3. PLAN FORMULATION

Problems and Opportunities

The list of public concerns presented in the *Coordination, Public Views and Comments* chapter was used as a guide for the baseline conditions analysis. These concerns are also the basis of the problem and opportunity statements presented in this section, in addition to other problems that have been identified during the baseline condition studies. Some of the problems and opportunities are applicable to both baseline conditions and future with-project conditions for potential dam removal or modification measures. The ♦ symbol designates problem statements and the ◘ symbol designates opportunity statements.

♦ **Degraded river habitat and upstream physical barriers in the Ventura River watershed have caused a significant decline in anadromous fish populations, particularly the endangered southern steelhead trout.**

The Ventura River watershed has historically supported one of the largest runs of the southern steelhead trout on the south coast.

Agricultural, industrial, and urban development in the Ventura River watershed has degraded the natural environment by adding system-wide stresses such as increased point and non-point pollution, loss of habitat, diversion and extraction of water, increased water use, increased raising of livestock, and structural alterations of waterways.

The Ventura River watershed is classified as impaired and is on the State's 303(d) list for pollutants (including DDT, copper, silver, zinc, algae (eutrophication) and trash) and the TMDL priority schedule.

Construction of Matilija Dam, Casitas Dam and Robles Diversion Dam has blocked access to historical upstream spawning and rearing habitats.

Poor water quality in the Ventura River, including increased water temperatures, low dissolved oxygen levels, and potentially high nutrient loads may adversely affect steelhead habitat.

◘ ***Increase anadromous fish populations by improving quality of mainstem Ventura River habitat and access to headwater spawning grounds that were historically highly productive.***

Construction of a fish ladder structure at Robles Diversion Dam would allow fish passage upstream to the base of Matilija Dam and also to the North Fork Matilija Creek, at least 4.5 creek miles. Local interests are pursuing this measure at this time.

Fish passage upstream of Matilija Dam would open at least 17.3 miles of pristine waters within the Matilija Wilderness.

Removal of Matilija Dam would restore fish and wildlife migratory corridor benefits.

Removal of Matilija Dam would return natural flows and sediment processes from Matilija Creek to the Ventura River. Water quality could potentially benefit in the Ventura River, including reduced temperatures and increased dissolved oxygen levels.

♦ **Significant erosion of the streambed has occurred in the Ventura River.**

The presence of Matilija Dam, Robles Diversion Dam, and Casitas Dam has decreased the sediment loads in the Ventura River system. Storm flows, especially from Matilija Dam, are sediment starved and pick up sediment in the downstream river channel. Various reaches of the river have been subject to degradation.

Some segments of the Ventura River have become so entrenched that flows including the 100-year event will remain in the active channel, effectively abandoning adjacent floodplain areas and potentially have a detrimental impact on the habitat.

Infrastructure could be potentially damaged in the future. At Shell Road Bridge, for example, erosion in the vicinity and downstream of the structure ranges from 10 to 16 feet below the 1971 thalweg elevation.

◘ ***Restore natural sediment transport and replenishment of riverine system.***

♦ **The coastline of Ventura County is subject to significant erosion.**

The Ventura River was once a major contributor of sediment supply for the beaches of Ventura County. Sediment yields have been greatly reduced as a result of the construction of Matilija Dam, the Robles Diversion Dam and Casitas Dam that trap sediment.

Beach erosion along the local coastline has impacted native habitats of sensitive species.

To protect against high erosion rates, the Ventura County Watershed Protection District has implemented costly coastal armoring measures. Damage to coastal infrastructure (roads, utilities, existing coastal armoring structures) and associated repair and mitigation costs (new coastal armoring structures) have been significant.

Coastal tourism is one of California's largest industries. Erosion can reduce the recreational value of the beaches.

◘ ***Restore natural sediment transport to the ocean from Matilija Creek benefiting coastal beaches and ecosystems.***

♦ **<u>The reservoir behind Matilija Dam has been subject to substantial sedimentation, almost six million cubic yards, since its construction.</u>**

Ventura River Watershed lies in an active tectonic region that contributes some of the highest sediment yields in the United States.

Matilija Dam serves a limited water supply use function and provides little protection against major floods. From an original storage capacity of 7,000 acre-feet, it is estimated that the current capacity of Matilija Dam is less than 500 acre-feet. The dam provides no practical attenuation of the peak flow for large flood events (return interval greater than 10 years).

Based on its current rate of sedimentation, it is estimated that the reservoir pool capacity will be less than 50 acre-feet by year 2020. It is estimated that by 2040, the reservoir will have reached equilibrium and will contain more than nine million cubic yards of sediment.

◘ ***Provide beach nourishment and coastal erosion protection along the Ventura coastline utilizing trapped sediment behind Matilija Dam.***

♦ **<u>Exotic and invasive species are replacing native species in Matilija Reservoir, and downstream of the dam along the Ventura River and within portions of the Ventura River estuary.</u>**

The Ventura River Watershed provides important riparian and wetland habitat for a wide variety of native wildlife species, including many sensitive species and several threatened and endangered species.

Upstream of Matilija Dam, the invasive giant reed (Arundo donax) has overtaken the majority of the original reservoir upstream of the reservoir pool (open water habitat). Downstream of the dam clumps of giant reed are colonizing the floodplain and the estuary.

◘ ***Eradicate exotics and invasive plant species within the Ventura River corridor and estuary, as well as non-native vertebrate species associated with the existing Matilija Reservoir.***

Local groups, such as the Ventura County Resources Conservation Agency, have made recommendations and plan eradication measures to control giant reed in Ventura County.

Revegetation with native species would occur.

A long-term monitoring and maintenance plan could measure the success of the eradication program.

♦ **<u>The existing reservoir (open water habitat) supports many non-native vertebrate species that are considered detrimental to the survival of many native fish and amphibians.</u>**

Non-native species include crayfish, bullfrogs, largemouth bass, and green sunfish.

The reservoir will eventually fill with sediments, and the open water and associated wetland habitats will decline.

Continued infilling of the reservoir will further reduce the non-native species habitat, potentially reducing their populations.

◘ ***Eradicate non-native vertebrate species associated with the existing Matilija Reservoir.***

♦ **<u>Dam safety has been a concern for Matilija Dam since shortly after its construction.</u>**

Matilija Dam has been subject to concrete deterioration due to alkali-silica reaction. The central portion of the dam has been notched twice to lower the spillway crest, thereby decreasing the maximum pool and alleviating loads and stresses acting on the structure.

Periodic dam safety studies have been performed on Matilija Dam since 1965. In addition, a surveillance program is also in effect, and includes surveys and instrumentation.

It is believed that Matilija Dam will remain in service, in its existing configuration, for at least an additional 50 years. Continued inspection and concrete sampling and testing will serve to monitor Matilija Dam's remaining life.

◘ ***Reduce or eliminate threat of dam failure by modification or removal of Matilija Dam.***

♦ **<u>There is no recreation access at Matilija Dam and reservoir.</u>**

Matilija Dam and reservoir are not accessible to the public.

There are no recreation trails that connect the Ventura River corridor south of the dam and the Los Padres National Forest land to the north of the dam via Matilija Creek.

Prior to the construction of Matilija Dam, the area drew many residents and tourists for recreational activities and enjoyment of the natural beauty of the region.

◘ ***Provide recreation access through the Matilija Dam and the reservoir area to establish connectivity between the Ventura River and Los Padres National Forest recreation trails along Matilija Creek.***

Potential extension of the Los Padres National Forest boundaries, as supported by the U.S. Forest Service, could provide additional recreation potential along Matilija Creek.

Objectives and Constraints

The problems and opportunities identified in this study are used to describe specific planning objectives that represent desired positive changes in the without-project conditions and provide focus for the formulation of alternative plans. The primary objectives for this study were developed by the Corps, the Sponsor, resource agencies and stakeholders based on public input, meetings, and identification of the problems and needs. The primary ecosystem restoration study objectives are:

- Improve aquatic and terrestrial habitat along Matilija Creek and the Ventura River to benefit native fish and wildlife species, including the endangered Southern California steelhead trout.
- Restore the hydrologic and sediment transport processes to support the riverine and coastal regime of the Ventura River Watershed.
- Create recreational opportunities along Matilija Creek and the downstream Ventura River system.

Constraints have been identified through the study process, particularly during meetings with the Sponsor, resource agency representatives and other stakeholders.

► Maintain the current level of flood protection along the Ventura River downstream of Matilija Dam.

► Minimize adverse impacts to local communities associated with the removal of the trapped reservoir sediment.

► Minimize disturbances to cottonwood – willow and marsh communities throughout the study area.

► Limit effects of potential deposition within the Ventura River estuary and associated wetlands from increased sediment yield resulting from Matilija Dam trapped sediments.

► Protect or limit adverse impacts to prehistoric/historic archeological sites in the vicinity of the original Matilija Dam Reservoir from construction activities.

- ► Limit adverse impacts to normal water supply quantity, quality and timing of delivery to Casitas Reservoir via Robles Diversion Dam.

- ► Limit impacts to water quality in Lake Casitas by turbid flows resulting from the release of Matilija Dam trapped finer sediments.

- ► Limit impacts to Robles Fish Passage Facility and opportunities of fish migration at the facility.

National Objectives

The "*Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies,*" also known as Principles and Guidelines (P&G) identifies a single Federal objective emphasizing National Economic Development (NED). The P&G is one of the most important sources of Corps planning guidance.

"The Federal objective of water and related land resources planning is to contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements."

Contributions to national economic development (NED) are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the nation.

Ecosystem restoration has become one of the primary missions of the Corps Civil Works program. Current Corps policy (Engineering Regulation (ER) 1105-2-100) establishes an additional national objective to contribute to National Ecosystem Restoration (NER). The NER objective is to contribute to the Nation's ecosystems through restoration, with contributions measured by changes in the amounts and values of habitat. The Habitat Evaluation Procedure (HEP), prepared by the Environmental Working Group (EWG), is the analysis used for this study to identify NER outputs. Primary ecosystem restoration benefits associated with the final array of alternative plans considered for this study are presented in non-monetary outputs (habitat units). The NER plan is the alternative with the greatest net ecosystem restoration benefits.

Four accounts are presented later in this chapter to organize and summarize important considerations used to compare and evaluate alternative plans. The accounts are NED, Environmental Quality (EQ), Regional Economic Development (RED), and Other Social Effects (OSE). The four categories, known as the System of Accounts and suggested by the U.S. Water Resources Council, address long-term impacts, defined in such a manner that each proposed plan can be easily compared to the no action plan and other alternatives.

Formulation of Measures and Alternative Plans

Multiple iterations of formulation and screening of measures and alternatives were conducted during the plan formulation process. These activities involved the multi-agency members represented in the Plan Formulation Group (PFG), the Environmental Working Group (EWG), and various technical groups formed to address specific issues related to dam fate, sediment management, ecosystem, fish migration barriers, water supply, flood control, air quality, noise, and traffic.

Measures that address the study objectives were considered, discussed, combined in different manners and screened during this process. Initial screening was accomplished by evaluating the measures against habitat, fish passage, and riverine and beach nourishment impacts. The criteria is defined as follows:

Habitat: The ability of the measure to maintain or improve/restore the natural processes that support aquatic ecosystems (e.g. spawning/rearing habitat) and riparian systems (e.g. floodplain vegetation). Also included are the measure's applicable beneficial or adverse impacts to the hydrologic regime (including sedimentation/erosion), long-term water quality and connectivity.

Fish Passage: The ability of the measure to restore fish passage at Matilija Dam. Consideration is also given to the measure's effectiveness either under a wide range of flow conditions or under a limited range of flows (as for a fish ladder). This criterion assumes that fish passage at Robles Diversion Dam is not a constraint.

Riverine and Coastal Nourishment: The ability of the measure to restore the natural hydrologic and sediment transport regime to downstream Ventura River reaches and the renourishment of local beaches. Consideration included whether the measure removes all, a portion of, or none of the trapped sediment for potential re-introduction into the riverine/coastal system, as well as whether the measure allows for re-introduction to the riverine/coastal system of new sediment from the watershed upstream of Matilija Dam.

Measures were combined to form alternatives, which were iteratively refined and screened with the intent to make plans complete, effective, efficient, and acceptable. Initial alternatives screenings were conducted with preliminary engineering design and construction cost estimates, developed with limited sediment modeling information and, therefore a preliminary HEP evaluation. Anticipated sediment deposition trends were assessed based on a comparison of the alternatives designs. Natural (fluvial) sediment transport alternatives, particularly those that included removal of the entire dam in one-phase were anticipated to have the most downstream beneficial and adverse impacts related to sediment deposition and turbidity as these alternatives were the most extreme in nature.

Modifications to design, cost estimates, and HEP evaluations were discussed and incorporated into the formulation and screening process as new information, including more refined sediment transport modeling results, became available. Some measures, or combinations thereof, were revisited as the study progressed and more refinements were made. Various combinations of alternative measures were considered throughout the formulation process.

The following sections present measures that were considered in the formulation process, summarized by category. The evaluation of each measure and screening outcome is summarized. For ease of discussion, the combinability of the measures into alternatives has been limited. The following premises were made during the formulation process: a fishway will be constructed at Robles Diversion Dam; all measures will not impede fish passage at Robles Diversion Dam; and the sites identified for sediment hauling, concrete recycling, and metal debris salvaging will still be in service when construction operations are under way.

The measures considered address no dam deconstruction, dam deconstruction, and actions independent of dam fate.

Measures Addressing Fate of Matilija Dam

<u>No Dam Deconstruction</u>

Restoration of Matilija Dam Water Supply – This measure would restore the water supply function of Matilija Dam, with a reservoir that is the approximate size of the 1960 condition (limited due to prior notching of the dam). The notched portions of the dam would not be restored. Since trapped sediments behind the dam would be removed to restore water storage capacity, this measure would need to be combined with other mechanical sediment transport measures. Sluicing sediment downstream by utilizing existing conduits through the structure would not be economical, primarily due to the exorbitant quantity and expense of importing water. The dam itself would potentially require significant structural modification due to the increase in loading conditions, requiring consultation with the California Department of the Safety of Dams (DSOD). The existing operation of the dam for water supply would be impacted during restoration operations. To meet study objectives, this measure would also need to be combined with the construction of a fish ladder to the top of dam. There are significant issues related to this prospective feature. The Sponsor (VCWPD) has indicated that they have no interest in pursuing either full or partial restoration of Matilija Dam. This decision was supported by the consensus of the stakeholder group. There would be very high costs associated with this measure when combined with other measures, such as mechanical sediment removal. The position of the EWG is that a fish ladder would not be an effective measure due to the necessary height for this feature (see "Construct New Fish Ladder" below). This measure was not carried forward.

Construct New Fish Ladder – This measure would leave the dam and trapped sediment in place. Construction of a fish ladder at Matilija Dam was not supported by the EWG, particularly the National Marine Fisheries Service and the California Department of Fish and Game. A memorandum (2003) was prepared by the EWG to state concerns regarding the likelihood of success of a large fish ladder structure at Matilija Dam. Amongst other factors, including compromising higher environmental outputs associated with an overall ecosystem restoration plan, no success has been reported for dams over 180 feet in height. This measure was not carried forward.

***Fish Tunnel Bypass to the North Fork of Matilija Creek* –** This measure would leave the dam and the majority of trapped sediment in place. A 600-foot long bypass tunnel would be excavated through a mountain face, connecting Matilija Creek upstream of the dam to the adjacent Lower North Fork of Matilija Creek, which currently merges to form the Ventura River about a half a mile downstream of Matilija Dam. The tunnel would be a 72-inch diameter pipe with lighting, and would divert some or all of the flows from upstream of dam to allow for fish passage. Maintenance would be required to remove sedimentation in the tunnel. Sedimentation at the upstream end of the tunnel would be problematic as too much sedimentation would bury the inlet or loss of sedimentation levels around the opening would strand it. Attraction flows to fish are questionable, and steelhead would likely still migrate to the bottom of Matilija Dam. This measure was not supported by the EWG and was not carried forward.

***Trap and Truck Fish* -** This measure assumes that the dam would remain in-place. A new temporary holding facility would be constructed for steelhead migrating up Ventura River to the base of Matilija Dam. The steelhead would be collected at the holding facility and trucked above the dam to an appropriate release site. Although this measure has some benefit to fish migrating upstream, it is not considered effective in assisting the migration of potentially significant numbers of fish. Some consideration was given to a similar trap and hold method for downward migrating fish, but it was not possible to design such a feature for the wide variety of storm events. The steelhead would likely not survive the drop from the top of the dam notch to the pool below, about 165 feet in height. In addition, trapping and trucking is traumatic to the fish with potential life-threatening consequences and is strongly opposed by the EWG. Therefore, this measure was not considered forward.

Dam Deconstruction

***Dam Deconstruction by Controlled Blasting* -** A Bureau of Reclamation (BOR) Appraisal Report (2000), prepared prior to this feasibility study, summarized results of field-testing for different methods of dam removal. The BOR tested these removal methods at one of the Matilija Dam abutments where prior notching had already occurred. The information in the appraisal report was used for this comparison of dam removal measures. Dam removal by controlled blasting allows the removal to happen relatively quickly. Excavation of sediments behind the dam would be necessary to access the back face of the structure for removal operations. The dam would be removed in 15-foot increments (lifts) by placing explosives at proper distances along horizontal planes of the dam face. Most of the dam would be removed in 11 of these 15-foot increments. The abutment may take some additional blasting.

Minimal processing would occur on-site to prepare the concrete rubble for removal by truck hauling. Concrete blocks would be prepared for hauling using a hoe-ram, with a maximum diameter of about 2 feet and all reinforcement cut flush with the concrete. The material, estimated to be about 77,000 cubic yards, would be hauled to a concrete recycling center, assumed to be Hanson Aggregates located about 28 miles away from the dam. Non-recyclable debris would be hauled to the Toland Landfill.

There would be temporary adverse impacts related to noise (from blasting and trucking), and associated traffic and air quality impacts due to the trucking of the material.

This measure is more time and cost effective than other deconstruction measures, and is therefore carried forward for more detailed analysis.

Dam Deconstruction by Diamond Wire Cutting - This measure was also addressed in the BOR appraisal report, but was found to be much more expensive and time consuming. Diamond wire cutting would be accomplished in smaller lifts. Each cut section would be secured with bolts and removed by a crane and loaded onto a truck for final processing and disposal. This method was not very effective due to the large size of the reinforcement used for the construction of the dam. Due to the significant increase in costs and the slow production rate, this measure was not carried forward.

Dam Deconstruction by Expansive Chemicals - This measure was also presented in the appraisal report. This method was the least effective and most costly of the three methods included in the appraisal report because of difficulties with the size of the reinforcement in the dam. It required relatively difficult cutting of the reinforcement before sections of the dam face could be removed. Therefore, this measure was not carried forward.

Dam Deconstruction by Hoe-Ram - This measure was also presented in the appraisal report. The method would not be as economical as blasting for a large structure, and would have limited control in maintaining horizontal and vertical breaklines. The hoe-ram is also less effective in poorer quality concrete, which would be a factor in the upper portions of the dam. The use of the hoe-ram for deconstruction is practical however in conjunction with controlled blasting.

Full Dam Removal – This measure would remove the dam (above the streambed) in one phase by controlled blasting. Full dam removal is combinable with mechanical or natural sediment transport modes, as well as on-site stabilization methods. This measure was carried forward in the formulation process.

Incremental (Staged) Dam Removal - The dam would be removed in 15-foot horizontal increments by controlled blasting. The analysis considered removal of the dam in two phases. The second phase would begin once storm events naturally transported the trapped sediments that are deposited at a higher elevation than the interim height of the dam created by first phase incremental removal. No additional increments of removal, such as three or four phases, were considered. Increasing removal phases would result in increasing the length of time for complete dam removal.

This measure offers some better control of the release of downstream sediments over a more extended period of time, potentially reducing downstream flooding and water supply impacts. The detriments are that restoration of fish passage to the Matilija watershed is dependent on the timeframe for the removal of the accumulated sediment behind the dam. If large storms occurred, the timeframe would be relatively short in comparison to the length of time it would take for sediments to erode during a drought cycle. This measure also does little to control the release of fines to the downstream reaches, so water supply activities could still be adversely affected by this measure. It is possible to combine this measure with the mechanical removal of fines from the 'Reservoir Area.' Incremental dam removal was supported by some of the Plan Formulation Group participants and was therefore carried forward in the formulation process.

Partial Dam Removal and Restoration of Water Supply Function – This measure would remove a portion of the dam in horizontal lifts by controlled blasting. The same issues are true for this measure as for the full restoration of Matilija Dam for water supply. This measure does not meet the objectives for this ecosystem restoration study alone, and would have to be combined with mechanical removal of sediments and restoration of a fish ladder. DSOD would have to be consulted about the structural integrity of a partial dam for water supply use. The costs are very high for this option and the Sponsor does not support the restoration of Matilija Dam as a water supply facility. Therefore, this measure was not carried forward.

Partial Dam Removal - This measure is similar to the previous measure, although the remainder of Matilija Dam is not being used for water supply. This measure would have to be combined with other measures including construction of a fish ladder and mechanical removal and/or natural transport of sediments. This measure was not supported by the PFG and, therefore was not carried forward.

Partial Dam Removal (with "V" Notch) - This measure cuts a vertical (V-notch) section in center of dam from top to bottom, with stabilization of the remaining sections of the dam structure. Some sediment would be removed/displaced to facilitate notching, including grading in the reservoir. The remainder of the trapped sediment would be removed over time by natural transport. There were significant concerns related to the structural integrity of the remaining dam structure. The dam is a concrete arch structure, and the structural integrity would likely be compromised with a vertical notch from top to bottom (loss of arch-action). This measure was not carried forward.

Measures to Address Trapped Sediment Behind Matilija Dam

Mechanical Transport of Sediment

<u>Sale/Disposal of Sediment Measures</u>

Truck All Sediment to a Processing Center - This measure assumed the transport of all trapped sediment (5.9 million cubic yards) to a local construction aggregate company (Vulcan Materials Co. or Hansen Aggregate Co.) located about 30 miles southeast from the dam site in Saticoy. Trucking would be the only method of delivery accepted at the sites. No claim for credit would be made for the disposed sediment. This measure was dismissed based on the very high costs associated with the transport of this significant volume of material, for the lengthy trucking distance, the excessive number of truck trips, and the significant and long-term traffic, noise and air quality impacts in the local communities. The same is true for trucking only sediments from the 'Delta Area' and the "Upstream Channel Area'- totaling 3.8 MCY.

Truck 'Reservoir Area' Sediment to a Disposal Site - The 'Reservoir Area' sediment (2.1 million cubic yards), comprised primarily of silts and clays, would be transported by truck to a designated off-site disposal area. There are inherent construction processing/handling problems associated with trucking this sediment (composed primarily of silts and clays) to an off-site disposal. This fine sediment lies primarily under the existing reservoir and is completely saturated. Excavation and handling of this wet sediment would be very cumbersome due to its cohesive and sticky nature. Following excavation, a significant drying operation would be necessary to facilitate handling of this sediment prior to transport from the dam site by truck. An option to drying the fine sediment would be to use liners in the truck beds. This however would increase the number of truck trips substantially, and was therefore not further considered. The high handling cost of the drying process together with the trucking impacts related to traffic, air quality and noise in the local community were reasons for dismissing this measure from further consideration.

The Sponsor investigated 14 areas for possible use as a *permanent disposal site*. Sites consisted of either open space or agricultural areas, and are in close proximity to the Ventura River. Distance downstream from Matilija Dam ranges from 2.5 to 13.5 miles. The size of the land parcels vary based on use and ownership. The Sponsor also queried land owners on their willingness to sell. An area located in the vicinity of the Highway 150 Bridge has been identified as a primary candidate for the designated disposal site. The area is comprised of four separate sites, located both upstream and downstream of the bridge, totaling 118 acres. The distance downstream of Matilija Dam varies from 3.6 to 6.3 miles.

Alternate uses for the "Reservoir Area' sediment, such as for *agriculture* and *landfill cover*, were also assessed. Based on Sponsor queries to local farmers, there was very limited demand, and only for small quantities. Similarly for landfills, though there was some potential interest for use, the option was not considered to be cost effective due to the demand for only limited quantities, the long distances to the sites, as well as the high costs in processing and hauling the materials. In addition there would be associated impacts to the local community. These alternate uses were not considered further.

Sell Coarse Sediment from the Dam and Truck to End-Users - This measure assumes the sale of marketable construction–grade aggregate from the dam site over a 10-year timeframe. There is approximately 3.0 MCY of marketable aggregate in the 3.8 million cubic yards of deposited sediments in the "Delta" and "Upstream Areas." This material would be stockpiled and sold on-site. Constant regrading would occur on an annual basis and sediments would be protected from downstream storm erosion. The residual non-marketable fine materials, 770,000 MCY, would be separated and either hauled by truck to a landfill or to the designated disposal site to limit downstream turbidity impacts.

This measure assumed no costs for the truck transport of this material since the construction contractor is selling directly to end users. The likely primary transportation routes associated with the sale of aggregate identified by the local sponsor are: Highway 33 to Highway 101 to local roads, and Highway 33 to Highway 150 to Highway 126 to local roads. The second route directly impacts Ojai since Highway 150 traverses the town.

Impacts to air quality, noise and traffic associated with this measure are being assessed for the EIS/R. There was interest from members of the PFG in pursuing this measure, even with the potential adverse impacts to the local community for up to 10 years. Therefore, this measure was carried forward in the formulation process.

A *dedicated haul route* along the Ventura River alignment that would connect to Highway 33 to Highway 101 was also considered. The expense of constructing the road, and opposition from the EWG, was reason for the dismissal of this feature.

The sale of materials from an *off-site disposal/processing area* would provide an alternative to selling the materials from the dam site. The town of Ojai could potentially be less impacted by truck traffic if the sale of materials is from the designated disposal site (temporary use), or a different designated site, with the only entry/exit route is the southern portion of Highway 33 and Highway 101. Adverse impacts including noise, air quality and traffic impacts are compounded by trucking at both the dam site and from the sale of materials to end users from the disposal/processing site (i.e double handling). In addition, the off-site disposal/processing area would also require a substantial amount of space for the processing/temporary stockpiling of materials. For capacity reasons, it is likely that this would have to be a separate site from the disposal site needed for the permanent storage of 'Reservoir Area' sediment identified by another measure. Sale of materials from off-site was not carried forward.

Use Conveyor System to Transport "Reservoir Area" Sediment to Disposal Site - This measure is similar to "Truck 'Reservoir Area' Sediment to a Disposal Site" except that a conveyor belt system is used in lieu of trucking. Due to the inherent difficulties and higher costs in excavation/handling/drying these materials, this measure was not carried forward.

This measure was also combined with the conveyor system to Surfer's Point (described below under Beach Nourishment Measures). The main belt to the coast would incorporate an off-line *"spur"* to the disposal site. For the same reasons described above, this measure was not carried forward.

Use Conveyor System to Transport ≤ 9" Sediment to a Temporary Downstream Processing Site - This measure is similar to the trucking option for sale of materials from an off-site disposal/processing area. This measure was considered in combination with transporting 'Reservoir Area' sediment to a disposal site by either a conveyor or a slurry pipeline system. Traffic, air quality and noise impacts could be improved by using a conveyor belt from Matilija Dam when compared to trucking, although impacts to the local communities would still be significant. This measure would also require some sorting of material at the dam and at the disposal site. Sale of the material to end-users would also have similar impacts as those described in the trucking measure. This measure was not carried forward for detailed analysis.

Slurry 'Reservoir Area' Sediment to a Downstream Disposal Site – The 'Reservoir Area' sediments would be slurried via pipeline to a disposal site. The remainder of the trapped sediment could be transported naturally or mechanically depending on the combination of measures. The slurry mix would need to be placed behind a constructed containment dike. Appropriate measures would be necessary to protect the dike against flood events should the disposal location be within the floodplain.

A minimum of 4,500 acre-feet (ac-ft) is needed to slurry the fines. Sources of water considered include Casitas Municipal Water District (CMWD); pumping groundwater; pumping seawater; using supply stored behind Matilija Dam; City of Ventura supplies or entitlements; and state water pipeline. CMWD has indicated that it cannot accommodate the sale of water for any potential future Matilija Dam removal project due to the limitations on the district's safe yield. Groundwater may be a potential source, but initial studies indicated that the aquifer capacity would not suffice for the need. The use of seawater would be a costly option due to the 17 miles of pipeline required to get the water to the dam, and the need for a desalination plant. The EWG objected to the use of seawater because of the potential adverse impacts to the environment if a leak were to occur in the system. There are only 500 acre-feet of water behind Matilija Dam, not enough for the slurry. The most promising source is the City of Ventura, which currently has a surplus of 5,000 to 6,000 ac-ft of CMWD water. The City has an entitlement of 8,000 ac-ft/yr from CMWD, and must annually purchase 6,000 ac-ft of water from the water district. The State pipeline is also a more expensive option.

In relative costs, a slurry system would be less expensive than a conveyor system. The alignment would require real estate right-of-way (temporary easements). There would need to be a road constructed adjacent to the slurryline for O&M. The alignment footprint, approximately 25 feet wide, would initially require the removal of native vegetation.

This measure could be combined with other dam removal and sediment management measures, and was carried forward for more detailed analysis.

Slurry all Less than ≤¼" Sediment to Downstream Processing Site/Disposal Site - Consideration was given to slurrying only ¼-inch and finer sediment (comprising approximately 4.5 MCY of total trapped sediment) to a temporary downstream processing site. The costs of obtaining the substantial quantity of water necessary, the potential multiple processing and disposal sites, together with the limited commercial aggregate value of the smaller grain sized sediment and the need to separate it from the fines, was reason for dismissal of this measure.

Beach Nourishment Measures

Truck Coarse Sediment to Surfer's Point – This measure would utilize trucking to transport the 3.8 million cubic yards of sediment from the 'Delta Area' and the 'Upstream Channel Area' to Surfer's Point, located about 16 miles downstream of Matilija Dam near the mouth of the Ventura River. Continuous operations would truck these sediments through Ojai and down Highway 33 to Surfer's Point. This is a lengthy operation, with significant impacts to the local community from traffic, air quality and noise. There would be significant costs associated with this alternative, much higher than other mechanical and natural transport measures. Although this measure would directly benefit beach nourishment, the effort would largely provide only temporary benefits to the local coastline as the high energy coastal environment would transport the majority of this material downcoast. Any replenishment benefits from re-introducing the Matilija Dam trapped sediments to the Ventura River system would be foregone. Other less expensive offshore borrow sites could be utilized as a source of beach compatible material when compared to the trucking option. The high costs associated with this measure, as well as the adverse impacts and effectiveness of the action provided justification for this measure to be dismissed from further consideration.

Consideration was also given to limiting the hauling efforts to only cobble–sized sediment. This larger sized material would be more erosion resistant in the high energy wave environment at Surfer's Point. However, even 0.5 MCY of cobbles from the dam site would require about 25,000 truck trips. This refinement of the original measure was not carried forward for reasons of cost effectiveness, compounded with similar (though smaller in scale) environmental impacts related to truck hauling as described above.

Use Conveyor System to Transport Coarse Sediment to Surfer's Point - This measure is similar to "Truck Coarse Sediments to Surfer's Point" except that a conveyor system is used in lieu of trucking. The more than 16-mile long conveyor belt system would be constructed along the general alignment of the Ventura River. Materials to be conveyed would be pre-sorted on-site. The system would be designed to accommodate materials no larger than 9 inches. This measure would be very expensive, both for initial construction of the system, and for operations and maintenance. There would need to be a road constructed adjacent to the conveyor for O&M. The alignment would require extensive real estate right-of-way (temporary easements). The alignment footprint, approximately 30 feet wide, would initially require the removal of native vegetation. Operation of the conveyor system would be required over a period of years. Noise impacts to downstream communities would have to be mitigated, requiring limited daily and seasonal operational timeframes and electric motors for the system. Preliminary costs were very high for this measure, and combined with other impacts, the decision was made to dismiss it from further consideration.

Slurry all ≤ ¼" Sediment to Nearshore - This measure would slurry only ¼-inch and finer sediment (comprising approximately 4.5 MCY of total trapped sediment) to the nearshore environment. The remaining 1.4 MCY of coarser material would remain at the dam site and be would be graded to conform to natural topographic contours. Approximately 9,300 ac-ft of water would be necessary to slurry sediment to the nearshore environment. This quantity of water would have to come from multiple and expensive freshwater sources if it was determined to be available. Pumping seawater was also considered, but the action was met with resistance from the EWG. Extensive temporary right-of-way would have been needed for the 16-mile long alignment, and native vegetation would be temporarily impacted. Permits would also need to have been negotiated for impacts of fines and turbidity to the near- and offshore environment. To limit the introduction of fine sediment to the ocean, a separate feature to slurry the 'Reservoir Area' to a disposal site (via a "spur" off of the main line) was also considered. Preliminary costs for either feature were high. This measure was dismissed from further consideration.

Slurry ≤ ¼" Sediment (except 'Reservoir Area' Sediment) to Floodplain Downstream of Robles Facility- This measure would be combined with "Slurry 'Reservoir Area' Sediment to a Downstream Disposal Site" (2.1 MCY). Approximately 2.4 MCY of ¼-inch and finer sediment from the 'Delta Area' would be slurried to an open area in the floodplain downstream of the Robles Facility. The intent of this action would be to preclude fine sediment impacts to the Robles facility and to allow the placed materials to be subsequently available to erosion by flows and eventual transport to the ocean. The preliminary costs for this action were high largely due to the need to procure a substantial quantity of water and the need for additional real estate. This measure was dismissed from further consideration.

Natural Sediment Transport

Natural Transport of all Trapped Sediments - This measure would be combined with full or incremental dam removal measures. All the trapped sediment (5.9 MCY) will be transported downstream by natural (fluvial) processes. A shallow pilot channel would be excavated through the sediment to concentrate all streamflow. This measure would have the most extreme downstream flooding and water supply impacts and would require the most mitigation measures. This measure is included in the final array of alternative plans.

Natural Transport of all 'Delta Area' and 'Upstream Channel Area' Sediment – This measure would be combined with full or incremental dam removal and the slurry of 'Reservoir Area' sediments (2.1 MCY) to a disposal site. A shallow pilot channel would be excavated through the sediment to concentrate all streamflow. The fluvial transport of the remaining trapped sediments would still require a high level of protection for potential downstream flooding impacts, but potential adverse impacts to water supply are significantly reduced based on much lower turbidity levels. This measure is included in the final array of alternative plans.

On-Site Sediment Stabilization

Long-Term Transport Period – This measure would be combined with the full dam removal measure. Sediment would be stabilized within the original reservoir basin limits by the creation of multiple storage sites. The storage of sediment in upland side canyons was also considered but not pursued because the majority of land adjacent to the reservoir basin was part of the National Forest. For 'Reservoir Area' sediment, both on-site stabilization and off-site disposal via slurryline was considered. The slurryline to a downstream disposal site was preferred as this option rendered cost savings compared to on-site excavation/drying/storage of the fine sediment.

The northern side of the reservoir basin (left side, looking downstream) was chosen for locating the majority of the storage sites. This would allow for easier access for construction operations from the adjacent Matilija Road. This also allowed for slope protection to be confined to only the northern side of the channel. The southern side of the channel would be confined by the canyon slope. Refinements added another storage site on the south side of the canyon upstream limit of the 'Reservoir Area.'

A channel would be excavated to convey storm flows through the basin and to restore fish passage to the upstream pristine Matilija wilderness areas. Excavated materials ('Delta' and 'Upstream Channel' areas) would be placed into the storage sites. The channel would offer a 100-year level of protection from storm erosion. Riprap stone, grouted stone, and soil cement were all considered for slope protection. The larger materials on-site (boulders) were not sufficient in quantity. If riprap stone is used, a local quarry located a few miles from the dam site has the capability of supplying the required quantity, size and quality. The riprap stone and soil cement (using on-site aggregate) were comparable in cost. Riprap was preferred for long-term stabilization. The use of grouted stone slope protection or a reinforced concrete channel was discarded early due to concerns expressed by the EWG.

Various channel widths and alignments were evaluated for this measure to address fish passage and channel stability. Eventually, a channel with a 100-foot base width was selected to better allow for alternating alluvial bars, pools and a thalweg meander to form, conditions more diverse and favorable to fish and aquatic habitat. The channel follows the general alignment and slope of the pre-dam channel in the canyon. The side slopes would be terraced to allow for vegetation to grow and provide some shade to the channel.

This measure minimizes the risk to with-project downstream flooding and water supply impacts. This measure is included in the final array of alternative plans.

Short-Term Transport Period - This measure has some similarities to the "*Long-Term Transport Period"* measure, although stored sediments would be exposed to more frequent erosion, and hence fluvial transport downstream, during storm events. The storage sites would occupy a similar footprint as described in the previous measure and the channel configuration would also be similar for flow conveyance and fish passage. Several levels of protection were investigated for the channel to be excavated in the basin, from a capacity containing only the annual to the 10-year storm event. Several structural measures were discussed for stabilization, including the use of riprap stone and soil cement. Soil cement was preferred for short- term stabilization.

This measure seeks to limit impacts to downstream water supply, though does not limit risks to downstream flooding. This measure is also included in the final array of alternative plans.

Pool and Riffle System - This measure would require removal of most of the existing dam to the bed elevation, and a system of stabilizing structures to be constructed across the full width of the Matilija canyon. The stabilizing structures would be stair-stepped in the downstream direction with a one-foot drop at each structure to enable fish passage. The footprint of the Pool and Riffle system would span the entire canyon downstream of the dam and only a portion of the basin upstream of the dam.

The Pool and Riffle System would render the topography substantially different than pre-dam conditions. The Environmental Working Group expressed the most objections to this measure, and could not propose any changes to the preliminary design that would make this measure more environmentally acceptable. The chief objection was that the structure provides only marginal habitat and had shortcomings in functioning properly for steelhead given the dynamic nature of Matilija Creek. Therefore, this measure was dismissed from further analysis.

Additional Measures

Downstream Flood Protection - The formulation of the final alternative plans included dam removal measures. Since there is some increased risk to downstream flooding based on existing conditions, and to a lesser degree future without-project conditions, flood protection measures were added to the initial measures. These include modification to all the existing levees and construction of new levees or floodwalls, some bridges, and the acquisition of some properties. Improvements were based on offering a 100-year level of protection even though there is currently not a 100-year level of protection with all of the existing levees. During screening, leading up the final array of alternatives, levels of improvements were offered at two levels: “low level” or “high level” depending on the risk involved in the release of sediments downstream by mechanical or natural transport or stabilized sediments in-place.

The earthwork quantity necessary to construct new or modify existing levees is estimated to not exceed approximately 200,000 cubic yards for the improvements requiring greater protection (“high level”). It is assumed that the required fill may be obtained from the materials removed from Matilija Dam. There would be some trucking impacts to the community, regardless of the alternative chosen, associated with hauling materials from the dam site to the levee improvement areas downstream. The raising of any levees would also require purchase and placement of additional riprap stone protection. These measures are included in the final array of alternatives.

Downstream Water Supply Protection – The previous measures that included mechanical transport of fines or stabilization of sediments have direct benefits related to the protection of the existing downstream water supply facilities. In particular, the slurry of fines to a downstream disposal site is used to decrease potential turbidity impacts to

CMWD Robles Diversion Dam operations and ultimately to Lake Casitas. Sediment deposition is also a concern for CMWD. Measures that stabilize Matilija Dam sediment either on-site, or transport the materials off-site, reduce the amount of potential deposition in the Robles facility sediment basin and other appurtenance features.

Additional measures include increasing the storage capacity of the sediment debris basin at the Robles facility; modifying the facility to include a sediment bypass structure (radial gates) to allow sediment-laden flows to pass downstream; constructing a desilting basin to limit the potential increase in fines diverted through flows into the Robles-Casitas Canal and to Lake Casitas; and the potential purchasing of water from other sources if water diversions are temporarily interrupted from significant sedimentation impacts. Water diversions will be impacted if greater than 40,000 CY of sediment is deposited in the existing Robles facility sediment basin, causing interruptions to diversion operations to Lake Casitas. Diversion operations cannot be resumed until the sediment is cleared from the sediment basin, a regulated maintenance operation that cannot occur during the wet season. Flows with turbidity that are diverted into the canal can cause water quality problems at Lake Casitas.

Foster Park water diversions may also be impacted by sediment deposition and turbidity levels. Measures were investigated to provide alternate water sources including the purchase of water and construction of additional groundwater pumping wells.

Removal of Exotics/InvasiveSpecies - This measure includes the removal of non-native species identified in the U.S. Fish and Wildlife Service Coordination Act Report (CAR). The predominant species of concern is giant reed (*Arundo donax*). Giant reed has overwhelmed native riparian vegetation in many Southern California watersheds and provides little habitat value. The plant is very difficult to eradicate and requires active monitoring to ensure success. The total estimate of acreage affected by giant reed in the study area is about 250 acres. Giant reed could be removed by combining mechanical removal with application of herbicides.

Other suggested removal programs considered for this measure include reservoir area species such as bullfrogs, crayfish and green sunfish. This measure is combinable with other structural ecosystem restoration measures and will be considered in the final array of alternative plans.

Recreation Trails and Facilities - There is interest in providing recreational trails around the vicinity of the dam to establish a link between the Ventura River and the Matilija Wilderness. The U.S. Forest Service manages the wilderness area. There is currently no recreation offered in the vicinity of the dam. This measure could be combined with measures that remove the dam and is therefore considered in the final array of alternatives.

Basis for General Characteristics of Alternative Plans

Based on extensive coordination and interaction with the Plan Formulation Group, the Environmental Working Group and some of the other technical teams, only measures that included the removal of Matilija Dam could reasonably address restoration of access for returning anadromous fish to historic spawning and rearing habitat on Matilija Creek and its tributaries. Other fish bypass measures that did not require dam removal, such as trapping and trucking, construction of a fish ladder, a bypass tunnel for fish passage, and stocking of fish upstream of the dam were considered and dismissed based on their effectiveness, cost, and technical viability. The dam still provides a major impediment to downstream migration in all of those circumstances, except for the bypass tunnel. Steelhead could not survive the drop over the face of the existing dam during higher flow conditions when they would be migrating. Trapping the steelhead while migrating downstream somewhere upstream of the dam was not a viable measure due to the flashy nature of storm flows in the canyon. Therefore, dam removal measures are included in the final array of alternative plans to fully address the restoration of access to the 17 miles of pristine riverine habitat upstream of Matilija Dam.

Restoration of natural sand replenishment will occur in the future No Action alternative, but it is estimated that the dam will trap an additional 3 million cubic yards of sediment over the next 35 years before pre-dam volumes of coarse-grained material will be transported over the dam. Restoration of the 16 miles of sediment-starved reaches along the Ventura River is estimated to take an additional 65 years (as discussed later in this chapter under "*Evaluation of Alternative Plans, Sediment Transport, No Action Alternative*"). Measures were considered to mechanically transport the more coarse-grained sediments from above the dam to areas downstream of the dam, from directly below the dam to the ocean. It was determined that these measures could not be considered without the removal of the dam because of potential dam safety issues. The dam, in the current condition with trapped sediment behind it, is a stable structure that is not expected to required additional improvements for the next 50 years. If the sediment were removed from behind the dam, significant structural improvements would have to be made to the dam to ensure that the structure is safe. Therefore, dam removal was included as a measure in the final array of alternative measures to restore sediment transport to the beaches in far less time (10 to 20 years for the Recommended Plan) when compared to 100 years for the No Action alternative. Furthermore, mechanical removal and placement of sediment downstream along the riverine system or along the coast would provide only a temporary solution, as the mechanism of sediment replenishment from upstream of Matilija Dam would not be possible if the structure were to remain in place.

Alternative Plans

For the final array of action alternatives, features common to each include removal of Matilija Dam (either full or incremental); restoration of fish passage; reestablishment of natural hydrologic and sediment transport processes from the upper Matilija Creek watershed; management of the sediment trapped behind the dam; removal of exotic and invasive species, particularly giant reed (Arundo donax) from the original reservoir basin and in the downstream reaches of the Ventura River, and non-native predatory species from the dam lake and immediately downstream of the dam, particularly large mouth bass, sunfish, catfish, and bullfrogs; and mitigation measures for impacts to downstream flooding and to water supply. Recreation measures include trails and facilities consistent with Corps of Engineers guidance.

A brief discussion of each alternative is presented below. More details are presented in the Engineering Design Appendix. Chapter 4 presents additional information related to the recommended plan.

No Action Alternative

The No Action Alternative assumes that no ecosystem restoration measures are implemented. There would be no action taken to modify Matilija Dam from its current configuration and there would be no removal of trapped sediments from within the limits of the original reservoir. No downstream flood control improvements or other measures to limit downstream impacts attributed to additional sediment deposition or increases to turbidity levels resulting from removal of the dam would be required.

Fish passage would be restored above Robles Diversion Dam on the Ventura River in several years with the construction of the fish ladder, but for only about 4.3 miles from Robles Dam upstream along the Ventura River to the first significant fish passage obstruction on the north fork of Matilija Creek. No fish passage would be restored to the pristine juvenile and rearing habitat reaches above Matilija Dam.

Alternative 1: Full Dam Removal/Mechanical Sediment Transport: Slurry 'Reservoir Area' Sediment to Disposal Site/Sell Coarse from Dam

The dam demolition process for Alternative 1 would be conducted in one phase. Alternative 1 would slurry the 'Reservoir Area' sediment (2.1 million cubic yards) to an offsite disposal area and allow for removal of the dam. Of the remaining trapped sediment (3.8 million cubic yards), sands and gravels would be sold on site as aggregate (3.0 million cubic yards). Residual fine sediment (770,000 cubic yards), remaining after extraction of marketable aggregate, would be trucked to the offsite disposal area. Figure 3-1 presents a schematic diagram showing the primary components of this alternative.

As part of the restoration effort, giant reed would be removed from the limits of the original reservoir basin and upstream in limited areas of Reaches 8 and 9 prior to any earthmoving or dam deconstruction activity. Giant reed removal would also continue in the downstream reaches (1 through 6) as construction activities proceed.

Concrete from the dam removal would be crushed and sold on site as aggregate. Metal debris would be hauled from the site and salvaged. Non-salvageable items would be hauled to the Toland Landfill, 41 miles away, between Santa Paula and Fillmore.

All aggregate would be sold and removed from the reservoir basin by trucking. Truck routes would utilize state highways and local roads.

For the removal of fine sediment by slurry operation, this alternative assumes for cost estimating purposes that the source of water would be pumped from Lake Casitas, utilizing a constructed 8-mile long pipeline. Slurried materials would be deposited within several areas in proximity of the Highway 150 (Baldwin Road) Bridge. The areas, comprising 118 acres in the floodplain, are both upstream and downstream of the bridge and are distant from 3.6 to 6.3 miles downstream of Matilija Dam. Earthen containment dikes, with an average height of 20 feet and partially protected from riverine flows with stone, would be constructed to contain the slurried materials. Following dewatering of the slurried materials, the return effluent would be permitted to return to stream flow. A 404(b)(1) permit would be required. The upstream-most disposal area would be subject to erosion for flow events greater than the 5- to 10-year recurrence interval. Loss of limited levels of fine sediments downstream would likely occur.

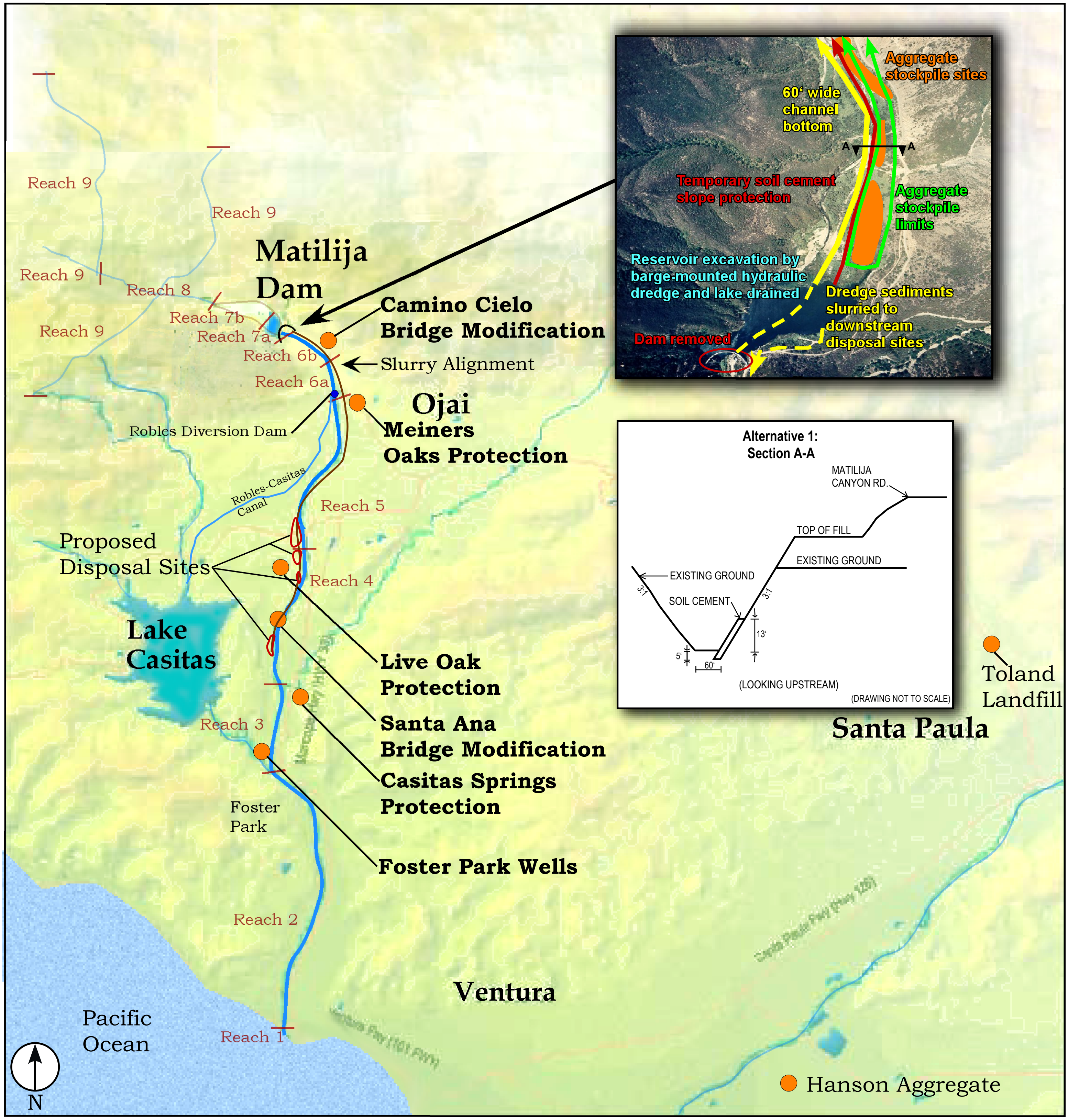
To convey flows through the reservoir basin, a 60-foot wide channel with 3:1 (horizontal to vertical) side slopes would be excavated. The channel would maintain an alignment along the southern side of the reservoir (i.e. right side, looking downstream) as adjacent as possible to the canyon wall. The channel would have a streambed elevation similar to the pre-dam streambed elevation, though the alignment would be straighter and slightly steeper. The aggregate sale stockpile would be located on the northern side of the reservoir (i.e. left side, looking downstream). To protect the sand and gravel operation during major storm events, the northern (left) side slope of the channel would be protected with an 8-foot wide soil cement revetment designed to contain a 100-year storm event. The soil cement revetment, constructed utilizing on-site aggregate, would extend 13 feet above the channel invert and 5 feet below. Following completion of the aggregate sale operation, the slope protection would be removed and the material recycled. The streambed channel configuration will subsequently be allowed to migrate naturally within the post-reservoir basin.

Downstream flood control protection would include purchase of the Matilija Hot Springs facility; purchase and removal of structures at Camino Cielo; removal/restore river channel width and replacement of Camino Cielo Bridge; extension of the Santa Ana Bridge and local river channel widening; and construction of new or raising existing levees and floodwalls at Meiners Oaks (2.8-ft average above the river bank), Live Oak and Casitas Springs (2- and 2.4-ft average, respectively, above the existing levee). The levee and floodwall at Meiners Oaks would be new features.

Modifications for sedimentation impacts at Robles Diversion Dam would include a high-flow bypass (radial sluice gates) structure to allow for evacuation of increased sediment loads at the facility debris basin resulting from removal of Matilija Dam. Modifications to the existing timber overflow weir structure would also be needed.

With the likely loss of fine sediments to riverine flows associated with at least one of the slurry disposal areas, modifications at the City of Ventura water supply facilities at Foster Park for increased turbidity impacts would include the placement of two groundwater supply wells.

This alternative is estimated to take 24 months for dam removal and slurry operations with a total time of 10 years for completion of aggregate sales and re-vegetation activities.


Aggregate stockpile sites
60' wide channel bottom
A
A
Temporary soil cement slope protection
Aggregate stockpile limits
Reservoir excavation by barge-mounted hydraulic dredge and lake drained
Dredge sediments slurried to downstream disposal sites
Dam removed
Alternative 1:
Section A-A
MATILIJA CANYON RD.
TOP OF FILL
EXISTING GROUND
EXISTING GROUND
3:1
SOIL CEMENT
3:1
13'
5'
60'
(LOOKING UPSTREAM)
(DRAWING NOT TO SCALE)
Reach 9
Reach 9
Reach 9
Reach 9
Reach 8
Reach 7b
Reach 7a
Reach 6b
Reach 6a
Matilija Dam
Camino Cielo Bridge Modification
Slurry Alignment
Ojai
Meiners Oaks Protection
Robles Diversion Dam
Robles-Casitas Canal
Reach 5
Proposed Disposal Sites
Reach 4
Lake Casitas
Live Oak Protection
Santa Ana Bridge Modification
Reach 3
Casitas Springs Protection
Foster Park
Foster Park Wells
Reach 2
Ventura
Pacific Ocean
Reach 1
N
Toland Landfill
Santa Paula
Hanson Aggregate

Alternative 2a: Full Dam Removal/Natural Sediment Transport: Slurry 'Reservoir Area' Sediment Offsite

The dam demolition process for Alternative 2a would be conducted in one phase. Alternative 2a would slurry the 'Reservoir Area' sediment (2.1 million cubic yards) to a designated downstream disposal site, remove the dam, and allow the natural flows to erode the remaining sediment trapped (3.8 million cubic yards) within the original reservoir limits. Figure 3-2 presents a schematic diagram showing the primary components of this alternative.

As part of the restoration effort, giant reed would be removed from the limits of the original reservoir basin and upstream in limited areas of Reaches 8 and 9 prior to any earthmoving or dam deconstruction activity. Giant reed removal would also continue in the downstream reaches (1 through 6) as construction activities proceed.

For the removal of fine sediment by slurry operation, this alternative assumes for cost estimating purposes that the source of water would be pumped from Lake Casitas, utilizing a constructed 8-mile long pipeline. Slurried materials would be deposited within several areas in proximity of the Highway 150 (Baldwin Road) Bridge. The areas, comprising 118 acres in the floodplain, are both upstream and downstream of the bridge and are distant from 3.6 to 6.3 miles downstream of Matilija Dam. Earthen containment dikes, with an average height of 20 feet and partially protected from riverine flows with stone, would be constructed to contain the slurried materials. Following dewatering of the slurried materials, the return effluent would be permitted to return to stream flow. A 404(b)(1) permit would be required. The upstream-most disposal area would be subject to erosion for flow events greater than the 5- to 10-year recurrence interval. Loss of limited levels of fine sediments downstream would likely occur.

Following controlled blasting of the dam, the concrete rubble would be processed as required for transportation to a commercial concrete recycling plant, assumed to be Hanson Aggregates (approximately 28 miles from Matilija Dam). Metal debris would be hauled from the site and salvaged. Non-salvageable items would be hauled to the Toland Landfill, 41 miles away, between Santa Paula and Fillmore.

Downstream flood control protection would include purchase of the Matilija Hot Springs facility; purchase and removal of structures at Camino Cielo; removal/restore river channel width and replacement of Camino Cielo Bridge; extension of the Santa Ana Bridge and local river channel widening; and construction of new or raising existing levees and floodwalls at Meiners Oaks (5-ft average above the river bank), Live Oak and Casitas Springs (6-ft and 5-ft average, respectively, above the existing levee). The levee and floodwall at Meiners Oaks would be new features.

Modifications for sedimentation impacts at Robles Diversion Dam would include a high flow bypass (radial sluice gates) structure to allow for evacuation of increased sediment loads at the facility debris basin resulting from removal of Matilija Dam. Modifications to the existing timber overflow weir structure would also be needed. In addition, a desilting basin would be included off-line to the diversion canal to allow for the settling out of increased suspended fine sediment loads associated with the removal of Matilija Dam prior to re-conveyance to the canal and final delivery to Lake Casitas.

Modifications at the City of Ventura water supply facilities at Foster Park for increased turbidity impacts from suspended fines (silts and clays) would include the placement of two groundwater supply wells.

After a large proportion of the reservoir basin has been eroded, the site will be revegetated. It is estimated that the revegetation could be completed within 10 years of initial construction operations, however this is entirely dependent on the hydrology of storm events. Dam removal and slurrying operations are estimated to take 24 months to complete.

Alternative 2b: Full Dam Removal/Natural Sediment Transport: Natural Transport of 'Reservoir Area' Sediment

As in Alternative 2a, the dam demolition process for Alternative 2b would be conducted in one phase. At the Matilija Dam site, Alternative 2b differs from Alternative 2a only in that the 'Reservoir Area' sediment would not be slurried off-site. Instead only a portion of the 'Reservoir Area' sediment (approximately 0.5 million cubic yards) necessary to ensure safe removal of the dam in one phase would be excavated by clam shell dredging. This dredged sediment would be placed upstream within the basin and allowed to be naturally eroded by fluvial processes with the other trapped sediment. Figure 3-3 presents a schematic diagram showing the primary components of this alternative.

Alternative 2b features associated with giant reed eradication in the reservoir, structural removal of the dam, downstream flood mitigation measures, and modifications at Robles Diversion Dam (with the exception of a desilting basin) and Foster Park diversion are similar to Alternative 2a. In addition however, increased impacts at the Robles Diversion facility resulting in missed water diversion opportunities (for up to 8 years) to Lake Casitas necessitates the procurement of up to 48,000 acre-ft of water for Casitas Municipal Water District from other water purveyor sources.

While removal of the trapped sediment by natural fluvial processes will be variable and dependent on the hydrology, it is estimated that the time for completion including re-vegetation could be within 10 years of initial construction operations. Dam removal would require approximately 24 to 30 months.


Reach 9
Reach 9
Reach 9
Reach 9
Reach 8
Reach 7b
Reach 7a
Reach 6b
Reach 6a
Reach 5
Reach 4
Reach 3
Reach 2
Reach 1
Matilija Dam
Camino Cielo Bridge Modification
Slurry Alignment
Ojai
Meiners Oaks Protection
Robles Diversion Dam
Proposed Desilting Basin Site
Robles-Casitas Canal
Proposed Disposal Sites
Lake Casitas
Live Oak Protection
Santa Ana Bridge Modification
Casitas Springs Protection
Foster Park
Foster Park Wells
Pacific Ocean
Ventura
Santa Paula
Toland Landfill
Hanson Aggregate
N
Trapped sediment to be removed by natural processes
Reservoir excavation by barge-mounted hydraulic dredge and lake drained
Dredged sediments slurried to downstream disposal sites
Dam removed


Reach 9
Reach 9
Reach 9
Reach 9
Matilija Dam
Reach 8
Reach 7b
Reach 7a
Reach 6b
Reach 6a
Camino Cielo Bridge Modification
Ojai
Robles Diversion Dam
Meiners Oaks Protection
Trapped sediment to be removed by natural processes
Low flow bypass prevents erosion of fines during non-storm flows and drains lake
Excavated sediments deposited upstream
Sediments behind dam excavated by barge-mounted clam shell
Dam removed
Reach 5
Reach 4
Lake Casitas
Live Oak Protection
Santa Ana Bridge Modification
Casitas Springs Protection
Reach 3
Foster Park
Foster Park Wells
Toland Landfill
Santa Paula
Reach 2
Ventura
Pacific Ocean
Reach 1
N
Hanson Aggregate

Alternative 3a: Incremental Dam Removal/Natural Sediment Transport: Slurry 'Reservoir Area' Sediment Offsite

The dam demolition process for Alternative 3a would be conducted in two phases. For Phase 1, the 'Reservoir Area' sediment (2.1 million cubic yards) would be slurried to a designated downstream site, and then the dam structure above elevation 1000 feet would be removed. The remaining trapped sediment behind the dam would be allowed to erode by natural fluvial processes. Once the trapped sediment reaches equilibrium with the modified dam height, the remainder of the dam would be removed in Phase 2. Following Phase 2 removal, the remaining trapped sediment would be allowed to erode by natural fluvial processes. Figure 3-4 presents a schematic diagram showing the primary components of this alternative.

As part of the restoration effort, giant reed would be removed from the limits of the original reservoir basin and upstream in limited areas of Reaches 8 and 9 prior to any earthmoving or dam deconstruction activity. Giant reed removal would also continue in the downstream reaches (1 through 6) as construction activities proceed.

For the removal of fine sediment by slurry operation, this alternative assumes for cost estimating purposes that the source of water would be pumped from Lake Casitas, utilizing a constructed 8-mile long pipeline. Slurried materials would be deposited within several areas in proximity of the Highway 150 (Baldwin Road) Bridge. The areas, comprising 118 acres in the floodplain, are both upstream and downstream of the bridge and are distant from 3.6 to 6.3 miles downstream of Matilija Dam. Earthen containment dikes, with an average height of 20 feet and partially protected from riverine flows with stone, would be constructed to contain the slurried materials. Following dewatering of the slurried materials, the return effluent would be permitted to return to stream flow. A 404(b)(1) permit would be required. The upstream-most disposal area would be subject to erosion for flow events greater than the 5- to 10-year recurrence interval. Loss of limited levels of fine sediments downstream would likely occur.

Following controlled blasting of the dam in each phase, the concrete rubble would be processed as required for transportation to a commercial concrete recycling plant, assumed to be Hanson Aggregates (approximately 28 miles from Matilija Dam). Metal debris would be hauled from the site and salvaged. Non-salvageable items would be hauled to the Toland Landfill, 41 miles away, between Santa Paula and Fillmore.

Downstream flood control protection would include purchase of the Matilija Hot Springs facility; purchase and removal of structures at Camino Cielo; removal/restore river channel width and replacement of Camino Cielo Bridge; extension of the Santa Ana Bridge and local river channel widening; and construction of new or raising existing levees and floodwalls at Meiners Oaks (5-ft average above the river bank), Live Oak and Casitas Springs (6-ft and 5-ft average, respectively, above the existing levee). The levee and floodwall at Meiners Oaks would be new features.

Modifications for sedimentation impacts at Robles Diversion Dam would include a high-flow bypass (radial sluice gates) structure to allow for evacuation of increased sediment loads at the facility debris basin resulting from removal of Matilija Dam. Modifications to the existing timber overflow weir structure would also be needed. In addition, a desilting basin would be included off-line to the diversion canal to allow for the settling out of increased suspended fine sediment loads associated with the removal of Matilija Dam prior to re-conveyance to the canal and final delivery to Lake Casitas.

Modifications at the City of Ventura water supply facilities at Foster Park for increased turbidity impacts from suspended fines (silts and clays) would include the placement of two groundwater supply wells.

It is estimated that this alternative would require approximately 18 months to complete the Phase I removal of the 'Reservoir Area' sediment and the dam. While removal of the remaining sediments will be variable and dependent upon the hydrology, it is estimated under wet year conditions that Phase II could be initiated as early as two years after completion of Phase I. Re-vegetation could be completed as early as 10 years after notice to proceed.

Alternative 3b: Incremental Dam Removal/Natural Sediment Transport: Natural Transport of 'Reservoir Area' Sediment

As in Alternative 3a, the dam demolition process for Alternative 3b would be conducted in two phases. For Phase 1, a portion of the 'Reservoir Area' sediment (approximately 300,000 cubic yards) necessary to ensure safe removal of the dam to elevation 1030 would be excavated by clam shell dredging. This dredged sediment would be placed upstream within the basin and allowed to be naturally eroded by fluvial processes with the other trapped sediment. A small pilot channel, no greater than 10 feet deep, would be excavated to initially convey flows through the reservoir basin. Once the trapped sediment reaches equilibrium with the modified dam height, the remainder of the dam would be removed in Phase 2. Following Phase 2 removal, the remaining trapped sediment would be allowed to erode by natural fluvial processes. Figure 3-5 presents a schematic diagram showing the primary components of this alternative.

Alternative 3b features associated with giant reed eradication in the reservoir, structural removal of the dam, downstream flood mitigation measures, and modifications at Robles Diversion Dam (with the exception of a desilting basin) and Foster Park diversion are similar to Alternative 3a. In addition however, increased impacts at the Robles Diversion facility resulting in missed water diversion opportunities (for up to 8 years) to Lake Casitas necessitates the procurement of up to 48,000 acre-ft of water for Casitas Municipal Water District from other water purveyor sources.

While removal of the trapped sediment by natural fluvial processes will be dependent on the hydrology, it is estimated under wet year conditions that the time for completion including re-vegetation could occur within 10 years of initial construction operations.

Alternative 3a

Alternative 3b

Alternative 4a Full Dam Removal/On-Site Sediment Stabilization: Long-Term Transport Period

The dam demolition process for Alternative 4a would be conducted in one phase.

Alternative 4a would slurry the 'Reservoir Area' sediment (2.1 million cubic yards) to the designated downstream disposal site and allow for removal of the dam. The remaining trapped sediment would be stabilized within the original reservoir basin limits.

A channel with a 100-foot wide base width would be excavated within the original reservoir basin following an alignment similar to the 1947 "pre-dam" alignment. The invert (bottom) of the excavated channel would be to pre-dam elevation and similar gradient. The channel would have a design capacity to convey the 100-year level flood event. Side slopes would be 3:1 (horizontal to vertical). The slope protection, consisting of riprap stone (ungrouted), would extend 11 feet above channel invert and 5 feet below the channel invert to prevent undermining of the revetment. Sediment excavated from the channel would be permanently placed in storage locations within the original reservoir limits. Figure 3-6 presents a schematic diagram showing the primary components of this alternative.

As part of the restoration effort, giant reed would be removed from the limits of the original reservoir basin and upstream in limited areas of Reaches 8 and 9 prior to any earthmoving or dam deconstruction activity. Giant reed removal would also continue in the downstream reaches (1 through 6) as construction activities proceed.

For the removal of fine sediment by slurry operation, this alternative assumes for cost estimating purposes that the source of water would be pumped from Lake Casitas, utilizing a constructed 8-mile long pipeline. Slurried materials would be deposited within several areas in proximity of the Highway 150 (Baldwin Road) Bridge. The areas, comprising 118 acres in the floodplain, are both upstream and downstream of the bridge and are distant from 3.6 to 6.3 miles downstream of Matilija Dam. Earthen containment dikes, with an average height of 20 feet and partially protected from riverine flows with stone, would be constructed to contain the slurried materials. Following dewatering of the slurried materials, the return effluent would be permitted to return to stream flow. A 404(b)(1) permit would be required. The upstream-most disposal area would be subject to erosion for flow events greater than the 5- to 10-year recurrence interval. Loss of limited levels of fine sediments downstream would likely occur.

Concrete rubble from the dam removal would be buried in the storage area fills. Metal debris would be hauled from the site and salvaged. Non-salvageable items would be hauled to the Toland Landfill, 41 miles away, between Santa Paula and Fillmore.

Downstream flood control protection would include purchase of the Matilija Hot Springs facility; purchase and removal of structures at Camino Cielo; removal/restore river channel width and replacement of Camino Cielo Bridge; extension of the Santa Ana Bridge and local river channel widening; and construction of new or raising existing levees and floodwalls at Meiners Oaks (2.8-ft average above the river bank), Live Oak and Casitas Springs (2- and 2.4-ft average, respectively, above the existing levee). The levee and floodwall at Meiners Oaks would be new features.

Modifications for sedimentation impacts at Robles Diversion Dam would include a high-flow bypass (radial sluice gates) structure to allow for evacuation of increased sediment loads at the facility debris basin resulting from removal of Matilija Dam. Modifications to the existing timber overflow weir structure would also be needed.

With the likely loss of fine sediments to riverine flows associated with at least one of the slurry disposal areas, modifications at the City of Ventura water supply facilities at Foster Park for increased turbidity impacts would include the placement of two groundwater supply wells.

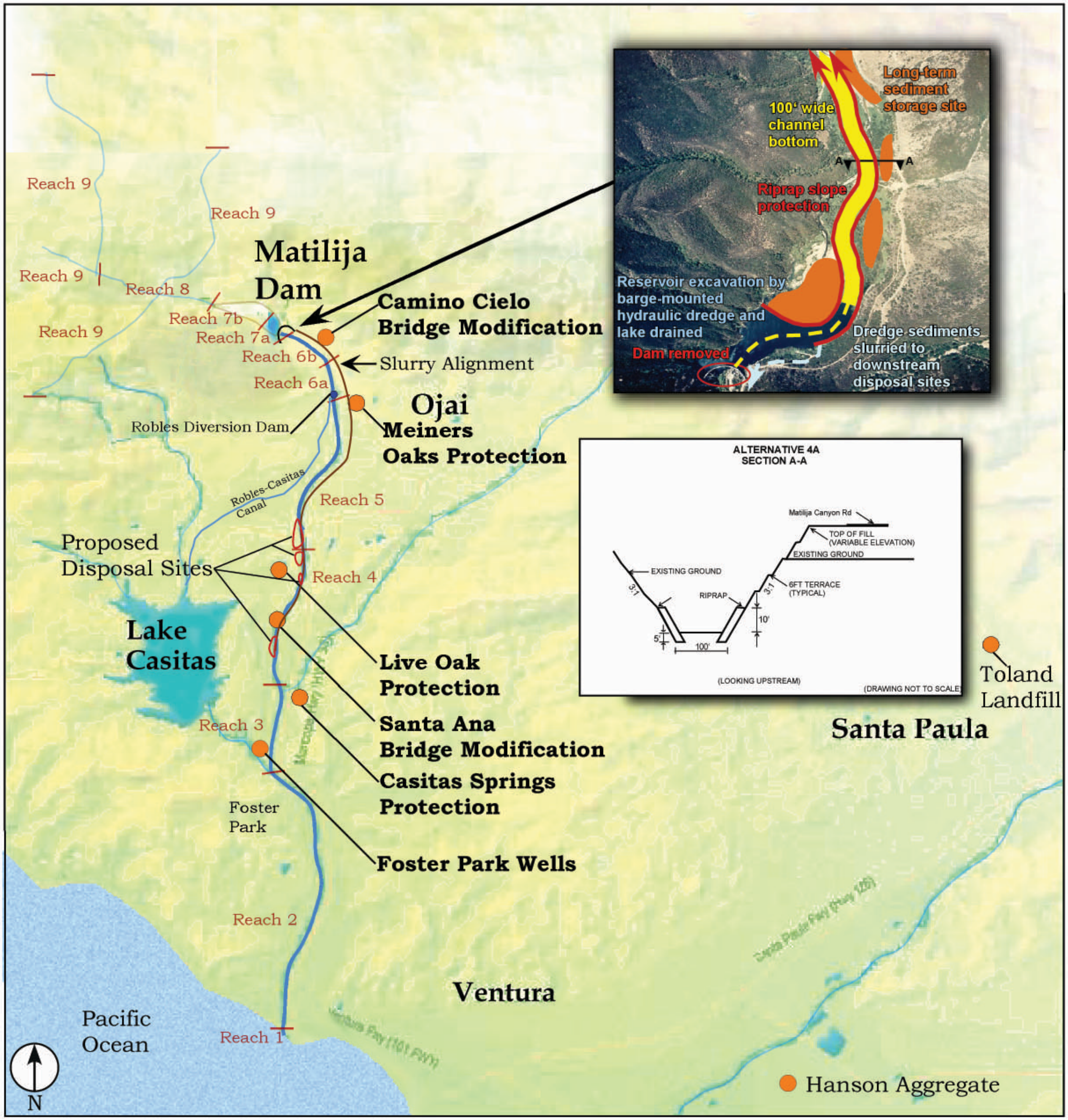
This alternative is estimated to take 3 years to complete, including slurrying the 'Reservoir Area' sediment, removal of the dam, channel excavation, riprap stone protection placement, and re-vegetation.

Alternative 4b Full Dam Removal/On-Site Sediment Stabilization: Short-Term Transport Period

The dam demolition process for Alternative 4b would be conducted in one phase. Alternative 4b would slurry the 'Reservoir Area' sediment (2.1 million cubic yards) to a designated downstream disposal site and allow for removal of the dam. The remaining trapped sediment would be temporarily stabilized within the original reservoir basin limits.

For the removal of fine sediment by slurry operation, this alternative assumes for cost estimating purposes that the source of water would be pumped from Lake Casitas, utilizing a constructed 8-mile long pipeline. Slurried materials would be deposited within several areas in proximity of the Highway 150 (Baldwin Road) Bridge. The areas, comprising 118 acres in the floodplain, are both upstream and downstream of the bridge and are distant from 3.6 to 6.3 miles downstream of Matilija Dam. Earthen containment dikes, with an average height of 20 feet and partially protected from riverine flows with stone, would be constructed to contain the slurried materials. Following dewatering of the slurried materials, the return effluent would be permitted to return to stream flow. A 404(b)(1) permit would be required. The upstream-most disposal area would be subject to erosion for flow events greater than the 5- to 10-year recurrence interval. Loss of limited levels of fine sediments downstream would likely occur.

Alternative 4a



A channel with a 100-foot wide base width and side slopes of 3:1 (horizontal to vertical) would be excavated within the original reservoir basin following an alignment similar to the 1947 “pre-dam” alignment. The invert (bottom) of the excavated channel would be to pre-dam elevation and similar gradient. Sediment excavated from the channel would be placed in storage site locations within the reservoir basin, and also within the area previously occupied by the ‘Reservoir Area’ sediment (following completion of slurrying operations). All sediment excavated from the “Delta Area’ would be placed (stored) within the lower half of the reservoir basin. The ‘Delta Area’ materials contain the majority of the residual portions of the finer sediment trapped in the basin. Sediments within the original reservoir basin would be subject to natural erosion and transport downstream by stream flows. Selective segments of the channel within the lower half of the reservoir basin would be protected with soil cement revetment. The purpose of the revetment is to “meter” the erosion of the ‘Delta Area’ sediment whenever the revetment is overtopped by larger flows. The height of the revetment would extend 7 feet above the channel invert and 5 feet below the invert to prevent undermining of the structure. The revetment height would be overtopped by flows exceeding a 10-year storm event (12,500 ft^3/sec). At the upstream end of the soil cement revetment, a tie-in to the adjacent canyon slope or road embankment would be required to prevent circumventing of the structure by breakout channel flows. The tie-in could consist of either soil cement or larger boulders (collected from on-site). Coarser-grained materials within the reservoir basin located upstream of the revetment (i.e. within the ‘Upstream Channel Area’) would remain unprotected and subject to natural erosion by stream flow.

The soil cement revetment would be constructed utilizing aggregate available on site. All soil cement revetment would be removed from the site following sufficient evacuation of trapped sediment from the reservoir basin. The removal would occur in stages, and will be dependent on criteria established in the monitoring and adaptive management plan taking into account levels of sediment evacuation and limiting adverse effects downstream. Complete removal is expected to occur within 20 years. Figure 3-7 presents a schematic diagram showing the primary components of this alternative.

As part of the restoration effort, giant reed would be removed from the limits of the original reservoir basin and upstream in limited areas of Reaches 8 and 9 prior to any earthmoving or dam deconstruction activity. Giant reed removal would also continue in the downstream reaches (1 through 6) as construction activities proceed.

Following controlled blasting of the dam, the concrete rubble would be processed as required for transportation to a commercial concrete recycling plant, assumed to be Hanson Aggregates (approximately 28 miles from Matilija Dam). Metal debris would be hauled from the site and salvaged. Non-salvageable items would be hauled to the Toland Landfill, 41 miles away, between Santa Paula and Fillmore.

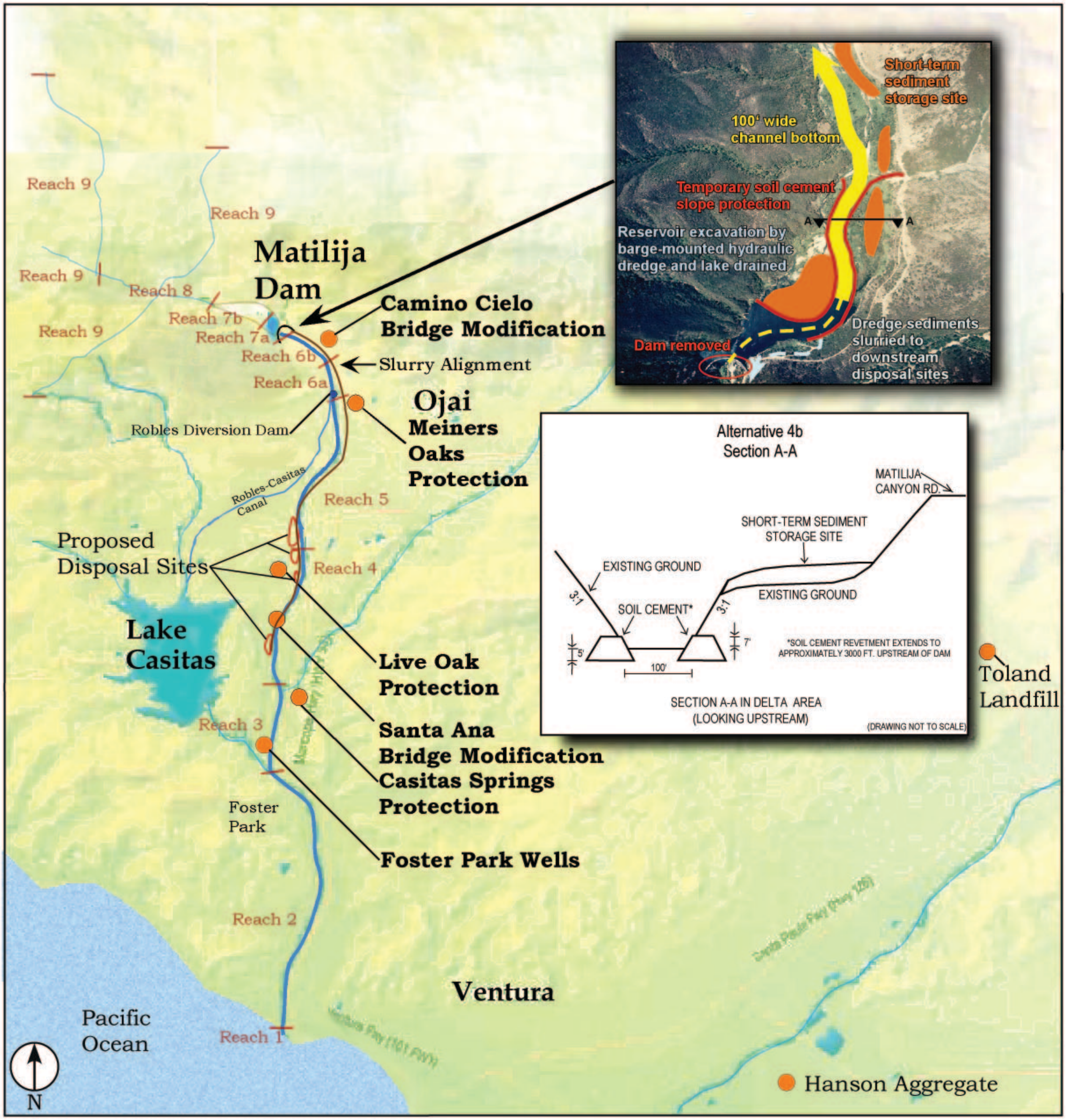
Downstream flood control protection would include purchase of the Matilija Hot Springs facility; purchase and removal of structures at Camino Cielo; removal/restore river channel width and replacement of Camino Cielo Bridge; extension of the Santa Ana Bridge and local river channel widening; and construction of new or raising existing levees and floodwalls at Meiners Oaks (5-ft average above the river bank), Live Oak and

Casitas Springs (6-ft and 5-ft average, respectively, above the existing levee). The levee and floodwall at Meiners Oaks would be new features.

Modifications for sedimentation impacts at Robles Diversion Dam would include a high flow bypass (radial sluice gates) structure to allow for evacuation of increased sediment loads at the facility debris basin resulting from removal of Matilija Dam. Modifications to the existing timber overflow weir structure would also be needed.

Modifications at the City of Ventura water supply facilities at Foster Park for increased turbidity impacts from suspended fines (silts and clays) would include the placement of two groundwater supply wells.

It is estimated that this alternative would require approximately 3 years to complete the slurrying operation of the 'Reservoir Area' sediment, removal of the dam, excavation of the channel, and construction of the soil cement revetment. While removal of the remaining trapped sediment will be variable and dependent upon the hydrology and natural fluvial processes, it is assumed that the re-vegetation phase within portions of the reservoir basin may be commenced within 10 years of initial earthmoving and deconstruction activities; other portions of the reservoir basin could require as long as 20 years.


Short-term sediment storage site
100' wide channel bottom
Temporary soil cement slope protection
Reservoir excavation by barge-mounted hydraulic dredge and lake drained
Dam removed
Dredge sediments slurried to downstream disposal sites
Alternative 4b
Section A-A
MATILIJA CANYON RD.
SHORT-TERM SEDIMENT STORAGE SITE
EXISTING GROUND
EXISTING GROUND
SOIL CEMENT*
3:1
3:1
5'
7'
100'
*SOIL CEMENT REVETMENT EXTENDS TO APPROXIMATELY 3000 FT. UPSTREAM OF DAM
SECTION A-A IN DELTA AREA
(LOOKING UPSTREAM)
(DRAWING NOT TO SCALE)
Matilija Dam
Camino Cielo Bridge Modification
Slurry Alignment
Ojai
Meiners Oaks Protection
Robles Diversion Dam
Robles-Casitas Canal
Proposed Disposal Sites
Lake Casitas
Live Oak Protection
Santa Ana Bridge Modification
Casitas Springs Protection
Foster Park
Foster Park Wells
Toland Landfill
Ventura
Pacific Ocean
Reach 9
Reach 9
Reach 9
Reach 9
Reach 8
Reach 7b
Reach 7a
Reach 6b
Reach 6a
Reach 5
Reach 4
Reach 3
Reach 2
Reach 1
N
Hanson Aggregate

Evaluation of Alternative Plans

The evaluation of the alternatives allows assessment and appraisal of the effects of the with-project conditions of each plan, and comparison to the future without project conditions. Specific criteria to be used in the evaluation of the alternatives, deemed the most important by the Sponsor, the Corps, Reclamation, participating environmental resource agencies and interest groups, and other stakeholders, are then used to compare the various plans against each other. The criteria established to be the most important in the evaluation of the alternatives and associated mitigation or restoration measures are presented below.

Sediment Impacts and Mitigation/Restoration Measures

Sediment Transport
- Downstream Riverine Deposition and Turbidity
- Flooding
- Beach Nourishment and Sediment Yield to the Ocean

Environmental Resources
- Dam Site Topography
- Biological Resources
- Cultural Resources
- Air Quality, Noise, and Traffic

Water Supply
- Water Source Need for Slurry Operation
- Robles Diversion Dam and Lake Casitas
- Foster Park
- Groundwater

Sediment Transport

Prior to describing sediment transport impacts and mitigation measures for the alternatives, a brief discussion of the *hydrologic input* to numerical models utilized in the evaluation of the alternatives will be presented. Various approaches for hydrologic input were considered depending on the assessed impact: downstream riverine deposition, turbidity, flooding, or sediment yield to the ocean.

<u>Riverine Deposition</u> The hydrologic input used to evaluate the long-term sediment depositional trends (including at Robles Diversion Dam) for the alternatives is a 50-year simulation utilizing a relatively wet period hydrograph of storm events from 1991 to 2001, repeated five times (see Figure 2-14). The hydrologic simulation does not include any events larger than the 20-year return period (5 percent exceedance). From a depositional perspective, large flood events (exceeding a 20-year return period) may actually produce less depositional effects downstream, as there may be more sediment transport to the ocean. The largest flows in the selected period occurred in 1992 and 1995 (approximately 20-year recurrence floods), and 1998 (approximately a 15-year

recurrence flood). The remaining flow events were between 2 and 7 yrs; two were less than the 2-yr event. Flow data from 1991 to 2001 has 15-minute intervals available, allowing sufficient representation of the rapidly varying flow conditions characteristic of the Ventura River. For establishing riparian habitat impacts as a result of riverine deposition and ensuing habitat recovery time periods, the results of the modeling prediction utilizing this established 50-yr simulation are appropriate. This information was utilized in the HEP assessment.

Turbidity Turbidity levels and durations associated under with-project conditions were also evaluated. Turbidity is the measurement of the suspended fine sediment (silts, clays, and fine sands) in the stream flow. Impacts due to increases in turbidity levels over existing or without-project conditions are of concern for the natural transport alternatives. The evaluation assessed the effects of a wet hydrograph, utilizing single back-to-back storm events (for a 3 to 4-year recurrence flood (1991 event) and a 15-year recurrence flood (1998 event)) and a dry hydrograph taken over a drought period (1954 to 1960). The latter hydrograph was evaluated because drought periods can cause the turbidity levels to persist longer, as the erosion capacity of lower flows is more limited to finer sediment (if readily available).

Flood Protection For with-project flooding mitigation, two approaches for hydrologic input were utilized. A preliminary assessment conducted for the purposes of evaluation and comparison of flood protection measures for the alternatives utilized a 50-yr simulation (described above) with the hydrologic record of the 1990's. This was then followed by a risk and uncertainty analysis that considered the hydrologic uncertainty attributed to the discharge-frequency relationships at selected river mile stations. Further discussion pertaining to flood protection is presented in "*Flood Protection Improvements,*" in the latter part of this section.

Sediment Yield to the Ocean An assessment of sediment yield to the ocean considered the results provided by sediment transport modeling utilizing the 1990 storms. However, limitations of the model with respect to representation of the dynamic estuary conditions precluded its sole use. The sediment delivery assessment depended largely on historical data and the factoring in of the sediment trapped behind Matilija Dam.

Downstream Deposition and Turbidity

The construction of Matilija Dam has contributed to the significant erosion that has occurred in the Ventura River. The channel elevation has decreased in some reaches over 10 feet. The removal of the dam would re-supply sediment downstream and change the trends in the river, most notably in the 8.5 miles between the dam and San Antonio Creek confluence, from degradational to aggradational. The deposition would continue until equilibrium of sediment supply in the riverine system is reached. A state of equilibrium occurs when the sediment entering the river system is in close balance with the sediment leaving the system. The equilibrium condition will be similar to that of the pre-dam condition. Each alternative will eventually reach equilibrium though the time frame will vary. Even if the dam was not removed (the No Action Alternative), at some time in the future all new sediment entering the reservoir would spill over the top and a replenishment process would be fully under way. Degradational trends would still likely however continue in Reach 2 (between river mile 5.5 and 3), though at slower rate depending on the action alternative. The main cause for erosion in this incised reach is channel constriction by bridges and the sediment trapping by Casitas Dam on the Coyote Creek tributary and the San Antonio Creek Watershed debris basins.

The deposition would re-create a riverine morphology similar to pre-dam conditions in terms of channel form characteristics, channel geometry, and riverbed material. However the aggradation may also cause flooding problems. There has been much infrastructure developed along the river corridor since the construction of the dam and some of these developments have come to depend upon the current river condition to prevent flooding. The process of returning the river to pre-dam conditions will increase the flooding risk of many of these structures. The level of flood risk is dependent on the alternative.

Depositional effects associated with the alternatives will be described below. Modeling results show that depositional levels for all the alternatives decrease in the downstream direction. The estuary reach is not expected to receive more than approximately 1 foot of deposition of sand, regardless of the alternative, over the 50-year period of analysis.

Associated with the removal of Matilija Dam is the increase above baseline conditions of turbidity levels in river flows following storm events. The impact varies according to the alternative and depends on whether all, a portion of, or no trapped fine (silts, clays, and fine sand) sediments are allowed to be naturally transported downstream, and also on the duration and rate of flows.

Following are the effects of the alternatives to hydraulic and sediment transport impacts.

No Action Alternative

Presently when a storm flow overtops the dam, of the sediment entering the Matilija Reservoir, fine sediment (mostly silts and clays) will be carried with the flows downstream. The coarser sediment entering Matilija Reservoir is still largely trapped behind the dam. With time, as the reservoir becomes more filled with sediment, these overtopping flows will contain greater amounts of coarser sediment. By approximately year 2040, after reservoir equilibrium is attained, sand and gravel size sediment entering the reservoir from the watershed will fully contribute to sediment loads passing over the dam. The erosional trend in the riverine system downstream will gradually become a depositional trend. Only in Reach 2 will this depositional trend not occur as this reach is controlled by local geologic features (This is the case for all the alternatives).

Under the No Action Alternative, it is estimated that it will take approximately 100 years for the Ventura River to be reach equilibrium. For the reaches between Matilija Dam and Robles Diversion Dam, this equilibrium will occur in approximately 50 to 70 years.

At Robles Diversion Dam, levels of deposition in the sediment basin (based on sediment removal records between 1966 and 1998) average about 13,300 cubic yards/year (yd^3/yr). Deposition however is highly variable and can range between practically zero during dry years to over 90,000 yd^3/yr for very large events (such as the 100-yr recurrence floods of 1969 and 1978). Based on model simulations (1991- 2001 hydrologic record), in the first year deposition at Robles Diversion Dam could reach 20,000 cubic yards. The main source of coarse sediment is currently from North Fork Matilija Creek. With future contributions from Matilija Creek coarse sediment, and eventual attainment of equilibrium in the upper reach, average annual deposition at Robles is expected to be two times the current average (26,600 yd^3/yr). Maintenance requirements would increase.

Under the No Action Alternative, it is estimated that fine sediment concentrations and associated turbidity levels downstream will increase by approximately 30 percent once the existing lake fills in (by approximately year 2020). Currently during storm events, silts and clays are transported with flows whenever the reservoir spills. The downstream reaches therefore experience approximately natural concentrations of fine sediment. These concentrations vary, according to flood flow (measured at Foster Park), between 10,000 mg/l (5000 ft^3/sec) to 1,000 mg/l (100 ft^3/sec). Natural fluctuation however may vary by a factor of two or more.

Alternative 1

For Alternative 1, all of the trapped sediment, 5.8 million cubic yards, will be mechanically removed from the riverine system (i.e., slurrying of 'Reservoir Area' sediment, 2.1 million cubic yards; sale of marketable aggregate by truck, 3.0 million cubic yards; trucking residual fines from the aggregate sale operations, 770,000 cubic yards). Unrestricted sediment from Matilija Creek watershed will gradually allow a natural re-supply of sediment to the downstream reaches. The complete return of the riverine system to pre-dam conditions will take approximately as long as the amount of time it took to degrade the river, or about 50 years. The reaches upstream of Robles Diversion Dam could reach a state of dynamic equilibrium within 10 years, assuming average hydrologic conditions prevail.

The deposition at Robles Diversion Dam is expected to increase by a factor of two- a magnitude similar to the No Action Alternative since in both cases trapped sediment behind Matilija Dam is not allowed downstream into the riverine system. The difference is that the increase under Alternative 1will occur sooner (within 10 years) than under the No Action Alternative (after 50 to 70 years). Maintenance efforts at the Robles facility would increase immediately.

Turbidity concentrations in the Ventura River upstream of the slurry disposal site will not significantly change over existing conditions, and can be expected to be similar to the No Action Alternative. At the slurry disposal site however (vicinity of Highway 150 Bridge), the upstream-most area is subject to erosion at flood events greater than the 5- to 10-year recurrence interval. There will likely be some erosion of fines into the riverine system if the containment dike is overtopped or if loss of any portion of the structure occurs. With time, a level of resistance to erosion would occur as vegetation becomes more established. It is expected that the majority of any eroded fine material however would be transported to the ocean. The other three disposal areas downstream of the bridge are located on higher floodplain terraces, and are not prone to flooding in events less than the 50- to 100-year level.

Alternative 2a

Alternative 2a slurries the 'Reservoir Area' sediment (2.1 million cubic yards) to the downstream disposal site, removes the dam in one phase, and allows the natural flows to erode the remaining sediment trapped within the original reservoir limits. When significant flows start to erode this material, rapid downcutting will cut a narrow deep channel through the material, followed by a slower and gradual widening of the channel. The rate of widening will be dependent upon bank stability and storm flow event. It is estimated that in the first year, approximately 1.0 million cubic yards of sediment could be eroded from the basin. The pre-dam thalweg within Reach 7 would essentially be re-established. The initial years could produce the most deposition downstream, especially in the upper reaches. It is estimated that the riverine system could reach a state of dynamic equilibrium within 10 years, assuming average hydrologic conditions prevail. If a dry period prevailed, as for example occurred during the 1940's Ventura River hydrologic record, the period necessary to reach equilibrium would be prolonged.

It is expected that the majority of the remaining trapped sediment in the original reservoir will eventually be eroded. The rate and extent of erosion at any time will depend on the hydrology and channel migration. A very large storm event, such as the 1969 flood, could potentially mobilize the remainder of the trapped sediment.

The outcome of the rapid downcutting stage will be an initial oversupply of sediment and aggradation to the downstream reaches. Some portions of reaches that have been significantly eroded, such as downstream of Robles Diversion Dam, can be expected to return to pre-dam conditions in a relatively short time frame. At some locations, aggradation levels may exceed pre-dam elevations. At these locations, the effects may be temporary, or the river may equilibrate at a slightly higher elevation. The deposition levels downstream would be monitored periodically to insure that deleterious effects could be minimized through mitigation measures. The growth of vegetation would also tend to stabilize these areas for a longer period of time. Relative depths of aggradation will decrease in the downstream direction.

Large amounts of sediment will deposit in the sediment basin area at Robles Diversion Dam. Deposition quantities will be dependent on the storm magnitudes following Matilija Dam removal. Based on model simulations, in the first year, deposition at Robles Diversion Dam could reach 70,000 cubic yards. Deposition volumes greater than 40,000 cubic yards will effectively shut down diversion operations. During the first few floods, sediment eroded from Matilija Reservoir could fill the sediment basin at the Robles Diversion facility and, without any maintenance intervention, spill over the diversion dam sluice gate crest.

For turbidity increases resulting from the removal of Matilija Dam, it is expected that levels at the Robles facility will not be excessive since the majority of fine sediments that were trapped at Matilija Dam have been slurried downstream of the diversion facility. The residual proportion of silt and clay remaining in the reservoir basin is a relatively small portion (about 20% or 770,000 cubic yards) of the total quantity of remaining trapped sediment within the 'Delta Area' and the 'Upstream Channel Area.' Before the flows of an average magnitude storm passes through the reservoir basin, turbidity levels are estimated to be between 2 to 10 times higher than No Action conditions. After the storm peak, turbidity levels will decrease to 2 to 4 times No Action conditions. These levels would be considered within the range of natural fluctuation under baseline conditions. After a period of three years, or just after one storm with a return period greater than 10 years, the increase in turbidity levels is expected to reduce to 10 to 50 percent greater than the No Action Alternative. Between 5 and 10 years, concentrations will be similar to the No Action Alternative. The duration and levels of turbidity increases associated with the trapped sediments however may be prolonged should an extended drought period prevail.

It is expected that turbidity increases will also be associated with at least one of the slurry disposal site areas, as described for Alternative 1.

Alternative 2b

Alternative 2b differs from Alternative 2a in that the 'Reservoir Area' sediment (typically silt) remains on-site and is allowed to be naturally eroded with the other trapped materials. However, as in Alternative 2a, erosion from Matilija Reservoir and deposition downstream is significant. From the reservoir, approximately 2.0 million cubic yards of sediment (twice the volume of erosion in the first year of Alternative 2a) could be eroded in the first year. The pre-dam thalweg will be re-established within the first year. The initial years could produce the most deposition downstream, especially in the upper reaches. Deposition at Robles Diversion Dam could reach 80,000 cubic yards in the first year following dam removal. It is estimated that the riverine system could reach a state of dynamic equilibrium within 10 years, assuming average hydrologic conditions prevail.

Turbidity will be exceedingly high immediately after the first storm flow following dam removal. The concentration of fine sediments downstream will be greater than 100,000 mg/l for a period of days to weeks, depending on flow rates. The higher the flow rate, the more sediment is eroded. Typical concentrations may remain 10 times higher than with the dam in place for a period of up to two years, depending on flow rates. Concentrations thereafter would decrease to levels up to 4 times natural conditions. (If one flood of average magnitude (2-year event) however were to occur, the concentrations would decrease to two to three times the levels experienced with the dam in place. These slightly higher than normal concentrations would persist for up to two more years, after which time the concentrations would return to normal levels.) After 10 years of average hydrology, the concentrations will not be significantly different from the No Action Alternative.

Alternative 3a

In the first phase of Alternative 3a, 'Reservoir Area' sediment (2.1 million cubic yards) is slurried to the downstream disposal site, and the initial portion of the dam is removed. A period follows when storm flows are allowed to erode trapped sediment until equilibrium is reached with the modified dam height. The remainder of the dam is removed entirely in the second phase. Remaining trapped sediment is then allowed to be eroded by flows and transported downstream.

Initiation of the second phase of dam removal could occur as early as the second year- if hydrologic conditions were consistent with the assumption of the 50-year simulation based on the wet period hydrographic input (described earlier in this subsection). However, if the region is experiencing drought conditions, (such as the hydrology similar to the 1940's) the period of removal between the first and the second phase would be prolonged. Should intermittent smaller storms re-deposit more sediment in previously evacuated areas within the reservoir limits, then the period between the first and second removal would be extended more.

Alternative 3a has a greater measure of control over the impacts of deposition, allowing monitoring upstream and downstream to the riverine environment and flood control system. For example, if more deposition occurred than acceptable at a particular location after the first phase of removal, it would be possible to mechanically remove that sediment from the stream channel before the remainder of the dam is removed. As an option to full removal of the remaining portion of the dam in the second phase, another increment could be removed if found to be warranted. Under average hydrologic conditions, it is estimated that the riverine system could establish equilibrium conditions within 10 years.

Erosion from Matilija Reservoir will be less than Alternative 2a during the first year since the dam is still in place (approximately 770,000 cubic yards). However, after the third year, the total amount of sediment eroded from the reservoir will be similar to Alternative 2a. Depositional trends downstream are similar to, though a little less than, Alternative 2a, including at Robles Diversion Dam. Turbidity levels and trends will be similar to Alternative 2a.

Alternative 3b

Alternative 3b differs from Alternative 3a in that the 'Reservoir Area' sediment remains on-site and is naturally eroded with the other trapped materials. Erosion from Matilija Reservoir is less than Alternative 2b in the first year because the dam is still in place. However, after the third year, the total amount of sediment eroded from the reservoir will be similar to Alternative 2b. Depositional trends downstream are similar to Alternative 2b, though moderated, including at Robles Diversion Dam. Turbidity levels will be similar to Alternative 2b, although after the second phase of removal a resurgence of levels would initially occur, followed by a diminishing pattern similar to the post-first phase removal. Under average hydrologic conditions, it is estimated that the riverine system could reach dynamic equilibrium conditions within 10 years. This alternative has a greater measure of control over the impacts of deposition, as compared to Alternatives 2a and 2b, allowing monitoring upstream and downstream to the riverine environment and flood control system.

Alternative 4a

Alternative 4a slurries the 'Reservoir Area' sediment (2.1 million cubic yards) to the downstream disposal area, and stabilizes the remaining trapped sediment (3.8 million cubic yards) within the Matilija Reservoir. The depositional impacts associated with this alternative are similar to Alternative 1 and will come from the natural re-supply of sediment from the Matilija Creek watershed upstream of the dam. No trapped sediment behind Matilija Dam will replenish the downstream riverine system for storm flows not exceeding the 100-year recurrence event. For turbidity impacts, concentrations in the Ventura River under Alternative 4a can be expected to be similar to the No Action Alternative except for increased effects resulting from the potential loss of slurried fines from the most upstream slurry disposal area. The time to reach riverine equilibrium conditions for Alternative 4a would be similar to Alternative 1, about 50 years.

Alternative 4b

Alternative 4b slurries the 'Reservoir Area' sediment (2.1 million cubic yards) to the downstream disposal area, and temporarily stabilizes the remaining trapped sediment excavated from the channel.

The volume of sediments eroded from the reservoir basin would depend on the magnitude of a specific storm event and access of flows to specific areas of the reservoir basin. Portions of the channel with soil cement revetment would provide a 10-yr recurrence level of protection. The flows from storm events less than the 10-yr return period would cause erosion of the coarser grained sediment not protected by soil cement revetment in the upper half of the reservoir basin (i.e. the 'Upstream Channel Area'). The flows from storm events exceeding the 10-yr return period would, in addition to the above, have access to materials protected by soil cement in the lower half of the reservoir basin since overtopping of the structure would occur, allowing erosion of mostly medium-grain sediment with fines, largely in the middle portion of the reservoir basin (i.e. the 'Delta Area') as well as the lowermost portion of the basin where 'Delta Area' materials have been placed following channel excavation operations. With time, as the soil cement revetment is removed in stages, sediment in areas of the reservoir basin previously stabilized would be subject to variable levels of erosion, depending on the magnitude of the storm flow event, and subsequent transport downstream.

The depositional effects downstream associated with this alternative will be similar to Alternative 2a, though moderated.

With respect to turbidity levels, the soil cement revetment would provide a measure of control against the mobilization of fine sediment. This control would be with respect to timing and volume releases of these fines downstream. For storm events less than a 10-year recurrence interval, there would be no turbidity increases above the No Action levels. For storm events greater than a 10-year recurrence interval, the soil cement revetment would temporarily be overtopped, and fine sediment concentrations in the flows would likely result in turbidity levels on the order of 2 to 4 times greater than No Action conditions depending on the amount of fines made accessible and eroded into the active channel. These levels would be considered within the range of natural fluctuation for higher flow events under No Action conditions. Prior to the staged removal of the soil cement revetment, turbidity levels and durations would not be affected by the onset of a drought period.

During the staged removal of soil cement revetment (starting from the downstream end) to allow for the eventual complete erosion of the remaining protected sediment, it is estimated that turbidity levels could temporarily increase by a factor of 2 to 10 above No Action conditions. The duration and level of turbidity would depend on how much fine sediment is exposed to a given magnitude of flow event. During lower flow conditions, flows would remain in the active channel thereby limiting any access to the finer sediment (hence increased turbidity effects) along the unprotected portion of the bank. Following the final staged removal of the revetment, turbidity levels would be expected to stabilize to levels similar to the No Action Alternative after one or two average storm flow events pass through the reservoir basin. The staged removal of the revetment would be tied to a monitoring/adaptive management program designed to minimize impacts downstream.

It is expected that turbidity increases will also be associated with at least one of the slurry disposal site areas as described for Alternative 1.

Under average hydrologic conditions, it is estimated that the riverine system could reach equilibrium conditions within 20 years.

Flooding

The removal of Matilija Dam would increase flooding levels and risk above existing conditions. Flood mitigation measures to protect against structural damages would include construction of levees/floodwalls (either new or raising/extending existing structures) and bridge modifications. The source for earth materials for the levee improvements would likely be from the Matilija Dam reservoir basin. Where protection is not possible, due to engineering, social, legal, or economical reasons, land acquisition would be necessary. Mitigation for occasional damages to croplands, beyond without-project conditions, would also require compensation.

With-project floodplain inundation mapping (overflows) was performed for the 10-, 50-, 100-, and 500-yr return periods. Channel geometries and bed elevations used in the hydraulic model input for overflow mapping were obtained by the cumulative effect of simulating a 50-yr period (with flow data from 1991 to 2001) with year 2001 channel cross-sections as a starting base. Compared to the existing conditions overflow limits, with-project overflows are moderately more extensive in the Meiners Oaks, Live Oak and Casitas Springs areas. Flooding depths associated with the riverine transport alternatives

(2a, 2b, 3a, 3b, and 4b) are higher than depths associated with the mechanical sediment removal/permanent stabilization alternatives (1 and 4a).

An assessment was made on potential flood risks related to the location of the proposed slurry disposal site within the Ventura River floodplain in the vicinity of Highway 150 bridge. For the four distinct areas that make up the disposal site, only the area upstream of the bridge will impede flows along one of the several active channels within the river reach. Due to the width of the river in this reach, however, it was determined that flow conveyance would remain hydraulically adequate. Additional flooding would not be induced. The remaining three sites downstream of the bridge are on river terraces and would not impede flows.

Flood Protection Improvements

Preliminary Determination of Level of Protection During the course of the formulation of alternatives and the screening process, the design of the levee and floodwall improvements considered under with-project conditions were conservative due to the considerable uncertainty regarding the downstream depositional effects to flow conveyance. Two levels of protection were recommended: "low level" and "high level." The "low level" of protection was established by determining the 100-year flood water surface elevation of the river channel based on the maximum aggradation predicted during a 50-year simulation of the natural erosion Alternative 2b (worst case downstream aggradation scenario), and then adding four feet of freeboard in the reaches upstream and two feet of freeboard in the reaches downstream of Baldwin Road to account for uncertainties. The "high level" of protection was determined by adding six feet of freeboard above the "low level" of protection.

Level of Protection Based on Risk and Uncertainty At a later stage of the formulation process, a risk and uncertainty analysis was conducted on the tentatively recommended plan to better define recommended levee or floodwall protection heights. The discussion is presented in Chapter 4, Recommended Plan, in the paragraph: "*Mitigation for Flooding Impacts.*"

In categorizing the flood protection levels associated with the action alternatives, the mechanical sediment removal/permanent stabilization alternatives (1 and 4a) were placed into one group, and the natural transport alternatives (2a, 2b, 3a, 3b, and 4b) were placed into a second group. This categorization is based on the relative differences in potential flooding depths. The first group will require a lower level of flood protection, whereas the second group will require a higher level of flood protection. The higher level of protection is based on the results of the risk and uncertainty analysis conducted for the recommended plan. For simplicity, no further distinction was made for the potentially higher levels of protection needed for alternatives 2b and 3b. The lower level of protection was established by proportionately diminishing the higher level of protection by the difference between the preliminary "high" and "low" levels described above in the paragraph "*Preliminary Determination of Level of Protection.*"

No Action Alternative

Under existing conditions, there is flood risk along the lower Matilija Creek (downstream of the dam) and the Ventura River where several developed areas are within the floodplain. The Matilija Hot Springs facility, just downstream of the dam, is subject to inundation along its lower grounds under a greater than 50-yr flood event. After restoration of full sediment load contribution from Matilija Creek and the eventual re-supply to the upstream reaches in the future, the facility will be at an increased flood risk. There is risk of flooding at Camino Cielo, Meiners Oaks, Live Oak, and Casitas Springs. Under the No Action Alternative, no improvements to increase flood level protection are planned. Currently there is an on-going sediment removal maintenance program at Santa Ana Road Bridge (Reach 4) to insure that the bridge is able to pass flows at full capacity. The bridge itself acts as a severe constriction.

Alternatives 1 and 4a

Flood control improvements for "lower level" levee/floodwall height protection would be required. Table 3-1 summarizes the required downstream flood mitigation measures. The Engineering Design Appendix contains additional details including alignments and profiles.

With the removal of Matilija Dam and the majority of the trapped sediment, there would be restoration of full sediment load contribution from Matilija Creek. Purchase of Matilija Hot Springs facility would be required, though removal of structures would be limited to only those most subject to instability. Structures at Camino Cielo would be purchased/removed. Levee and floodwall modifications would be required at Meiners Oaks, Live Oak, and Casitas Springs. Camino Cielo bridge and the Santa Ana bridge would require modifications to increase capacities to pass higher flows. The Camino Cielo Bridge is a low-flow crossing (concrete box culvert), and severely constricts the channel. Removal of bridge and restoration to original channel width will improve conveyance and prevent backwater effects and additional deposition. At the Santa Ana Bridge, the bridge would be extended following widening of the channel. The current sediment excavation maintenance just upstream of the structure would need to continue and would likely increase. The deposition is caused by the natural constriction of the river channel.

Alternatives 2a, 2b, 3a, 3b, and 4b

Due to the downstream depositional effects to flow conveyance, levee and floodwall heights for "higher level" protection would be required. The modifications and activities described for alternatives 1 and 4a would be applicable. Levee and floodwall heights however would be higher. Table 3-1 summarizes the required downstream flood mitigation measures.

Table 3-1: Required Downstream Flood Mitigation Measures

Feature	Reach	River Mile	Required Action	Level of Protection for Structural Modifications			
				Lower Level (Alts. 1 & 4a)		Higher Level (Alts. 2a, 2b, 3a, 3b, 4b)	
					Location of Structures (River Mile)		Location of Structures (River Mile)
Matilija Hot Springs	6b	16.4	Purchase and Vacate Structures at Complex.	See Req'd Action		See Req'd Action	
Camino Cielo Bridge	6b	15.5	Remove Bridge and Restore Channel Section. Construct New Bridge.	See Req'd Action		See Req'd Action	
Camino Cielo Structures	6b	15.6 to 15.4	Purchase and Remove 2 Houses and 9 Cabins.	See Req'd Action		See Req'd Action	
Meiners Oaks Area	6a/5	14.3 to 13.4	Add Levee/Floodwall Along East Bank.	Levee: 2.8 ft. avg Floodwall: 2.8 ft. avg Levee: 2.8 ft. avg	14.3 to 14.1 14.1to 13.6 13.6 to 13.4	Levee: 5.0 ft. avg Floodwall: 5.0 ft. avg Levee: 5.0 ft. avg	14.3 to 14.1 14.1 to 13.6 13.6 to 13.4
Live Oak Levee	4	10.6 to 9.4	Raise Existing (West) Levee.	2.0 ft avg.	10.2 to 9.4	6.0 ft. avg.	10.2 to 9.4
Santa Ana Bridge	4	9.4	Extend Bridge. Widen Channel at Bridge and to 500 ft Upstream. Continue Sediment Removal Maintenance Program.	See Req'd Action		See Req'd Action	
Casitas Springs Levee	3	7.8 to 6.8	Increase Existing (East) Levee Ht. With Levee/Floodwall.	Levee: 2.4 ft. avg Floodwall: 2.4 ft. avg Levee: 2.4 ft.avg	7.8 to 7.5 7.5 to 7.4 7.4 to 6.8	Levee: 5.0 ft. avg Floodwall: 5.0 ft. avg Levee: 5.0 ft avg	7.8 to 7.5 7.5 to 7.4 7.4 to 6.8

Beach Nourishment and Sediment Yield to the Ocean

Dam removal will accelerate the restoration of sediment transport from the Matilija subwatershed to the Ventura River shoreline when compared to the No Action Alternative. The sediment transport model results show that equilibrium transport (pre-dam conditions) to the shoreline from the Matilija subwatershed will be restored within about 10 years for Alternatives 2a, 2b, 3a, and 3b; 10 to 20 years for Alternative 4b; 50 years for Alternatives 1 and 4a. It would take about 100 years to reach equilibrium transport of sediments to the shoreline under the No Action Alternative. Estimates of the percent increase in sediment loads for the alternatives are presented in Table 3-2. The sediment volumes include both the quantity trapped in the reservoir basin and that supplied from the watershed. The modeling results indicate that the increases in sediment volumes are not significant over 50 years when compared to the No Action Alternative, but there would be beneficial impacts to the local shoreline.

Table 3-2: Summary of Sediment Delivery to the Ocean

	No Action	Alts 1, 4a		Alts 2a, 3a, and 4b		Alts 2b, 3b	
Time to Reach Equilibrium Transport to Beach (Yrs)	~ 100	~ 50	% Increase from No Action	< 10 (2a,3a) < 20 (4b)	% Increase from No Action	< 10	% Increase from No Action
Net 50-Yr Fine Transport (yd^3)	18,000,000	18,600,000	3%	19,000,000	6%	21,000,000	17%
Net 50-Yr Sand Transport (yd^3)	5,900,000	7,100,000	20%	7,800,000	32%	8,100,000	37%
Net 50-Yr Gravel Transport (yd^3)	410,000	490,000	20%	570,000	32%	570,000	32%
Net 50-Yr Cobble Transport (yd^3)	23,000	27,000	20%	32,000	32%	32,000	32%

Beach nourishment, utilizing trapped sediment from Matilija Dam, was considered from the earliest stages of this feasibility study for the array of alternatives. Mechanical transport of sediment to the shoreline was dismissed based on the high costs associated with trucking, conveyor or slurry pipeline. Natural transport also allows the re-supply to the sediment-starved riverine system first, thereby restoring sediment transport equilibrium.

Benefits related to beach nourishment in the Ventura River shoreline area are derived from the increased transport of coarse-grained material, from sands to gravels and cobbles. A prominent marine cobble area characterizes Surfer's Point, at the mouth of the Ventura River. A large fraction of the coarse sediments are delivered to the coast during extreme flood events. Cobbles may assist in stabilizing the nearby shoreline due to the strong currents (littoral transport) that consistently erodes the beaches in the area.

Alternatives 2a, 2b, 3a, 3b, and 4b provide the most benefits to the Surfer's Point at a net increase of almost one-third (9,000 cubic yards) more cobbles when compared to the No Action Plan for the 50-year period of analysis. Mechanical placement of the same volumes of cobbles would be relatively expensive.

The Beach Erosion Authority for Clean Oceans and Nourishment (BEACON, 2004) has estimated that one cubic yard of sand delivered via river to the ocean roughly equates to one square foot of dry sand on the beach. For Alternatives 2b and 3b, the net difference in sand transport to the shoreline is about 2.2 million cubic yards. Alternative 2a, 3a, and 4b have a net increase of about 1.9 million cubic yards of sand over 50 years. Alternatives 1 and 4a have a 1.2 million cubic yard increase of sand. Benefits associated with this volume of beach nourishment can be equated to storm damage reduction, improved recreation with a wider beach, and better protection of the threatened coastal dunes along this portion of the Ventura County shoreline. Emma Woods State Beach, west of the Ventura River mouth, has eroded approximately 150 feet over the past 50 years, indicating an erosion rate of 2-3 feet per year. Loss of upper beach zones has caused a loss of spawning habitat for the California grunion, and the threatened western snowy plover. The diminishing coastal dunes provide habitat for the silvery legless lizard, a California species of special concern.

BEACON (2004) also estimated that mechanical placement of sand at the beaches from local sources cost between $10 and $15 per cubic yard. Therefore, when compared to mechanical placement of the same volume of sand over 50 years, there would be a $22-$33 million dollar benefit by restoring natural transport of sand to the beaches for Alternatives 2b and 3b, $19-$29 million dollars for Alternatives 2a, 3a, and 4b, and $12-$18 million dollars for Alternatives 1 and 4a, without future discounting.

Detrimental effects related to the restoration of increased sediment transport to the shoreline include the short-term impacts of fine sediments on local crustaceans, and the potential increase in future dredging at the Ventura and Channel Islands Harbors due to longshore transport of increased sediments from the Ventura River. Since the increase in volumes of fines and sands are relatively small when compared to the No Action Plan, the detrimental impacts are not considered significant for this study.

Environmental Resources

Dam Site Topography

No Action Alternative

Under the No Action Alternative, sediment from the Matilija Creek watershed will continue to deposit behind Matilija Dam. Currently there is an estimated 5.8 million cubic yards trapped within the original reservoir limits. By approximately year 2040, when equilibrium conditions in the reservoir are expected, the estimated total volume of trapped sediment will be 9.3 million cubic yards. The lake, and thereby, the water storage capacity of the dam, will be essentially eliminated by 2020. As the trap efficiency continues to decrease prior to 2040, more and more sediment will be transported over the top of Matilija Dam with flood flows. This re-supply of sediment will eventually replenish scoured areas in the Ventura River.

The loss of the lake and the additional sediment build-up behind Matilija Dam is not as adverse an impact when compared to the beneficial impact of sediment replenishment in the riverine system downstream of the dam.

Alternative 1

Construction activities (i.e. slurrying of 'Reservoir Area' sediments, processing of aggregate for sale, dam removal, temporary engineered channel, etc.) would substantially alter the topography of the dam site. The restoration of the site to a more natural state, similar to conditions that existed prior to the construction of the dam, and restoration of natural fluvial processes and sediment source from upper Matilija Creek to the Ventura River and ultimately the coastal regime, would be considered a beneficial impact.

The construction and filling of the preferred slurry disposal site with fine sediments and the associated containment dikes would be adverse. The site is made up of four noncontiguous areas, totaling approximately 118 acres just upstream and downstream of Highway 150 Bridge. The upstream-most area lies in the existing riverbed; the one just downstream of the bridge is only partially within the riverbed. The other two areas are lower floodplain terraces. Each area would require protection by an earthen containment dike. Dike heights would range from 10 to 30 feet high above the riverbed. Partial protection of the side slope of the upstream-most area would be needed since a portion would be exposed to more constant river flows. Riprap stone would be placed to provide protection up to the 5- to 10-year flood event. Stone sizes of a minimum of two-foot diameter would be required. For the three areas located downstream of the bridge, riverbed boulders would be sufficient.

The "lower level" downstream flood protection proposed for the alternative would in large part expand upon existing flood protection measures and so it would not significantly alter the topography of those areas. A new levee and floodwall is proposed at Meiners Oaks. Topographical impacts for this new location would be more significant.

Alternative 2a

Topographic impacts are greater than Alternative 1 as this alternative relies upon storm events to transport the majority of trapped sediment downstream. The magnitude of erosion from the dam reservoir and the resulting larger amounts of sediment being transported and deposited downstream would be far greater than that which would normally occur under natural conditions. The restoration of the site to a more natural state, similar to conditions that existed prior to the construction of the dam, and replenishment of trapped materials and new sediment from the upper Matilija Creek to the Ventura River and ultimately the coastal regime, would be considered a beneficial impact.

The effects of slurrying the 'Reservoir Area" materials to the same disposal site as described in Alternative 1 would have the same level of impact as that alternative.

The "higher level" of protection required for the downstream flood control structures would have a greater degree of topographical impacts than Alternative 1. Existing levees would be raised higher than the elevations necessary for Alternative 1, requiring a larger footprint. New levees and floodwalls at Meiners Oaks and Live Oak will have a more significant impact.

Alternative 2b

Although this alternative does not include slurrying of the "Reservoir Area' sediment to the disposal site and does not therefore have the associated impact as in Alternative 2a, it does have downstream topographic alterations that are slightly greater than in Alternative 2a. This is attributed to the additional sediment ('Reservoir Area' sediment) that will be introduced into the riverine system. The level of downstream flood protection and impacts will be the same as in Alternative 2a.

Alternative 3a

Topographic impacts for 3a would be similar to those described for Alternative 2a. However, there would be a reduced potential for impacts because the dam would be removed in phases, allowing for a more gradual erosion of trapped sediment.

Alternative 3b

Topographic impacts would be the same as those described for 2b. However, just as in Alternative 3a, there would be a reduced potential for impacts because the dam would be removed in phases, allowing for a more gradual erosion of trapped sediment.

Alternative 4a

Alternative 4a will return the site to a semi-natural topography upon completion of the project. The trapped sediment, with the exception of the 'Reservoir Area' sediment, will be regraded and stabilized on site. An excavated channel with riprap stone slope protection on both sides of the channel would remain a permanent feature at the site. These impacts are adverse, but are less than significant. The alignment of the channel would be similar to the 1947 "pre-dam" alignment. Although the site will not be returned to pre-dam conditions, the removal of the dam and replenishment of upper Matilija Creek sediment to the Ventura River and ultimately the coastal regime, would be considered a beneficial impact.

The use of a slurry disposal area for this alternative would have the same impacts as discussed in Alternative 1. The downstream flood protection proposed for the alternative would have the same topographical impacts as Alternative 1.

Alternative 4b

Topographic impacts for Alternative 4b would be initially similar to Alternative 4a. However with time, the channel, with a limited level of slope protection, would allow erosion of trapped sediment (side slopes and adjacent sediment storage stockpile locations) when flow elevations are higher than the revetment elevation. The channel protection (soil cement) would serve a temporary function as it would be removed once the majority of trapped sediment is eroded from the site. The restoration of the site to a more natural state, similar to conditions that existed prior to the construction of the dam, and replenishment of upper Matilija Creek sediment to the Ventura River and ultimately to the coastal regime, would be considered a beneficial impact.

The use of a slurry disposal area for this alternative would have the same impacts as discussed in Alternative 1. The downstream flood protection proposed for Alternative 4b would have the same topographical impacts as Alternative 2a.

Biological Resources

Prior to evaluation of the alternatives for biological resources impacts, the Robles fishway, the extent of giant reed removal, short-term sediment deposition impacts, turbidity, and the effects to the Ventura River estuary.

Robles Fishway: Implementation of the Robles fishway will open approximately six miles of additional spawning and rearing habitat for steelhead, upstream of Robles Dam, including a portion of North Fork Matilija Creek. The new operating criteria, as established under the Biological Opinion (NOAA Fisheries, 2003), for downstream releases will provide sufficient depth in the river channel downstream of the fishway for migration.

Giant Reed (*Arundo Donax)* Management: Removal and management of giant reed and other exotic plant species (such as tamarisk) will be conducted in Reaches 7 through 9 at the commencement of construction operations. Exotic plant species eradication for Reaches 1 through 6 downstream of the dam will also be included as part of the ecosystem restoration measures of this study. Following project completion, a maintenance program to control future growth will be initiated. The removal and management of these invasive weeds would greatly improve the riparian ecosystem quality within the study area.

Short-Term Sediment Deposition Impacts: In the HEP assessment, depositional depths of three feet or greater were characterized as an adverse impact to the riparian habitat. Riparian habitat values associated with affected areas were reduced in Target year 5 (a value of zero was used for the “native vegetation cover” variable in the Riparian Habitat Value component of the HEP formula). A full recovery value for native vegetation cover was not assigned to the affected area until Target Year 20.

Turbidity: With respect to biological impacts from turbidity levels associated with the alternatives, the larger consensus of the Environmental Working Group (EWG) has not objected to the concentration levels and durations estimated as part of the sediment transport modeling effort. As a result, the associated turbidity levels, with respect to each of the alternatives, are not considered to be a significant adverse impact to southern steelhead in the Ventura River.

Ventura River Estuary: The sediment transport modeling results do not indicate that there will be substantial deposition in the estuary (see previous discussion under subsection: *Sediment Transport,* paragraph: *Downstream Deposition and Turbidity*). Therefore biological resources impacts to the estuary resulting from the alternatives were not considered.

No Action Alternative

The existing 500 acre-feet reservoir is estimated to be filled in by approximately year 2020. As the reservoir fills, lacustrine habitat will continue to decrease, to the detriment of the aquatic inhabitants - some of which are exotic predators such as bullfrogs and largemouth bass. The wetland area behind the dam will initially increase as the reservoir fills, but will then decrease as the filled land behind the dam begins to dry. Riparian habitat will replace the lake and wetlands area. California red-legged frogs are known to occur in the riverine and wetlands habitat within the influence of the lake (USFWS, 2003). Giant reed will continue to spread throughout the area behind the dam once occupied by the existing reservoir and also upstream of the original reservoir. It is estimated that by year 50, giant reed will have fully displaced native riparian vegetation.

Downstream of the dam, the riparian habitat will continue to decline as exotic and invasive species, such as giant reed, continue to persist and outcompete native species. Long-term changes to the habitats resulting from exotic species abundance could significantly reduce wildlife diversity and use in the study area, including special status wildlife species.

Steelhead habitat will improve in the reaches below Robles Diversion Dam once the Robles fishway is in full operation. The quality of the habitat (conduciveness to spawning and rearing) in these downstream reaches overall, however, will still generally be impaired (below average) compared to its historical condition.

The reaches upstream of Matilija Dam will continue to have no value to southern steelhead. The dam will continue to disrupt river connectivity and present a barrier to migrating fish and other wildlife.

The long-term replenishment (up to 100 years) of sediment to the downstream riverine system from the Matilija watershed as the dam loses its trapping capacity will be beneficial to the natural processes within the Ventura River system. However the natural hydrology in the Ventura River will still be adversely impacted in the downstream reaches due to on-going groundwater extraction operations, surface flow diversions and discharges. From a HEP standpoint, the Natural Processes component will continue to reflect very low quality.

Alternative 1

Alternative 1 would result in the temporary loss of habitat for sensitive species in Reach 7 during demolition and earthmoving activities including riverine and upland habitat types. The lacustrine and wetland habitat associated with the lake would however be permanently lost- an ultimate fate similar for the No Action Alternative. Prior to the draining of the lake, native fauna will be trapped and relocated (including the red-legged frog, southwestern pond turtle, and two-striped garter snake); exotic species will be eradicated (including bullfrogs, crayfish, bass, sunfish, and any other non-native aquatic predators). Following the completion of construction operations, an estimated duration of up to ten years, re-vegetation efforts will be undertaken in the disturbed areas.

Wildlife movement in Matilija Canyon and along Matilija Creek would be temporarily disrupted for a period of up to ten years. However, the removal of Matilija Dam, which is a barrier to wildlife dispersal, would increase species diversity by allowing separate populations to move more readily upstream and downstream, especially fish and other aquatic species, including southwestern pond turtle and California red-legged frog.

With the removal of Matilija Dam and construction of an engineered channel, just over 17 miles of habitat will be immediately reopened to southern steelhead and other aquatic species, and as a result, significant environmental outputs will be produced. Reaches 8 and 9 are considered high quality steelhead habitat. The quality of steelhead habitat in Reaches 6 and 7 will gradually improve as the beneficial effects from the removal of the dam are manifested. Smolt productivity, for example, will increase as there is more efficient movement of nutrients downstream. Reach 7 will eventually return to near pre-dam conditions. The quality of steelhead habitat downstream of Reach 6 is expected to remain similar to the without-project conditions after the Robles fishway is in full operation.

The removal of giant reed and other exotic plant species within the original reservoir limits (Reach 7) and upstream of the reservoir limits (Reaches 8 and 9) and the planting of native riparian vegetation will improve the value of riparian habitat quality. In the downstream reaches (1 through 6), restoration activities related to exotic plant eradication will continue to improve the environmental outputs (habitat units) significantly over the 50-year life of the project.

The reestablishment of natural sediment transport processes will improve the quality of the habitat in the Ventura River in terms of natural riverine processes. However the time frame for re-establishment of riverine equilibrium conditions in the Ventura River will be approximately 50 years, a longer-term scenario made necessary due to the unavailability of trapped sediment (mechanically removed from the system) and sole reliance on the natural re-supply of Matilija Creek sediment. Reach 6 and 7 will benefit the most, as the former will reach equilibrium before the downstream reaches, and the latter becoming more similar to pre-dam conditions within a relatively short time (few years) of completion of aggregate sale operations. The improvement to the habitat quality from a natural processes perspective is less dramatic in the downstream reaches due to the same adverse impacts on the natural hydrologic regime as described for the No Action Alternative.

The use of soil cement as temporary slope protection for the channel to be excavated on the southern side of the reservoir basin will not have any adverse aesthetic or environmental impacts once the revetment is removed following completion of aggregate sale from the dam site.

Construction and operation of the slurry disposal site in the vicinity of the Highway 150 Bridge would disturb habitat and wildlife corridors along portions of the riverbed and the lower floodplain terraces adjacent to the Ventura River. The four areas comprising the site are of relatively moderate quality. Non-native grassland, oak trees, some alluvial scrub and giant reed are present. The site would be revegetated following completion of construction operations and drainage of the site. It is unlikely that any sensitive or listed species would be impacted as a result of the disturbance to the site.

The "lower level" downstream flood protection will impact limited areas beyond where existing levees or floodwalls are already present. The footprint for new protection improvements would permanently remove primarily upland habitats along the Ventura River and would disrupt wildlife movement corridors to a very limited extent.

In terms of the HEP assessment, Alternative 1 offers the second to least value amongst all of the action alternatives. This is largely due to the longer time period required to establish riverine equilibrium based on the sole reliance of resupply from Matilija Creek and no contribution from the sediment trapped behind Matilija Dam.

Alternative 2a

In Reach 7, the beneficial and adverse impacts to biological resources of Alternative 2a are similar to those of Alternative 1 although duration of the construction activities will be over a period of about two years. Re-vegetation efforts will be undertaken where necessary after the majority of trapped sediment has been evacuated from the reservoir. This period of time may be up to ten years.

Alternative 2a will affect downstream habitat conditions more than Alternative 1. In reaches 5 and 6, increased aggradation of sediment will occur, a large portion likely in the initial years following dam removal, replacing sediment lost to degradation in the past 50 years. Relative depths of aggradation will decrease in the downstream direction.

The sudden influx of large amounts of sediment will initially overwhelm the riverine system causing natural processes effects to the habitat to remain effectively low for a minimum of several years depending on storm flows. With time however, as the system returns to equilibrium, natural riverine processes will return to normal, and the beneficial effects of the removal of the dam will effectively improve the habitat quality especially in

Reach 6 and 7. Downstream of Reach 6, the improvement to the habitat quality is less dramatic, similar to Alternative 1.

Sediment will collect initially within incised river channels and then will spread laterally within the channel. As a result, the river bottom will be raised. Vegetation communities, especially in Reach 6, will be impacted with up to 1-foot of sediment and will need time to recover.

For Reaches 7 through 9, the riparian habitat quality will improve by the removal of existing giant reed and other exotic plant species. In the downstream reaches (1 through 6), restoration activities related to exotic plant species eradication will continue to improve the environmental outputs (habitat units) significantly over the 50-year life of the project.

The beneficial impacts to southern steelhead will be similar to Alternative 1, however, there is uncertainty with the time that fish passage opportunity through Reach 7 (reservoir limits) will be restored. The timing of downcutting of the initial shallow pilot channel (excavated in the reservoir basin sediment at the time of dam removal) will depend on the hydrology and magnitude of storm flows, and the restoration of fish passage will depend on the earliest establishment of a stable and satisfactory gradient within the Reach 7 channel accessible from the streambed elevation downstream of the dam site. The depth of trapped sediment in the 'Delta Area' is up to 60 feet. Following the removal of the dam, should there be a prolonged period of smaller storm events (less than a 3-year recurrence period) or drought conditions prevailing, this could potentially significantly delay the time required to create fish passage conditions in Reach 7. For this reason, Alternative 2a is less attractive from the perspective of the timing of fish passage opportunity and consistent quality of passage availability. The HEP assessment assumed that fish passage opportunity and consistency would be established no earlier than 7 years after completion of construction activities. Sediment transport modeling results indicate a 90 percent probability that passage would not be restored in less than 10 years (Appendix D- Hydrologic, Hydraulic, and Sediment Studies, Section 9.8).

In the reaches downstream of the dam, changes to channel characteristics with respect to readjustments in width and depth resulting from the increased aggradation are not expected to adversely affect steelhead migration.

Impacts related to the construction and operation of the slurry disposal site is similar to Alternative 1. The same is true for impacts resulting from construction of "higher level" protection levee and floodwall improvements, though to a slightly higher degree.

In terms of the HEP assessment, Alternative 2a offers one of the higher values amongst the action alternatives. The value however may be compromised if longer-term restoration of fish passage is assessed.

Alternative 2b

Impacts resulting from Alternative 2b are largely the same as those described above for Alternative 2a. However, by not slurrying the 'Reservoir Area' sediments offsite and instead allowing the materials to be naturally eroded and transported downstream by fluvial processes, the resulting degree of aggradation downstream is significantly increased. The time frame for system recovery from depositional effects is longer than needed in Alternative 2a; however, over a 50-year period the difference is not as significant. Under average storm conditions, vegetation communities, especially in Reach 6, may initially be impacted with up to 5 feet of sediment.

For fish passage opportunity through Reach 7 (reservoir basin), the time required to create acceptable conditions would likely be prolonged due to the inherent slope instabilities associated with any downcutting through the 'Reservoir Area' sediment. Like Alternative 2a, the HEP assessment assumed that fish passage opportunity and consistency would be established no earlier than 7 years after completion of construction activities. Sediment transport modeling results indicate a 90 percent probability that passage would not be restored in less than 14 years (Appendix D- Hydrologic, Hydraulic, and Sediment Studies, Section 9.8).

Alternative 2b does not have the adverse impacts associated with the construction and operation of the slurry disposal site as this feature is not included with this alternative.

In terms of the HEP assessment, Alternative 2b offers one of the higher values amongst the action alternatives. The value however assumes fish passage opportunity within 7 years of construction activities, and would be compromised if a longer-term were assumed.

Alternative 3a

The impacts of Alternative 3a would be very similar to those of Alternative 2a discussed above, except that changes to downstream conditions would be slightly moderated in the short term due to the amount of trapped sediment detained during the first phase of dam deconstruction. The majority of impacts under Alternative 3a would be the same as those described for Alternative 2a, although the continuation of dam deconstruction processes during the second phase of dam removal would temporarily disrupt habitat and wildlife corridors in Matilija Canyon and the area immediately upstream of the dam.

For Alternative 3a, the time for fish passage restoration in Reach 7 is uncertain. Following phase 1 removal of the initial portion of the dam, a period of time is required for storm flows to erode the trapped sediment to a new equilibrium slope with the modified dam height. The sediment transport model estimated this period to be as early as the second year after phase 1 removal using a wet period hydrograph simulation. However should a period of smaller storms or a drought scenario (as described above for Alternative 2a) prevail instead, the time period to phase 2 removal would be prolonged. In addition it could also be possible to have episodes of deposition, prior to phase 2 removal, from smaller flood events in Reach 7, prolonging completion of dam removal.

Following phase 2 removal, the timing of fish passage availability and consistent quality of passage would still likely require a number of years. For these reasons, Alternative 3a is less attractive from the perspective of fish passage. Like Alternative 2a, the HEP assessment assumed that fish passage opportunity and consistency would be established no earlier than 7 years after completion of construction activities. Sediment transport modeling results indicate a 90 percent probability that passage would not be restored in less than 14 years (Appendix D- Hydrologic, Hydraulic, and Sediment Studies, Section 9.8).

In terms of the HEP assessment, Alternative 3a offers one of the higher values amongst the action alternatives. The value however assumes fish passage opportunity within 7 years of construction activities, and would be compromised if a longer-term were assumed.

Alternative 3b

The impacts of Alternative 3b would be similar to those of Alternative 2b discussed above, except that changes to downstream conditions would be slightly moderated in the short term due to the amount of trapped sediment detained during the first phase of dam deconstruction. The majority of impacts under Alternative 3b would be the same as those described for Alternative 2b, although the continuation of dam deconstruction processes during the second phase of dam removal would temporarily disrupt habitat and wildlife corridors in Matilija Canyon and the area immediately upstream of the dam.

The time for successful restoration of fish passage for Alternative 3b would not be different from Alternative 3a above, though potentially more prolonged due to the presence of the 'Reservoir Area' sediment. Like Alternative 3a, the HEP assessment assumed that fish passage opportunity and consistency would be established no earlier than 7 years after completion of construction activities. Sediment transport modeling results indicate a 90 percent probability that passage would not be restored in less than 18 years (Appendix D- Hydrologic, Hydraulic, and Sediment Studies, Section 9.8).

In terms of the HEP assessment, Alternative 3b offers one of the higher values amongst the action alternatives. The value however assumes fish passage within 7 years of dam deconstruction, and would be compromised if a longer-term were assumed.

Alternative 4a

Biological resource impacts resulting from Alternative 4a are similar to those described for Alternative 1, with three primary differences in Reach 7:

- The duration of construction activities for Alternative 4a would be approximately three years as opposed to the estimated 10 years for Alternative 1
- Matilija Canyon would be returned to a semi-natural topography upon completion of the project, but would not return to pre-dam conditions
- A 100-foot bottom width channel following a pre-dam alignment and armored on both sides with riprap stone protection would remain a permanent feature

The 100-foot bottom width channel with a pre-dam alignment provides benefits to habitat quality because it promotes the creation of alternating alluvial bars, pools and a thalweg meander. However the presence of armored side slopes is not natural, especially as a permanent feature, and therefore results in a lower habitat value. Although some vegetation may become established naturally through the voids of the riprap stone, the presence of larger and full grown plants can be detrimental to the structure during storms events when the plants are subject to being ripped out, displacing stone and weakening the integrity of the structure.

The effects of the engineered channel with permanent armored side slopes and a return to semi-natural topography produces less habitat value as compared to a natural channel and a return to pre-dam conditions. In addition, similar to Alternative 1, the longer time period required to establish riverine equilibrium based on the sole reliance of re-supply of sediment from Matilija Creek with no contribution from the sediment trapped behind Matilija Dam benefits the quality of the habitat less in the short term. In terms of the HEP assessment, Alternative 4a offers the least value amongst the action alternatives.

Alternative 4b

For Reach 7, biological resource impacts from Alternative 4b are similar to those described for Alternative 1, except that the duration of construction activities for Alternative 4b would be approximately three years as opposed to the estimated 10 years for Alternative 1. The soil cement revetment (located in the lower half of the reservoir basin) which would protect the side slopes of the 100-foot bottom width pre-dam alignment channel would be temporary. Some segments could be removed within 10 years and others up to a period within 20 years. Re-vegetation efforts would commence after the majority of the sediment has been evacuated from the original reservoir limits.

Impacts from sediment deposition levels affecting downstream riparian habitat would fall between levels associated with Alternative 2a and 3a.

The impacts to southern steelhead will be similar to Alternative 1 in that fish passage creation to Reaches 8 and 9 is immediate following completion of construction activities. The quality of Reach 7 with the pre-dam alignment, 100-foot bottom width channel is high as it promotes the creation of alternating alluvial bars, pools and a thalweg meander. The ample channel width is also beneficial in minimizing the possibility of temporary channel blockage should there be a large influx of trapped sediment entering the channel from sloughing or an adjacent slope failure.

Impacts resulting from construction of "higher level" protection levee and floodwall improvements will be similar to Alternative 1, though to a slightly higher degree.

In terms of the HEP assessment, Alternative 4b offers the highest value amongst the action alternatives.

<u>Restoration Measures For Biological Resources</u>

Giant Reed Management

The study area reaches in which restoration benefits associated with the eradication of giant reed and other exotic plant species (such as tamarisk) that could be realized by this feasibility study extend from upstream beyond the influence of the original reservoir limits (Reaches 8 and 9), to downstream through the present dam site and reservoir (Reach 7) and the Ventura River to the estuary (Reaches 6 to 1).

Eradication efforts would need to start from the uppermost reach and work downstream. The reverse direction would be counterproductive since potential propagules transported fluvially from upstream areas would likely infest eradicated areas downstream. Prior to commencement of dam deconstruction and earthmoving activities, efforts to eradicate giant reed in Reaches 9, 8 and 7 must be completed.

It is assumed that eradication of giant reed stands would be accomplished by mechanical and manual removal of the biomass (chip and haul), followed by herbicide spraying of the ground area. Periodic follow-up treatment would be required for a period of at least 5 years. Monitoring and any additional eradication efforts within the study area would also be needed for the additional life span of the project. To achieve success in eradicating giant reed in the watershed, a watershed–wide giant reed management plan would need to be in place to control the damaging riparian weed in areas adjacent to the 100-year floodplain and within sub-watersheds of the Ventura River (such as Coyote and San Antonio Creek).

Costs for giant reed eradication efforts, including monitoring and maintenance, from Reaches 9 through 1 are approximately $10 million.

Cultural Resources Impacts

No Action Alternative

Verification will be necessary to determine whether the historic/prehistoric sites COE#1 and COE#2 in the vicinity of the reservoir will be impacted as sediment continues to accumulate in the reservoir to equilibrium levels. Based on sediment transport modeling data, it appears that at some point in the future the site could be adversely affected by sedimentation. Based on initial evaluation, COE#1 is eligible for listing on the National Register of Historic Places (NRHP), and COE#2 is potentially eligible.

With a lack of project-related disturbance, cultural resources along Matilija Creek and the Ventura River would not be adversely affected by project construction activities. However, land disturbance associated with continuing urban development in the study area could affect cultural resources in the future as new development projects are initiated.

Alternatives 1, 2a, 3a, 4a and 4b

Matilija Dam itself is not considered to be eligible for the NRHP, and no adverse affect would result from its removal. The NRHP ineligibility of the dam is subject to concurrence by the California State Historic Preservation Officer.

Historic/prehistoric sites COE#1 and COE#2 are located at the margin of sediment removal activities. Erosion after removal of sediment at the margin may undermine the stability of the sites and damage any cultural deposits present. Also, portions of them may be buried under the reservoir. Additional studies will be necessary to evaluate these sites for the NRHP, and determine their horizontal and vertical extent. If they are determined to be NRHP eligible, and will be affected by sediment removal, mitigation measures will be necessary.

Other project features, including the downstream slurry disposal site, slurry line alignment, bridge modification sites, and the desilting basin site, have yet to be surveyed for the presence of historic or prehistoric cultural resources. These additional surveys will occur during the Preconstruction, Engineering and Design phase. If any resources are found, and determined to be eligible for the NRHP, the first step would be to try to avoid these sites. If it were not feasible to redesign, they would likely be adversely affected by these activities. However, subsurface archeological sites might possibly be protected and preserved by burial under sediment placed at the disposal site. This would require a detailed and comprehensive plan to ensure that it is implemented in a manner that minimizes damage.

Undiscovered buried historic and prehistoric resources may be present beneath sediment behind Matilija Dam. Removal of sediment by natural and mechanical means would have an adverse effect on any buried resource eligible for listing on the NRHP. It would be very difficult to stabilize buried cultural deposits as sediment is removed without disturbing their integrity. A discovery plan will be developed to treat previously unknown resources found during implementation of the project. It will include procedures to monitor and treat cultural resources discovered during mechanical and natural removal of sediment behind Matilija Dam. It would also include procedures for discoveries made during grading and earth moving activities.

Potentially NRHP eligible Matilija Hot Springs, which is located just downstream of Matilija Dam, may be adversely affected by sediment re-supply. This results from potential increased flooding that would result from it being returned to the 100-year floodplain.

Alternatives 2b and 3b

Impacts associated with Alternatives 2b and 3b will be similar to those discussed above for Alternatives 1, 2a, 3a, 4a and 4b, except for those associated with the disposal site and slurry line. Alternatives 2b, 3b, and 4a do not include these features.

Air Quality, Noise, and Traffic

Construction activities common to all of the action alternatives is dam removal. For the structural concrete all of the action alternatives, except Alternative 1 and 4a, will minimally process the rubble and then haul it to Hanson Aggregate Company for recycling. Alternative 1 will process (crush) the material into aggregate size and sell it on-site. Alternative 4a will bury the concrete on site. For all the action alternatives, all non-salvageable materials will be hauled to Toland Landfill.

Also common to all the action alternatives are construction activities related to flood protection mitigation and improvements. This would include demolition/removal of structures, levee and floodwall construction and demolition/modifications to Santa Ana Bridge and Camino Cielo Bridge.

The source for earth materials for the levee improvements will likely be from Matilija Dam reservoir basin. The materials would be hauled by truck to the improvement locations.

The primary haul route to Hanson Aggregate would be State Highway 33- U.S. Highway 101- State Highway 126- local roads (approx. 28 miles). The same route would be used for Toland Landfill to avoid passing through the City of Ojai (approx. 41 miles). The alternate route, through Ojai, would be State Highway 33- State Highway 150- State Highway 126 – local roads (approx. 28 miles). The haul routes are shown on Figure 3-8.

No Action Alternative

Under the No Action Alternative, the project would not be implemented, thereby avoiding all potential impacts associated with air pollutant emissions, noise, and construction or aggregate sale operations.

Alternative 1

Construction activities for Alternative 1 will result in more significant short-term air quality impacts (emissions, dust), noise impacts, and traffic impacts, both on and off-site, than for the other action alternatives. A significant impact of this alternative is the effects, especially to traffic, related to the sale of aggregate from the dam site.

An estimate of road truck traffic for construction activities related to sale of aggregate, disposal of non-salvageable materials, levee modifications, removal of structures, modifications to the Santa Ana and Camino Cielo bridges is about 14,000,000 truck trip miles. For the sale of aggregate, round trip miles was assumed to be 90 miles.

Primary truck routes to be used in the transport of the aggregate include State Highway 33 - U.S Highway 101- local roads, and State Highway 33 - State Highway 150 - State Highway 126 - local roads. The radius of influence for anticipated truck routes extends 50 miles from the dam, throughout Ventura and southern Santa Barbara Counties.

As a result of the significant truck mileage associated with this alternative, the feasibility of constructing a dedicated road was considered. The road alignment utilized was within the Ventura River floodplain. Preliminary estimates of environmental impacts and costs were high, and the measure was therefore dismissed.

Alternative 2a, 2b, 3a, 3b, and 4b

Construction activities for Alternative 2a, 2b, 3a, 3b and 4b include similar impacts as Alternative 1, with the exception that there is no activity related to sale of aggregates from the dam site.

An estimate of road truck traffic for construction activities related to disposal of concrete rubble and non-salvageable materials, levee modifications, removal of structures, modifications to the Santa Ana and Camino Cielo bridges is about 600,000 truck trip miles.

Alternative 4a

Construction activities for Alternative 4a include similar impacts as Alternative 1, with the exception that there is no activity related to sale of aggregates from the dam site, and that the concrete rubble will be buried on site. The contractor however would have the option of processing the rubble and selling it as aggregate.

An estimate of road truck traffic for construction activities related to disposal of non-salvageable materials, levee modifications, removal of structures, modifications to the Santa Ana and Camino Cielo bridges is about 150,000 truck trip miles. With the sale of aggregate, the truck trip miles could be similar to Alternative 2a, 2b, 3a, 3b, and 4b.

Water Supply

Water Source for Slurry Operation

Alternatives that slurry 'Reservoir Area' sediment (i.e. Alternatives 1, 2a, 3a, 4a, and 4b) would require the purchase of 4,500 ac-ft of water. Due to the high regional demand of water from Lake Casitas and limitations to safe yield, the purchase of 4,500 ac-ft of water from CMWD is not feasible.

The City of Ventura at present has a surplus supply of water, utilizing sources from diversions at Foster Park (surface and subsurface), as well as entitlements from CMWD and State water. The City has offered to consider the supply of 4,500 ac-ft of water for the use of the dam removal alternatives. The City does not utilize its full entitlement from CMWD. Water allocation could be made directly from Lake Casitas and purchased from CMWD at the same rate charged to the City (Year 2003 rates: $177/ac-ft). The project costs would need to include the construction of an 8-mile pipeline from Lake Casitas to the dam site. Another option under consideration is to utilize an existing

CMWD tap water connection at Lomita Avenue near Rice Road. However the rates at this source may be cost prohibitive.

Other potential sources to consider would be local groundwater in the vicinity of the dam site. Further investigation of the existing groundwater regime, including water rights, would need to be performed during the Pre-construction, Engineering, and Design phase.

Robles Diversion Dam and Lake Casitas

It is expected that both *without-project* and *with-project conditions* will cause adverse impacts to the Robles diversion facility and Lake Casitas in terms of both water supply and water quality. Deposition at the facility's sediment basin was addressed in the prior subsection *"Sediment Transport Impacts."*

<u>Loss of Diversion Operations</u> In the event that sediment deposition levels at the facility exceed 40,000 cubic yards, diversion operations to Lake Casitas will be interrupted until the sediment basin is cleared out. Should this occur at the beginning or middle of the diversion season, the facility will miss diversion opportunities for the remaining portion of the season. Environmental regulations do not allow for maintenance during the wet season. Repeated missed diversion opportunities could adversely affect the safe annual yield for Lake Casitas. The safe annual yield is defined as the amount of water that the reservoir can yield for consumption without producing unacceptable negative impacts on the long-term water supply within the jurisdictional boundaries of Casitas Municipal Water District.

<u>Deposition in Robles-Casitas Canal and Fish Screen</u> When sediment loads are high, sands carried in suspension may deposit in the canal due to the gentle gradient of the structure. In addition, once the fish screen is installed, deposition in the canal may increase upstream of the screen due to reduction in flow velocities. (The fish screen is a component of the soon-to-be completed fishway - the screen will function to keep downstream migrating steelhead from being entrained into the canal and transported to Lake Casitas). This deposition would increase maintenance requirements and even cause interruptions (short or long-term) to diversion operations. Increases to existing levels of deposition in the canal are difficult to determine since the effects of the screen on the flow regime under higher sediment loads cannot be evaluated until the component is on-line and operational and maintenance data become available. Deposition will also occur in the fishway (downstream and off-line of the canal), and will require periodic maintenance cleanout. The majority of sand deposition however under higher sediment loads is expected to occur upstream of the screen.

<u>Turbidity</u> Levels of turbidity associated with each of the alternatives was addressed in the prior subsection "*Sediment Transport Impacts.*" Turbidity from fine sediment (silts and clays) in Ventura River flows diverted to the Robles-Casitas Canal can contribute to water quality problems at Lake Casitas. Fine sediments, especially clays, do not easily come out of suspension. Fine sediments contain absorbed nutrients that tend to promote algal production, currently a problem at the reservoir. Water treatment efforts may also

need to be increased should large amounts of fine sediment be introduced into the reservoir lake and remain in suspension. These efforts, including additional chemical use, backwashes, filter media replacement, and staffing, result in cost increases. Fine sediment can also contribute to storage loss and can also adversely affect recreational activities (i.e. fishing, boating). The action alternatives that limit the introduction to Lake Casitas of fine sediment currently trapped at Matilija Dam will limit the adverse impacts there.

Lost Storage From Removal of Matilija Dam This issue only applies to with-project conditions. A study of flow diversions at the Robles Diversion facility conducted by the Bureau of Reclamation (Appendix D- Hydrologic, Hydraulic and Sediment Studies, Section 2.3) concluded that an average of 590 ac-ft/year of water is available for Robles diversions by operation of Matilija Dam in accordance with the current operating criteria. The current water rights agreement between VCWPD and CMWD for water storage use at Matilija Dam expires in year 2009. Should early termination of the agreement be necessary due to the removal of Matilija Dam prior to 2009, CMWD would be entitled to restitution of the potential lost water diversion opportunity and resulting impact to safe yield at Lake Casitas.

Other Water Quality Concerns This issue only applies to with-project conditions. Concerns expressed by CMWD regarding the detection of arsenic and DDT in discrete samples of the trapped sediment obtained from field investigations conducted in July through September 2001 in the Matilija reservoir basin, and the potential threat to Lake Casitas and Mira Monte well were assessed by the Corps and the VCWPD. Consultation with another water agency indicated that the concentration levels detected were considered within normal background levels and would not usually be associated with adversely impacting water quality (Related information is provided in the Geotechnical Appendix). Initial consultation by the Corps has occurred with the Environmental Protection Agency and the California Department of Health Services. Additional efforts to evaluate arsenic, DDT, and other regulated substances will not be pursued at this time. For the recommended plan, future consultation with the California Department of Health Services and the California Regional Water Quality Control Board will continue during the Preconstruction, Engineering and Design (PED) phase.

No Action Alternative

Once Matilija Dam reservoir reaches equilibrium and Matilija Creek is contributing coarse sediment loads downstream (within 50 to 70 years), the deposition and maintenance requirements at the Robles Diversion facility will significantly increase from current levels. The average annual deposition at the facility's sediment basin is expected to be twice the current average volume deposited of 13,300 yd^3/yr. The deposition capacity of the facility (40,000 yd^3), which is currently only exceeded by floods exceeding a 20-year return period (with the main source of coarse sediment upstream of the Robles Diversion facility currently being the North Fork Matilija Creek), would be exceeded even under a flood event larger than a 3- to 4- year return period. The probability of an interruption of diversion operations, potentially affecting an entire season of diversion, would therefore be significantly increased.

Deposition in the diversion canal and at the fish screen would also be expected to increase requiring additional maintenance effort by CMWD. Suspended sands entering the diversion canal could increase by as much as a factor of three. Deposition in the fishway is also expected to increase.

Turbidity impacts at Lake Casitas for the No Action Alternative are expected to increase by approximately 30 percent once the existing lake fills in (by approximately year 2020). Existing fine sediment concentrations vary, according to flood flow, between 10,000 mg/l (5,000 ft^3/sec) to 1,000 mg/l (100 ft^3/sec).

Alternative 1 and 4a

For Alternatives 1 and 4a, the sediment deposition impacts to the Robles Diversion facility would be similar to the No Action Alternative. However, the facility would experience these impacts within 10 years of dam removal compared to 50 to 70 years under the No Action Alternative.

To accommodate the increase of approximately twice the average sediment deposition levels at the sediment basin, and in addition, to preclude potential interruption of diversion operations should a storm event larger than a 3- to 4-year return period deposit sediment volumes that exceed the capacity for the facility to remain in operation, a high-flow sediment bypass that would allow for sediment flushing through the Robles Diversion facility has been determined to be a warranted feature. According to preliminary hydraulic modeling results, a high-flow sediment bypass placed at the sediment basin would limit the amount of deposition at that location to approximately existing condition levels. The effects of the high-flow sediment bypass, however, on suspended sediment loads when considering volumes being bypassed and volumes remaining in the sediment basin, is difficult to assess and is dependent on the operation of the bypass, the current sluice gates, and the magnitude and duration of the storm event. It is conservatively assumed that the bypass operation will keep a substantial amount of suspended sediment in the forebay to become available for diversion.

Other measures to control the increase in deposition at the Robles Diversion facility were dismissed after consideration, and include more frequent sediment removal operations and sediment basin enlargement.

The costs associated with the additional sediment removal efforts from the sediment basin over a period of 30 years (the period prior to takeover of maintenance responsibilities by CMWD) and restitution of at least one season of lost diversions would more than justify the cost of a high-flow bypass (including modification to the existing timber crib structure).

The enlargement of the existing sediment basin from its current capacity (about 40,000 cubic yards) was also considered. This concept was not further considered for several reasons: 1) the increase in the trap efficiency from basin size enlargement would tend to deposit more sands in suspension (due to the deeper, slower water) that may have otherwise been sluiced downstream through the diversion dam sluice gates during periods of no diversion operation to Lake Casitas, hence increasing the volume of sediment deposition; 2) removal of larger quantities of sediment and the need to haul away from the site would be costlier; and 3) a larger and deeper sediment basin would require lowering of the existing diversion dam sluice gates elevation – a costly modification.

Deposition of sand in the Robles-Casitas Canal, at the fish screen, and in the fishway is expected to be similar to the No Action Alternative as suspended sand loads entering the canal would increase by a factor of three over existing conditions. Maintenance requirements would be higher than under existing conditions and additional provisions would be needed for sediment clearing from the canal especially upstream of the fish screen. For estimation purposes, it is assumed that deposition upstream of the screen could approach a depth of one foot with a total accumulation of about 200 cubic yards of sediment once or twice a year. No significant water losses, however, due to diversion interruptions would be anticipated.

Turbidity impacts at Lake Casitas due to Alternatives 1 and 4a would not be significantly different from existing conditions (see No Action Alternative discussion above) as trapped sediments behind Matilija Dam would either be removed mechanically from the riverine system or permanently stabilized, and all fine sediment contributions to the riverine system would be from Matilija Creek flows. No mitigation measures for turbidity impacts are warranted.

Alternatives 2a and 3a

Without mitigation, the impacts to the Robles Diversion facility from Alternatives 2a or 3a would be significant. Potential deposition in the sediment basin of coarser sediments (coarse sand, gravel and cobbles) in the first few years of storms after full dam removal could potentially be large enough to effectively shut down diversion operations for the respective diversion season. Incremental removal in Alternative 3a does not moderate the impact very much. A high-flow sediment bypass would be a warranted feature. Preliminary modeling utilizing a 1998 storm (15-year recurrence flood) indicate that a high-flow sediment bypass placed at the sediment basin would limit the amount of deposition at the sediment basin to 18,000 cubic yards above existing levels even while full diversion operations are continuing throughout the storm event. Without a high-flow sediment bypass and assuming Robles was attempting to divert water (i.e the existing sluice gates were not fully open), deposition would be about 90,000 cubic yards for the same storm event. The model predicted that following only a few storm events through Matilija Reservoir basin, the deposition at the Robles facility would approach equilibrium conditions (i.e. influence from Matilija Creek only and no effects from Matilija Dam or trapped reservoir basin sediments).

Other measures to control sediment deposition in lieu of a high-flow sediment bypass were also considered, but were not cost effective as described above under Alternatives 1 and 4a.

There would also be significant quantities of suspended sand entering the Robles-Casitas Canal, increasing deposition within the structure, especially at the fish screen. For estimation purposes, it is assumed that deposition upstream of the screen could approach a depth of two to three feet with a total accumulation of about 400 cubic yards of sediment once or twice a year. Maintenance needs would potentially result in short-term interruption to diversions operations. Some sediment clean-out in the fishway would also be needed.

It is expected that turbidity impacts at Lake Casitas will likely result in water quality problems, including prolonged duration of algal bloom production, and potential increases in water treatment efforts (Refer to previous section *Downstream Deposition and Turbidity* for related discussion on turbidity levels associated with Alternatives 2a and 3a). Because of the uncertainties related to level and duration of impacts, especially in a drought scenario (where low flows could be still transport turbid loads), a desilting basin to settle out fines prior to conveyance to Lake Casitas is deemed warranted.

Alternatives 2b and 3b

For Alternatives 2b and 3b, coarse sediment deposition in the sediment basin would be at least as significant as Alternative 2a or 3a. For reasons similar to those stated in the discussion above for Alternative 2a and 3a, a high-flow bypass is warranted for Alternatives 2b and 3b.

Unlike Alternatives 2a and 3a where 2 million cubic yards of sediment from the 'Reservoir Area' (composed mostly of silts and clays) are slurried off-site, Alternatives 2b and 3b allow this volume of fine sediment to be fluvially transported in the riverine system. Sediment deposition in the canal and at the fish screen would be expected to be excessive if diversion operations were occurring when flows were carrying high levels of suspended sediment loads. These fine sediments would present significant and long–term water quality problems at Lake Casitas should these materials be conveyed there. A desilting basin that could intercept and settle out the fine sediment loads prior to conveyance to the reservoir would significantly reduce adverse impacts.

An ideal location for a desilting basin would be upstream of the diversion canal headworks and fish screen allowing the basin to function "in-line." However limited space in the basin upstream of Robles would preclude this. (For Alternatives 2b and 3b, the desilting basin would also need to be very large at least 40 acres). Therefore, since a desilting basin could only be placed downstream of the canal headworks and fish screen, build-up of sediment in these areas would be inevitable.

For Alternatives 2b and 3b, even with a high-flow sediment bypass and a desilting basin in place as mitigation features, diversions could not be assured due to the excessive finer sediments accumulating at the fish screen. An entire diversion season could essentially be missed or severely impaired if opportunities had to be foregone as a result of having to interrupt operations for potentially extended periods of time to allow for cleanout maintenance.

An assessment was performed to evaluate potential water supply losses to CMWD. The level of risk assumed in the evaluation was adopted by criteria utilized by CMWD to establish its safe annual yield to meet water supply demand after the current lease for use of Matilija Dam expires in 2009 (Entrix, 2002). For Lake Casitas, safe annual yield is defined as the amount of water that the reservoir can yield for consumption without producing unacceptable adverse impacts on long-term water supply within the boundaries of the water district. The primary criteria for determining safe annual yield was to insure that the water supply in Lake Casitas, when full, would extend through a period characterized by the most severe drought on record.

To plan for the missed diversions due to the removal of Matilija Dam, the reduction in safe annual yield that CMWD would need to accommodate is an annual volume of 6,000 ac-ft for a period of 8 years. CMWD has determined safe yield by utilizing the hydrologic record of 1944 to 1964. This is the driest period from the available 75-yr stream gage record starting from 1929. If it is assumed that the dam removal begins during a period such as this, then it would take approximately 8 years to remove enough trapped fine sediment from the reservoir during which time diversions at Robles would need to be interrupted so as to not cause adverse impacts at the facility. After 8 years, CMWD would be able to reinstate diversion. During that 8-yr period, it is assumed that CMWD would have a shortfall of 6,000 ac-ft per year compared to the No Action alternative. A survey of the cost to import water from an outside water purveyor was conducted by VCWPD and found to be an average of $650 per ac-ft. Therefore a total of $31 million dollars would be needed to purchase water to provide restitution to CMWD. As part of the cost estimates for alternatives 2b and 3b, a high-flow bypass feature was included but not a desilting basin. The high cost associated with water restitution to CMWD for Alternatives 2b and 3b provides the justification to not pursue these specific alternatives any further in the feasibility study.

From a turbidity standpoint, a drought period would prolong the adverse effects of turbidity since the lower flows associated with this period are capable of eroding and transporting only the trapped finer sediments. During this 8-year period, there would be a few intermittent storm events that cumulatively would allow mobilization of the sediment in the ‘Reservoir Area’ where the majority of fines (2.1 MCY) are trapped.

In an effort to assess whether other means exist that would preclude the potential costly shutdowns to diversion operations and long-term losses of water to CMWD, reconfiguring the Robles facility was considered. The need however to accommodate a large desilting basin, and reconstructing portions of the canal headworks, fish screen and fishway, would exceed $31 million including real estate acquisition, operation and maintenance and permanent disposal for the sludge fines. There would also be significant environmental impacts related to this option. The option of reconfiguring the Robles facility was therefore dismissed.

Alternative 4b

For Alternative 4b, the deposition impacts from coarser sediments in the sediment basin at the Robles facility would approach levels described for Alternatives 2a and 3a. A high-flow sediment bypass would be a warranted feature.

Prior to the staged removal of soil cement, flows below a 10-yr storm event would exhibit turbidity levels similar to No Action conditions. Moreover, should there be an onset of drought conditions, turbidity levels would still not increase above No Action conditions. For flows above a 10-yr storm event, turbidity levels would be on the order of 2 to 4 times greater than No Action conditions. During these high-flow events, the fine sediment concentrations are already high, and therefore the increase in turbidity would be expected to be within the natural variability.

During the staged removal phase of the soil cement revetment (removal phase sequence would be downstream to upstream), due to the likely temporary increases in turbidity levels, from 2 to 10 times greater than No Action conditions, it would be prudent to coincide removals in periods when reservoir levels at Lake Casitas are at or above average. Removal phases would be coordinated utilizing a monitoring/adaptive management plan. Turbidity levels would be expected to stabilize to levels similar to the No Action Alternative after one or two storm events of average magnitude pass through the reservoir basin.

Turbidity impacts to Lake Casitas resulting from the removal of Matilija Dam are not expected to be significant. A desilting basin would not be a warranted feature as part of a Federal plan.

Alternative 4b offers a compromise: providing a benefit to water supply by limiting turbidity impacts and at the same time providing environmental benefits to habitat quality by timely release of trapped sediment from Matilija Dam.

Only in the situation of a very large storm event (e.g. 100-yr recurrence), would the benefit of having the soil cement revetment be negated as the structure could be conceivably destroyed. In this situation, however, most of the trapped sediment in the basin would be transported to the ocean, thereby resulting in no adverse impact to water supply. The Robles facility was severely damaged during the 1969 storm (100-yr recurrence event).

Mitigation Measures For Diversion Operation Impacts to Robles Diversion Dam and Lake Casitas

Sediment Bypass A sediment bypass would limit the amount of deposition (typically coarser sediment) in the sediment basin at the Robles Diversion facility by allowing increased sediment loads associated with removal of Matilija Dam to be flushed downstream of the facility. The high-flow sediment bypass would be located to the east of the sediment basin overflow weir at the Robles Diversion facility. The bypass would be a radial gate structure (140-ft wide) with four gates, and have a capacity of 10,000 ft^3/sec. The advantage of a radial gate system is that it allows water levels to be maintained constant in the forebay for diversion operations while also allowing flushing of sediment at the gates from the lowermost portion of the water column profile where sediment loads (coarse materials) are the highest. The current sluice gate structure (three radial gates) to the west of the overflow weir would remain in place and would continue to operate as needed. It has a capacity of approximately 7,000 ft^3/sec.

In addition to the high-flow sediment bypass, a modification to the existing timber crib structure overflow weir is necessary to provide stability to the sediment bypass. Although the existing overflow weir structure is designed to withstand a 100–year event storm, a loss of the structure would undermine the stability of the high-flow sediment bypass. A new concrete overflow weir would need to be constructed allowing it to be tied into the concrete foundation of the sediment bypass structure.

The preliminary cost estimated for the high flow sediment bypass and the modification to the existing timber crib structure is $3.4 million and $1.3 million, respectively, for a total of $4.7 million.

The benefits associated with the high-flow sediment bypass, as well as operations to the existing Robles Diversion facility are:

- Limitation of deposition at the sediment basin to No Action Alternative levels within a short-term time frame.
- Increase of diversion opportunities to a wider range of river flows
- Potential improvement of fish passage opportunity at higher flows

Desilting Basin This feature is considered a Locally Preferred associated feature and applies to the tentatively recommended plan. The inclusion of a desilting basin would minimize any fine sediment introduction and related turbidity problems at Lake Casitas resulting from a) residual fines remaining in the Matilija Reservoir basin after slurrying operations; and b) natural levels of fine sediment concentrations associated with Matilija Creek and North Fork Matilija Creek.

The desilting basin, an off-line structure to the Robles-Casitas canal located downstream of the diversion canal headworks and fish screen, would function by allowing diverted flows from the Ventura River to settle out fine sediment (silts, clays) prior to conveyance of flows via the canal to Lake Casitas. Two potential sites for the desilting basin have been identified by the local sponsor. The preferred site is located on two parcels (totaling 16.9 acres) located less than a mile from Lake Casitas and owned by the Bureau of Reclamation.

The proposed basin would have a capacity of 61 ac-ft and would require excavation and levee construction to contain the diverted flows. (The capacity was determined by using the fine sediment load of 46 ac-ft, resulting from a 3- to 4-yr recurrence 1991 storm event; total fine sediment loads attributed to trapped sediment at Matilija Dam remaining after slurrying of ‘Reservoir Area’ sediment is 200 ac-ft). To prevent infiltration losses, a geofabric liner would be installed. The intake structure to the canal will require modification. The estimated cost of the basin is $5.7 million, and includes land acquisition of up to 13.2 acres. Costs could be lower should federal land become available.

Fine sediment would be settled out by the addition of a flocculating polymer. The resulting sludge would require periodic removal and disposal on another parcel nearby.

Alternate Water Source: Subsurface Diversion A preliminary assessment was performed to determine whether the local groundwater regime could support production quantities to temporarily offset the need for surface diversions at the Robles facility. This would effectively allow full or partial removal of trapped sediments at Matilija Dam by fluvial means without impacting diversion operations to Lake Casitas.

CMWD diverts an average of 12,000 ac-ft from the Ventura River to Lake Casitas. The local aquifer has a capacity of only 6,000 ac-ft and would therefore not be adequate for diversion needs.

Diversion Operation Impacts to Foster Park

The diversion at Foster Park (owned by the City of Ventura) is an operation dependent on surface diversion and subsurface wells. The surface diversion includes both a shallow intake (4 feet below the riverbed surface) and a riverbed surface diversion. The subsurface wells are approximately 50 feet deep. It should be noted that the riverbed surface diversion has not been operated since year 2000 as the river has shifted and has subsequently abandoned, for the time being, the channel where the structure is located. This situation cannot be assumed to persist under future without-project or with-project conditions.

Impacts to diversion operations at Foster Park under without-project and with-project conditions are described below. Figures for average surface diversion rates, average days of diversion shutdown per alternative, and average volume lost per day due to diversion shutdown, are based on an assessment described in Appendix D- Hydrologic, Hydraulic and Sediment Studies, Section 10.4.

Foster Park surface diversion operations are interrupted when turbidity levels exceed 10 NTU (NTU is a measurement for clarity or cloudiness of water). The shallow intake structure diversion is also affected by this limit because fines can be drawn into the pervious riverbed materials and decrease the infiltration rate in the vicinity of the intake. Based on City of Ventura diversion flow records for the period of 1984 to 2002, diversion shutdowns due to turbidity for an average rainfall year occur about 17 days/yr. This will be considered as baseline conditions. During shutdown periods, a representative flow rate based on the 90th percentile confidence limit is 2.5 ft^3/sec for the shallow intake and 4.6 ft^3/sec for the surface diversion. A day of missed surface diversion is approximately 14 ac-ft.

To account for the considerable uncertainty in the potential lost diversion days per year at Foster Park, an upper and lower bound for annual surface water loss was established based on modeling results and comparison of without- and with-project turbidity levels associated with various storm events. To evaluate and compare the effects of with- and without-project impacts to surface diversion losses due to above threshold (10 NTU) turbidity limits, a 15-year period was chosen as a time frame representative of when the trapped sediments from Matilija Dam could contribute most significantly. This period was divided into segments of three years based on the minimum recurrence interval of a storm (2.7 years) that could produce a sufficient peak flow (over 3000 cfs) to mobilize a significant amount of sediment.

Table 3-3 presents the estimated annual surface diversion water loss for each alternative at Foster Park Diversion. Results are presented in terms of lower and upper bounds.

For Alternatives 1 and 4a, the values presented assume conditions similar to No Action, except in the first time interval (1 –3 yrs) when turbidity levels could be slightly higher due to availability to natural erosion of remnant fine sediments remaining in the reservoir following slurrying operations

Mitigation Measures For Diversion Operation Impacts at Foster Park

For losses to surface water supply at Foster Park due to missed diversions, the Federal government would need to provide mitigation for alternatives 2a, 2b, 3a, 3b, and 4b. Alternatives 1 and 4a would not require mitigation as the net increase from the No Action condition is not substantial.

One option would be to purchase replacement water from an outside purveyor. According to a survey conducted by VCWPD, the estimated rate would be $650 per ac-ft. The costs associated with Alternatives 2a, 2b, 3a, 3b, and 4b would range from $700,000 to $2.5 million for the lower bound; and $2.7 to $5.4 million for the upper bound.

Another option would be to replace the surface water diversion operation with groundwater wells. Wells would not be affected by increased turbidity concentrations. It is estimated that two wells (50 feet deep each) would be needed at a total cost of $800,000. This option is more cost effective than the purchase of replacement water, and is therefore recommended. The operation of the two wells by the City of Ventura must insure that the increased water extraction capability provided by the two wells will not produce any net loss to the quantity of surface flows otherwise extracted by the surface diversion operation.

Table 3-3: Estimated Annual Surface Water Volume Not Diverted at Foster Park due to Above 10 NTU Threshold Turbidity (ac-ft/yr)

Lower Bound

Alternative	Yr. 1 - 3	Yr. 4 – 6	Yr. 7 - 9	Yr. 10 - 12	Yr. 13 -15	15-Yr. Total (ac-ft)	Change from No Action (ac-ft)
No Action	240	240	240	240	240	3600	-
1, 4a	330	240	240	240	240	3870	270
2a, 3a	420	330	330	240	240	4680	1080
2b	950	700	330	240	240	7380	3780
3b	950	700	330	240	240	7380	3780
4b	330	330	330	330	330	4950	1350

Upper Bound

Alternative	Yr. 1 - 3	Yr. 4 – 6	Yr. 7 - 9	Yr. 10 -12	Yr.13 -15	15-Yr. Total (ac-ft)	Change from No Action (ac-ft)
No Action	240	240	240	240	240	3600	-
1, 4a	420	330	240	240	240	4410	810
2a, 3a	700	700	420	420	330	7710	4110
2b	950	950	700	420	330	10050	6450
3b	950	950	950	700	420	11910	8310
4b	700	700	700	420	420	8820	5220

Groundwater Impacts

Within the study area, impacts to groundwater levels and groundwater quality resulting from removal of Matilija Dam have been assessed for the array of alternatives under consideration. The following summarizes the impacts and concerns.

<u>Groundwater Levels in Vicinity of Dam</u> Impacts to groundwater levels resulting from the array of alternatives are not expected to be significant. There are five groundwater wells located upstream of the reservoir limits of Matilija Dam. The well with the lowest elevation is more than 60 feet above the elevation of the dam crest. Should Matilija Dam be removed, the groundwater levels for upstream users would not be impacted even though within the limits of the original reservoir area the creek bed would be lowered and the gradient of the bed steepened to pre-dam conditions. Natural spring flows replenishes the aquifer upstream of the dam. Downstream effects of dam removal on groundwater levels would be expected to be minimal.

Downstream Infiltration Rates There are numerous groundwater wells that access the water in the Upper Ventura Aquifer and includes floodplains along the mainstem of the Ventura River from Casitas Springs upstream though Meiners Oaks to Camino Cielo Road. Meiners Oaks County Water District (MOCWD) operates 2 wells located approximately 1 mile downstream of Matilija Dam and 2 wells near Meiners Oaks adjacent to Rice Road. Ventura River County Water District (VRCWD) operates three wells located between Meiners Oaks and the Highway 150 crossing. Rancho Matilija Mutual Water Company also operates several groundwater wells along the Ventura River, serving agricultural water to approximately 400 acres. The City of Ventura diversion structure is located at Foster Memorial Park.

Impact to groundwater recharge is not expected to be significant. The infiltration to the Upper Ventura Aquifer occurs primarily through the active channel bed of the Ventura River. The river bottom carries runoff flows and also allows percolation to occur readily due to the bed composition of gravel and cobbles, with some sand and very few fines. The floodplain terraces are less important for aquifer recharge because they are subject only to rainwater and generally have soils with more fines and are therefore less conducive to percolation. The median particle diameter in the bed of the Upper Ventura River is over 4 inches. There is almost no silt or clay in the river bed. The Upper Ventura River Aquifer is recharged during the wet season as river flows percolate into the aquifer.

Recharge within the riverine system would be affected if fine sediments were to blanket the river bottom and side slopes and remain for an extended period of time. Due to the steepness of the river channel, very few of the fines will deposit in the main active channel. It is assumed that the recharge capacity that presently occurs will not be altered by any of the alternatives.

The 2.1 million yd^3 of slurried reservoir sediment (mostly silts) placed at disposal sites, located just upstream and downstream of Balwin Road Bridge (Highway 150), will be stabilized and protected so that this sediment is not accessed by flows smaller than the 10-yr flood. Sediment will be placed at or above the 10-yr flood elevations on the river terraces. Flows larger than the 10-yr flood may contact and mobilize some of the sediment, while smaller flows will not. These high flows typically transport very large amounts of sediment and have a large sediment supply. Therefore, sediments eroded from the disposal sites will constitute a small incremental increase in sediment concentrations during these events. When the high flows event captures this slurry sediment, it will not substantially change the overall character of the flow or result in substantial changes to the riverbed composition or configuration. The majority of the fines will be carried out to the ocean and the minor amounts deposited in the river will not affect percolation.

The disposal sites will not substantially reduce the percolation of water into the Upper Ventura Aquifer. The potential for fines to migrate into the pore spaces below the slurry site will be limited due to the low permeability of the fine sediment. In addition, the sites will be lined with sand or other filter that will prevent the potential downward movement of fines through soil pores carried by water. Compaction of the lower layers of the deposited fines would actually form a hard pan that would further be another barrier to water passage. In addition, the upper layers of the deposited material will be mixed with and covered with topsoil suitable for planting vegetation. This will reduce the potential for runoff to erode and carry fines into the river.

Comparison of the Alternative Plans

All of the action alternatives involve removal of Matilija Dam. The only variation between the alternatives is the duration of the removal. The majority of the action alternatives remove the dam in one phase (Alternative 1, 2a, 2b, 4a, and 4b), and the remainder in at least two phases (3a and 3b).

Reestablishment of fish passage upstream of Matilija Dam is also common to all the action alternatives, though the timeframe for restoration of fish passage varies between alternatives. For Alternatives 1, 4a and 4b, fish passage opportunity is immediate following completion of construction activities (For Alternative 1, the on-site aggregate sale operation for 10-years does not affect the constructed channel and hence fish passage). For Alternatives 2a, 2b, 3a and 3b, fish passage opportunity is dependent on hydrology and the magnitude of storm events and may require many years (up to possibly decades) to downcut through up to 60 feet of trapped sediment. The incremental removal alternatives (3a and 3b) will require the most time.

From the perspective of sediment management of the 5.8 million cubic yards of trapped materials to be removed from behind the dam, the fate of the materials, in general terms, involves two measures: removal out of the riverine system or mobilization into the riverine system. Removal out of the riverine system includes sale of materials from on-site (Alternative 1) or stabilization of materials on-site (Alternative 4a). Mobilization of the materials into the riverine system allows the sediment to be fluvially transported downstream (Alternatives 2a, 2b, 3a, 3b and 4b). Most of the action alternatives have some portion of both measures.

From the perspective of a riverine system in equilibrium (i.e when the sediment entering the river is in close balance with the sediment leaving the system), all of the alternatives, including the No Action, ultimately reach equilibrium. The natural transport alternatives (2a, 2b, 3a, and 3b) are estimated to reach equilibrium in the shortest time frame (up to 10 years). Alternative 4b may require up to 20 years. The alternatives with the longer time frame to reach equilibrium are Alternative 1and 4a (50 years) and the No Action Alternative (up to 100 years). The impacts associated with natural transport alternatives, however, are also the greatest. These impacts include higher deposition levels downstream, greater risk to flooding (hence higher flood control features), and greater impacts to Robles Diversion Dam.

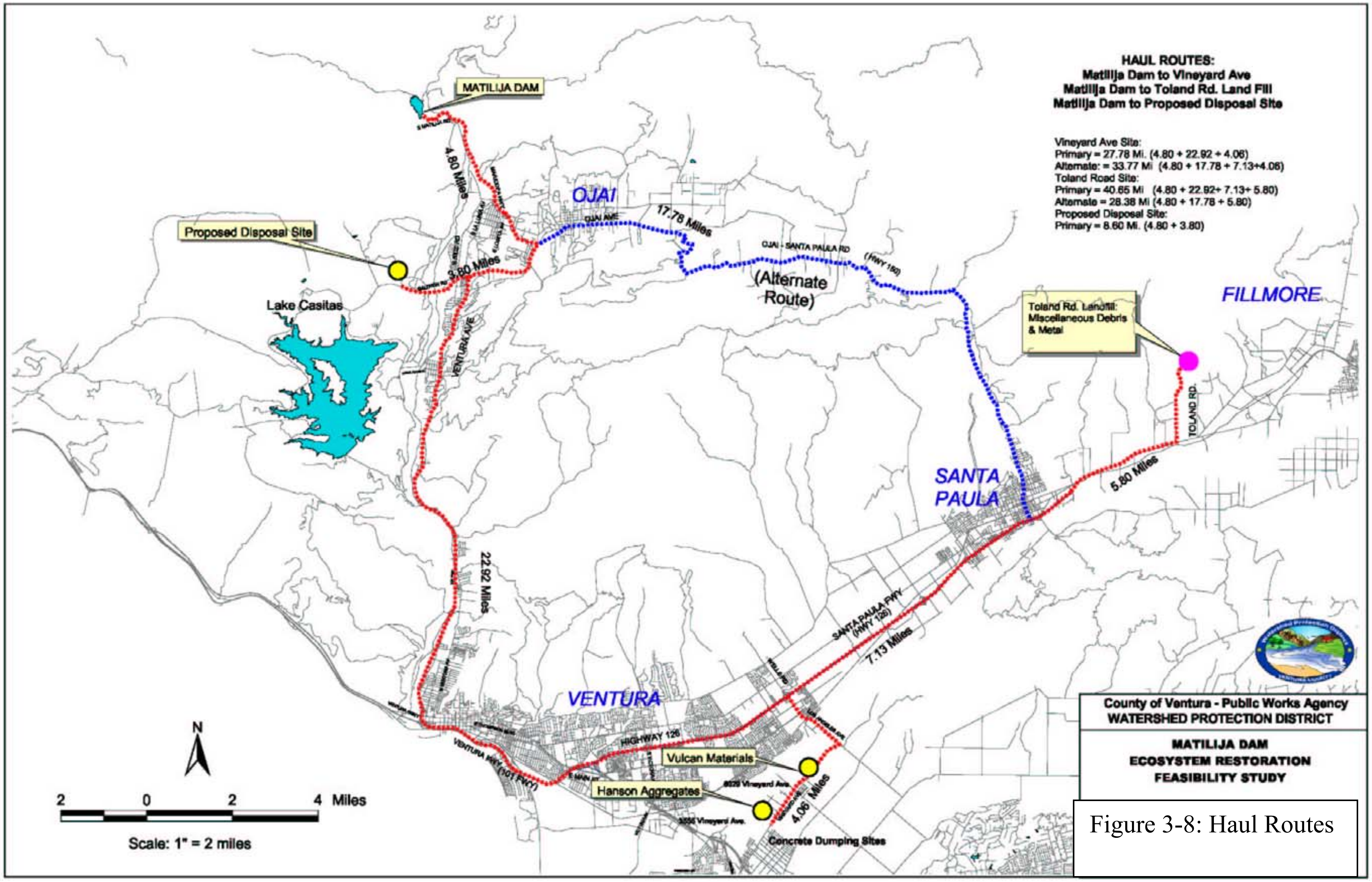


Figure 3-8: Haul Routes

Sediment delivery to the ocean, and resulting benefits to beach nourishment, would occur sooner for the action alternatives as compared to the No Action Alternative. Time frames would be similar as those described for the establishment of riverine equilibrium. Over a period of 50 years, increases in sediment delivery volumes would be approximately one-third greater than the No Action Alternative for sand, gravel, and cobble-sized sediment. The Beach Erosion Authority for Control Operations and Nourishment (BEACON) has estimated that a cubic yard of sand roughly equates to a square foot of dry sand on the beach. Detrimental effects related to the restoration of increased sediment transport to the shoreline include the short-term impacts of fine sediments on local crustaceans, and the potential increase in future dredging at the Ventura and Channel Islands Harbors due to longshore transport of increased sediments from the Ventura River. Since the increase in volumes of fines and sands are relatively small when compared to the No Action Plan, the detrimental impacts are not considered significant for this study.

The severity of downstream impacts for the natural transport alternatives is moderated if the dam is removed incrementally versus all in one phase. Incremental removal allows monitoring upstream and downstream of the environment and the flood control system between phases. To increase the level of control over uncertainties, the number of removal phases could be increased. As a result of increasing the number of removal phases, the level of risk would decrease, thereby allowing the degree of flood protection improvements to be moderated.

At Robles Diversion Dam, a mitigation feature is needed for the natural transport alternatives (2a, 2b, 3a, 3b, and 4b) to reduce or eliminate interruptions to diversion operations or turbidity impacts to Lake Casitas. This feature is a high-flow bypass to flush sediment eroded from behind Matilija Dam to downstream of the Robles facility. Alternatives that slurry the ‘Reservoir Area’ sediment off-site (1, 2a, 3a, 4a, and 4b) overall affect water supply issues less than alternatives that do not slurry these materials (2b and 3b).

Alternative 1 has the highest impacts to the community in terms of truck traffic as a result of the aggregate sale operation. In terms of public acceptability, the impacts associated with air quality, noise and traffic would warrant dismissal of this alternative.

For cultural resources impacts, Alternatives 2a, 2b, 3a, 3b, and 4b have the potentially highest impacts. The Matilija Hot Springs property is at risk of inundation due to its proximity downstream of the dam.

A summary of the affects of the different plans (System of Accounts) is shown on Tables 3-4 to 3-6.

To further provide an assessment of the alternatives, it is helpful to consider four evaluation criteria as outlined in Corps planning guidance: completeness, effectiveness, efficiency, and acceptability.

Completeness

Completeness is the extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects. In general, the alternatives are all complete. Impacts resulting from the action of dam removal, common to all the action alternatives, and necessary mitigation measures were evaluated. No further measures are needed to allow for the functioning of the alternatives.

Effectiveness

Effectiveness is the extent to which an alternative plan alleviates the specified problems, achieves the specified opportunities, and satisfies constraints. Each of the alternatives is effective in addressing the problems and opportunities identified as part of this study, and all make significant contributions to the objectives, while satisfying constraints. The degree of effectiveness however varies for the criterion of time required for fish passage opportunity. Alternatives 1, 4a, and 4b allow immediate passage; Alternatives 2a, 2b, 3a, and 3b are dependent on hydrologic conditions and have a 90 percent or higher probability of requiring at least 10 years.

Efficiency

Efficiency is the extent to which an alternative plan is the most cost-effective means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the Nation's environment. The individual components or measures of an alternative were selected after careful consideration of alternate means, including costs, of accomplishing a similar goal. For an ecosystem restoration study, the selection of the recommended plan, as will be addressed in the next section, will be based on cost-effectiveness and maximization of net benefits through an incremental cost analysis.

Acceptability

Acceptability is the workability and viability of the alternative plan with respect to acceptance by state and local entities and the public and compatibility of existing laws, regulations, and public policies. Besides being do-able, the alternatives with the best chance of acceptance are those that impact the environment and the community the least. Three action alternatives were found to be unacceptable due to significant adverse impacts: Alternative 1 (air quality, noise and traffic); Alternatives 2b and 3b (water supply). The other alternatives provide more of a measure of control against adverse impacts and at the same time benefiting the environment the most.

Table 3-4: Summary of NED/NER Outputs

Alt #	Alternative	*NED/NER Summary* Initial Construction Cost ($)	Annual Cost of Maintenance (O&M) ($)	Avg. Annual Costs ($)	Net Annual Benefits ($)	Annual Benefit to Annual Cost Ratio	Average Cost per AAHU ($/AAHU)	*HEP Outputs* 50-Yr Avg Annual Habitat Units (AAHU)	Change in AAHU over 'No Action"
	No Action Alternative - (Without Project Condition)	$0	$0	$0			NA	1393	NA
1	Full Dam Removal/Mechanical Sediment Transport: Dispose Fines, Sell Aggregate	$110,188,667	$289,265	$6,916,938			$11,358	2002	609
2	Full Dam Removal/Natural Sediment Transport								
	Slurry "Reservoir Area" Fines Offsite	$103,139,409	$433,256	$6,636,928			$9,789	2071	678
b.	Natural Transport of "Reservoir Fines"	$127,067,641	$319,910	$7,962,827			$11,745	2071	678
3	Incremental Dam Removal/Natural Sediment Transport								
	Slurry "Reservoir Area" Fines Offsite	$107,465,608	$436,483	$6,900,369			$10,178	2071	678
b.	Natural Transport of "Reservoir Fines"	$127,786,153	$319,526	$8,005,660			$11,808	2071	678
4	Full Dam Removal On-Site Sediment Stabilization								
	Long-Term Transport Period/100’ Channel (base width) behind Dam	$111,640,835	$283,785	$6,998,805			$12,633	1947	554
b.	Short-Term Transport Period /100’ Channel (base width) behind Dam	$102,620,140	$325,594	$6,498,033			$8,889	2124	731

Table 3-5: Summary of Environmental Quality Outputs

Alt #	Alternative	*Environmental Quality Impacts*									
		Turbidity	Air Quality (On/Off-Site)	Noise (On/Off-Site)	Road Truck Traffic: Total Trip Miles	Road Truck Traffic: Avg. Trip Mi/Day	Water Quality (Toxicity)	Vegetation (Impact Footprint in Acres)	T & E Species	Cultural and Historic Resources	Reach with Greatest Sedimentation Rate (6B)
	No Action Alternative - (Without Project Condition)	Low	NA	NA	NA	NA	Low	NA		Low	Gradual
1	Full Dam Removal/Mechanical Sediment Transport: Dispose Fines, Sell Aggregate	Low	High	High	14,000,000	13,000	Low	264	Moderate	Moderate	Gradual
2	Full Dam Removal/Natural Sediment Transport										
	Slurry "Reservoir Area" Fines Offsite	Moderate	Moderate	Moderate	625,000	860	Low	268	Moderate	Moderate	Moderate
b.	Natural Transport of "Reservoir Fines"	High	Moderate	Moderate	625,000	860	Low	175	Moderate	Moderate	Significant
3	Incremental Dam Removal/Natural Sediment Transport										
	Slurry "Reservoir Area" Fines Offsite	Moderate	Moderate	Moderate	625,000	570	Low	268	Moderate	Moderate	Moderate
b.	Natural Transport of "Reservoir Fines"	High	Moderate	Moderate	625,000	570	Low	175	Moderate	Moderate	Significant
4	Full Dam Removal On-Site Sediment Stabilization										
	Long-Term Transport Period/100' Channel (base width) behind Dam	Low	Moderate (Least)	Moderate	155,000	140	Low	179	Moderate	Moderate	Gradual
b.	Short-Term Transport Period /100' Channel (base width) behind Dam	Low To Moderate	Moderate	Moderate	155,000	140	Low	268	Moderate	Moderate	Moderate

Table 3-6: Summary of RED & OSE Outputs

Alt #	Alternative	*Other Impacts*				*Regional Economic Development (RED)*			*Other Social Effects (OSE)*		
		Constructibility Risks	Beach Nourishment (Time to Reach Riverine Equilibrium)	Robles Diversion Sedimentation Without Mitigation (See also impacts under 'Turbidity')	Levees/ Floodwalls Required	Benefits to Regional Beach Industry	Aggregate Sale	Regional Construction Industry	Flood Risk	Aesthetics (levees, revetment, etc)	Recreation Benefit
	No Action Alternative - (Without Project Condition)	NA	~ 100 yrs	2 times existing levels in future. Existing avg: 13,300 yd3	No Improvements to Existing Levees				Moderate - High	Low	Dam site has no public access
1	Full Dam Removal/Mechanical Sediment Transport: Dispose Fines, Sell Aggregate	Moderate	~ 50 yrs	2 times existing levels	Some Modifications				Low	Low	High
2	Full Dam Removal/Natural Sediment Transport										
	Slurry "Reservoir Area" Fines Offsite	Moderate (Least)	< 10 yrs	Up to 8 times existing levels	Substantial Modifications				Low	Moderate	High
b.	Natural Transport of "Reservoir Fines"	High	< 10 yrs	Up to 9 times existing levels	Substantial Modifications				Low	Moderate	High
3	Incremental Dam Removal/Nat Sed Transport										
	Slurry "Reservoir Area" Fines Offsite	Low (Least)	< 10 yrs	Up to 6 times existing levels	Substantial Modifications				Low	Moderate	High
b.	Natural Transport of "Reservoir Fines"	High (Least)	< 10 yrs	Up to 6 times existing levels	Substantial Modifications				Low	Moderate	High
4	Full Dam Removal On-Site Sediment Stabilization										
	Long-Term Transport Period/100’ Channel (base width) behind Dam	High (Least)	~ 50 yrs	2 times existing levels	Some Modifications				Low	Moderate	Moderate
b.	Short-Term Transport Period/100’ Channel (base width) behind Dam	Low	< 20 yrs	Similar to Alt. 3	Substantial Modifications				Low	Moderate	High

Alternative Benefits

All of the benefits associated with the alternatives are presented in non-monetary terms (Habitat Units). Ecosystem restoration benefits for this study have been prepared using a modified HEP analysis. The Average Annual Habitat Units (AAHUs) computed from the HEP are analyzed for each alternative in the same manner as the methods used for the baseline conditions analysis. The HEP is also used to analyze the benefits associated with the restoration alternatives. Table 3-7 presents the total benefits for each alternative, including breakdown by HEP formula component. Alternative benefits are compared to the 50-year average baseline condition, which includes the existing condition (year 0), year 5, year 20 and year 50 for the No Action alternative. The No Action alternative (without-project) is compared to the with-project condition to determine the gain in habitat units for each alternative. Details are presented in the Habitat Valuation Analysis, an appendix to the EIS/R.

Table 3-7: Comparison of Environmental HEP Outputs

ALT	STEELHEAD		RIPARIAN		NAT. PROCESS		TOTAL	
	Total AAHU	Increase Beyond No Action	Total AAHU	Increase Beyond No Action	Total AAHU	Increase Beyond No Action	Total AAHU	Increase Beyond No Action
No Action	231	0	917	0	245	0	1393	0
1	491	260	1143	226	368	139	2002	609
2a	473	242	1136	219	462	235	2071	678
2b	473	242	1136	219	462	235	2071	678
3a	473	242	1136	219	462	235	2071	678
3b	473	242	1136	219	462	235	2071	678
4a	493	262	1140	223	315	77	1948	554
4b	514	283	1147	229	464	233	2125	731

Alternative 4b provides the most net benefits to the ecosystem based on the HEP analysis, with an overall increase of 731 AAHUs when compared to the No Action Alternative. The outputs for Alternative 2a, 2b, 3a, and 3b are in a relatively close second position. There is a more distinct separation in AAHUs going to the next lower Alternative 1, followed by Alternative 4a.

Alternative Costs

The cost estimate for each of the alternatives, including initial construction costs, annual cost of maintenance and average annual costs is presented Table 3-8. The detailed cost estimates are presented in Technical Appendix F, Cost Estimates.

For some of the alternatives, there is an added measure of risk and uncertainty related to constructibility. Most affected by constructibility risk are the two natural transport alternatives with no slurrying of 'Reservoir Area' sediment off-site (Alternatives 2b and

3b). These alternatives require excavation and placement of all or a portion of 'Reservoir Area' sediment upstream, evacuation of water from the reservoir, and dam deconstruction (full or incremental), prior to the occurrence of a significant storm. Failure to accomplish these operations would result in re-deposition of the excavated sediment into the work area behind the dam. As a result of this risk, the costs for Alternatives 2b and 3b have added contingency. The estimates of the added costs however were preliminary and more detailed evaluation would be needed to refine the assessment. The constructibility risks associated with the other alternatives are somewhat less and are sufficiently covered under the standard contingency (25 percent).

Costs for Alternatives 2b and 3b are the highest since sediment and turbidity impacts would be so great at Robles Diversion Dam that water from an outside purveyor would need to be procured to restitute CMWD for lost diversion opportunity for a duration as long as 8 years should a drought period persist following dam removal.

Real Estate costs included in the alternatives analysis are for flood control improvement rights-of-way, purchase of structures, and the slurry disposal site. The desilting basin is also included as part of real estate costs for alternatives 2a and 3a.

TABLE 3-8: ECONOMIC OUTPUTS (FY 2004 Price Levels)							
	Alt. No. 1	Alt. No. 2A	Alt. No. 2B	Alt. No. 3A	Alt. No. 3B	Alt. No. 4A	Alt. No. 4B
Average Annual Habitat Units (AAHU)	2002	2071	2071	2071	2071	1947	2124
Gains beyond No Action[1] (AAHU)	609	678	678	678	678	554	731
Gross Project Costs							
First Costs	$98,879,834	$92,554,052	$114,026,494	$96,807,677	$115,298,299	$97,563,070	$92,088,077
Interest During Construction (Phase 1 only)	$5,376,043	$5,032,113	$6,199,558	$5,101,088	$5,961,246	$8,223,981	$5,006,779
Phase 2 Adjustment for Alt.3 Const. to base year				-$251,618	-$391,290		
Monitoring and Adaptive Management	$4,943,992	$4,627,703	$5,701,325	$4,840,384	$5,764,915	$4,878,153	$4,604,404
Cultural Resources	$988,798	$925,541	1,140,265	$968,077	$1,152,983	$975,631	$920,881
Total Gross Investment[2]	$110,188,667	$103,139,409	$127,067,641	$107,465,608	$127,786,153	$111,640,835	$102,620,140
Annual Costs							
Annual Cost of Total Gross Investment	$6,627,674	$6,203,672	$7,642,917	$6,463,886	$7,686,135	$6,715,019	$6,172,439
Annual Cost of Maintenance (O&M)	$289,265	$433,256	$319,910	$436,483	$319,526	$283,785	$325,594
Total Annual Costs (AAC)	$6,916,938	$6,636,928	$7,962,827	$6,900,369	$8,005,660	$6,998,805	$6,498,033
IV. Average Annual cost per AAHU	**$11,357.86**	**$9,788.98**	**$11,744.58**	**$10,177.54**	**$11,807.76**	**$12,633.22**	**$8,889.24**

[1]No Action Alternative has 1393 AAHUs

[2]Total Gross Investment does not include recreation costs (all alternatives) and associated feature costs for desilting basin (Alternative 4b).

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Table 3-9 presents the alternatives in order of increasing output (habitat units). From a cost effectiveness perspective, an alternative is cost effective if there are no other alternatives that provide the same output at a lower cost. Alternative 4b is the only cost effective alternative.

Table 3-9: Cost Effectiveness Analysis		
Alternative	Avg. Annual Habitat Units (AAHU)	Avg. Annual Cost ($)
No Action	Not Applicable	0
4a	554	6,999,000
1	609	6,917,000
3b	678	8,006,000
2b	678	7,963,000
3a	678	6,900,000
2a	678	6,637,000
4b	**731**	**6,498,000**

An incremental cost analysis is not necessary since there are no changes in output levels to be compared and levels to be selected, except for the No Action Alternative. Alternative 4b is the NER plan. Alternative 4b reasonably maximizes the ecosystem restoration benefits relative to costs. The average annual cost per average annual habitat unit is $8,890 (see Table 3-8 on previous page).

Locally Preferred Plan

The Plan Formulation Group (PFG) met in January 2004 to discuss the alternatives analyses results. In a consensus decision, the Sponsor and the majority of the stakeholder participants identified Alternative 4b as the preferred plan. In addition, however, to the NER plan, the group agreed to add a desilting basin as an additional feature to Alternative 4b. It was understood that the desilting basin would be considered a project associated feature. The Casitas Municipal Water District General Manager deferred to committing to Alternative 4b until further discussions of any remaining issues was possible with the CMWD Board of Directors. VCWPD is currently pursuing additional discussions with CMWD.

Revisions to Costs

Since the completion of the Public Draft Report costs have been updated to reflect technical review comments. In particular, cost estimates for the levees at Meiners Oaks, Live Oak and Casitas Springs have been revised based on further review of the necessary fill quantities for the structures. This increase in levee costs does not affect the selection of the Recommended Plan. Table 3-8 remains valid for screening purposes. The revised costs for the Recommended Plan are presented in Chapter 4, Table 4-4.