orchard operation covering 10 percent of the orchards themselves and are a major source of sediment (surface, gullies, and road cuts) coming from orchards.

Other Roads: Other roads include roads other than orchard roads in the uplands of the watershed. It does not include roads in urban areas or other densely populated or developed areas.

Natural Areas: Natural areas are areas of natural vegetation such as brushland, woodland, rangeland or other areas not developed for a specific purpose other than grazing. The rangeland or grassland areas are often grazed by cattle. Fish and wildlife and plant resources habitats are most prevalent in natural areas and are described in more detail in the "Resource Data Inventory" section of this report.

Construction Sites: Construction sites are a wide variety of sites that may be at any phase of construction from beginning to end.

Mines: Mines include all areas that have been excavated to extract material from the earth, except borrow pits adjacent to construction sites.

Confined Animal Facilities: Confined animal facilities include areas where either livestock (Horse Paddocks) or poultry are held in a concentrated area. Erosion rates are usually much higher in the horse paddock areas which average 2 acres in size. The potential for problems associated with nitrates carried off into adjacent surface and ground water bodies is also a concern in this watershed.

Pasture: Pasture includes areas of land that have been planted into some grass and managed to sustain grazing by domestic livestock. Pasture operations are usually associated with horse paddocks and cattle operations.

Urban Residential: Includes all urban areas where the concentration of buildings is greater than one dwelling unit per acre.

Rural Residential: Includes all rural areas where concentration of buildings is less than one dwelling unit per acre.

Field Crops: Field Crops are usually irrigated row crops grown on flat ground in the bottomlands of the watershed.

Typical Landuse Treatments

Following is a brief discussion of the land uses that were considered for erosion and sediment control treatment in the high priority subwatersheds. Also described are the typical land use conditions that are assumed in this study and the type of practices that were considered to address the problems.

Orchards And Orchard Roads: Citrus and Avocado

Typical Conditions: The orchard land use category includes orchards and orchard roads. Orchards were split into subcategories based on type of tree, age of trees, and slope of ground. These subcategories were considered the most dominant influences on erosion in orchards. Erosion rates for orchards (excluding orchard roads) are strictly sheet and rill sources. New citrus and avocado orchards are both equal in erosion rates on equal slopes. The major difference is influenced by slope. New orchards will usually have a higher erosion rate than older more mature orchards because they have less canopy cover and ground cover from litter and mulch from cuttings. Sheet and rill erosion rates in a typical orchard average between 1 and 10 tons per acre. Orchards account for 35 percent of the annual sediment yield from Grimes Canyon to Arroyo Los Posas Creek.

Orchard roads contribute slightly more to sediment yield in the watershed than do the orchard areas themselves (Finney, V.L., Tolsdorf, T., Krietemeyer, D., Mugu Watershed Sediment Yield To Main Channel, 1993, USDA, Soil Conservation Service Davis, California). To determine the quantity of roads in each category, the total road area (10 percent of the orchard area) was estimated. The percent of each type of orchard road within each typical acre of orchard is as follows:

Steep Paved - 15 percent
Flat Paved - 10 percent
Steep Unpaved - 15 percent
Flat Unpaved - 60 percent

Erosion rates were estimated in the field by measuring erosion from the following major road erosion sources: Surface, gullies associated with the road, and road cuts. The combined erosion rate from these sources averages 32 tons per acre.

Typical Treatment Options: The problem faced in the watershed is conveying rainfall runoff from steep orchards and minimizing the amount of sediment leaving the watershed.

A conservation management system that might be used to reduce sediment, nutrients (excess fertilizer), and any excess water from leaving citrus and avocado orchards could be made up of the following system of conservation practices:

1. Critical area planting (342) on roads and road banks (cuts and fills).
2. Regrading roads to tilt inwards (Access Road [356]).

3. Drain Lines(Subsurface Drain [606]) with inlets to take water off box roads in fields.

4. Foot terraces (Small Diversions [362]) between second and third rows of trees if four or more rows occur between box roads.

5. Outlets for foot terraces into concrete ditch (Access Road - Curb and Gutter [356]) along up and down hill dirt access roads.

6. Water bars (Access Road [356] on dirt access roads to break slope and convey water into concrete ditch at edge of road.

7. Outlets (620) for orchard drain lines and for concrete ditches on orchard roads.

8. Diversions (Earth or Lined [362]) to carry water from roads or fields if there is no channel at base of hill.

9. Grassed Waterway (412) Replace earth drainage ditches with grassed waterways where necessary to convey drain water off orchard slopes and reduce erosion.

10. Cover Crops (340) on newly planted orchards for the first four to seven years of growth.

11. Layout newly planted orchards and roads for maximum control of drain water using 1 thru 9 above.

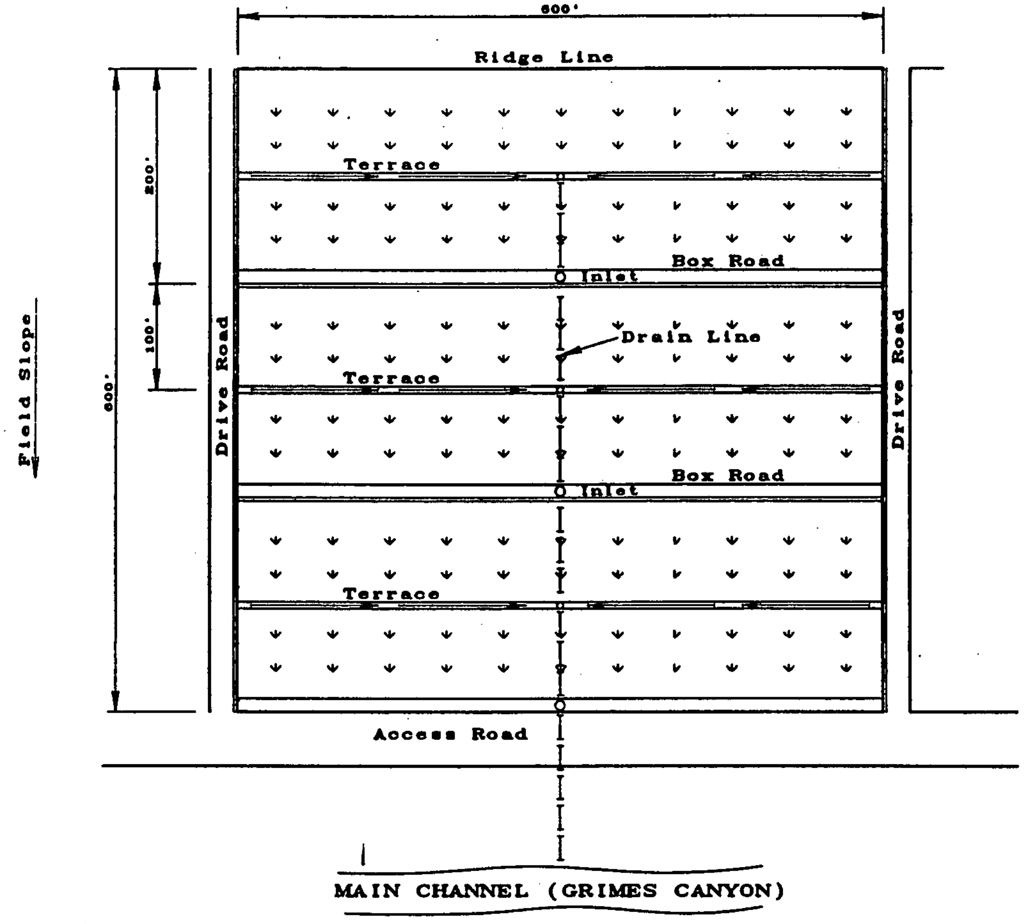
12. Irrigation Water Management (449) - To efficiently meet plant water requirements for the desired growth and to minimize soil erosion, loss of plant nutrients, and undesirable water loss.

13. Nutrient Management (590) - Managing the timing and rate of application to meet plant requirements and minimize the amount of excess nutrients that can be carried to ground and surface waters.

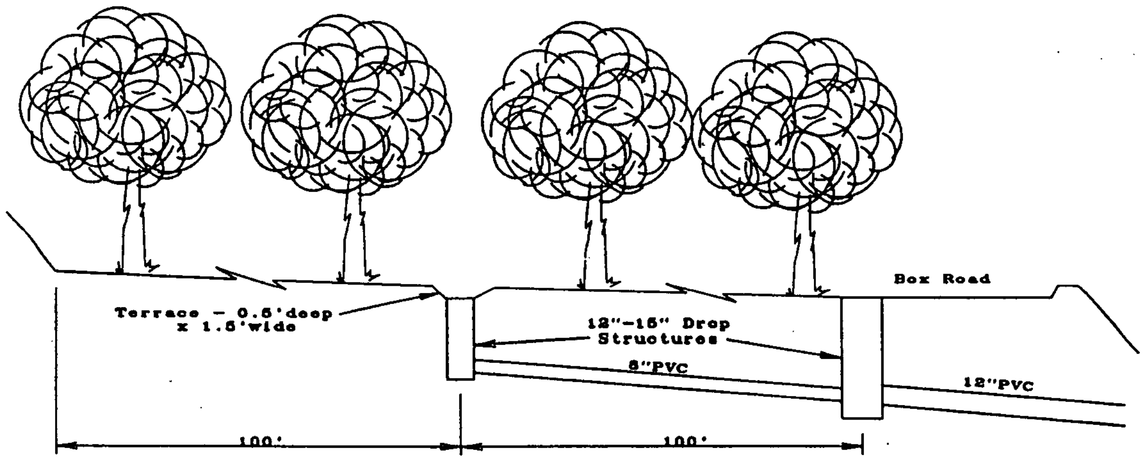
14. Filter Strip (393) - A strip of vegetation, usually at the lower ends of fields, used for trapping sediment and nutrients carried in runoff water so they are not carried down stream to the lagoon.

The following describes factors considered in developing alternatives and conservation management systems.

The basic unit of orchard is 600 feet long, perpendicular to the slope and 600 feet long parallel with the slope (See attached Figure C-1). The tree rows are planted parallel with the contours. There are generally four tree rows between box roads. Box roads are diversions used to haul fruit out of the orchards to the drive roads which run perpendicular to the contour. Over the years these box roads have silted in and are now either level or slope down hill. The drive roads erode severly each winter and soil is removed from the box roads for repairs.



DRAINAGE PLAN FOR BASIC ORCHARD UNIT



TYPICAL CROSS SECTION OF ORCHARD UNIT

FIGURE C-1: Typical Half-Section of Orchard Unit

Erosion within the orchard is taking place as sheet flow builds between the roads and as the box roads spill over. The most severe sheet erosion takes place as the water passes over the third and fourth tree rows. To reduce sheet erosion foot terraces (small ditches) will be installed between the second and third tree rows. In order to minimize potential erosion, the foot terraces will be sloped to the center of the tree row where runoff will be intercepted by an inlet to the underground drainline that will be installed. The underground drain line will outlet into a down stream intermittent channel or water way. Because of debris and the possibility of plugging 12 to 15 inch riser inlets will be used for the drainline. The area drained by the foot terraces is 0.7 acres. The foot terrace ditch needs to be 0.5 feet deep with a bottom width of 1.5 feet in order to carry the discharge of 0.3 cfs from a one inch per hour rainfall event. There are contractors in the area who have the equipment to install these ditches.

The box roads need to be regraded so that the cross slope is once again back into the hill. This will allow the road to once again be able to carry water. The box roads will drain to the center of the tree rows and drainage will be intercepted by the same drain lines with inlets that are used to drain the foot terraces. Some rock will be needed at the outlet into the intermittent channel.

Presently the drive roads run down slope collecting all of the box road water plus the rain fall on the road. The drive roads will be graded to one side with a six foot concrete section and a sloping curb. The flow depth will be about 6 inches deep. Waterbars will be installed in the earth section to direct the rainfall flows across to the concrete section. The road would outlet into the access road ditch. Some erosion protection will be needed at that point.

The access road ditches are on 7 to 10 percent slopes and will need to be stabilized. Lined and paved waterways will be used. Where these ditches outlet into the intermediate channels drop inlets will be needed.

Typical Treatment Cost: Sixty four percent of the orchards and orchard roads in Grimes Canyon occur on the steep to very steep lands, and it has been estimated that 70 percent of these orchards would need the following practices for maximum control of drain water and to reduce erosion-caused sediment damages that are occurring in the watershed.

Following are the types, quantity, and costs of the practices that would be required.

1. Install Cover Crops on 570 acres of new orchards (up to 7 years old) to reduce sheet and rill erosion until the trees produce enough litter to cover most of the soil.

2. Treat the 2.6 miles of up and down hill drive roads, the 7.6 miles of box roads, and 2.6 miles of access roads in the 928 acres of avocados and lemons on steep and very steep lands.

3. Do the above and install the diversions needed to safely outlet water from fields and roads into channels.

4. Do the above and stabilize the intermediate channel.

The installation cost for the orchard drainage system is estimated to be $4400 per acre with an average annual cost of $450 per acre. Installation cost for orchard cover crops is between $145 and $230 per acre with an average annual cost between $14 and $40 per acre. Between 41 and 90 percent of the sediment generated from orchards could be reduced by installing the orchard drainage system practices and the orchard cover crops.

Stream Corridors

Typical Condition: Stream corridor erosion includes all types of erosion associated with streams including mass wasting, degradation of the channel due to scouring, etc. Stream corridor erosion from 14.6 miles of primary tributaries contributes 3,000 tons or 20 percent of the sediment yield from Grimes Canyon Watershed.

An example of a conservation management system that might be used to reduce erosion and sediment caused by streambank erosion could be made up of sediment basins, streambank protection, and grade stabilization structures.

a. Streambank and Shoreline Protection (580) component

Typical Option: Stream channel banks will be stabilized to reduce and protect them against scour and erosion. Streambanks will be shaped and planted to locally adapted perennial grasses such as purple needle grass, giant wild rye, or California buckwheat to name a few. Willows, alders, cottonwoods, and other locally adapted species are other possible choices.

Typical Cost: The cost to install these improvements is estimated to be $6800 per streambank mile. This assumes that spot treatments will occur on both banks; approximately 25 percent of stream mile will be treated.

b. Sediment Basin (350) component

Typical Option: To collect and store debris and sediment on the lower end of the major tributary of Grimes Canyon before it reaches Arroyo Las Posas. The quantity of sediment expected from the various sources was estimated by the geologist. A sediment basin would serve to collect the sediment from the various sources rather than treatment of each source of erosion.

A sediment basin in Grimes Canyon was designed to hold the sediment yield from a 100 year event. This yield was calculated using both Scott's Method and the Army Corps of Engineers Method. The value from the Corps Method was used because it was larger. It was determined that the 100 year peak discharge is approximately 3,300 cfs and that the freeboard for the structure will be three feet.

The earth embankment will have 3:1 upstream and downstream slopes to guard against piping failure. A twelve foot wide by five foot deep keyway of compacted fill will also be constructed to prevent piping failure. This top width was set at twelve foot due to the equipment that will be used to construct the earth embankment. The materials to build the embankment will be excavated out of the pool area of the structure thereby providing more storage.

Typical Cost: The project plan life is 50 years and will cost $470,000 to install. The annual operation and maintenance cost will be $122,000, which includes annual removal of 10,000 cubic yards of sediment (at a cost of $12 per cubic yard) and $2,000 for repair work to the structure. The design trap efficiency of the basin is 80% (meaning that 80% of the 15,170 tons of average annual sediment yield, or 12,155 tons or 10,000 cubic yards, will be removed). Average annual bedload of 7,555 tons (100%) will be removed, and 4,600 tons (60%) of the inflowing average annual wash load will be removed. This means that (7,615 - 4,600) 3,015 tons of the wash load will still pass the structure after its installation. The installation of this structure will reduce the peak flow of the 100 year storm by about 25% or 900 cfs.

Under this scenario, streambanks continue to fail at the rate of 0.04 acres per year. Average annual sediment yield from the watershed is reduced by 80%, as mentioned above, so that the amount reaching the main stem of the Arroyo Las Posas will be about 3,000 tons per year (15,170 tons - 12,155 tons = 3,015 tons). All of the "average annual" figures used above come from the "Mugu Watershed Sediment Yield to Main Channel" 1993 SCS report (Finney, et al).

c. Grade Stabilization Structure (410) component

Typical Option: A structure used to control the grade and/or reduce head cutting in natural or artificial channels

Several field visits were made to Grimes Canyon watershed to inventory the existing channel grade stabilizers and assess how well they function. Approximately fifteen structures were found in various conditions.

Areas within Grimes Canyon watershed where grade stabilization structures are needed were identified by field visits. Identifying characteristics for these areas were noted and then located on the 1990 infra-red maps. Other areas within the subwatershed with the similar characteristics were then identified so that treatment could be developed for them.

It was also observed in the field that stable channel systems which were not producing sediment had a slope of 0.5 percent, therefore a channel slope of 0.5 percent was used in determining the number of structures needed. NRCS field office personnel have designed channel systems for 1 percent slope and found them to work well.

The upstream faces of the structures will have a slope of 2:1 and the downstream faces will have a slope of 3:1. The top width of the structures will be five feet. A compacted fill keyway will be placed under the upstream face to prevent piping under the structures, and concrete cutoff walls will be placed at the structures' junction with the existing banks to prevent piping around the sides. The size of the notch in the structures (2:1 sides, trapezoidal cross section) was set so that it would pass a 25 year peak discharge with one half foot freeboard. This peak discharge was determined using the "Flood Prevention and Watershed Conservation Plan for the Calleguas Creek Watershed" 1954 SCS report and verified using Engineering Field Manual Chapter 2 methods. Structures were designed with locking blocks on both faces and the top to ensure that the 100 year peak discharge can pass over the structure without damaging it. An apron constructed of locking block with "dragon teeth" installed on it will extend ten feet beyond the downstream toe in order to dissipate energy and transition flows back into the natural channel.

Based on field observations, design was for a ten foot deep channel with vertical banks. All the structures will be ten feet tall, and one of four different types to account for varying channel widths and notch sizes. These structures are as follows:

Type	Height	Bottom Width	Notch Depth
A	10'	30'	4.0'
B	10'	40'	3.5'
C	10'	25'	3.5'
D	10'	10'	4.0'

Having considered all the above, it was determined that 59 structures will be needed.

The following three descriptions describe three different installation scenarios for grade stabilization structures.

1. Grade Stabilization, Allow for Natural Bank Stabilization

Grade stabilization structures will be installed to establish a stable slope of 0.5 percent and existing banks allowed to fail at a present rates until the system is stable. In evaluating this option, four conditions were studied and the average values of the four conditions were used to come up with cost and effectiveness. The four conditions include:

a. Bank failure at 1.5:1 to the invert of the grade stabilizer weir.
b. Bank failure at 2:1 to the invert of the grade stabilizer weir.
c. Bank failure at 1.5:1 to the invert of the channel.
d. Bank failure at 2:1 to the invert of the channel.

It is assumed that the banks will fail at a slope varying from 1.5:1 to 2:1 and that the failure plane will vary from the toe of the existing bank to the invert of the grade stabilizer weir.

Typical Cost: The estimated cost of the project is $1,250,000 and its planned life is 50 years. The average annual operations and maintenance cost for the 59 structures including the fifteen existing structures will be $37,000. Soil loss from the banks before stability is calculated as 610,000 tons.

The "average annual" figures used below come from the "Mugu Watershed Sediment Yield to Main Channel" 1993 SCS report (Finney, et al, 1993d). The average annual streambank soil loss is about 4,700 tons, of which we calculated that 500 tons will be trapped. The average annual gross sediment yield is 15,170 tons, of which, we calculated that about 7,700 tons per year will be trapped by structures, assuming regular cleanout. This means that 7,500 tons still pass through the structures. The average annual bedload is 7,555 tons, which we calculate will all be trapped by structures. The average annual washload is 7,615 tons, of which we calculated 115 tons will be trapped.

2. Grade Stabilization, Allow for Riparian Restoration

Grade stabilization structures will be installed to establish a stable slope of 0.5% and the banks will be graded to side slope of 1.5:1. The material removed from the grading will be placed behind the structures as compacted fill. The banks will be planted with native species of riparian vegetation.

Typical Cost: The estimated cost of the project is $2,025,600 and its planned life is 50 years. The average annual operations and maintenance cost for the 59 structures including the fifteen existing structures will be $37,000.

The "average annual" figures used below come from the "Mugu Watershed Sediment Yield to Main Channel" 1993 SCS report (Finney, et al). The average annual streambank soil loss is about 4,700 tons, and we calculated a 90 percent reduction after the riparian vegetation is established, leaving 500 tons per year still passing through. We also calculated that 90 percent of the average annual sediment yield from streambanks will be eliminated due to the reshaping of the streambanks. This means that the average annual sediment yield from streambanks will be reduced by about 2,700 tons. The calculated combined effects of the riparian lined banks and grade stabilization structures will be to reduce gross average annual sediment yield to the Arroyo Las Posas from Grimes Canyon watershed to about 7,000 tons. With this option, it should be noted that 18.6 acres will be removed from agricultural crop production and planted to riparian vegetation.

3. Grade Stabilization, Allow for Replant of Orchard Groves

Grade stabilization structures will be installed to establish a stable slope of 0.5 percent and the banks will be graded to side slope of 2:1. The material removed from the grading will be placed behind the structures as compacted fill. Orchards will be reestablished along the banks.

Typical Cost: The estimated cost of the project is $1,818,700 and its life is set at 50 years. The average annual operations and maintenance cost for the 59 structures including the fifteen existing structures will be $37,000. Note, the overall net cost is less than the previously discussed grade stabilization scenario because less land will be taken out of agricultural production.

The "average annual" figures used below come from the "Mugu Watershed Sediment Yield to Main Channel" 1993 SCS report (Finney, et al). The average annual streambank soil loss is about 4,700 tons, and we calculated a 60% reduction after the groves are established, leaving about 1,900 tons per year still passing through the structures. We also calculated that about 60% of the average annual sediment yield from streambanks (or 1,800 tons) will be eliminated due to the reshaping of the streambanks. With this option, it should be noted that 17 acres will be removed from agricultural crop production for a short period of time and planted back to orchards once the grading is completed.

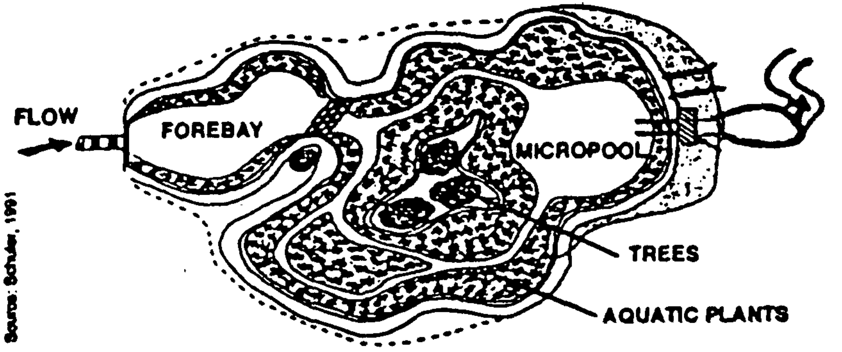
Other Roads

Typical Conditions: This category includes roads other than orchard roads in the uplands of the Calleguas Creek Watershed. It does not include roads in urban areas or other densely populated or developed areas. Erosion from other roads has been identified as the source of 14 percent of the sediment from Grimes Canyon.

Typical Treatment Options and Cost: The largest single erosion source (50 percent) is from unpaved roads concentrated flow sources (2,170 tons). This source is associated with the "road side ditches" and gullies extending from roads to drains. The proposed solution for the typical condition is an 18 inch culvert ($30 per foot installed) 80 feet long. An estimated 10 culverts are needed per road mile. The actual condition will vary both in spacing and diameter. In addition, road side ditches are planned to be replaced with lined waterways at a cost of $14 per linear foot. The cost for treatment for this source is 1.14 million dollars. The estimated reduction associated with installation is 85 percent of the original erosion volume.

The next road sediment source to be treated is paved road cut slope erosion (820 tons per year). There were two options considered for treatment. The first is where the 2:1 slope would intersect a high value improvement. The typical case used was the Eggs West Project (200 feet of crib wall for $140,000). The other option considered was sloping the cut to 2:1. It was assumed that this would require the purchase of an additional 20 feet of right of way, sloping, and critical area treatment ($35,000 per acre). The estimated cost was split between 5 percent high cost and 95 percent low cost options. The estimated amount of cut slope was 900 feet per road mile. The total estimated cost for treatment was $386,000 (8.4 miles at $46,000 per road mile). The estimated reduction associated with installation is 75 percent of the original erosion volume.

BMP: CONSTRUCTED WETLANDS



Source: Schuler, 1991

DESCRIPTION

Constructed wetlands have a significant percentage of the facility covered by wetland vegetation.

EXPERIENCE IN CALIFORNIA

Research facility constructed in Fremont in 1983 by the Association of Bay Area Governments. Several communities (Davis, Orange County) have regional detention ponds that are essentially constructed wetlands.

SELECTION CRITERIA

- Need to achieve high level of particulate and some dissolved contaminant removal.
- Ideal for large, regional tributary areas.
- Multiple benefits of passive recreation and wildlife.

LIMITATIONS

- Concern for mosquitoes.
- Cannot be placed on steep unstable slopes.
- Need base flow to maintain water level.
- Not feasible in densely developed areas.
- Wet season coincident with minimal plant growth.
- Nutrient release may occur during winter.
- Overgrowth can lead to reduced hydraulic capacity.
- Regulatory agencies may limit water quality to constructed wetlands.
- May be regulated under Chapter 15, Title 23, California Code of Regulations regarding waste disposal to lands.

DESIGN AND SIZING CONSIDERATIONS

- Suitable soils for wetland vegetation.
- Surface area equal to at least 1% and preferably 2% of the tributary watershed.
- Forebay.

CONSTRUCTION/INSPECTION CONSIDERATIONS

- Involve qualified wetland ecologist to design and install wetland vegetation.
- Establishing wetland vegetation may be difficult.

MAINTENANCE REQUIREMENTS

- Remove foreign debris and sediment build-up.
- Areas of bank erosion should be repaired.
- Remove nuisance species.
- Control mosquitoes.

Considerations

[✓ *Soils*]
[✓ *Area Required*]
[✓ *Slope*]
[✓ *Water Availability*]
Aesthetics
Hydraulic Head
[✓ *Environmental Side Effects*]

Targeted Constituents

- ● *Sediment*
- ● *Nutrients*
- ● *Heavy Metals*
- ● *Toxic Materials*
- ● *Floatable Materials*
- ● *Oxygen Demanding Substances*
- ● *Oil & Grease*
- ◒ *Bacteria & Viruses*

● *Likely to Have Significant Impact*
○ *Probable Low or Unknown Impact*

Implementation Requirements

- ● *Capital Costs*
- ◒ *O&M Costs*
- ◒ *Maintenance*
- ○ *Training*

● *High* ○ *Low*

TC3

Best Management Practices

BMP: CONSTRUCTED WETLANDS (Continue)

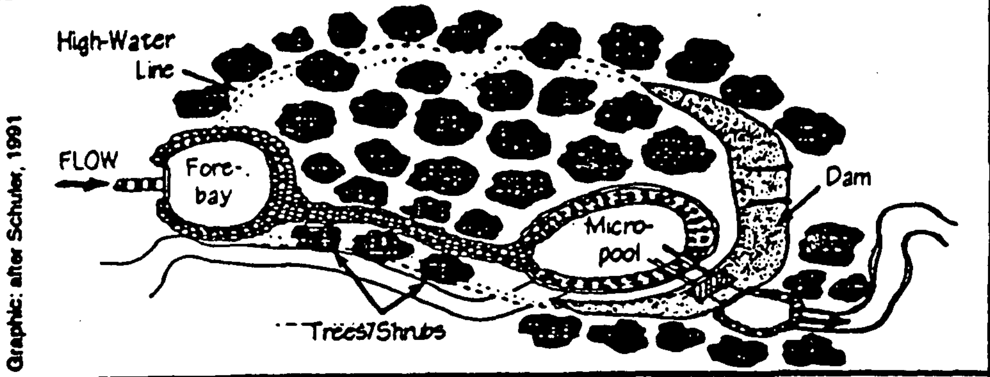
COST CONSIDERATIONS

- Wetlands being shallower than wet ponds may result in larger area requirements.
- Costs for providing supplemental water may be prohibitive.

TC3

Best Management Practices

BMP: EXTENDED DETENTION BASINS



DESCRIPTION

Extended detention basins are dry between storms. During a storm the basin fills. A bottom outlet releases the storm water slowly to provide time for sediments to settle.

EXPERIENCE IN CALIFORNIA

There are no known extended detention basins in California. Hydraulic detention basins may function like extended detention basins if the former has been sized to control the pre-development 2-year event. More liberal standards do not provide sufficient detention time.

SELECTION CRITERIA

- Objective is to remove only particulate pollutants.
- Use where lack of water prevents the use of wet ponds, wetlands or biofilters.
- Use where wet ponds or wetlands would cause unacceptable mosquito conditions.

LIMITATIONS

- May be less reliable than other treatment control BMPs.
- Inability to vegetate banks and bottom may result in erosion and resuspension.
- Limitation of the orifice diameter may preclude use in small watersheds.
- Requires differential elevation between inlet and outlet.
- Pending their volume and depth basin designs may require approval from State Division of Safety of Dams.

DESIGN AND SIZING CONSIDERATIONS

- Basin volume is sized to capture a particular fraction of the runoff.
- Drawdown time of 24 to 40 hours.
- Shallow basin with large surface area performs better than deep basin with same volume.
- Place energy dissipators at the entrance to minimize bottom erosion and resuspension.
- Vegetate side slopes and bottom to the maximum extent practical.
- If side erosion is particularly severe, consider paving or soil stabilization.
- If floatables are a problem, protect outlet with trash rack or other device.
- Provide bypass or pass through capabilities for 100 year storm.

CONSTRUCTION/INSPECTION CONSIDERATIONS

- Make sure the outlet is installed as designed.

Considerations

Soils

[✓ *Area Required*]

Slope

Water Availability

Aesthetics

[✓ *Hydraulic Head*]

Environmental Side Effects

Targeted Constituents

- ● *Sediment*
- ◒ *Nutrients*
- ◒ *Heavy Metals*
- ◒ *Toxic Materials*
- ◒ *Floatable Materials*
- ◒ *Oxygen Demanding Substances*
- ◒ *Oil & Grease*
- ○ *Bacteria & Viruses*

● *Likely to Have Significant Impact*
○ *Probable Low or Unknown Impact*

Implementation Requirements

- ● *Capital Costs*
- ◒ *O&M Costs*
- ◒ *Maintenance*
- ○ *Training*

● *High* ○ *Low*

TC5

Best
Management
Practices

BMP: EXTENDED DETENTION BASINS (Continue)

MAINTENANCE REQUIREMENTS

- Check outlet regularly for clogging.
- Check banks and bottom of surface basin for erosion and correct as necessary.
- Remove sediment when accumulation reaches 6-inches, or if resuspension is observed.

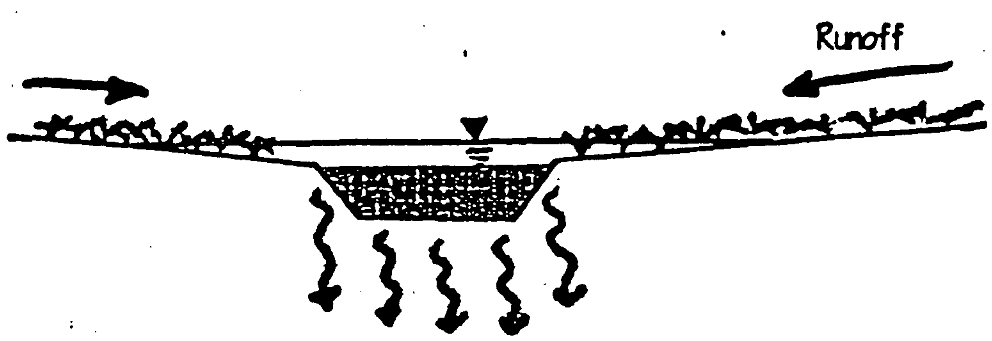
COST CONSIDERATIONS

- Generally less expensive than wet ponds and wetlands, but more expensive than biofilters.
- Erosion of unprotected areas in residential developments increases maintenance costs.

TC5

Best Management Practices

BMP: INFILTRATION



DESCRIPTION
A family of systems in which the majority of the runoff from small storms is infiltrated into the ground rather than discharged to a surface water body. Infiltration systems include: ponds, vaults, trenches, dry wells, porous pavement, and concrete grids.

EXPERIENCE IN CALIFORNIA
Infiltration ponds have been used by many local jurisdictions and CalTrans in the Central Valley for about three decades.

SELECTION CRITERIA
- Need to achieve high level of particulate and dissolved pollutant removal.
- Suitable site soils and geologic conditions; low potential for long-term erosion in the watershed.
- Multiple management objectives (e.g., ground water recharge or runoff volume control).

LIMITATIONS
- Loss of infiltrative capacity and high maintenance cost in fine soils.
- Low removal of dissolved pollutants in very coarse soils.
- Not suitable on fill sites or steep slopes.
- Risk of ground water contamination in very coarse soils, may require ground water monitoring.
- Should not use until upstream drainage area is stabilized.
- Infiltration facilities could fall under Chapter 15, Title 23, of California Code of Regulations regarding waste disposal to land.

DESIGN AND SIZING CONSIDERATIONS
- Volume sized to capture a particular fraction of annual runoff.
- Pretreatment in fine soils.
- Emergency overflow or bypass for larger storms.
- Observation well in trenches.

CONSTRUCTION/INSPECTION CONSIDERATIONS
- Protect infiltration surface during construction.
- Vegetation of pond sides to prevent erosion.
- Frequent inspection for clogging during construction.

Considerations

[✓ *Soils*]
[✓ *Area Required*]
[✓ *Slope*]
Water Availability
Aesthetics
Hydraulic Head
[✓ *Environmental Side Effects*]

Targeted Constituents

● *Sediment*
◒ *Nutrients*
● *Heavy Metals*
● *Toxic Materials*
● *Floatable Materials*
● *Oxygen Demanding Substances*
● *Oil & Grease*
● *Bacteria & Viruses*

● *Likely to Have Significant Impact*
○ *Probable Low or Unknown Impact*

Implementation Requirements

◒ *Capital Costs*
◒ *O&M Costs*
◒ *Maintenance*
○ *Training*

● *High* ○ *Low*

TC1

Best
Management
Practices

California Storm Water Best Management Practice Handbooks prepared by Camp, Dresser, and Mckee et al

BMP: INFILTRATION (Continue)

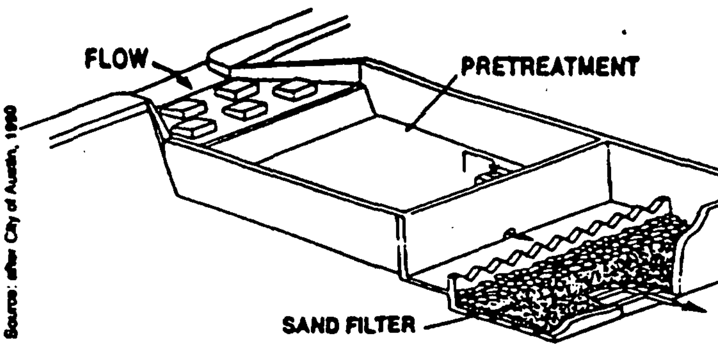
MAINTENANCE REQUIREMENTS

- Remove sediment at frequency appropriate to avoid excessive concentrations of pollutants and loss of infiltrative capacity.
- Frequent cleaning of porous pavements.
- Maintenance is difficult and costly for underground trenches.

COST CONSIDERATIONS

- Potential for high maintenance costs due to clogging.

BMP: MEDIA FILTRATION



Source: after City of Austin, 1990

DESCRIPTION

Consists of a settling basin followed by a filter. The most common filter media is sand; some use peat/sand mixture.

EXPERIENCE IN CALIFORNIA

- A tenant at the Port of Long Beach recently installed a sand filter. The City of Los Angeles will soon install several experimental filters.

SELECTION CRITERIA

- Objective is to remove only sediment (particulate pollutants).
- Use where unavailability of water prevents the use of wet ponds, wetlands, or biofilters.
- Can be placed underground.
- Suitable for individual developments and small tributary areas up to about 100 acres.
- May require less space than other treatment control BMPs.

LIMITATIONS

- Filter may require more frequent maintenance than most of the other BMPs.
- Head loss.
- Dissolved pollutants are not captured by sand.
- Severe clogging potential if exposed soil surfaces exist upstream.

DESIGN AND SIZING CONSIDERATIONS

- Settling basin smaller than wet or extended detention basin.
- Spread flow across filter.
- Place filter offline to protect from extreme events.
- Minimize erosion in settling basin.

CONSTRUCTION/INSPECTION CONSIDERATIONS

- Be certain filter sand is clean and the outlet device from the basin to the filter is level.

MAINTENANCE REQUIREMENTS

- Clean filter surface about twice annually; or more often if watershed is excessively erosive.

COST CONSIDERATIONS

- Filtration system may use less space than other systems.
- Smaller media improves performance but increases maintenance costs.

Considerations

Soils
Area Required
Slope
Water Availability
Aesthetics
[✓ *Hydraulic Head*]
Environmental Side Effects

Targeted Constituents

● *Sediment*
◒ *Nutrients*
◒ *Heavy Metals*
○ *Toxic Materials*
● *Floatable Materials*
◒ *Oxygen Demanding Substances*
◒ *Oil & Grease*
◒ *Bacteria & Viruses*

● *Likely to Have Significant Impact*
○ *Probable Low or Unknown Impact*

Implementation Requirements

● *Capital Costs*
◒ *O&M Costs*
◒ *Maintenance*
○ *Training*

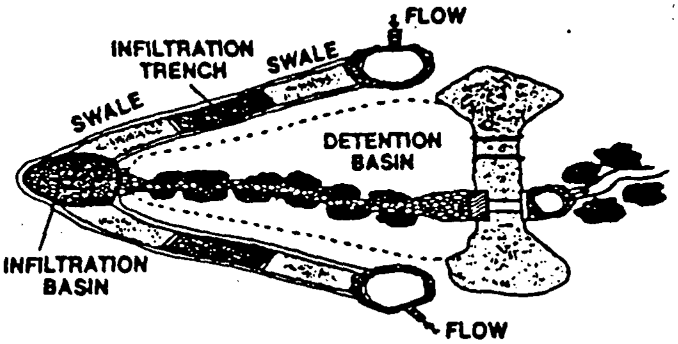
● *High* ○ *Low*

TC6

Best Management Practices

California Storm Water Best Management Practice Handbooks prepared by Camp, Dresser, and Mckee et al

BMP: MULTIPLE-SYSTEMS



Source: Schueler, 1991

DESCRIPTION

A multiple treatment system uses two or more of the preceding BMPs in series. A few multiple systems have already been described: settling basin combined with a sand filter; settling basin or biofilter combined with an infiltration basin or trench; extended detention zone on a wet pond.

EXPERIENCE IN CALIFORNIA

- The research wetlands at Fremont, California are a combination of wet ponds, wetlands, and grass biofilters.

SELECTION CRITERIA

- Need to protect a downstream treatment system
- Enhanced reliability
- Optimum use of the site

LIMITATIONS

- Available space

DESIGN AND SIZING CONSIDERATIONS

- Refer to individual treatment control BMPs

CONSTRUCTION/INSPECTION CONSIDERATIONS

- Refer to individual treatment control BMPs

MAINTENANCE REQUIREMENTS

- Refer to individual treatment control BMPs

COST CONSIDERATIONS

Considerations

Soils

Area Required

Slope

Water Availability

Aesthetics

Hydraulic Head

Environmental Side Effects

Targeted Constituents

● *Sediment*

◓ *Nutrients*

◓ *Heavy Metals*

◓ *Toxic Materials*

● *Floatable Materials*

◓ *Oxygen Demanding Substances*

◓ *Oil & Grease*

◓ *Bacteria & Viruses*

● *Likely to Have Significant Impact*

○ *Probable Low or Unknown Impact*

Implementation Requirements

● *Capital Costs*

● *O&M Costs*

● *Maintenance*

○ *Training*

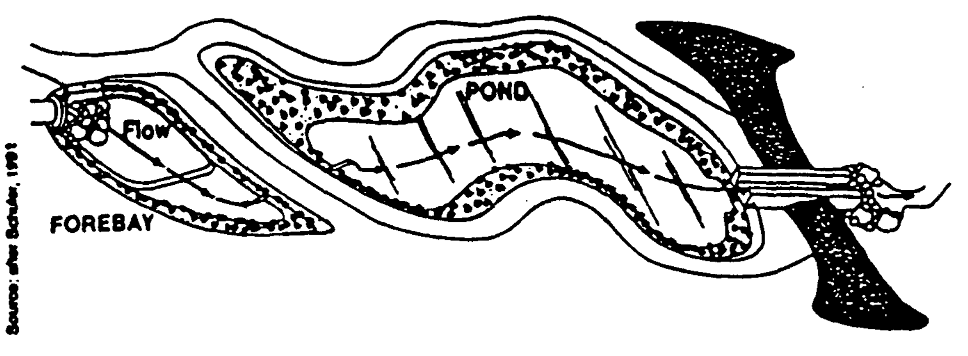
● *High* ○ *Low*

TC8

Best Management Practices

California Storm Water Best Management Practice Handbooks prepared by Camp, Dresser, and Mckee et al

BMP: WET PONDS



Source: after Schueler, 1991

DESCRIPTION

A wet pond has a permanent water pool to treat incoming storm water. An enhanced wet pond includes a pretreatment sediment forebay

CALIFORNIA EXPERIENCE

There are regional flood control basins in California that function like wet ponds or constructed wetlands (TC3).

SELECTION CRITERIA

- Need to achieve high level of particulate and some dissolved contaminant removal.
- Ideal for large, regional tributary areas.
- Multiple benefits of passive recreation (e.g., bird watching, wildlife habitat).

LIMITATIONS

- Concern for mosquitoes and maintaining oxygen in ponds.
- Cannot be placed on steep unstable slopes.
- Need base flow or supplemental water if water level is to be maintained.
- Infeasible in very dense urban areas.
- In California the wet season is coincident with minimal plant growth.
- Could be regulated as a wetlands or under Chapter 15, Title 23, California Code of Regulations regarding waste disposal to lands.
- Pending volume and depth, pond designs may require approval from State Division of Safety of Dams.

DESIGN AND SIZING CONSIDERATIONS

- Wet pool volume determined by Figures 2B and C.
- Water depth of 3 to 9 feet.
- Wetland vegetation, occupying 25-50% of water surface area.
- Design to minimize short-circuiting.
- Bypass storms greater than two year storm.

CONSTRUCTION/INSPECTION CONSIDERATIONS

- Be careful when installing wetland vegetation.

MAINTENANCE REQUIREMENTS

- Remove floatables and sediment build-up.
- Correct erosion spots in banks.
- Control mosquitoes.
- May require permits from various regulatory agencies, e.g. Corps of Engineers.

COST CONSIDERATIONS

- Costs for providing supplemental water may be prohibitive.

Considerations

Soils
[✓ *Area Required*]
[✓ *Slope*]
[✓ *Water Availability*]
[✓ *Aesthetics*]
Hydraulic Head
[✓ *Environmental Side Effects*]

Targeted Constituents

● *Sediment*
◒ *Nutrients*
◒ *Heavy Metals*
◒ *Toxic Materials*
● *Floatable Materials*
◒ *Oxygen Demanding Substances*
◒ *Oil & Grease*
◒ *Bacteria & Viruses*

● *Likely to Have Significant Impact*
○ *Probable Low or Unknown Impact*

Implementation Requirements

● *Capital Costs*
◒ *O&M Costs*
◒ *Maintenance*
○ *Training*

● *High* ○ *Low*

TC2

Best Management Practices

Part 2. Maintenance Considerations.

Regardless of what approach is pursued to enhance and maintain Mugu Lagoon, the importance of maintenance of all measures should not be overlooked.

Conservation practices require maintenance to assure proper funtioning. Maintenance of the various vegetative and structural practices is part of the average annual installation cost. Maintenance should be done annually and during the dry season to ensure practices are functioning properly year round.

Maintenance of streambank/riparian vegetative measures will consist of replacement of damaged plants to assure the designed density and diversity of the planted area is maintained. Orchard cover crops, buffer strips and other similar type vegetative practices should be maintained by mowing, disking, reseeding or overseeding and fertilizing to ensure continued plant vigor and health.

Stream channel structural measures such as diversions, drop structures, trash racks, et. should be kept free of debris and other obstructions to ensure they function properly and reduce the occurance of damage. Other structures such as inlets, outlets, irrigation delivery and drainage systems should be maintained to ensure proper functioning.

Landowners, special districts and others who are responsible for annual maintenance should develop check lists and tour their properties on a regular basis to ensure new as well as previously installed pracices are functioning properly and are protecting the resources for which they were inteneded.

Part 3. Ordinances.

Ordinances and the enforcement of them can play an important role in addressing the Calleguas Creek Watershed resource concerns. Following is a list of existing ordinances to address erosion and sediment.

a. Ventura County Grading Ordinance (Chapter 70 - Excavation and Grading):
This ordinance sets forth the rules and regulations to control excavation, grading and earthwork construction including fills and embankments; establishes the administrative procedure for issuance of permits; and provides for approval of plans and inspection of grading construction. The County Grading Ordinance requires that property owners excavating or filling in excess of 50 cubic yards obtain a grading permit unless the work is located in an isolated, self contained area.

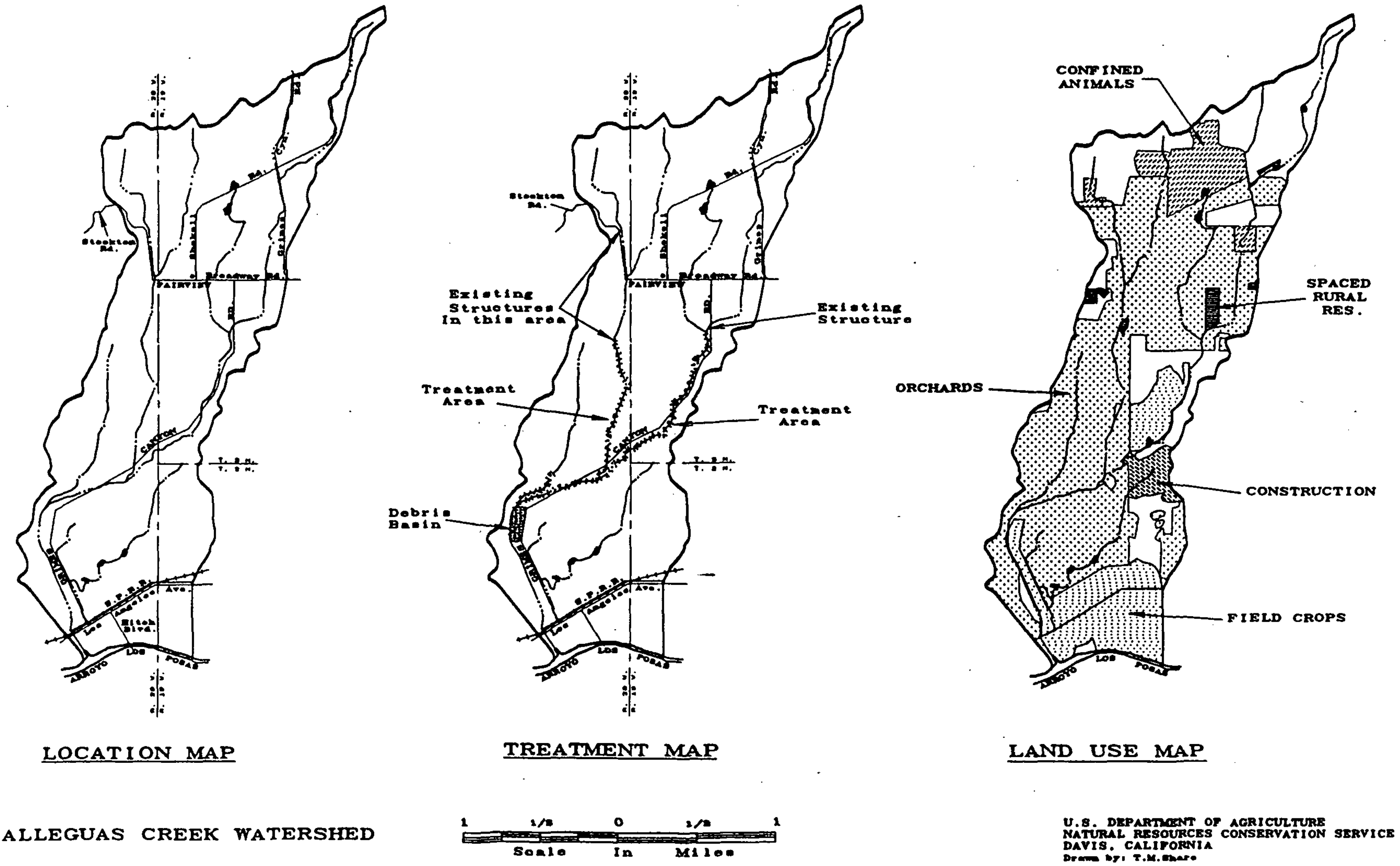
An isolated, self contained area is defined as being more than 100 feet from the nearest property line and an area where Public Works has determined the proposed work will cause no apparent danger to adjacent private or public properties.

b. Ventura County Hillside Erosion Control Ordinance - Agricultural Land Use:
Many hillside areas in isolated and self contained areas not subject to the County Grading Ordinance are being developed in a manner that can cause serious runoff and erosion hazards. If these areas have been designated as critical erosion areas as defined on official erosion maps located at the Ventura County Public Works Agency, Development Services Division and The Ventura County Resource Conservation District (RCD), and a landowner plans to clear vegetation or perform land preparation for new agricultural uses, or makes a change in agricultural use, than a hillside erosion control plan must be developed. This plan must be approved by the RCD; the RCD can provide technical assistance in planning through the USDA, Natural Resources Conservation Service.

c. City Ordinances:
Most cities within the watershed have ordinances similar to the Ventura County ordinance to reduce runoff and control erosion where excavation, grading and earthwork construction is taking place. The ordinances are usually intended to protect the resources from degradation and are municipal codes relating to subdividing land and are intended to be consistent with the provisions of the California State Subdivision Map Act.

Part 4. Practice Impacts for High Priority Erosion Sources, Grimes Canyon Subwatershed.

GRIMES CANYON SUB-WATERSHED



CALLEGUAS CREEK WATERSHED

U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
DAVIS, CALIFORNIA
Drawn by: T.M.Share

Figure C-2

Below is a brief description of each treatment impact listed in the following tables. Note that not all treatment impacts are listed on each table.

- Installation cost includes all costs required to construct the practices and the purchase of necessary land. Average annual installation cost is the amortized cost over the life of the practice, using 8.0 percent interest rate.
- Project maintenance cost is the annual estimated maintenance cost.
- Erosion is the estimated tons/year from the erosion source.
- Sediment delivered in tons/year from the specific erosion source. Sediment is also separated between washload and bedload. An average annual cost per ton of sediment reduced is also included, calculated by dividing average annual installation cost including maintenance cost by the sediment reduction volume.
- Cropland acres required for the installation of the particular practice are identified.
- Cropland (change in acres lost) represents estimated change in bank erosion rate.
- Expected significant change in crop yields is also noted.
- A qualitative measure of the practice impact on the lagoon due to a change in sediment delivered is included.
- The on-site habitat value is a relative value of the particular site that the practice is addressing. The other number is the change with the project installed.
- A relative water quality measurement associated with reduction in sediment is also included.
- Change in runoff of 100-year peak flow, with practice installed is included on some tables.

There are several erosion, sediment, and flood damage categories included. Damages estimated for each category was based on historical and interview information. The numbers are displayed as annual dollar values for comparison to the annual costs. They are:

- On-farm land erosion damage includes field gully restoration work.
- On-farm road damage includes farm road repair expenses due to erosion and flooding.
- On-farm equipment damage includes irrigation equipment damage due to erosion.
- County road damage is associated with flood events.
- On-farm land protection expense is associated with landowner activities to restore fields adjacent to drainage ways after a flood event.
- Stream restoration expense and structure repair cost is associated with major reclamation and restoration work outside of a single landowner's property line after flood events.
- Change in county maintenance is associated with road improvements that would reduce maintenance costs.
- Management skills required category is included to note practices that require a significant operator management style change.
- The category for other resource issues is included to allow practice-specific notes to be added.

Summary of Practice Impacts on the High Priority Erosion Sources
1. Subwatershed: Grimes Canyon

2. Practice & Description: Installation of a large sediment basin at the canyon outlet. This project is designed to store the 100-yr. storm sediment with an 80% trap efficiency. (100% bedload, 60% washload)

3. Average annual sediment yield to the basin from all sources is 15,200 tons per year. Washload is 7,600 tons per year.

4. Estimated % of Erosion Source with Practice Already Applied: No basin present.

5. Remaining Acres or Feet of Erosion Source that Needs to be Treated: Basin will store sediment from all erosion sources in the watershed.

6. Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a. Install. Cost ($) &	▨	$470,000	$470,000
Life of Practice is 50 yrs & Avg. Ann. Cost=	▨	$37,000	$37,000
b. Maintenance Cost ($/year) @ $12 per cuyd	▨	$92,000	$92,000
c. Erosion (tons/year)	39000	39000	0
d. Sediment(tons/year)	15200	3000	-12200
Washload Reduction (tons)	7600	3000	-4600
Bedload Reduction (tons)	7600	0	-7600
e. Crop land Acres Required for Project	0.00	10.50	10.5
f. Crop Yields		0	0
g. Effect on Lagoon Habitat(+,-,0)	-	+	+
h. On-site Hab. Value(WHR Value)	68	112	44
i. Water Quality(qual. +,-,0)	-	+	+
j. Water Runoff 100-yr peak(cfs), below project	2500	2500	0
Erosion, Sediment, Flood Damage Expense:			
k. On-farm Land Damage (erosion)($/year)	$19,000	$19,000	$0
l. On-farm Road Dam(eros./flood)($/year)	$38,000	$38,000	$0
m. On-farm Equip. Damage(erosion)($/year)	$26,900	$26,900	$0
n. County Road Damage (flood)($/year)	$15,000	$15,000	$0
o.On-farm Land Protect. Expense(flood)($/yr)	$4,000	$3,600	($400)
p. Stream Restoration Expense(flood)($/year) & Existing Structure Repair Cost(flood)($/year)	$6,000	$5,400	($600)
q. Total Damage:	$108,900	$107,900	($1,000)
r.			
s. Management Skills Required (more, less, same)	▨	Required mgmt. is same as other basins.	
t. Other Soil, Water, Animal, Plants, Air and Human Considerations:			

Summary of Practice Impacts on the High Priority Erosion Sources

1. Subwatershed: Grimes Canyon

2. Practice & Description: Installation of a grade stabilization system in the canyon (approximately four miles) to control the channel invert, and to establish the invert at a stable slope of 0.5%. The existing banks will be allowed to continue to fail until system is stable (about 50 years). The failure plane will vary from 1.5:1 & 2:1.

3. The volume of sediment from the watershed from all sources is 15,200 tons per year. The sediment associated with streambanks will be reduced by 500 tons per year. Sediment from upstream will also be stored at an annual rate of 7000 tons/year. Sediment yield to Arroyo Las Posas is calculated at 7500 tons per yr.

4. There are 15 existing structures in the watershed. The system will add 59 more.

5. All other sources will continue to contribute sediment to the system.

6. Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a. Install. Cost ($) &		$1,250,000	$1,250,000
Life of Practice is 50 yrs & Avg. Ann. Cost=		$98,400	$98,400
b. Maintenance Cost ($/year)		$37,000	$37,000
c. Erosion (tons/year)	39000	38500	−500
d. Sediment(tons/year)	15200	7500	−7700
Washload (tons)	7600	7500	−100
Bedload (tons)	7600	0	−7600
e.1 Crop Land Acres Required for Project	0	replant 17	0
e.2 Crop land (annual lost acres from erosion)	0.04	0	−0.04
f. Crop Yields		0	0
g. Effect on Lagoon Habitat(+,−,0)	−	−	0
h. On−site Hab. Value(WHR Value)	102	70	−32
i. Water Quality(qual. +,−,0)	−	+/−	+/−
j. Water Runoff(cfs)	2500	2500	0
Erosion, Sediment, Flood Damage, Expense:			
k. On−farm Land Damage(erosion)($/year)	$19,000	$19,000	$0
l. On−farm Road Dam(eros./flood)($/year)	$38,000	$38,000	$0
m. On−farm equip. Damage(erosion)($/year)	$26,900	$26,900	$0
n. County Road Damage(flood)($/year)	$15,000	$6,000	($9,000)
o. On−farm Land Protect. Expense(flood)($/yr)	$4,000	$1,600	($2,400)
p. Stream Restoration Expense(flood)($/year) & Existing Structure Repair Cost(flood)($/year)	$6,000	$300	($5,700)
q.Total Damages:	$108,900	$91,800	($17,100)
r.			
s. Management Skills Required (more, less, same)		More. Land owners required coord. maint.	
t. Other Soil, Water, Animal, Plants, Air and Human Considerations:			

Summary of Practice Impacts on the High Priority Erosion Sources
1. Subwatershed: Grimes Canyon

2. Practice & Description: Installation of a grade stabilization system in the canyon (approximately four miles) to control the channel invert, and to establish the invert at a stable slope of 0.5%. The existing banks will be shaped to a slope of 2:1 so the system will be stable. This will allow the slopes to be replanted to orchard.

3. The volume of sediment from the watershed from all sources is 15,200 tons per year. The sediment associated with streambanks will be reduced by 1800 tons per year. The orchard on the slopes is expected to produce 1900 tons per year. Sediment yield to Arroyo Las Posas is calculated at 7600 tons per yr.

4. There are 15 existing structures in the watershed. The system will add 59 more.

5. All other sources will continue to contribute sediment to the system.

6. Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a. Install. Cost ($) &		$1,819,000	$1,819,000
Life of Practice is 50 yrs & Avg. Ann. Cost=		$143,000	$143,000
b. Maintenance Cost ($/year)		$37,000	$37,000
c. Erosion (tons/year)	39000	36100	−2900
d. Sediment(tons/year)	15200	7600	−7600
Washload (tons)	7600	6900	−700
Bedload (tons)	7600	700	−6900
e.1 Crop Land Acres Required for Project	0	replant 17	0
e.2 Crop land (annual lost acres from erosion)	0.04	0	−0.04
f. Crop Yields		0	0
g. Effect on Lagoon Habitat(+,−,0)	−	−	0
h. On−site Hab. Value(WHR Value)	102	70	−32
i. Water Quality(qual. +,−,0)	−	+/−	+/−
j. Water Runoff(cfs)	2500	2500	0
Erosion, Sediment, Flood Damage, Expense:			
k. On−farm Land Damage(erosion)($/year)	$19,000	$19,000	$0
l. On−farm Road Dam(eros./flood)($/year)	$38,000	$38,000	$0
m. On−farm equip. Damage(erosion)($/year)	$26,900	$26,900	$0
n. County Road Damage(flood)($/year)	$15,000	$6,000	($9,000)
o. On−farm Land Protect. Expense(flood)($/yr)	$4,000	$1,600	($2,400)
p. Stream Restoration Expense(flood)($/year) & Existing Structure Repair Cost(flood)($/year)	$6,000	$300	($5,700)
q.Total Damages:	$108,900	$91,800	($17,100)
r.			
s. Management Skills Required (more, less, same)		More. Land owners required coord. maint.	
t. Other Soil, Water, Animal, Plants, Air and Human Considerations:			

Summary of Practice Impacts on the High Priority Erosion Sources

1. Subwatershed: Grimes Canyon

2. Practice & Description: Installation of a grade stabilization system in the canyon (approximately four miles) to control the channel invert, and to establish the invert at a stable slope of 0.5%. The existing banks will be shaped to a slope of 1.5:1 so system is stable. This will allow the slopes to be planted to riparian vegetation.

3. The volume of sediment from the watershed from all sources is 15,200 tons per year. The sediment associated with streambanks will be reduced by 2,200 tons per year. The erosion from riparian streambanks is expected to be reduced from 4,700 tons to 500 tons per year.

4. There are 15 existing structures in the watershed. The system will add 59 more.

5. All other sources will continue to contribute sediment to the system.

6. Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a. Install. Cost ($) &		$2,025,000	$2,025,000
Life of Practice is 50 yrs &Avg. Ann. Cost=		$159,500	$159,500
b. Maintenance Cost ($/year)		$37,000	$37,000
c. Erosion:all sources (tons/year)	39000	34700	-4200
d. Sediment:all sources(tons/year)	15200	6900	-8300
Washload (tons)	7600	6300	-1300
Bedload (tons)	7600	600	-7000
e.1 Crop land acres for Project	0	18.6	-18.6
e.2 Crop land (annual lost acres from erosion)	0.04	0	-0.04
f. Crop Yields		0	0
g. Effect on Lagoon Habitat(+,-,0)	-	+	+
h. On-site Hab. Value(WHR value)	101	111	10
i. Water Quality(qual. +,-,0)	-	+	+
j. Water Runoff(cfs)	2500	2500	0
Erosion, Sediment, Flood Damage, Expense:			
k. On-farm Land Damage(erosion)($/year)	$19,000	$19,000	$0
l. On-farm Road Dam(eros./flood)($/year)	$38,000	$38,000	$0
m. On-farm equip. Damage(erosion)($/year)	$26,900	$26,900	$0
n. County Road Damage(flood)($/year)	$15,000	$6,000	($9,000)
o. On-farm Land Protect. Expense(flood)($/yr)	$4,000	$1,600	($2,400)
p. Stream Restoration Expense(flood)($/year) & Existing Structure Repair Cost(flood)($/year)	$6,000	$300	($5,700)
q.Total Damage:	$108,900	$91,800	($17,100)
r.			
s. Management Skills Required (more, less, same)		More. Owner coord. maint. is required.	
t. Other Soil, Water, Animal, Plants, Air and Human Considerations:			

Summary of Practice Impacts on the High Priority Erosion Sources

1. Subwatershed: Grimes Canyon

2. Practice & Description: Installation of a road stabilization measures in the canyon to reduce sediment sources on road cuts, concentrated flow areas and road fills. Protection measures include sloping cuts to 2:1, critical area treatment, fertilization, and adding culverts to convey water to safe outlets.

3. The volume of sediment from the watershed from all sources is 15,200 tons per year. The sediment associated with roads is 2,100 and will be reduced by 1,500 tons per year.

4. About 8.4 miles of paved and 11.6 miles of unpaved roads were included.

5. All other sources will continue to contribute sediment to the system.

6. Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a. Install. Cost ($) &		$2,530,000	$2,530,000
Life of Practice is 50 yrs & Avg. Ann. Cost=		$199,200	$199,200
b. Maintenance Cost (mile) ($/year)	$190,000	$100,000	($90,000)
c. Erosion (tons/year)	4300	1300	-3036
d. Sediment:other roads(tons/year)	2100	600	-1500
Washload (tons)	1050	300	-750
Bedload (tons)	1050	300	-750
e. Crop land (annual lost acres)		0	0
f. Crop Yields		0	0
g. Effect on Lagoon Habitat(+,-,0)	-	-	0
h. On-site Hab. Value(WHR value)	n/a	n/a	n/a
i. Water Quality(qual. +,-,0)	-	+/-	+/-
j. Water Runoff(cfs)	2500	2500	0
Erosion, Sediment, Flood Damage, Expense:			
k. On-farm Land Damage(erosion)($/year)	$19,000	$19,000	$0
l. On-farm Road Dam(eros./flood)($/year)	$38,000	$38,000	$0
m. On-farm Equip. Damage(erosion)($/year)	$26,900	$26,900	$0
n. County Road Damage(flood)($/year)	$15,000	$1,500	($13,500)
o. On-farm Land Prot. Expense(flood)($/yr)	$4,000	$4,000	$0
p. Stream Restoration Expense(flood)($/year) & Existing Structure Repair Cost(flood)($/year)	$6,000	$6,000	$0
q.Total Damages:	$108,900	$95,400	($13,500)
r.			
s. Management Skills Required (more, less, same)		Same type work would be required.	
t. Other Soil, Water, Animal, Plants, Air and Human Considerations:			

Summary of Practice Impacts on the High Priority Erosion Sources

1. Subwatershed: Grimes Canyon

2. Practice & Description: Vegetative Streambank Protection (580)
   Stabilize 3 miles of channel banks to reduce and protect them against scour and erosion. Shape where necessary and plant to perennial grasses, willows, alders, cottonwoods or other locally adapted species.

3. Total Acres or Feet of Erosion Source In The Subwatershed: 14.6 Miles

4. Estimated % of Erosion Source with Practice Already Applied = 80 percent

5. Remaining Acres or Feet of Erosion Source that Needs to be Treated = 1.5 Miles

6. Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a. Install. Cost ($) & ($6800/mile x 1.5 miles)	▨	$20,400	$20,400
Life of Practice is 20 yrs & Avg. Ann. Cost=	▨	$1,050	$1,050
b. Maintenance Cost ($/year) = (2%)$6818/mi.	▨	$200	$200
c. Erosion (tons/year)	4700	1800	−2900
d. Sediment(tons/year)	3000	1200	−1800
Washload (tons)	1500	700	−800
Bedload (tons)	1500	500	−1000
e. Crop land (annual lost acres)		0	0
f. Crop Yields		0	0
g. Effect on Lagoon Habitat(+,−,0)	−	+	−
h. On−site Hab. Value(WHR Value)	106	116	10
i. Water Quality(qual. +,−,0)	−	+	+
j. Water Runoff(cfs)	2500	2500	0
Erosion, Sediment, Flood Damage, Expense:			
k. On−farm Land Damage(erosion)($/year)	$19,000	$19,000	$0
l. On−farm Road Dam(eros./flood)($/year)	$38,000	$38,000	$0
m. On−farm equip. Damage(erosion)($/year)	$26,900	$26,900	$0
n. County Road Damage(flood)($/year)	$15,000	$12,000	($3,000)
o. On−farm Land Protect. Expense(flood)($/yr)	$4,000	$1,600	($2,400)
p. Stream Restoration Expense(flood)($/year) & Existing Structure Repair Cost(flood)($/year)	$6,000	$4,800	($1,200)
q.Total Damages:	$108,900	$102,300	($6,600)
r.			
s. Management Skills Required (more, less, same)	▨	more	
t. Other Soil, Water, Animal, Plants, Air and Human Considerations:			

Summary of Practice Impacts on the High Priority Erosion Sources

1. Subwatershed: Grimes Canyon

2. Practice & Description: Orchard Drainage System:
   (1) Foot Terraces (Small Diversions [362]) between tree rows
   (2) Regrade box roads to grade into hillside.
   (3)Install drain lines (Underground Outlets [620]) on 300 foot centers between up and down hill drive roads
   (4) Install Concrete Road Ditches on up and down hill roads and orchard access roads (560)
   (5) Install Drop Inlet Structures where drain lines and drive roads drain into orchard access road ditches (Access Road 560)
   (6) Install drop inlet structures where access road ditches outlet into channels.
   (7) Critical Area Planting on 2.6 miles of orchard access road cuts and fills

3. Total Acres or Feet of Erosion Source In The Subwatershed: 1325 acres

4. Estimated % of Erosion Source with Practice Already Applied = 30 percent

5. Remaining Acres or Feet of Erosion Source that Needs to be Treated = 928 acres

6. Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a. Install. Cost ($) 4200/ac x 928 ac		$3,898,000	$3,898,000
Life of Practice is 20 yrs & Avg. Ann. Cost=		$397,000	$397,000
b. Maintenance Cost ($) (2%) = $85x928 ac		$78,900	$78,900
c. Erosion (tons/year)	5000	2200	−2800
d. Sediment(tons/year)	2400	1000	−1400
Washload (tons)	1200	600	−600
Bedload (tons)	1200	400	−800
e. Crop land (annual lost acres)		0	0
f. Crop Yields		0	0
g. Effect on Lagoon Habitat(+,−,0)	−	−	0
h. On−site Hab. Value(WHR Value)	50	84	34
i. Water Quality(qual. +,−,0)	−	+	0
j. Water Runoff(cfs)	2500	2500	0
Erosion, Sediment, Flood Damage, Expense:			
k. On−farm Land Damage(erosion)($/year)	$19,000	$1,000	($18,000)
l. On−farm Road Dam(eros./flood)($/year)	$38,000	$3,800	($34,200)
m. On−farm equip. Damage(erosion)($/year)	$26,900	$2,700	($24,200)
n. County Road Damage(flood)($/year)	$15,000	$13,500	($1,500)
o. On−farm Land Protect. Expense(flood)($/yr)	$4,000	$4,000	$0
p. Stream Restoration Expense(flood)($/year) & Existing Structure Repair Cost(flood)($/year)	$6,000	$6,000	$0
q.Total Damage:	$108,900	$31,000	($77,900)
r.			
s. Management Skills Required (more, less, same)		Less	
t. Other Soil, Water, Animal, Plants, Air and Human Considerations:			

Summary of Practice Impacts on the High Priority Erosion Sources

1. Subwatershed: Grimes Canyon

2. Practice & Description: Cover Crops In Orchards (340)
Plant a reseeding winter annual cover crop of Blando Brome between tree rows to form a protective cover on 570 acres of young orchards (Up to 7 yrs.)

3. Total Acres or Feet of Erosion Source In The Subwatershed: 630 acres

4. Estimated % of Erosion Source with Practice Already Applied = 10 percent

5. Remaining Acres or Feet of Erosion Source that Needs to be Treated = 570 acres

6. Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a. Install. Cost ($) 145/acre		$79,800	$79,800
Life of Practice is 20 yrs & Avg. Ann. Cost=		$8,000	$8,000
b. Maintenance Cost ($/year) = $81/ac		$38,800	$38,800
c. Erosion (tons/year)	3800	350	-3450
d. Sediment(tons/year)	1200	110	-1090
Washload (tons)	600	60	-540
Bedload (tons)	600	50	-550
e. Crop land (annual lost acres)		0	0
f. Crop Yields		0	0
g. Effect on Lagoon Habitat(+,-,0)	-	-	0
h. On-site Hab. Value(WHR value)	70	78	8
i. Water Quality(qual. +,-,0)	-	+	+
j. Water Runoff(cfs)	2500	2450	50
Erosion, Sediment, Flood Damage, Expense:			
k. On-farm Land Damage(erosion)($/year)	$19,000	$5,700	($13,300)
l. On-farm Road Dam(eros./flood)($/year)	$38,000	$34,200	($3,800)
m. On-farm equip. Damage(erosion)($/year)	$26,900	$8,100	($18,800)
n. County Road Damage(flood)($/year)	$15,000	$15,000	$0
o. On-farm Land Protect. Expense(flood)($/yr)	$4,000	$4,000	$0
p. Stream Restoration Expense(flood)($/year) & Existing Structure Repair Cost(flood)($/year)	$6,000	$6,000	$0
q.Total Damage:	$108,900	$73,000	($35,900)
r.			
s. Management Skills Required (more, less, same)		more	
t. Other Soil, Water, Animal, Plants, Air and Human Considerations:			

Summary of Practice Impacts on the High Priority Erosion Sources

1. Subwatershed: Grimes Canyon

2. Practice & Description: Cover Crops In Orchards (340)
   Plant a reseeding winter annual cover crop of Zorro Annual Fescue between tree rows to form a protective cover on 570 acres of young orchards (Up to 7 yrs.)

3. Total Acres or Feet of Erosion Source In The Subwatershed: 630 acres

4. Estimated % of Erosion Source with Practice Already Applied = 10 percent

5. Remaining Acres or Feet of Erosion Source that Needs to be Treated = 570 acres

6. Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a. Install. Cost ($) 230/acre	▨	$132,200	$132,200
Life of Practice is 20 yrs & Avg. Ann. Cost=	▨	$23,650	$23,650
b. Maintenance Cost ($/year) = $80/ac	▨	$46,700	$46,700
c. Erosion (tons/year)	3800	350	−3450
d. Sediment(tons/year)	1200	110	−1090
Washload (tons)	600	60	−540
Bedload (tons)	600	50	−550
e. Crop land (annual lost acres)		0	0
f. Crop Yields		0	0
g. Effect on Lagoon Habitat(+,−,0)	−	−	0
h. On−site Hab. Value(WHR value)	70	79	9
i. Water Quality(qual. +,−,0)	−	+	+
j. Water Runoff(cfs)	2500	2500	50
Erosion, Sediment, Flood Damage, Expense:			
k. On−farm Land Damage(erosion)($/year)	$19,000	$5,700	($13,300)
l. On−farm Road Dam(eros./flood)($/year)	$38,000	$34,200	($3,800)
m. On−farm equip. Damage(erosion)($/year)	$26,900	$8,100	($18,800)
n. County Road Damage(flood)($/year)	$15,000	$15,000	$0
o. On−farm Land Protect. Expense(flood)($/yr)	$4,000	$4,000	$0
p. Stream Restoration Expense(flood)($/year) & Existing Structure Repair Cost(flood)($/year)	$6,000	$6,000	$0
q.Total Damage:	$108,900	$73,000	($35,900)
r.			
s. Management Skills Required (more, less, same)	▨	more	
t. Other Soil, Water, Animal, Plants, Air and Human Considerations:			

Summary of Practice Impacts on the High Priority Erosion Sources
1. Subwatershed: Grimes Canyon

2. Practice & Description: Filter Strip (393)
Install filter strips (Zorro Annual Fescue) on the lower ends of 570 acres of young orchards. filter strips 600 ft. long and 30 ft. wide will be installed at lower ends of orchards between up and down hill drive roads to remove sediment and other pollutants from runoff water by infiltration, absorption and adsorption and reduce water velocities in return flow ditches.

3. Total Acres or Feet of Erosion Source In The Subwatershed: 630 acres

4. Estimated % of Erosion Source with Practice Already Applied = 30 percent

5. Remaining Acres or Feet of Erosion Source that Needs to be Treated = (Reduces sediment leaving 570 acres and requires 11 acres or 17,100 ft.of Filter Strip)

6. Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a. Install. Cost ($) 230/acre x 11 ac.		$2600	$2600
Life of Practice is 20 yrs & Avg Ann Cost=		$260	$260
b. Maintenance Cost ($/year) = $68/ac		$890	$890
c. Erosion (tons/year)	3800	3800	0
d. Sediment(tons/year)	1200	800	−400
Washload (tons)	600	500	−100
Bedload (tons)	600	300	−300
e. Crop land (annual lost acres)		0	0
f. Crop Yields		0	0
g. Effect on Lagoon Habitat(+,−,0)	−	−	0
h. On−site Habitat Value(WHR value)	56	69	13
i. Water Quality(qual. +,−,0)	−	+	+
j. Water Runoff(cfs)	2500	2500	0
Erosion, Sediment, Flood Damage, Expense:			
k. On−farm Land Damage(erosion)($/year)	$19,000	$17,000	($2,000)
l. On−farm Road Dam(eros./flood)($/year)	$38,000	$34,200	($3,800)
m. On−farm equip. Damage(erosion)($/year)	$26,900	$24,200	($2,700)
n. County Road Damage(flood)($/year)	$15,000	$15,000	$0
o. On−farm Land Protect. Expense(flood)($/yr)	$4,000	$4,000	$0
p. Stream Restoration Expense(flood)($/year) & Existing Structure Repair Cost(flood)($/year)	$6,000	$6,000	$0
q.Total Damage:	$108,900	$100,400	($8,500)
r.			
s. Management Skills Required (more, less, same)		more	
t. Other Soil, Water, Animal, Plants, Air and Human Considerations:			

Summary of Practice Impacts on the High Priority Erosion Sources
1. Subwatershed: Grimes Canyon

2. Practice & Description: Filter Strip (393)
Install filter strips (Blando Brome) on the lower ends of 570 acres of young orchards. filter strips 600 ft. long and 30 ft. wide will be installed at lower ends of orchards between up and down hill drive roads to remove sediment and other pollutants from runoff water by infiltration, absorption and adsorption and reduce water velocities in return flow ditches.

3. Total Acres or Feet of Erosion Source In The Subwatershed: 630 acres

4. Estimated % of Erosion Source with Practice Already Applied = 30 percent

5. Remaining Acres or Feet of Erosion Source that Needs to be Treated = (Reduces sediment leaving 570 acres and requires 11 acres or 17,100 ft.of Filter Strip)

6. Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a. Install. Cost ($) 145/acre x 11 ac.	▨	$1600	$1600
Life of Practice is 20 yrs & Avg Ann Cost=	▨	$165	$165
b. Maintenance Cost ($/year) = $68/ac	▨	$750	$750
c. Erosion (tons/year)	3800	3800	0
d. Sediment(tons/year)	1200	800	−400
Washload (tons)	600	500	−100
Bedload (tons)	600	300	−300
e. Crop land (annual lost acres)		0	0
f. Crop Yields		0	0
g. Effect on Lagoon Habitat(+,−,0)	−	−	0
h. On−site Habitat Value(WHR value)	56	69	13
i. Water Quality(qual. +,−,0)	−	+	+
j. Water Runoff(cfs)	2500	2500	0
Erosion, Sediment, Flood Damage, Expense:			
k. On−farm Land Damage(erosion)($/year)	$19,000	$17,000	($2,000)
l. On−farm Road Dam(eros./flood)($/year)	$38,000	$34,200	($3,800)
m. On−farm equip. Damage(erosion)($/year)	$26,900	$24,200	($2,700)
n. County Road Damage(flood)($/year)	$15,000	$15,000	$0
o. On−farm Land Protect. Expense(flood)($/yr)	$4,000	$4,000	$0
p. Stream Restoration Expense(flood)($/year) & Existing Structure Repair Cost(flood)($/year)	$6,000	$6,000	$0
q.Total Damage:	$108,900	$100,400	($8,500)
r.			
s. Management Skills Required (more, less, same)	▨	more	
t. Other Soil, Water, Animal, Plants, Air and Human Considerations:			

Part 5. Impacts of Selected Practices Treating High Erosion Sources in All Priority Subwatersheds.

Selected Practice Option 1.	Sediment Basin
Selected Practice Option 2.	Orchard Cover Crop, Bank Protection, and Grade Stabilization

Summary of Construction of Sediment Basins in Watershed
1. Subwatershed: Beardsley (#2)

2. Practices: Sediment Basin

3. Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a.1 Install. Cost ($): Project Sediment Basins		$1,020,000	$1,020,000
a.2 Life of Practice is: 50 years			
a.3 Average Annual Cost: Project		$83,000	$83,000
a.4 Total Average Annual Maintenance Cost=		$174,000	$174,000
b.1 Total Average Annual Cost Project		$257,000	$257,000
c. Erosion (tons/year)	59900	59900	0
d. Sediment(tons/year)	21700	6500	−15200
Washload (tons)	13000	6500	−6500
Bedload (tons)	8700	0	−8700
Avg. Ann. Cost Per Ton of Sed. Reduction			$17
Avg. Ann. Cost Per Ton of Washload Reduct			$40
Avg. Ann. Cost Per Ton of Bedload Reduct			$30
e. Crop land Acres Required for Project			20
g. Effect on Lagoon Habitat(+,−,0)	−	+	+
h. On-site Hab. Value(WHR Value)	68	112	44
i. Water Quality(qual. +,−,0)	−	+	+
Erosion, Sediment, Flood Damage, Expense:			
k. On-farm Land Damage(erosion)($/year)	$10,900	$10,900	$0
l. On-farm Road Dam(eros./flood)($/year)	$21,700	$21,700	$0
m. On-farm equip. Damage(erosion)($/year)	$15,400	$15,400	$0
n. County Road Damage(flood)($/year)	$14,700	$14,700	$0
o. On-farm Land Protect. Expense(flood)($/yr)	$2,100	$1,900	($200)
p. Stream Restoration Expense ($/year) & Existing Structure Repair Cost ($/year)	$400	$350	($50)
q.			
r.			
s. Management Skills Required (more, less, same)		More	
t. Other Soil, Water, Animal, Plants, Air and Human Considerations:			
− Cleanout is expected after large events or 15% loss of capacity			

Summary of Construction of Sediment Basins in Watershed
1. Subwatershed: Mahan (#6)

2. Practices: Sediment Basin

3. Total Number of Acres Served By Sediment Basins In The Watershed: 1280

4. Total Number of Acres Not Served By Sediment Basins In The Watershed: 220

5. Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a.1 Install. Cost ($): Project Sediment Basins		$300,000	$300,000
a.2 Life of Practice is: 50 years			
a.3 Average Annual Cost: Project		$25,000	$25,000
a.4 Total Average Annual Maintenance Cost=		$49,000	$49,000
b.1 Total Average Annual Cost Project		$74,000	$74,000
c. Erosion (tons/year)	17500	17500	0
d. Sediment(tons/year)	7400	2600	−4800
Washload (tons)	4500	2200	−2300
Bedload (tons)	2900	400	−2500
Avg. Ann. Cost Per Ton of Sed. Reduction			$15
Avg. Ann. Cost Per Ton of Washload Reduct			$32
Avg. Ann. Cost Per Ton of Bedload Reduct			$30
e. Crop land Acres Required for Project			10
g. Effect on Lagoon Habitat(+,−,0)	−	+	0
h. On−site Hab. Value(WHR Value)	111	113	2
i. Water Quality(qual. +,−,0)	−	+	+
Erosion, Sediment, Flood Damage, Expense:			
k. On−farm Land Damage(erosion)($/year)	$2,000	$2,000	$0
l. On−farm Road Dam(eros./flood)($/year)	$3,450	$3,450	$0
m. On−farm equip. Damage(erosion)($/year)	$2,400	$2,400	$0
n. County Road Damage(flood)($/year)	$4,500	$4,500	$0
o. On−farm Land Protect. Expense(flood)($/yr)	$300	$250	($50)
p. Stream Restoration Expense ($/year) & Existing Structure Repair Cost ($/year)	$2,400	$2,150	($250)
q.			
r.			
s. Management Skills Required (more, less, same)		More	
t. Other Soil, Water, Animal, Plants, Air and Human Considerations:			
− Potential negative impact to 4 endangered/threatened species.			
− Cleanout is expected after large events or 15% loss of capacity			

Summary of Construction of Sediment Basins in Watershed
1. Subwatershed: Long Canyon (#7)

2. Practices: Sediment Basin

3. Total Number of Acres Served By Sediment Basins In The Watershed: 3150

4. Total Number of Acres Not Served By Sediment Basins In The Watershed: 455

5. Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a.1 Install. Cost ($): Project Sediment Basins		$360,000	$360,000
a.2 Life of Practice is: 50 years			
a.3 Average Annual Cost: Project		$29,000	$29,000
a.4 Total Average Annual Maintenance Cost=		$90,000	$90,000
b.1 Total Average Annual Cost Project		$119,000	$119,000
c. Erosion (tons/year)	28300	28300	0
d. Sediment(tons/year)	12300	4300	−8000
Washload (tons)	7400	4000	−3400
Bedload (tons)	4900	300	−4600
Avg. Ann. Cost Per Ton of Sed. Reduction			$15
Avg. Ann. Cost Per Ton of Washload Reduct			$35
Avg. Ann. Cost Per Ton of Bedload Reduct			$26
e. Crop land Acres Required for Project			10
g. Effect on Lagoon Habitat(+,−,0)	−	+	0
h. On−site Hab. Value(WHR Value)	118	113	5
i. Water Quality(qual. +,−,0)	−	+	+
Erosion, Sediment, Flood Damage, Expense:			
k. On−farm Land Damage(erosion)($/year)	$11,700	$11,700	$0
l. On−farm Road Dam(eros./flood)($/year)	$23,400	$23,400	$0
m. On−farm equip. Damage(erosion)($/year)	$16,500	$16,500	$0
n. County Road Damage(flood)($/year)	$14,550	$14,550	$0
o. On−farm Land Protect. Expense(flood)($/yr)	$2,300	$2,050	($250)
p. Stream Restoration Expense ($/year) & Existing Structure Repair Cost ($/year)	$1,200	$1,050	($150)
q.			
r.			
s. Management Skills Required (more, less, same)		More	
t. Other Soil, Water, Animal, Plants, Air and Human Considerations:			
− Potential negative impact to 5 endangered/threatened species.			
− Cleanout is expected after large events or 15% loss of capacity			

Summary of Construction of Sediment Basins in Watershed

1. Subwatershed: Hunt Wash (#8)

2. Practices: Renovation of Existing Sediment Basin

3. Total Number of Acres Served By Sediment Basins In The Watershed: 1000

4. Total Number of Acres Not Served By Sediment Basins In The Watershed: 350

5. Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a.1 Install. Cost ($): Project Sediment Basins		$93,000	$93,000
a.2 Life of Practice is: 50 years			
a.3 Average Annual Cost: Project		$8,000	$8,000
a.4 Total Average Annual Maintenance Cost=		$25,000	$174,000
b.1 Total Average Annual Cost Project		$33,000	$33,000
c. Erosion (tons/year)	10300	10300	0
d. Sediment(tons/year)	3700	1300	-2400
Washload (tons)	2200	1200	-1000
Bedload (tons)	1500	100	-1400
Avg. Ann. Cost Per Ton of Sed. Reduction			$14
Avg. Ann. Cost Per Ton of Washload Reduct			$33
Avg. Ann. Cost Per Ton of Bedload Reduct			$24
e. Crop land Acres Required for Project			0
g. Effect on Lagoon Habitat(+,-,0)	-	+	0
h. On-site Hab. Value(WHR Value)	68	112	44
i. Water Quality(qual. +,-,0)	-	+	+
Erosion, Sediment, Flood Damage, Expense:			
k. On-farm Land Damage(erosion)($/year)	$5,100	$5,100	$0
l. On-farm Road Dam(eros./flood)($/year)	$10,300	$10,300	$0
m. On-farm equip. Damage(erosion)($/year)	$7,300	$7,300	$0
n. County Road Damage(flood)($/year)	$2,400	$2,400	$0
o. On-farm Land Protect. Expense(flood)($/yr)	$1,000	$900	($100)
p. Stream Restoration Expense ($/year) & Existing Structure Repair Cost ($/year)	$4,400	$3,950	($450)
q.			
r.			
s. Management Skills Required (more, less, same)		More	
t. Other Soil, Water, Animal, Plants, Air and Human Considerations:			
- Cleanout is expected after large events or 15% loss of capacity			

Summary of Construction of Sediment Basins in Watershed

1. Subwatershed: Grimes (#9)

2. Practices: Sediment Basin

3. Total Number of Acres Served By Sediment Basins In The Watershed: 3800

4. Total Number of Acres Not Served By Sediment Basins In The Watershed: 315

5. Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a.1 Install. Cost ($): Project Sediment Basins		$470,000	$470,000
a.2 Life of Practice is: 50 years			
a.3 Average Annual Cost: Project		$38,000	$38,000
a.4 Total Average Annual Maintenance Cost=		$92,000	$174,000
b.1 Total Average Annual Cost Project		$130,000	$130,000
c. Erosion (tons/year)	38900	38900	0
d. Sediment(tons/year)	15200	4900	−10300
Washload (tons)	7600	4600	−3000
Bedload (tons)	7600	300	−7300
Avg. Ann. Cost Per Ton of Sed. Reduction			$13
Avg. Ann. Cost Per Ton of Washload Reduct			$43
Avg. Ann. Cost Per Ton of Bedload Reduct			$18
e. Crop land Acres Required for Project			10.5
g. Effect on Lagoon Habitat(+,−,0)	−	+	0
h. On−site Hab. Value(WHR Value)	68	112	44
i. Water Quality(qual. +,−,0)	−	+	+
Erosion, Sediment, Flood Damage, Expense:			
k. On−farm Land Damage(erosion)($/year)	$19,000	$19,000	$0
l. On−farm Road Dam(eros./flood)($/year)	$38,048	$38,048	$0
m. On−farm equip. Damage(erosion)($/year)	$26,912	$26,912	$0
n. County Road Damage(flood)($/year)	$15,000	$15,000	$0
o. On−farm Land Protect. Expense(flood)($/yr)	$4,000	$3,600	($400)
p. Stream Restoration Expense ($/year) & Existing Structure Repair Cost ($/year)	$6,000	$5,400	($600)
q.			
r.			
s. Management Skills Required (more, less, same)		More	
t. Other Soil, Water, Animal, Plants, Air and Human Considerations:			
− Cleanout is expected after large events or 15% loss of capacity			

Summary of Construction of Sediment Basins in Watershed
1. Subwatershed: Alamos Canyon (#13)

2. Practices: Sediment Basin

3. Total Number of Acres Served By Sediment Basins In The Watershed: 4400

4. Total Number of Acres Not Served By Sediment Basins In The Watershed: 365

5. Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a.1 Install. Cost ($): Project Sediment Basins		$437,000	$437,000
a.2 Life of Practice is: 50 years			
a.3 Average Annual Cost: Project		$36,000	$36,000
a.4 Total Average Annual Maintenance Cost=		$81,000	$81,000
b.1 Total Average Annual Cost Project		$117,000	$117,000
c. Erosion (tons/year)	29400	29400	0
d. Sediment(tons/year)	9900	800	-9100
Washload (tons)	5000	500	-4500
Bedload (tons)	4900	300	-4600
Avg. Ann. Cost Per Ton of Sed. Reduction			$13
Avg. Ann. Cost Per Ton of Washload Reduct			$26
Avg. Ann. Cost Per Ton of Bedload Reduct			$25
e. Crop land Acres Required for Project			10
g. Effect on Lagoon Habitat(+,-,0)	-	+	0
h. On-site Hab. Value(WHR Value)	118	113	5
i. Water Quality(qual. +,-,0)	-	+	+
Erosion, Sediment, Flood Damage, Expense:			
k. On-farm Land Damage(erosion)($/year)	$0	$0	$0
l. On-farm Road Dam(eros./flood)($/year)	$0	$0	$0
m. On-farm equip. Damage(erosion)($/year)	$0	$0	$0
n. County Road Damage(flood)($/year)	$10,200	$10,200	$0
o. On-farm Land Protect. Expense(flood)($/yr)	$0	$0	$0
p. Stream Restoration Expense ($/year) & Existing Structure Repair Cost ($/year)	$6,800	$6,100	($700)
q.			
r.			
s. Management Skills Required (more, less, same)		More	
t. Other Soil, Water, Animal, Plants, Air and Human Considerations:			
- Potential negative impact to endangered/threatened species.			
- Cleanout is expected after large events or 15% loss of capacity			

Summary of Construction of Sediment Basins in Watershed
1. Subwatershed: Runkle Canyon (#21)

2. Practices: Renovation of Existing Sediment Basin

3. Total Number of Acres Served By Sediment Basins In The Watershed: 1000

4. Total Number of Acres Not Served By Sediment Basins In The Watershed: 1420

5. Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a.1 Install. Cost ($): Project Sediment Basins	▨	$500,000	$500,000
a.2 Life of Practice is: 50 years	▨	▨	▨
a.3 Average Annual Cost: Project	▨	$41,000	$41,000
a.4 Total Average Annual Maintenance Cost=	▨	$103,000	$103,000
b.1 Total Average Annual Cost Project	▨	$144,000	$144,000
c. Erosion (tons/year)	22300	22300	0
d. Sediment(tons/year)	4000	1500	-2500
Washload (tons)	3400	1000	-2400
Bedload (tons)	600	500	-100
Avg. Ann. Cost Per Ton of Sed. Reduction	▨	▨	$58
Avg. Ann. Cost Per Ton of Washload Reduct	▨	▨	$60
Avg. Ann. Cost Per Ton of Bedload Reduct	▨	▨	$1,440
e. Crop land Acres Required for Project	▨	▨	0
g. Effect on Lagoon Habitat(+,-,0)	-	+	0
h. On-site Hab. Value(WHR Value)	68	68	0
i. Water Quality(qual. +,-,0)	-	+	+
Erosion, Sediment, Flood Damage, Expense:			
k. On-farm Land Damage(erosion)($/year)	$0	$0	$0
l. On-farm Road Dam(eros./flood)($/year)	$0	$0	$0
m. On-farm equip. Damage(erosion)($/year)	$0	$0	$0
n. County Road Damage(flood)($/year)	$3,750	$3,750	$0
o. On-farm Land Protect. Expense(flood)($/yr)	$0	$0	$0
p. Stream Restoration Expense ($/year) & Existing Structure Repair Cost ($/year)	$0	$0	$0
q.			
r.			
s. Management Skills Required (more, less, same)	▨	More	
t. Other Soil, Water, Animal, Plants, Air and Human Considerations:			
- This project would increase capacity of existing basin to 50,000 cy.yd.			
- Cleanout is expected after large events or 15% loss of capacity			

Summary of Practice Impacts on the High Priority Erosion Sources
1. Subwatershed: Beardsley Wash (#2)
2. Practices: Orchard Cover Crop(Blando) + Bank Protection + Riparian Grade Stab
(for more detailed practice descriptions see Appendix C)
3. Total Acres or miles of Erosion Source In The Subwatershed:

Cover Crop:	2427 acres
Bank Protection:	31.2 miles
Riparian Corridor Grade Stabilization:	31.2 miles

4. Total Acres or miles of Erosion Source In The Subwatershed to Treat

Cover Crop:	2180 acres
Bank Protection:	2.1 miles
Riparian Corridor Grade Stabilization: 2 Strt	0.13 miles

5. Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a.1 Install. Cost ($): Cover Crop($145/ac)=		$316,100	$316,100
Bank Prot.($6,800/mi)=		$21,100	$21,100
2 Grade Stabilization Structures @ $22,500		$45,000	$45,000
a.2 Life of Practice is: Cover Crop= 20 yr. Bank Prot.= 20 yr. Grade Str. = 50 yr.			
a.3 Average Annual Cost Cover Crop=		$32,200	$32,200
Bank Prot.=		$2,100	$2,100
Grade Stab.=		$3,700	$3,700
a.4 Total Average Annual Installation Cost		$38,000	$38,000
b.1 Maintenance Cost Cover Crop ($/year)		$177,000	$177,000
b.2 Maintenance Cost Bank Prot ($/year)		$500	$500
b.3 Maintenance Cost Grade Stab.($/year)		$1,000	$1,000
b.4 Total Maintenance Cost ($/year)		$178,500	$178,500
b.5 Total Avg. Ann. Inst. & Main. Cost ($/yr.)		$216,500	$216,500
c. Erosion (tons/year)	59900	40600	−19300
d. Sediment(tons/year)	21700	14700	−7000
Washload (tons)	13000	9000	−4000
Bedload (tons)	8700	5700	−3000
Avg. Ann. Cost Per Ton of Sed. Reduction			$31
Avg. Ann. Cost Per Ton of Washload Reduct			$54
Avg. Ann. Cost Per Ton of Bedload Reduct			$72
e. Crop land Acres Required for Project			0.5
g. Effect on Lagoon Habitat(+,−,0)	−	+	0
h. On−site Hab. Value(WHR Value)	93	102	9
i. Water Quality(qual. +,−,0)	−	+	+
Erosion, Sediment, Flood Damage, Expense:			
k. On−farm Land Damage(erosion)($/year)	$10,900	$3,300	($7,600)
l. On−farm Road Dam(eros./flood)($/year)	$21,700	$19,500	($2,200)
m. On−farm equip. Damage(erosion)($/year)	$15,400	$4,600	($10,800)
n. County Road Damage(flood)($/year)	$14,700	$5,900	($8,800)
o. On−farm Land Protect. Expense(flood)($/yr)	$2,100	$1,900	($200)
p. Stream Restoration Expense(flood)($/year) & Existing Structure Repair Cost(flood)($/year)	$400	$50	($350)
q.			
r.			
s. Management Skills Required (more, less, same)		More	
t. Other Soil, Water, Animal, Plants, Air and Human Considerations:			

Summary of Practice Impacts on the High Priority Erosion Sources

1. Subwatershed: Sand Canyon (#5)
2. Practices: Orchard Cover Crop(Blando) + Bank Protection + Riparian Grade Stab
   (for more detailed practice descriptions see Appendix C)
3. Total Acres or miles of Erosion Source In The Subwatershed:

Cover Crop:	665 acres
Bank Protection:	6.3 miles
Riparian Corridor Grade Stabilization:	6.3 miles

4. Total Acres or miles of Erosion Source In The Subwatershed to Treat

Cover Crop:	466 acres
Bank Protection:	0.6 miles
Riparian Corridor Grade Stabilization: 72 Strt.	2.4 miles

5. Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a.1 Install. Cost ($): Cover Crop($145/ac)=		$67,600	$67,600
Bank Prot.($6,800/mi)=		$4,100	$4,100
2 Grade Stabilization Structures @ $17,300		$1,247,000	$1,247,000
a.2 Life of Practice is: Cover Crop= 20 yr. Bank Prot.= 20 yr. Grade Str. = 50 yr.			
a.3 Average Annual Cost Cover Crop=		$6,900	$6,900
Bank Prot.=		$400	$400
Grade Stab.=		$101,900	$101,900
a.4 Total Average Annual Installation Cost		$109,200	$109,200
b.1 Maintenance Cost Cover Crop ($/year)		$37,800	$37,800
b.2 Maintenance Cost Bank Prot.($/year)		$100	$100
b.3 Maintenance Cost Grade Stab.($/year)		$36,000	$36,000
b.4 Total Maintenance Cost ($/year)		$73,900	$73,900
b.5 Total Avg. Ann. Inst. & Main. Cost ($/yr.)		$183,100	$183,100
c. Erosion (tons/year)	14300	6700	−7600
d. Sediment(tons/year)	6000	2800	−3200
Washload (tons)	3600	2800	−800
Bedload (tons)	2400	0	−2400
Avg. Ann. Cost Per Ton of Sed. Reduction			$57
Avg. Ann. Cost Per Ton of Washload Reduct			$229
Avg. Ann. Cost Per Ton of Bedload Reduct			$76
e. Crop land Acres Required for Project			6.5
g. Effect on Lagoon Habitat(+,−,0)	−	+	0
h. On-site Hab. Value(WHR Value)	93	102	9
i. Water Quality(qual. +,−,0)	−	+	+
Erosion, Sediment, Flood Damage, Expense:			
k. On-farm Land Damage(erosion)($/year)	$9,400	$2,800	($6,600)
l. On-farm Road Dam(eros./flood)($/year)	$19,100	$17,100	($2,000)
m. On-farm equip. Damage(erosion)($/year)	$13,500	$4,050	($9,450)
n. County Road Damage(flood)($/year)	$43,050	$40,450	($2,600)
o. On-farm Land Protect. Expense(flood)($/yr)	$1,900	$400	($1,500)
p. Stream Restoration Expense(flood)($/year) & Existing Structure Repair Cost(flood)($/year)	$9,600	$500	($9,100)
q.			
r.			
s. Management Skills Required (more, less, same)		More	
t. Other Soil, Water, Animal, Plants, Air and Human Considerations:			

Summary of Practice Impacts on the High Priority Erosion Sources

1. Subwatershed: Mahan Barranca (#6)
2. Practices: Orchard Cover Crop(Blando) + Bank Protection + Riparian Grade Stab (for more detailed practice descriptions see Appendix C)
3. Total Acres or miles of Erosion Source In The Subwatershed:

Cover Crop:	120 acres
Bank Protection:	6.1 miles
Riparian Corridor Grade Stabilization:	6.1 miles

4. Total Acres or miles of Erosion Source In The Subwatershed to Treat

Cover Crop:	84 acres
Bank Protection:	0.6 miles
Riparian Corridor Grade Stabilization: 7 Struct	0.23 miles

5. Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a.1 Install. Cost ($): Cover Crop($145/ac)=		$12,200	$12,200
Bank Prot.($6,800/mi)=		$4,100	$4,100
2 Grade Stabilization Structures @ $18,600		$130,000	$130,000
a.2 Life of Practice is: Cover Crop= 20 yr. Bank Prot.= 20 yr. Grade Str. = 50 yr.			
a.3 Average Annual Cost Cover Crop=		$1,200	$1,200
Bank Prot.=		$400	$400
Grade Stab.=		$10,600	$10,600
a.4 Total Average Annual Installation Cost		$12,200	$12,200
b.1 Maintenance Cost Cover Crop ($/year)		$6,800	$6,800
b.2 Maintenance Cost Bank Prot.($/year)		$100	$100
b.3 Maintenance Cost Grade Stab.($/year)		$4,000	$4,000
b.4 Total Maintenance Cost ($/year)		$10,900	$10,900
b.5 Total Avg. Ann. Inst. & Main. Cost ($/yr.)		$23,100	$23,100
c. Erosion (tons/year)	17500	13600	−3900
d. Sediment(tons/year)	7400	5700	−1700
Washload (tons)	4500	3400	−1100
Bedload (tons)	2900	2300	−600
Avg. Ann. Cost Per Ton of Sed. Reduction			$14
Avg. Ann. Cost Per Ton of Washload Reduct			$21
Avg. Ann. Cost Per Ton of Bedload Reduct			$39
e. Crop land Acres Required for Project			1
g. Effect on Lagoon Habitat(+,−,0)	−	+	0
h. On−site Hab. Value(WHR Value)	93	102	9
i. Water Quality(qual. +,−,0)	−	+	+
Erosion, Sediment, Flood Damage, Expense:			
k. On−farm Land Damage(erosion)($/year)	$2,000	$600	($1,400)
l. On−farm Road Dam(eros./flood)($/year)	$3,450	$3,100	($350)
m. On−farm equip. Damage(erosion)($/year)	$2,400	$700	($1,700)
n. County Road Damage(flood)($/year)	$4,500	$1,800	($2,700)
o. On−farm Land Protect. Expense(flood)($/yr)	$300	$50	($250)
p. Stream Restoration Expense(flood)($/year) & Existing Structure Repair Cost(flood)($/year)	$2,400	$100	($2,300)
q.			
r.			
s. Management Skills Required (more, less, same)		More	
t. Other Soil, Water, Animal, Plants, Air and Human Considerations:			

Summary of Practice Impacts on the High Priority Erosion Sources

1. Subwatershed: Long Canyon (#7)
2. Practices: Orchard Cover Crop(Blando) + Bank Protection + Riparian Grade Stab
   (for more detailed practice descriptions see Appendix C)
3. Total Acres or miles of Erosion Source In The Subwatershed:

Cover Crop:	1045 acres
Bank Protection:	17.9 miles
Riparian Corridor Grade Stabilization:	17.9 miles

4. Total Acres or miles of Erosion Source In The Subwatershed to Treat

Cover Crop:	940 acres
Bank Protection:	1.8 miles
Riparian Corridor Grade Stabilization: 54 Strt.	3.1 miles

5. Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a.1 Install. Cost ($): Cover Crop($145/ac) =	▨	$136,300	$136,300
Bank Prot.($6,800/mi) =	▨	$12,270	$12,270
2 Grade Stabilization Structures @ $23,200	▨	$1,250,000	$1,250,000
a.2 Life of Practice is: Cover Crop = 20 yr. Bank Prot. = 20 yr. Grade Str. = 50 yr.	▨	▨	▨
a.3 Average Annual Cost Cover Crop =	▨	$13,900	$13,900
Bank Prot. =	▨	$1,200	$1,200
Grade Stab. =	▨	$102,200	$102,200
a.4 Total Average Annual Installation Cost	▨	$117,300	$117,300
b.1 Maintenance Cost Cover Crop ($/year)	▨	$76,200	$76,200
b.2 Maintenance Cost Bank Prot ($/year)	▨	$300	$300
b.3 Maintenance Cost Grade Stab. ($/year)	▨	$27,000	$27,000
b.4 Total Maintenance Cost ($/year)	▨	$103,500	$103,500
b.5 Total Avg. Ann. Inst. & Main. Cost ($/yr.)	▨	$220,800	$220,800
c. Erosion (tons/year)	28300	9000	−19300
d. Sediment(tons/year)	12300	4300	−8000
Washload (tons)	7300	4300	−3000
Bedload (tons)	5000	0	−5000
Avg. Ann. Cost Per Ton of Sed. Reduction	▨	▨	$28
Avg. Ann. Cost Per Ton of Washload Reduct	▨	▨	$74
Avg. Ann. Cost Per Ton of Bedload Reduct	▨	▨	$44
e. Crop land Acres Required for Project	▨	▨	13
g. Effect on Lagoon Habitat(+, −, 0)	−	+	0
h. On−site Hab. Value(WHR Value)	91	95	4
i. Water Quality(qual. +, −, 0)	−	+	+
Erosion, Sediment, Flood Damage, Expense:			
k. On−farm Land Damage(erosion)($/year)	$11,700	$3,500	($8,200)
l. On−farm Road Dam(eros./flood)($/year)	$23,400	$21,100	($2,300)
m. On−farm equip. Damage(erosion)($/year)	$16,500	$4,950	($11,550)
n. County Road Damage(flood)($/year)	$14,550	$5,850	($8,700)
o. On−farm Land Protect. Expense(flood)($/yr)	$2,300	$450	($1,850)
p. Stream Restoration Expense(flood)($/year) & Existing Structure Repair Cost(flood)($/year)	$1,200	$100	($1,100)
q.			
r.			
s. Management Skills Required (more, less, same)	▨	More	
t. Other Soil, Water, Animal, Plants, Air and Human Considerations:			
− Potential negative impact on 4 endangered /threatened species.			

Summary of Practice Impacts on the High Priority Erosion Sources

1. Subwatershed: Hunt Wash (#8)
2. Practices: Orchard Cover Crop(Blando) + Bank Protection + Riparian Grade Stab
   (for more detailed practice descriptions see Appendix C)
3. Total Acres or miles of Erosion Source In The Subwatershed:

Cover Crop:	210 acres
Bank Protection:	6.7 miles
Riparian Corridor Grade Stabilization:	6.7 miles

4. Total Acres or miles of Erosion Source In The Subwatershed to Treat

Cover Crop:	190 acres
Bank Protection:	0.7 miles
Riparian Corridor Grade Stabilization: 24 Strt.	1.1 miles

5. Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a.1 Install. Cost ($): Cover Crop($145/ac)=		$27,800	$27,800
Bank Prot.($6,800/mi)=		$4,800	$4,800
2 Grade Stabilization Structures @ $22,300		$512,000	$512,000
a.2 Life of Practice is: Cover Crop= 20 yr. Bank Prot.= 20 yr. Grade Str. = 50 yr.			
a.3 Average Annual Cost Cover Crop=		$2,800	$2,800
Bank Prot.=		$500	$500
Grade Stab.=		$41,900	$41,900
a.4 Total Average Annual Installation Cost		$45,200	$45,200
b.1 Maintenance Cost Cover Crop ($/year)		$15,400	$15,400
b.2 Maintenance Cost Bank Prot ($/year)		$100	$100
b.3 Maintenance Cost Grade Stab.($/year)		$12,000	$12,000
b.4 Total Maintenance Cost ($/year)		$27,500	$27,500
b.5 Total Avg. Ann. Inst. & Main. Cost ($/yr.)		$72,700	$72,700
c. Erosion (tons/year)	10300	3400	−6900
d. Sediment(tons/year)	3700	1200	−2500
Washload (tons)	2200	1200	−1000
Bedload (tons)	1500	0	−1500
Avg. Ann. Cost Per Ton of Sed. Reduction			$29
Avg. Ann. Cost Per Ton of Washload Reduct			$73
Avg. Ann. Cost Per Ton of Bedload Reduct			$48
e. Crop land Acres Required for Project			4
g. Effect on Lagoon Habitat(+,−,0)	−	+	0
h. On−site Hab. Value(WHR Value)	93	102	9
i. Water Quality(qual. +,−,0)	−	+	+
Erosion, Sediment, Flood Damage, Expense:			
k. On−farm Land Damage(erosion)($/year)	$5,100	$1,500	($3,600)
l. On−farm Road Dam(eros./flood)($/year)	$10,300	$9,300	($1,000)
m. On−farm equip. Damage(erosion)($/year)	$7,300	$2,200	($5,100)
n. County Road Damage(flood)($/year)	$2,400	$950	($1,450)
o. On−farm Land Protect. Expense(flood)($/yr)	$1,000	$200	($800)
p. Stream Restoration Expense(flood)($/year) & Existing Structure Repair Cost(flood)($/year)	$4,400	$200	($4,200)
q.			
r.			
s. Management Skills Required (more, less, same)		More	
t. Other Soil, Water, Animal, Plants, Air and Human Considerations:			

Summary of Practice Impacts on the High Priority Erosion Sources

1. Subwatershed: Grimes Canyon (#9)
2. Practices: Orchard Cover Crop(Blando) + Bank Protection + Riparian Grade Stab
   (for more detailed practice descriptions see Appendix C)
3. Total Acres or miles of Erosion Source In The Subwatershed:

Cover Crop:	630 acres
Bank Protection:	14.6 miles
Riparian Corridor Grade Stabilization:	14.6 miles

4. Total Acres or miles of Erosion Source In The Subwatershed to Treat

Cover Crop:	570 acres
Bank Protection:	1.5 miles
Riparian Corridor Grade Stabilization: 59 Strt.	3.9 miles

5. Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a.1 Install. Cost ($): Cover Crop($145/ac)=		$79,800	$79,800
Bank Prot.($6,800/mi)=		$10,200	$10,200
2 Grade Stabilization Structures @ $34,300		$2,026,000	$2,026,000
a.2 Life of Practice is: Cover Crop= 20 yr. Bank Prot.= 20 yr. Grade Str. = 50 yr.			
a.3 Average Annual Cost Cover Crop=		$8,100	$8,100
Bank Prot.=		$1,000	$1,000
Grade Stab.=		$165,600	$165,600
a.4 Total Average Annual Installation Cost		$174,700	$174,700
b.1 Maintenance Cost Cover Crop ($/year)		$46,200	$46,200
b.2 Maintenance Cost Bank Prot.($/year)		$200	$200
b.3 Maintenance Cost Grade Stab.($/year)		$37,000	$37,000
b.4 Total Maintenance Cost ($/year)		$83,400	$83,400
b.5 Total Avg. Ann. Inst. & Main. Cost ($/yr.)		$258,100	$258,100
c. Erosion (tons/year)	38900	14800	-24100
d. Sediment(tons/year)	15200	5800	-9400
Washload (tons)	7600	5500	-2100
Bedload (tons)	7600	300	-7300
Avg. Ann. Cost Per Ton of Sed. Reduction			$27
Avg. Ann. Cost Per Ton of Washload Reduct			$123
Avg. Ann. Cost Per Ton of Bedload Reduct			$35
e. Crop land Acres Required for Project			19
g. Effect on Lagoon Habitat(+,-,0)	-	+	0
h. On-site Hab. Value(WHR Value)	93	102	9
i. Water Quality(qual. +,-,0)	-	+	+
Erosion, Sediment, Flood Damage, Expense:			
k. On-farm Land Damage(erosion)($/year)	$19,000	$5,700	($13,300)
l. On-farm Road Dam(eros./flood)($/year)	$38,050	$34,250	($3,800)
m. On-farm equip. Damage(erosion)($/year)	$26,900	$8,100	($18,800)
n. County Road Damage(flood)($/year)	$15,000	$6,000	($9,000)
o. On-farm Land Protect. Expense(flood)($/yr)	$4,000	$800	($3,200)
p. Stream Restoration Expense(flood)($/year) & Existing Structure Repair Cost(flood)($/year)	$6,000	$300	($5,700)
q.			
r.			
s. Management Skills Required (more, less, same)		More	
t. Other Soil, Water, Animal, Plants, Air and Human Considerations:			

Summary of Practice Impacts on the High Priority Erosion Sources

1. Subwatershed: Alamos Canyon (#13)
2. Practices: Orchard Cover Crop(Blando) + Bank Protection + Riparian Grade Stab
   (for more detailed practice descriptions see Appendix C)
3. Total Acres or miles of Erosion Source In The Subwatershed:

Cover Crop:	0 acres
Bank Protection:	22 miles
Riparian Corridor Grade Stabilization:	22 miles

4. Total Acres or miles of Erosion Source In The Subwatershed to Treat

Cover Crop:	0 acres
Bank Protection:	1.1 miles
Riparian Corridor Grade Stabilization: 72 Strt.	1.7 miles

5. Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a.1 Install. Cost ($): Cover Crop($145/ac)=		$0	$0
Bank Prot.($6,800/mi)=		$7,500	$7,500
2 Grade Stabilization Structures @ $16,000		$1,147,000	$1,147,000
a.2 Life of Practice is: Cover Crop= 20 yr. Bank Prot.= 20 yr. Grade Str. = 50 yr.			
a.3 Average Annual Cost Cover Crop=		$0	$0
Bank Prot.=		$800	$800
Grade Stab.=		$93,800	$93,800
a.4 Total Average Annual Installation Cost		$94,600	$94,600
b.1 Maintenance Cost Cover Crop ($/year)		$0	$0
b.2 Maintenance Cost Bank Prot.($/year)		$200	$200
b.3 Maintenance Cost Grade Stab.($/year)		$36,000	$36,000
b.4 Total Maintenance Cost ($/year)		$36,200	$36,200
b.5 Total Avg. Ann. Inst. & Main. Cost ($/yr.)		$130,800	$130,800
c. Erosion (tons/year)	29400	22600	−6800
d. Sediment(tons/year)	9900	5000	−4900
Washload (tons)	5000	4500	−500
Bedload (tons)	4900	500	−4400
Avg. Ann. Cost Per Ton of Sed. Reduction			$27
Avg. Ann. Cost Per Ton of Washload Reduct			$262
Avg. Ann. Cost Per Ton of Bedload Reduct			$30
e. Crop land Acres Required for Project			4
g. Effect on Lagoon Habitat(+,−,0)	−	+	0
h. On−site Hab. Value(WHR Value)	118	113	−5
i. Water Quality(qual. +,−,0)	−	+	+
Erosion, Sediment, Flood Damage, Expense:			
k. On−farm Land Damage(erosion)($/year)	$0	$0	$0
l. On−farm Road Dam(eros./flood)($/year)	$0	$0	$0
m. On−farm equip. Damage(erosion)($/year)	$0	$0	$0
n. County Road Damage(flood)($/year)	$10,200	$4,100	($6,100)
o. On−farm Land Protect. Expense(flood)($/yr)	$0	$0	$0
p. Stream Restoration Expense(flood)($/year) & Existing Structure Repair Cost(flood)($/year)	$6,800	$300	($6,500)
q.			
r.			
s. Management Skills Required (more, less, same)		More	
t. Other Soil, Water, Animal, Plants, Air and Human Considerations:			
− Potential negative impact on endangered /threatened species.			

Summary of Practice Impacts on the High Priority Erosion Sources

1. Subwatershed: Arroyo Conejo (#30)
2. Practices: Orchard Cover Crop(Blando) + Bank Protection + Riparian Grade Stab
   (for more detailed practice descriptions see Appendix C)
3. Total Acres or miles of Erosion Source In The Subwatershed:
   Cover Crop: 780 acres
   Bank Protection: 0 miles
   Riparian Corridor Grade Stabilization: 0 miles
4. Total Acres or miles of Erosion Source In The Subwatershed to Treat
   Cover Crop: 702 acres
   Bank Protection: 0 miles
   Riparian Corridor Grade Stabilization: 0 Strt 0 miles

5. Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a.1 Install. Cost ($): Cover Crop($145/ac)=		$101,800	$101,800
Bank Prot.($6,800/mi)=		$0	$0
2 Grade Stabilization Structures @ $16,000		$0	$0
a.2 Life of Practice is: Cover Crop= 20 yr. Bank Prot.= 20 yr. Grade Str. = 50 yr.			
a.3 Average Annual Cost Cover Crop=		$10,400	$10,400
Bank Prot.=		$0	$0
Grade Stab.=		$0	$0
a.4 Total Average Annual Installation Cost		$10,400	$10,400
b.1 Maintenance Cost Cover Crop ($/year)		$56,900	$56,900
b.2 Maintenance Cost Bank Prot.($/year)		$0	$0
b.3 Maintenance Cost Grade Stab.($/year)		$0	$0
b.4 Total Maintenance Cost ($/year)		$56,900	$56,900
b.5 Total Avg. Ann. Inst. & Main. Cost ($/yr.)		$67,300	$67,300
c. Erosion (tons/year)	33800	29800	−4000
d. Sediment(tons/year)	15300	13300	−2000
Washload (tons)	9300	7350	−1950
Bedload (tons)	6000	5950	−50
Avg. Ann. Cost Per Ton of Sed. Reduction			$34
Avg. Ann. Cost Per Ton of Washload Reduct			$35
Avg. Ann. Cost Per Ton of Bedload Reduct			$1,346
e. Crop land Acres Required for Project			1.5
g. Effect on Lagoon Habitat(+,−,0)	−	+	0
h. On−site Hab. Value(WHR Value)	70	77	7
i. Water Quality(qual. +,−,0)	−	+	+
Erosion, Sediment, Flood Damage, Expense:			
k. On−farm Land Damage(erosion)($/year)	$8,200	$2,500	($5,700)
l. On−farm Road Dam(eros./flood)($/year)	$16,400	$14,750	($1,650)
m. On−farm equip. Damage(erosion)($/year)	$11,600	$3,500	($8,100)
n. County Road Damage(flood)($/year)	$9,300	$9,300	$0
o. On−farm Land Protect. Expense(flood)($/yr)	$1,600	$1,600	$0
p. Stream Restoration Expense(flood)($/year) & Existing Structure Repair Cost(flood)($/year)	$0	$0	$0
q.			
r.			
s. Management Skills Required (more, less, same)		More	
t. Other Soil, Water, Animal, Plants, Air and Human Considerations:			

Summary of Practice Impacts on the High Priority Erosion Sources

1. Subwatershed: Peach Hill (#33)
2. Practices: Orchard Cover Crop(Blando) + Bank Protection + Riparian Grade Stab
   (for more detailed practice descriptions see Appendix C)
3. Total Acres or miles of Erosion Source In The Subwatershed:

Cover Crop:	370 acres
Bank Protection:	0 miles
Riparian Corridor Grade Stabilization:	0 miles

4. Total Acres or miles of Erosion Source In The Subwatershed to Treat

Cover Crop:	330 acres
Bank Protection:	0 miles
Riparian Corridor Grade Stabilization: 0 Strt	0 miles

5. Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a.1 Install. Cost ($): Cover Crop($145/ac)=		$47,850	$47,850
Bank Prot.($6,800/mi)=		$0	$0
2 Grade Stabilization Structures @ $16,000		$0	$0
a.2 Life of Practice is: Cover Crop= 20 yr.			
Bank Prot.= 20 yr. Grade Str. = 50 yr.			
a.3 Average Annual Cost Cover Crop=		$4,900	$4,900
Bank Prot.=		$0	$0
Grade Stab.=		$0	$0
a.4 Total Average Annual Installation Cost		$4,900	$4,900
b.1 Maintenance Cost Cover Crop ($/year)		$26,700	$26,700
b.2 Maintenance Cost Bank Prot.($/year)		$0	$0
b.3 Maintenance Cost Grade Stab.($/year)		$0	$0
b.4 Total Maintenance Cost ($/year)		$26,700	$26,700
b.5 Total Avg. Ann. Inst. & Main. Cost ($/yr.)		$31,600	$31,600
c. Erosion (tons/year)	3500	400	-3100
d. Sediment(tons/year)	1400	200	-1200
Washload (tons)	1000	100	-900
Bedload (tons)	400	100	-300
Avg. Ann. Cost Per Ton of Sed. Reduction			$26
Avg. Ann. Cost Per Ton of Washload Reduct			$35
Avg. Ann. Cost Per Ton of Bedload Reduct			$105
e. Crop land Acres Required for Project			0
g. Effect on Lagoon Habitat(+,-,0)	-	+	0
h. On-site Hab. Value(WHR Value)	70	77	7
i. Water Quality(qual. +,-,0)	-	+	+
Erosion, Sediment, Flood Damage, Expense:			
k. On-farm Land Damage(erosion)($/year)	$9,200	$2,800	($6,400)
l. On-farm Road Dam(eros./flood)($/year)	$18,450	$16,550	($1,900)
m. On-farm equip. Damage(erosion)($/year)	$13,050	$3,950	($9,100)
n. County Road Damage(flood)($/year)	$6,000	$6,000	$0
o. On-farm Land Protect. Expense(flood)($/yr)	$1,800	$1,800	$0
p. Stream Restoration Expense(flood)($/year) & Existing Structure Repair Cost(flood)($/year)	Included in main chan.	--	--
q.			
r.			
s. Management Skills Required (more, less, same)		More	
t. Other Soil, Water, Animal, Plants, Air and Human Considerations:			

Summary of Practice Impacts on the High Priority Erosion Sources

1. Subwatershed: Arroyo Los Posas (#34)
2. Practices: Orchard Cover Crop(Blando) + Bank Protection + Riparian Grade Stab
   (for more detailed practice descriptions see Appendix C)
3. Total Acres or miles of Erosion Source In The Subwatershed:

Cover Crop:	520 acres
Bank Protection:	0 miles
Riparian Corridor Grade Stabilization:	0 miles

4. Total Acres or miles of Erosion Source In The Subwatershed to Treat

Cover Crop:	470 acres
Bank Protection:	0 miles
Riparian Corridor Grade Stabilization: 0 Strt	0 miles

5. Treatment Impacts: Impact	Before Treatment Condition	After Treatment Condition	Net Change
a.1 Install. Cost ($): Cover Crop($145/ac)=	▨	$68,150	$68,150
Bank Prot.($6,800/mi)=	▨	$0	$0
2 Grade Stabilization Structures @ $16,000	▨	$0	$0
a.2 Life of Practice is: Cover Crop= 20 yr.	▨	▨	▨
Bank Prot.= 20 yr. Grade Str. = 50 yr.	▨	▨	▨
a.3 Average Annual Cost Cover Crop=	▨	$6,900	$6,900
Bank Prot.=	▨	$0	$0
Grade Stab.=	▨	$0	$0
a.4 Total Average Annual Installation Cost	▨	$6,900	$6,900
b.1 Maintenance Cost Cover Crop ($/year)	▨	$38,100	$38,100
b.2 Maintenance Cost Bank Prot ($/year)	▨	$0	$0
b.3 Maintenance Cost Grade Stab. ($/year)	▨	$0	$0
b.4 Total Maintenance Cost ($/year)	▨	$38,100	$38,100
b.5 Total Avg. Ann. Inst. & Main. Cost ($/yr.)	▨	$45,000	$45,000
c. Erosion (tons/year)	3900	400	−3500
d. Sediment(tons/year)	1600	200	−1400
Washload (tons)	1100	100	−1000
Bedload (tons)	500	100	−400
Avg. Ann. Cost Per Ton of Sed. Reduction	▨	▨	$32
Avg. Ann. Cost Per Ton of Washload Reduct	▨	▨	$45
Avg. Ann. Cost Per Ton of Bedload Reduct	▨	▨	$113
e. Crop land Acres Required for Project	▨	▨	0
g. Effect on Lagoon Habitat(+,−,0)	−	+	0
h. On−site Hab. Value(WHR Value)	70	77	7
i. Water Quality(qual. +,−,0)	−	+	+
Erosion, Sediment, Flood Damage, Expense:			
k. On−farm Land Damage(erosion)($/year)	$9,800	$2,900	($6,900)
l. On−farm Road Dam(eros./flood)($/year)	$20,000	$18,000	($2,000)
m. On−farm equip. Damage(erosion)($/year)	$14,100	$4,200	($9,900)
n. County Road Damage(flood)($/year)	$0	$0	$0
o. On−farm Land Protect. Expense(flood)($/yr)	$2,000	$2,000	$0
p. Stream Restoration Expense(flood)($/year) & Existing Structure Repair Cost(flood)($/year)	Included in main chan.	−−	−−
q.			
r.			
s. Management Skills Required (more, less, same)	▨	More	
t. Other Soil, Water, Animal, Plants, Air and Human Considerations:			

APPENDIX D

REFERENCE LIST

CALLEGUAS CREEK STUDY
REFERENCE LIST
(with Subject/Category Identifiers)

The following list of references is in alphabetical order. A brief description of each reference is included. In addition, each reference has been identified by a subject category code(s). The subject categories are:

SUBJECT/CATEGORY	CODE
Soils, Erosion	S
Water, Hydrology	W
Plants, Animals and Fish	P
Socioeconomic	SE
Engineering, Practices, Models	E
Mugu Study Area	M
Water Quality, Nonpoint Source	N

At the end of the reference section is a list of maps used in this study.

Subject
Category

N, SE **Adler**, Smolen, Painter, and Wagner, (February 1989 - Final Draft); Selecting Priority Nonpoint Source Projects: You Better Shop Around.

Suggested methods for prioritizing nonpoint source water bodies and several examples of states and which method they use.

M, SE **Alegrete**, Debbie, December 1991; Senior Geography Project, unpublished.

Evaluated urban expansion in the Simi Valley, Moorpark area of Mugu Lagoon Watershed over the last thirty years using aerial photos.

P **Andersen, Frede** and Erik Kristensen (1992); The importance of benthic macrofauna in decomposition of microalgae in a coastal marine sediment, In the American Society of Linmology and Oceanography, Inc., Vol. 37, P. 1392-1403.

The effectiveness of macrofauna in decomposing organic matter was studied in microcosms by adding ^{14}C-labeled microalgae to undisturbed sediment cores with and without fauna.

M **Balance Hydrologies, Inc**. and WEST Consultants, Inc. (February 1992); Mugu Lagoon Watershed Plan: Reconnaissance Study and Work Program for a Lagoon Enhancement Plan, prepared for California State Coastal Conservancy.

A work plan for Mugu Lagoon which suggests further study, a cost estimate and bibliography.

S **Barry**, Joseph, Robert Rodgers, and Joan Greenhood (April 1976); San Elijo Lagoon Erosion and Sediment Study; 58 pages.

The objectives of the study were to: describe the environmental effects associated with erosion and sedimentation in and adjacent to San Elijo Lagoon, described the conditions and mechanisms that cause erosion and sediment, describe areas where erosion and sedimentation have occurred, suggest methods for improving erosion and sediment control, and try to achieve the kind of erosion and sediment control the public needs.

M, S **Bein**, Robert, William Frost and Associates (1993); Project Description for Calleguas Creek Flood Control Improvement Project, prepared for Ventura County Flood Control District.

The proposed project includes: realignment and excavation of channel, construction of slope protection, construction of drop structures, reconstruction of Mission Oaks Bridge, and creation of vegetative corridors and habitat replacement areas, and creation of linear park and bicycle trail.

Subject
Category

N, SE **Bouwes**, Nicolaas and Robert Schneider (Feb.-Aug. 1979); Procedures in Estimating Benefits of Water Quality Change, In American Journal of Agricultural Economics, Vol. 61:1-3, pages 535-539.

This article outlines a procedure to determine whether the benefits of preserving a currently good water quality lake in Wisconsin is worth the project costs. To demonstrate the effects of a decline in water quality the number of recreators and the associated value was analyzed. The difference between good water quality condition and a degraded condition provided the estimated benefit, and was compared to the cost of preserving the lake. It was concluded that the benefits of the project were greater than the costs and therefore preserving the lake would be the proper decision.

E, W **Boyle Engineering Corporation** (December 1991); Reclaimed Water Seasonal Storage Project, Phase 1, Environmental and Engineering Studies, Volume 6, Engineering Data, Facilities, and Costs, for Las Virgenes Municipal Water District and Triunfo County Sanitation District. One of six reports.

This report deals with engineering data, facilities and costs, for each of six identified sites.

E, S, W **Boyle Engineering Corporation**, Water Resources Division (June 1982); Los Penasquitos Lagoon Watershed Management Plan, 126 p.

This report describes the engineering methods used to estimate water and sediment runoff for existing and future conditions in the watershed. The report discusses potential mitigation measures to reduce the expected sediment increase, and recommends specific measures to be implemented as the watershed management plan.

E, S, W **Boyle Engineering Corporation**, Woodward-Clyde Consultants, Staal, Gardner and Dunne, Inc., and Bauer Environmental Services (February 1992); Reclaimed Water Seasonal Storage Project, Phase 1, Environmental and Engineering Studies, Volume 1, Summary Report, for Las Virgenes Municipal Water District and Triunfo County Sanitation District. One of six reports.

Report on investigation of groundwater alternative for seasonal storage and to provide enough environmental, engineering and cost information to allow two or three preferred surface storage reservoir sites. The three preferred sites are Agoura Hills Site, Ahmanson Ranch Site, and Donnell Ranch Site which are recommended for further study.

P, SE **Brendler, R.A.**, (June 1990); Costs and Practices in Ventura County for Lima Beans and Vegetables, Brendler is a University of California Cooperative Extension Farm Advisor

Crop budgets for crops grow in Ventura County.

Subject
Category

P, SE **Brendler, R.A.,** Ventura County, (1991); Cropland History, Brendler is a University of California Cooperative Extension Farm Advisor

Summarizes the crop history of Ventura County.

N, E **Brenner**, F.J., W. Kanour, B. Weston, G. Valeria, and K.R. Grayburn (1986); Impact of Flood Control Reservoirs and Pollution Influx on the Sandy Creek Watershed; Mercer County, Pennsylvania, 22 p.

Fecal coliforms were significantly reduced in the outflows without affecting water chemistry, thereby improving the overall water quality. Pollution influx primarily from communities and agricultural drainage had a greater impact on the stream ecosystem than did impounding of the streams. Natural wetlands and riparian vegetation were important factors in reducing the pollution load on these streams. The reestablishment and maintenance of riparian vegetation should therefore be an integral part of the landuse plan for watersheds in order to improve water quality and wildlife habitats.

M, S **Breuer**, Howard (March 1992); Oxnard beach judged best bet for erosion test, Article in Ventura County Star Free Press.

Article on an experimental project to reverse beach erosion, by dredging sand from the Ocean floor, depositing the sand near the shore, and allowing the waves to carry the sand to the beach.

N, P **Brown**, Zhang and Rubio (October 1992); Development of Diagnostic Measures of Tree Nitrogen Status to Optimize N Fertilizer Use, Proceedings of the First Annual Fertilizer Research and Education Program Conference, October 1992, California Department of Food and Agriculture.

Orchard crops utilize large amounts of fertilizer N and are potentially major contributors to groundwater pollution in many areas of California. Large acreages of orchard crops are grown in areas designated as nitrate 'sensitive' in recent water quality assessments. Fertilizer management of orchard crops is, however, poorly regulated and the dynamics of N in orchard crops is the least well understood of any cropping system. In this research we aim to improve plant N-monitoring techniques so that fertilizer applications can be better managed. This aim will be achieved by monitoring the concentration, composition, and distribution of a range of N-compounds in mature trees and relating this to plant, yield, fertilizer N application and nitrate movement in the soil. Research of this type has been performed in annual crops but has not been adapted to perennial systems.

P **Caffrey** and Kemp (1992); Influence of the submersed plant, Potamogeton perfoliatus, on nitrogen cycling in estuarine sediments, In American Society of Limnology and Oceanography, Inc., Vol 37, p. 1483-1495.

Effects of Potamogeton perfoliatus on N transformations in sediments were examined with ^{15}N isotope techniques.

Subject
Category

N, P **California State Water Resources Control Board** (March 1979); California Marine Waters, Areas of Special Biological Significance Reconnaissance Survey Report, Mugu Lagoon to Latigo Point, Ventura and Los Angeles Counties, Water Quality Monitoring report No. 79-5, 224 pages.

The Mugu Lagoon to Latigo Point Area of Special Biological Significance (ASBS) includes the ocean waters between Latigo Point in Los Angeles County and Laguna Point in Ventura County, from the intertidal to 100 foot depth or 1,000 feet offshore, whichever is further. Four major land vegetation types border the ASBS: salt marsh, coastal strand, coastal sage scrub and riparian woodland. The biota of this ASBS is rich and diverse which reflects the variety of habitats in this area. Potential water quality threats to the area include: 1) discharges of agricultural, industrial and domestic wastes into Mugu Lagoon and Calleguas Creek which may subsequently enter the ASBS, 2) septic tanks and leach fields near or on the beach in some areas of the ASBS, 3) rapid development of the land bordering the ASBS which may lead to increased erosion and flooding, 4) possible input of pollutants carried on currents from distant, but large outfalls on either side of the ASBS.

N **California State Water Resources Control Board** (May 1992); Water Quality Assessment.

A catalog of the State's waterbodies and their water quality condition.

N **California State Water Resources Control Board** (1990); Proposed: 1990 Water Quality Assessment (WQA), Division of Water Quality.

Reports on the water quality conditions, special State issues, accomplishments, and water quality control programs within the State of California as of 1990.

E, N **California State Water Resources Control Board**, California Coastal Commission (1991); Comments on Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, 7 chapters and appendices.

Managers from the State Water Resources Control Board provides comments on the Proposed EPA Guidance for nonpoint source pollution in coastal waters. Comments are presented for agricultural, forestry, urban sources, recreational uses, hydromodification, and wetlands protection measures. The general consensus reached is that the guidance is useful in a broad sense, but conditions vary extensively that measures used in Chesapeake Bay may or may not be useful in California.

Subject
Category

E **Camp, Dresser, & McKee, Larry Walker Associates, Uribe and Associates, and Resources Planning Associates** (March 1993); California Storm Water Best Management Practice Handbooks, for Stormwater Quality Task Force.

The Municipal Best Management Practices (BMPs) Handbook presents specific guidance on selecting best Management practices for reducing pollutants in storm water discharges from urbanized areas. The primary audience of the handbook is the municipality responsible for developing a storm water Management program under its NPDES storm water permit. The handbook outlines a six step decision making process for developing a municipal storm water management program. More importantly the handbook identifies a process for selecting source and treatment control BMP's that become a part of the municipality's storm water management program.

Detailed fact sheets are provided for the BMPs includes information regarding where they should be applied, what are the targeted pollutants of the BMP, design criteria (when applicable), and examples of their application. The handbook also give guidelines for measuring the BMP's performance.

P **Castren**, James (February 1963); A General Survey of the Fauna of the Beardsley-Revolon Project Area, Preliminary.

Observations made during this survey indicate that while there are no areas completely devoid of fauna, the numbers and kinds of animals present are probably fewer than occurred in the past and are affected by several factors.

SE **Centaur Associates, Inc.**, (August 1984); Cumulative Socioeconomic Impacts of Oil and Gas Development in the Santa Barbara Channel Region, A Case Study, p 100-137, 307 pages plus appendices.

The study assesses what actually happened to the socioeconomic environment of Santa Barbara and Ventura County as a result of oil and gas development and recommends ways to improve methods to predict socioeconomic impacts from future development, mutivariate regression analysis was used and a regional economic model was developed for this study. Significant socioeconomic data as far back as the 1960's is included. The study concluded that oil and gas development has not been a major factor in the tremendous socioeconomic changes in the region.

M **CH2M Hill** (Final: November 1991); Water Rights Application No. 29408, Notice of Preparation of a Draft Environmental Impact Report (EIR), prepared for City of Thousand Oaks, Draft: May 1991

Ventura Co. relies heavily on groundwater as a source of water. This application is for the development of a diversion project on Conejo Creek to capture water for beneficial use.

Subject
Category

SE **Chesapeake Bay Local Government Advisory Committee** (April 1991); Chesapeake Bay Restoration: Innovations at the Local Level.

A overview of Local Governments involvement in the Chesapeake Bay Project, includes examples of questionnaires, brochures and regulations that were changed. There are approximately 6,400 local governments in the Bay drainage area.

E, N **Chesapeake Bay Program** (Feb. 1992); Progress Report of the Baywide Nutrient Reduction Reevaluation, printed by EPA, 68 p.

Reports on progress made by the Chesapeake Bay Program during the past year and the reevaluations made for the pollutant transport model. Includes problem identification, agreements, strategy, inventories, objectives, modeling, technology effectiveness and costs, and findings. Also included is a Technical Appendix for objectives and model refinement processes.

E, W **Chescheir**, Skaggs, and Gilliam (1992); Evaluation of Wetland Buffer Areas for Treatment of Pumped Agricultural Drainage Water. In: Transaction of the American Society of Agricultural Engineer, General Edition, Vol. 35, No. 1.

A computer method was developed for predicting nutrient and sediment removal from agricultural drainage water pumped onto wetland buffer areas. The method utilizes a model for simulating drainage from agricultural land and a model for simulating overland flow, and nutrient and sediment removal on wetlands. Both simulation models were calibrated using data collected in field experiments. The simulation models were then coupled to predict the percent removal of sediment, total phosphorus (P), total Kjeldahl nitrogen (TKN), and nitrate nitrogen (NO_3-N) from drainage water for a 20-year period of climatological data. This method predicted that the 240 ha wetland buffer at the field research site could be expected to remove over 79% of the TKN, NO_3-N, P and sediment in drainage water from a 1250 ha agricultural watershed. The method was used to evaluate the effects of buffer size and shape on the nutrient and sediment removal effectiveness of the wetland.

E **City of Encinitas, California** (June 1988); An Ordinance Of The City Of Encinitas, California Adding Chapter 23.24 To The Encinitas Municipal Code Relating To Grading, Erosion and Sediment Control and Amending Chapter 23.32 Eliminating Reference To San Diego County Grading Ordinance, 45 p.

The purpose of Chapter 23.24 is to establish minimum requirements for grading, excavating and filling of land, to provide for the issuance of grading permits and to provide for the enforcement of the requirements.

Subject
Category

E, S **City of Portland**, Bureau of Environmental Services, and Unified Sewerage Agency of Washington County, Oregon (January 1991); Erosion Control Plans - Technical Guidance Handbook.

The handbook introduces plan submittal requirements and recommended measures for construction site erosion control. The handbook was developed to address state-mandated erosion control requirements for the Tualatin River Basin and its applicability to the west Portland metropolitan area and other areas with similar soils conditions. An important concept to keep in mind when developing construction and erosion control plans is: construction practices which minimize the amount of disturbed land area and avoidance or minimizing work on steep slopes are encouraged.

E, N, SE **Clark**, Edwin H., Jennifer A. Haverkamp, and William Chapman (1985); Eroding Soils - The Off-Farm Impacts, The Conservation Foundation.

This book examines the problems caused by soil erosion off the farm and, in doing so, addresses non-point source pollution. The book summarizes what is known about the effects of erosion on water quality, and provides an estimate of how much the problems cost each year (1980 dollars equal $6 billion).

E, W **Corbitt**, Robert A., Editor (1989); Standard Handbook of Environmental Engineering, McGraw-Hill, 1990, 628 p., Chapter 3. Air and Water Quality Standards, Chapter 6. Wastewater Disposal, and Chapter 7. Storm Water Management.

The textbook style chapters include the standards for water quality and water quality monitoring/testing, design and effects of practices for wastewater and storm water management and control, wastewater and storm water pollutants, and guidelines for use and maintenance of the BMP's. Specific examples and monitoring results are not given.

E, S **County of Los Angeles** (1973); Green Belts for Brush Fire Protection and Soil Erosion Control in Hillside Residential Areas, Department of Arboreta and Botanic Gardens, Los Angeles State and County Arboretum, Descanso Gardens, South Coast Botanic Garden, 38 p.

This booklet describes plants for the area that are moderate to low growing, fire retardant or succulent, drought resistant, and provide erosion control. Some tips on planting for fires, fire breaks, and erosion control are given. Tips for plant maintenance and irrigation are also given.

E **County of Los Angeles** and USDA-Forest Service (June 1982); A Homeowners Guide to Fire and Watershed Management at the Chaparral/Urban Interface.

Booklet provides a brief description of the chaparral plant community as well as sections describing some basic consideration of watershed and fire management. Later sections deal with improving safety around the home design, landscaping and maintenance; protecting oneself and one's property during a wildfire; and finally, providing emergency treatment of hillsides after a fire.

Subject
Category

E, **Galli** (December 1990); Peat-Sand Filters, A Proposed Stormwater Management Practice for Urbanized Areas, Prepared for The Coordinated Anacostia Retrofit Program and Office of Policy and Planning, D.C. Department of Public Works, 45 pages.

The report describes the proposed use and modification of existing peat-sand filter technology for urban stormwater management control. The proposed made-soil infiltration system combines peat, sand and a grass cover crop to achieve high overall pollutant removal efficiency within a single, relatively compact unit. In addition, the system also features a small wet pool for pre-treating stormwater runoff. The general compactness and relative freedom of the proposed system from common site constraints (such as high water table, poor soils, etc.) make it a leading candidate for many end of pipe applications. The paper both presents a comprehensive overview of peat and peat-sand filters, and describes in detail the design features and workings of the proposed system.

E, P **Galli**, Dubose, and Metropolitan Washington Council of Governments, (December 1990); Thermal Impacts Associated with Urbanization and Stormwater Management Best Management Practices - Appendices, for the Sediment and Stormwater Administration of the Maryland Department of the Environment.

The report provides an overview of known, or potential, general effects of temperature regime modification on stream biota. A two-part holistic ecosystem approach was used. Part one examined principal environmental factors and various human activities which influence the thermal regime of streams. Part two investigated the general thermal requirements of stream biota as well as the potential biological affects associated with thermal regime modification. Potential biological consequences occurring at all general levels of the aquatic food chain were researched.

E, P **Gearheart**, R.A. Ph.D., and Humboldt State University (1989); An Overview of Potential Wetland Opportunities in the Malibu Creek Watershed, Marsh System Subcommittee, Malibu Regional Wastewater Systems, Citizen Committee.

The objective of this planning study was to determine the feasibility of using constructed wetlands and marsh forests in the Malibu Creek Watershed for receiving treated effluent and nonpoint source polluted waters. This study developed the need for freshwater wetlands in California and specifically on the Malibu Creek Watershed, and it presented a list of benefits which would accrue from using these wetlands systems to process reclaimed water and targeted watershed runoff. Wetland benefits include wildlife support such as habitat, food source, water supply, nesting, wildlife corridor, etc. Other benefits include passive recreation, educational, health, economic, conservation, aesthetic, and others. Of primary importance are the benefits from the ability of a wetland to remove nitrogen, phosphorous, suspended solids, and biological oxygen demand and to allow for natural die-off of pathogens.

Subject
Category

N, SE **Gosz**, James R. (1982); Non-Point Source Pollution of Water by Recreation: Research Assessment and Research Needs, Eisenhour Consortium for Western Environmental Forestry Research, Bulletin 13, USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

> Literature review shows conflicting opinions as to the significance of water quality degradation due to recreation. Thus specific management guidelines for maintaining water quality at a specific new site are not feasible. Interdisciplinary research is needed to determine coefficients of material transport and energy transmission through watershed ecosystems.

SE, **Gruntfest** and Taft (1992); What we can Learn from the February 1992 Floods in Ventura County, California, Quick Response Research Report #50.

> The paper has two parts; first a discussion of the geographical context, the flood detection/warning system in Ventura County, the peripheral uses of the ALERT system, and the county flood history; the second consists of a summary of findings based on the February 1992 floods, comments, and controversial topics and recommendations.

P, SE **Hageman**, Ronda (September 1985); Valuing Marine Mammal Populations: Benefit Valuations in a Multi-Species Ecosystem, National Marine Fisheries Service, Southwest Fisheries Center, Administrative Report LJ-85-22.

> A valuation of aesthetic and consumptive/non-consumptive uses of marine mammals and marine mammal management, based upon a San Diego State University contingent valuation study of July 1984.

N, E **Hamlet**, Miller, Day, Peterson, Baumer, and Russo (September-October 1992); Statewide GIS-based ranking of watersheds for agricultural pollution prevention, In: Journal of Soil and Water Conservation, Volume 47, No. 5, Pages 399-404.

> In efforts to control and reduce agricultural nonpoint pollution, it is important to identify critical contributing source areas. A geographic information system (GIS), combined with a pollutant generation and transport model, can be used to identify and rank critical pollutant source areas on a regional basis. In this study, a GIS-based, statewide screening model was used to rank the agricultural pollution potential of 104 watersheds in Pennsylvania. Cost constraints were an overwhelming factor in determining which data could be used and assumptions that had to be made to simplify the model. The ranking index was composed of four components: a runoff index, a sediment production index, an animal loading index, and a chemical use index. Statewide data used in the ranking are commonly available or can be developed readily for areas within the United States and include watershed boundaries, land cover, animal density, topography, soils, precipitation, and rainfall-runoff factors. The ranking allowed identification of critical nonpoint-pollutant contributing watersheds in Pennsylvania and is useful for targeting further investigations and control programs. A similar GIS approach could be useful in other state and regional studies.

Subject
Category

E, P **Hammer**, Donald A. (1989); Constructed Wetlands for Wastewater Treatment Municipal, Industrial, and Agricultural; 831 p.

Provides general principals on wetland ecology and function, case histories, design, and treatment of nonpoint source pollutants, urban and agricultural.

E, P **Hartz** (October 1992); Optimizing Drip Irrigation Management for Improved Water and Nitrogen Use Efficiency, Proceedings of the First Annual Fertilizer Research and Education Program Conference, October 1992, California Department of Food and Agriculture.

Irrigation studies on fresh market tomatoes were conducted at the UC South Coast Field Station (SCFS) in Santa Ana and the West Side Field Station (WSFS) in Five Points. The 1991 SCFS trial, the final season of a three-year study, compared drip irrigation scheduling based either on soil moisture depletion or on evapotranspiration estimates (ET0).

Field trials to establish appropriate nitrogen fertigation regimes for fresh market tomato and bell pepper production were conducted at WSFS and the University of California, Davis (UCD), during the summer of 1992.

W, M, E **Hawks and Associates** (December 1990); Simi Valley Master Plan of Drainage, prepared for City of Simi Valley.

The purpose was to analyze the hydrologic characteristics of the Simi Valley drainage basin and provide a planning framework within which existing and future drainage system needs can be identified and acted upon.

E, S **High Sierra Resource Conservation and Development Area Council** (1981); Erosion and Sediment Control Guidelines for Developing Areas of the Sierras, EPA Grant, 270 p.

The document presents the design guidelines, effectiveness, construction methods, costs and maintenance requirements for a variety of erosion and sediment control practices that work in sandy soils and semi-arid conditions.

P, M **Holmes**, Robert W., C. Onuf, and C. Peterson (1979); Coastal Wetlands Management: Biological Criteria, 7 p.

Conclusions and questions raised after studying Mugu lagoon on the effects of large storm event, tides, and organic matter influx on the various biological systems.

Subject
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M, N **Izbicki**, John (1991); Chloride sources in A California coastal aquifer: American Society of Civil Engineers, Proceedings of the Irrigation and Drainage Division Conference on Ground Water in the Pacific Rim Countries, Honolulu, Hawaii, July 23-25, pages 71-77.

The Oxnard Plain, about 60 miles northwest of Los Angeles, is underlain by a complex system of five aquifers that are used for water supply. These aquifers have a total thickness of more than 1,000 feet. On the basis of previous studies, it has been estimated that more than 23 square miles of the Oxnard aquifer (shallowest of the five major aquifers) is intruded by seawaters that entered primarily through outcrop areas in submarine canyons near the coast. Water-quality data, including stable-isotope analyses, from more than 40 wells installed as part of this study show that the area affected by seawater intrusion is less than originally believed. The source of elevated chloride concentration, at least in some wells, is leakage of seawater through failed well casings or through abandoned irrigation wells perforating more than one aquifer. In other wells, irrigation return may be the cause of elevated chloride concentrations. In addition, seawater has intruded in deeper aquifers near Hueneme submarine canyon and a brine other than seawater may have invaded deeper aquifers near Point Mugu.

E **Jewell**, William J. and Belford L. Seabrook (April 1979); A History of Land Application as a Treatment Alternative, EPA 430/9-79-012, Technical Report, Richard E. Thomas, Project Officer, 83 p.

This report discusses various land application methods and sites and provides the monitoring data. History and design data prevail, and the numbers of sites is limited to those undertaken with EPA assistance. Includes information on what does and does not work.

E, P **Josselyn**, Chamberlain, Romberg Tiburon Center San Francisco State University, Goodwin, Cuffe, Philip Williams and Associates (1992); Draft Wetland Inventory and Restoration Potential, Santa Monica Bay Restoration Project.

This report provides information on wetland habitat type(s), current conditions, and potential for protection/restoration/creation. Specific objectives were to characterize the historic changes and current status of the wetlands within the watershed; inventory, map and describe the existing wetlands; identify potential restoration/creation sites; and select example to describe the issues involved in the implementation of restoration/creation plans.

E, P, W, **Josselyn**, Michael, Editor (1982); Wetland Restoration and Enhancement in California, A proceedings of a workshop held at California State University, Hayward, 110 p.

Information on wetland restoration techniques, inventory, legal constraints on wetland enhancement, circulation, sedimentation, and water quality of wetlands, monitoring, and other subjects.

Subject
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N, P
E **Kahn**, James R. (1987); "Measuring the Economic Damages Associated with Terrestrial Pollution of Marine Ecosystems", In Marine Resource Economics, Volume 4, Number 3, 1987, pages 193-209.

Reviews the welfare consequences of the effects of environmental changes on the bioeconomic equilibrium of fisheries. Shows that a model in which the equilibrium catch function is estimated directly as a function of environmental quality will be superior to a model which takes the stock effects from an independent ecosystem model.

S **Kelley**, Hubert W. (1983); Keeping the Land Alive, Soil Erosion - Its Causes and Cures, German Agency for Technical Cooperation, Soil Resources, Management, and Conservation Service, Land and Water Development Division for Food and Agriculture Organization of the United Nations, FAO Soils Bulletin 50, 79 p.

The report discusses, in simple terms, soil erosion, its causes and effects, land degradation because of erosion, human barriers to conservation, soil management, erosion control, and governmental actions. Report is not specific, but gives good examples from worldwide sites for erosion control. Non-mechanical methods are focused on.

S **Leopold**, L.B., M.G. Wolman, and J.P. Miller (1964); Fluvial Processes in Geomorphology, W.H. Freeman and Company, San Francisco

N, SE **Lichtenberg**, Erik and David Zilberman (February 1988); Efficient Regulation of Environmental Health Risks, In the Quarterly Journal of Economic, Volume 103.

The article introduces a decision framework for regulating environmental health risks and incorporates the characteristic uncertainty about the dissemination and toxicological impacts of environmental contaminants and the behavioral restrictions commonly encountered. Analysis indicates that increases in uncontrollable uncertainty will increase emphasis on average performance, that more potent or less controllable risks will be regulated more stringently and that increasing aversion to uncertainty may result in poorer average performance. The paper also develops an alternative measure for valuing risk of loss of life taking into account uncertainty about health risk generation processes.

P, SE **Lynne**, Gary D., Patricia Conroy and Frederick J. Prochaska (1981); "Economic Valuation of Marsh Areas for Marine Production Processes", In Journal of Environmental Economics and Management, Vol. 8, No. 2, June 1981, pages 175-186.

Develops an approach for relating blue crab economic productivity on Florida's coast to marsh availability in the area. The marginal value productivity of marsh is shown to vary with alternative levels of marsh and effort in the fishery.

Subject
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P MacGinitie, G.E. (1939); Some Effects of Fresh Water on the Fauna of a Marine Harbor, In The American Midland Naturalist, Vol. 21, 681-686 p.

In March 1938, a large storm caused flooding in Southern California. The resulting fresh water from the Santa Ana River flowed into Newport bay created a condition whereby various species of marine life were ill or died. When the fresh water has sufficiently mixed with the ocean water, the species below the fresh water level began to repopulate.

E, N Magette, Brinsfield, Palmer, and Wood (1989); Nutrient and Sediment Removal by Vegetated Filter Strips, In transactions of the American Society of Agricultural Engineers, Volume 32, No. 2.

A field study utilizing simulated rainfall and bare plots 5.5 m wide by 22 m long was conducted to study the effectiveness of vegetative filter strips 4.6 and 9.2 m long in removing nutrients and sediments from agricultural runoff. Losses of N and P from plots with filters were highly variable as compared to losses from plots with no filters. Generally, nutrient removals appeared to be greater with the longer filters, but decreased as the number of runoff events increased. Mass losses of TSS, TN and TP in surface runoff were reduced by 66%, 0%, and 27% respectively, by 4.6m (15 ft.) long filters. TSS, TN and TP reductions by 9.2 m (30 ft) long filter strips of the lengths utilized in this study were effective in removing sediment from runoff but should not be relied upon as the primary means to reduce nutrient losses from agricultural areas.

N McKee, Jack Edward and Warold W. Wolf, EDS (1976); Water Quality Criteria, Second Edition, State of California, Resources Agency, State Water Quality Control Board, Publication No. 3-A, 550 p.

Report contains a wealth of information on the development and use of water quality criteria and regulations. Information topics include: background, policy origin of criteria, general considerations, criteria promulgated by state and interstate agencies, judicial uses and restraints, quality criteria for major beneficial uses, potential pollutants, biological pollutants, radioactivity, pesticides, and surface active agents. The alphabetical listing of contaminants includes chemical and common names, volatility, solubility, uses/sources, and toxicity.

E, N Meisinger, Hargrove, Mikkelsen, Williams, and Benson (1991); Groundwater Impacts - Effect of cover crops on groundwater quality, Reprinted from Soil and Water Conservation Society.

A discussion of the effect of cover crops on groundwater quality focuses on NO3 because it has been shown to be the dominant contaminant in several state and national groundwater quality surveys.

Subject
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N **Meister Publishing Company** (1991); Farm Chemicals Handbook, 770 p.

Handbook contains information on fertilizers, pesticides, and herbicides - definitions, nomenclature, conversions, uses, producers, environmental constraints, registration, common and other names, composition, formulations, toxicity, precautions, and medical data. There are also separate tables for uses, registration, toxicity, and medical data.

N **Meister Publishing Company** (1992); Insect Control Guide, 450 p.

Guide containing pesticide information - names, composition, manufacturer, uses, permits, etc. for insect control. Includes: integrated pest control, biocontrols, traps and lures, identifying invasions, chemical and insect thresholds, and regulations.

N **Meister Publishing Company** (1992); Weed Control Manual, 442 p.

Guide containing herbicide information - names, composition, manufacturer, uses, permits, etc. for weed control. Includes: integrated pest control, premixing, identifying invasions, environmental constraints, chemical and plant thresholds, and regulations.

N **Metropolitan Washington Council of Governments** (1989); The State of the Anacostia, 1989 Status Report, prepared for the Anacostia Watershed Restoration Committee, State of Maryland, District of Columbia, Prince George's County, and Montgomery County.

Provides an overview of existing water quality and environmental conditions within the 170 square-mile watershed of the Anacostia River, as a means tracking progress made towards the unique restoration of the highly urbanized river system. Includes summaries of recent water quality conditions in both the free-flowing and tidal portions of the watershed. Reviews of recent fish populations are also summarized. Restoration accomplishments, guided by the Anacostia Restoration Agreement of 1987, are summarized along with recommendations for future efforts in the Anacostia restoration program. Note: The Anacostia system is tributary to Chesapeake Bay.

N, SE **New York State Soil and Water Conservation Committee and New York State Department of Environmental Conservation** (January 1992 Revised); Procedure for Preparing and Implementing County Water Quality Strategies (Supplemental Guidance).

Gives basic steps in preparing and carrying out a water quality strategy for a county. The phases; Getting Organized, Problem Identification and Prioritization, Setting Goals and Objectives, Preparing a Written Strategy and Implementing the Strategy summarize the key components and process involved in preparing and carrying out a county water quality strategy. A vital component of the strategy, informing and involving the public, should not be viewed as a separate component but as an integral part of the entire strategy formulation and implementation process.

Subject
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N, SE **North Carolina Department of Environment, Health and Natural Resources** (1992); Tar-Pamlico NSWI Implementation Strategy, North Carolina Department of Environmental Health, and Natural Resources, Division of Environmental Management, Water Quality Planning, Raleigh, NC; Adopted December 14, 1989, revised February 13, 1992.

> Formalizes and clarifies the details of the first phase of the Tar-Pamlico Nutrient Sensitive Waters Strategy, including the interim nutrient reduction trading program.

N, SE **North Carolina Department of Natural Resources and Community Development** (April 1989); Report 89-07, Tar-Pamlico River Basin Nutrient Sensitive Waters Designation and Nutrient Management Strategy, North Carolina Department of Natural Resources and Community Development, Division of Environmental Management, Water Quality Section, Raleigh, NC.

> Summarizes major concerns of the state and researchers who have studied the Pamlico River Estuary and proposes a nutrient management strategy to address present and future water quality in the larger Tar-Pamlico Basin.

N, P **O'Conner**, J.M., D.A. Newmann, and J.A. Sherk Jr. (Dec. 1976); Lethal Effects of Suspended Sediments on Estuarine Fish, 37 p.

> A three year laboratory study identified certain estuarine fish sensitive to the effects of particle size and concentration of suspended mineral solids similar in size to sediments likely to be found in estuarine systems in the concentrations typically found during flooding, dredging, and disposal of dredged material and natural sediments in identical experiments. Significant mortality of estuarine fish was demonstrated at these suspended mineral solid concentrations. Estuarine fish were classified, using static bioassays. Generally, bottom dwelling fish species were most tolerant to suspended solids; filter feeders were most sensitive. Early life stages were more sensitive than adults. This study provides base-line information for pre-project decision making based upon the anticipated concentration of suspended sediments at the project site and the effect of various lengths of exposure on estuarine fish of different life-history stages and habitat preference.

N, P **Odum**, William E. (October 1970); Insidious Alteration of the Estuarine Environment, In Transactions of the American Fisheries Society Vol. 99, No. 4, 11 p.

> Shallow estuaries are characterized by certain features which make them rich and productive ecosystems, these same characteristics however, are responsible for the delicate nature of the estuarine environment and greatly enhance its vulnerability to subtle alteration. In this paper and the subsequent discussions, we examine some of these features and discuss how insidious changes in estuaries can occur.

Subject
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N **Olsenholler**, Sandra and Metropolitan Washington Council of Governments (May 1991); Annual Loading Estimates of Urban Toxic Pollutants in the Chesapeake Bay Basin, Final Report to US EPA Region 3, Chesapeake Bay Program Office.

The report provides a review of the urban toxic pollutant literature and applies methodology for quantifying toxic pollutant loads in urban stormwater runoff. Toxic pollutant loading estimates are presented for the Chesapeake Bay Basin.

N, W **Oltmann**, Richard N. and Michael V. Schulters (1987); Rainfall and Runoff Quantity and Quality Characteristics of Four Urban Land-Use Catchments in Fresno, California, October 1981 to April 1983, US Geological Survey Open-File Report 84-710, in Cooperation with Fresno Metropolitan Flood Control District, 132 p.

Rainfall and runoff quantity and quality were monitored for an industrial, single-dwelling residential, multiple-dwelling residential, and commercial land-use catchments during the 1981-82 and 1982-83 rain seasons. Storm-composite rainfall and discrete runoff samples were analyzed for numerous inorganic, biological, physical, and organic constituents. Atmospheric dry-deposition and street-surface particulate samples also were collected and analyzed.

M, P **Onuf**, Christopher P., and Millicent L. Quammen (1981); Fishes in a California Coastal Lagoon: Temporal and Spatial Variation, Especially as Related to Two Major Natural Disturbances, 35 p.

An analysis of fish community dynamics in an estuarine system (study in Mugu lagoon). It analyzes the changes in the fish community in light of the observed site-specific alterations of the lagoon environment. The report concludes by suggesting which aspects of the observed dynamics will generalize to many other shallow water marine systems and which will be restricted to other geographically and climatically similar situations.

M, P **Onuf, C.**June 1987); The Ecology of Mugu Lagoon, California: An Estuarine Profile, Marine Science Institute, UC Santa Barbara, for the USDI - Fish and Wildlife Service and US Dept. of the Navy (122 p.

Among the protected shallow-water embayments of the arid and steep Pacific Southwest, Mugu Lagoon is large, important, and relatively little disturbed (because of protection by the US Navy for more than 40 years). This report is a synthesis of information on Mugu Lagoon, supplemented by other sources as necessary to provide an integrated treatment of ecosystem structure and function. Events of the last decade have altered the "health" and little-disturbed state of the Mugu Lagoon ecosystem. The report chronicles how the impacts of those alterations ramified through the estuarine ecosystem. The information base for this report is weak in some topical areas where the companion report in this series, "The Ecology of Tijuana Estuary: An Estuarine Profile" by Joy Zedler, is strong. That report is encouraged regarding the analysis of factors influencing primary productivity and salt marsh community structure.

Subject
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M, SE **P&D Technologies** (November 1989); Pitts Ranch Specific Plan, prepared for the City of Camarillo.

The Pitts Ranch (211 acres) and a 53 acre portion of St. Johns Seminary property are planned for residential, industrial and public uses. Specific plans are a further refinement of the city's general plan and provides details for the intended growth in a particular area. Land uses are more clearly defined, intended development patterns and phases are outlined, and design criteria are identified. These plans help ensure that development of a specific site will proceed according to an established set of conditions and standards.

M, SE **POD Inc.** and Kaku Associates (May 1988); Rancho Calleguas Specific Plan, prepared for the City of Camarillo.

The Rancho Calleguas (11.84 acres) property is planned for a recreational park and student parking. Specific plans are a further refinement of the city's general plan and provides details for the intended growth in a particular area. Land uses are more clearly defined, intended development patterns and phases are outlined, and design criteria are identified. These plans help ensure that development of a specific site will proceed according to an established set of conditions and standards.

E, P **Pacific Estuarine Research Laboratory** (1990); A Manual for Assessing Restored and Natural Coastal Wetlands, California Sea Grant Report No. T-CSGCP-021. 105 p.

This manual presents recommendations for assessing the structure and functioning of coastal wetlands, with emphasis on salt marshes and tidal creeks.

S **Pacific Southwest Interagency Committee, Water Management Subcommittee** (1991); Proposed Revision of Sediment Yield Procedure Pacific Southwest Inter-Agency Committee Report of the Water Management Subcommittee (October 1968)

The PSIAC, 1968, Sediment Yield Procedure is a resource evaluation tool that can be used to characterize sediment and salt yield from various sized hydrologic units, watersheds, and geomorphic units. This sediment yield model is a documented reliable procedure that will result in quantification of sediment and salt yield. A sediment delivery ratio can be applied to derive sediment and salt delivery quantification from the modelled hydrologic unit or watershed to a downstream delivery point. These proposed revisions incorporate recent research into the procedure and improve the utility of the procedure. The revisions include applying the procedure to three planning frameworks; Present Conditions, Future without Project Conditions, and Future with Project Conditions, and is applicable to a burned watershed condition (wildfire). All of these planning model procedures can be used in a timely manner for planning purposes or for emergency watershed protection evaluations. A new evaluation sheet is presented for efficient field use. Emphasis is placed on the necessity of maintaining the field oriented interdisciplinary method of applying the sediment yield model.

Subject
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M, N, P **Peterson**, C.H. (1976); Relative abundances of living and dead molluscs in two Californian lagoons, In: Lethaia, Vol. 9, pp 127-148. Oslo ISSN 0024-1164.

Assemblages of living benthic invertebrates (predominantly bivalve molluscs) from the sand-channel habitat of two Southern California (USA) lagoons were sampled on ten occasions over a 37-month period. A one-time sampling of the corresponding assemblages of accumulating dead remains made possible a contrast of living and dead assemblages designed to assess the biasing effects of postmortem transportation, shell dissolution, and time averaging.

P **Peterson**, C.H. (1977); Competitive Organization of the Soft-Bottom Macrobenthic Communities of Southern California Lagoons, Marine Biology 43, p. 343-359, 17 p.

A sandy bottom macrobenthic community of Mugu lagoon, a relatively pristine southern California marine lagoon, demonstrated nearly constant community composition, relatively little temporal variation in the population densities of the most abundant species, and a pattern of depth stratification in which very little vertical overlap existed among the six most abundant species.

N, P **Pommepuy**, M., J.F. Guillaud, Y. Martin, E. Duprey, E. Derrien, and Cormier M. L'Yavano (1991); Fate of Bacteria in the Coastal Zone from National Colloquium, The Sea and Urban Waste Disposals, Bendor Island, From 13 to 15 June 1990. 11 p.

Two studies were carried out to compare the behavior of fecal bacteria in coastal estuary areas. Bacteria was found in the sediments and suspended in the turbid water. Because light penetration is stopped by suspended matter, the bactericidal effect is very low. It was determined that the bacteria survived very long times and can tolerate coastal salinities. Low nutrients and high sunlight intensities promoted fast die off rates of the coliform in the comparison study.

N **Puget Sound Cooperative River Basin Team** (1991); Dungeness River Area Watershed, Prepared for the Dungeness River Area Watershed Management Committee, 132 p. and Appendices.

Provides the local watershed management committee with a characterization of the watershed, a description of the nonpoint sources of pollution and beneficial uses of water in the watershed. Information about stream corridors and wetlands is provided as it relates to the land uses that impact them. The report includes a summary of findings with conclusions and recommendations by land use, as well as for stream corridors, the irrigation system and wetlands.

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N **Puget Sound Cooperative River Basin Team**, Washington Department of Ecology, Tulalip Tribes, Battelle Human Affairs Resources Centers (Seattle), Puget Sound Water Quality Authority, Snohomish County Department of Public Works, Snohomish Conservation District, Washington Department of Natural Resources, USGS Water Resources Division, US EPA (September 1990); Final Report Geographic Information System Pilot Project in Portage Creek, Analyzing nonpoint source pollution in a Puget Sound Watershed: A cooperative project using Geographic Information Systems.

The report summarizes the results of a cooperative project to evaluate nonpoint source pollution in a specific Puget Sound watershed, the Portage Creek watershed of the Stillaguamish River, Snohomish County, Washington. The project was also designed to evaluate the use of computerized geographic information systems (GIS) for nonpoint source pollution investigations and planning in the Puget Sound Basin, and emphasized the integration of study results through the use of GIS.

N **Puget Sound Water Quality Authority** (1991); 1991 Puget Sound Water Quality Management Plan, 344 p. and Appendices.

Document was submitted to the EPA for adoption as the Comprehensive Conservation and Management Plan for the Puget Sound Estuary Program. Presents site information, the expanded and updated plan, and plan priorities.

E, W Roley, Bill; Water Conservation, Flood Control and Restoration of the Palo Comado Watershed, 27 p.

Paper presents a conceptual plan using Bioengineering and landform sculpturing techniques for flood risk reduction and water harvesting conservation strategies. The purpose of the plan is to fit a development into the natural landscape and to enhance the surrounding environment so the natural biota will be more diverse and more complex than before the development's presence. A key issue in planning is to turn both rain runoff (referred to as nuisance water) and sewage waste water, (thought to be a health hazard), into resources that will enhance the community's ecological wealth.

S, M Sadd, James L. (1994); A Holocene Depositional History and Sedimentary Processes in Mugu Lagoon - Barrier System, CA, paper, Occidental College

P, N **San Diego County Association of Resource Conservation Districts** (1990); Backyard Ranches, a pamplet.

A horse management program for San Diego County.

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E, N **Schueler** and Metropolitan Washington Council of Governments (July 1987); Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMP's, for Washington Metropolitan Water Resources Planning Board.

Manual provides detailed guidance for engineers and siteplanners on how to plan and design urban best management practices (BMP's) to remove pollutants and protect stream habitat. Describes water quality and habitat impact in streams that result from uncontrolled watershed development. Contains a simple method for estimating pollutant export from development sites. Presents a series of tools to assist the site designer in selecting the best BMP option for a site. Provides detailed design guidance on seven major urban BMP practices in the use in the Washington metropolitan area: extended detention ponds, wet ponds, infiltration basins and trenches, porous pavement, water quality inlets and vegetative practices. Each BMP is reviewed from the standpoint of stormwater management benefits, pollutant removal, physical feasibility, costs, maintenance requirements, and impact to the environment and adjacent communities. A list of recommended design standards that enhance BMP performance is also presented.

E, S **Schueler**, Lugbill, Department of Environmental Programs, and the Occcoquan Watershed Monitoring Laboratory (January 1990); Performance of Current Sediment Control Measures at Maryland Construction Sites, prepared for Sediment and Stormwater Administration, Maryland Department of the Environment.

This document summarizes a monitoring study of the sediment trapping efficiency of current designs of sediment traps and basins utilized at construction sites in Maryland. The report summarizes current and proposed designs for sediment control facilities, and indicates the major limitations to high sediment removal rates. Next, the report summarizes the monitoring study design. The results of the laboratory and field laboratory sampling are then reviewed. Finally, a series of recommendations are made to improve local and state sediment and erosion control programs.

M, S **Scott**, Kevin and Rhea Williams (1978); Erosion and Sediment Yield in the Transverse Ranges, Southern California, USGS Professional Paper 1030, for USDI-Geological Survey.

Major storm and long-term erosion rates in mountain watersheds of the western Transverse Ranges of Ventura County are estimated to range from low values that will not require the construction of catchments or channel-stabilization structures to values as high as those recorded anywhere for comparable bedrock erodibilities.

P **Shaffer**, G.P. (1984); The effect of sedimentation on the primary production of benthic microflora, In ESTUARIES, Vol. 7, No. 48, pp 497-500.

During February 1978, 20 cm of rain over a seven day period caused an enormous deposition of fine-grained sediments in the eastern arm of Mugu Lagoon, California. For February-July 1978, this deposition decreased the net primary production of the benthic community by an estimated 6.5 fold. The persistence of the fine-grained sediment over much of the lagoon will continue to render these areas lower in exportable organic carbon.

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S, W **Shepard, Marshall, Mcloughlin and Sullivan** (August 1979); Currents in Submarine Canyon and Other Seavalleys,

Early studies of low-velocity turbidity currents in Southern California offshore canyons failed due to beaches being a chief source of sediment, no large rivers, and great masses of kelp and seagrasses. However, in canyons off large rivers and no kelp problems, measurements for slow turbidity currents were recorded. These currents may be a major contributor to sediment delivery to the offshore canyons, but continuous currents in the canyons were also considered important. Some answers to the questions concerning sewer outfalls, and their effect on these canyons is also presented.

N, P **Sherk Jr.**, Albert (Feb. 1971); The Effects of Suspended and Deposited Sediments on Estuarine Organisms, 61 p.

This report discusses the effects of sediment on biological systems and filter-feeding organisms, off shore waste disposal, and research needs.

E, S **Simons**, Li and Associates (February 1982); Hydraulics and Sediment Transport of the San Lorenzo River, Santa Cruz, California, prepared for Ogden Beeman and Associates.

The San Lorenzo River in the City of Santa Cruz was channelized during 1955-1959 by dredging the channel bed, widening channel dimensions and constructing levees on both banks. The original design capacity has been significantly impaired due to the severe sediment deposition subsequent to project completion. Four flood control alternatives were proposed, but with severe sediment deposition problems, the effectiveness of these flood control measures can be significantly impaired if the channel is not properly maintained. Sediment control through watershed management and/or sediment detention can reduce the sediment loading to the project reach. This measure should be considered in combination with selected flood control alternatives.

E, M, S **Simons**, Li and Associates (December 1989); Development of Interim Sedimentation Control Measures for Calleguas Creek, For County of Ventura, Public Works Agency, Flood Control Department, 160 pages plus appendices.

The study used available data bases, the results of previous studies, and additional analyses to develop interim sediment control measures along the study channel. Sediment control measures within Arroyo Los Posas between Seminary Road and Hitch Boulevard were emphasized.

E, S, M **Simons**, Li and Associates (January 1993); Quasi-Unsteady Modeling of the Sedimentation Control Plan for Arroyo Las Posas, prepared for Ventura County Flood Control District.

The analysis utilized the computer program Quased - a quasi-dynamic sediment routing procedure developed by Simons, Li and Associates. The model simulates and computes erosion and sediment through the entire flood hydrograph. The

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tributary flows were also considered. The evaluation indicates that the proposed plan will also provide substantially increased stability to this reach .

E, S, M **Simons, Li and Associates** (March 1992), Evaluation of Sedimentation Control Measures for Arroyo Las Posas, prepared for Ventura County Flood Control District.

Arroyo Las Posas channel improvement project extends upstream from the Upland Road bridge to Hitch Boulevard bridge. The purpose is to address sediment deposition in the lower portion of Calleguas Creek which is causing reduction in flood conveyance capacity, filling Mugu Lagoon, and resulting in added maintenance costs.

S **Singer**, Michael J., John Blackard, Ernest Gillogley, and Kandiah Arulanandan (1978); Engineering and Pedological Properties of Soils as They Affect Soil Erodibility, Department of Land, Air and Water Resources and Department of Civil Engineering, University of California, Davis, California Water Resources Center, Contribution No. 166, 32 p.

This study evaluated the erodibility of three major range soils through field study. A persistent drought during the study period prevented the collection of meaningful data from the field plots. Rainfall from a small laboratory simulator was used to evaluate the relative erodibilities of eight extensive California soils. The physical, chemical, and engineering properties of these soils were determined in the laboratory and related to the relative erodibility of the soils. Critical shear stress, SAR, and dithionite iron content are three measurable properties of soils found to be important in determining their relative erodibility.

The relationship between mulch cover percentage and sediment in surface runoff from simulated rainfall was also studied for oat, straw, oak leaf, and redwood litter mulches. A single model was insufficient to accurately show the relationship between soil cover percentage and soil loss. The relationship between soil cover percentage and soil loss was generally parabolic but this does not include soil splash.

N, P **Sivakumar**, V., P. Lakshmanaperumalsamy, G.S. Thangaraj, R. Chandran, and K. Ramamoorthi, (1986); Studies on Fecal Coliform in an Estuarine Environment, from the proceedings of the symposium on coastal aquaculture. 8 p.

The study was on the occurrence and distribution of fecal coliforms and E. coli, in water, sediments, plankton, finfish and shellfish in different zones of the estuary. It revealed that there was extensive contamination from sewage sludge material.

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E, SE **Smith**, V. Kerry and John V. Krutila (Feb.-Aug. 1979); Resource and Environmental Constraints to Growth, In American Journal of Agricultural Economics, Vol. 61:1-3, pages 395-408.

This article reviews the specific attributes of past and current models that included natural resources, considering both micro analyses of extractive firm behavior and aggregate optimal planning models and examines conventional assumptions about constraints to economic activities including both the availability of production materials and the absorptive capacity of environmental resources. The need to recognize the interdependence between economics and the natural sciences was emphasized.

P **Sport Fishing Institute** (March 1971); A symposium on the Biological Significance of Estuaries. 111 p.

This book discusses the biology of estuaries, gives examples of biological effects from around the country.

M, S **Steffen, Lyle** (April 1982); Mugu Lagoon and its Tributaries, for USDA Soil Conservation Service, 74 p.

The paper provides information on rates and volumes of erosion and sediment yield in tributary watersheds to Mugu Lagoon. A section of the report deals with the history of Mugu Lagoon.

P, SE **Thomson**, Cynthia J. and Stephen J. Crooke (August 1991); Results of the Southern California Sportfish Economic Survey, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Center, NOAA-TM-NMFS-SWFSC-164.

The first comprehensive survey of the marine recreational fishery in Southern California, it provides information on fishing participation and related socioeconomic variables on a county by county basis. It was jointly sponsored by the NMFS-SWFSC and the California Department of Fish and Game.

N, P **Topanga-Las Virgenes Resources Conservation District**, (June 21, 1983); Effects of Land Use on Water Quality and Macroinvertebrates in Selected Watersheds of the Santa Monica Mountains.

The primary purpose of this study is to establish a relationship between land use, water quality, and macroinvertebrate (insect) communities. The secondary purpose of this study is to determine the correlation between macroinvertebrate communities and the physical/chemical conditions of streams.

Subject
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E, N **University of California** (UCLA) and Woodward and Clyde Consultants (1992); Annual Pollutant Loadings to Santa Monica Bay From Storm Water Runoff, 17 pages plus tables and graphs, appendices not included. Prepared for Santa Monica Bay Restoration Project, DRAFT ONLY.

The report summarizes the methodology and results of pollutant loading calculations for the Santa Monica Bay watershed. The general methodology, land use characteristics, water quality parameters, and intermediate results used to calculate the pollutant loadings are presents. Summarizes of the annual pollutant loading calculations by land use type and by drainage basins are given in the third section. The final section contains conclusions and recommendation based on these results.

P, SE **University of California Cooperative Extension**, (1992); Sample Costs to Establish and Produce Avocados in the Southern Coast Region, 20 pgs.

Detailed costs for avocados production in the southern coast region of California.

E, **University of California**, Salinity/Drainage Task Force and Water Resources Center (1988); Opportunities for Drainage Water Reduction, UC Committee of Consultants on Drainage Water Reduction, Number 1 in a Series on Drainage, Salinity, and Toxic Constituents, 28 p.

Report generally discusses methods of reducing drainage water from irrigated and non-irrigated lands. Includes short discussion on salinity and toxicity caused by inadequate leaching and on water quality changes that may be expected in the drain water.

N, **US Army Corps of Engineers** (1972); Hydrologic Engineering Methods for Water Resources Development, Volume 11, Water Quality Determinations, The Hydrologic Engineering Center, 8 Chapters and appendices.

Examines the technology of the water quality field as it applies to water resource planning. Includes water quality requirements for beneficial uses, causes of degradation, and physical, chemical and biological parameters.

M, W **US Army Corps of Engineers** (1973); Calleguas Creek, Simi Valley to Moorpark Feasibility Report for Flood Control and Recreational Development, Ventura County, Ca.

This report considered flood control and recreational development in a segment of the Calleguas Creek Basin. The remainder of the basin will be considered in a later report.

M, S, W **US Army Corps of Engineers** (June 1991); Lower Calleguas Creek and Mugu Lagoon Flood Control and Sedimentation Study, Ventura County, California, Information Paper, Draft - Subject to revision.

Subject
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M, W **US Army Corps of Engineers** (March 1970); Santa Clara River (Vicinity of Santa Paula), prepared for the County of Ventura.

The report related the flood situation along the Santa Clara River in the general vicinity of the City of Santa Paula, Calif. The information contained in the report is based on hydrologic data related to the flood problems in the study area.

M, W **US Army Corps of Engineers** (November 1987); Calleguas Creek, Hydrology for Survey Report.

This report presents hydrology in support of survey studies for flood control and allied purpose in the Calleguas Creek basin. It updates and in some instances revises methods, criteria, and results used for hydrologic studies as found in the District Engineer's report entitled "Calleguas Creek, Simi Valley to Moorpark, Feasibility Report for Flood Control and Recreational Development, Ventura County, California" dated July 1974.

M, W **US Army Corps of Engineers** (Sept. 1969); Calleguas Creek, (Including Conejo Creek and Arroyo Santa Rosa) Somis to Pacific Ocean, Ventura County, California.

The report related to the flood situation along Calleguas Creek and its tributary, Conejo Creek, including Arroyo Santa Rosa, in the general vicinity of the City of Camarillo, Ca.

M, W SE **US Army Corps of Engineers**, (1969); Ventura County, Appendix C, Report on Floods of January and February 1969.

The appendix provides a complete description of the floods in Ventura County during the periods January 18-26 and February 20-26, 1969. It includes a general description of the flood-damaged areas and the drainage areas in which flooding occurred. A brief description of the hydrologic data collected, as well as a description of activities undertaken as part of emergency work.

M, W **US Army Corps of Engineers**, LA District (July 1970); Flood Plain Information, Calleguas Creek, Vicinity of Moorpark, Ventura County, California, prepared for County of Ventura.

This report relates to the flood situation along Calleguas Creek in the general vicinity of the town of Moorpark, California. Information contained in the report is based on available and theoretical hydrologic data, theoretical flood heights and limits, and other technical data related to the flood problems in the study area. Also considered are the nature and effect of two probable future floods, namely, the Intermediate Regional Flood and Standard Project Flood.

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M, W **US Army Corps of Engineers**, LA District (June 1992); Calleguas Creek, California, Reconnaissance Report.

Flood problems associated with the Calleguas Creek system. Previous studies using traditional techniques to estimate benefits indicated there is not a economically feasible project. This study includes additional methodologies and evaluates environmental benefits. The results of this analysis indicate that the next level of planning should be done.

S **US Army Corps of Engineers**, LA District, (February 1986); Southern California Coastal Photography and Beach Profile Index, Coast of California Storm and Tidal Waves Study.

The report contains an inventory of the aerial photography, ground photos, and beach profile data along the Coast of California. The photographs and beach profiles were compiled to document dimensions and beach characteristics, historic shoreline changes, effects of storms and structures on the beach and any significant beach and inlet changes.

P **US Army Corps of Engineers**; Information Brochure Alternative Proposals for Flood Control and Allied Purposes, Calleguas and Conejo Creeks, Ventura County, Ca.

Presents for public evaluation all alternative solution studied to date for flood control and associated needs along selected reaches of Calleguas and Conejo Creeks.

SE **US Department of Commerce**, Economics and Statistics Administration, Bureau of the Census, 1990 Census Data - Summary Tape File 3A.

Census data.

E, N **US EPA** (1973); The Control of Pollution from Hydrographic Modifications; 188 p.

This manual deals mainly with stream channels and vegetated watershed changes (land use) and the resulting sedimentation. The manual is simplistic, but gives a good basic look at the pollution loads that may be caused by changes in hydrology and hydraulics.

N **US EPA** (1982); Guidelines for Evaluation of Agricultural Nonpoint Source Water Quality Projects, Prepared by EPA Interagency Taskforce, Implementation Branch.

Provides basic guidelines for measuring water quality changes and for estimating socioeconomic impacts resulting from nonpoint source control programs. Outlines the philosophy and basis for the evaluation of many NPS control program components.

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E, P US EPA (1988); Constructed Wetlands and Aquatic Plant Systems for Municipal Wastewater Treatment, EPA /615/1-88/022, Design Manual, 84 p.

The manual discusses wetland construction as a alternative for wastewater treatment in municipal settings.

E, N US EPA (1990); Urban Targeting and BMP Selection, An Information and Guidance Manual for State Nonpoint Source Program Staff Engineers and Managers, Prepared by Woodward-Clyde Consultants, Oakland, CA for EPA, Region V, Water Division, Chicago, IL., 54 p.,

This manual consolidates existing information and describes a methodology for targeting urban areas for control. It is designed to assist in the prioritization for the development and implementation of nonpoint source management programs.

E, N US EPA (1991); Modeling of Nonpoint Source Water Quality in Urban and Non-urban Areas, Office of Research and Development, Washington D.C.

Nonpoint source assessment procedures and modeling techniques are reviewed and discussed for both urban and non-urban land areas. Detailed reviews of specific methodologies are presented, along with overview discussions focusing on urban methods and models, and on non-urban (primarily agricultural) methods and models. Brief case studies of ongoing and recently completed modeling efforts are described.

E, N US EPA (1991); Nonpoint Source Watershed Workshop, Prepared for Center for Environmental Research Information, Seminar Publication EPA/6254/4-91/027, 209 p.

Notes from a workshop held in New Orleans in January 1991 to facilitate the exchange of information relating to the development and implementation of nonpoint source pollution control projects. Presentations addressed watershed management in both urban and rural settings and included an opportunity for participants to apply watershed management techniques to actual nonpoint source pollution problems.

E, N US EPA (1991); Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Proposed under the authority of Section 6217(g) of the Coastal Zone Act Reauthorization Amendments of 1990. 7 chapters and appendices.

Guidance for management measures for sources of nonpoint pollution in coastal waters. The proposed management measures guidance addresses five source categories of nonpoint pollution: agriculture, silviculture, urban, marinas, and hydromodification. This document will be used by States to develop and implement programs recommending the best, economically achievable measures available to protect coastal waters from nonpoint pollution.

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N **US EPA** (August 1978); Environmental Impact of Land Use on Water Quality - Project Data- Final Report on the Black Creek Project - Technical Report, EPA-905/9-77-007-C, 274 p.

E, S **US EPA** (July 1973); Comparative Costs of Erosion and Sediment Control, Construction Activities, Office of Water Program Operations, Water Quality and Non-Point Source Control Division, EPA-430/9-73-016, 205 p.

Report provides design guidelines, construction methods and costs, and maintenance methods and costs for a variety of the more common erosion/sediment control practices.

N **US EPA** (July 1976); Quality Criteria for Water, Office of Water and Hazardous Materials, Water and Planning Standards, EPA-449/9-76-023, 502 p.

This report addresses the effects of basic water constituents and pollutants considered most significant in the environment. Each listing provides criteria, an introductory statement, rationale, and references.

E, **US EPA** (June 1980); Aquaculture Systems for Wastewater Treatment: An Engineering Assessment, Sherwood C Reed, USA/CRRL, and Robert K. Bastian, EPA/OWPO, Project Officers, Office of Water Program Operations, Municipal Construction Division, EPA 430/9-80-007, 128 p.

Describes aquaculture and wetland systems for waste water treatment. Presents design parameters and effects of the treatment for a range of wetland and aquaculture system types that have been installed, either as research systems or as operating systems. Reductions of nitrates, pesticides and sediment are provided for general types.

M **US EPA** (March 1993); Watershed Protection: Catalog of Federal Programs, EPA-841-B-93-002, Office of Water.

Complete listing and description of Federal government programs and funding to address resource problems on a watershed basis.

E, N **US EPA** (October 1973); Methods and Practices for Controlling Water Pollution from Agricultural Nonpoint Sources, EPA-430/9-73-015, 83 p.

This manual describes management practices, their purpose and the effectiveness for agricultural (and related) lands. Most of the practices deal with reducing erosion, sediment and runoff from the lands.

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N **US EPA** (October 1973); Methods for Identifying and Evaluating the Nature and Extent of Nonpoint Sources of Pollutants, EPA-430/9-73-014, 261 p.

This manual discusses the kinds of pollutants and their sources. Methods of identifying the sources and the quantities of pollutants are given. The methodology and evaluation are heavy on testing and regulation, but do contain some practical advice on other methodologies of determining pollutant volumes and sources.

E, S **US EPA** (October 1973); Processes, Procedures, and Methods to Control Pollution Resulting from All Construction Activity, EPA 430/9-73-007, 234 p.

This manual discusses construction pollutants, their origins, process of movement, methods of control, design guidelines, and monitoring and effects for water quality pollutants originating from construction sites (any disturbed area). Water quality is the main consideration, though air quality is also discussed. Most of the work is simplistic and the number of monitored sites are few. A good basic manual to start with for the processes of movement and the kinds of pollutants to expect.

N **US EPA** (October 1991); Coastal Nonpoint Pollution Control Program, Proposed Program Development and Approval Guidance, 43 p.

NOAA and EPA guidance document for the Coastal Zone Management Plans and use of Section 6217(g) management measures. Details required documentation and report contents.

N **US EPA** (Sept. 1991); Seminar Publication, Nonpoint Source Watershed Workshop, Nonpoint Source Solutions, EPA/625/4-91/027, 209 p.

Contains copies of papers presented at the Nonpoint Source Watershed Workshop, New Orleans, Louisiana, January 1991. Subjects range from prioritization to implementing regulatory programs.

SE **US EPA** (September 1990); The Economics of Improved Estuarine Water Quality: An NEP Manual for Measuring Benefits, EPA Office of Marine and Estuarine Protection, Office of Policy, Planning, and Evaluation, EPA/503/5-90-001.

A manual to help managers evaluate the economic benefits of various water pollution abatement options. Presents concepts of economic benefit, describes how pollution abatement can generate benefits, and explains methodologies for measuring benefits.

N **US EPA** and Extension Committee on Organization and Policy (1974); Workshop on Agricultural Non-point Source Water Pollution Control, September 16-17, 1974, Mayflower Hotel, Washington, D.C.

Proceedings from a cooperative effort by the EPA and the Cooperative Extension Service to explore problems in agricultural nonpoint source pollution.

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E **USDA Soil Conservation Service** (June 1984);Strawberry Hills Target Area, Monterey County, Ca.

The objectives of the study were to estimate the relative contribution of erosion sources, especially for strawberry production, recommend and evaluate solutions for the strawberry hills area, provide cost estimates, and determine feasibility for implementation under USDA programs.

E **USDA Soil Conservation Service** (June 1984);Strawberry Hills Target Area Technical Report, Monterey County, Ca.

The technical report is the second part of the Strawberry Hills Target Area Watershed Area Study Report. The purpose of this technical report was to assist the Target Area Team, Salinas Field Office, and private consultants to develop erosion control plans for individuals.

SE **USDA Soil Conservation Service - Utah**, and Utah Department of Natural Resources, Division on Water Resources (August 1990); Virgin River Basin - Utah Cooperative Study, Summary.

A summary of six different appendices: Socioeconomic, Recreation, Historical and Archaeological Resources; Water Supply; Soil, Erosion, Sedimentation and Flooding; Cropland; Range and Forest; and Wildlife and Riparian Habitat to explore the potential for water and soil conservation considering development opportunities and better utilize the resources in the study area.

E, S **USDA Soil Conservation Service** (1975 and updates, new version in printing); Guides for Erosion and Sediment Control, 104 p.

Manual provides design guidelines for determining erosion quantities before and after various control practices and for sediment/debris basins.

E, N, S, SE **USDA Soil Conservation Service** (1978); Tillamook Bay Drainage Basin Erosion and Sediment Study: Main Report and Appendices; a cooperative study by the Tillamook Bay Task Force, the Oregon State Water Resources Department, USDA - Soil Conservation Service and Forest Service-Economics, Statistics, and Cooperatives Service, USDA-Soil Conservation Service, Portland, Or.

Addresses the problem of sedimentation in Tillamook Bay, providing managerial strategies for sediment reduction with related costs and impacts. The continual deposition of sediment in the bay had caused adverse effects on shipping and navigation, commercial and sports fishing, oyster production and clamming, and environmental and aesthetic qualities of the basin.

N **USDA Soil Conservation Service** (1983, updated 1991); Water Quality Field Guide, SCS-TP-160, 64 p.

Provides guidelines to identify and control pollutants, causes of impairments, delivery processes, control processes, glossary, and references.

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E, P, S, SE **USDA Soil Conservation Service** (Annual Update, 1990); Field Office Technical Guide, Section 4,Conservation Practices.

Guide contains listing of applicable SCS conservation practices for various conditions, including general criteria, specifications, allowed uses, and design criteria.

S, SE **USDA Soil Conservation Service** (April 1989); Upper Stony Creek Watershed, Watershed Plan and Environmental Assessment, Colusa, Glenn, and Lake Counties, California, 82 pages plus appendices.

The study was conducted to appraise the economic feasibility and environmental acceptability of measures to reduce accelerated soil erosion and to sustain agricultural production in the Upper Stony Creek Watershed. The report describes the watershed problems and resources, plan formulation, the recommended plan, and potential environmental impacts.

E, M **USDA Soil Conservation Service** (January 1983); Environmental Assessment - Revolon Slough Watershed Outlet, Ventura County, California.

This study documents and displays the discernable impacts of each alternative being proposed to develop an outlet for the Revolon Slough and Beardsley Wash watershed projects and reduce flooding from the 50-year storm on agricultural land west of Revolon Slough and between Las Posas Road and Highway 1. The biological impacts were emphasized since the area is ecologically important.

E, W **USDA Soil Conservation Service** (January 1988); Drainage Improvement Guide for Unpaved Roads, Central Coast Resource Conservation and Development Program, 12 p.

A simple guide to providing drainage for unpaved roads.

E, M **USDA Soil Conservation Service** (June 1985); Beardsley Watershed Project, Drop Structure No. 3 (Triple Arch), Supplemental Finding of No. Significant Impact/Negative Declaration.

A report on the solutions to replacement or reinforcement of Drop Structure No. 3 for the Beardsley project.

M, S **USDA Soil Conservation Service** (September 1983); Lower Calleguas Creek Watershed, Field Examination Report, 45 p.

This field examination determined the extent of soil erosion and sedimentation problems in the Lower Calleguas Creek Watershed and determined the potential for solving these problems under PL-566. The study was based on available information supplemented with some field data.

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E, S **USDA Soil Conservation Service** (September 1989); Morro Bay Watershed Enhancement Plan, San Luis Obispo County, California, for Coastal San Luis Resource Conservation District, and California Coastal Conservancy.

A plan to reduce sediment deposited in Morro Bay, by using conservation measures, sediment control structures and technical assistance.

E, M, S, W, **USDA Soil Conservation Service** and Forest Service, (December 1953); Work Plan, Calleguas Creek Watershed, California, prepared for Calleguas and Simi Valley Soil Conservation Districts.

The purpose to this plan was to state specifically the practices that are required and feasible, and to show how they will be carried out to achieve the maximum practicable reduction of erosion, floodwater and sediment damage.

S **USDA Soil Conservation Service** and UC Ag. Experiment Station (April 1970); Soil Survey Ventura Area, California.

Soil descriptions and maps for the Ventura Area.

M **USDA Soil Conservation Service** (1992); Ventura County Resource Conservation District and Soil Conservation Service Benefits to Ventura County.

Reports the benefits from the activities of the Ventura County Resource Conservation District and the SCS Somis Field Office (Ventura County) during the 1991-1992 fiscal year. These two organizations play a lead role in supporting natural resource conservation planning and management efforts within the county, including special emphasis on flood control channel work. The benefits include direct economic benefits, environmental benefits, and social benefits.

S **USDA Soil Conservation Service** - South National Technical Center (Feb 3, 1989); Guide for Estimating Participation in Conservation Operations and Watershed Pollution Projects, Technical Note: Subject: Social Science Series #1801 (Revised)

Technical guide provides a systemtic procedure to identify areas of our delivery system where we need to increase our efforts to identify strategies to focus our work and estimates participation rates in conservation operation programs and watershed protection programs.

N, P **USDI** (1969); The Practice of Water Pollution Biology, Federal Water Pollution Control Administration, Division of Technical Support, 391 p.

Considers many aquatic environments, their biotic constituents, and the effects of the various pollutants upon them. Describes how to form study objectives, plan a field study, station selection, sample collection and examination, data analyses and interpretation, and results reporting. Investigations in marine waters are discussed.

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N, P **USDI** - Fish and Wildlife Service (October 1981); Proceedings of the National Symposium on Freshwater Inflow to Estuaries Volume 1 and 2, 523 and 525 p.

Two large volumes of information covering the following topics: estuaries and freshwater flow, policies and problems in dealing with freshwater inflow to estuaries, freshwater inflow studies along the mid- and north Atlantic coast, restoration of freshwater inflow to an estuary in conjunction with urban development, fisheries management and freshwater inflow, flood plains and estuarine productivity: energy transport, freshwater runoff, and biological responses, Mississippi River delta freshwater inflow rehabilitation, fisheries management and freshwater inflow studies, freshwater inflow studies in southern Texas estuaries, effects and measurement of freshwater inflow, freshwater inflows and the San Francisco Bay complex, Gulf of Mexico freshwater inflow effects, rehabilitation of estuaries through reintroduction of freshwater inflow, planning, fundamental factors influencing freshwater inflow, and basin management.

M, W **USDI** - Geological Survey (July 1970); Floods from small drainage areas in California.

A compilation of peak data October 1958 to September 1969.

M, S **USDI** Geological Survey (August 1979); Sediment Discharge in the Santa Clara River Basin, Ventura and Los Angeles Counties, California, prepared in cooperation with Ventura County Flood Control District, United Water Conservation District and California Dept. of Boating and Waterways.

Sediment data collected in the Santa Clara River basin during the 1967-75 water years were analyzed to determine the particle size and quantity of sediment transported past three gaging stations.

W **USDI** Geological Survey (August 1980; Ground Water in the Thousand Oaks Area, Ventura County, California, prepared in cooperation with City of Thousand Oaks and the Conejo Recreation and Park District

This study was made to evaluate the groundwater resources available to the City of Thousand Oaks, so that the city might use groundwater to reduce its water importation requirement. At present the city imports all its water.

E, M **Ventura County** (1980); Land Development Manual, 48 pages plus appendices.

This manual was prepared to introduce Developers and Engineers to the procedures of the Dept. of Public Works.

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M, S **Ventura County** (December 1990); Ventura County General Plan, Hazards Appendix, 150 p.

This document provides additional background information and technical details regarding the following subjects: Fault Rupture, Ground Shaking, Tsunami, Seiche, Liquefaction, Subsidence, Expansive Soils, Landslides/Mudslides, Airport Hazards, Coastal Wave and Beach Erosion, Flood Hazards, Inundation from Dam Failure, Fire Hazards, Hazardous Materials and Waste, and Noise. Maps of the hazard zones and areas can be found at the end of the individual sections.

M, SE **Ventura County** (March 1992); Ventura County General Plan, Goals, Policies, and Programs, 146 p.

The County's general plan consists of; (1) countywide goals, policies and programs containing four chapters (Resources, Hazards, Land Use, and Public Facilities and Services), (2) four appendices (Resources, Hazards, Land Use, and Public Facilities and Services) which contain background information and data in support of the county's plan, and (3) several area plans which contain specific goals, policies, and programs for specific geographical areas. Map showing buildout to the year 2010.

W **Ventura County** (1993); Ventura County Water Management Plan, Volume 1, Goals, Policies and Programs, Attachment B.

This plan addresses water supply sources including groundwater, surface, imported and reclaimed water as well as alternative resources such as conjunctive use and desalination. Also addressed as drought planning, mandatory rationing and several water conservation programs.

W **Ventura County** (1993); Ventura County Water Management Plan, Volume 2, Technical Appendix, Attachment C.

This volume discusses regulations and procedures.

M **Ventura County** (April 1994); Ventura Countywide Stormwater Quality Management Program, Volume 2

This is the second half of a application for a Storm Water Permit Application filed by Ventura County with RWQCB.

S, M, N **Ventura County Flood Control District**, CA., (1991); Debris Basins, Inventory, Technical Data, Flight Data, prepared by Surface Water Section, 136 p.

M **Ventura County Flood Control District**, CA (April 1993); A Proposal for Improvement of Calleguas Creek, State Route 140 Pleasant Valley Road,

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M **Ventura County Flood Control District**, (1993); Preliminary Planned Capital Projects, Five-Year Plan.

This document outlines the projects that the Ventura County Flood Control District will be working on in the region in order to reduce flooding problems. Most of the projects listed are described in detail in EIR documents. These projects are at sites throughout the watershed. The purpose of each project is to complete portions of large projects or address a site specific problem with flooding and/or sedimentation.

E, M, W **Ventura County Public Works Agency**, (1991); Ventura County Hydrology Manual.

The intent of this manual is to present guidelines and sufficient input data for the establishment of a uniform method for computing design hydrology in Ventura County.

M, S **Ventura County Public Works Agency**, (1993); Notice of Preparation of Draft EIR for Arroyo Simi Channel Improvements.

The proposed improvements include widening the channel, installing riprap, installing grade stabilizers to control bed erosion. In addition, about 12 acres of riparian wetlands will be created in three parcels adjacent to the channel for mitigation banking purposes for this and other projects. The project consists of improvements to about 16,300 linear feet of existing flood control channel between Hitch Boulevard and Spring Street.

M **Ventura County Resource Conservation District** (August 1991); Mugu Lagoon Watershed Enhancement and Implementation Plan, submitted to The California Coastal Conservancy.

A project proposal for a two phase project - one: a review of existing study, identification of pertinent on-going projects and producing a summary document which defines the problem, estimates the extent and source of the problem(s) and includes projections on the life of the lagoon if no action is taken, as well as recommended solutions on a broad conceptual level, and two: identify specific problem areas and suggested methods of treatment which attempt to optimize benefits to both agriculture and wetlands and other wildlife habitat.

E, N SE Voss (October 1992); Educating California's Small and Ethnic Minority Farmers about ways to improve fertilizer use efficiency and reduce contamination on their farms through the use of Best Management Practices, (BMP), Proceedings of the First Annual Fertilizer Research and Education Program Conference, October 1992, California Department of Food and Agriculture.

Small acreage farmers and ethnic farmer constitute the vast majority of farmers in California. Yet they are not targeted for education on Best Management Practices (BMP), because they do not individually use as much fertilizer and other inputs as larger acreage farmers and because no educational group or institution specifically identifies them as their unique clientele - except the Small

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Farm Program. These farmers have an acute need for this education because:

> They tend to cluster around urban areas where ground water contamination is more of an issue.
>
> Their use of fertilizers may be less sophisticated than the large farms, so they have a greater need of education in Best Management Practices.
>
> The number of small farms is increasing relative to large farms.
>
> Vegetables and other high value crops tend to be grown on smaller farms, (compared to agronomic crops), and most vegetables are relatively inefficient users of fertilizer.
>
> Ethnic minority farmers frequently have language and cultural barriers that require special educational methodologies to surmount. Their methodologies differ from those required by larger and conventional farmers.

The Small Farm Program is using the funds to augment and focus projects already underway on the techniques for Best Management Practices, and to fund three field days per year, held across the state under the direction of Cooperative Extension.

S, SE **Waddell**, Thomas (Editor)(May 1985); The Off-Site Costs of Soil Erosion, Proceedings of a Symposium held in May 1985.

A series of papers discussing the significance of off-site effects of soil erosion and the substantial economic costs.

E, N **Walker**, Mostaghimi, Dillaha, and Woeste, 1990; Modeling Animal Waste Management Practices: Impacts on Bacteria Levels in Runoff from Agricultural Lands, In Transaction of American Society of Agricultural Engineers, Vol 33, No. 3, May-June 1990, p. 807-817.

Runoff from agricultural lands carrying microorganisms from livestock manure can contaminate the food and water supplies of both animals and humans. Planning and design of animal waste management practices, thus, becomes more important as livestock population become more concentrated. A computer model is proposed to predict the effects of animal waste management practices on the bacteria concentrations of runoff from agricultural lands. The model uses Monte Carlo simulation to combine the deterministic relationships with statistical knowledge concerning rainfall and temperature variation. The model outputs maximum and minimum bacteria concentration in runoff resulting from a storm assumed to occur immediately after manure is applied to the land. The model can simulate the effects of waste storage, filter strips and incorporation of manure into the soil. Data and information collected from the Owl Run watershed in Fauquier County, Virginia is used to demonstrate the model's applicability and potential.

Long-term manure storage was found to be the most appropriate practice for reducing bacteria concentrations for the study site. Incorporation of manure was as effective as long-term storage, but is more costly. Buffer strips alone were not

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sufficient for reducing bacteria concentrations to meet the water quality goal. Since animal waste management practices have only recently been implemented on the watershed, no field data is yet available to validate the model's predictions.

M, P, S **Warme**, J.E. (1969); Mugu Lagoon, Coastal Southern California: Origin, Sediments, and Productivity; In: LAGUNAS COSTERAS, Un Simposio, Mem. Simp. Intern. Lagunas Costeras, UNAMUNESCO, Nov, 28-30, 1967, Mexico, D.F.,p. 137-154.

This paper discusses the hydrography,, salinity, temperature, physiography, tidal inlet, various tidal areas, sediment sources, grain size analysis, flora, fauna, algáe, microfauna, macrofauna, and lagoon productivity information.

M, P, S **Warme**, J.E. (1971); Paleontological Aspects of A Modern Coastal Lagoon, 24 p.

The physiographic development, sediments, flora, and fauna have been investigated in the Mugu Lagoon, a shallow coastal lagoon in southern California. The objective of this work was to determine what facets of the ecological history of the lagoon are preserved in its sedimentary record.

N, SE **Warrender**, Usher, Pendergast, and Lewis (July 1992); A Grass-Roots Approach to Nonpoint Source Pollution Management.

The New York State Department of Environmental Conservation and the New York State Soil and Water Conservation Committee recognized in 1989 that the management of nonpoint source pollution required commitment at the local level. Together they developed a two-phase procedure for updating the state's Nonpoint Source Assessment Report with the 57 soil and water conservation districts acting as local catalysts. During 1990, they prepared guidelines for establishing County Water Quality Strategies and trained soil and water conservation districts in their use. A majority have initiated the development of strategies and more are anticipated in the coming year.

SE **Weithman** and Haas (1982); Socioeconomic Value of the Trout Fishery in Lake Taneycomo, Missouri, In Transactions of the American Fisheries Society, Volume 111, Pages 223-230.

Lake Taneycomo, a 700 hectare hydroelectric impoundment in Southwestern Missouri, supports an excellent put-grow-and-take fishery for rainbow trout Salmo gairdneri. When the fishery became threatened by releases of deoxygenated water from an upstream reservoir, it became important to determine its value. We used three methods for estimating the value of the fishery: replacement cost of fish, travel cost and income multiplier. Information for the latter two methods was based on 500 angler interviews. Replacement cost of the rainbow trout would be $0.5 million. The travel-cost method provided an estimate of $2.9 million for the value of the fishery to anglers (consumers' surplus). The income-multiplier method provided an estimate of $9.9 million for the net economic benefit to the local economy, or about 7% of all economic activity in the area. The benefit:cost ratio of the

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rainbow trout stocking program at Lake Taneycomo was 22:1 for the local economy.

E, N Wengrzynek, Robert J. (Sept. 1990); Using Constructed Wetlands to Control Agricultural Nonpoint Source Pollution, 13 p.

Discusses the benefits and limitations of using constructed wetlands to reduce agricultural runoff.

E, S White, Charles A. and Alvin L. Franks (Final Report, March 1978); Demonstration of Erosion and Sediment Control Technology, Lake Tahoe Region of California, California State Water Resources Control Board, Division of Planning and Research, Demonstration Grant No. S803181-01, Municipal Environmental Research Laboratory, Office of Research and Development, EPA.

Report describes erosion control techniques used, design criteria, and monitoring results from installed projects in determining effective practices and BMPs to recommend for further installation.

P Wilcox, Glenn (August 1981); Management and Uses of California Cordgrass, Draft, 9 p.

Cordgrass is a coarse perennial grass with strong creeping rootstocks that are remarkably well adapted to withstand long periods of tidal inundation. Cordgrass survives lower in the intertidal zone than any other seed producing plant. In the upper levels of the intertidal zone where tolerance to submergence is not as critical, cordgrass is soon displaced by other plants, principally pickleweed.

P Wilcox, Glenn (1981); Vegetation Survey, Mugu Lagoon, Ventura County, California, for USDA-Soil Conservation Service.

The central arm of Mugu Lagoon is part of a dynamic estuarine system. Vegetative patterns have changed in the past and will continue to change as a result of sedimentation and other influences. As vegetation changes, so will wildlife distribution, species composition or abundance.

E, N Williams, Phillip and Associates, and Peter Warshall and Associates (1992); Malibu Wastewater Management Study, prepared for the City of Malibu.

The plan includes policy and administrative recommendations concerning the three aspects of the city's wastewater management: existing on-site wastewater systems, package plants, and nonpoint sources of potential pollution. A final wastewater plan adopted by the City of Malibu will be formulated following hearings based on this report.

E, N Williams, Phillip and Associates (1994); Closure Conditions for California Coastal Lagoons

Subject
Category

E, N **Woodward-Clyde Consultants** (November 1992); Selection of Best Management Practices for Control of Storm Water Pollution to Santa Monica Bay, for Santa Monica Bay Restoration Project.

Purpose of the report was to provide operators of municipal storm water systems with the information needed to evaluate a Best Management Practices (BMP's), formally select BMP's that would be most effective in dealing with local conditions, and begin the process of developing effective implementation plans.

P **Zedler**, Joy B. (1982); The Ecology of Southern California Coastal Salt Marshes, A Community Profile, US Fish and Wildlife Service Biological Report FWS/OBS-81/54, 110 p.

This document brings together a wide range of information on coastal salt marshes, with emphasis on the vegetation which dominates the intertidal sediments. Several conceptual models are suggested as hypotheses of marsh dynamics.

P **Zedler**, Joy B. (Nov. 1979); Coastal Wetlands Management: Effects of Disturbance on Estuarine Functioning, 20 p.

This paper sought to develop an understanding of southern California wetlands, in their relatively undisturbed state, and then, through comparisons and controlled experiments, under the effects of various alterations.

P **Zedler**, Joy B., Phil Williams, and John Boland (March 1986); Catastrophic Events Reveal the Dynamic Nature of Salt-Marsh Vegetation in Southern California, In: Estuaries Vol. 9, No. 1, p. 75-80.

Recent hydrologic disturbances, including flooding, dry-season streamflow, and drought altered coastal wetland habitats in southern California. At Tijuana Estuary, a six year study of salt-marsh vegetation patterns during these rare conditions documented substantial temporal variability in plant growth and distribution. Important to cordgrass dynamics were the amount and timing of streamflows, which reduced soil salinity and alleviated stresses on plant growth. A carbon allocation model is proposed to explain the varied responses.

E, P **Zedler**, Joy B.; Salt Marsh Restoration A Guidebook for Southern California, California Sea Grant Report No. T-CSGCO-009.

An easy to understand document to assist people in wetland restoration and planning. Topics include: goals in wetland restoration, recommendations for defining regional goals, techniques, assessing project success, policies, information storage and dissemination, and more.

MAPS

City of Camarillo, Ventura Co., CA. (March 26, 1993); Zoning Guide, Department of Planning and Community Development

City of Camarillo, Ventura Co., CA. (unknown); Camarillo General Plan

City of Moorpark, Ventura Co., CA. (September 29, 1986); Flood Hazard Boundary Map Revisions,

City of Oxnard, Ventura Co., CA. (Jan. 20, 1989); FIRM - Flood Insurance Rate Map, Panel 20 of 25 (1 map)

City of Oxnard, Ventura Co. CA. (unknown); Master Plan of Drainage, 4 maps - 2 of existing facilities and 2 of proposed facilities

City of Simi Valley, Ventura Co., CA. (June 1990); Master Drainage Plan Hydrology Map, Plates 3A,3B and 3c (3 maps)

City of Simi Valley, Ventura Co, CA. (Oct. 1988); General Plan Update - Exhibit B, (1 sheet)

City of Thousand Oaks, California (Revised April 1991); City of Thousand Oaks Zoning Maps,

Federal Emergency Management Agency, (various); Flood Insurance Rate Maps (FIRM)

Thousand Oaks	#15 dated 1/83
	#20 dated 9/78
Ventura County	#975 dated 10/85
	#980 dated 10/85
	#915 dated 10/85
Moorpark	Only Panel, dated 9/86
Simi Valley	# 1, 2, 4, 6, 7, 8, and 9 of 16, dated 9/91
Camarillo	# 1, 2, 3, 4, 5, and 6 of 6, dated 9/86
Oxnard	# 10 dated 10/85

State of California (1992); Land Use Maps, Department of Water Resources, Glendale, CA

USGS; Orthophoto Quads, US Geological Survey, Rocky Mt. Mapping Center,

USGS; Infared Aerial Photos, EROS Data Center,

Ventura County; Ventura County General Plan, FEMA map, 1985

Ventura County; County Resources Map including Important Farm Lands

APPENDIX E

GLOSSARY

Glossary:

The following pages define many terms commonly used in reports and documents produced by the Water Resources Planning Staff. The use of this glossary will help provide consistency to major documents where segments are written by different members of the interdisciplinary team, both in terms of word usage and meaning. This will also be quite valuable when there are personnel changes on the staff.

Glossary

acre - A unit of measurement of land. It is equal to the area of land inside a square that is about 209 feet on each side (43,560 square feet).

acre-foot (ac.- ft.) - Unit of volume measurement equal to one acre (43,560 sq. ft.) by one foot depth.

algae - Primitive, chiefly aquatic, plants that lack true stems, roots, and leaves but usually contain chlorophyll. They serve as food for other organisms.

alluvial - Pertaining to material that is transported and deposited by running water.

alluvium - A general term for all detrital material deposited o in transit by streams, including gravel, sand, silt, clay, and all variations and mixtures of these; unless otherwise noted, alluvium is unconsolidated.

alternatives - Possible practice and designs or combinations thereof chosen to fulfill the objectives of a project; one of which will be chosen based upon multidisciplinary criteria.

amortization - The process of liquidating a debt by installation payments or payment into a sinking fund; to prorate over a defined period, at a specified rate.

aquifer - A geologic formation or structure that transmits water in sufficient quantity to supply the needs for a water development; usually saturated sands, gravel, fractures, and cavernous and vesicular rock. The term water-bearing is sometimes used synonymously with aquifer when a stratum furnishes water for a specific use.

average annual gross erosion - the average loss of soil per acre over a watershed or area of concern; listed in tons/ac.

average annual sediment yield - the weight of sediment per acre that passes or is trapped at the point of measurement, listed as tons/acre or tons/time.

bacteria - Microscopic organisms that live on water and on land. They help break down organic materials into simpler nutrients in a process called decay. Bacteria release nutrients to the soil.

base level - The theoretical limit towards which erosion constantly tends to reduce the land. Sea level is the general base level, but in the reduction of the land there may be many temporary base levels which, for the time being, the streams cannot reduce. These temporary base levels may be controlled by the level of a lake or river into which the stream flows or by a particularly resistant stratum of rock that the stream has difficulty in removing.

bedload - Sediment that moves by sliding, rolling, or bounding on or very near the streambed; sediment moved mainly by tractive or gravitational forces or both but at velocities less than the surrounding flow.

bedrock - The solid rock underlying soils and the regolith in depths ranging from zero (where exposed by erosion) to several hundred feet.

beneficial uses - Resource uses that provide benefits to the environment, especially to humans. For water quality, beneficial uses are those uses of the water that provide adequate life support to riparian and aquatic biota and allow full use of the resource according to various human needs, i.e.: domestic water, recreation.

benefits, average annual - The long-term average of the benefits expected to occur each year spread out over the evaluation period.

benefits, net - The difference between the average annual benefits and the average annual costs; expressed as a negative value when costs exceed benefits.

benefit-cost (B:C) ratio - Average annual benefits divided by the average annual costs; value must exceed 1.0 for the project to be considered for authorization by Congress.

berm - A narrow ledge or shelf in a cut or fill slope to achieve stability; the shoulder of a road; a small dike or rice check.

biological communities - See ecological communities.

California Environmental Quality Act (CEQA) - Instituted in 1970, this state law recognizes environmental interrelationships and regulates impacts by requiring an Environmental Impact Report

capacity - The maximum volume that a water conveyance system is capable of transporting, or that a reservoir can hold.

channelization - The process of altering any water carrying system (stream, river, channel, ditch, etc to change its capacity ; syn - channel enlargement, channel modification.

chaparral - A broad-leafed vegetative community of the coast ranges and western slope of the Sierra Nevada, characterized by buckwheat, sage, buckbrush, manzanita, and chamise.

cohesion (geol.) - The capacity of a material, rock or sediment to adhere together and resist breakdown (erosional detachment).

commodity - A useful or valuable product of agriculture such as soybeans, beets, or cattle.

conservation - the protection, improvement, and use of natural resources according to principles that will assure their highest economic or social benefits.

construction (landuse def.) - Includes those areas known to be under development.

costs, average annual - The average cost incurred each year to pay for a project; usually involves the amortized construction costs plus the annual cost of operation, maintenance, and replacement.

costs, engineering services - Those expenses associated with surveys, investigations, designs, and preparation of plans and specification; includes vegetative work.

costs, landrights - The cost of securing easements, rights-of-way, and real property; for PL-566 purposes also includes construction cost of bridges, culverts and utility modifications.

cross section - A view of an object formed by cutting through it, usually at right angles to its axis.

cubic feet per second (cfs) - A hydraulic term denoting flow rate.

culvert - Any water conveyance structure passing underneath a road or embankment, usually a pipe or reinforced concrete box.

culvert, inverted - A pipe which passes water beneath an obstruction (road, ditch, or other obstacle ; syn - inverted siphon or sag culvert.

cut - A slope or embankment from which earth is excavated (removed); antonym - fill

damage factors - Anticipated damages to crops and/or urban structures expressed as a percentage of the total value of the undamaged drop/or structure; i.e., a decimal amount which, multiplied by the value of the undamaged crop and/or structure, yields an estimate of damages in dollars.

delivery - The transportation of a specified amount of water to a given outlet; often used in reference to fresh water that has been sold.

denudation - A geologic term which refers to the natural process of erosion and which, if continued far enough, would reduce the earth to a smooth round ball.

dike - 1: in engineering: An embankment to confine or control water, especially one built along the banks of a river to prevent overflow of lowlands; a levee. 2: In geology, a tabular body of igneous rock that cuts across the structure of adjacent rocks or cuts massive rocks.

discharge (Q) - The flow rate of water through any pipe, ditch, culvert, etc.; usually expressed in cfs.

diversion channel - Any channel that redirects the flow of flood water, may reroute all flows (i.e., new channel) or only excess flow, by not being cut quite as deep as the original channel.

diversion levee - A linear mound of earth that redirects overland flows.

diversity, habitat - The variety of habitat components in an area; in general the greater the habitat variety, the greater the value of that area to wildlife.

diversity, species - The variety of the kinds of plants or animals in an area; in general, high species diversity indicates high biological productivity.

drop structure - A structure for dropping water to a lower level and dissipating its surplus energy; a fall. A drop may in vertical or inclined.

dry density - The mass of quantity of soil or sediment after water has been removed; typically expressed as grams per cubic centimeter or pounds per cubic foot.

easements - A right given or sold to a person or agency to make limited use of another's real property; see also right-of-way.

ecological communities - An association of plants and animals that commonly occur together; usually named for the dominant vegetation in the area.

ecosystem - The area of influence by all biotic (living) and abiotic (non-living) factors in the environment; because of the principal of environmental interrelationships, ecosystems always interact with each other, forming larger ecosystems and, therefore, necessitate the limitations of arbitrary boundaries.

ecozone - The transitional zone between ecological communities.

embankment - A mound of earth and/or stone built to hold back water or support a roadway.

Endangered Species Act (1973) - By law, provides protection to all species of plants or animals (including invertebrates) that are currently in danger of extinction ("endangered") and those that may become so in the foreseeable future ("threatened"); allows for the preservation of ecosystems upon which an endangered species is dependent, designated as "critical habitat".

Environmental Quality Plan (EQ) - A plan, or element of a plan, that enhances ecological, cultural, or esthetic aspects of the environment.

ephemeral stream - A stream or portion of a stream that flows only in direct response to precipitation, and receives little or no water from springs or no longer continued supply from snow or other sources, and its channel is at all times above the water table.

epoch - A unit of geologic time (subdivision of the period) defined by major geologic event; the current ("recent") epoch started 12,000 years ago; see also period and era.

era - The longest unit of geologic time comprising one to several periods; see also period and epoch.

erosion - 1: The wearing away of the land surface by running water, wind, ice or other geological agents, including such processes as gravitational creep. 2. Detachment and movement of soil or rock fragments by water, wind, ice or gravity.

erosion, gully - The erosion process whereby water accumulates in narrow channels and , over short periods, removes the soil from this narrow area to considerable depth, ranging from 1 to 2 feet to as much as 75 to 100 feet.

erosion, rill - An erosion process in which numerous small channels only several inches deep are formed; occurs mainly on recently cultivated soils.

erosion, sheet - The removal of a fairly uniform layer of soil from the land surface by runoff water.

erosion yield - The loss of soil per acre from an area of measurement or of concern to a waterway. The rate is discounted for transport losses across the landscape. Listed as tons/acre or tons/time.

field crops (landuse def.) - All agricultural crops besides avocado and citrus orchards.

fill - In geology, any sediment deposited by any agent so as to fill or partly fill a channel, valley, sink, or other depression.

filtration - A process installed on channels wherever subsurface water drains into them; eliminates soil from entering the channel and causing internal damage (erosion and sedimentation).

fines - The fine fraction of a sediment, consisting of clay and silt particles smaller than 0.075 mm in diameter (by USDA nomenclature): see soil texture.

flashboard - Boards temporarily placed in a structure to restrict water flow in the channel.

floodplain - An area subject to flooding; includes lands bordering streams, rivers, ponds, lakes, and undrained lowlands.

flood-prone - Area that is likely to experience inundation by floodwater.

flood warning system - A system or device, usually electronic, that sounds an audible alarm when flooding danger is imminent in a local area; e.g., overtopping of a dam.

floodwater retarding structure - A structure providing for temporary storage of floodwater and for its controlled release.

freeboard - The distance between the design water surface and the top of a levee, dam or channel.

grade stabilization structure - Any of a variety of devices installed in steep-sloped channels to reduce the velocity of the water below that required to erode the channel bottom.

ground water - Water beneath the earth's surface held in saturated soil and rocks; supplies wells and springs

habitat - The area where an organism or biological population normally lives or occurs; includes the total area where all physical and biological life requirements of a species are found.

habitat encroachment - The slow, but finite loss of habitat due to the expansion of man's activities into natural areas (e.g., urban development); loss of living space for plants and animals.

habitat requirements - All biotic (living) and abiotic (non-living, physical) elements in the environment that are necessary for a particular species to live; syn - life requirements

habitat units (HU) - A mathematical index of habitat value to wildlife, incorporating both size and suitability; derived by multiplying habitat quantity (in acres) by a habitat quality factor (0.0 to 1.0, where 1.0 is superior).

herbaceous vegetation (herbs) - All non-woody vascular plants other than grasses and sedges; any plant without persistent woody growth, at least above ground.

hydrologic cycle - The cycle of water movement from the atmosphere to the earth and back again through these steps: evaporation, transpiration, condensation, precipitation, percolation, runoff, and storage.

hydrophytic vegetation (hydrophytes) A plant that grows in and is adapted to an aquatic or very wet environment; occurs wherever the water table is at, near, or slightly above the ground surface.

impacts, environmental - Any change in environmental conditions, positive or negative, that occur as a result, direct or indirect, of installing a project or any other modification.

incremental benefit-cost analysis - The process by which each individual segment, measure, or structure is separately evaluated in terms of comparing benefits to costs before adding the next segment, measure, or structure.

indigenous - Occurring or living naturally in an area; not introduced; native.

infiltration - the measure or rate of water movement through the soil surface, into the soil profile; (cm/sec or in/hr).

land - One of the major factors of production that is supplied by nature and includes all natural resources in their original state such as mineral deposits.

landfill - A location where solid waste (garbage) is disposed of.

land treatment - Soil and water conservation practices on rural lands that preserve and perpetuate the soil resource base.

land use - The service or activity to which a parcel of land is employed; e.g. urban residential, commercial, industrial, green belt, recreation, etc.

lands of statewide importance - Those farmlands that are nearly prime agricultural land and economically produce high yield when managed according to modern farming methods. Some may produce as high a yield as prime farmlands if conditions are favorable. These lands may occur on slightly greater slopes or be salt affected. These lands have a dependable water supply eight of ten years.

lateral recession rate - The depth of soil (in feet) removed from an area by erosion per year.

leaching - The process by which nutrients, chemicals, or contaminants are dissolved by water and moved into a lower layer of soil

levee - An embankment raised to prevent a river or stream from overflowing.

levee, setback - Refers to the placement of levees at a distance from the watercourse; useful to maintain the natural features of the floodplain, while still containing flood water.

low-flow channel - A small, secondary channel (cut within the main channel) to control the direction of water during low-flow conditions; useful to develop fisheries, marshes, pools, etc.

migration corridor - A strip of vegetation or prime habitat that allows or encourages migratory passage of wildlife through less suitable areas; e.g. green belts, riparian forests, natural parks, etc.

mitigation - The process of incorporating project design features that reduce project impacts on fish, wildlife, esthetics, and other environmental elements.

natural areas (landuse def.) - All areas marked native vegetation, and any other area having brush, grass, or mixed chaparral.

natural resources - Those components of the environment which are at least potentially useful to man, both economically and metaphysically; includes minerals, trees, fossil fuels, fish, wildlife, scenery, etc.

National Economic Development Plan (NED) - A plan or element of a plan, that maximizes net national economic development benefits.

National Environmental Policy Act (NEPA) - A 1970 law that requires each federal agency to prepare an Environmental Impact Statement to assess and avoid environmental impacts in advance of each major action, recommendation, or project that would significantly affect the quality of the human environment.

Native Americans - The people who lived in the United States before it was inhabited by people from Europe, Asia, and other continents.

nematodes - Microscopic, elongated worms that live on other organisms in the soil.

Non-point Discharge Elimination System (NPDES) - A permit system which governs the stormwater discharges from municipalities.

nonstructural - the use herein of the term "nonstructural " is expedient rather than informative. It ties to the legislative language of Section 73 of the 1974 Water Resources Act. "Nonstructural" is not a communicator of important ideas, and, in fact, causes confusion of the type which must be overcome if understanding in the field of hazards adjustments is to be fostered. The proper context of adjustments whether they modify floods or modity the way in which man occupies or uses the flood planin is the flood plain management context as described in the Corps of Engineers regulations of 1970, entitled "Alternatives in Flood Related Planning" and in the "Unified National Program for Flood Plain Management" issued by the Water Resources Council. (Taken from Annotations of Selected Literature on Nonstructural Flood Plain Management Measures, U.S. Army Corps of Engineers, Davis, CA. 3/77)

n-value - A coefficient of channel roughness used in hydraulic computations; determined by such factors as bed material, bank material, surface irregularity, vegetation, uniformity of cross section, obstructions, and meandering.

nutrient - a substance that supplies nourishment for an organism to live. It can be food or chemicals depending upon the organism.

nutrient exchange - The process by which plant roots exchange an acid from nutrients from the soil.

off-site storage - A reservoir, built along side of a channel, to which flood water is temporarily diverted; syn - off-channel storage

operation and maintenance (O&M) - The general use and repairs of channels, reservoirs, structures, and their related rights-of-way; often used in reference to costs.

other land use - Land in which the primary use is for a purpose not described on the tables, but are shown on the land use maps.

parent material - The earthy materials, both mineral and organic, from which soil is formed.

percent event - Denotes the magnitude of a flood; i.e., a flood that has a certain percent chance of occurring in any one year.

percolation - The downward movement of water through soil, especially the downward flow of water in saturated or nearly saturated soil at hydraulic gradients of the order of 1.0 or less.

period - A unit of geologic time, longer than an epoch and shorter than an era; see also epoch and era.

precipitation - Rain, snow and other forms of water that fall to earth.

prime agricultural land - Prime farmland that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops, and is also available for these uses (the land could be cropland, pastureland, or other land, but not urban build-up or water). It has the soil quality, growing season, and irrigation supply needed to economically produce sustained high yields of crops when treated and managed, including water management, according to acceptable farming methods. See also unique farmland.

probable maximum flood - The amount of surface water produced from a theoretical storm in which all meteorological parameters are maximized at the same time.

productivity - The amount of crops or animals that can be harvested from land. It can also mean the general amount of goods made in a given time or a given area.

Public Law 83-566 (PL-566) - See Watershed Protection and Flood Prevention Act.

reach - A segment of the project area associated with a stream or channel; boundaries are arbitrarily defined and are generally established early in the study.

recharge - The process of restoring reserves where water input exceeds withdrawals (draft) during the wet part of the year; often said of ground water basins or aquifers; see also overdraft.

recurrence interval - The time period (in years) between storms of a specified intensity; inverse of percent event (e.g., 1 percent event = 100-year storm).

reservoir - Any water storage facility.

residual flooding - All surface water flooding recognized to remain after project measures have been implemented.

Resource Conservation District - A local unit of state government that is responsible for soil and water conservation within its boundaries.

right-of-way - The right to pass over property owned by another party.

riparian - The zone along banks and adjacent areas of water bodies, water courses, seeps, and springs whose water provide soil moisture in excess of that otherwise available locally; supports hydrophytic vegetation that otherwise would not thrive due to lack of soil moisture.

riparian habitat - An environment associated with riparian corridors which provides food, cover, water and space for animals to survive.

riprap - A loose assemblage of stones or broken concrete (usually 0.8 to 3.0 ft. diam.) placed along the inside slope of a levee or embankment to reduce erosion and provide fortification.

runoff - Water that flows off land into streams and other waterways.

rural residential (landuse def.) - includes houses with lot sizes of 1 to 20 acres and all parks contained within these areas.

scoping - The process of determining the significant issues to be addressed in the development of a project.

sediment - Solid material, both mineral and organic, that is in suspension, is being transported, or has been moved from its site of origin by air, water, gravity, or ice and has come to rest on the earth's surface either above or below sea level.

sedimentation - The act or process of eroding, transporting, and depositing sediment.

sediment delivery ratio - The ratio of soil actually transported out of the watershed as sediment to the total amount eroded; usually expressed as a percentage.

sediment yield - The amount of soil removed from a drainage basin; only represents a fraction of the total erosion as some material remains in the watershed.

soil - The layer of the earth's surface composed of both organic and mineral elements and capable of supporting plant life.

soil horizon - A layer of soil that is nearly parallel to the land surface and is different from the layers above and below.

soil loss - The detachment of soil particles and loss from a plot of land not to exceed 72.6 feet in length.

soil structure - The arrangement of primary soil particles into larger aggregates termed granular, platy, prismatic, columnar, and blocky.

soil survey - The identification, classification, mapping, interpretation, and explanation of the soil over a given area of land.

soil texture - the relative proportions of soil particle sizes found within a given soil sample or type; sizes include silt, clay, sand, and gravel.

species - A fundamental category of classifying living things, ranking after genus, and consisting of organisms capable of interbreeding.

species, endangered - See Endangered Species Act.

spillway, emergency - An ungated outlet from a reservoir which prevents overtopping by floodwater during large storms.

spillway, principal - A structure associated with a dam to allow for controlled releases of water.

spoil - Refuse material removed by digging or dredging.

stage - The elevation of the water surface at any channel or reservoir cross-section.

structural measures - Water and sediment management practices that involve the construction of channels, reservoirs, sewers, and other devices.

unique farmland - Land other than prime farmland that is used for the production of specific high value food and fiber crops. It has the special combination of soil quality, location, growing season, and moisture supply needed to economically produce sustained high quality and/or high yields of a specific crop when treated and managed according to acceptable farming methods. Examples of such crops are citrus, tree nuts, olives, cranberries, fruits and vegetables; see also prime agricultural land.

unique habitat - Any field, marsh, stream border, woodland, or other natural area that has an usually high wildlife value for the general area in which it occurs.

urban (landuse def.) - residential, commercial, industrial and all parks contained within these areas.

washload - That part of the total sediment load composed of all particles normally washed into and through the stream system being discussed. In this report, sediment particles fines than 0.062 mm in size.

watershed - The topographic area drained by a single river or creek system.

Watershed Protection and Flood Prevention Act (PL-566) - Administered by the Natural Resources Conservation Service, formerly the Soil Conservation Service, this law provides technical assistance and cost sharing to local sponsors for developing and implementing plans in watersheds no larger than 250,000 acres; may be multipurpose.

water year - A year beginning on October 1st, corresponding with the annual season of surface water runoff.

weir - A dam placed in a stream to raise the water level or regulate the flow; often used to divert water into another channel.

wetland - Lowlands covered with shallow and sometimes temporary or intermittent waters; includes marshes, bogs, wet meadows, potholes, sloughs, riparian systems, vernal pools, and vegetated shallow margins of lakes, ponds, and reservoirs; a broad category of wildlife habitat.

wetted perimeter - The surface of a pipe or channel that is in contact with flowing water.

WHR - Wildlife Habitat Relationships: a database used to establish what wildlife may be living in the area.

wildlife enhancement - The process of improving the habitat value of an area to wildlife.

wing walls - Wall extending up and downstream from a culvert to retain the earth and funnel channel water into the culvert opening.

woodland - Any land bearing a stand of trees whether naturally occurring or planted; includes coniferous forest, broadleaf forests, windbreaks, shelter-belts and woodlots.

xeric - A moisture regime common to arid regions in Mediterranean climates where water is a limiting factor.

xerophyte - A plant species adapted to arid climates and capable of surviving periods of prolonged drought.

zone of accumulation - The layers in a soil into which soluble compounds are moved and deposited by water.

zone of decomposition - Surface layers in a soil in which organic matter decays

zone of leaching - The layers in a soil from which soluble nutrients are removed by water.