

THE MATILJIJA DAM
A CASE STUDY IN
MANAGEMENT/DECOMMISSIONING OPTIONS



Prepared by:
Nina Marie Anderson
May 1998

I. INTRODUCTION

This project is undertaken to fulfill the requirements to obtain a Master's Degree at the Bren School of Environmental Science and Management (ESM). ESM's focus is on the diagnosis and assessment of environmental problems of today and the future. The curriculum provides multi-disciplinary scientific study with an emphasis on application of policy and management principles to provide real solutions.

In lieu of a thesis, ESM requires that students complete a project indicating knowledge and understanding of the technical, and policy and management concepts of the school's instruction.

It is the goal of this project to provide useful information to the owners and operators of the Matilija Dam in Ventura, California, regarding the options for future management of the dam, including decommissioning.

Dam decommissioning has recently become the subject of great interest to the environmental community, as the potential for restoration of watershed ecosystems is an obvious benefit to consider. This project is not intended to appeal only to proponents of decommissioning the Matilija Dam per se, as this would violate the spirit which ESM emphasizes as an approach to policy issues.

The choice of the Matilija Dam as the project case study was based on a number of factors, among them:

- On August 18, 1997, the National Marine Fisheries Service (NMFS) designated the Evolutionary Significant Unit (ESU) of *steelhead* in Southern California as endangered. The listing presented an opportunity to assess the overall ecosystem quality of the Ventura River watershed. The Matilija Dam presents a barrier to the upstream passage of adult steelhead to important historical spawning and rearing habitat.
- The Matilija Dam was constructed in 1947 to provide water storage and flood control. The initial capacity of the dam impoundment was 7020 acre feet (AF). Fires, floods, and earthquake concerns (aka: life in California) have reduced the storage capacity to approximately 700 AF. This renders this dam almost useless for its intended purpose. Ongoing inspection, maintenance and structural testing along with liability issues present long term costs to the taxpayers of the county.
- The Matilija Dam appears to be a classic candidate for removal, however this may not be as clear-cut as it appears on the surface. An effective proposal to retire this facility requires a clearly defined strategy to address economic, administrative, social and ecosystem needs.

Section II contains a thorough description of the Matilija Dam: its location, ownership and purpose, physical description, hazards, current use, and political and social aspects. Section III presents the Management/Decommissioning Options, including a discussion of fish ladders and fish passage restoration. Section IV provides information regarding the regulatory requirements of the management/decommissioning options.

I would like to take this opportunity to thank the many individuals who provided me access to their valuable time and expertise. I am very grateful for all of their support. A list of these individuals is provided in the reference section of the report.

II. THE MATILIJA DAM

Geographic Location

The Matilija Dam is located on Matilija Creek in the upper reaches of the Ventura River Watershed, in Ventura County, California. The dam is approximately 0.6 miles upstream of the confluence of Matilija Creek and the North Fork Matilija Creek, approximately 5 miles northwest of Ojai, California.

Project Ownership and Purpose

Matilija Dam was designed for the Ventura County Flood Control District ("VCFCD") by Donald JR. Warren Company Engineers. The dam was constructed by Atkinson-Kier-Bressi and Bevanda, beginning in late 1946 and completed in March, 1948. Matilija Dam is owned by VCFCD. Casitas Municipal Water District ("Casitas"), formerly the Ventura River Municipal Water District, assumed responsibility for the operation of the dam and associated pipeline to Ojai in 1959. Casitas agreed to pay the remaining bond indebtedness for the rental of the Matilija Dam for a 50-year operating period, amounting to \$2,388,750. Casitas is a non-profit public agency.

Physical Description

The Matilija Dam is a concrete arch structure, 190 feet high and 620 feet long. The arch section varies in thickness from 8 feet at the crest to 35 feet at the base. A horizontal slip joint in the concrete is provided at elevation 960 feet. Arch dams are structures limited to narrow canyons with strong rock walls. An arch dam is in form like a normal architectural arch pushed onto its back, with its curved head facing upstream and its feet braced against the sides of its canyon. The inherent strength of the arch form enables the relatively thin wall of an arch dam to hold back a reservoir with only a fraction of the concrete needed for a gravity dam of similar height.

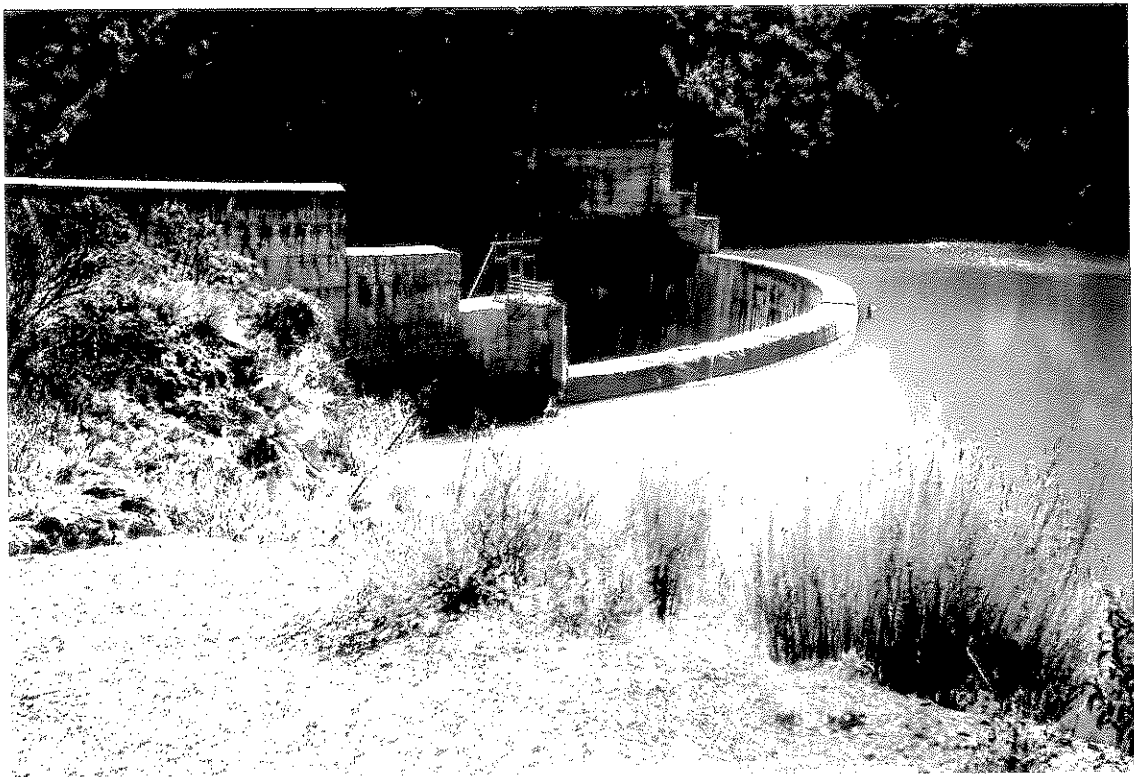


Figure II.1 –Upstream Matilija Dam

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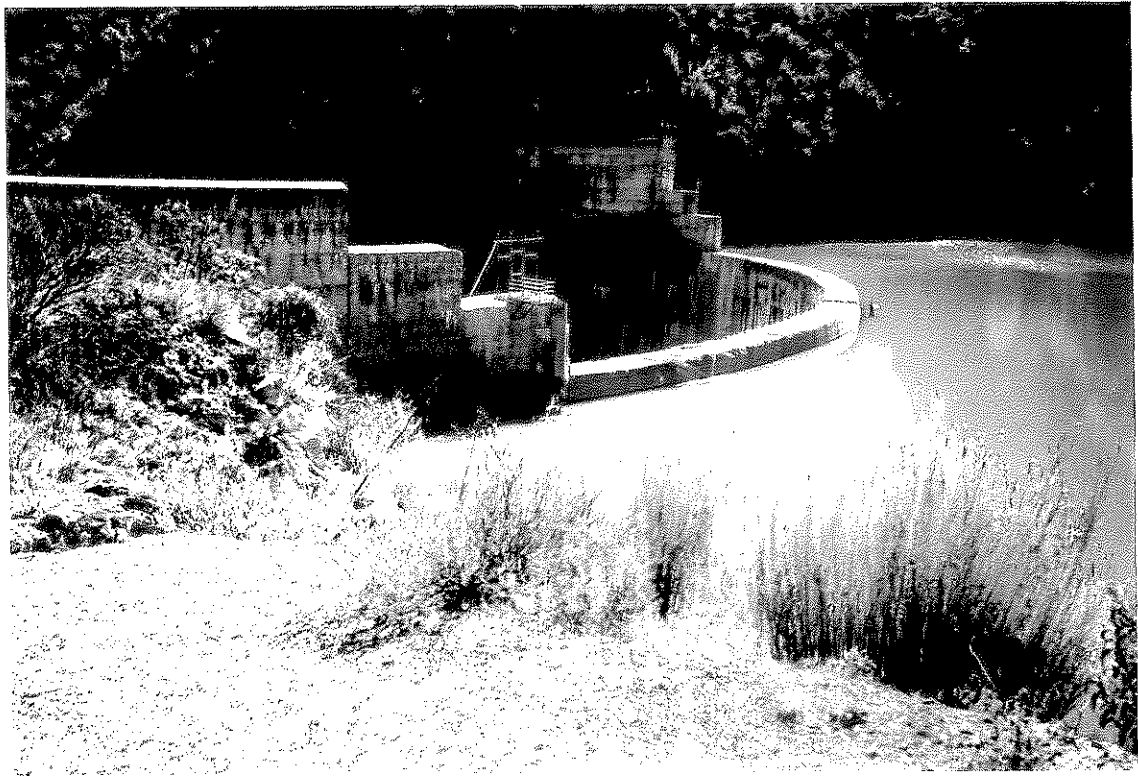


Figure II.1 –Upstream Matilija Dam

In 1964, Bechtel Corporation was contracted by VCFCO to determine the cause of cracks in the dam and structural integrity. Bechtel identified alkali-aggregate reactivity as the cause of the cracks and determined that expansion of the dam due to the cracks had lowered the safety factors of the dam to unacceptable levels. The decision was made to reduce the storage capacity behind the dam. In 1965, a 30 feet deep by 280 feet wide notch was cut into the central part of the top of the dam, lowering the elevation of the top of the dam from 1125 to 1095, and reducing storage capacity from the original 7020 to 3860 AF. The notch was expanded horizontally in 1978 to remove additional deteriorated concrete [Figure II.2 - diagram of Matilija Dam].

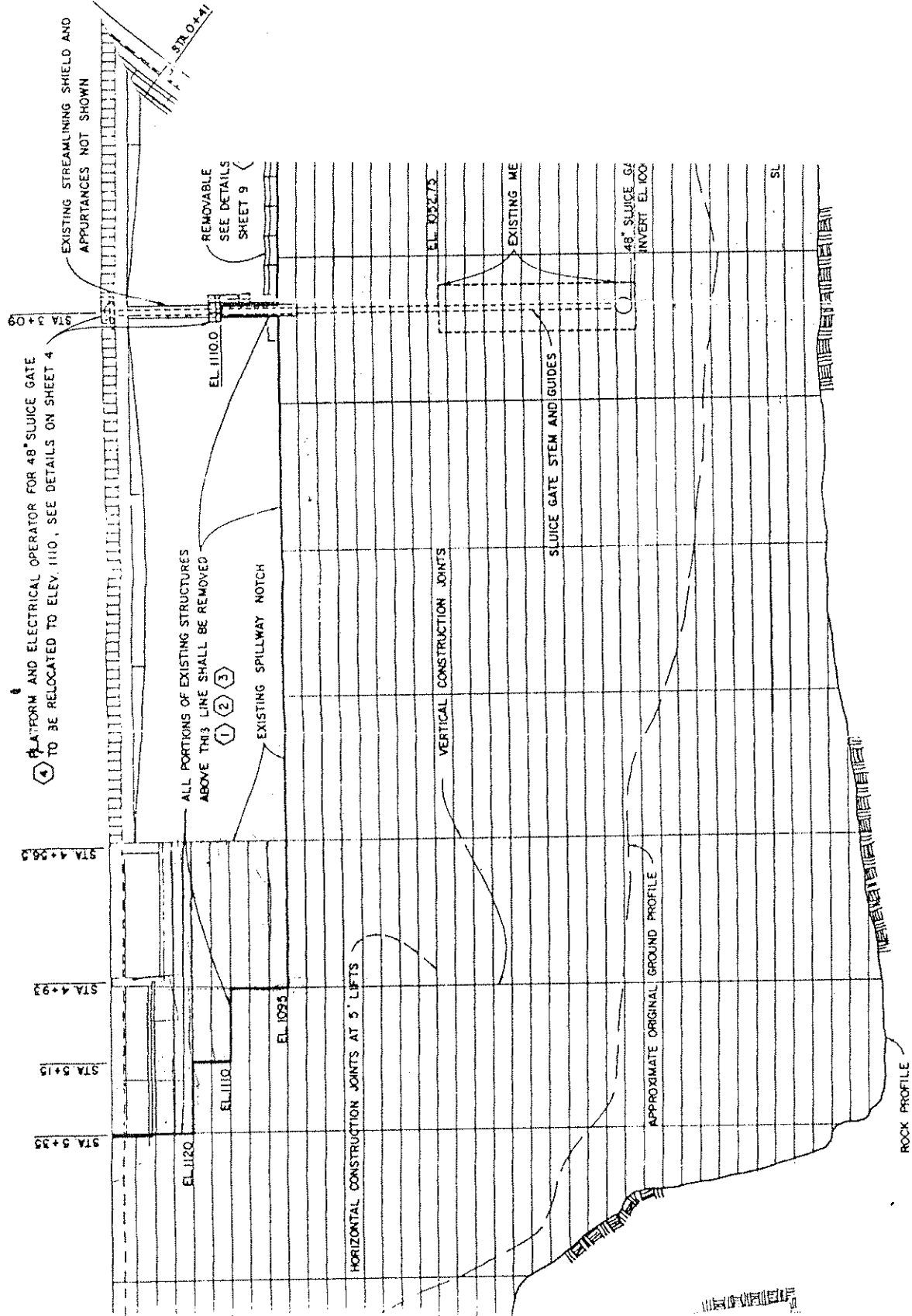
In addition to notching, siltation from flood flows has reduced the storage capacity of the impoundment behind the Matilija to approximately 700 AF at the present. In 1954, the US Bureau of Reclamation ("BuRec") had estimated that there would be 3220 AF storage capacity in 1998, and 2550 AF in 2008 (the end of the Casitas lease of the dam).

The Matilija damsite is located in the narrow, steep-sloped canyon of Matilija Creek. The site is in a sedimentary formation of mostly thin, closely fractured sandstone with interbedded weak layers of shale. The sandstone layers are angled up to an approximately vertical position so that they tilt approximately 80 degrees to the upstream direction. These strata are such that they follow the axis of the dam under the left abutment and streambed so that the left half of the dam rests on the same beds throughout. The left abutment is less strong than the right, because of greater deformation by fracturing, slipping and crushing. Both abutments were covered with a gunite blanket to reduce erosion. Faulting has been reported in various locations throughout the foundation. [Bechtel, IECO].

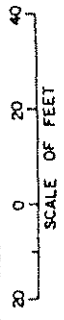
There are no significant developments upstream of the Matilija Dam. The nearest development is private residence approximately 1/8 mile downstream, and an orchard on private property approximately 1/2 mile downstream.

A fish ladder and holding facilities were constructed at the base of the dam [Figure II.3 - photo of fish ladder]. The plan was for adult migrant fish to be trapped at the base of the dam and trucked to the top. However, the slip pools of the fish ladder were built only a few yards out from the base of the dam, and subject to inundation by water cresting over the spillway. In addition, water was normally released down a side apron on the downstream face of the dam, and competed with the smaller flow of the ladder. Migrating fish tended to run up the heavier flow, which led to a dead end. The last county warden (retired in 1953) reported that the most fish he saw in the holding tank were "three confused adults." No provisions were made for the downstream transport of adults and smolts caught above the dam - the spillway was a straight drop from the crest of the dam. In 1965, the California Fish and Game Commission authorized deactivation of the fish trapping facilities. [Capelli, 1974].

PLATFORM AND ELECTRICAL OPERATOR P.
TO BE RELOCATED TO ELEV. 1110. SEE DE
12/20
A.D. 193



DAM ELEVATION



- GENERAL NOTES:
1. NUMBERS IN ○ INDICATE BID ITEMS UNDER WHICH PAYMENT WILL BE MADE
 2. EXISTING FACILITIES ARE GENERALLY SHOWN IN HALFTONE ON SHEETS 4 THROUGH 7, WITH PROPOSED WORK SHOWN IN INK AND BOLD LETTERING.

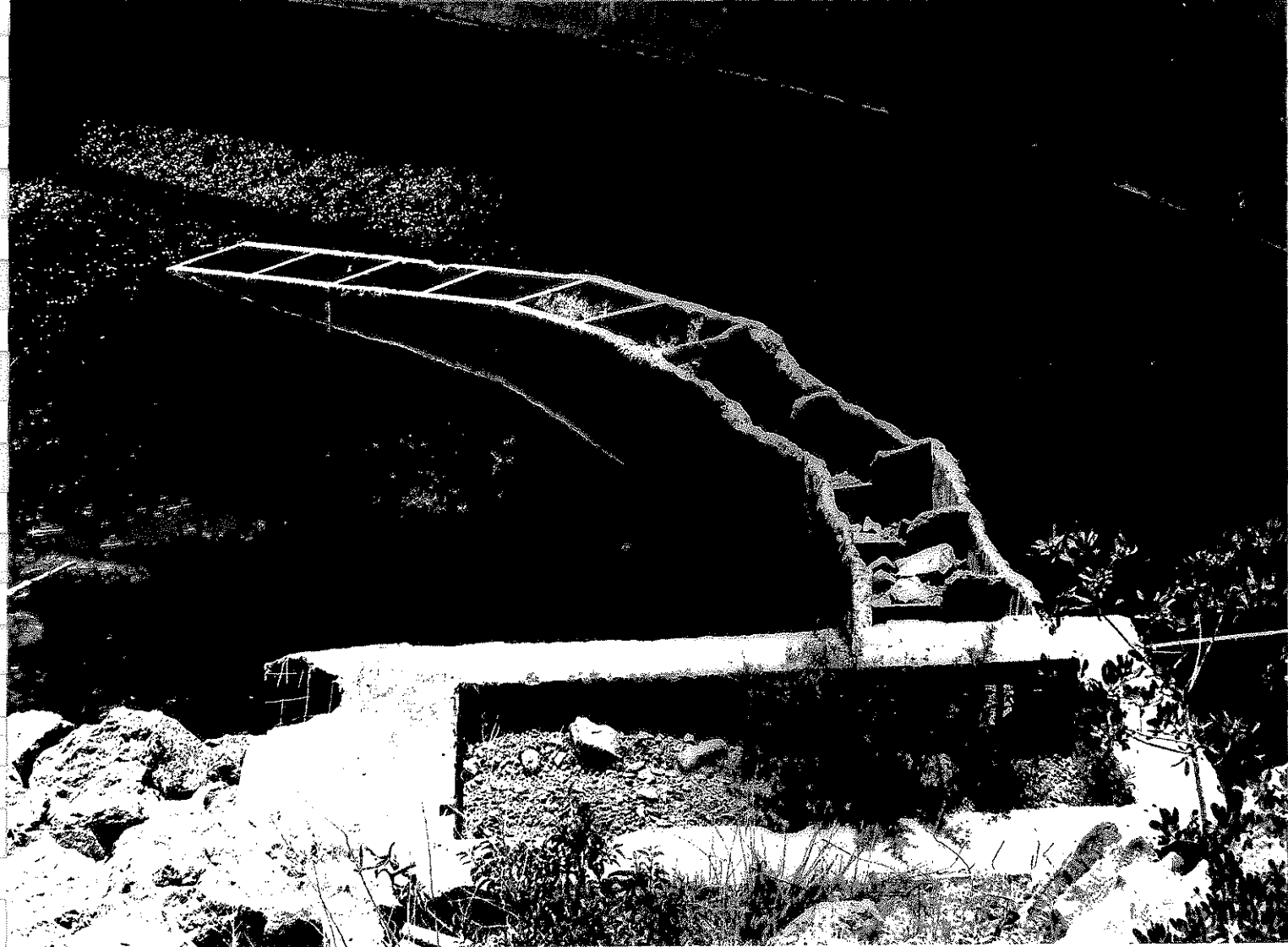


Figure II.3 The Fish Ladder

Hazards

VCFCFD maintains fences and gates around the dam, and posted signs indicate NO TRESPASSING. Maintenance associated with the dam is minimal at this time. VCFCFD conducts weekly visual inspections of the dam, and annual surveys of the dam to detect movement of the structure. California Division of Safety of Dams (“DSD”) conducts regular inspections of the dam (annually to biannually, or on an as needed basis). The notching work on the dam in 1965 and 1978 was the result of DSD’s concern for the integrity of the concrete due to the ongoing alkali-aggregate reaction.

In 1996, DSD requested that VCFCFD take sample cores from the dam to evaluate the condition of the concrete. The 1996 core data did not compare well with the corings from 1975, as the latter were taken from the upstream-face of the dam, and the 1996 corings from corresponding locations (horizontally and vertically measured), but on the downstream-face. The 1996 downstream corings show significant deterioration, however

it would be expected that downstream-face samples would exhibit the tendency for the alkali-aggregate reaction to be accelerated due to the lack of compressive force on the downstream-face and increased exposure to reaction-enhancing air and water. Subsequent samples taken in 1997 from the upstream-face showed deterioration when compared with the 1975 samples, however the analysis showed the upstream face had superior strength results when compared with the 1996 downstream-face coring samples. Despite the improved values from the 1997 samples, DSD issued a formal request in March 1998 for further engineering stability assessment to be performed on the dam, including static and dynamic analysis. Pending the results of the future analysis, DSD may again require VCFCD to stabilize the dam or reduce storage capacity in the impoundment behind the dam.

Current Use

The impoundment behind the Matilija dam is estimated to currently contribute approximately 500 AF per year to Lake Casitas. This figure is averaged over recent years reflecting normal, above normal, and drought conditions common to Southern California watersheds. The contribution is expected to decrease as the lake continues to fill with sediment, and will most likely have no active storage beyond 1999.

During a non-drought year, the Matilija impoundment fills approximately every two to three weeks in the months including March through May. During storm events, water often spills over the top of the dam. Casitas does not allow this water to enter the diversion channel to Lake Casitas due to its heavy sediment load, and sends it downstream to the mainstem Ventura River. The reach between the Matilija Dam and the Robles Diversion has large material input during storm events due mostly to agricultural practices, including avocado orchards growing on the hills above the reach. It is because of this input that it is necessary for Casitas to remove between 30 and 50 thousand cubic yards of material from the Robles Diversion during heavy rainfall years, at a most recent (1995) cost of \$120,000.00.

Water from the Matilija impoundment is released through the dam and moves downstream at up to 250 cubic feet per second (cfs) – the outlet works capacity. When the water reaches the Robles Diversion, a holding pond is allowed to fill, then gates are opened to send water via the diversion canal to Lake Casitas. When the flow from the dam slows to 50 cfs, the Matilija impoundment is once again allowed to fill. 8-12 cfs is the normal downstream flow between releases.

During the dry season, Casitas attempts to maintain the water in the impoundment at elevation 1090 feet (approximately 600 AF), with a downstream release of approximately 5 cfs. Maintenance of water in the impoundment is a source of comfort to the homeowners living upstream of the dam, as it is considered an emergency source of water in the event of a wildfire. Ventura County Fire Protection District includes this water as a potential source for fire-fighting helicopters in the event of an emergency.

During a December 1997 communication with Larry Whelan, Battalion Chief with the Fire Protection District of Ventura County regarding the use of the Matilija impoundment water for this purpose, Chief Whelan indicated that the water might be used by helicopters if the depth of the water was sufficient to allow for the buckets to fill (minimum 10 feet required). In addition, pumper trucks might also use the water for both ground and air support. However, Chief Whelan also explained that another common tactic is to temporarily dam flowing water and use the pumper trucks to obtain water in that manner. In his words "if the water is there [in the impoundment], we may use it. If not, we'll get it somewhere else." Chief Whelan also opined that if need be, Casitas Lake water would be available in the event of an emergency.

VCFCFD does not consider the Matilija Dam useful for any level of flood control at this time. [Alex Sheydayi, Director, 11/7/97].

As storage capacity has decreased, the impoundment behind the Matilija Dam, known in the past as Lake Matilija, is no longer useful for any type of recreational activity.

Political and Social Aspects

On August 18, 1997, the National Marine Fisheries Service (NMFS) designated the Evolutionary Significant Unit (ESU) of *steelhead* in Southern California as endangered under the Endangered Species Act (ESA). The listing presented an opportunity to assess the overall ecosystem quality of the Ventura River watershed.

Under ESA, any project or action that may affect steelhead or their habitats will require consultation with NMFS to obtain an incidental "take" permit. To address steelhead issues and permit requirements for the Ventura River, a group of ten public and private agencies with responsibility for surface water, ground water, flood control and other public works sponsored the formation of a steelhead "Restoration and Recovery Plan."

Despite the minimal contribution of 500 AF to the Lake Casitas reservoir, Casitas maintains that any storage capacity at the Matilija impoundment is crucial to the system as a whole, and to their mission of providing water to their customers. Water is a rare and precious resource, particularly in the arid climate of the Southwestern United States, and other sources are not currently available to the residents of Ventura County. [John Johnson, Director, Casitas Municipal Water District, November, 1997]

Ventura County has the ability to obtain California State water, however the plumbing to do so is not in place, and it was estimated in 1991-1992 to require approximately 80 million dollars to complete the project. A referendum on the Ventura County ballot failed to acquire the necessary votes to fund the project.

III. MANAGEMENT/DECOMMISSIONING OPTIONS

This section describes the options for decommissioning the Matilija Dam. Although the option to dredge the impoundment to increase water storage capacity is not a "decommissioning" option, it has been included based on the goal of providing a thorough analysis of management options. As previously discussed, it is anticipated that the dam impoundment will be filled to sediment capacity within the next 10 years. This chapter is based on that inevitability, and identifies the options that are technically available to management to respond appropriately.

A. Dredge to Continue Dam Operation

The purpose of dredging the impoundment is to increase water storage capacity for diversion to Casitas, as well as flood control and fire suppression. The dam operations would continue as they have in the past, with water diverted during the wet season to the Casitas Reservoir.

Dredging Operations

There are three techniques appropriate to the site to remove material from the impoundment.

1. During the wet season a hydraulic dredge can be employed to remove material as an 80% water to 20% sediment slurry. The slurry then can be piped down the face of the dam and on downstream to an appropriate location for further processing. The sediment will be stockpiled, and sediment laden water returned to either the Matilija Creek or the mainstem Ventura River, depending on the location of working area. The advantage to this technique would be returning the turbid water to the system during the high-flow season when it would tend to mimic the more natural conditions of sediment transport.

The hydraulic dredge may also be appropriate for dry season sediment removal, as the Upper Ventura River basin is a shallow, unconfined layer that reaches only 60-100 feet below the earth's surface [Entrix, 1997]. Groundwater can therefore be relatively easily accessed to provide the water ratio necessary for the slurry. However, after reaching the working area for stockpiling, the turbid water would likely need to be filtered before returning to the creek or mainstem, as the lower flows associated with the dry season cannot accommodate the high sediment transport without unnatural and undesirable impacts to the watershed and its ecosystem.

The significant advantage to this technique would be the avoidance of truck traffic transporting material dredged from the site via other-than-hydraulic means. Both SR 33 and Matilija Canyon Road are narrow roads

with substantial curves, particularly at the conflux of the two, where Matilija Canyon Road turns almost 180° to intersect with SR 33.

2. The most effective technique for removing sediment would be to use a scraper, in terms of volume of material excavated per unit time. This technique would only be appropriate during the dry season, and would require dewatering the sediment prior to removal. The material would then be placed on a portable conveyor system for transport to a staging area at the conflux of Matilija Canyon Road and the existing dirt road that leads to the dam face.

The alternative to the conveyor system would be to improve the approximately 1-mile long dirt road to enable dump trucks to travel along it and remove material from the point of excavation. This alternative would necessitate the creation of an area near the face of the dam large enough to accommodate trucks turning around.

3. The third technique would utilize a long-arm crane rigged with a drag-line or a clam shell for excavating sediment. The crane would sit atop pontoons equipped with tracks that can move about the impoundment in both the wet and dry seasons. The sediment can then be temporarily stockpiled in the vicinity of the crane and dewatered sufficiently for transport either by the above-mentioned conveyor system or the dump truck alternative.

At Matilija Canyon Road, a staging area can be established with screening operations designed to separate dredged material into useful and saleable construction material for beach restoration, road bed, landscaping and fill material.

The alternative to processing the material on-site, or at the piped-slurry location downstream, would be to transport the material to the nearest landfill. The nearest potential engineered landfill site is approximately one half mile downstream of the dam, at the base of the hills on the west side of the river between Camino Cielo and Kennedy Canyon [Entrix, 1997].

Dredging operations and material transport will necessarily have negative impacts to the surrounding communities for the duration of the activity. These impacts include noise, air pollution, water pollution, increased traffic and short-term aesthetic degradation.

DSD requires notification of dredging work. Since water has more compressive force compared to sediment, and because the argument that the dam currently presents a low hazard due to the fact that it is storing sediment (versus water, as in the damage done should the structure fail) DSD would require additional stability analysis during and after the dredging operation. Engineering analysis is

necessary prior to undertaking any dredging operation to prolong the life of the dam in order to assess the structural integrity of the dam under the increased load of water storage. Stabilization of the dam structure may be required (see discussion under Section III.B., re: stabilization)

Dredging the reservoir to preserve the impoundment would not increase fish passage upstream of the dam.

B. Cease Current Operations

The Matilija Dam will become run-of-the-river when the impoundment becomes entirely full of sediment. This describes the option to leave the dam in place without attempting to recover water storage capacity via dredging.

DSD would continue to conduct regular inspections of the dam, annually to biannually, or on an as needed basis. VCFCFCD would continue to conduct weekly visual inspections of the dam, and annual surveys of the dam to detect movement of the structure. As with recent DSD inspections, VCFCFCD would be required to respond to requests for engineering and stability analysis. The results of those analyses may potentially establish the need to stabilize the structure for safety purposes, due to the ongoing alkalai-aggregate reaction deteriorating the quality and strength of the dam.

Stabilization

In the case of the Matilija, the previous response to address the deterioration of the structure has been to notch the dam in order to reduce storage capacity and remove poor quality concrete. This again may be the response to a DSD requirement to stabilize the dam, however, it is assumed in this chapter that the dam would be full of sediment. This response would require the same sediment management options described below in the sections describing partial notching as a removal technique, albeit not necessarily for the goal of fish passage.

The other identified technique to stabilize the dam would be to fill in the downstream arch section of the structure with concrete [communication with BuRec, 2/13/97]. The dam would then no longer be a concrete arch dam, but a concrete gravity dam.

In 1985, the City of Santa Barbara ("the City") was faced with a similar problem when the DSD required the Gibraltar Dam to be strengthened to meet seismic safety standards. The Gibraltar Dam is a 195' high, 600' long concrete arch dam, located on the Santa Ynez River, CA. The City was given until April, 1989 to complete the strengthening of the dam, otherwise DSD would have required that the water level in the reservoir be significantly lowered. This would have reduced the amount of water available to the City, which did not have replacement sources available at the time.

The City and their consultants determined the best method for strengthening the dam would be to construct a roller-compacted concrete (RCC) buttress against the downstream face of the existing concrete arch dam. RCC is relatively dry concrete that can be put in place using earthmoving equipment, and is less costly than concrete placed using conventional construction technology.

The cost of design and construction of the project was approximately 10 million dollars, took one year to complete. The project is a good comparative study for a stabilization requirement for the Matilija Dam. Details regarding project description, alternatives, and environmental impacts can be found in the Gibraltar Dam Strengthening Project Final Environmental Impact Report/Environmental Assessment, SB-18-87, prepared for the City of Santa Barbara in 1988. A photograph of the dam taken 4/15/98 is provided.

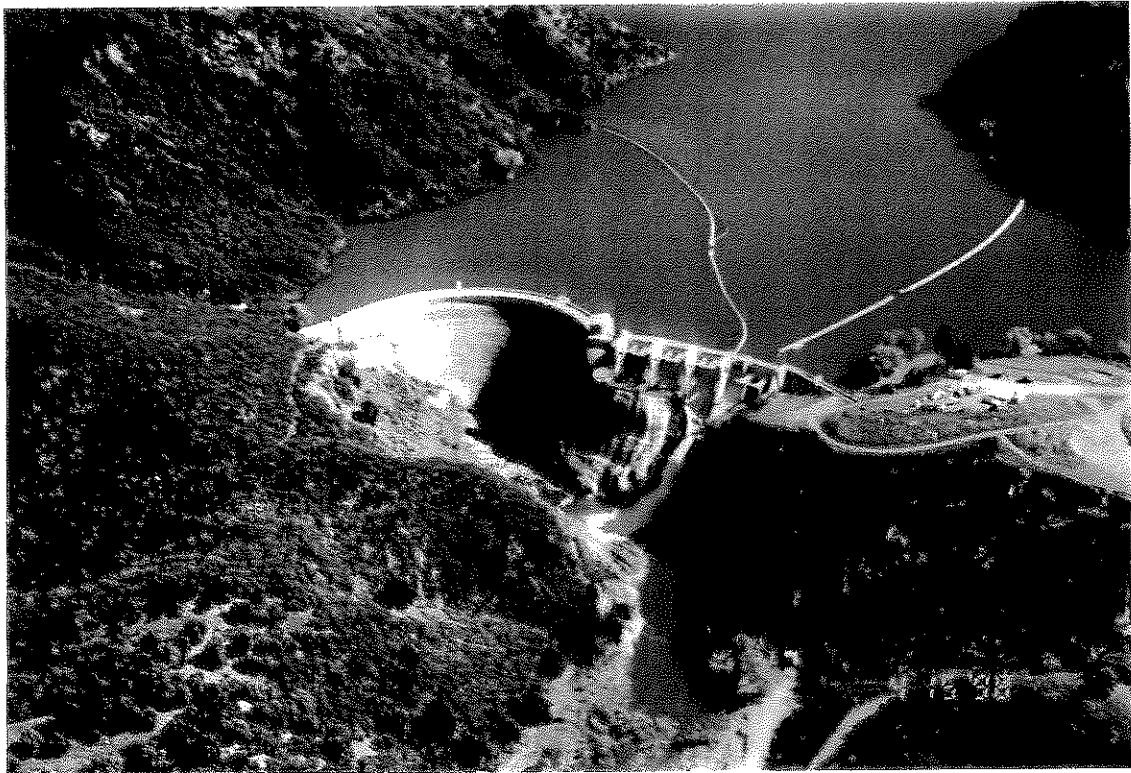


Figure III.1 Gibraltar Dam (stabilized)

VCFCD would continue to maintain fences and gates around the dam, and posted signs indicating NO TRESPASSING. The issue of liability associated with the dam including trespass/injury and dam failure remains a significant concern.

When the dam impoundment is full and operating as run-of-river, sediment loads carried by the Matilija Creek will return to natural, pre-dam volumes, and will be carried downstream. It will be necessary to dramatically increase the volume and frequency of sediment removal at the Robles Diversion to maintain diversion capacity and water quality.

NOTE: The options presented as follows have the identified goal of allowing fish passage to the area upstream of the Matilija Dam. It is therefore necessary to mention that the success of these strategies is based on the ability of fish to access the Matilija Creek, where the dam is located. Therefore, it is essential that access is provided upstream of the Robles Diversion. The following passage is taken from the 1997 Ventura River Steelhead Restoration and Recovery Plan ("the Plan"), prepared by ENTRIX, Inc.:

"Providing access to habitats upstream of Robles Diversion is one of the most important actions that can be taken to improve steelhead populations in the Ventura River. The best long term passage can probably be provided (1) constructing a fish ladder at Robles Diversion, (2) installing a fish collection/bypass facility in the canal, and (3) perhaps maintaining a low flow passage channel from the live stretch (Foster Park) to Robles Diversion to assist fish in low flow years. Success will depend on appropriate design of passage facilities for upstream and downstream migrants, steelhead access to Robles, ..."

It is assumed herein that the Plan's Recommended Action 10.1.1 *Provide Access to Habitats Upstream of Robles Diversion* will be undertaken.

C. Partial Removal

Concrete segments are removed from the dam over a period of several years, in stages. The goal of the partial removal is to allow for fish passage via a fish ladder to the spawning and rearing habitat of Matilija Creek upstream of the dam location. This option minimizes the amount of construction, concrete disposal and sediment management required, as concrete removal will be to the maximum elevation that allows for the construction of a viable fish ladder.

Fish Ladder

A step and pool fish ladder is the most probable design for the Matilija dam. The San Clement Dam on the Carmel River, CA, provides a good example of a working fish ladder for a dam of similar design. The San Clemente is an 85' tall, concrete arch dam.

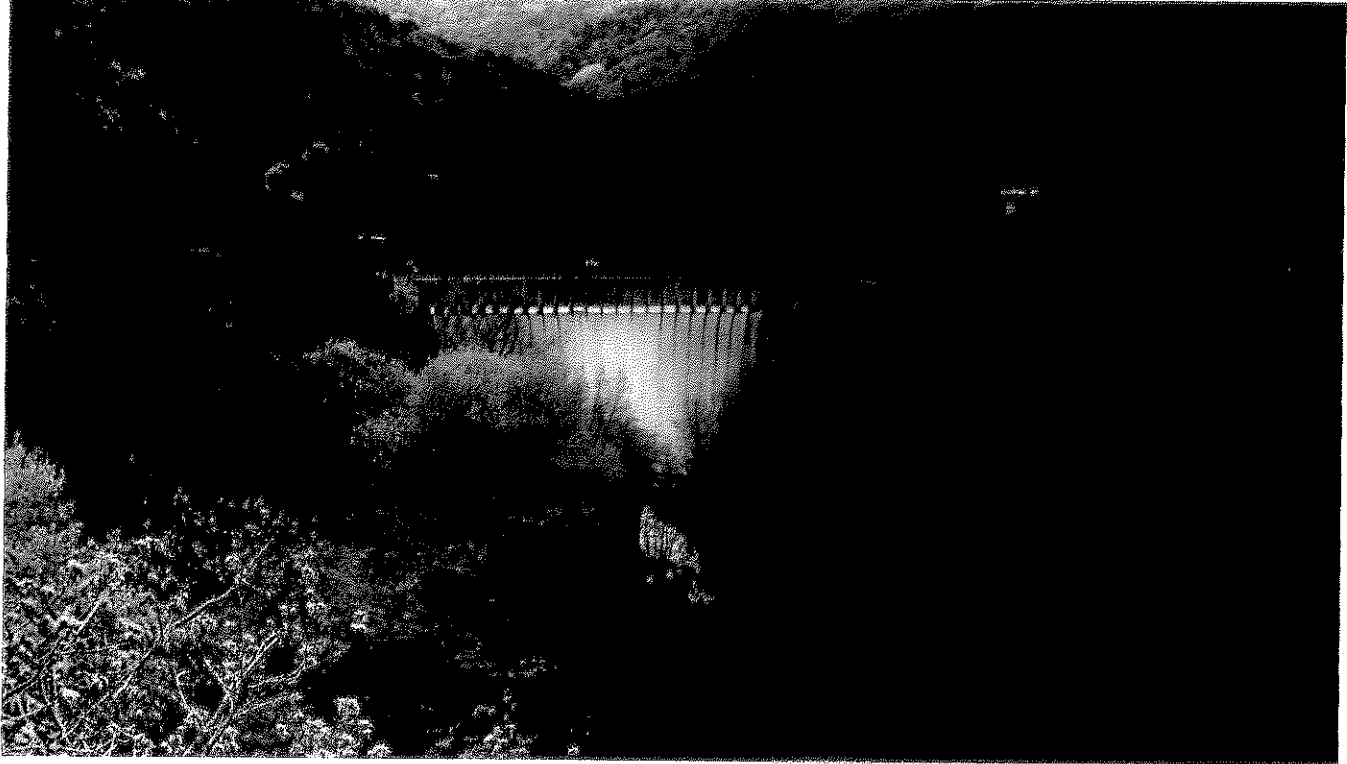


Figure III.2 San Clemente Dam, Carmel River, California

The fish ladder was built in 1922, at the time of dam construction. The design of the ladder incorporates one turn midway up the series of step-pools

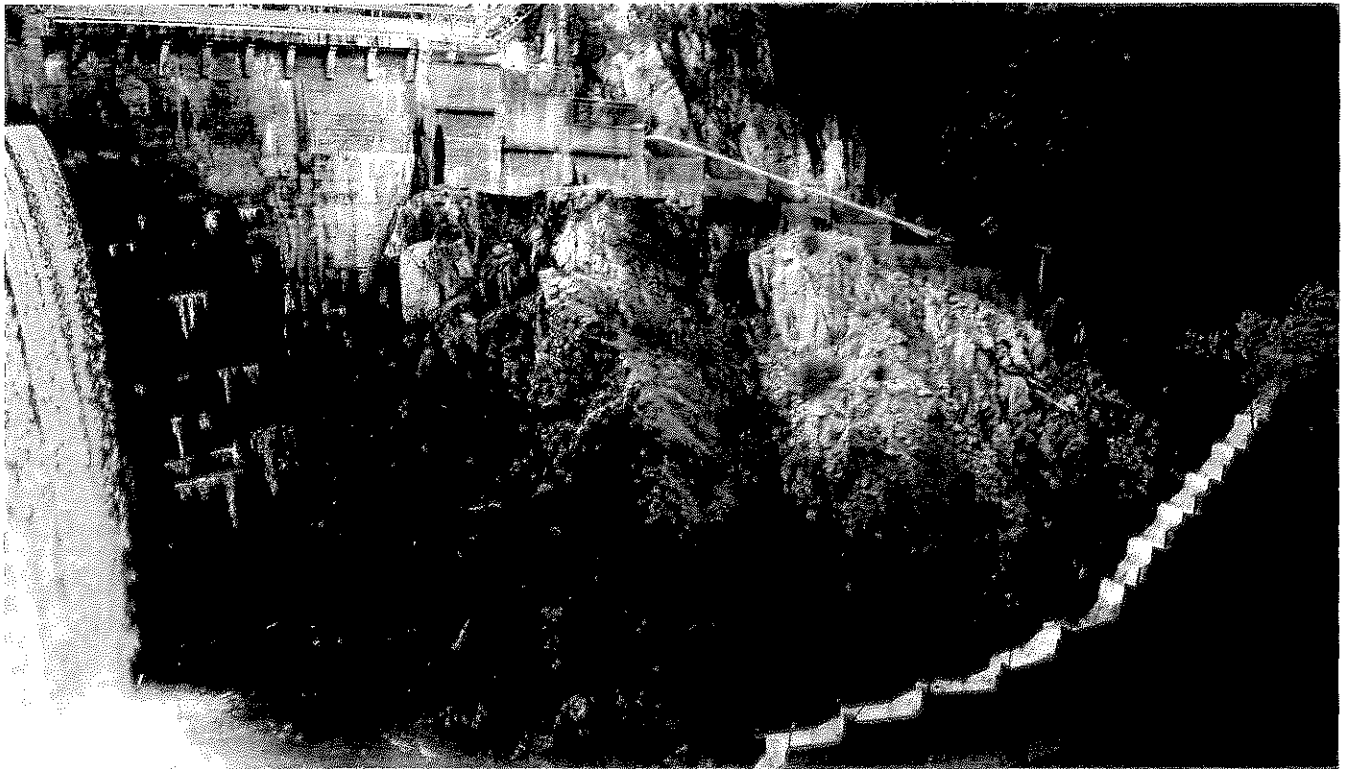


Figure III.3 Fish Ladder at San Clemente Dam

Although fish ladder design was much less sophisticated in the early part of the century, the ladder does indeed provide access to the upstream habitat. In the 1996/1997 season, 775 steelhead were counted, and as of the date of the accompanying photographs (3/7/98), 650 steelhead had made the journey up the ladder. It was noted however, by Beverly Chaney, a fishery biologist with the Monterey Peninsula Water Management District, that the less than ideal design coupled with the large elevation change puts enormous stress on the fish. In her words, "the fish that make it up are exhausted and somewhat beat up." It is not known how successful these steelhead are at spawning and rearing, as there is no way to keep track of the numbers of fish that migrate back downstream, due the competition of the water flowing down the face of the dam with the upstream entrance to the ladder taking adult and juvenile fish.

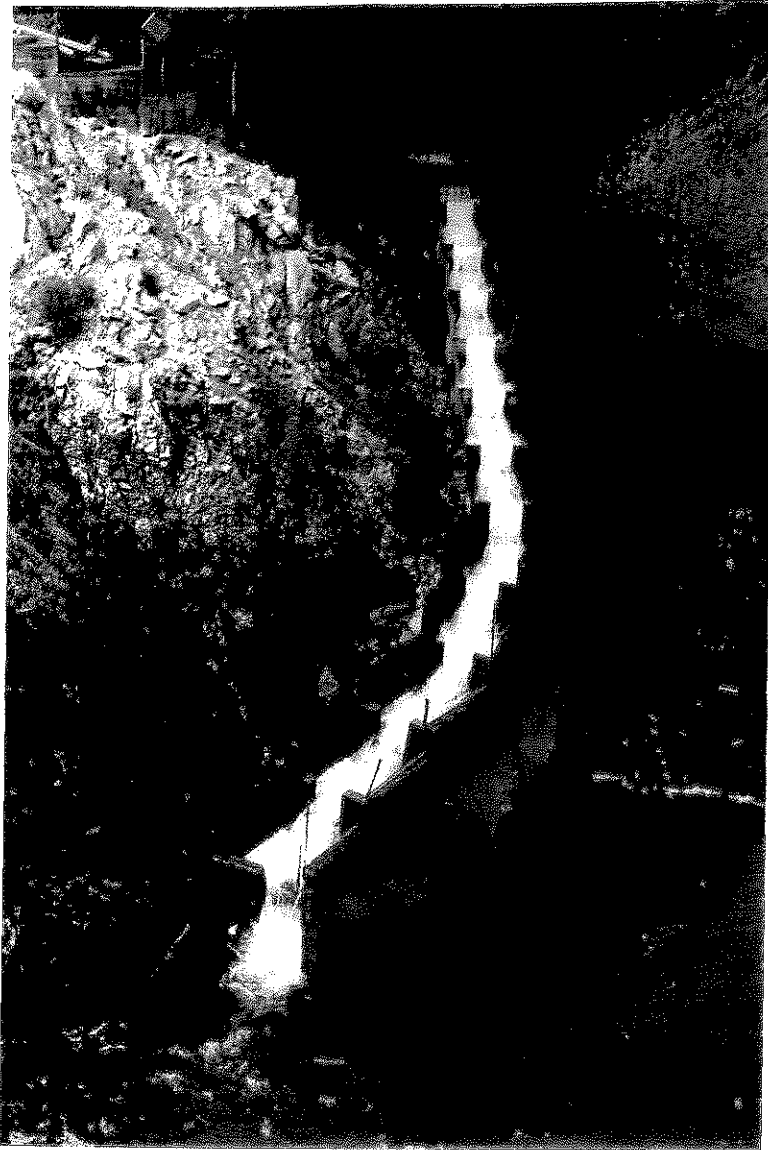


Figure III.4 Lower half of Step-Pool Fish Ladder at San Clemente Dam

Without notching the Matilija, a fish ladder must overcome an approximately 145' elevation differential. There is no height limit to fish ladders, since the step and pool design incorporates resting areas. However, the optimal design standards require 1'-1 ½' of rise per pool; therefore, a minimum of 97 pools would be necessary. Standard specifications for a step and pool ladder also require pools that are 6' to 10' long, 6' wide, and 4' deep. Using these specifications, a straight ladder would need to be between 580' to 1350' in length. It is possible to reduce the straight length of a ladder by including turning pools [Figure III.5 - diagram of Fish Ladder Options].

Limiting factors to the design and construction of the ladder would be cost and downstream topography. A fish ladder must be accessible and designed to minimize requirements for cleaning, regulating and repair. A fish ladder at the Matilija would therefore necessarily be placed at the left abutment (as there is extremely limited access to the right side) and utilize the sloping face as a base to construct the ladder [Figure III.6 – photo of left abutment at Matilija Dam]. The actual size and dimensions of the ladder would also be dependent on the design flow moving through the ladder, which is based on a percent of river flow when the targeted fish are migrating upstream (and downstream in the case of steelhead).

The steep and narrow Matilija Canyon is not a likely candidate for a straight ladder. An additional requirement for the ladder is that flows in and near the fishway entrance should be sufficient to attract fish. Again, the downstream topography at the Matilija would indicate that the entrance to a ladder would most likely be situated in the limited area of the pool at the base of the dam. It therefore seems unlikely that there is adequate space with which to design a ladder that would accommodate the 145' elevation differential.

Partial removal of the dam would reduce the length and cost of a fish ladder.

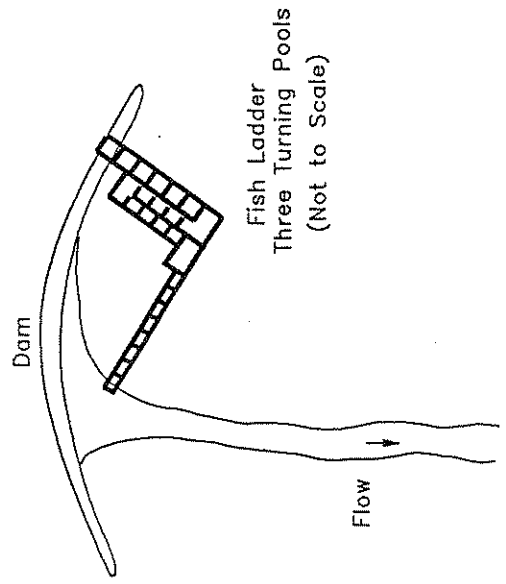
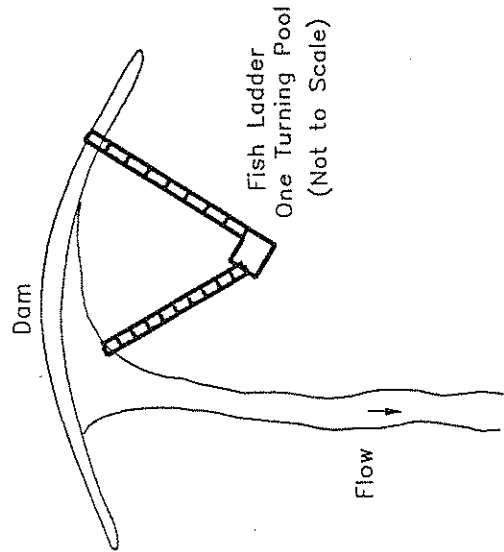
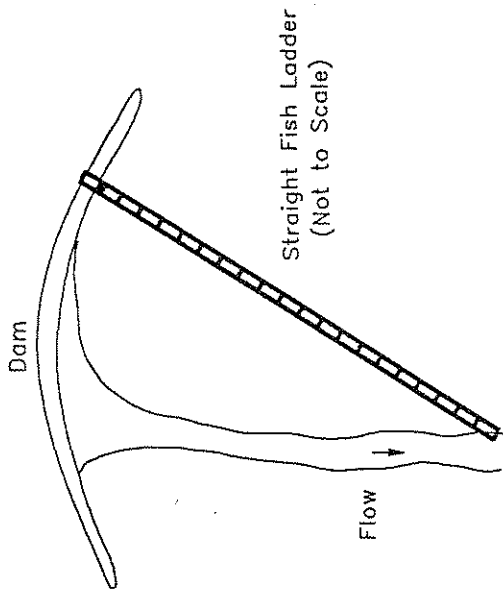


Figure III.5 Fish Ladder Options

A final consideration regarding the design and construction of a fish ladder is that the area is prone to landslides and rockslides in the vicinity of the left abutment. The ladder may therefore require extensive, expensive engineering to withstand the potential impacts of a slide. If the slope is determined to be unstable, it may not be feasible to construct the fish ladder at all.



Figure III.6 Left Abutment at Matilija Dam

Concrete Removal

As previously noted, the efforts to reduce the capacity of the impoundment and remove deteriorated concrete have resulted in a strategy of notching the center of the structure. In contrast, this option requires the removal of concrete across the crest of the dam to the left abutment canyon wall to accommodate an accessible fish ladder.

The structural integrity of the dam may pose additional concern, as the material alongside the notch (moving toward the right abutment) would no longer sustain the compressive forces that are the strength of the dam at that elevation. Without the compressive forces, the concrete is likely to expand, crack and disintegrate due to alkali-aggregate reaction. Due to this, the notching construction will include horizontal removal of segments all the way to the canyon walls supporting both abutments of the dam.

Since the dam increases in thickness closer to the base (35'), the remaining portion of the dam will support itself and is not likely to fail. The remaining sections of the dam (the base, concrete apron, and lower portions of the abutments) would continue to retain sediment, and continue to have a hydraulic effect on water passing through the breach.

The removal of concrete would take place during the summer months when stream flows are at their lowest, thus minimizing the difficulty of diverting the stream from the construction area. Mobilization of equipment would occur on the downstream side of the dam. Large segments of concrete (from 6' by 6' to 10' by 10' blocks) will be diamond wire sawcut and removed using a long-arm crane. Diamond wire sawcutting is preferable to the more common technique of controlled blasting or drilling and splitting to break out segments because it minimizes the impact to the remaining portion of the structure.

As segments are removed, the high flows associated with the subsequent wet seasons will erode the sediment from the impoundment. These sediment pulses may have a negative impact on downstream wildlife and habitat due to altered water chemistry and increased turbidity. For example, fish habitat will be affected by filling of pools used for rearing, and covering of gravels used for spawning. In addition, sediment erosion provides for the potential of riverbed aggradation, which may lead to downstream flooding.

As noted in Section III.B., Robles Diversion would require increased sediment removal activities, due not only to natural run-of-river sediment inflow to the system, but also due to the material currently stored behind the dam and exposed and activated by notching.

Downstream sediment traps would lessen the negative impacts of the pulses of material. However, traps would also require dredging and material management, albeit from well-designed locations that would be chosen for ease of access and engineered so as to minimize dredging effort.

Upstream Dredging

The partial removal option can be paired with dredging to reduce the volume of the eroding sediment. The dredging operations would be the same as those in Section III.A.

Fish Passage Restoration

After the third and final stage of concrete removal, it is desirable to restore critical habitat for the successful migration of fish upstream and downstream in Matilija Creek. A channel shall be constructed that is approximately one-tenth of the width of the reservoir with a grade of less than 6% from tail to head. In addition, bank

stabilization of the restored channel through the former dam impoundment may provide additional reduction in sediment erosion rates.

The restored channel banks should be cut to a 2:1 slope, and stabilized with boulders acquired from the former dam impoundment. Boulder structures are the preferred material for stabilizing stream banks because of their longevity and resistance to movement. Boulder riprap is a method for armoring banks with large boulders for preventing bank erosion. Riprap footing is laid in a "toe" trench dug along the base of the unstable bank. Boulder riprap is then laid on the bank slope up to the bankfull discharge level. It may be necessary to secure boulders using polyester resin adhesive and cable to form larger structures so that perimeter scour will not cause boulders to bury themselves during high flows.

Revegetation with native species, including coniferous and deciduous trees, shrubs and groundcover should be included as part of the treatment. Planting or transplanting appropriate vegetation is a primary means for long-term restoration of the health of the watershed. Planting is appropriate for treatment of areas that have stable footing, adequate temperatures, and enough water for plant survival. Correct choice of plant species and proper planting technique are critical. Appropriate species are usually those found growing nearby.

D. Full Removal

As with Section III.C., concrete segments are removed from the dam over a period of several years, in stages, and as described therein. The goal of full dam removal is to allow for restoration of natural fish passage to the spawning and rearing habitat of Matilija Creek upstream of the dam location. This option requires the maximum amount of construction, concrete disposal and sediment management required. However, this option also provides for the most aesthetically natural outcome of restoration of the canyon to its pre-dam condition, and does not rely on expensive artificial means (fish ladders) to transport migrating fish.

Concrete would be removed horizontally to the abutments and vertically to elevation 985 feet, which is approximately the former streambed elevation prior to dam construction. An arch of concrete from the streambed elevation to the base of the dam would remain subsurface. The concrete apron would also be removed and the downstream channel restored to provide a 3-8% grade for fish passage.

Upstream Dredging

The full removal option can be paired with dredging to reduce the volume of the eroding sediment. The dredging operations would be the same as those in Section III.A.

IV. REGULATORY REQUIREMENTS

Regulatory considerations will impact the choice of management options. The following is a list of the agencies* with the most likely required notification to, and input, approval and permit issuance from, regarding Matilija Dam projects.

Federal:

Environmental Protection Agency
Federal Emergency Management Agency
National Marine Fisheries Service
National Park Service
Soil Conservation Service
U.S. Army Corp of Engineers
U.S. Forest Service
U.S. Fish and Wildlife Service
U.S. Geological Survey
U.S. Bureau of Land Management
U.S. House of Representative Staff and Committees
U.S. Senate Staff and Committees

California State:

Division of Safety of Dams
Department of Fish and Game
Regional Water Quality Control Board
Coastal Commission
Parks and Recreation
Lands Commission

Local:

Ventura County Flood Control District
Ventura County Air Pollution Control District
Ventura County Transportation Department
Ventura County Solid Waste Management Department
Casitas Municipal Water District
Ventura River County Water District
Ojai Basiin Ground Water Management Agency
Meiners Oaks County Water District
City of San Buenaventura
Ojai Valley Sanitary District
Southern California Water Company

*This list was created with the consideration of the specific characteristics of the Matilija Dam and may not include every agency that requires notification to, or input, approval or permit issuance from.

Management Options and Regulatory Requirements Relationship

Every management option available to the owners/operators of the Matilija will require regulatory input, even the decision to cease operations. For example, it is expected that although the engineering analysis performed in response to DSD's March 1998 letter to VCFCD may indicate that the dam is stable enough to not require further reduction in impoundment capacity or stabilization at the present, the alkali-aggregate reaction is ongoing and will continue to weaken the structure.

Unlike previous capacity-reducing efforts, any future notching construction will necessitate sediment removal as part of the project. Dredging and/or natural erosion of sediment exposed as a result of notching will require VCFCD to obtain a Section 404 of the Clean Water Act permit (a "404 permit") from the Army Corp of Engineers.

The following is information obtained from Lisa Mangione, Project Manager, Los Angeles District, Regulatory Branch, U.S. Army Corp of Engineers ("the Corp") in March 1998. Ms. Mangione was informed of the background history and issues regarding the Matilija, and asked to provide advice with which to best manage the 404 permit requirement.

Ms. Mangione began with an explanation of the Corps' mission and role in the overall project design and implementation, including the statement that "the Corp can only permit the least environmentally damaging alternative." From the Corps Regulatory Program Applicant Information pamphlet, the following excerpt is provided regarding the process:

Evaluation Factors

The decision whether to grant or deny a permit is based on a public interest review of the probable impact of the proposed activity and its intended use. Benefits and detriments are balanced by considering effects on items such as:

- Conservation
- Economics
- Aesthetics
- General environmental concerns
- Wetlands
- Cultural values
- Fish and wildlife values
- Flood hazards
- Floodplain values
- Food and fiber production
- Navigation
- Shore erosion and accretion
- Recreation

Water supply and conservation
Water quality
Energy needs
Safety
Needs and welfare of the people
Considerations of private ownership

The following general criteria will be considered in the evaluation of every application:

- the relative extent of the public and private need for the proposed activity;
- the practicability of using reasonable alternative locations and methods to accomplish the objective of the proposed activity; and
- the extent and permanence of the beneficial and/or detrimental effects which the proposed activity is likely to have on the public and private uses to which the area is suited.

Section 404(b) of the Clean Water Act

If your project involves the discharge of dredged or fill material, it will be necessary for the Corps to evaluate your proposed activity under Section 404(b)(1) guidelines prepared by the Environmental Protection Agency. The guidelines restrict discharges into aquatic areas where less environmentally damaging, practicable alternatives exist.

The most likely scenario for a 404 permit process would begin with notification to the Corp of the project and need for subsequent permit approval. The 404 permit requirements would include the need for compliance with the National Environmental Policy Act (NEPA). The 404 permit and NEPA provide the nexus for a Section 7 of the Endangered Species Act consultation with other appropriate agencies with regards to listed ESUs, in particular, Southern California Steelhead. Ms. Mangione suggested that prior to submission of a 404 permit application, VCFCD should request an informal meeting with the Corp (the "lead agency"), and the NMFS and the U.S. Fish and Wildlife Service (F&W), as these agencies will play a critical role in the Section 7 consultation. The informal meetings would prove invaluable to the project design, as mutual knowledge of project expectations and clear communication between the agencies and VCFCD would serve to expedite the process.

Ms. Mangione believes that once VCFCD is informed of the specific requirements and potential areas of dispute regarding the chosen management option, the project design can be undertaken with the best chance for a smooth 404 permit approval process. The actual permit application should include a well-defined phased implementation plan for the chosen option. VCFCD's application will begin the permit process, including the formal consultation with NMFS and F&W, which are required to issue a "biological opinion" and terms and conditions that will be applied to the permit. Because VCFCD

will have had the informal meetings prior to permit application, the project design should have the best chance for a “no jeopardy” opinion from NMFS and F&W, allowing the process to move forward.

This information is intended to show the forethought and planning necessary when considering the choice of management options.

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