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BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

Application of California-American Water
Company (U210W) for Authorization to
Implement the Carmel River Reroute and San
Clemente Dam Removal Project and to Recover
the Costs Associated with the Project in Rates.

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(Filed September 22, 2010)
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APPLICATION OF CALIFORNIA-AMERICAN WATER COMPANY (U210W) FOR AUTHORIZATION TO IMPLEMENT THE CARMEL RIVER REROUTE AND SAN CLEMENTE DAM REMOVAL PROJECT AND TO RECOVER THE COSTS ASSOCIATED WITH THE PROJECT IN RATES

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Dated: September 22, 2010

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I. INTRODUCTION

Pursuant to Article 2 of the California Public Utilities Commission's ("Commission") Rules of Practice and Procedure, and as directed by the Commission in D.06-11-50,[1] California-American Water Company ("California American Water") hereby files this application for authorization to implement the Carmel River Reroute and San Clemente Dam Removal Project (the "Reroute and Removal Project") and to recover the costs associated with the Project over a twenty-year period. The Reroute and Removal Project addresses longstanding seismic issues associated with the San Clemente Dam, provides significant environmental benefits, and due to an innovative public/private partnership, will not cost California American Water's customers any more than the least-cost option.

Over the last several decades, California American Water, as directed by the California Department of Water Resources Division of Safety of Dams (DSOD), has analyzed

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[1] D.06-11-050, *Application of California-American Water Company (U210W) for an Order Authorizing it to Increase its Rates for Water Service in its Monterey District to Increase Revenues by $9,456,100 or 32.88% in the Year 2006; $1,894,100 or 4.95% in the Year 2007; and $1,574,600 or 3.92% in the Year 2008; and for an Order Authorizing Sixteen Special Requests with Revenue Requirements of $3,815,900 in the Year 2006, $5,622,300 in the Year 2007, and $8,720,500 in the Year 2008; the Total Increase in Rates for Water Service Combined with the Sixteen Special Requests Could Increase Revenues by $13,272,000 or 46.16% in the Year 2006; $7,516,400 or 17.86% in the Year 2007; and $10,295,100 or 20.73% in the Year 2008, and Application of California-American Water Company (U210W) for Authorization to Increase its Rates for Water Service in its Felton District to Increase Revenues by $796,400 or 105.2% in the Year 2006; $53,600 or 3.44% in the Year 2007; and $16,600 or 1.03% in the Year 2008; and for an Order Authorizing two Special Requests*, 2006 Cal. PUC LEXIS 479, *64.

and taken steps to address the seismic stability of the San Clemente Dam. In January 2008, the DSOD certified the Final Environmental Impact Report and Environmental Impact Statement (EIR/EIS) for the San Clemente Dam Seismic Safety Project. The Final EIR/EIS made clear that the "no project" alternative would not comply with current seismic safety standards and that California American Water must go forward with either a dam buttressing project or the Reroute and Removal Project that California American Water proposes in this application.

The Reroute and Removal Project will address the seismic safety risks associated with the continued operation of the San Clemente Dam by permanently removing the dam. In addition, removal of the dam will resolve continuing issues relating to fish passage, the preservation of habitat for wildlife on the river, and compliance with the federal Endangered Species Act. California American Water has teamed up with the California State Coastal Conservancy ("State Coastal Conservancy") to obtain a commitment for up to $35 million dollars in public funding. Trish Chapman of the State Coastal Conservancy has provided direct testimony describing the agency's role. The State Coastal Conservancy is a state agency that uses entrepreneurial techniques to purchase, protect, restore and enhance coastal resources. Working with the State Coastal Conservancy means that the cost to customers of the Reroute and Removal Project will be no more than the cost of buttressing the San Clemente Dam, a lower cost option that provides fewer environmental benefits and is less certain.

California American Water has a current deadline of September 2012 to start construction. The Reroute and Removal Project presents a unique opportunity for public and private interests to work together to realize benefits far beyond what either could achieve working alone. California American Water requests that the Commission grant the relief requested in this application to facilitate implementation of this beneficial project, including the ratemaking treatment designed to provide recovery of costs over a reasonable period at a lower overall cost to customers. Specifically, California American Water seeks the following:

- Authorization to implement the Reroute and Removal Project

- Final review and approval of the costs tracked in the San Clemente Dam memorandum account through October 31, 2010
- Approval of the proposed ratemaking treatment, including a twenty-year recovery of the proposed regulatory asset
- Authorization to begin recovering costs and earning on the average unrecovered balance of the regulatory asset via surcharge starting January 1, 2012
- Authorization to cease tracking costs in the San Clemente Dam memorandum account on January 1, 2012
- Approval of a revenue balancing account to track the difference between the amount recovered from customers via the authorized surcharge and the final adjusted Commission-authorized revenue requirement for the Reroute and Removal Project
- Approval of the transfer of land where the dam and current reservoir are located as open space; transfer will be to a suitable governmental or nonprofit entity
- Adoption of the proposed process for updates and final review of the completed Reroute and Removal Project

II. HISTORY

The San Clemente Dam is a 106-foot high concrete arch dam located approximately 18.5 miles from the Pacific Ocean on the Carmel River. It was constructed in 1921 and has been operated by California American Water since 1966. Historically, the San Clemente Dam provided water for California American Water's Monterey County District by diverting the surface flow of the Carmel River at the dam. California American Water has reduced over time the amount of water it takes from the Carmel River and, to address concerns regarding endangered species, ceased using the dam as a point of diversion beginning in 2002.

In 1980, the DSOD requested that California American Water evaluate the ability of the San Clemente Dam to safely pass the Probable Maximum Flood and withstand the Maximum Credible Earthquake. Woodward-Clyde Consultants completed an initial report in

1982. The DSOD requested additional analysis; however, at the same time the Monterey Peninsula Water Management District (MPWMD) was evaluating construction of a new dam on the Carmel River, and investigated the San Clemente Dam site as an alternative project location for the "New San Clemente Dam." If constructed, the new reservoir would have inundated the existing dam and reservoir, so the DSOD agreed to defer their request for a more detailed analysis pending the outcome of action by MPWMD. In February 1989, MPWMD shifted its focus away from San Clemente Dam to other parts of the Carmel River. The DSOD then renewed its request for California American Water to perform a detailed analysis of the San Clemente Dam's stability.

In 1990, California American Water began the requested seismic and flood stability studies, which were completed in 1992. Those studies concluded that with full storage, San Clemente Dam might not be stable under the Maximum Credible Earthquake. The studies also concluded that the Probable Maximum Flood could overtop the dam by fourteen feet and cause excessive erosion in the area of the downstream abutments. Based on these findings, the DSOD ordered California American Water to improve the San Clemente Dam so that it would meet current seismic safety standards.

As F. Mark Schubert describes in Section III.B. of his direct testimony, since 1992, there have been numerous engineering and environmental studies regarding the proposed solution to the San Clemente Dam's stability. When the DSOD certified the Final EIR/EIS in January 2008, it concluded that California American Water must go forward with a project to address the San Clemente Dam seismic issues. The Final EIR/EIS focused on two projects, the dam buttressing project and the Reroute and Removal Project, but remained neutral as to which project California American Water should pursue.

III. CARMEL RIVER REROUTE AND SAN CLEMENTE DAM REMOVAL PROJECT

A. Project Description

The Reroute and Removal Project will address the seismic and flood safety risks associated with continued operation of the San Clemente Dam by permanently removing the dam. The Reroute and Removal Project includes relocating approximately 370,000 cubic yards of sediment accumulated behind the dam on the San Clemente Creek arm of the reservoir to the Carmel River arm of the reservoir and removing the dam. A portion of the Carmel River would be permanently bypassed by cutting a 450-foot long channel between the Carmel River and San Clemente Creek, approximately 2,500 feet upstream of the dam. The bypassed portion of the Carmel River would be used as a sediment disposal site for the accumulated sediment. The rock spoils from the channel construction would be used to construct a diversion dike at the upstream end of the bypassed Carmel River channel. California American Water has attached as Appendix 1 a description of the project. F. Mark Schubert also provides a more detailed description in Section IV.A. of his direct testimony.

The State Coastal Conservancy is leading a group of agencies and interested parties that is collaborating with California American Water on the removal of the San Clemente Dam and the restoration of a naturally functioning river channel. The estimated cost of the Reroute and Removal Project is $83 million. The basis for this estimate is the *Advance Basis of Design Report: Carmel River Reroute and San Clemente Dam Removal* that MWH Americas, Inc. prepared for the State Coastal Conservancy in January 2008 ("MWH Report"). California American Water has attached the MWH Report to this application as Appendix 2. Subject to Commission approval, California American Water has committed to pay an amount equivalent to the estimated cost of buttressing the dam (estimated to be approximately $49 million) and to transfer 928 acres where the dam and current reservoir are located as open space to a yet-to-be determined government agency or nonprofit entity. The State Coastal Conservancy will secure approximately $34 million from state, federal, and private foundation resources.

The State Coastal Conservancy has demonstrated its commitment to the Reroute and Removal Project by agreeing to share the costs of the permitting, compliance review and preliminary engineering for the Project, beginning this fall. This represents millions of dollars in avoided costs for California American Water customers. Trish Chapman of the State Coastal Conservancy has provided direct testimony discussing the Conservancy's role in the project.

The Reroute and Removal Project enjoys widespread support at the federal, state and local level. California American Water has attached as Appendix 3 the January 2010 San Clemente Dam Removal Project Collaboration Statement. The signatories to the Statement, which includes state legislators, federal, state and county agencies, and Commissioner John Bohn, among others, agreed to work collaboratively to further the project.

B. Comparison to Dam Buttressing

Dam buttressing (also referred to as "dam thickening" or "dam strengthening") would add steel-reinforced concrete to the existing structure and a state-of-the-art fish ladder. Dam buttressing has the lower estimated construction costs at approximately $49 million; however, the National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA Fisheries) has asserted that this project may jeopardize the continued existence of the steelhead trout. NOAA Fisheries is concerned that the operation of the sluice gates with the new fish ladder could harm migrating steelhead downstream, may cause undue delay in migration, may not open a channel for passage, and may wash migrating steelhead back through the sluice gates at the point they leave the fish ladder and drop them back downstream, or any combination of these effects. Thus, while dam buttressing may have lower construction costs, addressing the concerns of NOAA Fisheries may require significant capital costs, operations and maintenance expense, or both.

The Reroute and Removal Project provides superior environmental benefits by removing a barrier to fish passage and restoring the natural character and function of the area. It enjoys widespread support and will enable California American Water to avoid the permitting delays and Endangered Species Act issues that could ensue from the dam buttressing project.

Finally, the initial estimates indicate that the Reroute and Removal Project will likely have reduced operation and maintenance costs compared to dam buttressing. F. Mark Schubert discusses the preliminary estimates for post-construction costs in Section VI. of his direct testimony.

The primary and significant demerit to the Reroute and Removal Project is that the construction costs are estimated to be $83 million - $34 million more than dam buttressing. A cost breakdown comparing the costs of each alternative is attached as Appendix 4. Because the State Coastal Conservancy has pledged to obtain public funding for approximately $34 million of the difference between the two projects, however, California American Water will be able to provide the enhanced benefits of the Reroute and Removal Project at no additional cost to its customers.

C. Schedule for the Reroute and Removal Project

Successfully implementing this public-private partnership depends significantly on adhering to the proposed schedule. California American Water and the State Coastal Conservancy have developed a work plan for the Reroute and Removal Project. The DSOD reviewed the work plan and found it acceptable, but emphasized that construction must be underway by 2013 (see Appendix 5). The schedule contains a series of tasks that allows the parties to meet the DSOD's deadline. California American Water has attached a Gantt chart of the schedule for the Reroute and Removal Project as Appendix 6 and has summarized the key dates below.

Fall 2010	California American Water, the State Coastal Conservancy, and NOAA Fisheries formally commit to the project
Summer 2011	Complete preliminary design, prepare a Request For Proposal for a design-build contractor, draft an Implementation Agreement, and obtain approval of seventy-five percent of public agency funds.

Fall 2011	Commission approval of Reroute and Removal Project and cost recovery
Summer 2012	Secure all funding, execute an Implementation Agreement, execute a design-build contract and issue a Notice to Proceed to the contractor.
September 2012	Commencement of construction
Fall 2015	Estimated completion of construction

These tasks are interdependent. For example, the State Coastal Conservancy will not be able to obtain a final commitment for funds until the DSOD has approved the designs. California American Water cannot grant the design-build contract until it has obtained Commission approval to recover the cost of the Reroute and Removal Project. Failure to complete any of these items in a timely manner could jeopardize the success of the Reroute and Removal Project as a whole. Further discussion of the proposed schedule for the Project is provided in Section IV.D. of the direct testimony of F. Mark Schubert.

IV. REQUESTED RELIEF

A. Authorization to Implement the Reroute and Removal Project

As discussed above and in Section IV.C. of the direct testimony of F. Mark Schubert, the Reroute and Removal Project will result in multiple environmental benefits, including improving access to twenty-five miles of spawning and rearing habitat for steelhead trout, restoring the ecological connectivity of the river and riparian corridor, and restoring river functions and sediment transport. These benefits would not occur if California American Water pursued the dam buttressing option. Moreover, by working with the State Coastal Conservancy and its partners, California American Water will be able to provide these additional benefits to its customers without projecting additional costs. California American Water requests that the Commission determine that the Reroute and Removal Project is reasonable and authorize California American Water to take steps to implement the project.

B. Review and Approval of Memorandum Account Costs Through October 31, 2010

As authorized by D.06-11-050, California American Water has been recording preconstruction costs in the San Clemente Dam memorandum account. California American Water requests that the Commission review and approve recovery of and on all reasonable costs (including AFUDC) incurred through October 31, 2010. Although the earliest costs tracked in the memorandum account date to 1982, the Office of Ratepayer Advocates (predecessor to the Division of Ratepayer Advocates) already reviewed and agreed that $4,406,700 in pre-2002 costs were reasonable, which the Commission recognized in D.03-02-030.[2] Therefore, only the San Clemente Dam-related costs for the period from January 1, 2002 to October 31, 2010 need to be reviewed for reasonableness at this time

California American Water chose October 31, 2010 as the cut-off date because it is the point at which the costs will, in general, shift from San Clemente Dam-related preconstruction costs to preliminary costs for the Reroute and Removal Project. It is necessary for California American Water to make the transition from tracking previously incurred costs for later recovery to recovery of the estimated costs of a specific project. The State Coastal Conservancy has agreed to pay half of the permitting, compliance review, and preliminary engineering costs. The beginning of the shared costs for the Reroute and Removal Project is a reasonable point at which to make this transition.

As shown in the proposed procedural schedule below, California American Water will make a supplemental filing on November 19, 2010. This filing will include all of the specific details and support for the costs tracked in the San Clemente Dam memorandum account through October 31, 2010. With this supplemental filing, the Commission, the Division of Ratepayer Advocates and other interested parties will have the information necessary to make a

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[2] D.03-02-030, *Application of the California-American Water Company (U210W) for an Order Authorizing it to Increase its Rates for Water Service in its Monterey Division to Increase Revenues by $5,725,300 or 22.47% in the Year 2003; $1,772,100 or 6.94% in the Year 2004; and $ 996,500 or 3.02% in the Year 2005*, 2003 Cal. PUC LEXIS 121, *59.

final determination as to the reasonableness of the memorandum account costs. These final costs will be included in the proposed surcharge.

C. Proposed Ratemaking Treatment

The costs that California American Water is seeking to recover are involuntary – the DSOD is requiring California American Water to incur a certain level of costs in order to address the seismic safety issues associated with the San Clemente Dam. It is well-established Commission practice to allow a utility to recover costs that it is incurring in response to an order from another government agency. California American Water's portion of the cost of the Carmel River Reroute and San Clemente Dam Removal may be characterized as retirement and/or repair costs for the San Clemente Dam and surrounding area. As such, they are properly recovered from customers.

David Stephenson discusses California American Water's ratemaking requests in more detail in Section VII of his direct testimony and a summary of the requests is attached as Appendix 7. In general, California American Water requests that the Commission approve deferral of all prudent costs of the Reroute and Removal Project into a regulatory asset account and allow California American Water to earn a return on the average balance and recover those costs over a twenty-year period commencing on January 1, 2012. This ratemaking treatment reduces the overall cost of the Reroute and Removal Project to customers and allows California American Water to recover its costs in a relatively timely fashion. Additionally, as Charles A. Lenns and David Stephenson discuss in their direct testimonies, California American Water's proposal also provides tax benefits that flow to the company's customers.

D. Recovery of Costs Via Surcharge Beginning January 1, 2012

California American Water requests that the Commission authorize it to begin earning a return on the average balance and recovering the regulatory asset costs via surcharge on January 1, 2012. The costs included in the surcharge fall into six categories: (1) approved San Clemente Dam memorandum account costs (including AFUDC) through October 31, 2010, (2) estimated AFUDC for the San Clemente Dam memorandum account from October 31, 2010 to December 31, 2012, (3) estimated interim dam safety and environmental costs, (4) estimated permitting, compliance, and preliminary engineering costs for the Reroute and Removal Project, (5) estimated construction costs for the Reroute and Removal Project, and (6) estimated post-construction mitigation costs for the period from completion of the project until the regulatory asset costs are moved into base rates. In developing the proposed surcharge, California American Water subtracted the public agency funds to be collected by the State Coastal Conservancy and remitted to California American Water from the total cost of the Reroute and Removal Project. The total current estimate of costs to be included as part of the regulatory asset is approximately $76 million.

1. Memorandum Account Costs Through October 31, 2010

As discussed above, California American Water requests that the Commission as part of this proceeding conduct its final reasonableness review of the costs tracked in San Clemente Dam memorandum account through October 31, 2010. For the purpose of this application and in order to develop the proposed surcharge, California American Water estimates that the costs for this category will be $21,775,029. This includes the $21,159,164 in the memorandum account as of September 1, 2010, the costs that California American Water expects to incur in September and October 2010, and the associated AFUDC for the entire amount. David Stephenson discusses this figure in Section VIII.A. of his direct testimony. Following the Commission's review of these costs, the final approved amount will be in the actual surcharge.

2. AFUDC for San Clemente Dam Memorandum Account

In D.08-05-036, the Commission authorized California American Water to include in the San Clemente Dam memorandum account AFUDC (at the company's authorized rate of return) on the costs it tracks in that account. As discussed in the previous section, California American Water will include the AFUDC accrued through October 31, 2010 in its November 19, 2010 supplemental filing. Until the Commission authorizes recovery of the Reroute and Removal Project costs via surcharge, however, California American Water will continue to track costs in the San Clemente Dam memorandum account in order to avoid retroactive ratemaking. The AFUDC will continue to accrue as long as California American Water tracks costs in the San Clemente Dam memorandum account. California American Water proposes to stop tracking costs in the memorandum account on January 1, 2012, the date that the proposed surcharge will go into effect.

California American Water estimates that the amount of AFUDC that will accrue to the San Clemente Dam memorandum account from November 1, 2010 to December 31, 2011 will be $2,577,751. To reach this figure, California American Water applied its current authorized rate of return (8.04%) to the estimated costs that it expects to incur during that period. The costs that will be tracked in the memorandum account during that period include preliminary engineering costs for the Reroute and Removal Project and interim dam safety and environmental costs, both of which California American Water discusses in the immediately following sections.

3. Estimated Interim Dam Safety and Environmental Costs

In June 2002, the DSOD ordered California American Water to make modifications to San Clemente Dam in order to meet interim dam safety and environmental requirements. In 2003, California American Water drilled six twelve-inch diameter ports, or holes, through the dam itself in order to allow a seasonal drawdown of the reservoir of ten feet, to an elevation of approximately 515 feet during low flow periods. California American Water equipped each port with a trash rack to prevent large debris from entering and blocking flow through the port. The timing of the seasonal drawdown allows migratory fish passage. These seasonal drawdowns occur every year, with the accompanying need to adequately ensure that California American Water meets the environmental requirements for proper care of the California red-legged frog and steelhead trout. California American Water must continue to undertake these measures until the San Clemente Dam is removed.

California American Water will include the costs for the interim safety and environmental measures that it incurs through October 31, 2010 in the November 19, 2010 supplemental filing. In order to develop the proposed surcharge in this application, California American Water estimated the costs for the interim dam safety and environmental measures that it will undertake from November 1, 2010 until the dam is removed. The estimated cost is $2.5 million. In Section V. of his direct testimony, F. Mark Schubert provides more detail on the interim dam safety and environmental measures.

4. Estimated Permitting, Compliance and Preliminary Engineering Costs

Between 2010 and 2012, the Reroute and Removal Project planning and management team (composed of California American Water, the State Coastal Conservancy and NOAA Fisheries) will undertake a number of tasks to implement the project, focusing on securing funds, preliminary engineering, selecting a design-build contractor, and permitting.

To meet the DSOD's schedule, beginning in the third quarter of 2010 the project team will select a qualified engineering consultant to prepare a thirty percent design from the current conceptual design prepared by the State Coastal Conservancy. The State Coastal Conservancy's Technical Review Team will review the draft design criteria, design concepts, and the draft thirty percent design and provide input before the engineering consultant produces the final design. The preliminary design is expected to take approximately one year to develop.

The Technical Review Team is comprised of a variety of experts from, among others, NOAA Fisheries, the Bureau of Reclamation, the U.S. Fish and Wildlife Service, the California Department of Fish and Game, the Monterey County Water Resources Agency, the Regional Water Quality Control Board, the Carmel River Steelhead Association, U.C. Berkeley, and private engineering firms. The Technical Review Team, paid for by the State Coastal Conservancy, will provide guidance and assistance throughout the process.

While the thirty percent design is in process, the State Coastal Conservancy will be working with various regulatory agencies to secure the significant number of permits required to construct the Reroute and Removal Project, including coordination between permitting agencies where permits are interdependent, preparing permit applications, and obtaining approvals from the agencies.

The State Coastal Conservancy will also prepare an environmental compliance plan that combines the mitigation measures identified in the EIS/EIR and the measures and conditions required by the project permits and authorizations. For each environmental compliance measure, the plan will describe the necessary action, the affected area, when compliance with the measure must take place, the entity responsible for implementing the measure, and the entity responsible for confirming that the measure is implemented.

The Bureau of Reclamation has also agreed to undertake its Design, Engineering, and Construction (DEC) Review for the Reroute and Removal Project. As described in more detail in Appendix 8, the purpose of this review is to provide an independent oversight process that ensures that major elements of proposed development and construction projects (i.e. design, cost estimating, and construction) are technically sound and provide a credible basis for decision making by the project sponsors and partners, along with leadership members and other decision makers. The Bureau of Reclamation will cover the labor and associated costs of the review; California American Water will only be responsible to the travel costs – a significant saving for customers.

The estimated cost for all of the permitting, compliance and preliminary engineering activities is $6 million. The MWH Report, attached as Appendix 2, provides a more detailed explanation of the estimated costs. F. Mark Schubert also discusses the permitting, compliance and preliminary engineering activities in Section III.C. of his direct testimony. California American Water and the State Coastal Conservancy have agreed to share this cost, creating savings for California American Water's customers. Therefore, California American Water is only seeking to recover half of the permitting, compliance and preliminary engineering costs from its customers.

5. Estimated Construction Costs

The Reroute and Removal Project will address the seismic and flood safety risks associated with continued operation of San Clemente Dam by permanently re-routing a portion of the Carmel River and removing the dam. The construction portion of the project includes relocating approximately 370,000 cubic yards of sediment accumulated behind the dam on the San Clemente Creek arm of the reservoir to the Carmel River arm of the reservoir and removing the dam. A portion of the Carmel River will be permanently bypassed by cutting a 450-foot long channel between the Carmel River and San Clemente Creek, approximately 2,500 feet upstream of the dam. The bypassed portion of the Carmel River will be used as a sediment disposal site for the accumulated sediment. The rock spoils from the channel construction would be used to construct a diversion dike at the upstream end of the bypassed Carmel River channel.

The current estimate of the construction costs for the Reroute and Removal Project is $77 million. A more detailed description of the construction portion of the Reroute and Removal Project is included in the MWH Report, attached as Appendix 2.

6. Estimated Post-Construction Costs

California American Water anticipates that either it or the post-construction owner will have to undertake certain post-construction mitigation measures to ensure the success of the Reroute and Removal Project. It is unclear if the post-construction owner will be willing to perform the required tasks. Even if the post-construction owner will perform the required monitoring, the terms of the transfer may require California American Water to fund these activities.

California American Water has included $560,000 in post construction costs in its regulatory asset surcharge estimate. This reflects estimated post construction expenses for the period from project completion to inclusion of the regulatory asset in base rates. The estimated remaining post construction costs will be included in the final application filed six months after project completion.

David Stephenson discusses the calculation of the post-construction costs in the regulatory asset surcharge in Section VIII.F. of his direct testimony. F. Mark Schubert discusses post-construction mitigation activities in Section VI of his direct testimony.

7. State Coastal Conservancy Contribution

The State Coastal Conservancy is leading the effort to secure grants from public agencies and private foundations to help fund the cost of the Reroute and Removal Project. The Legislature created the State Coastal Conservancy as a unique entity with flexible powers to serve as an intermediary among government, citizens and the private sector. The State Coastal Conservancy has prepared a funding plan that identifies the amounts and sources of over $40 million in grant funds that, when discounted for probability of success, would result in approximately $34 million dollars in public agency grants. The State Coastal Conservancy will also take care of the administration of these grants, including ensuring compliance with grant terms.

Once the State Coastal Conservancy has secured commitments from other agencies for the required funding, the California Ocean Protection Council[3] will provide a grant to California American Water for the total amount of the public agency contributions. California American Water will then transmit invoices to the California Ocean Protection Council for payment to California American Water as they are received from contractors and other vendors.

The State Coastal Conservancy's current funding plan calls for seventy-five percent of the public agency grants to be committed to the State Coastal Conservancy by summer 2011 and it expects to have all funds committed by summer 2012, in time for California American Water to award the design-build construction contract and meet the DSOD's deadline for construction.

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[3] The California Ocean Protection Council coordinates and administers the activities of ocean-related state agencies to improve the effectiveness of state efforts to protect ocean resources within existing fiscal limitations.

In developing the proposed surcharge, California American Water subtracted State Coastal Conservancy's contribution from the overall estimated costs of the Reroute and Removal Project.

8. Implementation of the Surcharge

California American Water based the proposed surcharge on the projected annual revenue requirement of the estimated regulatory asset balance. California American Water used the current schedule for the Reroute and Removal Project and the estimates contained in the MWH Report to determine the estimated regulatory asset balance for each year. Based on the schedule for the Reroute and Removal Project, California American Water proposes to recover revenue requirement of the estimated regulatory asset balance through a surcharge from 2012 through 2017. Appendix 9 shows the estimated annual revenue requirement and proposed surcharges for 2012-2017. After the final review of the Reroute and Removal Project costs and true up of the requested balancing account, California American Water will include the revenue requirement of the remaining unamortized regulatory asset in base rates as part of the 2018 test year in its general rate case. Recovery of the regulatory asset will continue through 2031. California American Water proposes to bill the surcharge to customers of the main Monterey system, and the Ryan Ranch and Bishop subsystems.[4] David Stephenson provides additional information on the proposed surcharge in Section VII.B. of his direct testimony.

E. Closure of San Clemente Dam Memorandum Account

In order to avoid retroactive ratemaking, California American Water will continue to track the costs it incurs for the Reroute and Removal Project in a memorandum account until December 31, 2011. As discussed above, beginning January 1, 2012, California American Water seeks to treat all project costs as a regulatory asset and to begin recovering the estimated costs over a twenty-year period.[5] Therefore, California American Water seeks to close the San Clemente Dam memorandum account as of January 1, 2012.

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[4] The purchase agreement for the Hidden Hills subsystem prohibits the allocation of costs of projects related specifically to items on the Carmel River to Hidden Hills customers.

[5] The surcharge adopted in this proceeding will provide an estimated basis for recovery of the amounts tracked from

F. Balancing Account Request

California American Water requests that the Commission authorize California American Water to track in a balancing account the difference between the amounts recovered in rates and the actual revenue requirement of the Reroute and Removal Project. The actual revenue requirement will be based on: (1) final approved costs, (2) the actual timing of the expenditures, (3) the actual authorized rate of return, (4) the ability to recover the costs related to the project for tax purposes, and (5) other standard ratemaking items.[6] If, after the Reroute and Removal Project is completed, the actual revenue requirement of the authorized costs is less than the actual surcharge recovery in rates, California American Water will return the difference to customers.

Although the current estimated costs for the Reroute and Removal Project are based on extensive research and analysis and are more than reliable enough for the Commission to use to develop the regulatory asset and associated surcharge, they are still estimates, and the final costs may differ. This balancing account will ensure that California American Water's customers pay only for the actual cost of the Reroute and Removal Project and provides California American Water recourse if the revenue requirement on the cost of the project is more than the surcharge collections from customers. In keeping with the Commission's decision in D.08-05-036, California American Water requests that this balancing account accrue interest at the company's authorized rate of return. Finally, California American Water requests that the Commission authorize it to track in the proposed balancing account any financing costs the California American Water incurs because of delays or reductions in grant payments.

G. Land Transfer

California American Water currently owns 928 acres of land surrounding the dam and reservoir. Apart from the dam facilities, this land is pristine open space adjacent to the Los Padres National Forest. As part of the Reroute and Removal Project, California American Water

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November 1, 2010 through December 31, 2011, including AFUDC.

[6] Standard ratemaking items include uncollectibles, franchise fees, ad valorem tax and similar items that are determined in general rate cases.

intends to transfer the land to a government or non-profit entity. Transfer of the land will be conditional upon restricting use of the land to recreational and open space use in perpetuity, and not for commercial or other development, and acceptance of responsibility for future stewardship and management of the land.

In addition to reducing the long-term liability to California American Water and its customers, the land transfer may also provide significant tax benefits that will reduce customer costs. The transfer of the land may provide a tax deduction for the donation generally equal to the fair market value of the donated property, determined on the date of the donation. A tax benefit resulting from the donation of the land will reduce the regulatory asset and thereby reduce the costs to ratepayers of the Reroute and Removal Project. A discussion of the tax consequence of the land donation is in the direct testimony of Charles A. Lenns of Ernst & Young.

H. Proposed Process for Updates and Final Review

The current schedule provides for the design/build contract for the Reroute and Removal Project to be awarded by summer 2012. By that time, the State Coastal Conservancy will also have secured its commitments for public funding. If either of these milestones results in a significant change in the overall cost of the Reroute and Removal Project, California American may file an advice letter to revise the revenue requirement.[7] Otherwise, the difference between the estimated and final costs will be tracked in the balancing account and reviewed after the Reroute and Removal Project is completed.

If actual construction costs are lower, the cost savings will be allocated between California American Water and the State Coastal Conservancy based on the source of the saving. Trish Chapman of the State Coastal Conservancy discusses the allocation of cost savings in her direct testimony.

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[7] To the extent that General Order 50-B is applicable to the Reroute and Removal Project, California American Water will also include the final plans as approved by the DSOD.

Six months after completion of the Reroute and Removal Project, California American Water will submit an application for review of the final project costs and true up of the balancing account. In that application, as discussed previously, California American Water will also provide estimates of the remaining post-construction mitigation, compliance, monitoring and/or operation and maintenance costs. After completion of this review, in the general rate case following the completion of the Reroute and Removal Project, California American Water will include in base rates the annual revenue requirement on the remaining balance of the regulatory asset and its share of the estimated post-construction costs.

V. REQUIRED INFORMATION

A. Applicant Information

Applicant's legal name is California-American Water Company. California American Water's corporate office and post office address is 1033 B Avenue, Suite 200 Coronado, California 92118. California American Water is a California corporation organized under the laws of the State of California on December 7, 1965. California American Water is a Class A regulated water utility organized and operating under the laws of the State of California. California American Water provides water and wastewater service in various areas in the following California counties: Los Angeles, Monterey, Placer, Sacramento, San Diego, Sonoma, and Ventura.

A certified copy of California American Water's articles of incorporation was filed with the Commission on January 6, 1966 in connection with Application 48170. A certified copy of an amendment to California American Water's articles of incorporation was filed with the Commission on November 30, 1989 in connection with Application 89-11-036. A certified copy of an Amendment to California American Water's Articles of Incorporation dated October 3, 2001 and filed with the office of the California Secretary of State on October 4, 2001, was filed with the Commission on February 28, 2002 in connection with Application 02-02-030. The Articles of Incorporation have not been subsequently amended.

None of the persons described in Section 2 of General Order No. 104-A has a material financial interest in any transaction involving the purchase of materials or equipment or the contracting, arranging, or paying for construction, maintenance work, or service of any kind to which Applicant has been a party during the period subsequent to the filing of California American Water's last Annual Report with this Commission or to which California American Water proposed to become a party at the conclusion of the year covered by said Annual Report.

B. Application Correspondence

Correspondence and communications concerning this application should be addressed to the following:

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C. Category

Rule 1.3(e) of the Commission's Rules of Practice and Procedure defines ratesetting proceedings as those in which "the Commission sets or investigates rates for a specifically named utility (or utilities), or establishes a mechanism that in turn sets the rates for a specifically named utility (or utilities)." The Commission should categorize this proceeding as ratesetting.

D. Evidentiary Hearings

Evidentiary hearings will likely be necessary to address factual disputes on material issues.

E. Issues

The main issue in this proceeding is whether the Commission should authorize California American Water to implement the proposed Reroute and Removal Project. Depending on the Commission's determination as to the reasonableness of the Reroute and Removal Project, the Commission will also need to determine the appropriateness of California American Water's ratemaking treatment, including the proposed balancing account mechanism, the justification for the company's memorandum account requests, whether the costs incurred by California American Water are prudent, and the reasonableness of California American Water's estimate of the cost of the Reroute and Removal Project.

F. Schedule

Protests to Application	30 days from Daily Calendar notice
Reply to Protests	10 days from protest deadline
Prehearing Conference	October/November 2010
Supplemental Filing	November 19, 2010
Scoping Memorandum	December 2010
Public Participation Hearings	December 2010 – January 2011
DRA/Intervenor Testimony	March 11, 2011
Rebuttal Testimony	April 1, 2011

Settlement Meetings	April 6-15, 2011
Evidentiary Hearings	April 25-29, 2011
Briefing	May 16-May 30, 2011
Proposed Decision	August 30, 2011
Commission Decision	September 2011

VI. NOTICE AND SERVICE

In accordance with Rule 3.2(b), California American Water will serve a copy of this application upon the attached service list.

Within ten days of the filing, California American Water will cause to be published once, in a newspaper of general circulation in the area served, a notice of the general terms of the proposed increases. California American Water will submit proof of such publication to the Commission. California American Water has provided a draft of the customer notices to the Public Advisors Office. A sample draft notice is attached as Appendix 10. California American Water will send notice of the application to its customers in accordance with Rule 3.2(d).

VII. SUPPORT FOR APPLICATION

A. Appendices

Appendix 1 – Reroute and Removal Project Description

Appendix 2 – MWH Report

Appendix 3 – San Clemente Dam Removal Project Collaboration Statement

Appendix 4 – Project Cost Comparison

Appendix 5 – DSOD Letter

Appendix 6 – Project Schedule

Appendix 7 – Ratemaking Summary

Appendix 8 – DEC Process Summary

Appendix 9 – Revenue Requirement and Proposed Surcharges

Appendix 10 – Draft Customer Notice

Appendix 11 – Balance Sheet and Income Statement

B. Testimony

Direct Testimony of Trish Chapman – Role of the State Coastal Conservancy

Direct Testimony of Charles A. Lenns – Tax Issues

Direct Testimony of F. Mark Schubert – San Clemente Dam Review and Reroute and Removal Project Description

Direct Testimony of David Stephenson – Cost Recovery and Ratemaking

VIII. CONCLUSION

As discussed above, the Reroute and Removal Project presents a unique opportunity for public and private interests to work together to realize public benefits far beyond what either could achieve working alone. Not only does this project permanently address the San Clemente Dam's seismic safety issues, it also provides significant environmental benefits by restoring the Carmel River's natural processes. By partnering with the State Coastal Conservancy, California American Water will be able to provide the benefits of the superior Reroute and Removal Project at no more than the cost of the dam buttressing option, which is less certain and provides fewer advantages. California American Water requests that the Commission grant the relief requested in this application so that California American Water may implement this beneficial project.

Dated: September 22, 2010

MANATT, PHELPS & PHILLIPS, LLP

By: ____________________________
Lori Anne Dolqueist

Attorneys for Applicant
California-American Water Company

VERIFICATION

I, the undersigned, say:

I am an officer of CALIFORNIA-AMERICAN WATER COMPANY, a corporation, and am authorized to make this verification for and on behalf of CALIFORNIA-AMERICAN WATER COMPANY, and I make this verification for that reason. I have read the foregoing application, am informed, and believe the matters therein are true, and, on that ground, allege that the matters stated therein are true.

I declare under penalty of perjury that the foregoing is true and correct.

Executed at Sacramento, California, September 22, 2010.

CALIFORNIA-AMERICAN WATER COMPANY

By ____________________________
David P. Stephenson

NOTICE OF AVAILABILITY

The appendices and testimony in support of California American Water's application exceed 50 pages in length and 3.5 megabytes in size. Therefore, pursuant to Rules 1.9(c)(1)-(2), California American Water hereby provides this Notice of Availability of the appendices and testimony. Upon written request, California American Water will provide a copy of the appendices and testimony. Parties that wish to obtain a copy of the appendices and testimony should contact:

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Assistant to Lenard G. Weiss, Lori Anne Dolqueist, and Demetrio Marquez
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Appendix 1 – Reroute and Removal Project Description

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Direct Testimony of David Stephenson – Cost Recovery and Ratemaking

Dated: September 22, 2010

By: Cinthia A Velez
Cinthia A. Velez

PROOF OF SERVICE

I, Cinthia A. Velez, declare as follows:

I am employed in San Francisco County, San Francisco, California. I am over the age of eighteen years and not a party to this action. My business address is MANATT, PHELPS & PHILLIPS, LLP, One Embarcadero Center, 30th Floor, San Francisco, California 94111. On September 22, 2010, I served the within:

Application of California-American Water Company (U210W) for Authorization to Implement the Carmel River Reroute and San Clemente Dam Removal Project and to Recover the Costs Associated with the Project in Rates

on the interested parties in this action addressed as follows:

See Attached Service List

☒ **(BY MAIL)** By placing such document(s) in a sealed envelope, with postage thereon fully prepaid for first class mail, for collection and mailing at Manatt, Phelps & Phillips, LLP, San Francisco, California following ordinary business practice. I am readily familiar with the practice at Manatt, Phelps & Phillips, LLP for collection and processing of correspondence for mailing with the United States Postal Service, said practice being that in the ordinary course of business, correspondence is deposited in the United States Postal Service the same day as it is placed for collection.

☒ **(BY OVERNIGHT MAIL)** By placing such document(s) in a sealed envelope, for collection and overnight mailing at Manatt, Phelps & Phillips, LLP, San Francisco, California following ordinary business practice. I am readily familiar with the practice at Manatt, Phelps & Phillips, LLP for collection and processing of overnight service mailing, said practice being that in the ordinary course of business, correspondence is deposited with the overnight messenger service, September 22, 2010, for delivery as addressed.

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct and that this declaration was executed on September 22, 2010, at San Francisco, California.

Cinthia A Velez

Cinthia A. Velez

Application of California-American Water Company (U210W) for Authorization to Implement the Carmel River Reroute and San Clemente Dam Removal Project and to Recover the Costs Associated with the Project in Rates

SERVICE LIST

Via Federal Express
*With Appendices and Testimony

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Application of California-American Water Company (U210W) for Authorization to Implement the Carmel River Reroute and San Clemente Dam Removal Project and to Recover the Costs Associated with the Project in Rates

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APPENDIX 1

San Clemente Dam Removal Project

Project Description

In Cannery Row, John Steinbeck wrote *"The Carmel is a lovely little river. It isn't very long but in its course it has every thing a river should have."* Since 1921, however, the Carmel River and its wildlife resources have been impacted by San Clemente Dam. As a result of the dam, the Carmel River suffers accelerated erosion, the once vibrant steelhead run has dramatically decreased, and lives and property below the dam are threatened with collapse of the unsafe structure. Today, there is an extraordinary opportunity to remove the antiquated dam and initiate a watershed restoration process that will bring this river back to life.

Background

The Carmel River is located in Monterey County along California's central coast. The river has its headwaters in Los Padres National Forest and its 255-square mile watershed drains the north side of the Santa Lucia Mountains. The river provides essential habitat for many important species, including steelhead trout and California red-legged frog, both listed as threatened under the Federal Endangered Species Act.

San Clemente Dam is a 106-foot high concrete arch dam located approximately 18.5 miles from the Pacific Ocean on the Carmel River (Figure 1). California American Water (CalAm) owns and operates the dam. When the dam was constructed in 1921, it had a reservoir storage capacity of approximately 1,425 acre-feet. Today the reservoir is over 90% filled with more than 2.5 million cubic yards of sediment, leaving a reservoir storage capacity of approximately 125 acre-feet. At this point, the sole function of the dam is to provide a diversion point for water withdrawals from the river.

Figure 1: San Clemente Dam

In the early 1990s, the California Department of Water Resources (DWR) Division of the Safety of Dams (DSOD) issued a safety order, determining that the dam structure could potentially fail in the event of either the maximum credible earthquake or probable maximum flood. CalAm was tasked with finding a solution to this safety problem and proposed a project to strengthen the dam's structure. In 2006, DWR released a Draft Environmental Impact Report/Environmental Impact Statement (EIR/EIS) evaluating CalAm's preferred approach of Dam Strengthening (also referred to as 'buttressing"), as well as four alternative projects.

The most feasible alternative, the Carmel River Reroute and Dam Removal (Reroute and Removal) option, provided a solution to the dam safety issue, while also addressing the other issues related to the dam's impact on the river. The Reroute and Removal project would provide numerous public benefits including:

- Permanent resolution to the dam safety concern
- Unimpaired access for steelhead trout to over 25 miles of spawning and rearing habitat

- Restoration of sediment to the lower river and Carmel River State Beach
- Restored ecological connectivity of aquatic and riparian habitats

For these reasons, the California State Coastal Conservancy (Conservancy), National Marine Fisheries Service (NMFS), and the Planning and Conservation League Foundation worked with CalAm to develop a feasible approach to cooperatively implementing the Reroute and Removal option. In December 2007, DWR certified the Final EIR/EIS, and in February 2008, DSOD confirmed the Reroute and Removal project would alleviate the dam safety deficiencies.

Implementation Strategy

The Conservancy, CalAm and NMFS, outlined the key elements of the implementation strategy for the Reroute and Removal project, in an agreement signed in February 2008. Per the agreement, project implementation will be shared by the three entities as follows:

- The Conservancy will manage project planning and design;
- The Conservancy, with the assistance of NMFS, will coordinate with the regulatory agencies to secure all permits and expeditious approval of the project;
- CalAm will manage the project construction;
- Upon completion of the project, CalAm will transfer the project area lands, approximately 928 acres, to the Monterey Peninsula Regional Park District for watershed conservation and compatible public access.

Project Costs

The total project cost for the Reroute and Removal project is currently estimated at $83 million (Figure 2). According to the implementation agreement, CalAm will pay an amount equivalent to the estimated cost of buttressing the dam, or approximately $49 million. The Conservancy, with assistance from NMFS, will secure the additional $34 million from state, federal, and private foundation sources (the “public funders”).

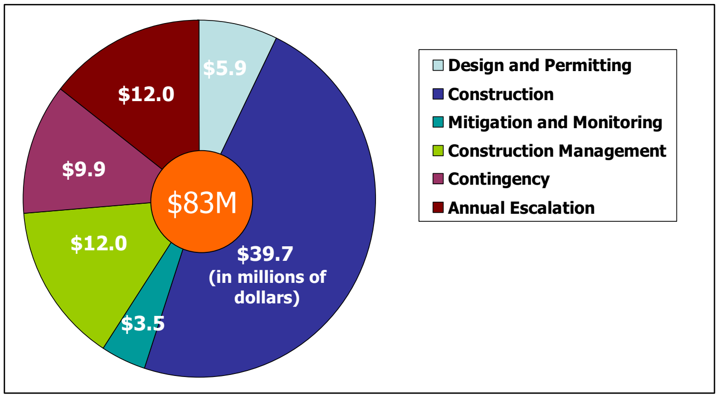

Figure 2: Project Costs

This cost estimate includes the costs of final design and engineering, additional technical studies and review, environmental review and permitting, project construction, design and implementation of required mitigation and monitoring measures, project management, and project administration. The $83 million cost estimate includes a 25% contingency as well as a category for “unidentified items” accounting for 10% of the construction costs. Thus, it is considered a fairly conservative cost estimate.

There is a potential opportunity for reducing the cost of dam removal by obtaining the assistance of the U.S. Department of Defense's Innovative Readiness Training Program (IRT). Through this program, members of the military reserves achieve their training objectives through participation in civilian projects. Civilian partners must pay for equipment and materials, but the military pays for the labor costs. IRT troops could potentially undertake many elements of the dam removal project including construction of roads, pipelines, and the diversion dike; earthmoving; blasting of the reroute channel;

and removal of the dam (see Project Description for more information). IRT staff has expressed serious interest in participating in the project. The project team is working on an application for IRT participation.

Project Description

Figure 3: Aerial Photo of Project Site

With any dam removal project in the western U.S., one of the most difficult issues is determining how to manage the sediment which has accumulated behind the dam. It is estimated that there are 2.5 million cubic yards of sediment behind San Clemente Dam. Due to limited and difficult access to the dam site, trucking the sediment out was deemed infeasible, both environmentally and economically. Likewise, due to the current significant flooding issue along the lower Carmel River, allowing the sediment to erode downstream was deemed infeasible because it would likely worsen downstream flooding. Therefore, the project design proposes to re-route a half-mile portion of the Carmel River into San Clemente Creek and use the abandoned reach as a sediment storage area. This is described in greater detail below and illustrated in Figures 3-5.

San Clemente Dam is located just downstream of the confluence of the Carmel River and San Clemente Creek (Figures 3 and 4). The two waterways are separated by a narrow ridge. As can be seen in Figure 3, the majority of the sediment which has accumulated behind the dam is located along the Carmel River side of the reservoir. The design of the Reroute and Removal project takes advantage of this situation by transforming the Carmel River arm of the lower reservoir (already full of sediment) into a permanent sediment storage area. This design minimizes the amount of sediment which must be excavated and moved, thereby reducing the project cost as well as some of the environmental impacts.

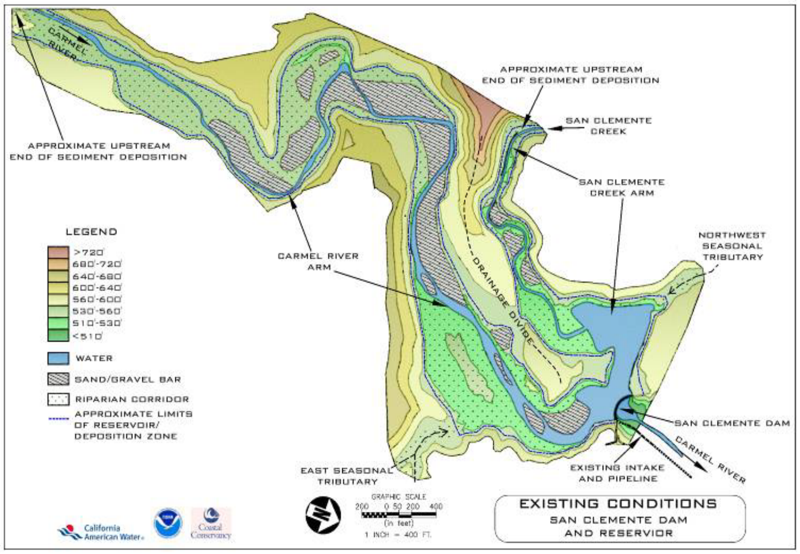

Figure 4: Schematic of Existing Conditions

To establish the lower Carmel River arm of the reservoir as a permanent sediment storage area, the river must be rerouted into the adjacent San Clemente Creek, upstream of this area. This will be accomplished by cutting a “bypass channel” (also called a diversion channel) through the narrow ridge separating the two waterways, approximately one-half mile upstream of the dam (Figure 5, Label #1). The bypass channel would be cut by a combination of blasting and ripping the rock. Rock excavated from the bypass channel would then be used to create structure that would block the river from entering the sediment disposal area and divert it into the newly cut bypass channel. This structure, the “diversion dike”, would essentially be a new ridge cutting across the valley floor (Figure 5, Label #2).

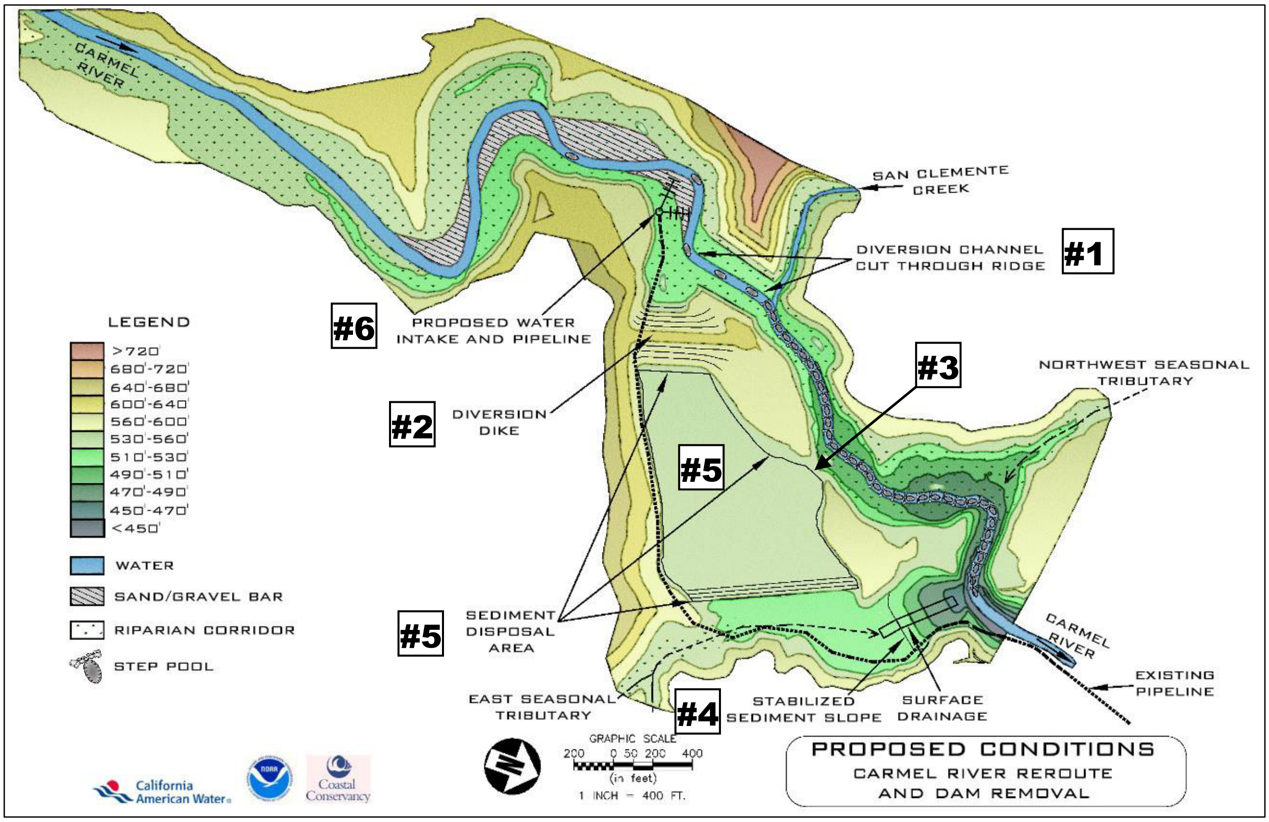

Figure 5: Schematic of Dam Removal Project Components

Although the majority of accumulated sediment is already on the Carmel River side of the reservoir, approximately 380,000 cubic yards of sediment that has accumulated in the San Clemente Creek arm would need to be excavated and added to the Carmel River sediment storage area. A temporary haul road would be created at a low point in the ridge separating the river and the creek (Figure 5, Label #3) to transport the excavated sediment, using heavy earthmoving equipment. Sediment that has accumulated immediately behind the dam on the Carmel River side would also need to be excavated and moved further upstream. Once all the sediment excavation and placement is complete, the sediment disposal area will slope gently up from the edge of the river (Figure 5, Label #4) to a broad plain (Figure 5, Label #5) where the disposed sediment has been placed. The sediment slope will be stabilized to ensure that it is not eroded by the river during high flows. Eventually the sediment disposal area is expected to revegetate with upland scrub habitat similar to the surrounding hillsides.

On the San Clemente Creek side of the reservoir, the half-mile reach between the dam and the downstream end of the bypass channel would be reconstructed to carry the combined flows of both the river and the creek, and to allow for fish passage. First, the sediments would be excavated down to the pre-dam elevations. In order to facilitate fish passage, a series of step pools will be created along this reach. The step pools will be created by placing large rocks across the bottom of the channel (Figure 6a). In high flows, water will flow over the rocks creating small (approximately 1 foot) jumps for the steelhead. Behind the rocks, water will pool, creating an area of slower moving water where the fish can rest before taking the next jump. This design is based on naturally-forming step pools that can be found further upstream in steeper reaches of the Carmel River (Figure 6b).

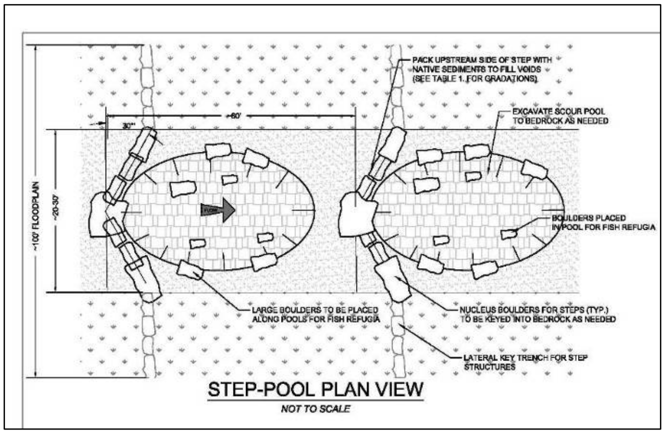

Figure 6a: Step-pool Design

Figure 6b: Step pools in upper Carmel River

Along both the reconstructed reach of San Clemente Creek and the bypass channel, measures will be taken to restore and/or establish riparian habitat. This will include creation and/or enhancement of seasonal ponds that can be used by California red-legged frogs. The ultimate goal is to create a dynamically resilient riparian corridor. In other words, the design assumes that while step pools, frog ponds, riparian habitat and other features may be changed by high flows, the system will naturally re-establish itself in such a way so that the functions of fish passage, sediment transport, and habitat support will continue to be provided.

Once the sediment excavation and stream restoration is complete, the dam will be demolished. The concrete rubble will be used to help stabilize the sediment stockpile and the diversion dam. All concrete rubble will be used on site. No construction wastes will need to be trucked off site.

CalAm currently maintains a water withdrawal or “diversion” point in the reservoir. This diversion point will not be functional once the dam is removed and the reservoir drained. Therefore, the project includes a component to relocate the diversion point. As shown on Figure 5, Label #6, the new water withdrawal structure will be placed upstream of the bypass channel. The new diversion point will be below ground along the bank of the river using a Ranney collector, a well-established technology for subsurface water withdrawal.

Finally, the project currently includes notching the Old Carmel River Dam (OCRD) located approximately 1800 feet downstream of San Clemente Dam. The OCRD is a 32-foot high structure built in 1893. Notching it would improve fish passage. However, in a separate effort, the National Marine

Fisheries Service is working with CalAm to have the dam removed rather than notched. Removing the OCRD would provide even greater benefits to fish passage and river function.

Project Construction

Construction of the project is expected to take three years. Construction activities will be restricted to approximately April to November to avoid the rainy season and impacts to migrating steelhead. During years two and three of construction, the Carmel River and San Clemente Creek will be diverted around the reservoir and dam site, and the reservoir will be dewatered.

Primary access to the site during construction will be from Cachagua Road. There is an existing jeep trail off of Cachagua Road that leads part way to the reservoir. This jeep trail will be improved and extended all the way to the reservoir (Figure 7, Label #1). For work on the dam itself, construction equipment will be brought in along San Clemente Drive and the low access road to the dam (Figure 7, Label #2). The low access road will need to be improved to accommodate construction vehicles.

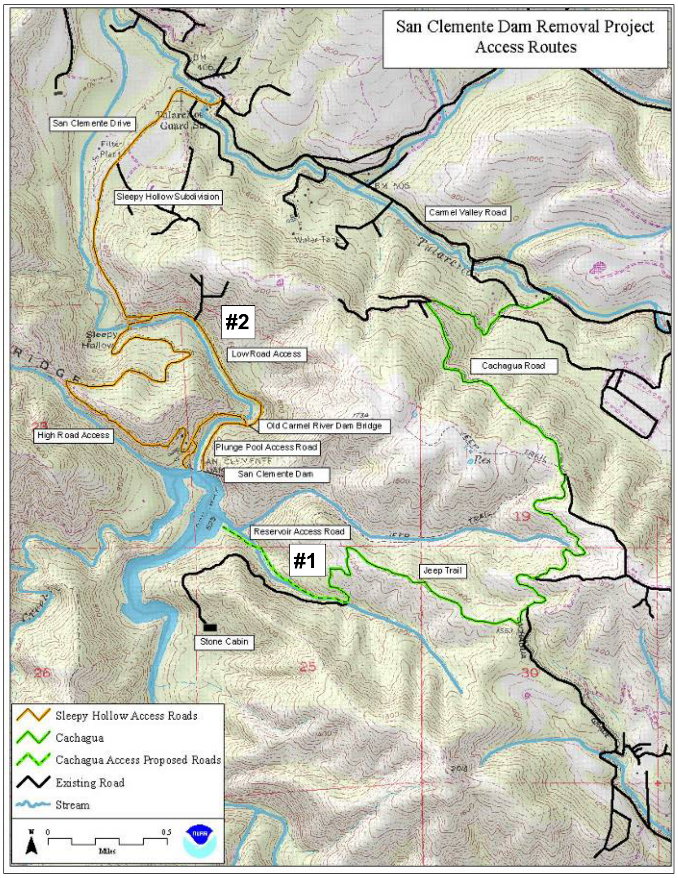

Figure 7: Construction Access Routes

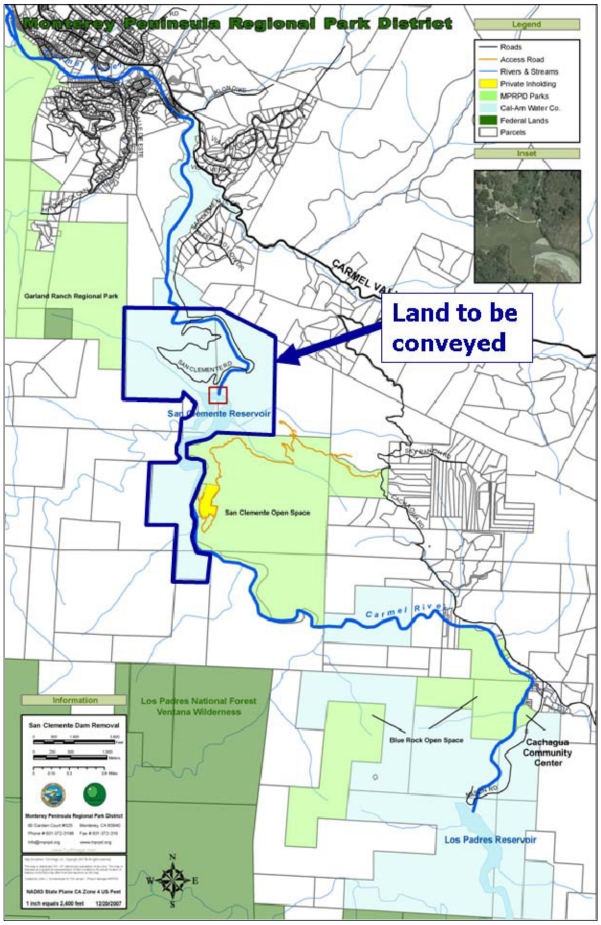

Figure 8: Land to be Conveyed to MPRPD

The first year of construction would consist primarily of road improvements and site preparation work such as clearing the area for the bypass channel excavation and creating the temporary haul road. In the second year, the bypass channel will be cut, the diversion dike constructed, and sediment excavated from San Clemente Creek. The third year of construction will include reconstruction of the San Clemente Creek arm, stabilization of the sediment disposal area, dam removal, and initiation of habitat restoration elements. Habitat monitoring and maintenance is expected to continue for several years after the project construction is complete.

At the completion of the project, CalAm will transfer the project lands (Figure 8) to the Monterey Peninsula

Regional Park District (District). The donated property will link Garland Regional Park and the San Clemente Open Space, which are both owned and operated by the District. Use of the property will be restricted for watershed conservation and compatible public access.

Summary

The Reroute and Removal project presents a unique opportunity for public and private interests to work together to realize public benefits far beyond what either could achieve working alone. It offers a permanent solution to the dam safety issue while also restoring the Carmel River's natural processes and providing unimpaired access to over 25 miles of spawning and rearing habitat for steelhead trout.

Additional Information:

http://www.scc.ca.gov/disp_gen.file?san_clemente

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APPENDIX 2

Advance Basis of Design Report

Carmel River Reroute and San Clemente Dam Removal

Monterey County, California

January 2, 2008

MWH

DRAFT BASIS OF DESIGN REPORT
CARMEL RIVER REROUTE AND SAN CLEMENTE DAM REMOVAL
MONTEREY COUNTY, CALIFORNIA

Prepared for

CALIFORNIA STATE COASTAL CONSERVANCY

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LIST OF ACRONYMS AND ABBREVIATIONS

ac-ft	acre-foot/acre-feet
BOD	Basis of Design
Cal-Am	California American Water Company
cfs	Cubic feet per second
CVFP	Carmel Valley Filter Plant
CDWR	California Department of Water Resources
CRRDR	Carmel River Reroute and Dam Removal
DSOD	Division of Safety of Dams
EIR	Environmental impact report
EIS	Environmental impact statement
El. XXX	XXX feet elevation above mean sea level
fps	Feet per second
g	Unit of acceleration of gravity
km	Kilometer/kilometers
MCE	Maximum credible earthquake
mi	Miles
MPWMD	Monterey Peninsula Water Management District
NCEER	National Center for Earthquake Engineering Research
OCRD	Old Carmel River Dam
PG&E	Pacific Gas and Electric Company
PMF	Probable maximum flood
psi	Pounds per square inch
Ranney Intake	River water intake system
RM	River mile
SCC	California State Coastal Conservancy
SWPPP	Stormwater pollution prevention plan
USACE	US Army Corps of Engineers
USGS	United States Geologic Survey
WY	Water year

1.0 INTRODUCTION

This section provides the background information for the project and Basis of Design Report (Report).

1.1 Background

San Clemente Dam is a concrete thin-arch dam located on the Carmel River in central California (**Figure 1-1**). The dam is owned and operated by the California American Water Company (Cal-Am). Dam construction was completed in 1921. San Clemente Dam has a maximum structural height of 106 feet, a crest length of 300 feet, and spillway crest at elevation (El.) 525 feet. The seismic stability of the structure was evaluated in 1992 in accordance with the California Department of Water Resources (CDWR), Division Safety of Dams (DSOD) requirements. The maximum credible earthquake (MCE) with a magnitude 6.7 on the Tularcitos Fault located 1.9 miles to the west was used to evaluate the seismic stability of the dam structure. The results of the analysis showed that the dam would not meet minimum stability requirements when subjected to the MCE. In addition, the study reviewed the performance of the dam under probable maximum flood (PMF) loading conditions. The PMF was estimated by CDWR and will have a peak discharge of 81,200 cubic feet per second (cfs) (Mussetter Engineering, Inc. [MEI], 2005a). It was concluded that the PMF would overtop the dam and subject its foundation to erosion, which would compromise the stability of the dam. Subsequently, DSOD has required that San Clemente Dam meet dam safety criteria to withstand the MCE and safely pass the PMF.

The Carmel River Reroute and San Clemente Dam Removal (CRRDR) project is described in the San Clemente Dam Seismic Safety Project Draft Environmental Impact Report (EIR)/Environmental Impact Statement (EIS) (Entrix, 2006) as a project alternative to dam safety modifications. This project alternative will mitigate dam stability concerns by removing the dam and rerouting the Carmel River. Recognizing additional benefits to the public that would result from the CRRDR project, several organizations have been working with Cal-Am to further consider and enable this alternative for implementation as the preferred project. The California State Coastal Conservancy (SCC) has been appointed as the lead state agency in this process and is spearheading supplemental technical studies to support this effort. The goals for the supplemental studies are to: 1) provide sufficient information to enable consensus among the parties on a feasible strategy for removing the dam, and 2) prepare the CRRDR project for the permitting and final design phases. The work provided herein, at the request of SCC is a Basis of Design (BOD) document for the CRRDR project conceptual design that summarizes all of the design elements and assumptions used to develop the project.

1.2 Overview of the Carmel River Reroute and San Clemente Dam Removal

The CRRDR project will meet the seismic safety goals through the removal of the dam and relocation of approximately 380,000 cubic yards (235 acre-feet [ac-ft]) of accumulated sediment behind the dam on the San Clemente Creek arm of the San Clemente Reservoir. A site plan for the CRRDR project is shown in **Figure 1-2**. A portion of the Carmel River would be permanently bypassed by cutting a 450-foot-long channel between the Carmel River and San Clemente Creek, approximately 2500 feet upstream of the dam. The bypassed portion of the

Carmel River would be used as a sediment disposal site for the accumulated sediment. The rock spoils from channel construction (145 ac-ft or 235,000 cubic-yards) would be used for construction of a diversion dike at the upstream end of the bypassed reservoir arm.

During the active construction seasons, the Carmel River and San Clemente Creek would be diverted around the reservoir and dam site, and the reservoir would be dewatered. Over one season, accumulated sediment in San Clemente Creek would be removed from behind the dam, by excavation with heavy earthmoving equipment, to match pre-dam contours. The extent of removal is indicated on **Figure 1-1**. The sediment would be transported to a disposal area in the bypassed portion of the reservoir. The dam and fish ladder would be demolished, and the demolished concrete debris, segregated from reinforcing steel, would be placed in the abandoned Carmel River arm of the reservoir or used as part of construction material for diversion dike and stone columns for slope stabilization/liquefaction mitigation. The sediments at the downstream end of the bypassed reservoir arm would be stabilized and protected from erosion. The San Clemente Creek channel would be reconstructed through its historic inundation zone from the exit of the diversion channel to the dam site. The pre-dam (1921) topography is shown on **Figure 1-3**.

The volumes of the sediments associate with the project are listed as follows based on the MEI Hydraulic and Sediment-Transport Analysis (2005a):

- San Clemente Creek sediments (all to be relocated): 235 ac-ft (380,000 cubic-yards)
- Carmel River sediments, downstream of diversion dike (to be bypassed): 810 ac-ft (1,307,000 cubic-yards)
- Carmel River sediments, upstream of diversion dike (to remain in place): 510 ac-ft (823,000 cubic-yards)
- Carmel River sediment to be cut off to form a slope upstream of the dam: 88 ac-ft (142,000 cubic-yards). This is included in the 810 ac-ft

The CRRDR BOD Report will address the following major project elements/activities:

1. Relocation (excavation and disposal) of approximately 380,000 cubic yards (235 ac-ft) of accumulated sediments from the San Clemente arm of the reservoir to the Carmel River arm of the reservoir
2. Rock excavation of a 450-foot long diversion channel connecting the Carmel River drainage to the San Clemente Creek drainage at a location approximately 2500 feet upstream of the dam; approximate quantity of rock excavation is 235,000 cubic yards (145 ac-ft)
3. Installation of a diversion grade control sill at the upstream end of the diversion channel
4. Construction of a 75-foot high diversion dike at the upstream end of the bypassed Carmel River arm of the reservoir

5. Construction of a three-stage river channel in the diversion channel and the reconstructed San Clemente Creek channel
6. Excavation of the portion of the accumulated sediments directly adjacent to the dam in the Carmel River arm of the reservoir, and stabilization of the downstream slope face and extent of the remaining accumulated sediments with a grid of deep soil/cement columns and a geogrid-reinforced surface drainage channel
7. Surface stabilization of the accumulated and relocated sediments in the Carmel River arm of the reservoir
8. Restoration of disturbed surfaces and revegetation with native riparian species
9. Decommissioning of the dam and fish ladder and relocation of the demolished concrete debris in the abandoned Carmel River arm of the reservoir
10. Extension of Cal-Am's water diversion pipeline and establishment of a new diversion structure at a location approximately 3000 feet above the existing diversion location at the dam, maintaining Cal-Am's water extraction rights on the Carmel River
11. Construction and maintenance of temporary access roads and improvement of existing roads for project use
12. Installation and maintenance of temporary stream diversion, reservoir drawdown and dewatering measures
13. Protection of resources through implementation of erosion and pollution control, species salvage, and relocation and species passage measures
14. Excavation of a notch in the Old Carmel River Dam (OCRD) to facilitate fish passage

1.3 Review of Goals, Objectives, Failure Modes, Risk, and Design Criteria

The goal of the CRRDR project is to eliminate the dam safety hazard, provide comprehensive restoration of the natural character and function of the valley bottom, and restore fish passage. This includes a continuum of habitat elements, including aquatic, riparian, and upland habitats. The risks from failure to meet these goals include flooding, public safety impacts, and property damage. Environmental impacts to be considered are sediment release into the downstream river, harm to aquatic habitat, and impact on plant and animal species. Risk acceptability for various project elements have not formally been identified, but two risk categories that will be addressed include 1) flooding, for which the acceptable risk threshold is very low; and 2) downstream sediment delivery, for which the threshold is moderate in the short term, with hazard vulnerability expecting to diminish in the long term.

Elements of the dam removal project are discussed below. **Section 1.3.1** discusses the diversion channel. **Sections 1.3.2** and **1.3.3** address the lower and upper reconstructed channel, respectively. **Section 1.3.4** discusses the Carmel River above the diversion channel. **Section 1.3.5** examines the diversion dike. **Sections 1.3.6** and **1.3.7** analyze the impacts on the bypassed Carmel River arm of the sediment stockpile and sediment retention slope, respectively. **Section 1.3.8** discusses water diversion. **Section 1.3.9** examines the notching of the OCRD. **Sections 1.3.10** and **1.3.11** discuss construction phasing as they apply to access features and diversion, dewatering, and environmental controls, respectively.

1.3.1 Diversion Channel

Construction of the diversion channel will provide a point of diversion for the Carmel River into a short, restored section of the San Clemente Creek, achieving a bypass of an approximately 3,500-foot section of the Carmel River. In addition to constructability and engineering evaluation, design considerations include fish passage, sediment continuity, and riparian and aquatic habitat. Fish passage must provide suitable flow conditions for upstream migration of adult steelhead, as well as providing conditions for downstream passage for kelts, smolts, and juvenile steelhead (with potential for upstream passage for juveniles at some flows) within historic annual migration periods.

Potential failure modes of the diversion channel include slope failure that could cause blockage of the diversion channel and sediment delivery to downstream reaches, channel modification that could cause a partial or total barrier to upstream migration of adult steelhead, limited erosion and redistribution of sediment that leads to temporary disassembly of channel morphology, and excessive floodplain scour and removal of riparian habitat. Risk acceptability for various project elements have not formally been identified, but risk categories that will be addressed include 1) slope failure and formation of a passage barrier, for which the acceptable risk thresholds are very low; and 2) channel adjustment and excessive floodplain scour, for which the acceptable risk thresholds are moderate.

Design criteria for the diversion channel feature have been developed for geotechnical and hydraulic elements. These are discussed further in this report.

1.3.2 Lower Reconstructed Channel

The lower reconstructed channel includes the San Clemente Creek drainage from the dam site to outlet of diversion channel.

Functional objectives include 1) conveyance of combined flow of San Clemente Creek and the Carmel River to the lower river; 2) establishment of fish passage for upstream migration of adult steelhead and downstream passage for kelts, smolts, and juvenile steelhead; 3) sediment continuity assurance to maintain instream habitat and channel morphology and achieve dynamic equilibrium of sediment transport; and 4) support of riparian habitat including a dense riparian corridor and incorporation of red-legged from habitat.

Potential failure modes include slope failure that could block the reconstructed channel and deliver sediment to downstream reaches, formation of a passage barrier to upstream adult steelhead migration, channel adjustment from erosion, and floodplain scour that removes riparian habitat. Risk acceptability standards have not been identified to date, but potential standards include a very low acceptable risk threshold for slope failure and passage barrier, and moderate risk threshold for channel adjustment and floodplain scour.

Design criteria for the lower reconstructed channel feature have been developed for geotechnical, hydraulic (including geomorphology, sediment transport, flood routing, and fish passage), and restroration design elements. These are discussed further in this report.

1.3.3 Upper Reconstructed Channel

The upper reconstructed channel includes the San Clemente Creek drainage, above the outlet of the diversion channel.

Functional objectives include 1) conveyance of flow of San Clemente Creek to the lower reconstructed reach, 2) establishment of fish passage for upstream migration of adult steelhead and downstream passage for kelts, smolts, and juvenile steelhead; 3) sediment continuity assurance to maintain instream habitat and channel morphology and achieve dynamic equilibrium of sediment transport; and 4) support of riparian habitat including a dense riparian corridor and incorporation of red-legged from habitat.

Potential failure modes include slope failure that could block the reconstructed channel and deliver sediment to downstream reaches, formation of a passage barrier to upstream adult steelhead migration, channel adjustment from erosion, and floodplain scour that removes riparian habitat. Risk acceptability standards had not been identified to date, but potential standards include a very low acceptable risk threshold for slope failure and passage barrier, and moderate risk threshold for channel adjustment and floodplain scour.

Design criteria for the upper reconstructed channel feature have been developed for geotechnical and hydraulic elements and are discussed further in this report. No design criteria are currently identified for habitat and fish passage. Potential general criteria for habitat include supporting the riparian habitat and creating red-legged frog habitat along the flood terraces. No specific design criteria have been established for fish passage; however, criteria were recommended by the Technical Review Team. These are the same as those recommended for the diversion channel as discussed in this report.

1.3.4 Carmel River Above the Diversion Channel

Functional objectives of construction on the Carmel River above the diversion channel include 1) conveyance of flow of the Carmel River to the bypass reach, 2) establishment of fish passage for upstream migration of adult steelhead and downstream passage for kelts, smolts, and juvenile steelhead; 3) sediment continuity assurance to maintain instream habitat and channel morphology and achieve dynamic equilibrium of sediment transport; 4) support of spawning and rearing habitat; and 5) construction of point of diversion for Cal-Am.

Potential failure modes include formation of a passage barrier to upstream adult steelhead migration, channel adjustment from erosion, excessive channel scour resulting of delivery of historic sediment to lower reaches and sediment-related impacts, excessive floodplain scour resulting in removal of riparian habitat, and failure (i.e., poor performance or destruction from flood) of the point of diversion. Risk acceptability standards have not been identified to date, but potential standards include a very low acceptable risk threshold for formation of a passage barrier, and moderate risk threshold for channel adjustment and channel and floodplain scour.

Design criteria for the Carmel River above the diversion channel have been developed for hydraulic design (including geomorphology, sediment transport, flood routing, and fish passage) and restoration design elements, which are discussed further in this report. Geotechnical criteria have not been established for this feature as no major features or changes to the existing channel will be implemented. Preliminary hydraulic design was to leave this reach intact, with minor realignment at the entrance to the diversion channel. Refinement of the preliminary design is currently under evaluation. Specific design criteria for flood capacity have been established such that a range of flows will have to be evaluated to determine channel design.

1.3.5 Diversion Dike

Functional objectives of the diversion dike include flow diversion, or redirection of flow of the Carmel River, into the diversion channel while preventing the river water from flowing through the abandoned Carmel River reach; and support of riparian and upland habitat including support of vegetation and design that allows for passage of terrestrial wildlife.

Potential failure modes include 1) overtopping and lateral erosion of the river, allowing water access to the abandoned reach and mobilization of the accumulated sediment in the stockpile; 2) slope failure that contributes to overtopping, displacing materials that lead to changes in the river channel and potentially obstructing sediment transport and fish passage from upstream and downstream reaches; 3) excessive voids that limit vegetation and block wildlife migration; and 4) slope failure that leads to changes in the river channel that obstruct sediment transport and fish passage from upstream and downstream reaches. Risk acceptability standards have not been identified to date, but potential standards include a very low acceptable risk threshold for overtopping and lateral erosion failure, a low threshold for slope failure, and moderate threshold for excessive voids.

Design criteria for the diversion dike feature have been developed for geotechnical, hydraulic, and restoration design elements and are discussed further in this report. Specific criteria for habitat are not currently identified, but will be developed in subsequent design phases. General potential criteria include 1) support of vegetation that is native to the Carmel River Valley in similar settings, and 2) allowing for passage of terrestrial wildlife.

1.3.6 Sediment Stockpile

Functional objectives of the sediment stockpile are to dispose of excavated San Clemente Creek sediment, provide habitat for the California red-legged frog, and provide upland habitat to support native vegetation and create finish topography with variability. Future evaluation will assess whether CRLF habitat will be maintained in this location. If it is not, the need to maintain a high water table in this area may be eliminated.

Potential failure modes include 1) mobilization of sediment, delivery to downstream reaches as a result of dike overtopping, and local runoff or structural failure of downstream stabilization structure; 2) loss of the high water table, leading to compromised frog habitat; and 3) failure of site plantings, reducing upland habitat value. Risk acceptability standards have not been identified to date, but potential standards include a very low acceptable risk threshold for mobilization of sediment, low to moderate for compromise of frog habitat, and moderate for vegetation failure.

Design criteria for the sediment stockpile feature have been developed for geotechnical and hydraulic design elements and are discussed further in this report. Criteria for habitat are not currently identified. Specific criteria will be developed in subsequent design phases. General potential criteria include 1) support of native vegetation; 2) contouring of the ground surface to create habitat diversity; and 3) configuration of the finished disposal area to maximize sustainability of various habitat types, including reduced elevation difference between the top of the disposal area and the accumulated sediments in the Carmel River arm of the reservoir.

1.3.7 Sediment Retention Slope

Functional objectives for the sediment retention slope are to 1) retain accumulated sediments in the abandoned reach by providing a lateral barrier to sediment migration, limiting erosion of the slope face by the Carmel River, and limit erosion of the slope face by surface flows; 2) convey small tributary drainage to the Carmel River; 3) maintain a high water table to support California red-legged from habitat; and 4) provide upland slope habitat. Future evaluation will determine whether CRLF habitat will be maintained in this location. If it is not, the need to maintain a high water table in this area may be eliminated.

Potential failure modes include 1) slope stabilization structure failure in response to seismic or static loading, leading to excessive delivery of sediment to downstream reaches or blockage of channels or migration barriers; 2) surface erosion leading to delivery of sediment to downstream reaches; and 3) failure of vegetation to become established, limiting habitat value and reducing resistance to surface erosion. Risk acceptability standards have not been identified to date, but potential standards include a very low acceptable risk threshold for slope stabilization structure failure and surface erosion and moderate for vegetation failure.

Design criteria for the sediment retention slope feature have been developed for the geotechnical and hydraulic design elements and are discussed further in this report. No habitat criteria are currently identified; however, potential general criteria include sloping to support native vegetation to provide upland slope habitat and erosion resistance to overland flows.

1.3.8 Water Diversion

Functional objectives of water diversion are to maintain Cal-Am's ability to extract water from the Carmel River. Potential failure modes include compromise of the Ranney Intake that would limit the ability to withdraw water, and slope failure in excavated reaches causing damages to pipelines that limit the ability to withdraw water, leading to operational/supply setbacks. Risk acceptability standards have not been identified to date, but potential standards include a low acceptable risk threshold for both the Ranney Intake compromise and pipeline damage.

Design criteria for water diversion have been developed for civil and hydraulic design elements and are discussed further in this report. No habitat criteria are currently identified; however, potential general criteria include 1) structure and pipeline alignment that impacts the least amount of habitat and riparian vegetation, and 2) conformance with NOAA's Conservation Agreement including no pumping in the summer low-flow season.

1.3.9 Notching of the Old Carmel River Dam

Functional objectives of notching the Old Carmel River Dam are to provide fish passage and maintain site access. Fish passage should provide suitable flow for upstream migration of adult steelhead and for downstream passage of kelts, smolts, and juvenile steelhead. Upstream access to the project site needs to be maintained in case of Old Carmel River Dam removal. This option will be evaluated in future design phases.

Potential failure modes include structural failure and sediment accumulation behind the notched structure. Both modes may create a fish passage barrier and disrupts access to the site. Risk acceptability standards have not been identified to date, but potential standards include a low acceptable risk threshold for a fish migration barrier and moderate for disruption of site access.

Design criteria for notching of the Old Carmel River Dam have been developed for civil design, but have not been developed for hydraulic and habitat design elements. The Technical Review Team recommended criteria that are similar to the diversion channel. These are discussed further in this report.

1.3.10 Construction Phase Access Features

Construction phase access features include roads such as Cachagua Grade, Jeep Trail, Dam High Road, Dam Low Road, and Plunge Pool Access Road. Functional objectives are to provide multiyear access for construction operations. Potential failure modes include slope and road failure that leads to blockage causing disruption of construction progress, project delays, and cost escalation. Risk acceptability standards have not been identified to date, but potential standards include a low acceptable risk threshold for both slope and road failure.

Design criteria for construction considerations of the access features are discussed further in this report.

1.3.11 Construction Phase Diversion, Dewatering, and Environmental Controls

Construction phase diversion, dewatering, and environmental controls include San Clemente Creek, Carmel River, and Old Carmel River Dam diversion pipelines; coffer dams for diversions; settling basins; and erosion, sediment, and pollution controls.

Functional objectives are to convey flows around work areas to maintain reasonable working conditions and limit downstream delivery of turbid water, dewatering reservoir sediments, and limiting construction period sedimentation and pollutant-delivery impacts on the surrounding environment.

Potential failure modes include 1) diversion dam failure causing delivery of water into the construction work area, leading to damage of completed work and slowed work progress; 2) diversion pipeline failure causing delivery of water into the construction work area, leading to damage of completed work, slowed work progress and potentially disrupted downstream fish passage; 3) sediment dewatering provisions failure that would slow work progress; 4) settling basin cofferdam failure that would cause delivery of sediment laden water to reaches below; and 5) failure of erosion, sediment, and pollution control provisions causing delivery of sediment laden water and/or other pollutants to reaches below. Risk acceptability standards have not been identified to date, but potential standards include a low threshold acceptable risk threshold for diversion dam and pipeline failure as well as sediment dewatering provisions failure, and a very low acceptable risk threshold for settling basin cofferdam failure and failure of erosion, sediment, and pollution control provisions.

Design criteria for construction phase diversion, dewatering, and environmental controls features have been developed for geotechnical and hydraulic design elements (including fish passage). These are discussed further in this report. Fish passage features are not generally applicable but diversion pipes may be designed to allow for fish passage downstream, rather than trapping fish and moving them.

1.4 Structure of the Report

This report is organized by dividing the CRRDR project into the major design disciplines, where the design components of each project feature are addressed within the discipline sections (e.g., the diversion channel design requires both hydraulic and geotechnical analysis). Detailed technical analyses are included in the appendices of the report and summarized in their respective discipline sections. The following summarizes the report sections:

- **Section 1** Introduction
- **Section 2** Geotechnical Design
- **Section 3** Civil Design
- **Section 4** Hydraulic and Hydrologic Design
- **Section 5** Landscape Design and Environmental Restoration
- **Section 6** Construction Operations
- **Appendix A** Geotechnical Analyses
- **Appendix B** Hydraulic and Geomorphologic Analyses
- **Appendix C** MWH Cost Estimates
- **Appendix D** Comment Log for Draft BOD

2.0 GEOTECHNICAL DESIGN

This section provides the basis of design for the geotechnical considerations for each of the design components of the proposed CRRDR project. Design criteria are provided for site-wide general geotechnical issues, such as seismicity and ground motion requirement. This section also provides the basis of design and geotechnical design criteria for specific features of the project including the proposed diversion dike, the diversion channel, and the sediment stabilization in the Carmel River upstream of the San Clemente Dam. This section also provides a description of some conceptual features of the project to address the design criteria presented herein. The results of the geotechnical investigation conducted in support of this BOD report is included as **Appendix A** and summarized below.

2.1 Geotechnical Basis of Design

MWH and the Project Team established general and quantitative design criteria for the proposed CRRDR project. The design criteria are presented in the following subsections, categorized by the design feature associated with the specific criteria.

2.1.1 General

The following two general design criteria are proposed for the CRRDR project:

- The design flow for CRRDR project will be maximum mean daily discharge for the Carmel River as determined by MEI (2005a). However, the diversion dike will be analyzed with respect to a range of peak flood flows. Average hydraulic flow parameters near the diversion dike are shown in **Table 2-1**.

- The design ground motion (on rock) that will be used for the CRRDR project will be based on a 5 percent probability of exceedence in 50 years (a 975-year return interval). Fault parameters used to determine the ground accelerations on rock for various return periods are presented in **Table 2-2**. A summary of the mean probabilistic motion on rock for various return periods is summarized in **Table 2-3**.

At a minimum, geotechnical slope stability analyses of the diversion dike shall consider water elevations to be equivalent to the 2-year mean maximum daily for static, pseudo-static, and post liquefaction conditions. Additional analyses shall consider the stability of the diversion dike under PMF conditions.

A PSHA was developed for the site, considering fault and background sources within a 100 kilometers (km) radius. Direct seismic hazards were also considered because of the proximity of the site with documented active faults. The mean peak horizontal ground accelerations resulting from the PSHA are summarized and presented in **Table 2-3**. A detailed description of the PSHA is provided in the Report of Geotechnical Investigation for the project, included as **Appendix A** of this report.

Table 2-1: Average Hydraulic Flow Parameters Near the Diversion Dike

Flow	Main Channel Velocity (feet/s) [1]	Main Channel Hydraulic Depth (feet) [1]	Superelevation at Diversion Dike (feet) [1]	Estimated Hydraulic Depth at Diversion Dike (feet)
Median Flow	3.7	0.3	-	-
2-Year Peak	9.9	1.6	1.4	3.0
100-Year Peak	16.4	7.2	6.9	14.3
PMF	15.7	23.7	11.4	35.1

Source: MEI, 2005a

Note:

[1] Includes sections with supercritical flow.

Key:

feet/s – feet per second

Table 2-2: Fault Parameters for San Clemente Dam

Fault	Characteristic Magnitude (M)	Slip Rate (mm/year)	Closest Approach to San Clemente Dam (miles)
San Andreas (Creeping section)	8.1	>5.0	28
Tularcitos (Tularcitos section)	7.3/7.2	0.5	1.5
Rinconada	7.5	1	12
San Gregorio (San Gregorio section)	7.3	1.0 to 5.0	8
Calaveras (Central and Southern section)	6.4	15	30

Source: USGS, 2002

Note:

[1] Characteristic magnitude is estimated using source scaling relations based on fault area or fault length. USGS reports estimate mean characteristic magnitude for faults based on commonly used magnitude-area scaling relationships for crustal faults

Key:

M –

mm/year – millimeters per year

> - greater than

Table 2-3: Mean Probabilistic Ground Motion on Rock

Probability of Exceedence (percent in 50 years)	Return Period (years)	Mean Peak Ground Acceleration (g)
10	475	0.28
5	975	0.37
2	2,475	0.52

Key:

g – unit of acceleration of gravity

Ground motion acceleration (on rock) of 0.37g, which is associated with a 975-year return period (5 percent probability of exceedance in 50 years) seismic event, was selected as the design criteria for all components of the project. Several factors were considered during selection: consequences of potential release of the stabilized sediment, failure of the rock slopes at the project site, and the reduced downstream impact of a failure as compared to a dam failure. The MCE and corresponding ground motion, established by Woodward Clyde Consultants (WCC (WCC, 1992), was not selected as the recommended seismic design criteria for the project because the results of the PSHA utilize updated seismicity and attenuation relations. In addition, whereas the MCE is often used for high-hazard dams, the CRRDR project is not a dam project, and the downstream impacts of a failure are far less than the downstream impacts of a dam failure. MCE's are generally developed using a 2475 year return period or greater whereas the current design criteria uses a 975 year return period.

The above selected peak ground acceleration is used for design basis in pseudo-static analyses of the project features, which are currently are based on US Army Corps of Engineers (USACE) criteria for selection of pseudo-static loads. The pseudo-static load to be used in all analyses is a "great earthquake", or 0.15g, as defined by USACE. Detailed analyses in the next phase of design will require some dynamic analysis (not pseudo-static) for evaluation of seismically induced deformations. The next phase of design shall consider a risk-based design approach, where cost-benefit relations will be used to select appropriate design criteria for seismic loading.

2.1.2 Diversion Dike

The following lists the design criteria for the diversion dike.

- The dike must be high enough to divert design flows without ever overtopping. The height of the embankment must include superelevation of Carmel River during peak flows.

- Settlement and deformation due to static forces must remain within limits that allow the dike to function as intended.

- Seepage through the dike and dike foundation must be evaluated and designed to minimize the risk of piping and to mitigate uplift pressures at the toe of the dike or further downstream

- The dike must be able to resist erosion and the design flow from the Carmel River.

- Settlement and deformation due to seismic forces must remain within limits that will allow the dike to function as intended after a seismic event, including evaluation of deformations due to both ground accelerations and seismically induced liquefaction. Analyses shall consider the diversion dikes ability to function as required following the event, the potential risks associated with a seismic related dike failure, and the serviceability of the dike following a design seismic event.

- The factor of safety for static, seismic, and post-liquefaction slope stability analysis of the dike design must meet appropriate minimum standards based on the requirements set for by the presiding government agencies.

Preliminary recommendations of minimum factors of safety for slope stability of the proposed diversion dike and other quantified design criteria for the CRRDR project diversion dike are presented in **Table 2-4**. These factors of safety are based on the recommendations set for by FERC (USSD 2007; FEMA, 2005). While these factors of safety are based on the design of dams, they are thought to be appropriate for the preliminary design of the diversion dike. The final design criteria will be dependent on the requirements of the presiding governing agency. As such, the final design minimum factors of safety are subject to change.

Table 2-4: Quantified Design Criteria
CRRDR Project Diversion Dike

Design Criteria	
Minimum Dike Final Crest Elevation:	605 feet
Maximum Allowable Settlement at Crest:	TBD[1]
Minimum Static Factor of Safety of Slopes:	1.5
Minimum Pseudo-Static Factor of Safety of Slopes:	>1.0
Minimum Post Liquefaction Factor of Safety for Slopes:	1.2
Minimum Factor of Safety for Bearing Failure:	3

Note:
[1] As indicated by the United States Bureau of Reclamation (USBR, 1987), maximum allowable settlements of several feet may be allowable. Typically, settlement can be accounted for by simply overbuilding the dam with a camber equivalent to the magnitude of the anticipated post construction settlement. However, it is recommended that allowable post-construction settlements be determined as part of the final project design and selected diversion dike geometry. Settlement due to foundation liquefaction will also be considered.

Key:
> – greater than

To meet the geotechnical design criteria presented above, a preliminary design for the diversion dike was established based on the data presented in the Draft EIR/EIS and is shown on **Figure 2-1** (Entrix & Cal-Am, 2006). A summary of the salient features of the preliminary design is presented in **Table 2-5**.

Table 2-5: Summary of Preliminary Design Information
CRRDR Project Diversion Dike

Design Criteria	
Dike Construction Material:	Diversion Channel Waste Rock
Dike Crest Elevation:	605 feet
Dike Crest Length:	520 feet
Dike Crest Width:	50 feet
Dike Structural Height:	75 feet
Upstream Slope:	2.5:1
Downstream Slope:	3:1
Dike Freeboard During PMF	39 feet
Seepage Cutoff:	Cement-Bentonite Wall

Key:
PMF – probable maximum flood

The diversion dike will be located in the Carmel River immediately downstream of the diversion channel cut, diverting water around the bypassed portion of the Carmel River. The location and general site plan of the diversion dike are shown in **Figure 1-2** and a typical cross-section is shown on **Figure 2-1.**

Based on the recent MWH geotechnical investigation, the near surface soil in the vicinity of the proposed diversion dike consists of recent alluvium primarily comprised of loose, poorly graded sand with gravel. This alluvial sand was observed to range from 23 to 38 feet at borehole locations and contains frequent interbeds of sandy gravels with cobbles, sand with silt, and organic debris. The poorly graded sand layer is typically underlain by an organic rich layer of soil consisting of varying proportions of silt and sand about 9 feet thick. Bedrock was encountered at depths ranging from 36 to 47 feet at the borehole locations.

The diversion dike will utilize blasted material from the diversion channel cut for graded and compacted rockfill. The valley walls within the footprint of the dike will have sufficient excavation so that the ends of the dike could be appropriately embedded and tied in. The diversion dike is currently designed with a 75-foot height (crest at El. 605), 50-foot crest width, and about 460-foot base width. The height of the dike is determined based on the super-elevation of river water surface under PMF conditions based on hydraulic analysis (MEI, 2005a) and to contain all the material from the diversion channel excavation. The dike geometry will contain the materials from diversion channel excavation (approximately 319,000 cubic yards, assuming about 36 percent greater volume than in-place rock of 235,000 cubic yards). One-foot and larger blasted rock pieces from the diversion channel excavation would be used to armor the diversion dike upstream face, which will encounter river flows during the PMF up to El. 566 (MEI, 2003), or approximately 39 feet below the proposed diversion dike crest. The rock armoring may be held together by casing of steel wire mesh to form gabion blocks in order to withstand the high PMF velocity. Also, large rock import may be required if adequately sized material cannot be extracted from the channel cut (cost implications discussed in **Section 6.6**). During the detailed design, an erosion resistance/hydraulic analysis would be required for the upstream of the diversion dike to determine the maximum riprap particle size and whether larger riprap should be produced or imported or gabion steel meshing should be incorporated into the armoring scheme.

Preliminary design of the diversion dike includes a cutoff wall placed at the upstream toe of the diversion dike and extending to bedrock to control seepage through the dike foundation, thereby limiting the risk of piping and uplift forces. At this time, the proposed wall will consist of a cement-bentonite mix and will be about 160 feet long, 40 feet deep, and 3 feet wide.

Liquefaction potential: The diversion dike foundation will rest on 40-foot-thick reservoir sediment deposits, consisting of saturated granular soils. These soils were evaluated for liquefaction potential given the anticipated peak ground acceleration for the specified return period of 975-years. Based on the results of the liquefaction deformation and stability analysis that showed high liquefaction potential, mitigation measures were preliminarily considered, including reconstruction of the dike following a liquefaction induced failure, modification to the dike's geometry to reduce the effects of liquefaction, or modifications to the foundation soil to reduce the susceptibility to liquefaction (**Appendix A**). Subsequent design phases will provide a detailed post-liquefaction deformation and stability analysis.

Based on the data presented by MEI (2005a), the depth of the Carmel River near the diversion dike is expected to be 0.3 feet during median flows, and 3.0 feet during the 2-year peak discharge, and 14.3 feet during the 100-year peak discharge. Further, the likelihood that the effective crest height would be reduced to less than 14.3 feet due to liquefaction, given the current geometry, is presumed to be negligible. Accordingly, it is that the dike would still perform as intended following liquefaction. Thus, reconstruction of the dike following a liquefaction induced failure should be considered as a viable mitigation option. As such, the cost estimate presented in Section 6 use this option for developing costs for the diversion dike.

If appropriate, the dike's geometry could be modified to help account for the effects of liquefaction. Such measures could potentially include increasing the height of the dike, reducing the angle of the dike's slopes, or construction a secondary dike to contain stream flow in the event of a complete failure.

If deemed appropriate, mitigation measures to reduce liquefaction potential and associated foundation settlement will be investigated and may include providing soil-cement columns, stone columns, dynamic compaction, or vibro-compaction. The most appropriate mitigation measure will be selected primarily based on result of cost-benefit analyses. The need for mitigation measures shall consider the serviceability of the diversion dike and the potential risks and consequences associated dike failure as a result of liquefaction.

Bearing capacity and settlement: The foundation design will provide for sufficient bearing capacity for the embankment of the dike, and the maximum allowable settlement of the dike will be controlled by the maximum PMF water surface elevation of the dike including superelevation plus an appropriate amount of freeboard, as determined during the final design.

Possible improvement measures to mitigate excessive dike settlement and provide sufficient bearing capacity could potentially include overbuilding to account for settlement, regrading following settlement, reducing slope angles, reducing the crest elevation, foundation improvement measures, or excavation and replacement of the compressible and/or weak materials below the dike. Mitigation measures incorporated for general settlement considerations will be designed to concurrently address settlement for seismic considerations.

Seepage: The dike design will control seepage through and beneath the dike to avoid internal erosion and piping and to control uplift pressures on the downstream toe, which would reduce the dike stability. To control seepage, subsequent design phases will consider reducing overall foundation permeability by implementing a cement-bentonite cutoff wall. Final analysis and design of the seepage control system will require additional geotechnical investigation to determine the following soil parameters:

- Effective shear strength values of the foundation granular materials.
- Total density of the foundation granular materials.
- Permeability of the foundation granular materials.
- Effective shear strength values of the compacted dike fill.
- Total density of the compacted dike fill.
- Effective shear strength values of the compacted dike fill.

2.1.3 Diversion Channel

The following lists the design criteria for the diversion channel.

- The diversion channel must support the hydraulic requirements determined in the Preliminary Hydraulic Analyses (MEI, 2005a).
- The rock cut required for the diversion channel must be configured such that the side slopes of the channel walls remain stable, and the slopes will not experience rockfall resulting in blockage of the channel or in a substantial turbid water release. The factor of safety for seismic and static slope stability analysis of the upper soil slopes of the channel must meet minimum requirements.
- The cut in the soils overlying the rock must be configured such that the side slopes of the channel walls remain stable, and the slopes will not experience landslides resulting in blockage of the channel or in a substantial turbid water release. The factor of safety for seismic and static slope stability analysis of the upper soil slopes of the channel must meet minimum requirements.
- The channel banks must be able to resist erosion and the design flow from the Carmel River.

Preliminary recommended minimum factors of safety for slope stability and other quantified design criteria of the proposed diversion channel are presented in **Table 2-6**. These factors of safety are based on the recommendations set for by FERC (USSD 2007; FEMA, 2005). While these factors of safety are based on the design of dams, they are thought to be appropriate for the preliminary design of the diversion channel. The final design criteria will be dependent on the requirements of the presiding governing agency. Thus, the final design minimum factors of safety are subject to change.

Table 2-6: Quantified Design Criteria CRRDR Project Diversion Channel

Channel Layout and Geometry	MEI Hydraulic Requirements
Maximum Height of Channel Cut:	120 feet
Maximum Height of Channel Rock Cut:	106 feet
Maximum Height of Channel Soil Cut:	14 feet
Minimum Static Factor of Safety of Rock Cut:	1.5
Minimum Static Factor of Safety of Soil Cut:	1.5
Minimum Pseudo-Static Factor of Safety of Rock Cut:	>1.0
Minimum Pseudo-Static Factor of Safety of Soil Cut:	>1.0

Key:
> – greater than

To meet the geotechnical design criteria presented above, a preliminary design for the diversion channel was established and is shown on **Figure 2-1.** A summary of the salient features of the preliminary design is presented in **Table 2-7**.

Table 2-7: Summary of Preliminary Design Information CRRDR Project Diversion Channel

Design Information	
Channel Length:	450 feet
Average Channel Gradient:	2.7 percent
Minimum Channel Width at Thalweg:	150 feet
Maximum Channel Width at Thalweg:	215 feet
Channel Rock Cut Slope:	1:1
Channel Soil Cut Slope:	2:1
Maximum Channel Width at Top of Rock:	340 feet
Maximum Channel Width at Surface:	400 feet

The diversion channel will connect the two reservoir arms about 3,000 feet upstream of the San Clemente Dam, as measured along the Carmel River. The location and plan of the diversion channel are shown in **Figure 1-2**, and typical profile and cross-section for the diversion channel are shown in **Figure 2-1**.

The preliminary channel design is for a channel length of about 450 feet, with side slopes of 1:1 and a gradient of 2.7 percent. The bottom width of the channel transitions from 150 feet at the downstream end to 215 feet at the upstream end. The size and geometry of the diversion channel were determined based on the results of recent hydraulic analyses by MEI (2005a). The gradient of the channel will likely be modified in subsequent phases of design to improve fish passage conditions, as indicated by Alternative 2 in **Appendix B**.

Based on the recent MWH geotechnical investigation, the overburden soil within the footprint of the proposed diversion channel cut consists of a soil and cobble strata about 14 feet thick. The underlying bedrock consists primarily of biotite rich diorite. Localized portions of the rock encountered were slightly metamorphosed, and exhibited gneissic texture. In general, the intact rock mass was observed to be moderately to highly weathered, moderately hard, moderately to very strong, and highly to intensely fractured. Rock quality designations of 25 or less were most prevalent during the investigation. Laboratory test results indicate the unconfined compressive strength of the rock ranges from 10,200 to 26,300 pounds per square inch (psi) and the point load compression index ranges from 300 to 1,180 psi (MWH, 2007).

Mechanical excavation and blasting operations are anticipated for removal of about 235,000 cubic yards of rock from the proposed diversion channel (Entrix, 2006). The blast material from the diversion channel will be a source of material for armoring the upstream face of the diversion dike, increasing toe stability or buttressing the stabilized sediment slope, and providing boulders for the San Clemente Creek restoration area. With significant additional on-site processing, the blast material may by suitable for use in stone columns, should that method of ground improvement be found beneficial to the project. Also, if large boulders cannot be extracted from the channel cut due to the rock quality and fracturing, then off site import of boulders from local area quarries would be required to support channel restoration activities. This would add cost and potentially impact the project construction schedule.

The preliminary rock slope stability analysis was conducted for diversion channel side slopes in rock at 1:1 (height to width ratio) slopes using the data from the recent geotechnical investigation

(MWH, 2007). The analysis results show that the diversion channel configured with 1:1 slopes would provide the minimum required factor of safety set forth in the project design criteria and indicate that steeper slopes may be feasible. Additional investigation will need to be conducted prior to final design. With these additional studies, it may be feasible to modify the design of the channel to reduce the amount of blasting and/or excavation that may be required for construction of the channel. Additional field investigations will also provide more information regarding the feasibility of rock rippability or whether excavation will require blasting.

2.1.4 Sediment Stabilization

The following lists the design criteria for sediment stabilization.

- The sediment left in place after the removal of the San Clemente Dam must remain stable during static conditions with an appropriate factor of safety.
- The sediment must remain stable during seismic loading with an appropriate factor of safety.
- The sediment must be resistant to erosion due to storm surface water runoff.
- The sediment must provide areas with high groundwater elevations to support development of engineered mitigation wetlands.

Preliminary recommended minimum factors of safety for the stability of the proposed sediment slope and other quantified design criteria are presented in **Table 2-8**. These factors of safety are based on the recommendations set for by FERC (USSD 2007; FEMA, 2005). While these factors of safety are based on the design of dams, they are thought to be appropriate for the preliminary design of the sediment slope. The final design criteria will be dependent on the requirements of the presiding governing agency. Thus, the final design minimum factors of safety are subject to change.

Table 2-8: Quantified Design Criteria
CRRDR Project Sediment Stabilization

Design Criteria	
Maximum Stabilized Slope Height:	80 feet
Design Runoff Down Stabilized Slope:	337 cfs*
Minimum Static Factor of Safety of Stabilized Slope:	1.5
Minimum Pseudo-Static Factor of Safety of Stabilized Slope:	>1.0

Key:
cfs – cubic feet per second
> – greater than
* - This design flow is currently an estimate based on preliminary evaluation in Section 6. A range of runoff flows will be evaluated to determine the erosion control measures in the next phase of design.

As part of the conceptual design, the slope stabilization calls for a 50-foot wide drainage channel to be constructed on the face of the stabilized sediment slope. This drainage channel is intended to collect and direct runoff and overflow water from the abandoned portion of the Carmel River to the base of the sediment slope. To minimize the erosion of surface sediments, reinforcement of the surficial sediments on the drainage channel will be achieved with geogrid geosynthetic textiles.

Design of the geogrid reinforced slope shall be conducted in accordance with the methods presented by the Federal Highway Administration (FHWA), which is considered appropriate for the proposed project application (2001). Further, the design shall adhere to the criteria set forth by this design method used for the design. An overview of the design criteria specified by this design method is presented in **Table 2-9**.

Table 2-9: Quantified Design Criteria for the Design of Geogrid Reinforced Drainage Channel

Design Information	
Minimum Factor of Safety for Sliding:	1.3
Maximum Eccentricity at Base:	Base Width/6
Minimum Factor of Safety for Bearing Capacity:	2.5
Minimum Factor of Safety for Deep Seated Slope Stability	1.3
Minimum Factor of Safety Compound Slope Stability	1.3
Minimum Factor of Safety Under Seismic Conditions	75 percent of Static Factor of Safety
Minimum Factor of Safety for Internal Stability	1.5
Minimum Factor of Safety for Pullout Resistance	1.3
Minimum Allowable Tensile Strength of Geogrid	T allowable [1]
Minimum Design Life:	100 years

Note:

[1] Based on design life requirements and including all appropriate reduction factors.

To meet the geotechnical design criteria presented above, a preliminary design for the stabilized sediment slope was established and is shown on **Figure 2-2.** A summary of the salient features of the preliminary design is presented in **Table 2-10**.

Table 2-10: Summary of Preliminary Design Information CRRDR Project Sediment Stabilization

Design Information	
Method of Stabilizing Slope:	TBD
Maximum Stabilized Slope Height:	80 feet
Maximum Stabilized Slope Width:	330 feet
Maximum Stabilized Slope:	4:1
Minimum Runoff Channel Width:	50 feet

The preliminary design calls for the bypassed sediments in the Carmel River arm, roughly 100 feet upstream of the dam, to be graded to produce a slope with a maximum length from crest to toe of about 330 feet. The slope would span the width of the river channel (about 300 feet) with the top of slope at El. 530 and the toe of slope at El. 450 (the pre-dam topography) at the deepest point of the river channel. The preliminary slope configuration of the slope has a grade of 4:1 (H:V). The method of stabilizing the sediment cut slope has not been optimized. Conceptual ideas for design to date have indicated a matrix of overlapping soil-cement columns installed to sufficient depth below the ground surface (about 80 feet) to provide stability and to limit seepage through the face of the slope. This method and other methods that will be investigated during the next phase of design are introduced briefly below:

Soil-Cement Columns: The soil-cement columns are developed by deep mixing of in-place soils with a cement mixture via an auger drilling and mixing method. The columns are drilled vertically from the slope surface into the soil in a square grid pattern (**Figure 2-2**), creating cells of soil surrounded by the strengthened grid of soil cement. This method both increases the overall soil strength and decreases the permeability of the soils, allowing preservation of the existing wetland areas immediately upstream of the slope. The maximum depth of the columns would be about 80 feet. Installation of the columns will require substantial grading to provide relatively flat temporary benches on ground surface to provide near-vertical columns.

Stone Columns: An alternative slope stabilization method that may be considered is installation of stone columns supplemented with a cement-bentonite cutoff wall. The installation of stone columns involves drilling holes from the surface of the slope and replacing the existing soils with gravel- to cobble-sized crushed rock. The in-place sediments are densified as the stone columns are installed, further strengthening the slope. An impermeable cutoff wall would accompany the stone column installation to provide a means of maintaining high groundwater levels to support wetland development.

Installation of the columns will require substantial grading to provide relatively flat temporary benches on ground surface to provide near-vertical columns.

Retaining Wall: Another stabilization method consists of a retaining wall that would be located at the toe of the proposed slope with the base of the wall at about El. 450. The retaining wall can be constructed as either a reinforced concrete structure, or a rockfill structure using the rock excavated from the diversion channel. The retaining wall would be about 30 feet high and 200 feet long. To increase the stability of a concrete retaining wall, the wall can be configured as an arch facing upstream. This alternative would be constructed near the toe of the stabilized slope and raise the groundwater table due to its relative impermeability.

Buttress: Buttressing is a technique used to offset or counter the driving forces of a slope by an externally applied force system that increases the resisting force. Buttresses or a stability berm that would be appropriate for the sediment slope may consist of rock spoil excavated from the diversion channel or concrete rubble from the dam demolition. The buttress material can cover small portion of the slope near the toe as shown in **Figure 2-2**, or replace a large portion of the toe of the slope and be placed on bedrock. However, a cement–bentonite cutoff wall, similar to the case of stone column, would be required to maintain a high water table for the sediment stock pile.

2.1.5 Relocated Sediments on Bypassed Carmel River Channel

The design criteria for relocating the San Clemente Creek sediments onto the bypassed Carmel River are defined below:

- The distance of the relocated sediment stockpile from San Clemente Creek should minimized in order to minimize haul distances, thereby minimizing air pollution, noise, schedule, and costs of sediment transport.

- The relocated sediments should be placed and compacted in place in a manner that promotes stability of the stockpile (e.g. flat sediment stockpile slopes and erosion resistance) while allowing for vegetative growth
- The sediment footprint should be minimized in order to minimize impacts to existing vegetation and habitat. As such, the footprint should be limited to the surface of the bypassed Carmel River and away from any significant tribs that would be impacted and also discharge onto the sediment stockpile that would require additional erosion control measures and maintenance.

In addition, the design criteria and slope factors of safety for these sediments are the same as for the stabilized sediment slope in Section 2.1.4., excluding the slope stabilization method (relocated sediment slopes would require only compaction and erosion control for stability), geogrid, and slope geometry requirements. The description of the conceptual layout of the sediments is summarized below.

Most of the sediment from the San Clemente Creek arm of the reservoir will be relocated on the bypassed arm of the Carmel River. These sediments will be placed on an approximately 13-acre area with a thickness of about 20 feet, and stabilized by compaction and revegetation. The toe of the slope of the stabilized stock pile (the relocated San Clemente Creek sediments) would be located at approximately El. 530; the top of the slope of stock pile would be level at about El. 550 (**Figure 1-2**). The slope of the stock pile would be about 2.75:1 (H:V) (**Figure 2-1**). The entire sediment stock pile would be bounded by the diversion dike upstream and by the toe of the slope of the stock pile at El. 530 downstream. The maximum capacity of the storage site is undetermined but is well in excess of the excavated volume of approximately 370,000 cubic yards of sediments in the San Clemente Creek as estimated by MEI (2005a).

2.1.6 Post-Construction Slope Stability of the San Clemente Arm

The following lists the design criteria for the post-construction slope stability of the San Clemente Arm.

- Slopes within the San Clemente arm must be stable with respect to landsliding and erosion capable of causing significant blockage and turbid water event.

- Regrading of the San Clemente arm shall be done in a manner that minimizes the risk of significant landsliding or erosion events while maintaining the appropriate channel capacity and gradient for the combined flows of the Carmel River and San Clemente Creek.

- The stream banks must be able to resist erosion and the design flow from the combined stream flow.

Design criteria of the post-construction slope stability of the San Clemente arm shall be evaluated while considering the pre-dam site topography, proposed site grading operations, predicted combined flow characteristics, and site geology.

To meet the criteria presented above, a qualitative evaluation of the post-construction slope stability of the San Clemente arm has been conducted to determine the relative risk of a landslide or erosion event that would cause a significant blockage or turbid water event. Further details regarding this evaluation are present in **Appendix A** of this report.

2.2 Summary of Geotechnical Conditions and Considerations

A summary of the geotechnical conditions and consideration are presented in the following paragraphs. Further details regarding the geotechnical site conditions can be found in the draft preliminary geotechnical report, which in included as **Appendix A** of this report.

The San Clemente Dam is located at River Mile 18.6 (measured upstream of the Pacific Ocean) at the confluence of the Carmel River and San Clemente Creek, which constitute the two main branches of the reservoir. Storage capacity of the reservoir has been reduced by approximately 90 percent as a result of accumulation of sediments deposited primarily from the San Clemente Creek and Carmel River. Originally, the reservoir had a storage capacity of about 1,425 ac-ft. The San Clemente Reservoir currently provides approximately 130 ac-ft of storage. The dam and the reservoir (including most of the land bordering the reservoir) are owned by Cal-Am. The surrounding land is privately owned[1].

The reservoir is nestled in a steep V-shaped canyon within the northwest-southeast trending Santa Lucia Range. The in-filled portion of the reservoir consists of relatively flat sand and gravel bars with varying density of vegetation, depending on locations. Adjacent to the sand and gravel bars, the canyon slopes rise steeply, reaching El. 2,200 along the nearby ridgelines. Slopes adjacent to the site rise at a 1 to 1, horizontal to vertical ratio (1H:1V). The geology of the bedrock beneath the site consists of Mesozoic grandiorite with phenocrysts of feldspar and a heterogeneous granitic complex – mixtures of granitic rocks and metasedimentary rocks such as quartzite and gneiss (Kleinfelder, 2002).

The reservoir behind the dam has been estimated to contain approximately 2.5 million cubic yards (1,550 ac-ft) of sediment (MEI, 2003). Sediment has accumulated through natural processes resulting in a downstream sloping deposit surface, which allows the volume of sediment to be larger than the original volume of water stored behind the dam, as defined by a full reservoir pool and the original post dam construction topography. As defined during a previous subsurface exploration by Kleinfelder (2002), the sediment consists of sandy gravel, gravelly sand, sand, silty sand, and sandy silt. The finer-grained sediment is located nearest to the dam in both the Carmel River and San Clemente Creek arms of the reservoir. The coarser (more gravelly and cobbly) materials are encountered in the upper reaches of the Carmel River arm.

MWH recently completed a subsurface exploration program to provide additional geotechnical information for the geotechnical design (MWH 2007). **Figure 2-3** shows the boring and test pit locations for both the previous investigation (Kleinfelder 2002) and the MWH investigation. Details of the subsurface geotechnical information for the reservoir area are presented in Kleinfelder (2002) and MWH (2007), which are summarized in the following sections.

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[1] Currently, negotiations are being conducted to transfer ownership of the dam and surrounding Cal-Am property to the Coastal Conservancy as part of an agreement with Cal-Am to implement the CRRDR project. Easements through the private property surrounding the reservoir are also being negotiated in order to gain access to the reservoir during construction.

2.2.1 Upper Reaches of the Carmel River Arm of the San Clemente Reservoir

The subsurface materials at the upper reaches of the Carmel River arm of the reservoir (from about 5,500 to 3,500 feet upstream from the dam, approximately from test pit explorations TP-1 to TP-10 (**Figure 2-3**) generally consist of gravelly sand and sandy gravel with varying amounts of cobbles and boulders. The gravels, cobbles, and boulders are typically sub-rounded to rounded. The boulders are generally 6 inches or less, with occasional 30-inch size (maximum dimension) boulders encountered. Boulders to 30 inches are observed at the surface and/or near-surface units with a general decline in the percentage of coarse particles observed from the headwaters toward the dam.

An organic layer (decaying leaves and wood fragments in a silt matrix) occurs at depths ranging 10 to 14 feet in three test pits (TP-7, 8, and 9[1]), located on **Figure 2-3** as "Previous Test Pits". Below this depth, fine to coarse-grained sand with varying amounts of gravel and silt occurs at depths of 20 to 25 feet. Sand with gravel and occasional cobbles occur below 25 feet. This unit is believed to be the pre-dam alluvium and was encountered at or near the anticipated depths based on the 1921 topographic contours.

2.2.2 Carmel River Arm of Reservoir

Further downstream from the upper reaches of the Carmel River arm, at a distance of about 3,100 feet upstream from the dam (approximately the location of TP-12, **Figure 2-3**), sandy gravel and gravelly sand exist to a depth of about 12 to 16.5 feet. Below this depth, sandy silt and silty sand occur with thin interbeds of organic soils to a depth of 38 feet. Pre-dam alluvium of silty sand and silt occur beneath these materials and extend to 40 to 44 feet. Thin organic rich silt layers are interbedded with the silty sand from about 33 to 44 feet.

From about 1,700 feet (near boring B-5) to 300 feet (near boring B-12) upstream of the dam, the subsurface materials typically consist of sand, silty sand, and sandy silt with thin interbeds of organic rich silt throughout. The pre-dam alluvium occurs at depths ranging from about 44 to 68 feet below the ground surface. The thickness of the pre-dam alluvium is not known at this reach, but it is assumed, based on the 1921 topographic contours, that the bedrock is below 65 feet. "Significant pressurized gas pockets/vigorous bubbling" were encountered in some borings (B-9, 10, 11, and 12) in the area near to the dam. The gas pockets "blew materials out of top of augers at least 30 feet into air," as described in the log of boring B-11 (Kleinfelder, 2002). Because of these gas pockets, construction activities in this area need to be performed with necessary precautions to prevent injury to workers or damage to equipment.

2.2.3 San Clemente Creek

On the San Clemente Creek arm of the reservoir, Kleinfelder (2002) drilled five borings (B-13 through B-17, **Figure 2-3**) which are located from about 700 feet (B-13) to about 1,500 feet (B-17) upstream from the dam. No geotechnical exploration has been done downstream of boring B-13. One boring was also recently drilled by MWH (2007) located about 700 feet upstream of boring B-17, or about 150 feet downstream of the proposed diversion channel.

Based on the five borings (B-13 through B-17), it was found that the subsurface materials above the pre-dam alluvium vary from 31 feet (B-17) to 45 feet (B-13) in thickness. This alluvium

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[1] While TP-8 is mentioned in the Kleinfelder (2002) report, neither its location nor the log of test pit was found in the report.

consists of sand, silty sand, and sandy silt, with minor gravels. Thin interbeds of organic rich silt occur throughout, although with less frequency than along the Carmel River arm of the reservoir. The pre-dam alluvium consists of gravelly sand with occasional cobbles (Kleinfelder, 2002). The total thickness of soil deposit further upstream from the Kleinfelder borings tapers to 17.5 feet at BH-5 with an estimated pre-dam soil deposit thickness of 2.5 feet (MWH, 2007). It is expected that the sediments that have not been explored between the MWH and Kleinfelder borings will be of similar composition and have a thickness between 18 to 31 feet. In general, sediment thickness decreases in the upstream direction.

The subsurface materials above the pre-dam alluvium for the area downstream of boring B-13 are expected to be relatively deep, except for soils close to the dam in the remnant reservoir pool.

2.2.4 Slope and River Bank Stability of the Reconstructed San Clemente Creek

After the reservoir sediments in the San Clemente Creek portion of the reservoir are removed, the pre-dam (i.e. 1921) alluvial deposits in the river channel and floodplain through the historic reservoir inundation zone would be exposed. A three-stage channel would be provided through selective contouring along San Clemente Creek (See details in **Section 5.3**). The broad valley containing the reconstructed stream channel would generally follow the pre-dam contours. The bankfull and thalweg channels would be reconstructed by limited grading of the existing alluvial deposits.

The slopes and river banks at the San Clemente Creek will be evaluated for their stability under earthquake and high flood conditions once they are exposed to the pre-dam surface. Although the slopes and river banks are expected to be stable in general as they were developed during the process of the river channel evolution, steep, thick slopes and areas will be evaluated in particular to prevent any potential landslide of large volume, as large volume of landslide will pose a major risk to the project site by intercepting the river channel. Necessary mitigation measures, such as grading/buttressing, may be performed on potentially unstable slopes of relatively large impact to the river. In addition, stabilization of the exposed land and slopes would also be accelerated by planting the area with native upland vegetation.

MWH (2007) has conducted a qualitative stability assessment of the San Clemente Creek drainage, located between the proposed diversion channel and the San Clemente Dam. The purpose of this qualitative analysis was to provide a preliminary evaluation of the effects that additional water flow through the drainage resulting from the diversion of the Carmel River might have on the stability of the adjacent slopes. The analysis was conducted to address specific concerns regarding erosion or undercutting of sediment, original alluvium (pre-dam soil deposits), and destabilization of rock faces that could potentially result in substantial blockage and rerouting of the combined stream, significant turbid water releases, or both. The qualitative slope stability assessment took into consideration the proposed stream channel and channel gradient, steepness of adjacent slopes, geologic conditions, and proposed grading operations within the combined flow reach. As part of this assessment, MWH utilized data collected from a geological reconnaissance of the combined flow reach available published data to assign impact risk levels. The combined flow reach was divided into 10 areas based on similar properties associated with slope stability and erosion. Each of the areas where then qualitatively evaluated based on the categories of stream orientation and gradient, slope steepness, geologic conditions, and proposed channel regrading. Each category was assigned a value with an associated risk level 1 for low risk, 2 for moderate risk, and 3 for high risk. The risk values were then summed to provide a total risk level. The results of the qualitative stability assessment are presented in **Appendix A**.

2.2.5 Stream Diversion, Reservoir Drawdown, and Construction Dewatering

The construction of the project would involve stream diversion, reservoir drawdown, and construction dewatering at various stages of construction and seasons. Both the Carmel River and the San Clemente Creek would be diverted around the active areas of excavation using pipelines. Stream flows would be passed downstream to maintain the flow and habitat in the Carmel River during construction. The reservoir level would be draw down and sediments would be drained before excavation and relocation.

Stream Diversion: The diversion facility is currently envisioned to consist of interlocking sheet pile cofferdams that cut off river flow upstream of the construction area. Temporary bypass pipelines would be connected to the sheet pile cofferdams to divert flow through the construction site to a point downstream of the dam, consisting of approximately 18- to 36-inch diameter PVC pipes. Exact locations of these facilities will be determined as the design criteria are progressively defined. The facilities may also need to be relocated and reinstalled as construction progresses. In general, the diversion on the Carmel River would be located upstream of the diversion channel inlet, and the diversion of the San Clemente Creek reservoir branch would be placed upstream of the diversion channel outlet during each construction season. The diversion piping would follow along the reservoir banks.

Since a permanent diversion pipeline would be required for the river water intake system, it might possible to make use of this permanent pipeline as temporary pipeline to divert stream flow during construction. Thus, it is envisioned that at least two diversion pipelines would be required, one for San Clemente Creek and one for Carmel River. The pipeline for Carmel may be placed under the diversion dike and relocated San Clemente Creek sediments to minimize disturbance. The temporary pipeline for San Clemente Creek can be secured hanging on the valley walls using rockbolts and soil nails. The feasibility of using one of the two pipelines as both temporary and permanent pipeline would need further study.

Reservoir Drawdown: Within the reservoir area, the reservoir level would be drawn down and the sediment deposits would be pre-drained to keep the active excavation area as dewatered and drained as possible to facilitate earthmoving. Currently, the sediment behind the dam is estimated at El. 515, which is about the same level as the upper intake gate. The middle and lower intake gates are located at El. 495 and El. 470, respectively; and are currently blocked due to the buildup of sediment.

Construction Dewatering: Reservoir dewatering could be achieved by installing a sheet pile barrier around the intakes, as shown in **Figure 2-4**. Excavation/removal of the sediment between the sheet pile barrier and the dam intake (downstream sediment), and upstream of the sheet pile barrier (upstream sediment) would be performed in stages. The downstream sediment would be excavated to a certain depth of 10 to 15 feet to form a sump, and water in the sump would be pumped out after soil particles of relatively large sizes (larger than medium sand) have settled. Then, the upstream sediment would be excavated to the same depth. This would be followed by excavation of downstream sediment to another 15 feet and subsequent dewatering, and excavation of upstream sediment to the same depth. The process will repeat until the upstream and downstream sediment is excavated to bedrock (thus to expose the entire dam), and the upstream sediment is excavated to the design grade (**Figure 2-4**). During the entire process, dewatering can be accomplished by pumping, or releasing water through the intake gates if the intake gates can be opened after exposure. A number of dewatering methods such as wellpoints, suction wells, or deep wells may be considered to supplement the sump dewatering process in order to mitigate for "quick" soil conditions.

Dewatering could be supplemented by installation of several deep wells into the San Clemente Creek sediments, where groundwater levels are high, and water can be pumped from the wells. In addition, the dewatering for the sediments in the reservoir of Carmel River arm and San Clemente Creek arm could be expedited by excavating temporary trenches along the length of reservoir to channel subsurface water to the dam dewatering area, although the geotechnical characterization of these sediments suggests this may not be advisable (**Appendix A**)[1]. Drainage trenches would be constructed by backhoe excavation along the upstream-downstream centerline of the sediments. Cross-section for a typical trench is shown in **Figure 2-4**. Sediment would be excavated for the portion where the water table is sufficiently lowered and the material is sufficiently drained. Water could also be released from the intake gates as they become exposed from the sediments. It is also possible to combine the use of sheet pile barriers and well pumps to speed up the dewatering/drainage process and excavation.

Design of a dewatering system will depend on a number of factors including rate of construction, use of shoring, and type of dewatering system. It is recommended that the dewatering system design be the contractor's responsibility, as they will have control of construction means and methods. This will allow the contractor to provide a dewatering system that is compatible with the contractor's selected construction and shoring methods.

A filtration system or desilting basin would likely be constructed at the dewatering discharge point, or down stream of the dam, to reduce water turbidity prior to discharge into the downstream river. The existing plunge pool may be utilized as such a desilting basin, or the basin could be constructed immediately downstream of the plunge pool, where two cofferdams would be constructed in the immediate downstream channel to create a basin. The filtration system and/or desilting basin would be used primarily to remove soil particles of relatively small sizes (such as fine sand, silt, and clay); however, the required size/capacity of the filtration system/desilting basin and the estimated time to clear turbidity would depend on the construction dewatering method and system configuration. This will be studied in detail in the next phase of design.

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[1] Although trench dewatering is not currently advisable, future analyses and studies may indicate potential feasibility of this dewatering option. Also, dewatering design will ultimately be the contractor's responsibility. Therefore, it is suggested that no dewatering alternative is rejected until it is designed by the contractor and reviewed by the engineer.

3.0 CIVIL DESIGN

This section addresses the civil and structural aspects of the relevant design components of the project. **Section 3.1** discusses civil design considerations and **Section 3.2** summarizes existing conditions of the pertinent equipment and facilities.

3.1 Civil Design Criteria

This section presents a discussion of planned demolition of the dam, spillway, and outlet structure; the plunge pool and cofferdams; the valve house, fish ladder, and fishery habitat; the Diversion Grade Control Sill; and the Ranney Intake.

3.1.1 Demolition of the Dam, Spillway, and Outlet Structure

The following lists the design criteria for the demolition of San Clemente Dam, spillway, and outlet structure:

- Dam to be fully demolished to allow passage of diverted Carmel River
- Demolition to be conducted in a safe manner and minimizing environmental impacts
- Rubble from dam demolition should be re-usable for erosion control on site

At the conclusion of the sediment removal process, the dam would be demolished by controlled blasting using explosives. This involves the demolition and reuse of about 7,000 to 8,000 cubic yards of concrete on the site. Demolition will also include the spillway, outlet structure, diversion structure, gates, pipes, and appurtenances. A truck-mounted crane may be used to drill holes in the downstream face of the dam, load the explosives, and lift out the concrete debris. The crane would be located downstream of the dam in the drained plunge pool to provide adequate access to the entire footprint of the dam, and would be moved downstream during each blast. Steel from dam appurtenances and within demolished concrete would be segregated for transport off site to waste and recycling facilities. The remaining concrete debris would be further broken into pieces of manageable size that would be loaded and transported by off-highway trucks to the base of the stabilized slope and the sediment disposal pile for use in erosion control.

3.1.2 Plunge Pool and Cofferdams

The following lists the design criteria for the plunge pool and temporary cofferdams downstream of San Clemente Dam during CRRDR project construction:

- Plunge pool must be dewatered for dam demolition activities
- Prior to plunge pool dewatering, fish rescue must occur.
- Cofferdams will be constructed and sized to contain discharge from plunge pool and reservoir dewatering, allowing for settling of turbid water and preventing backflow to the dam from the Carmel River

- After construction, plunge pool bathymetry should be contoured to match the restored channel upstream and should not impede fish passage.

The approximate cofferdam geometry is listed below; however, it is expected that the cofferdam will be a contractor-designed temporary structure (subject to engineer review and approval):

• Height	10 feet
• Crest width	10 feet
• Type	Compacted earth fill
• Slopes	1V:2H

The plunge pool would be completely drained prior to dam demolition to allow access for demolition operations. To keep the plunge pool staging area dry, two cofferdams would be installed. One cofferdam would be located downstream of the plunge pool to prevent backflow from the Carmel River. The second would be located about 100 feet upstream of the first cofferdam to create a settling basin between the cofferdams. This basin would hold any leakage from the upstream cofferdam, and be used to allow settling or filtration of turbid water that is pumped from the upstream reservoir before it is released downstream. After construction is completed, the solids accumulated in the settling basin would be excavated and brought to the sediment disposal site when the cofferdams are removed.

3.1.3 Valve House, Fish Ladder, and On-site Structures

The following lists the design criteria for the demolition of San Clemente Dam, spillway, and outlet structure:

- Demolition to be conducted in a safe manner and minimizing environmental impacts
- Rubble from fish ladder demolition should be made re-usable for erosion control on site, where possible

The existing valve house on the right abutment and fish ladder on the left abutment of the dam would be demolished and removed. The instrument hut near the left abutment would also be removed. The dam tender dwelling above the left abutment would be preserved and possibly converted to other uses.

3.1.4 Diversion Grade Control Sill

The civil design criteria for the diversion control sill included providing grade control of the sediments retained in the Carmel River upstream of the diversion channel. However, the grade control sill will potentially provide a fish barrier due to possible headcutting of the diversion channel invert and thus may be eliminated in future project design refinements if it is determined that the rock invert of the diversion channel will withstand design flows without excessive headcutting. PWA's preliminary design evaluation (**Appendix B**) does not include a grade control sill, using only the bedrock in the diversion channel to control the river grade upstream. The grade control sill design criteria and summary description are provided below.

The diversion sill would be a new structure located immediately upstream of the proposed diversion channel (**Figure 2-3**) and would be used to regulate passage of upstream sediments.

The geometry, dimension, and size of the diversion sill will be based on results of hydraulic analyses and channel design. The design criteria for the sill will be to found the sill on bedrock, anchor with rock dowels, and construct with high strength reinforced concrete designed to resist scouring.

The diversion sill will be designed and constructed with the following material properties and parameters:

- Concrete strength: 90-day unconfined compressive strength at 5,000 psi or above
- Reinforcement: ASTM Grade 60 steel (60,000 psi minimum yield strength)
- Rock strength: 10,000 psi unconfined compressive strength
- Rock dowel: ASTM Grade 60 steel rods grouted into rock

3.1.5 River Water Intake System (Ranney Intake)

The following lists the design criteria for the Ranney Intake to be installed for Cal-Am's replacement water diversion after demolition of San Clemente Dam:

- Diversion point must maintain hydraulic head of El. 525
- Intake system must divert water into Cal-Am's existing diversion pipeline downstream of San Clemente Dam
- Intake system must be capable of diverting river water at a flow rate sufficient to deliver Cal-Am's annual water right
- Intake system must adhere to various agency criteria for seasonally adjusted maximum diversion rates
- A temporary diversion system must be installed to maintain Cal-Am's ability to divert water during CRRDR project construction

A preliminary layout and cross-section of the intake pipes and well are shown in **Figure 3-1**. The basic considerations for sizing the well and planning for the intake pipes include the following:

- Maximum anticipated rate of diversion will be 16 cfs.
- Concrete caisson will be designed to withstand lateral earth pressure.
- Concrete caisson will be designed to have minimal long term settlement.
- Intake pipes will be stainless steel.
- Sands, gravels, cobbles, and/or geotextile will be provided to screen flow as it enters the intake pipes to minimize the entrance velocity of groundwater, thus reducing the frequency of required maintenance.

- The screening materials of the intake pipes will be designed based on granulated filter criteria or geotextile filter criteria defined in detailed design.

The river water intake system will be installed to maintain Cal-Am's ability to divert from the Carmel River. It will be similar to a Ranney Intake system, consisting of a network of 12-inch diameter stainless-steel perforated pipes embedded in the gravels and cobbles that line the river bottom. The intake pipes will discharge to a common well (Ranney well) on the riverbank and then to the extended conveyance pipeline. The Ranney well would comprise a central concrete caisson, excavated to a target depth at which the perforated pipes and screens project laterally outward underneath the river bank. Infiltration and flow to the well and to the conveyance pipeline will be induced by gravity.

Based on the longitudinal profile of the Carmel River developed by MEI (2003), the screened river water intake system will be constructed and maintained approximately 3,500 feet upstream of the dam, or about 400 feet upstream of the diversion channel, in order to maintain hydraulic head at the point of diversion at El. 525. The exact location of the intake will be determined during detailed design. The existing 30-inch-diameter steel conveyance pipeline will be extended from its current end at the dam site to the location of the new intake. The Ranney Intake will be constructed early in the construction sequence and connected to a separate, temporary diversion pipeline connected to Cal-Am's water conveyance pipeline at the dam, serving to maintain Cal-Am's ability to divert water from the Carmel River during the years of construction. The permanent diversion pipeline that extends Cal-Am's existing water conveyance pipeline will be constructed in conjunction with land restoration activities.

3.1.6 Notching Old Carmel River Dam

The design criteria for OCRD are summarized below:

- OCRD must be notched to provide fish passage
- The OCRD bridge must be preserved or update to provide access to the left abutment buildings
- Construction activities in the river channel for notching must comply with strict environmental constraints on impacts to water quality and fish habitat
- The remaining OCRD structure must remain stable after notching

Studies must be conducted to determine the optimal location and size of the notch and impacts to the river flows, local geomorphology, OCRD stability, and OCRD bridge stability. The preliminary concept is to construct a approximately 19-feet wide by 9-feet deep notch near the right abutment of the dam..

3.2 Existing Conditions

This section presents information and design features of existing facilities of the San Clemente Dam and Reservoir, spillway, outlet structure, valve house, plunge pool, fish ladder and fishery habitat, and the Carmel Valley Filter Plant (CVFP).

3.2.1 San Clemente Dam and Reservoir

San Clemente Dam is a concrete thin arch dam with a maximum structural height of 106 feet and a crest length of 300 feet. The base of the dam has a thickness of approximately 20 feet and crest width of 8 feet. The reservoir serves as a point of diversion of water to serve the Monterey Peninsula and is operated to facilitate fish passage. A major portion of the Monterey water distribution system relies upon the pressure head supplied by diversion from the reservoir, and many of the appurtenant system components (pumps, feed systems, etc.) were designed and installed accordingly.

The original design storage capacity of the reservoir was 1,425 ac-ft at the spillway crest and 2,260 ac-ft at the top of the gates with the spillway gates in place. However, siltation has reduced the storage capacity of the reservoir to less than 130 ac-ft at the spillway crest based on results of a recent survey conducted by Cal-Am.

3.2.2 Spillway

The San Clemente Dam crest is at El. 537. The spillway is an overflow weir structure that discharges over the center of the dam with a crest at El. 525. The spillway capacity is currently 20,000 cfs, which is insufficient for passing the updated PMF flow of 81,200 cfs.

3.2.3 Outlet Structure

The outlet structure consists of a concrete outlet tower attached on the upstream face of the dam with three intake gates at El. 515, 495, and 470. The two lower gates are inoperable due to buildup of sediment. The upper gate has been fitted with a standpipe at El. 522 to extend the intake above the current sediment level of about 515 feet surrounding the outlet tower.

3.2.4 Valve House

A valve house is located at the downstream toe of the dam on the right abutment (looking downstream). The valve house contains a diversion structure that directs water to a conveyance pipe for treatment at the CVFP and to a low-level discharge pipe to the river. The eastern-most spillway bay (on the right side of the spillway looking downstream) is permanently closed to prevent damage to the valve house and appurtenant structures at the toe of the dam during spilling. Two additional sluice pipes extend through the dam at approximately El. 454, but the intakes to these pipes have been buried by sediment and are not operational.

3.2.5 Plunge Pool

A plunge pool fills the bottom of the canyon immediately downstream of the dam at the impact point of spillway discharge. The base elevation of the plunge pool is approximately El. 455 and normal tailwater is at about El. 464.

3.2.6 Fish Ladder and Fishery Habitat

The fish ladder is located on the west side of the dam (left abutment) approximately 68 feet high, and provides passage for migrating steelhead between the plunge pool at the downstream base of the dam and additional spawning habitat on the Carmel River and San Clemente Creek upstream of the reservoir.

3.2.7 Carmel Valley Filter Plant

The CVFP is a surface water direct filtration and treatment facility, owned and operated by Cal-Am, and is located approximately two miles downstream from the San Clemente Dam on the east bank of the Carmel River. A diversion structure and 24-inch diameter diversion pipe parallel to the Carmel River delivers water from the reservoir to the CVFP. No alterations to the CVFP are proposed as part of this project.

4.0 HYDRAULIC/HYDROLOGIC DESIGN

This section addresses the hydraulic and hydrologic aspects of the San Clemente Dam and reservoir area. **Section 4.1** presents the proposed modification to the Carmel River and San Clemente Creek and **Section 4.2** discusses stabilization of the sediment, during and after project construction. **Section 4.3** presents a discussion of relocated water diversion. **Section 4.4** outlines plans for a temporary bypass pipeline and **Section 4.5** presents the proposed modification to that channel.

4.1 Proposed River Channel

This section presents a discussion of the proposed re-routed Carmel River channel that bypasses approximately 3,000 feet of the existing river (from San Clemente Dam, upstream to the point of diversion). Included in the discussion are design criteria and conceptual design summaries for the proposed river channel geomorphology, sediment transport, fish passage, and hydraulic performance requirements for the permanent and temporary diversions. In general, the design criteria for the proposed channel, temporary diversion, and permanent diversion include the following:

- The proposed channel should bypass peak flood flows[1] through the diversion channel and restored section of the San Clemente Creek without major damage (e.g., slope failure or large turbid water release) to any diversion structure, including the diversion dike, diversion channel slopes, restored San Clemente Creek side slopes, and stabilized sediment slope.
- The channel configuration should not inhibit fish passage.
- The channel should be geomorphologically stable and not significantly change the flooding characteristics in the downstream Carmel River.
- The temporary river diversion should provide protection of the construction area and allow for a dewatered Carmel River and San Clemente Creek channel.
- The permanent diversion should maintain Cal-Am's ability to divert water from the Carmel River.

A summary of average hydraulic conditions through the reconstructed reach of San Clemente Creek and in the diversion channel, which will be used as a basis for evaluating project features and are developed from the preliminary project design by MEI, is provided in **Table 4-1**.

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[1] The preliminary channel design (MEI, 2005b) shows that the project concept will pass flows up to the PMF. However, designing specific project features to withstand PMF flows will likely be excessively conservative and costly. Also, specific hydraulic criteria such as designing features to withstand 100-year flows will not be used. Rather, a full range of floods will be used in formulation an evaluation of project features, including evaluation and selection of alternatives that reasonably maximize expected net benefits. This procedure will be consistent with the state of the art for evaluation and risk analysis for flood damage reduction as outlined by USACE (USACE, 2006).

Table 4-1: Summary of Average Hydraulic Parameters in the Reconstructed Reach of San Clemente Creek and Diversion Channel

Flow	Discharge at Existing Dam (cfs)	Reconstructed Reach of San Clemente Creek				Diversion Channel			
		Main Channel Velocity[1] (feet/s)	Hydraulic Depth* (feet)	Top Width[1] (feet)	Energy Grade[1] (feet/foot)	Main Channel Velocity[1] (feet/s)	Hydraulic Depth[1] (feet)	Top Width[1] (feet)	Energy Grade[1] (feet/foot)
Median Flow	15	3.8	---	12.8	0.0488	3.7	0.3	12.4	0.0270
2-year Peak	2,250	11.1	2.2	97.5	0.0248	9.9	1.6	149.2	0.0234
100-year Peak	22,700	21.8	8.3	143.5	0.0221	16.4	7.2	194.5	0.0103
PMF	81,200	22.0	22.2	206.8	0.0087	15.7	23.7	232.9	0.0016

Note:

[1] Includes sections with supercritical flow.

Key:

cfs – cubic feet/s – feet per second ft – feet

PWA recently developed two revised alternatives for the proposed river channel by MEI (MEI, 2005), which are presented in detail in **Appendix B**. The revised alternatives include step pools, coarse material supply to step pools, boulder placement, and a flatter gradient in the proposed river channel, and are intended to achieve geomorphic stability faster. PWA's design criteria are summarized in the following subsections. The following subsections also summarize details of MEI's previous analysis, which is used as the basis for the overall proposed channel design.

4.1.1 Proposed River Channel Geomorphology and Sediment Transport Criteria and Design Summary

The design criteria and objectives for the proposed river channel geomorphology include the following[1]:

- Construct a channel that is geomorphically-appropriate to the setting and that minimizes the risk of a failure that is not self-repairing.
- Boulders used in step-pool construction should be sized to remain in place for as long as feasible without producing step sizes that endanger fish passage.
- The diversion reach should access a reasonably large supply of 6- to 24-inch cobbles and boulders that can be mobilized by flows in the 2- to 5-year recurrence interval.

Based on the preliminary design (MEI, 2005b), the inlet to the proposed diversion channel and dike for the CRRDR project will be located about 3,000 feet upstream from the existing dam in the Carmel River branch, and the outlet will be located about 2,200 feet upstream from the San Clemente Dam in the San Clemente Creek branch (**Figure 4-1**). The gradient of the pre-dam valley bottom in the San Clemente Creek branch in this portion of the reach where the reconstructed Carmel River channel will be located was about 2.5 percent, based on the 1921 mapping, and the width of the pre-dam valley bottom was in the range of 80 to 100 feet (**Figures 4-2** and **4-3**). At the time the dam was constructed, this portion of the reach most likely consisted of a low-flow channel that was bounded by a low floodplain surface that extended to the valley walls. Upstream from the diversion channel in San Clemente Creek, the material that will remain

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[1] These criterions are defined in recent studies by PWA (Appendix B), which provides additional detail to the proposed channel design.

in place, through the transition from the natural channel to the reconstructed channel, is mostly a mix of coarse sand, gravel, and cobbles.

4.1.1.1 San Clemente Creek Reach

The design criteria and objectives for the proposed river channel geomorphology in the San Clemente Creek reach include the following:

- Use the existing channel dimensions in the upper Carmel River reach as a starting point and allow the channel to adjust through erosion and deposition of the gravel and sand.
- Provide step-pools and boulders that allow for fish passage, habitat, and resting areas.

Based on the preliminary design (MEI, 2005), a two-stage channel was used for the preliminary design cross-section for the reconstructed reach in the San Clemente Creek branch downstream from the diversion channel (**Figure 4-3**). The low-flow portion of the channel was sized to maintain reasonable depths and velocities over a range of flows up to about 200 cfs, which corresponds to about the 10 percent exceedence flow on the mean daily flow-duration curve. The high-flow channel was designed to convey the 2-year flood peak of 2,250 cfs while maintaining width-depth ratios between 30 and 40, consistent with observed bankfull width-depth ratios in natural, gravel-bed streams (Parker, 1979; Andrews, 1984). The resulting low-flow channel that was used to model this alternative has a trapezoidal shape, with a top width of 24 feet and depth of 2 feet. The high-flow channel has a top width of about 80 feet, with total thalweg depth of 4.1 feet (**Figure 4-3**).

4.1.1.2 Diversion Channel

The design criteria and objectives for the proposed river channel geomorphology in the diversion channel include the following:

- Use the existing channel dimensions in the upper Carmel River reach as a starting point and allowing the channel to adjust through erosion and deposition of the gravel and sand.
- Provide step-pools and boulders that allow for fish passage, habitat, and resting areas.

Based on the preliminary design (MEI, 2005), a two-stage channel with dimensions that are similar to those in the downstream San Clemente Creek reach was also assumed for the approximately 450-foot long diversion channel that will be cut through the ridgeline between the Carmel River and San Clemente Creek (**Figure 4-4**). The longitudinal gradient of this channel, established by matching the invert at the downstream end with the elevation of the pre-dam valley bottom in San Clemente Creek and setting the invert at the upstream end at the thalweg of the existing channel on the sediment deposits in the Carmel River branch, is about 2.9 percent (**Figure 4-2**). The diversion channel was initially assumed to have a uniform, 150-foot bottom width throughout its length. Comparison of the modeled water-surface elevations in the Carmel River, upstream from the diversion under existing and design conditions indicated that the uniform, 150-foot bottom width would create significant upstream backwater that would induce sediment deposition in the upstream river at flows greater than about the 2-year event. After several iterations with the modeled configuration, it was determined that transitioning the bottom width from 150 feet at the downstream end to 215 feet at the upstream end eliminated the backwater effect.

4.1.1.3 Diversion Grade Control Sill

The design criteria and objective for the proposed river channel geomorphology for the diversion control sill included providing grade control of the sediments retained in the Carmel River upstream of the diversion channel. However, the grade control sill will potentially provide a fish barrier due to possible headcutting of the diversion channel invert and thus may be eliminated in future project design refinements if it is determined that the rock invert of the diversion channel will withstand design flows without excessive headcutting. PWA's preliminary design evaluation (**Appendix B**) does not include a grade control sill, using only the bedrock in the diversion channel to control the river grade upstream. MEI's use of the grade control sill in channel morphology evaluation is summarized below.

The inlet to the proposed diversion channel and dike for the CRRDR project will be located about 3,000 feet upstream from the existing dam in the Carmel River branch (**Figure 4-1**). The modeled cross-section at the diversion channel inlet has a compound, trapezoidal shape, with the invert at the same elevation as the thalweg of the Carmel River at the point of diversion at El. 528.7 (profile on **Figure 4-2** and cross-section on **Figure 4-5**). The low-flow portion of the cross-section has a 1-foot deep, v-shaped bottom that slopes upward from the invert at 10H:1V; thus, the effective bottom-width is 20 feet. The banks of the low flow channel have 2H:1V side slopes and height of 2.1 feet, creating a total top width of 24 feet and total thalweg depth of 4.1 feet. The total width of the channel between the top of the cut on either side of the channel is 215 feet; thus, the left and right overbanks are 68.3 feet wide.

With the invert set at this elevation, about 510 ac-ft of the estimated 1,320 ac-ft of sediment in the Carmel River arm of the reservoir would be located in the Carmel River branch upstream from the point of diversion. The existing gradient of the Carmel River in the approximately 0.8-mile reach between the diversion and the upstream extent of the sediment deposits is about 0.5 percent, and the surface of the reservoir deposits at the time of the reservoir sediment characterization study (Kleinfelder, 2002) consisted of a mixture of coarse sand, gravel, and cobble, with the percentage of gravel and cobbles increasing in the upstream direction (**Figure 4-6**). The MEI HEC-6T model results using the sill (MEI, 2005b) indicate that an additional 97 ac-ft (1978 start-date) to 117 ac-ft (1985 start-date) of sediment would be stored in this portion of the reach over the 41-year simulation period. This represents 16 to 19 percent of the estimated 674 ac-ft of sediment delivered to the head of the reservoir over this period, and would result in an average increase in bed elevation through the reach of approximately 2.2 feet.

4.1.1.4 Hydraulic Routing

The objectives of the hydraulic routing and evaluation of the river channel will evaluate the following:

- River morphology
- Passage of peak flows
- Impacts to project features at various levels of peak flows

- Unsteady or continuous hydraulic modeling to assess fish passage conditions, where passage flow was between 40 and 800 cfs and the channel velocity was below 3 fps in pools or 6 fps in crests or riffles.

As described in Appendix B, over-inferring conclusions from the one-dimensional HEC-RAS hydraulic analysis should be avoided. The analysis should overlay quantitative data on qualitative understanding of the system to synthesize a final conclusion about proposed alternatives.

Based on modeled water-surface elevations in the reconstructed reach of San Clemente Creek (MEI, 2005), the selected channel geometry will convey flows up to and including the PMF peak discharge of 81,200 cfs without overtopping the relatively low saddle in the ridge that separates the San Clemente Creek and Carmel River branches of the reservoir, about 1,400 feet upstream from the existing dam (**Figure 4-7**). The analysis also indicates that hydraulic jumps will form at discharges greater than the 2-year event at locations where the valley constricts the flow, causing a localized increase in the energy slope. It may be possible to eliminate some of these jumps at moderate flows in the 2- to 50-year range by adjusting the channel configuration and profile as the channel design is developed. At higher flows, the valley configuration controls the jumps, and it will likely not be possible to eliminate them. The detailed design will also consider super elevation of the water surface around the relatively sharp bend upstream from the diversion channel inlet.

PWA (**Appendix B**) adapted MEI's existing HEC-RAS model for use in their channel alternatives analysis by updating the model's geometry to reflect their alternatives and by changing the model's boundaries to include unsteady flow conditions to evaluate fish passage criteria. The analysis showed that fish passage criteria were met for the step-pool design in both alternatives evaluated.

4.1.1.5 Sediment Transport

The sediment transport criteria for the proposed river channel are defined below:

- The channel should not allow for changed sediment transport conditions that would significantly change the flood plain downstream.
- Newly exposed or mobilized sediments should not adversely affect the quality of the river habitat in the Carmel River.

Based on the preliminary design (MEI, 2005b), sediment-transport modeling of the proposed project was carried out to evaluate the effects of the CRRDR project on sediment transport through the reservoir and subsequent effects in the downstream Carmel River. The initial sediment-transport modeling of the CRRDR project (MEI, 2005b) assumed that all of the sediment deposits in the reconstructed reach of San Clemente Creek would be excavated prior to removal of the dam. This model was developed by adjusting the existing conditions model to include the channel geometry of the reconstructed reach of San Clemente Creek and the diversion channel that was developed for the hydraulic model. It is impractical to remove all of the existing deposits from the valley bottom in the reconstructed reach of San Clemente Creek. As a result, the original model was revised to account for residual sediment by including a 1-foot deep bed sediment reservoir in this portion of the reach (MEI, 2006). The gradation of the deep bed sediment reservoir in both the reconstructed reach of San Clemente Creek and in the Carmel River, upstream from the diversion channel, was based on information from the reservoir sediment investigation (Kleinfelder, 2002; MEI, 2003; MEI, 2006) (**Figures 4-6** and **4-8**). Consistent with the existing conditions model runs, two 41-year simulations were executed with initially wet and dry periods.

Model results indicate that the total load passing the location of the existing dam will be 12 percent (dry start condition) to 14 percent (wet start condition) higher than under existing conditions, with most of the increase occurring in the gravel and cobble size-ranges. The results also indicate that the reach at the head of the reservoir upstream from the diversion channel will continue to be aggradational, with approximately 97 ac-ft (wet start condition) to 117 ac-ft (dry start condition) of sediment being stored over the 41-year simulation period. The impacts to the downstream river for the CRRDR project will be similar to those for existing conditions. The total volume of sediment stored in the downstream river is relatively small, representing an increase of about 10 percent over existing conditions, with most of this storage occurring in localized low energy zones and in the overbanks under flood conditions. The impact of the increased sediment storage on flood potential is also relatively small, with average changes in a 100-year water-surface elevation of 0.1 to 0.2 feet in the portion of the reach upstream from Rosie's Bridge (river mile [RM] 14.8), and less than 0.1 feet downstream from that point.

Specific locations where the CRRDR project results in a significant increase in flooding over baseline conditions include the following:

1. The reach upstream from Rancho San Carlos Road (increase of about 2.5 feet for the wet start condition)
2. Midway between Quail Lodge Bridge and Schulte Road (increase of about 0.6 feet for both wet and dry start conditions)
3. Three locations in the vicinity of Stonepine Bridge (increase of between 0.5 and 0.7 feet for the wet start condition)
4. Upstream from the Sleepy Hollow Filter Plant (increase of 0.7 feet for the wet start condition)
5. Near Old San Clemente Dam (increase of about 0.7 feet for both wet and dry start conditions)

In addition to MEI's sediment transport analysis, PWA performed an entrainment analysis to ensure that cobbles and boulders that are already deposited on the upper Carmel River reach can be transported to the diversion reach and beyond during 2-year flows. The entrainment analysis showed that placement of gravels and use of GeoTubes may be necessary to provide adequate filling of the step-pools in the first years after construction. PWA also conducted a rock sizing analysis and determined rock sizes that would remain in place during a 100-year flow and PMF (**Appendix B**).

4.1.2 Fish Passage Hydraulic Criteria and Performance Objectives

The basic hydraulic performance criteria for fish passage (per PWA, **Appendix B**) for the proposed channel include the following:

- Maximum velocity for a distance of greater than 300 feet is 2-3 fps
- Steelhead velocity criteria based on Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife, California Department of Fish and Game, and National Marine Fisheries Service guidelines for culvert passage
- Reach Length less than 60 feet, velocity maximum 6 fps
- Reach Length 60 to 100 feet, velocity maximum 5 fps
- Reach Length 100 to 200 feet, velocity maximum 4 fps
- Reach Length 200 to 300 feet, velocity maximum 3 fps
- Minimum depth 1 foot
- Maximum hydraulic drop 1 foot

Additional performance objectives and criteria include the following:

- Velocity and depth criteria cited above assume that there will be resting pools (i.e. criteria developed for short reaches should not be applied over the entire project length). Pools should be created approximately every 200 feet. Pools should have sufficient space protected from the fastest velocity zones that fish can rest even during flows at approximately the 2-5 year recurrence interval.
- Step heights should be minimized and should not exceed 1 foot where possible. Ideally, step heights should be kept below 6 inches.
- Pools should be at least 2 feet deep below jumps, or 1.5 times the jump height, whichever is larger. Pools should be at least 6 ft long unencumbered by hydraulic transitions (e.g. nappes from upstream steps.)
- Channels should have a compound cross-section so that at high flows there will be shallow zones and off-channel refugia.

4.2 Stabilized Sediment

The hydraulic design criteria for the stabilized sediments and slope are defined below:

- The relocated San Clemente Creek sediments and stabilized sediment slope should withstand storm surface water runoff from tributaries without significant erosion and damage to the slopes and release of sediment into the Carmel River channel.

- The stabilized sediment slope should withstand erosive forces from peak flood flows from the Carmel River that would flow against the base of the slope.

The stabilized sediment slope will not be exposed to flows from the Carmel River due to the construction of the diversion channel and diversion dike, except during peak flow events, which will impact the lower portion of the slope at infrequent intervals. The stabilized sediment slope will be armored with either rip rap or broken concrete from the demolished San Clemente Dam. An erosion resistance analysis will be required to determine the armoring height, size, and layout in the next phase of design. In addition, the next phase of design will provide a determination of an appropriate flood (smaller than PMF) for design basis, weighing cost of mitigation vs. benefits.

The stabilized slope and relocated San Clemente Creek sediments will also experience flow from the drainage basin (tributary) immediately uphill from the slope during local precipitation events. A watershed map is shown on **Figure 4-9**, which indicates the contributing drainage areas to the sediment stockpile and the stabilized sediment area upstream of the dam. Based on the figure, the tributary watershed draining to the sediment stockpile is about 1.42 square miles. In order to determine the anticipated flows onto the stabilized slope during large storm events, the expected flow was analyzed using the National Flood Frequency Program's methodology below. Additional evaluation of these flows and selection of the design flow will evaluated in the next phase of design.

4.2.1 National Flood Frequency Program Methodology

The NFFP has developed regression equations to estimate the frequency of flood-peak discharges and flood hydrographs (United States Geological Survey [USGS], 2007). The program uses inputs of the drainage basin area (square miles), mean annual precipitation (inches), and an altitude index. The altitude index can be defined as the average of altitudes in thousands of feet at points along the main channel at 10 percent, and 85 percent of the distances from the site to the divide.

San Clemente Dam is located within the Central Coast Hydrologic Region. Drainage area and altitude index were estimated from topographic maps. Mean annual precipitation was determined from Western Regional Climate Center precipitation data measured at San Clemente Dam (station # 047731). The input values used in this analysis are summarized in **Table 4-2** below.

Table 4-2: Input values for NFFP

Variable	Value
Area (square miles)	1.42
Mean Annual Precipitation (inches)	21.85
Altitude index	1.2

4.2.2 Design Flow

Using the NFFP regression equations, probable discharges from the drainage basin upstream of the stabilized sediment slope for various return period storms were estimated. **Table 4-3** below summarizes the peak discharges calculated over the stabilized sediment slope for mean annual precipitation as well as the standard error.

Table 4-3: Peak Discharge Predicted Over Stabilized Sediment Slope

Recurrence Interval (years)	Peak Discharge (cfs)	Standard Error (%)
2	17.4	150
5	57.5	110
10	102	96
25	177	96
50	249	110
100	337	120
500	586	-

Key:
% – percent
cfs – cubic feet per second

Expected flow over the stabilized slope can be expected to vary widely depending on the annual rainfall. High rainfall years, resulting in significantly higher peak flows will be taken into account for design of erosion control measures for the stabilized slope.

4.3 Relocated Water Diversion

The design criteria for the relocated water diversion are defined below:

- The maximum anticipated rate of diversion will be 16 cfs.
- Sands, gravels, cobbles and/or geotextile will be provided to screen flow as it enters the intake pipes to minimize the entrance velocity of groundwater in order to reduce the frequency of required maintenance.
- Head loss from pipeline extension will require potential head elevation increase at Ranney Intake (i.e., moving the Ranney Intake upstream from the current layout).
- Cal-Am's new water diversion will provide hydraulic head equivalent to the existing point of diversion, which is at El. 525.

Cal-Am's current infrastructure and operations are dependent upon a water surface of El. 525 at the point of diversion at San Clemente Dam to provide the required hydraulic head in the conveyance pipeline between the dam and the downstream filter plant to drive the water though the existing filters to the clearwell for distribution. The clearwell provides the hydraulic head for distributing the treated water into the distribution system. Therefore, the point of diversion would need to be maintained at El. 525 and would need to be located in the immediate vicinity of San Clemente Reservoir in order to avoid the need for extensive improvements to the existing filter plant. The maximum anticipated rate of diversion is 16 cfs, although summer diversions are not expected to exceed 3 to 4 cfs. Cal-Am's annual water right from the Carmel River is 3,376 ac-ft, or an average of 4.7 cfs throughout the year.

Installation of a subsurface screened intake at the head of San Clemente Reservoir has been planned. The intake, similar to a Ranney Intake system, would consist of a network of 12-inch diameter stainless-steel perforated pipes embedded in the gravels and cobbles that line the river bottom. The intake pipes would discharge to a common well on the riverbank and then to a conveyance pipeline. Based on the longitudinal profile of the Carmel Branch developed by MEI (MEI, 2003), the screened intake would need to be constructed and maintained approximately 3,500 feet upstream of the dam in order to provide a diversion at El. 525. The existing 30-inch-diameter steel conveyance pipeline would need to be extended from its current end at the dam site to the location of the new intake.

Current PWA alternatives analysis of the proposed channel show that one of their alternatives would require moving the point of diversion upstream an additional 440 feet. The next phase of design will coordinate point of diversion with channel design to ensure the required hydraulic head is maintained.

4.4 Temporary Bypass Pipeline

The design criteria for the temporary bypass pipeline are defined below:

- The temporary bypass pipeline should provide capacity to bypass Carmel River flows (and a separate pipeline to divert San Clemente Creek flows) in the May through October construction season.
- The temporary bypass pipeline should safely pass fish downstream per USACE guidelines (USACE 1991).
- The temporary bypass pipeline design should consider construction and use of permanent diversion pipeline for bypass of river flows.

Diversion of the stream flow during construction will require installation of temporary bypass pipelines. The size of the pipelines will be determined primarily based on hydraulic gradients and historical flow rate of the river channel, considering seasonal variations. The bypass pipeline and preliminary route of the bypass pipeline is shown in **Figure 1-2**. The size and layout of the pipeline will be confirmed during detailed design. Duration and available upstream reservoir capacity created by the sheet pile cutoff will also be considered during design.

The potential for fish passage through the temporary diversion pipeline would be subject to the Fisheries Handbook of Engineering Requirements and Biological Criteria, Fish Passage Development and Evaluation Program (USACE, 1991). This criterion shows there is some potential harm to fish from the change in hydraulics and pressure as water is conveyed over dams or through penstocks or spillways as fish descend from one level in the river to another. However, if fish are moving into the pipe from the surface (at 1 atmosphere pressure) and then quickly pressurizes and depressurizes back to 1 atmosphere, there is relatively small risk for injury. Temperature will be a factor with warmer conditions, such as occur at San Clemente Dam during summer, and may create higher mortalities. Under conditions expected for the temporary diversion, there will be low risk if the pipe passing fish from the dam to the river downstream was open, or if it included an open pool approximately half-way down the passage.

4.5 Existing Conditions of Geomorphology and Sediment Transport

This section presents a current understanding of the existing Carmel River channel, including geomorphology and sediment transport.

4.5.1 Existing Conditions of Geomorphology and Sediment Transport

The reservoir created by San Clemente Dam is approximately 1.7 miles in length. Upstream and beyond the backwater effects of the reservoir, the Carmel River is canyon-bound and relatively steep, with coarse-grained bed material consisting primarily of cobbles and gravel, with some boulders and varying amounts of sand. Since its construction in 1921, a substantial amount of sediment has deposited in the backwater-affected area, with less than 130 ac-ft of the original 1,425-ac-ft of water storage capacity of the reservoir remaining due to the deposits. As of 2001, the nose of the sediment deposits in the Carmel River arm of the reservoir was about 200 feet upstream from the dam, and additional deposition has occurred since that time (**Figure 4-10**). Based on measurements of the accumulated sediment in San Clemente Reservoir, the average annual sediment load to the reservoir is about 16.5 ac-ft, but it is highly variable from year-to-year depending on the runoff and watershed conditions (MEI, 2002).

The surface material in the reservoir deposits exhibit a typical downstream fining trend, with the surface near the head of the reservoir consisting of gravel and cobbles, transitioning to gravel and sand in the middle portions of the reservoir, and finally to primarily sand near the nose of the delta (**Figures 4-6** and **4-8**). Based on data from the subsurface investigation conducted by Kleinfelder in July and August 2002, the reservoir deposits also show a typical upward coarsening trend (Kleinfelder, 2002; MEI, 2003). The existing reservoir deposits in the Carmel River branch, on which the restored channel will be constructed, transitions from gravel and cobbles at the upstream limit of the deposits to coarse sand and gravel at the head of the proposed diversion channel. The sediment deposits in San Clemente Creek, downstream from the outlet of the proposed diversion channel that will be removed, are primarily composed of medium and coarse sands, with some fine sand and silt in the lower and downstream zones. Upstream from the diversion channel outlet in the San Clemente Creek arm, the deposits are primarily coarse sand, gravel, and cobbles.

The approximately 19-mile reach of the Carmel River downstream from the dam transitions from a canyon-bound, cobble- and boulder-bed river with significant bedrock outcrop control at the upstream end to a sand-bed system in the downstream portions of the reach (MEI, 2002). In 2002, when the bed-material data used in the previous modeling efforts were collected, the interface between the gravel- and sand-bed portions of the reach occurred between about RM 4 and RM 5. Recent information from the Monterey Peninsula Water Management District (MPWMD) indicates that this interface has moved downstream to about RM 2.5 (Larry Hampson, personal communication by MEI, 2007), most likely due to the continued adjustment of the downstream river to sediment trapping in the upstream reservoir, and the absence of significant episodic tributary sand inputs.

Typical of most coastal streams, the gradient of the river flattens significantly from the upstream, canyon-bound reaches to the flatter, less confined reaches near the coast. The gradient of the approximately 1.7-mile reach of the river between San Clemente Dam and Sleepy Hollow is about 1 percent, which is about one order of magnitude steeper than the reach between Highway

1 and the coast. According to Kondolf and McBain (1995), the lower Carmel River incised by up to 12 feet between the time of construction of San Clemente Dam in 1921 and the late 1930s. Between the 1930s and about 1980, the river remained relatively stable in this reach until locally severe bank erosion began to occur, possibly due to increased bank instability associated with a loss of vegetation, resulting from drawdown of the water table by groundwater pumping. Kondolf and Curry (1986) concluded that the middle reach of the river narrowed, incised, and appeared to be more laterally stable after construction of San Clemente Dam, although some bank erosion continued to occur. Recent information from MPWMD indicates that the river has incised by a few feet in recent years in the vicinity of the sand/gravel transition (Larry Hampson, personal communication by MEI, 2007).

Hydraulic (HEC-RAS) and sediment-transport (HEC-6T) modeling of the existing reservoir and downstream Carmel River were performed to establish a baseline for which the effects of the CRRDR project could be compared. The sediment-transport model includes both branches of the reservoir and the entire approximately 19-mile reach of the river between the dam and the coast (MEI, 2003). The model was executed over two 41-year periods, representing initially wet and dry conditions. The model results indicate that the delta in the Carmel River branch of the reservoir would reach the dam within the first six months of the simulation with the wet period that begins with water year (WY) 1978 flows, and in about six years for the simulation with the initially dry period that begins with WY1985 flows. Over the 41-year simulation period, about 75 percent of the sediment load that was supplied to the reservoir (about 674 ac-ft) passes into the downstream river, all of which is sand and fine gravel, and the remaining approximately 25 percent is stored in the reservoir. The model also indicates that the main channel of the river is net degradational over the simulation period under existing conditions. Of the approximately 500 ac-ft of material passing the reservoir, between 50 ac-ft (dry start period) and 60 ac-ft (wet start period) is, however, stored in the overbanks of the downstream Carmel River at the end of the simulation.

5.0 LANDSCAPE DESIGN AND ENVIRONMENTAL RESTORATION

This section presents basic information and considerations related to the landscape design and environmental restoration for the San Clemente Dam project. **Section 5.1** briefly summarizes the current conditions for the site. **Section 5.2** discusses revegetation of the Carmel River arm of reservoir. **Section 5.3** discusses reconstruction of river channel and revegetation of valley floor of San Clemente Creek. **Section 5.4** presents considerations for biological mitigations focusing on the steelhead and California red-legged frog.

5.1 Current Conditions

Currently, the in-filled portion of the reservoir is mostly covered with willows, cottonwoods, and associated riparian flora. Dense coastal oaks and poison oak inhabit the upland areas. Bedrock outcrops are common, especially in the sidewalls of canyon and in road cuts along the unpaved access road through the property. The site is habitat to both the California red-legged frog (Rana aurora draytonii) and steelhead trout (Oncorhynchus mykiss), which are both federally listed as threatened species.

5.2 Revegetation of Carmel River Arm

The sediment disposal site, the stabilized sediment slope, and the diversion dike slope of the Carmel River arm would be revegetated after construction. The purpose of revegetation includes soil stabilization and environmental considerations, due to the susceptibility of the ground surface to runoff and wind erosion. Vegetation stabilizes the soil surface by intertwining of its roots, minimizes seepage of runoff into the soil by intercepting rainfall, and retards runoff velocity (Abramson et al., 2002). The surface vegetation also provides a favorable habitat for the establishment of deeper-rooted vegetation such as shrubs and trees. Moreover, the vegetation will provide benefits of habitat restoration and reduction in visual impact of engineered slopes.

The considerations for design of the revegetation include the following:

- Agencies' and stakeholders' requirements (e.g., habitat creation/preservation requirements)
- Soil erodibility
- Hydrologic conditions and soil-water retention characteristics of the site
- Adaptability of plant species proposed for revegetation to local climate and soil type of the site

Re-vegetation design assumes erosion control measures will be employed during and after construction for a period of several years while native plant species establish growth in the newly constructed areas. The following assumptions for re-vegetation design are divided by project component below:

- **Stabilized sediment and slopes in the bypassed Carmel River arm:** Relatively large slopes will require geo-grids or geo-cells to provide erosion resistance while allowing for vegetative growth through the cells of the geo-grids. Relatively small slopes formed by the stored San Clemente Creek sediments will use standard erosion control methods (straw waddles, hydroseeding, etc.). Initial vegetation of all slopes will be achieved using hydroseeding of native grasses. Geo-grid stability is addressed in **Section 2**.

- **Diversion dike:** Surfaces of the slopes of the diversion dike will likely be constructed of highly permeable granular materials, which will not be favorable for vegetative growth. The geotechnical design of the dike preliminarily investigated whether placement of material with relatively small grain size from the sediment removal operations. The materials encountered showed that grading the dike materials to allow for vegetative growth will be feasible. However, further analysis of grading the dike materials (thereby decreasing permeability) and its impact on slope stability, foundation stability (due to piping from seepage pressures) and cost of additional processing will be required at the next phase of design. Other revegetation alternatives include placing planters on benches constructed on the face of the permeable dike. Revegetation concepts will be further evaluated and selected based on dike design and cost evaluation. Revegetation and erosion control concepts similar to the stabilized sediment slopes on the bypassed arm of the river will be considered.

5.3 Reconstruction of River Channel and Revegetation of the Valley Floor of San Clemente Creek

The design criteria for the reconstruction of river channel and revegetation of the valley floor of San Clemente Creek are defined below:

- The reconstruction and revegetation should provide natural riparian habitat similar to the non-dammed portions of the Carmel River upstream and downstream of the project site
- The reconstruction should allow fish passage and provide fish habitat
- As the restored riparian vegetation communities develop over time, they should show a trend toward developing species composition, structure, and percent vegetative cover similar to the undisturbed reaches up- and down-stream from the project.
- Upland habitats should develop sufficiently to stabilize and allow for the eventual recruitment of native woody species.
- Red-legged frog habitat should be created by establishing instream pools and off-channel ponds that maintain 20 inches of ponding through July in an average year. Wetland vegetation should naturally establish along the edges of the pools in the Diversion and San Clemente Creek Reaches.

Removal of the sediment in the San Clemente Creek portion of the reservoir would expose the pre-1921 alluvial deposits in the river channel and floodplain through the historic reservoir inundation zone. A three-stage channel would be provided through selective contouring along San Clemente Creek:

1. The river/creek valley formed by the pre-1921 alluvial deposits

2. A bankfull channel appropriately sized with capacity for a two-year flood event

3. A thalweg (low-flow channel) to pass median annual flows and provide depths needed for migration even during low flows

Preliminary restoration design is included in **Appendix B** and summarized in the following paragraphs. The summary criteria and objectives below will be used for future detailed design for landscape and environmental restoration.

The primary objective for the riparian habitat restoration is to create self-sustaining riparian habitat dominated by native species that provides food, shelter, and shade functions for salmonids. This will be accomplished by creating hydrogeomorphic conditions that support riparian habitat. With creation of soil and hydrologic conditions that support riparian habitat, restoration will rely on natural recruitment from surrounding source populations as the primary means of establishing and maintaining riparian habitat. Natural recruitment processes will be supplemented (jump-started) by selective active planting of riparian tree species. These new riparian communities will develop into important components of salmonid habitat. The riparian forest will also help to stabilize the channel and eventually contribute woody debris to the system. Upland habitat should be created in areas above the 10-year floodplain to stabilize the soil. The upland areas will be seeded to provide immediate cover to prevent erosion, and over time upland woody species will naturally establish (PWA, **Appendix B**).

The broad valley containing the reconstructed stream channel would generally follow 1921 contours. The bankfull and thalweg channels would be reconstructed by limited grading of the existing alluvial deposits. Habitat complexity would be promoted within the channel by constructing step pools, runs, and riffles to provide suitable depth and velocity conditions for steelhead migration. Instream structures such as downed trees, boulders, and simulated landslides would be placed at strategic locations to improve conditions along the stream channels. .

Stabilization of the exposed land would be accelerated by planting the exposed reservoir canyon slopes with native upland vegetation. Likewise, once the channel has been contoured, the establishment of riparian vegetation on the lowered sediment terraces would be accelerated through cultivation and planting of selected areas of the valley floor. Native saplings of suitable riparian species would be obtained from nearby reaches of the Carmel River and San Clemente Creek and planted at appropriate densities along the stream banks. Temporary stabilization of stream banks would also be provided using vegetative matter and plantings.

The project would establish off-channel ponds adjacent to the Carmel River Reach and step-pools within the Diversion Reach and San Clemente Creek Reaches appropriate for the California red-legged frog. The pools should be deep enough to provide refuge habitat for the frogs and wetland vegetation should naturally establish along the edges. The off-channel ponds along the Carmel River are expected to be temporary in nature due to the predicted sediment deposition and channel migration. Over time the channel will likely naturally migrate, depositing sediment within these pools and scouring out other pools elsewhere that will support California red-legged frogs. (PWA, **Appendix B**)

Natural revegetation and river restoration design is considered a highly iterative, hands-on process that cannot be planned in detail in advance and mainly occurs during the first several years of post-construction. Design drawings and contract specifications will show initial design layouts and planting schemes for revegetation and river restoration, but thereafter will have provisions for field changes as river flows are observed the first several years. Preliminary stabilization measures may consider placing willow cuttings to revegetate the river channel banks quickly.

5.4 Biological Mitigations

Biological mitigation measures for steelhead and California red-legged frog would be required, as tentatively outlined in the following activities. Additional measures may be required by the stakeholder agencies as a result of the environmental review and permitting process during the finalization of the EIR/EIS. In addition, a steelhead and California red-legged frog biologist, who are familiar with the requirements of National Marine Fisheries Service and has local knowledge of Central California Coastal Evolutionarily Significant Unit, should be retained for hands-on surveying, monitoring and management of rescuing/relocating the steelhead and California red-legged frog.

5.4.1 Steelhead

Mitigation measures to protect steelhead trout would occur prior to the start of each construction mobilization, during the construction season, and through annual demobilization for the winter season. The measures likely include the following:

Two weeks prior to diverting the streamflow around the reservoir and dam, migrant trapping upstream of the reservoir will be initiated to reduce the number of steelhead that might be present within the reservoir pool.

Fish rescues will occur in the areas between the diversion points on the Carmel River and San Clemente Creek and the reservoir during the early phases of the reservoir drawdown.

When the streamflow is diverted, fyke nets and traps will be installed upstream of the diversion points to prevent steelhead, California red-legged frogs, turtles, and other animals from entering the pipelines. The traps and nets will be maintained each construction season throughout the period the streams are diverted. A possible alternative to traps and nets may include allowing fish to enter the bypass pipeline. Design criteria for fish passage through pipes are established in Section 4.4 and will be evaluated in the next design phase.

After the streamflow is diverted, the water in the reservoir pool will be pumped out or released through the drawdown ports and the outlet pipe. Steelhead and California red-legged frog will be salvaged using nets and traps or other methods, as appropriate. Steelhead will be relocated downstream of construction activities. Red-legged frogs will be moved to designated relocation sites defined during permitting.

Fish rescue will also be required in the plunge pool below the dam after the cofferdams are installed. After partial dewatering of the plunge pool, efforts will be made to rescue all steelhead and other fish using nets or electro-fishing gear, as appropriate. Rescued fish will be relocated well downstream of the cofferdam.

It is anticipated that the dam will be removed in several lifts during the last construction season, and that the fish ladder will remain in operation every winter prior to dam removal. Therefore, trapping of adult upstream migrating adult steelhead during their migration season (December through March or April) is not anticipated to be necessary.

5.4.2 California Red-Legged Frog

The California red-legged frog mitigation will also occur prior to the start of each construction mobilization, during the construction season, and through annual demobilization for the winter season. Mitigation measures will include the following:

- During construction, California red-legged frog protection and oversight require trained personnel on site to monitor compliance with mitigation and conservation measures and communicate with Cal-Am and resource agencies.

- During construction, trained personnel will conduct daily visual inspections to clear construction areas of red-legged frog.

- During construction, trained personnel will also continually remove bullfrog adults and tadpoles from the remnant reservoir pool and upstream pools/ponds (late fall season) to reduce bullfrog numbers.

- During dewatering of the plunge pool, trained personnel will remove bullfrog adults and tadpoles and translocate any red-legged frogs to appropriate translocation sites.

- After demobilization each fall, bullfrog tadpole removal will continue until November to maximize the impact to bullfrog populations.

- Habitat restoration for California red-legged frog will be completed. The following activities would be included to benefit the California red-legged frog:

    - Habitat improvements to potential breeding sites (after bullfrog removal) located upstream in the historic inundation zone
    - Construction and planting of new (optimal) breeding habitats within the historic inundation zone
    - Construction and planting of new (optimal) breeding habitats within the sediments in the bypassed reservoir arm and sediment disposal areas

6.0 CONSTRUCTION OPERATIONS

This section discusses considerations related to construction and operations of the project. **Section 6.1** lists the anticipated permits that are required for the project and provides a preliminary permitting schedule. **Section 6.2** briefly discusses several key issues for project operations. **Section 6.3** discusses access to the project site. **Section 6.4** briefly addresses the availability of construction materials at the site. **Section 6.5** discusses considerations regarding the construction methods. **Section 6.6** provides the cost estimating criteria and a probable cost estimate for the project. **Section 6.7** presents the scheduling criteria and a preliminary construction schedule. Finally, **Section 6.8** provides preliminary lists of the construction documents including drawings and specifications.

6.1 Required Permits

The permitting schedule will open with the Notice of Determination filed by CDWR in January 2008 and will close in November 2008 with the Federal Record of Decision. Several major permits will be obtained during the permitting process. The permitting schedule is shown in detail in **Figure 6-1**. **Figure 6-2** shows the permitting schedule in relation to the project schedule. The permits shown on the permitting schedule are the major permits anticipated; other permits may be required as well. Environmental permitting activities are assumed to extend until early 2009, at which time the Record of Decision would be adopted by the lead agencies.

The major components of the permitting schedule include the following:

- USACE Clean Water Act 404 Permit
- NOAA Fisheries Endangered Species Act Consultation
- USWFS Endangered Species Act Consultation
- CDFG Streambed Alteration Agreement
- California SHPO Section 106 NHPA
- Monterey County Land Use Permit
- Grading Permit
- Encroachment Permit

Throughout the permitting processes, a number of consultation and coordination meetings will take place between agencies. Site visits will also take place by various agencies as needed. Additionally, construction permits may be required, which will be identified during final design, and obtained by the contractor. The contractor will be responsible for obtaining the General Construction Permit from National Pollutant Discharge Elimination System, which includes the preparation of a Storm Water Pollution Prevention Plan (SWPPP). Because of the extended time that will be required to complete and approve a SWPPP for this project, it is recommended that the owner/engineer works with the State Water Resources Control Board to prepare a draft SWPPP that the contractor can finalize and submit.

It should be noted that the project permitting phase will develop some restrictions to construction activities. Recently, permitting agencies have indicated that construction operations in the river channel for the project site will be restricted from about May 15 to October 15 each year. In addition, environmental monitoring will occur during construction and will have defined operating restrictions to mitigate impacts to endangered species, air quality, and adjacent habitat, etc.

6.2 Project Operations

The overall project construction scheme will be highly unique and subject to detailed environmental restrictions, such as a seasonal construction window in the river corridor. The detail of all the anticipated environmental constraints on construction activities will be given as permits for the project are issued. Currently, the major considerations for the project operation (during and after construction) include the following:

- During construction, timing of work on the dam demolition and sediment excavation, and in the downstream plunge pool must be optimized to minimize the risk of flooding due to uncontrolled operation of the river and reservoir.

- Dewatering for the project will be extensive, and the dewatering system will be designed by the Contractor with operating parameters defined during the design.

- The existing electrical service is supplied by Pacific Gas & Electric Company (PG&E). A 12-kV 3-phase pole line branches from an existing 60-kV transmission line and provides power to San Clemente Dam. Construction power requirements would be limited for the bypass construction and dam removal because the sediment and dam removal operations would be primarily performed with diesel-powered equipment. However, smaller loads would be imposed by dewatering requirements, construction office trailers, equipment maintenance shop, and night lighting. Alternatively, gas or diesel engine generator sets could be used if the PG&E permitting timeline and costs for the project are restrictive. The level of service that would be needed from PG&E will be further evaluated during the final design.

6.3 Access to Site

The design criteria for project access are defined below:

- Project access during construction should allow for heavy equipment mobilization onto the San Clemente Dam reservoir and to the base of San Clemente Dam
- Temporary access should minimize noise and pollution impacts to local communities
- Permanent access requirements to the CRRDR project features will be minimal, except to allow for periodic inspection and maintenance by project owner’s personnel via light vehicles

The project access would follow existing routes to the base of the dam (with some improvements) via San Clemente Drive through the Sleepy Hollow community; and the

Cachagua Route to the reservoir via a jeep trail that begins at the Cachagua Grade Road (**Figure 1-1**).

Existing vehicle access from Carmel Valley Road to both the San Clemente Dam and the filter plant is provided via San Clemente Drive, a private gated road. San Clemente Drive crosses Tularcitos Creek over a single-lane bridge approximately 22 feet wide and leads to Cal-Am gates at the southern bounds of the Sleepy Hollow subdivision. Access to the left abutment of the dam in the first season of construction will be through San Clemente Drive.

San Clemente Drive beyond the turnoff to the filter plant is approximately 1.7 miles to the base of the dam and is a one-lane unpaved service road with turnouts. A narrow “pipeline access route” parallels a portion of this route. Access beyond the Sleepy Hollow community and CVFP will continue via either the “High Road,” crossing a ford across the Carmel River, or via the “Low Road,” using an existing bridge across the river at the OCRD 1,500 feet downstream from San Clemente Dam.

Access to the base of the dam will be by the existing Low Road and the Plunge Pool Access Road, which starts at the OCRD. The Plunge Pool Access Road is an existing unimproved single lane road follows the southeast side of the Carmel River to the plunge pool at the base of the dam. This road has been in limited use and has a number of washouts from the 1995 and 1998 floods. This plunge pool access road would need to be improved to place the downstream cofferdams and stage the crane and other construction equipment used in demolition operations at the base of the dam. Some tree pruning and removal would be needed. The roadbed would be filled with sand and gravel and topped with crushed rock to provide one lane, two-way access and designated pullouts. A detailed survey and construction access evaluation will be required during final design to determine exact locations for improvement of the existing roads. It is anticipated that blasting and excavation will be required to widen the road at specific locations along San Clemente Drive.

The primary access to the reservoir would be via Carmel Valley Road and Cachagua Grade. An existing dirt road, with entrance off Cachagua Grade approximately three miles from the intersection with Carmel Valley Road, would be used. The road profile is shown on **Figure 6-3**, including the new access road to the reservoir that is described below. The entrance is controlled by a locked steel swing gate. "Truck Crossing - 500 Feet" signs would likely be necessary on both Cachagua Grade approaches. Asphalt pavement would be placed at the intersection to protect the Cachagua Grade edge of pavement and to reduce dust at the intersection.

About 1.5 miles of this existing dirt road, or “jeep trail” (from the intersection with Cachagua Grade to the new access road, described below) would need to be improved to allow access of construction personnel and equipment. Improvement of the existing road would consist of widening the road to a width of 20 feet (minimum width of 15 feet with turnouts for passing in tight reaches), improving the radius of curvature at sharper curves to allow passage of large trucks, and constructing a drainage ditch along the uphill edge of the road. The road surface would have 6 inches of Class II base rock installed. A double chip seal coat would be placed as a minimum wearing surface. Fifteen-inch-diameter or larger culverts with inlet structures would be installed at approximately 400-foot intervals for drainage.

A new 0.5-mile-long access road would be constructed from the improved dirt road to the reservoir (**Figure 1-1**). A typical cross-section of the road is shown on **Figure 6-3** along with a composite profile of Cachagua Grade and the haul road (described below). The road would be excavated along the slope of the ravine and would consist of a 15-foot-wide surface and 3-foot drainage ditch. The excavated slope above the road would be stabilized with small anchors, wire mesh and shotcrete as needed. The road surface would have 6 inches of Class II base rock installed. The road's travel surface would be sealed with a double chip seal coat. Fifteen-inch diameter or larger culverts with inlet structures would be installed at approximately 400-foot intervals for drainage.

As described in Section 6.5.2, a temporary haul road would be constructed between the San Clemente Creek and Carmel River arms of the reservoir for sediment removal operations during construction as shown on **Figure 1-2**. A profile of the road is shown on **Figure 6-3**.

6.4 Availability of Materials

The major materials needs for the project are for engineered slopes and earthen structures. Boulders and coarse and fine aggregates for dike and stabilized slope construction will be produced on site. Cement and cement aggregates for soil-cement mixing, diversion pipeline foundations, diversion sill, Ranney well, and other miscellaneous structures will be brought in from local manufacturers. Water used for construction activities will be taken from the Carmel River, subject to permitting restrictions on quantity and rate of diversion. Materials used for slope and foundation stabilization (e.g., anchors, grout, geogrid, graded stone, etc.) are available from local suppliers in the vicinity and greater California.

6.5 Construction Methods

This section presents construction methods for the CRRDR project. Stream diversion, reservoir drawdown, and construction dewatering is presented in **Section 6.5.1**. Sediment excavation, transport, and placement is discussed in **Section 6.5.2**. Sediment slope stabilization is presented in **Section 6.5.3**. **Sections 6.5.4** and **6.5.5** discuss construction of the diversion channel and dike, respectively. Environmental protection and erosion control are presented in **Section 6.5.6**.

6.5.1 Stream Diversion, Reservoir Drawdown, and Construction Dewatering

Project construction will involve stream diversion, reservoir drawdown, and construction dewatering. Both the Carmel River and the San Clemente Creek will be diverted around the active areas of excavation during the construction seasons. Stream flows will be passed downstream to maintain the flow and habitat in the Carmel River during construction. Within the reservoir area, the reservoir level will be drawn down, and the sediment deposits will be pre-drained to keep the active excavation area as dewatered and drained as possible to enable operation of scrapers and similar self-propelled earthmoving equipment.

The reservoir drawdown requirement constrains the main construction activities to a period when stream flow is low enough to be passed. A diversion facility, consisting of an interlocking sheet pile cofferdam (preliminary design), will be installed in the channel at the upper end of the reservoir to divert incoming flows through a pipeline. If necessary, another sheet pile cofferdam will be constructed across San Clemente Creek for water diversion. The temporary diversion facilities (sheetpile and pipeline) will be winterized between construction seasons by either moving them to higher elevation and tied down, or dismantling and placement in a designated area outside the flood zone within the project site (such as on the land adjacent to the haul road between San Clemente Creek and the Carmel River). A portion of the sheetpile may be left in place in the river channel in order to save construction cost and schedule for the following construction season. If sheetpile is left in place, sufficient amount of sheet piling within in the low flow channel will require removal in order to not impact fish passage. The next phase of design will establish the flood zone to determine where bypass piping might be placed and minimum required opening of the cofferdam.

Demolition and construction operations in the reservoir area will impact the diversion piping. Thus, burial or encasement of diversion piping will be necessary near the channel demolition areas, diversion dike foundation, and sediment disposal area. In addition, during the final construction season, when the dam is demolished, diversion piping will be required to be routed over the dam (instead of through the dam intakes) along the right abutment.

Prior to commencing excavation operations and after stream diversion has been established, the reservoir water surface will be drawn down by gravity to the invert of the drawdown ports at El. 514 and then further lowered to the lowest level possible. A sheet pile barrier will be installed around the intake, and the sediment between the sheet pile barrier and the dam intake will be removed. After the turbidity has cleared, the reservoir will be further lowered.

Reservoir drawdown and sediment excavation operations will be managed to promote pre-drainage of the sediments ahead of the excavation. Drainage trenches and/or well points may be installed within the sediment deposits and maintain the water surface in the reservoir below the bottom of the excavation, although dewatering design will be by the contractor. Desilting basins during the construction season will also be required. Exact locations of the diversion cutoff walls and pipelines, drainage trenches and well points will be determined during detailed design.

6.5.2 Sediment Excavation, Transport and Placement at the Disposal Site

Several excavation methods (mechanical excavation and hydraulic dredging) and transportation systems (truck, conveyor, and slurry) were evaluated and considered feasible (MWH, 2005). However, due to the vicinity of the disposal area on the bypassed arm of the Carmel River, mechanical excavation has a cost advantage and is simpler to implement than other methods. The selected approach is described in more detail below.

Excavation of sediment above the water table would be performed using self-loading scrapers or similar self-propelled excavating equipment. Pre-drainage of sediments prior to excavation would likely become ineffective in the silt deposits that exist below approximately El. 485 within 600 to 900 feet of the dam. The sediments would need to be mucked out using large hydraulic excavators, draglines, or clamshells working from firm ground. The excavated materials would be placed in a drying/staging area in the immediate vicinity of the point of excavation, from where they would be re-handled and transported to the disposal area on the bypassed reservoir arm.

Scrapers and other earthmoving equipment would transport the excavated sediment from San Clemente Creek to the bypassed Carmel River arm via a connecting road across a low-point between the San Clemente Creek and Carmel River (**Figure 1-2** and profile on **Figure 6-3**). At the disposal site, a bulldozer would be used to spread the sediment across the disposal area in preparation for compaction.

Site preparation prior to sediment disposal would include the following:

- Clearing and grubbing of trees and vegetation from the sediment pile footprint
- Removal of any existing facilities (none have been identified)
- Stripping and stockpiling of organic soils (minimal) for use in subsequent restoration and revegetation of the site once sediment placement has been completed

Upon delivery of sediment to the site, the sediment would be spread by means of bulldozers into thin, nearly horizontal lifts. Each lift would be compacted using bulldozers or vibratory compactors. The sediment pile would be constructed with a side slope as required for stability. Concrete debris from dam removal would be placed on selected areas of the final sediment disposal pile contours to provide long-term erosion protection.

At the conclusion of each construction season, the portions of the excavation and disposal site above the maximum reservoir level (El. 525) would need to be winterized. This would involve the following:

- Interim drainage and diversion of ravine flows
- Stabilizing sloping sediment surfaces and other disturbed areas by installing erosion protection features such as erosion control mats or straw mulch and wattles
- Sediment collection features such as silt fences, straw bales, and sediment traps along the toe of the pile and other disturbed areas

Once placement of sediment and concrete debris has been completed, the topsoil from the temporary topsoil stockpile developed during site stripping would be spread over the sediment pile. Prior to topsoil placement on concrete debris, geotextiles, or available sediments (sands, gravels, and cobbles) will be used to provide a filter before adding topsoil for vegetation. This will prevent topsoil from migrating into the voids of the debris. Rockfill erosion protection may also be provided up to the 2-year flood level (bank full conditions).

For the diversion channel construction, blasting operations will be required to remove the large volume of rock between the two reservoir arms. It is anticipated that minor operations will be required to reduce a small percentage of the blasted rock into 1-foot size and smaller with hoe-rams and similar equipment. A portion of the 1-foot and larger pieces (boulders up to 6 ft by 4 ft by 2 ft) of blasted rock will be separated for use in creating pools in the restored San Clemente Creek and armoring of the diversion dike face that would be exposed to river flows. During and after blasting operations, blasted rock material will be pushed by dozers and other excavation equipment a short distance from the diversion channel area to the diversion dike foundation area for use in dike construction.

6.5.3 Sediment Slope Stabilization using Soil-Cement Columns

After initial excavation of the silty "muck" soils at the base of the slope, the 4H:1V slope would be benched at regular intervals to allow for slope stabilization construction using large augers. The large augers would produce soil-cement columns by mixing cement with the existing soil to bedrock in a grid-like pattern along most of the slope face, starting 50 feet from the top of slope. After soil-cement mixing equipment demobilization, minor grading would be performed on the slope face and a geogrid would be installed on the center of slope to form a 50-foot-wide shallow channel to convey runoff from the local drainage area above the slope and minimize surficial erosion. In addition, concrete debris from the demolished dam would be placed at the lower third of the slope to further stabilize the sediment and protect it against erosion from flood flows in the main river channel, although the long-term effect of the concrete debris to the river water quality will require further evaluation in the next phase of design. Once stabilization is complete, a 2-foot-thick layer of organic soil would be added, and the slope would be vegetated. Prior to topsoil placement on concrete debris, the placement of the concrete debris would include filling the voids with earth. This will make the slope more stable in the long term, prevent topsoil from migrating into the voids of the debris, and allow for deep rooting of plants.

6.5.4 Diversion Channel Construction

For the construction of the diversion channel, ripping or blasting operations will be required to remove the large volume of rock between the two reservoir arms. Blasting operations will include the following:

- Clearing and grubbing of the blast area
- An explosives magazine established onsite to store explosive
- Pre-drilling of rock to place explosives
- Pre-splitting of rock at the channel boundaries to define the channel geometry

Most of the blasted rock will be broken into 1-foot pieces or smaller. Although, some specialized blasting or excavation (quarrying) may be required to produce seven hundred fifty 6 ft by 4 ft by 2 ft boulders (about 1500 CY with allowance for replacement boulders) to be used in the stream restoration. It is anticipated that minor operations will be required to reduce a small percentage of the blasted rock into 1-foot size and smaller with hoe-rams and similar equipment. A portion of the 1-foot and larger pieces of blasted rock will be separated for use in armoring of the diversion dike face that would be exposed to river flows. Bankfull and thalweg channels would be constructed as part of the channel excavation operations. In addition, habitat complexity would be promoted within the channel by constructing pools, runs, and riffles to provide suitable depth and velocity conditions for steelhead migration.

During and after blasting operations, blasted rock material will be pushed by bulldozers and other excavation equipment a short distance from the diversion channel area to the diversion dike foundation area for use in dike construction.

6.5.5 Diversion Dike Construction

Diversion dikes will include compacted rock within the geometry of the dike and a cutoff wall at the diversion dike toe. The 200-foot-wide by 3-foot-thick by 40-foot-deep soil-bentonite cutoff wall will be constructed to bedrock in order to prevent undermining and seepage of river flows below the diversion dike. One-foot and larger blasted rock pieces will be used to armor the diversion dike face, which will encounter river flows during the PMF up to elevation 566 (MEI, 2003), or approximately 39 feet below the proposed diversion dike crest. Rock pieces may be caged by wire mesh to form large blocks for armoring the upstream face of the dike if it is dictated by further hydraulic analyses.

6.5.6 Notching Old Carmel River Dam

The OCRD notching construction will consist of sawcutting, hoeramming, drilling and blasting, or combinations of these methods to cut a notch in the dam. It is anticipated that sheetpiling or other methods will be used to cutoff the Carmel River locally around the notch excavation. Cranes parked at the right abutment will be used to lift equipment, place and drive sheetpile, and remove the demolished portions of the dam.

6.5.7 Environmental Protection and Erosion Control

The overarching design criteria requirement will be that a comprehensive environmental protection and erosion control plan should be developed prior to the commencement of any construction work and implemented during the construction.

6.5.7.1 Environmental Protection

The considerations for environmental protection will include limiting air pollution, maintaining water quality, and providing natural vegetation. Some of the requirements/ mitigation measures may include the following:

- Dust and other particulate matters containing pollutants may settle on the site and carried to waters of the state through rainfall or other means. As such, dust shall be minimized to the extent practicable, utilizing all measures necessary, including: 1) wetting haul and access roads and other exposed dust-producing areas with water, 2) establishing temporary vegetative cover, 3) placing wood chips or other effective mulches on vehicle and pedestrian use areas, 4) maintaining the proper moisture condition on all fill surfaces, 5) pre-wetting cut and borrow area surfaces, and 6) use of covered haul equipment.

- Natural native vegetation shall be, as far as is practicable, protected and left in place in undisturbed buffer areas. Work areas shall be carefully located and marked to reduce potential damage. Trees shall not be used as anchors for stabilizing working equipment. During clearing operations, in areas designated for selective cutting or clearing, care shall be taken in falling and removing trees and brush to avoid injuring trees and shrubs to be left in place. Where natural vegetation has been removed, or the original land contours disturbed, the site shall be revegetated per a submitted and approved seeding and maintenance plan.

Additional requirements, such as working hours, specific access routes, noise abatement, work in the riparian zone, etc. will require attention during project development. Environmental requirements are outlined in the project EIR/EIS (Entrix, 2007) and will be detailed during the permitting process in 2008. Permit requirements shall be consulted when developing detailed plans and specifications. Construction contract documents will be required to explicitly outline environmental protection requirements during construction.

6.5.7.2 Erosion Control

Considerations for erosion control will include the following:

- Site plans for storm drainage, grading, and erosion control plans will be required for all grading activities.

- Erosion control plan shall include a schedule for implementation of erosion measures, including measures to cover bare soil following final grading and implementation of wet weather measures. On sites where vegetation and ground cover have been removed, the site shall be protected through the wet season with straw mulch, erosion blankets, or other approved method, where appropriate.

- Water containing sediment shall not be discharged into the surface water management system, wetlands, or streams without first passing through an approved sediment filtering facility or device. Discharge from temporary sedimentation ponds or detention facilities used for sedimentation during construction shall be constructed to applicable standards to provide adequate sediment filtration.

6.6 Cost Estimating Criteria and Estimate

An opinion of probable construction cost has been developed for the CRRDR project by MWH. The estimated costs are summarized in **Table 6-1** at end of this section. Details of the estimate are found in Appendix C.

6.6.1 Basis of the Cost Estimate

The opinion of probable construction cost estimate is based on the following:

- The dam removal, sediment stabilization, channel construction, sediment removal, and disposal concepts described in this report

- The volume of sediment to be removed and rock to be excavated as estimated by MEI (2003 and 2005b)

- The cost estimate prepared by Entrix for environmental permitting and steelhead and California red-legged frog mitigation activities (Entrix, 2004)

- MWH's evaluation of the major construction items appropriate to complete the work

- Quantity estimates for the stream diversion facilities, access roads, and sediment stabilization that were developed from the layouts included herein and from experience with similar projects

6.6.2 Cost Estimate Criteria

The estimated costs are also based on the following criteria:

- Labor rates and fringes are based on 2007 Davis-Bacon rates for Monterey County.

- Labor costs are based on 5 days per week, 10 hours per shift. Payroll tax and workers compensation insurance are set at 38 percent.

- Equipment rates are drawn from estimator's equipment history information.

- Material costs are based on typical costs for similar work. Construction water is assumed to be available on site.

- The construction crews developed for use in these estimates are derived from experience for similar work. The estimated requirements for labor, which affects the number of vehicle trips to and from the site, vary from an approximate average of 15 workers per day during Phase I (road construction and improvements scheduled for first season for approximately eight months), to an approximate average of 25 workers per day during Phase II (dam demolition, sediment stabilization, excavation, and disposal). A maximum of about 40 workers would be needed during July through October. Construction crews could be transported to work in car pools to minimize construction related traffic, or shuttled from a designated offsite parking facility.

- Direct construction costs are based on 3rd-quarter 2007 dollars.

- Project financing costs are excluded.

- Escalation to mid-point of construction is assumed at 7.5% based on escalation observed in the heavy civil construction industry.

- No costs have been added for damage or lost time due to the potential for overtopping of the stream diversion system and work site.

- The cost for those permitting and mitigation measures associated with steelhead and California red-legged frog that were described by Entrix (2004) is included and based on the San Clemente Dam strengthening alternative monitoring. However, it is assumed that the costs will be similar because most of the in-stream work for the CRRDR project will occur over 2-years, as with the strengthening alternative. Additional measures that may be required by regulatory agencies are not included.

- If further restrictions on the construction schedule are imposed based on environmental issues not described above, the construction schedule may need to be extended. This would result in additional mobilization, dewatering and winterization costs that are not included in the current estimate.

- Weather conditions could also impact the construction schedule. If the construction program occurs during a wet part of the hydrologic cycle and spring flows remain high for an extended period at the beginning of the construction season, or if significant storms occur in early fall, construction delays could occur that would increase the number of construction seasons. This would result in additional mobilization, dewatering and winterization costs that are not included in the current estimate.

- The average unit weight of the sand/gravel sediments is assumed to be 105 pounds per cubic foot. In-situ moisture content at the time of transport is assumed to be on the order of 20 percent.

- Diversion dike foundation improvements are not included in this estimate, as it is assumed the design will employ overbuilding and/or dike redundancy to mitigate for unfavorable foundation conditions.

6.6.3 Limitations of the Cost Estimate

The opinion of probable construction cost was developed using the software of the Chief Estimator developed by International Project Estimating Limited (IPE 2007). A contingency of 25 percent has been added to account for pricing variations. Non-construction project costs also presented. It should be emphasized that the opinion of probable construction cost has been prepared at a conceptual level. The actual cost will change up or down as the design is defined in more detail and as it evolves in response to the evolving needs of the project's stakeholders. For example, it should be noted that, if an insufficient amount of large boulders are produced for the channel restoration, large boulders would have to be imported and placed at an approximate cost of $250,000 $500,000 for roughly 750 boulders required for channel restoration (includes replacement boulders), thereby adding to project construction costs and potentially impacting the overall schedule.

Furthermore, the estimate of costs shown and any resulting conclusions on the project financial, economic feasibility, or funding requirements, have been prepared from guidance in the project evaluation and implementation from the information available at the time the estimate was prepared. The final costs of the project and resulting feasibility will depend on actual labor and material costs, competitive market conditions, and other variable factors. Accordingly, the final project costs may vary from the estimate. Project feasibility, benefit/cost analysis, risk and funding must be carefully reviewed prior to making specific funding decisions and establishment of the project budget.

6.7 Scheduling Criteria and Schedule

The project scheduling criteria are defined below:

- The project should be sequenced and designed such that the project can be completed as soon as possible in order to minimize escalation costs and make the project attractive to contractors (i.e., project construction that extends multiple years will likely reduce the number of bidders on the project).
- The schedule must incorporate environmental restrictions that define a specific construction window for activities occurring within the river channel.

A conceptual schedule is presented on **Figure 6-2** using the general schedule criteria above and schedule detail and assumptions described below.

The project is expected to take four to five years to complete, from environmental review, permitting, and design, to infrastructure improvements, sediment removal, diversion channel excavation, diversion dike construction, dam demolition, and creek channel reconstruction. The overall schedule could be affected by the amount of yearly rainfall and its effects on river flow conditions in the spring.. Construction in the river channel will be limited to between May 15 and October 15 each year, although in dry seasons it is anticipated that some limited construction activity, based on permit requirements and detailed authorizations from agencies (e.g., CDFG, NOAA, USFWS), may occur into December each year. During extended construction seasons, the contractor will be required to completely demobilize from the river channel and banks no later than December 31. Conversely, in wet seasons the construction window will be shortened depending on river stage.

Environmental permitting activities are assumed to extend until early 2009, at which time the Record of Decision would be adopted by the lead agencies. Final engineering studies would be performed in 2008 and 2009, including final geotechnical investigations for the diversion channel, sediment stabilization, sediment disposal site, and access roads; design of the access roads; design of the sediment pile including stability and hydrologic analyses; planning for demolition of the dam; planning and design of stream bypass and dewatering facilities; design of the bypass channel and diversion dike construction; design of the reconstruction of the San Clemente Creek channel; and design of mitigation or habitat enhancement plans for red-legged frogs and steelhead.

In order to expedite the project construction and make the project more attractive for bidders, two separate construction contract packages would be developed, where construction bids would be solicited for the first phase in late 2008, for award in early 2009. However, it should be emphasized that first phase construction will only occur in early 2009 if permitting activities complete as planned or are adjusted to fit this phasing sequence[1]. The second phase would solicit for construction bids in late 2009, for award in early 2010. The first construction phase (Phase 1), in 2009, would include mobilization, improvement of the access road from Cachagua Grade to a new access road, construction of a new access road from the existing access road to the reservoir, and initial construction activities to prepare for Phase II construction (e.g., placement of diversion piping, clearing, and preparation of stream cutoff).

The second construction phase (Phase 2), in years 2010 through 2011 would include the construction of temporary roads across the reservoir sediment surface to allow access for excavating equipment, the removal of sediment, blasting and construction of the diversion channel and diversion dike, sediment slope stabilization, demolition of the dam, the reconstruction of stream channels, and the restoration and revegetation of the sediment pile and reservoir area. Reservoir restoration and channel reconstruction activities would take place

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[1] The current permitting schedule (Figure 6-1) shows that the CDFG Streambed Alteration Agreement (SAA) will not complete until mid- to late-2009. The Phase I schedule assumes that some stream diversion preparation activities will be allowed to occur in 2009. This will be necessary in order to allow the Phase II construction to complete in two construction seasons. Permitting activities planned for 2008 should be defined such that a limited SAA permit be prepared to allow for pre-construction activities in the river channel in 2009. Moreover, this schedule will be impacted if delays occur for permit approval of road improvements and the new reservoir access road, access survey, engineering design, Phase I bid package preparation, and construction contract procurement, all of which are planned to be completed in 2008.

concurrently with sediment removal activities. During each construction season, mobilization would occur during the month of March. Field work in the reservoir area would start on or about April 15. Installation of temporary diversion and dewatering facilities would take about one month, with closure of the cofferdams on or about May 15. Fish rescue and drawdown of the reservoir would continue until about May 31. Actual channel excavation, dike construction, sediment stabilization and excavation, and dam removal operations would take place during a five-month period from June through October. Removal of cofferdams and demobilization of in-stream construction operations would occur in November. Allowing for holidays and a few days of bad weather, it was assumed that each season would have approximately 100 working days of actual channel excavation, sediment stabilization and excavation, and dam removal production operations.

Sediment excavation, transport and placement operations would be conducted in two 10-hour shifts, five days per week. For computation of actual production, it was assumed that each shift would have one unproductive hour, that is, the 10-hour shifts would have nine hours of actual production.

The equipment for sediment excavation and transport was sized to be able to sustain an average rate of 300 cubic yards per hour with a peak capacity of 500 cubic yards per hour. This results in a sediment removal rate that would remove 360,000 cubic yards of sediment in San Clemente Creek channel in about three months.

It is assumed that, during the third and last year of construction operations, sediment removal and sediment slope stabilization (soil-cement mixing) would be completed in September. The upper portion of the dam would be demolished while sediment removal and sediment stabilization are being completed. Then, dam demolition and removal activities would continue into the fall and be completed in October. Removal of cofferdams and demobilization of in-stream construction operations would occur later in October and November.

Reservoir restoration and channel reconstruction activities would take place concurrently with sediment removal activities. This work would begin at the upstream end of the reservoir (San Clemente arm of reservoir) and progress toward downstream as new areas of the historical stream terraces and channel are uncovered. Additional time would be needed at the conclusion of the sediment removal, dam demolition, and cofferdam removal operations to complete the reconstruction of the river channel and the revegetation of the reservoir and sediment areas.

6.8 Construction Documents

A preliminary description of the construction documents including drawings and specifications to be developed for the project are listed in this section.

6.8.1 Drawings

Civil Drawings

C-1 General notes for civil engineering
C-2 Site plan
C-3 Demolition plan

C-4 Temporary stream diversion plan
C-5 Plan of diversion channel
C-6 Cross-section of diversion channel and details of diversion sill
C-7 Plan of diversion dike
C-8 Cross-section of diversion dike
C-9 Plan of slope stabilization
C-10 Cross-section and details of slope stabilization
C-11 Profile of permanent diversion pipeline
C-12 Details of pipeline connections
C-13 Erosion, sediment, and pollution control plan
C-14 Channel restoration plan,
C-15 Channel restoration profiles, sections and typical details

Structural Drawings
S-1 General notes for structural engineering
S-2 Plan of river water intake system
S-3 Section and details of river water intake system
S-4 Plan, section and details for diversion sill
S-5 Typical details of foundation support for permanent pipelines
S-6 Sections and details of the temporary sheet pile cofferdam

Mechanical and Electrical Drawings
ME-1 General notes
ME-2 Schedule of valves

Landscape Drawings
L-1 General notes
L-2 General plan for landscape and revegetation
L-3 Plan and schedule of landscape and revegetation at San Clemente Creek riverbank
L-4 Plan and schedule of landscape and revegetation at sediment disposal area and slope

6.8.2 Specifications

DIVISION 1 - GENERAL REQUIREMENTS

01500	Landscaping & Site Restoration

DIVISION 2 - SITE WORK

02050	Removal and Demolition
02140	Diversion and Care of Water
02200	Earthwork
02210	Rock Excavation
02266	Drilling and Grouting
02490	Rock Bolts
02900	Water System
02901	Soil-Cement Mixing
02902	Riprap

DIVISION 3 - CONCRETE

03100	Concrete Formwork
03200	Concrete Reinforcement
03250	Concrete Accessories
03300	Concrete
03361	Shotcrete
03600	Grout
03701	In Situ Concrete Testing

DIVISION 11 - EQUIPMENT

11010	Quality Requirements for Equipment
11020	Inspections and Tests for Equipment
11030	Materials and Equipment
11040	Manufacturer’s Services
11050	Operation and Maintenance Manuals

DIVISION 15 - MECHANICAL

15010	Basic Mechanical Requirements
15060	Miscellaneous Piping and Accessories
15100	General Requirements for Engineered Valves

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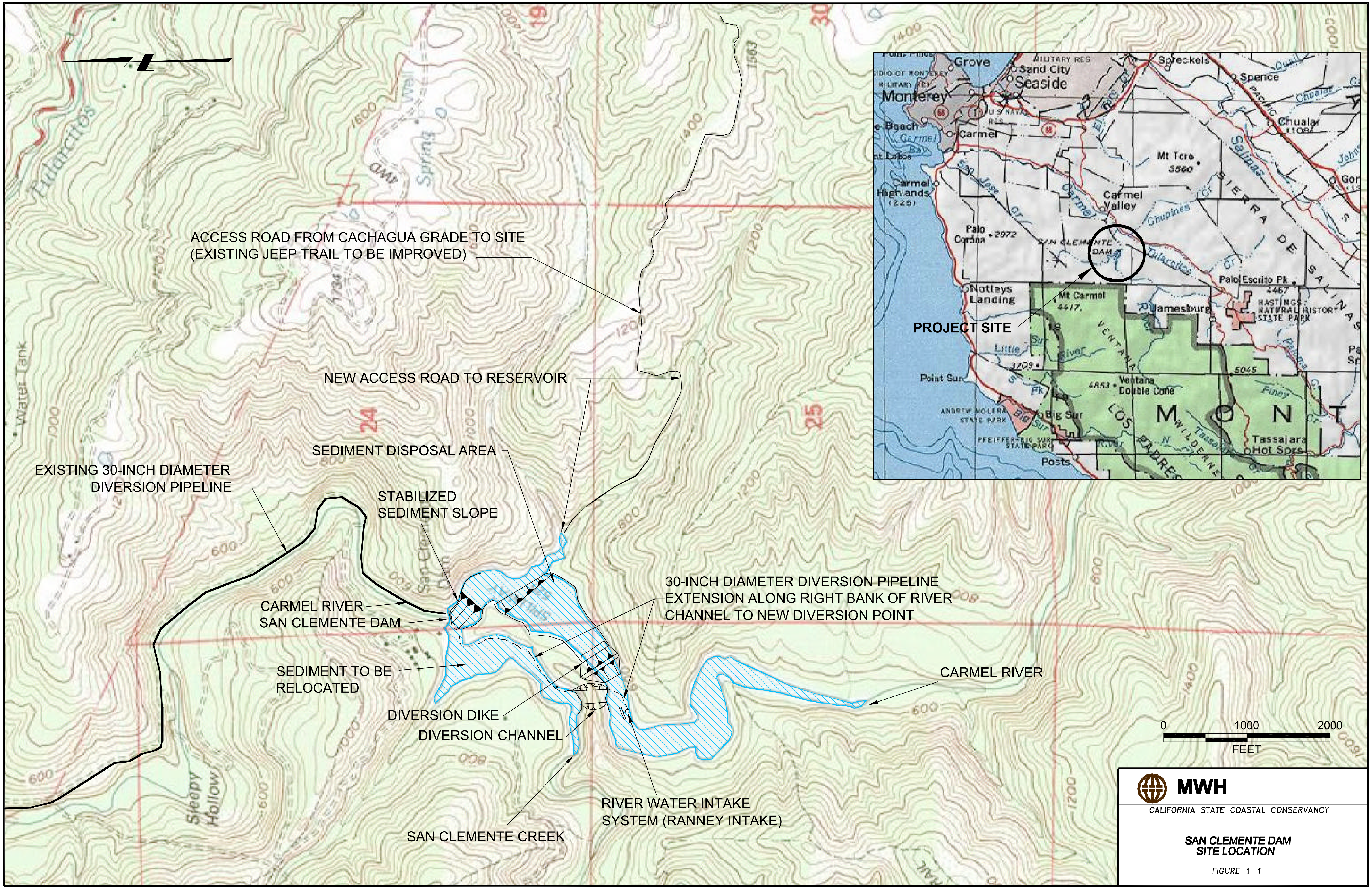
FIGURES



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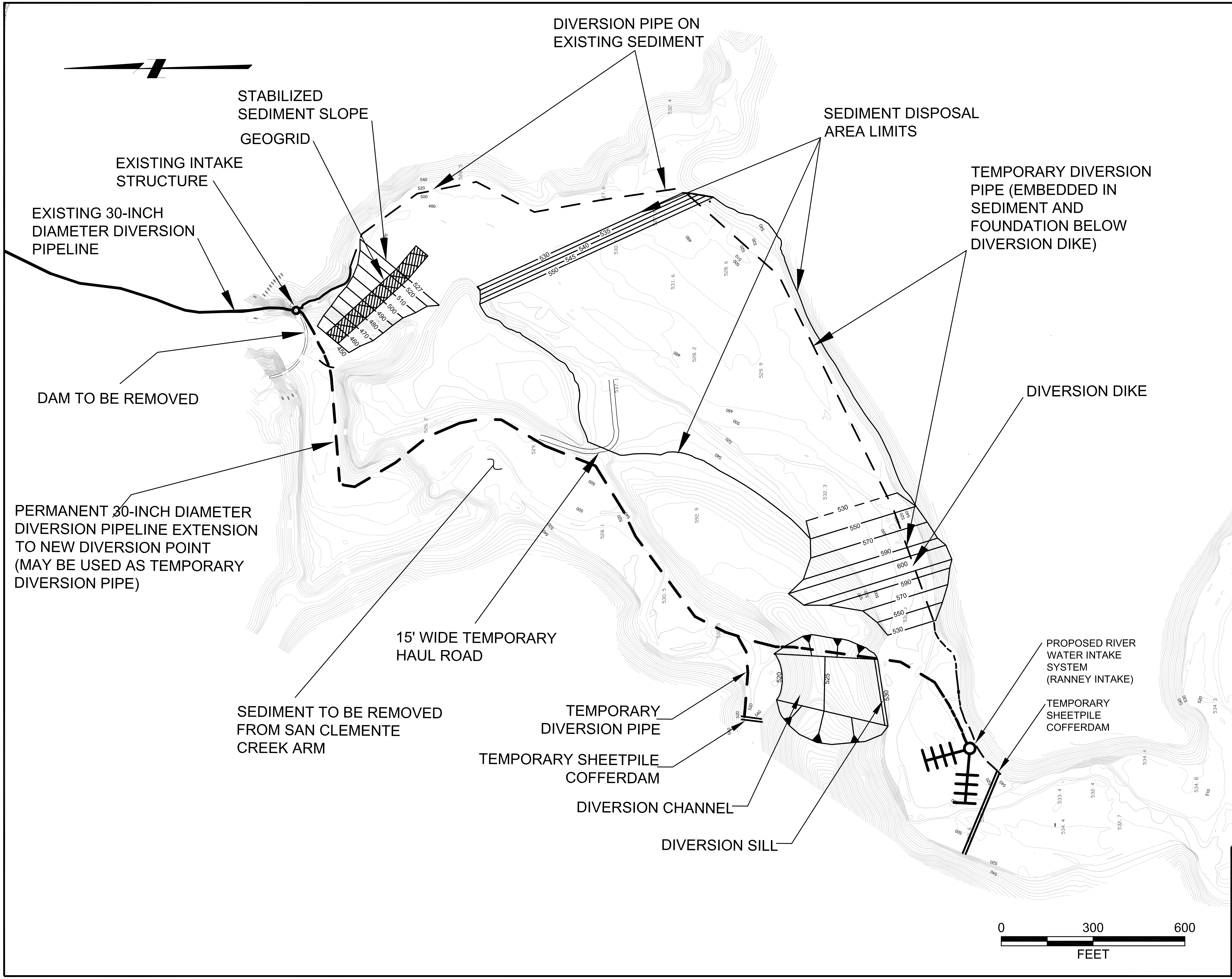
CALIFORNIA STATE COASTAL CONSERVANCY

SAN CLEMENTE DAM
SITE LOCATION

FIGURE 1-1



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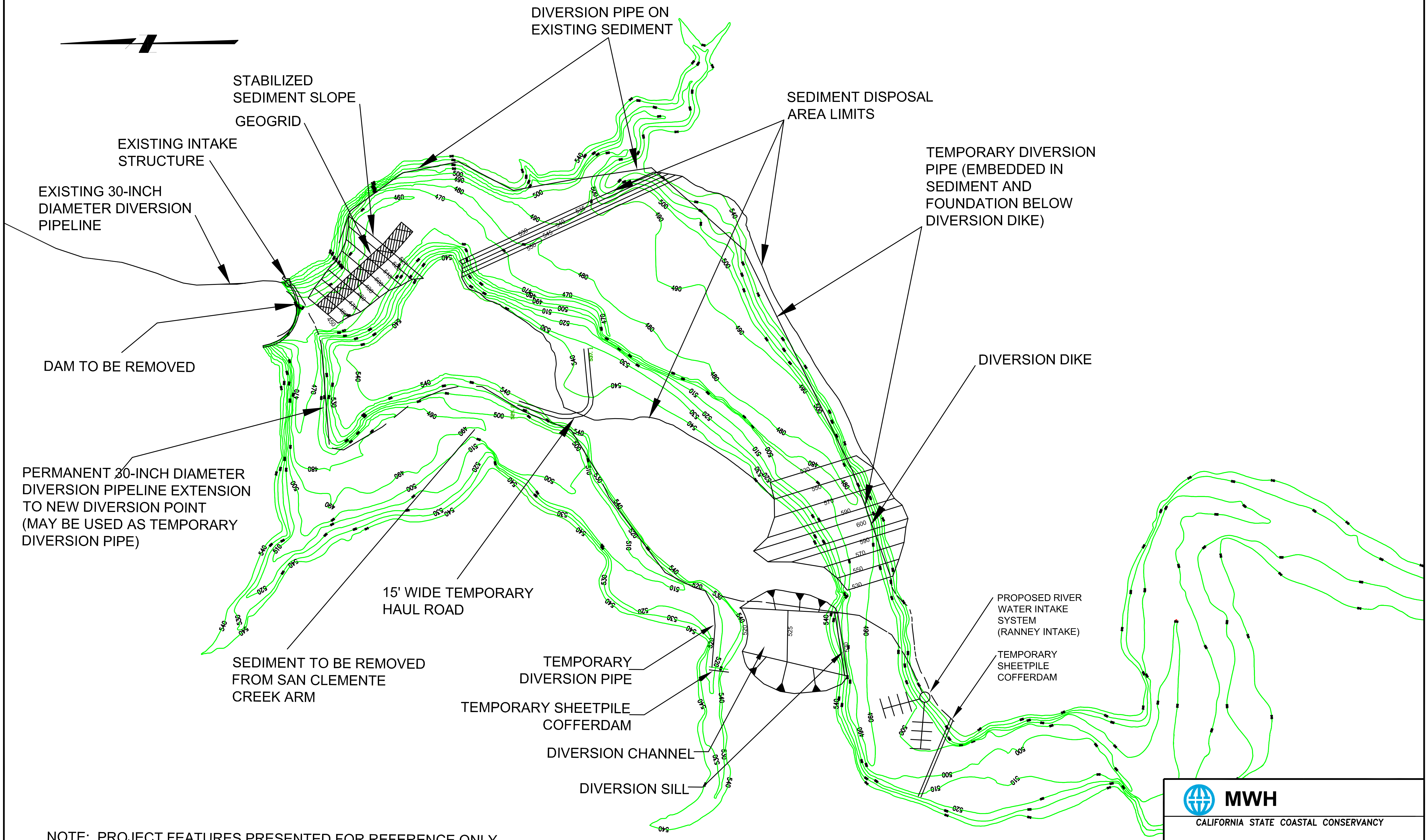
CALIFORNIA STATE COASTAL CONSERVANCY

SAN CLEMENTE DAM
SITE PLAN

FIGURE 1–2



NOTE: PROJECT FEATURES PRESENTED FOR REFERENCE ONLY.
ACTUAL FINISHED TOPOGRAPHY WILL VARY.

SOURCE: MEI

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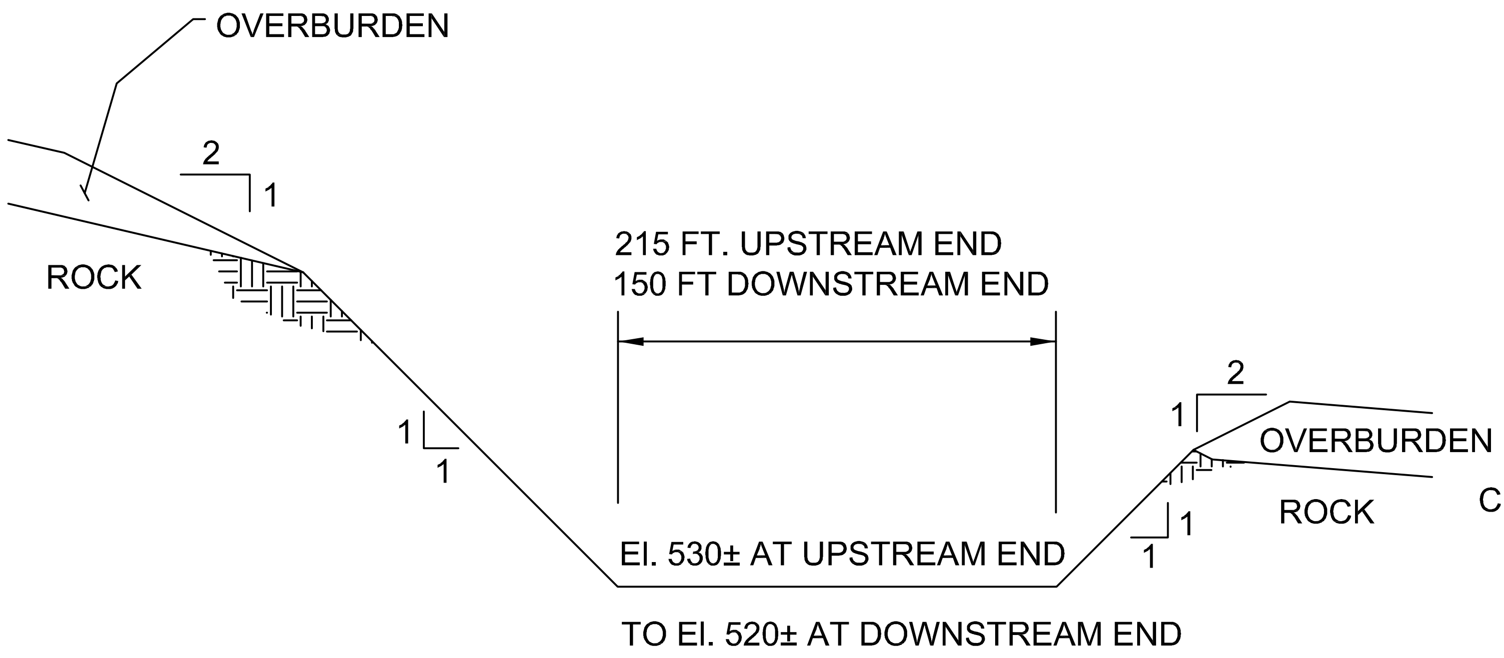
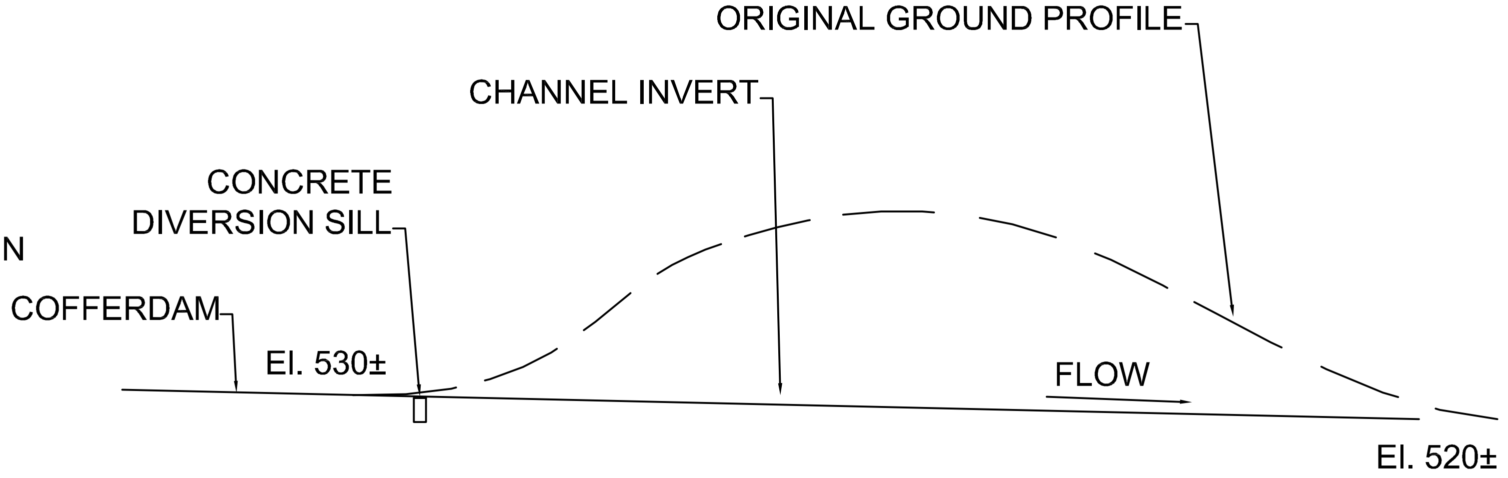
CALIFORNIA STATE COASTAL CONSERVANCY

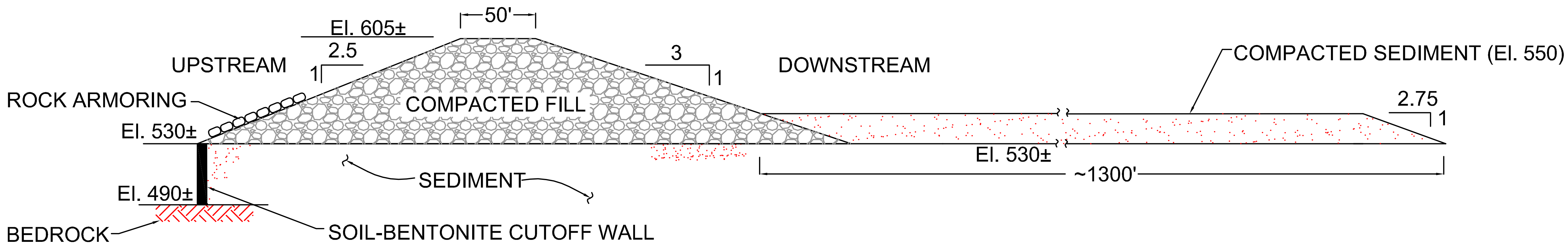
SAN CLEMENTE DAM
PRE-DAM (1921) TOPOGRAPHY
With PROPOSED NEW STRUCTURES
FIGURE 1–3



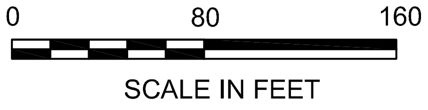
DIVERSION CHANNEL TYPICAL CROSS-SECTION
(LOW-FLOW THALWEG & INSTREAM FEATURES NOT SHOWN)



DIVERSION CHANNEL TYPICAL PROFILE



DIVERSION DIKE AND SEDIMENT PILE TYPICAL CROSS-SECTION



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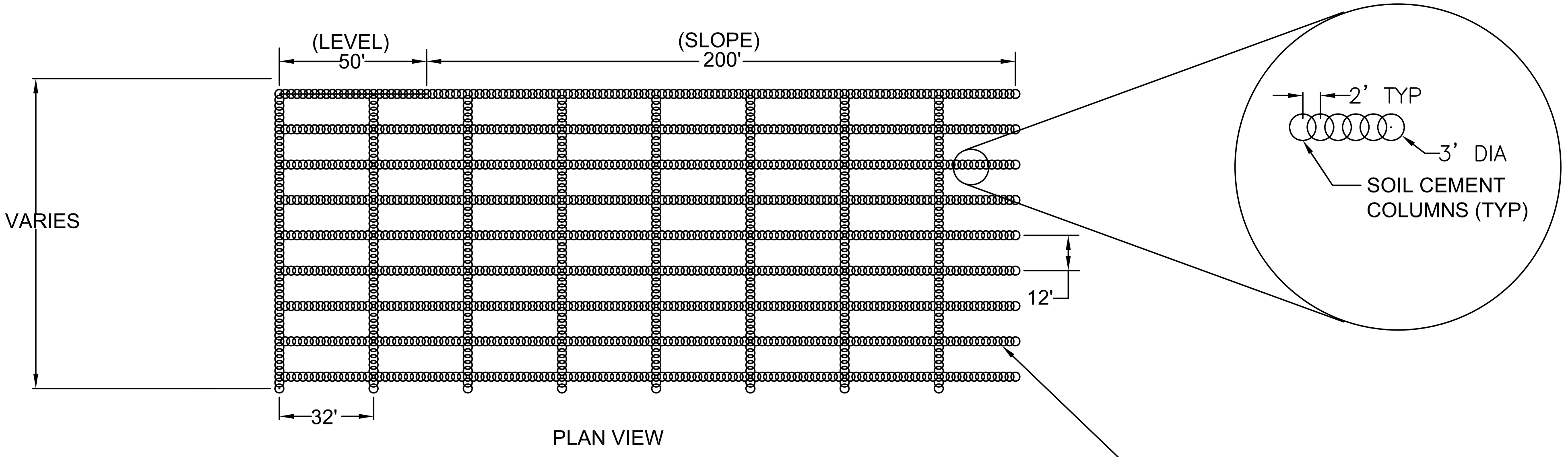
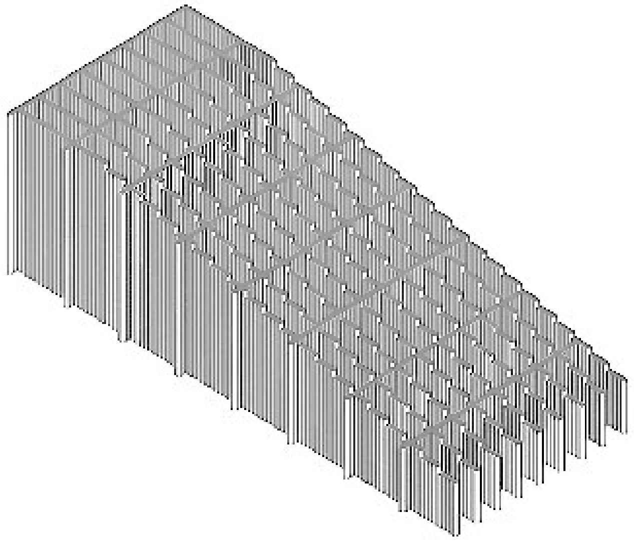
CALIFORNIA STATE COASTAL CONSERVANCY

SAN CLEMENTE DAM
TYPICAL PROFILE AND CROSS-SECTION

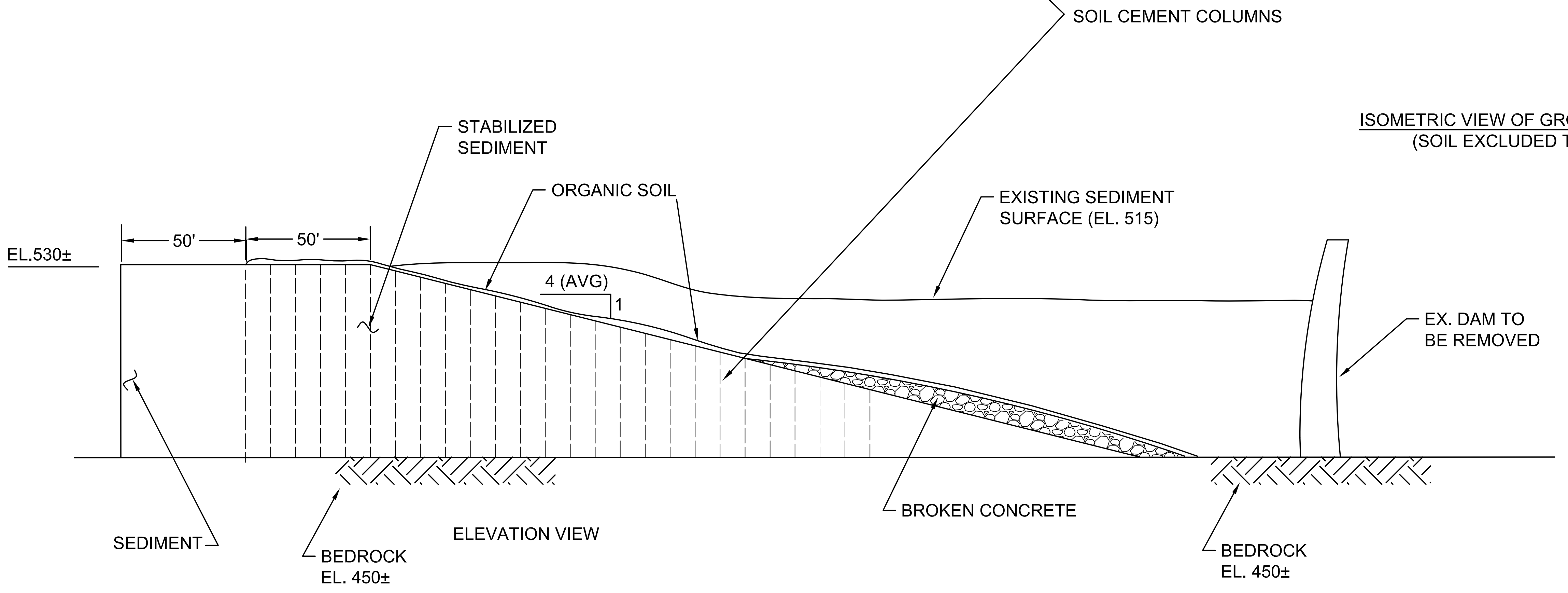
FIGURE 2-4



DEEP SOIL/CEMENT MIXING PATTERN



ISOMETRIC VIEW OF GROUND TREATMENT BY SOIL MIXING (NTS)
(SOIL EXCLUDED TO SHOW SOIL-CEMENT COLUMNS)



TYPICAL STABILIZED SLOPE SECTION

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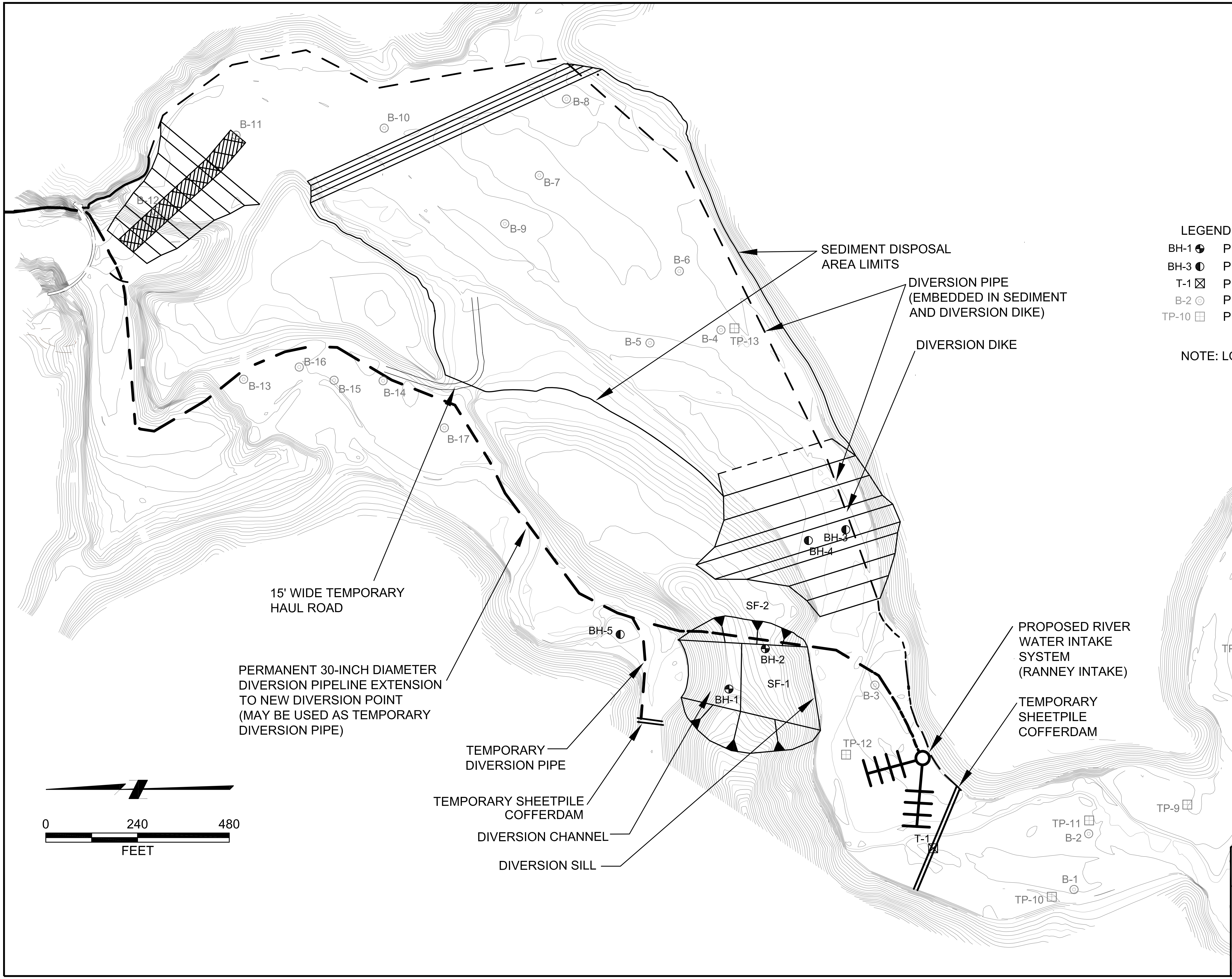
CALIFORNIA STATE COASTAL CONSERVANCY

SAN CLEMENTE DAM
PROFILE OF STABILIZED SEDIMENT SLOPE
CEMENT MIXING PLAN
FIGURE 2-5



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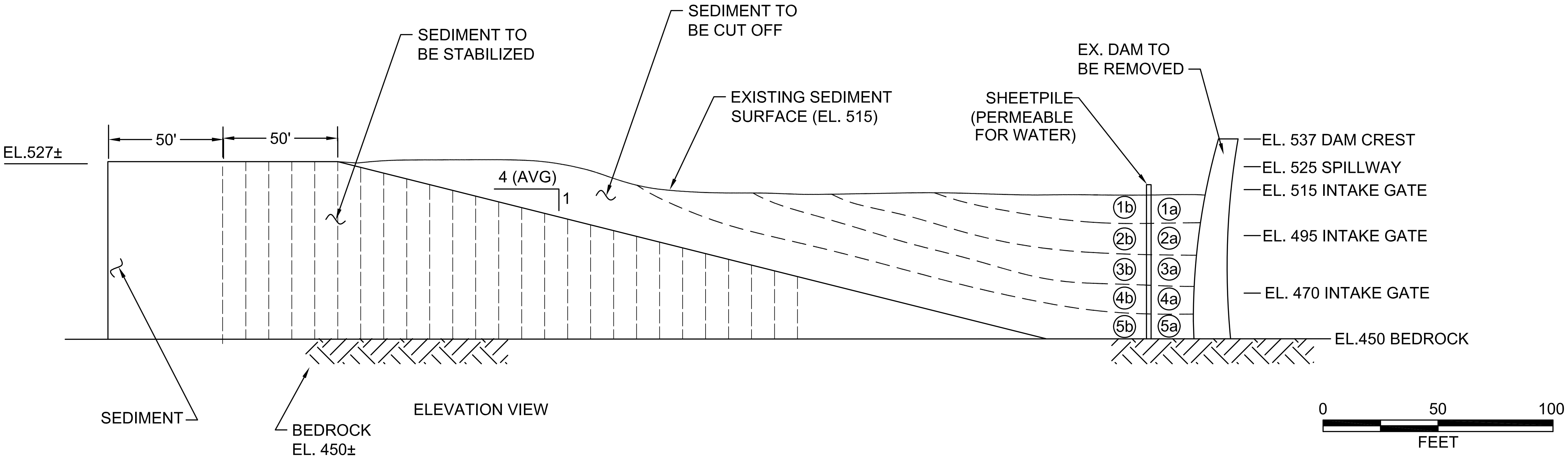
CALIFORNIA STATE COASTAL CONSERVANCY

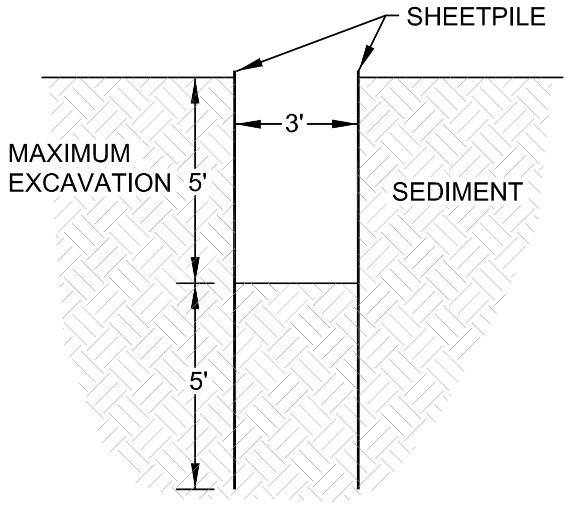
SAN CLEMENTE DAM
SUBSURFACE INVESTIGATION PLAN

FIGURE 2–1

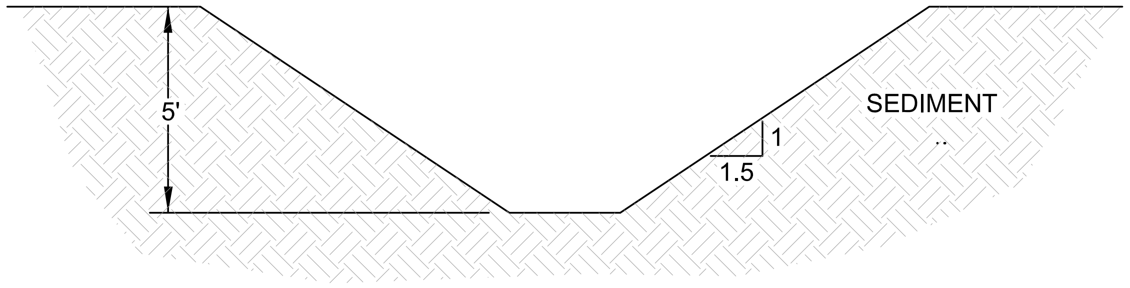


TYPICAL SLOPE PROFILE

NOTE: TYPICAL CONSTRUCTION SEQUENCE SHOULD BE
1. INSTALL SHEETPILE (DEPTH AND LOCATION TO BE DETERMINED ON SITE)
2. EXCAVATE PART 1a
3. DEWATER FOR PART 1a
4. EXCAVATE PART 1b
5. REPEAT STEPS 2 THROUGH 4 (2a, 2b, 3a, 3b, ETC.)



TYPICAL TRENCH FOR DEWATERING



TYPICAL DETAIL FOR OPEN DEWATERING TRENCH

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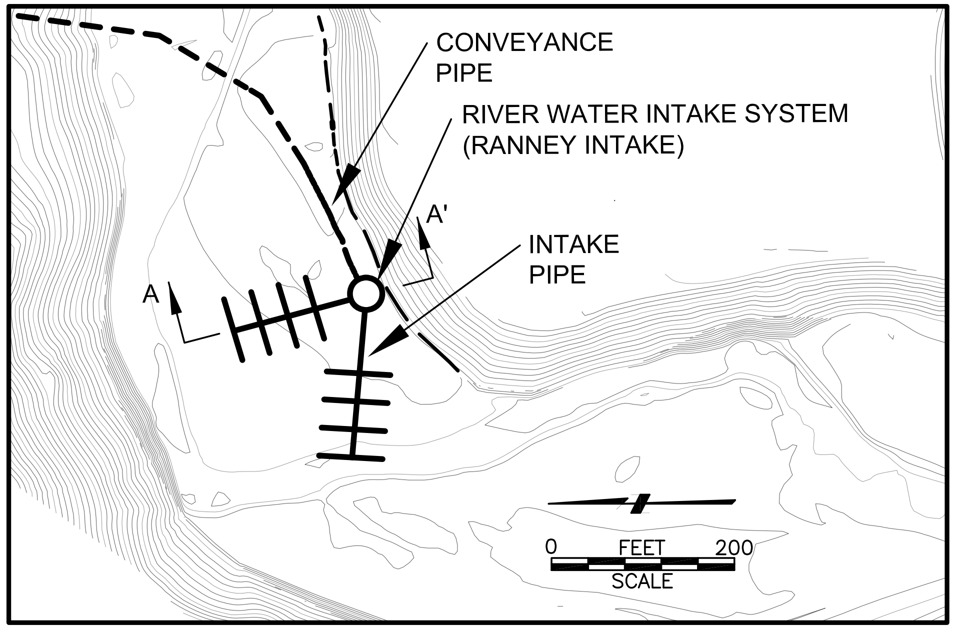
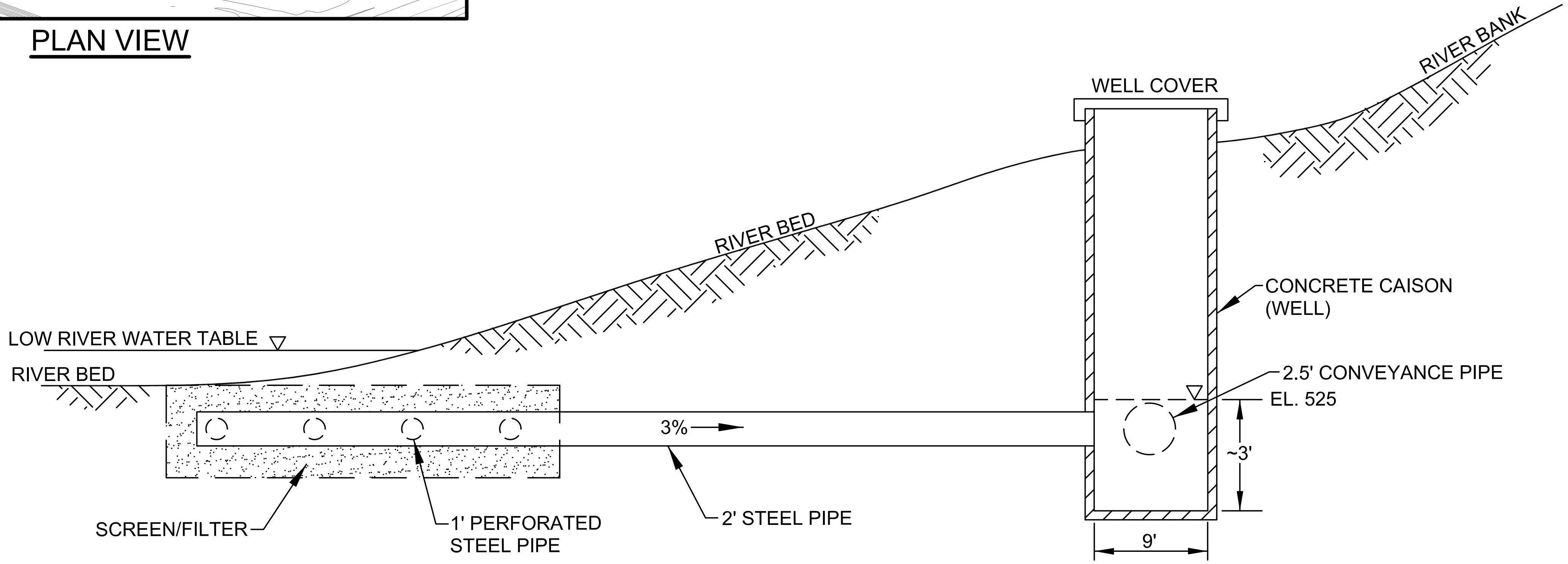
CALIFORNIA STATE COASTAL CONSERVANCY

SAN CLEMENTE DAM
EXCAVATING AND DEWATERING PLAN
NEAR UPSTREAM OF DAM
FIGURE 2–6



PLAN VIEW



CROSS SECTION A-A'

NOT TO SCALE

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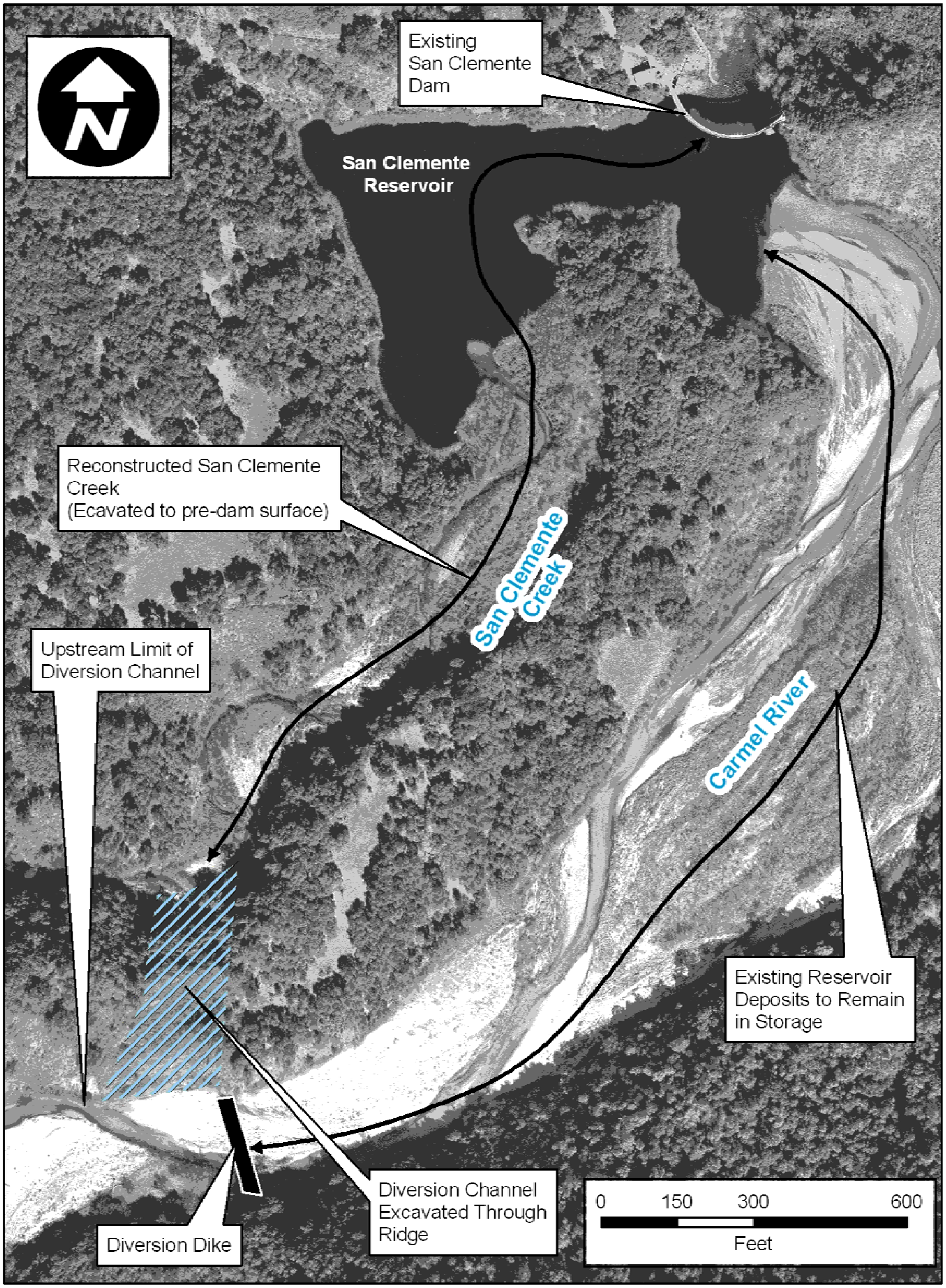
CALIFORNIA STATE COASTAL CONSERVANCY

SAN CLEMENTE DAM
RIVER WATER INTAKE SYSTEM

FIGURE 3–1



JOB No. ____ FILE: ____

REFERENCE: TAKEN FROM MEI, 2005

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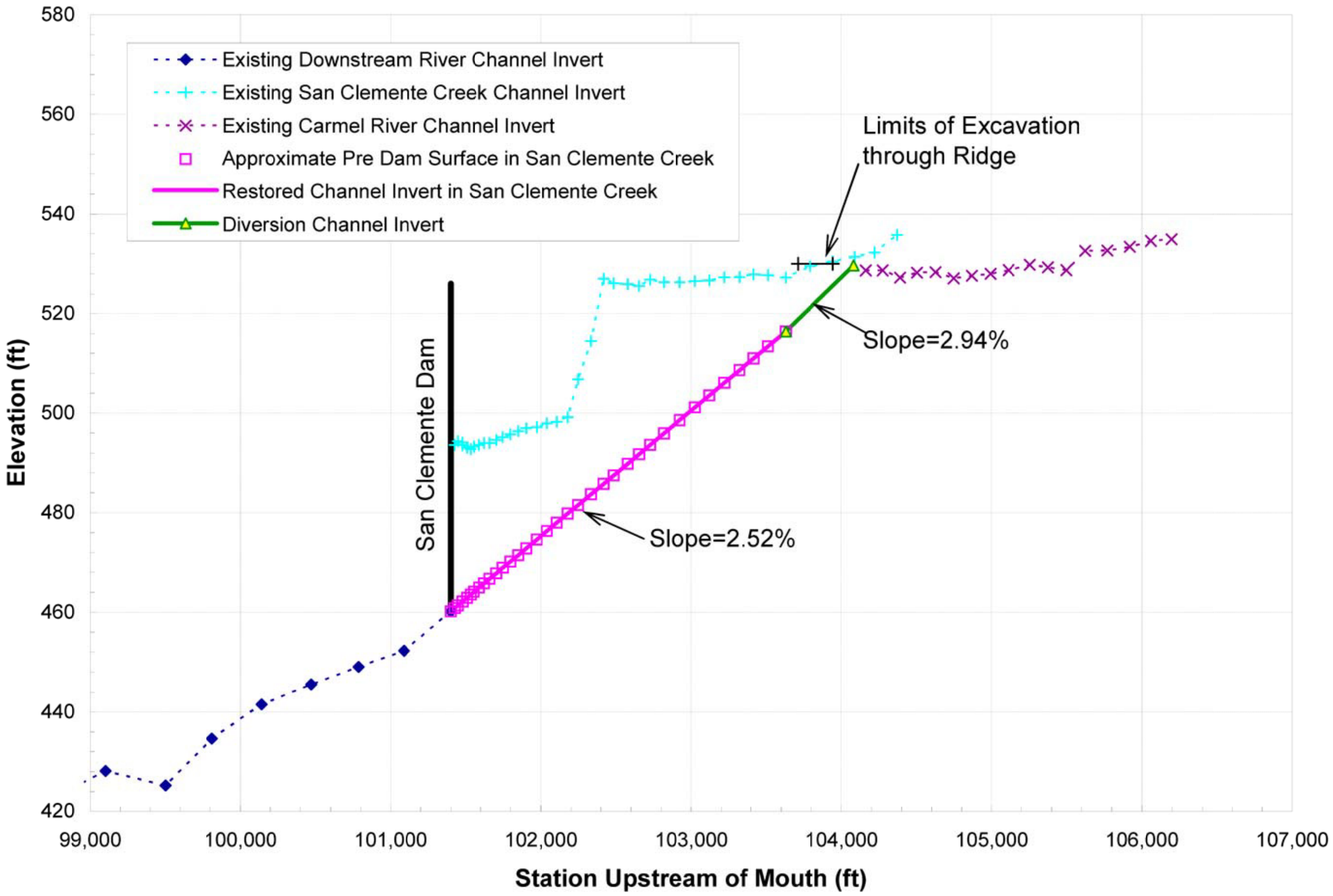
CALIFORNIA STATE COASTAL CONSERVANCY

SAN CLEMENTE DAM
PROPOSED ELEMENTS
OF REROUTE ALTERNATIVE
FIGURE 4-4



REFERENCE: TAKEN FROM MEI, 2005

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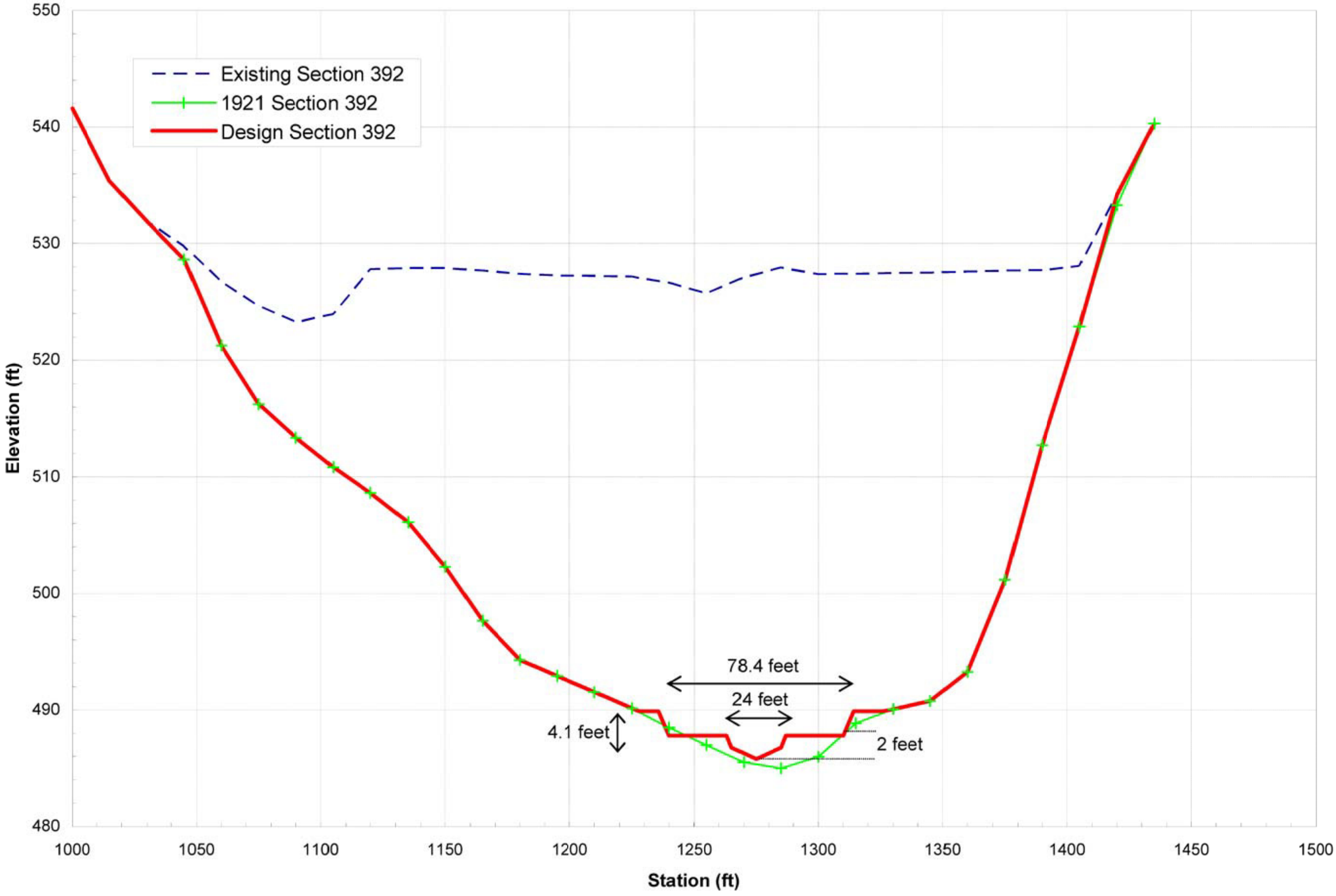
CALIFORNIA STATE COASTAL CONSERVANCY

SAN CLEMENTE DAM
EXISTING AND PROPOSED PROFILE
CARMEL RIVER REROUTE ALTERNATIVE
FIGURE 4-5



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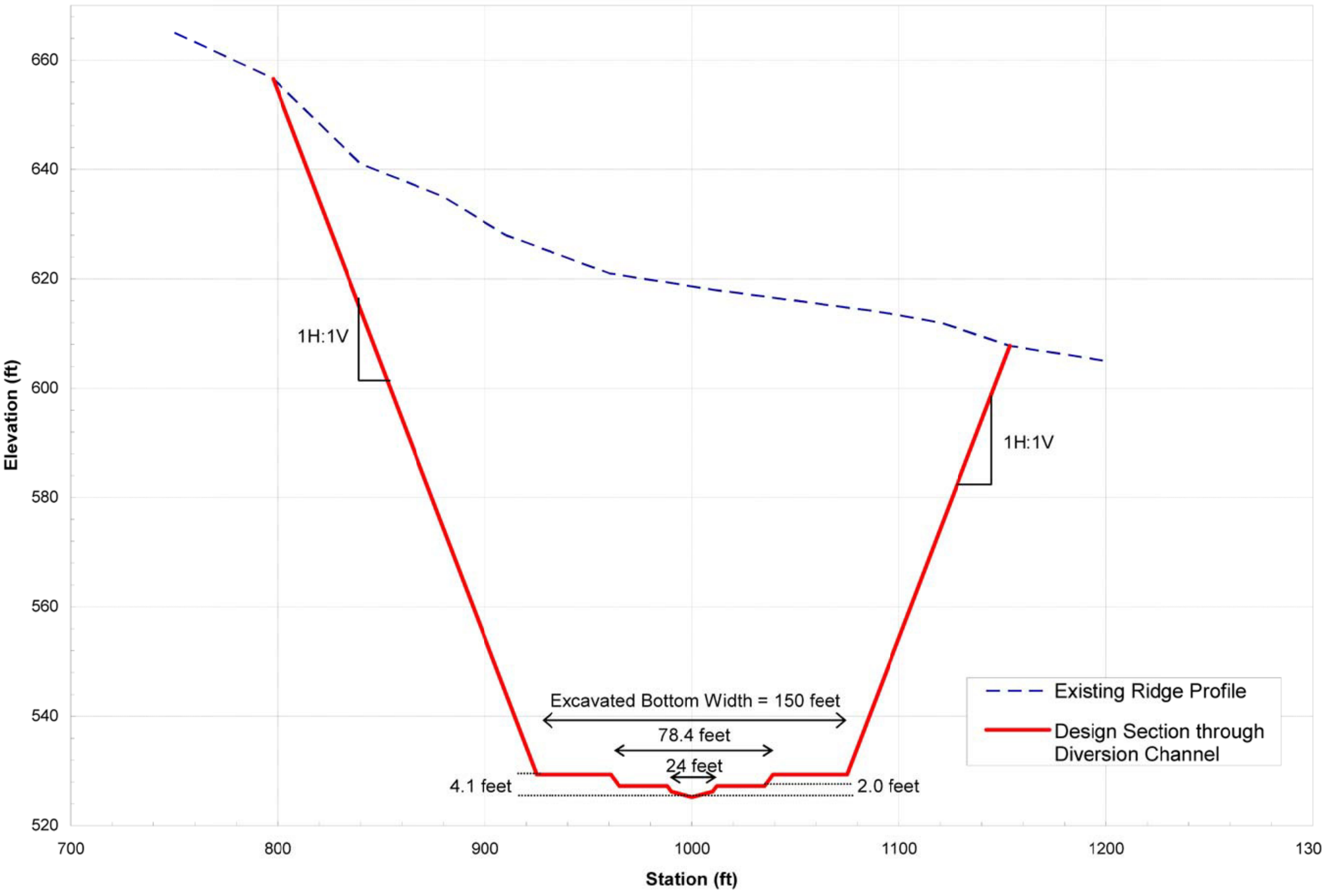
CALIFORNIA STATE COASTAL CONSERVANCY

SAN CLEMENTE DAM
PROPOSED CROSS SECTION
SAN CLEMENTE CREEK
FIGURE 4-6



REFERENCE: MEI, 2005

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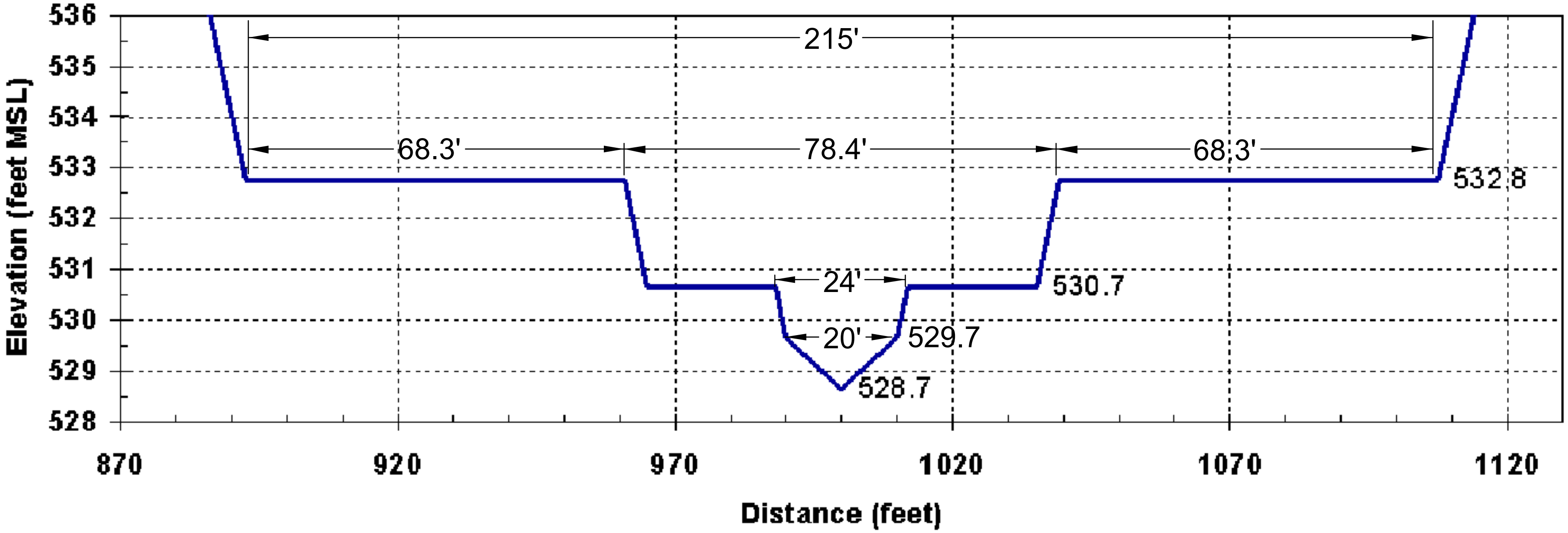
CALIFORNIA STATE COASTAL CONSERVANCY

SAN CLEMENTE DAM
PROPOSED CROSS SECTION
DIVERSION CHANNEL OUTLET
FIGURE 4-7



REFERENCE: MEI, 2005

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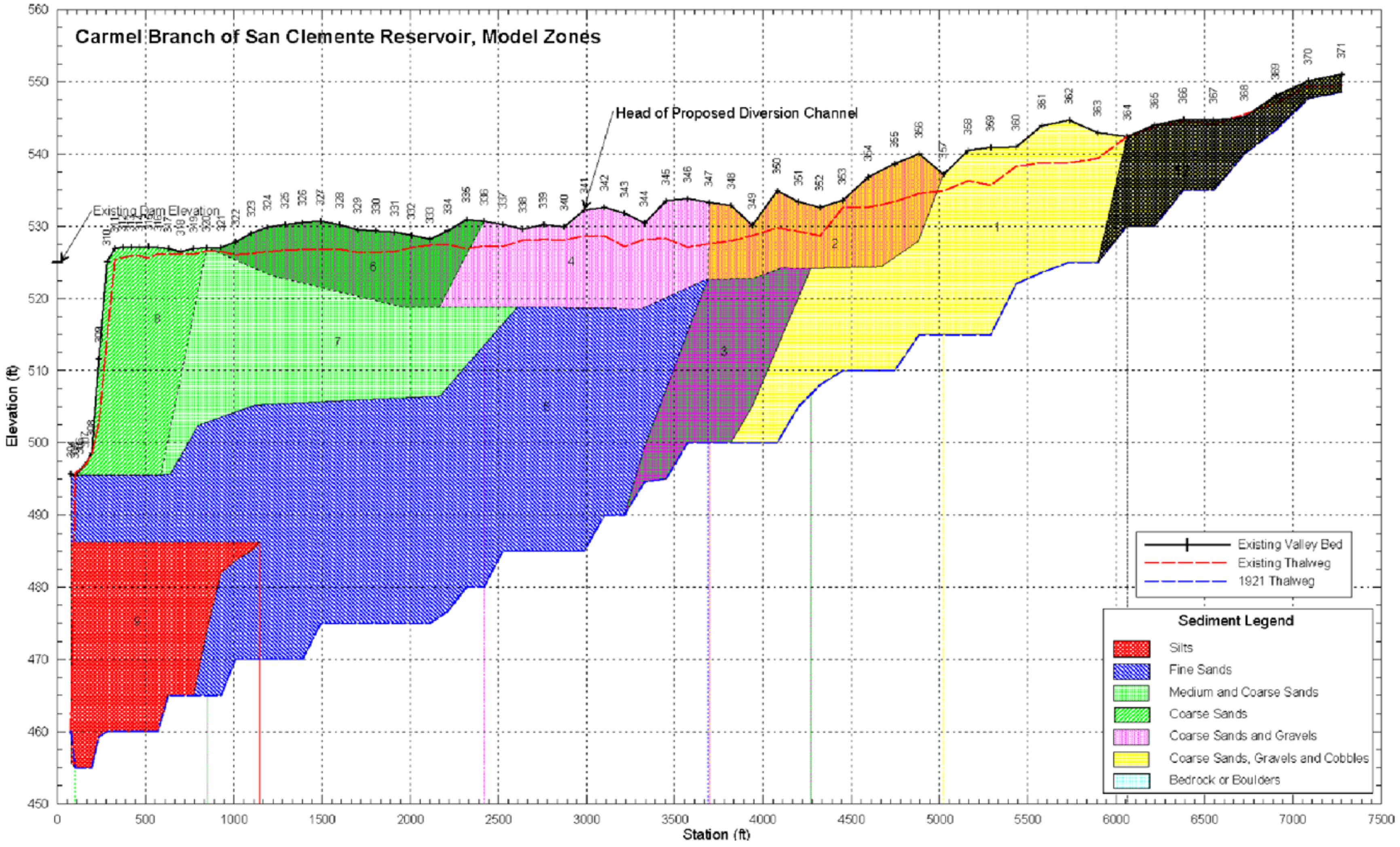
CALIFORNIA STATE COASTAL CONSERVANCY

SAN CLEMENTE DAM
PROPOSED CROSS SECTION
DIVERSION CHANNEL INLET
FIGURE 4-8



REFERENCE: TAKEN FROM MEI, 2005

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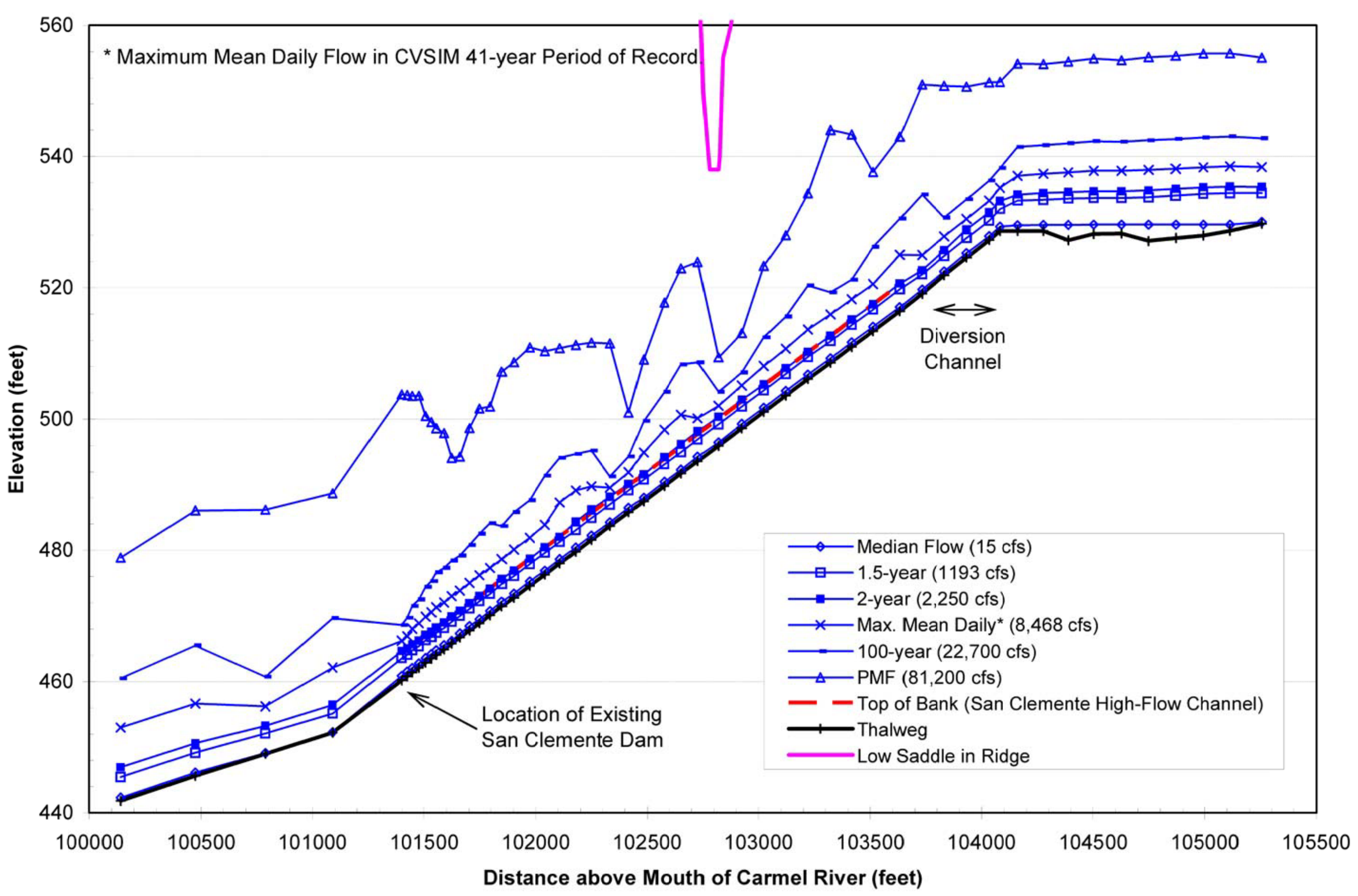
CALIFORNIA STATE COASTAL CONSERVANCY

SAN CLEMENTE DAM
STRATIGRAPHIC PROFILE
CARMEL RIVER BRANCH
FIGURE 4–2



REFERENCE: TAKEN FROM MEI, 2005

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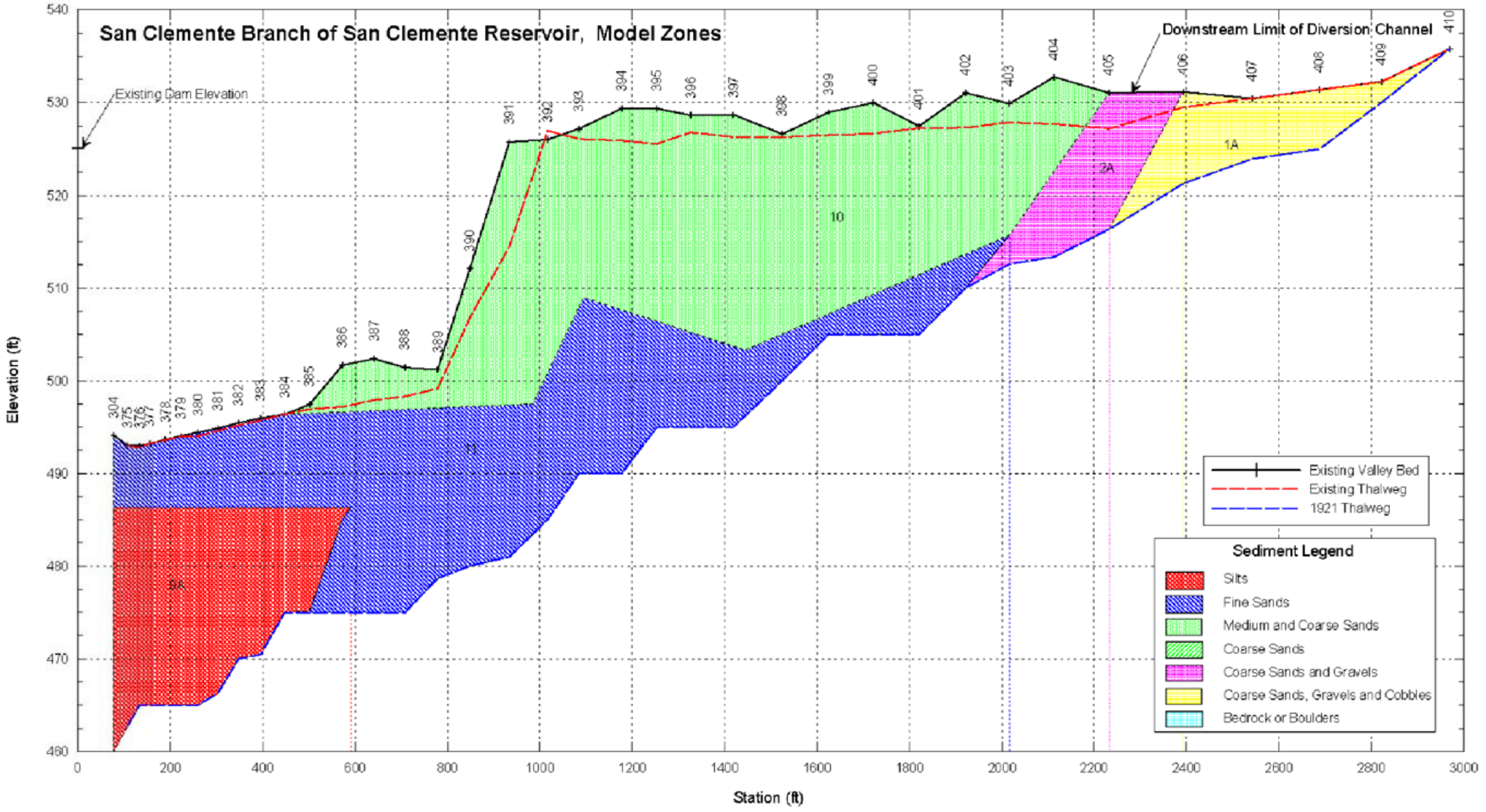
CALIFORNIA STATE COASTAL CONSERVANCY

SAN CLEMENTE DAM
MODELED SURFACE WATER ELEVATIONS
RECONSTRUCTED SAN CLEMENTE CREEK
FIGURE 4-9



REFERENCE: TAKEN FROM MEI, 2005

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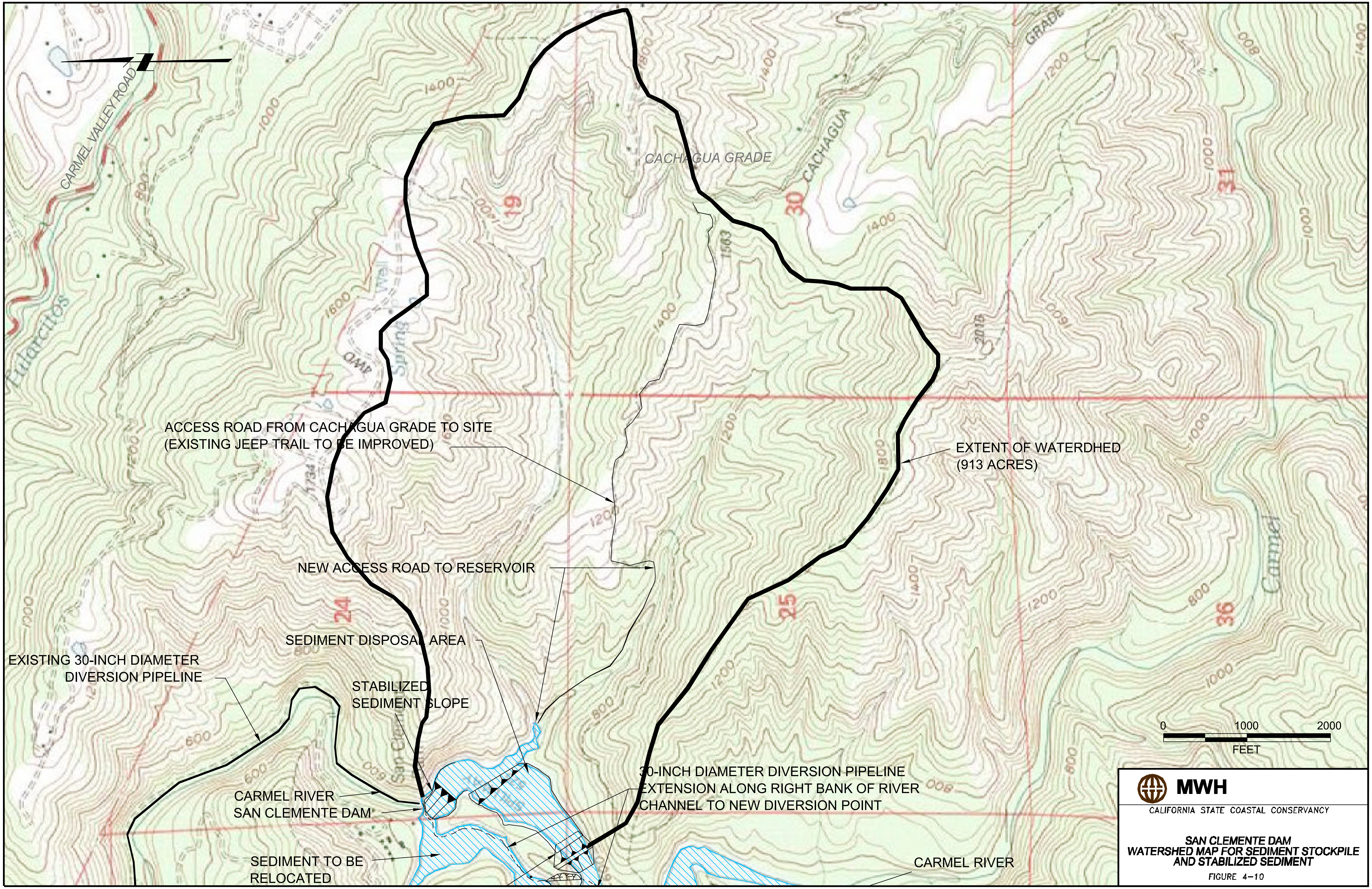
CALIFORNIA STATE COASTAL CONSERVANCY

SAN CLEMENTE DAM
SIMPLIFIED STRATIGRAPHIC PROFILE
SAN CLEMENTE CREEK BRANCH
FIGURE 4-3



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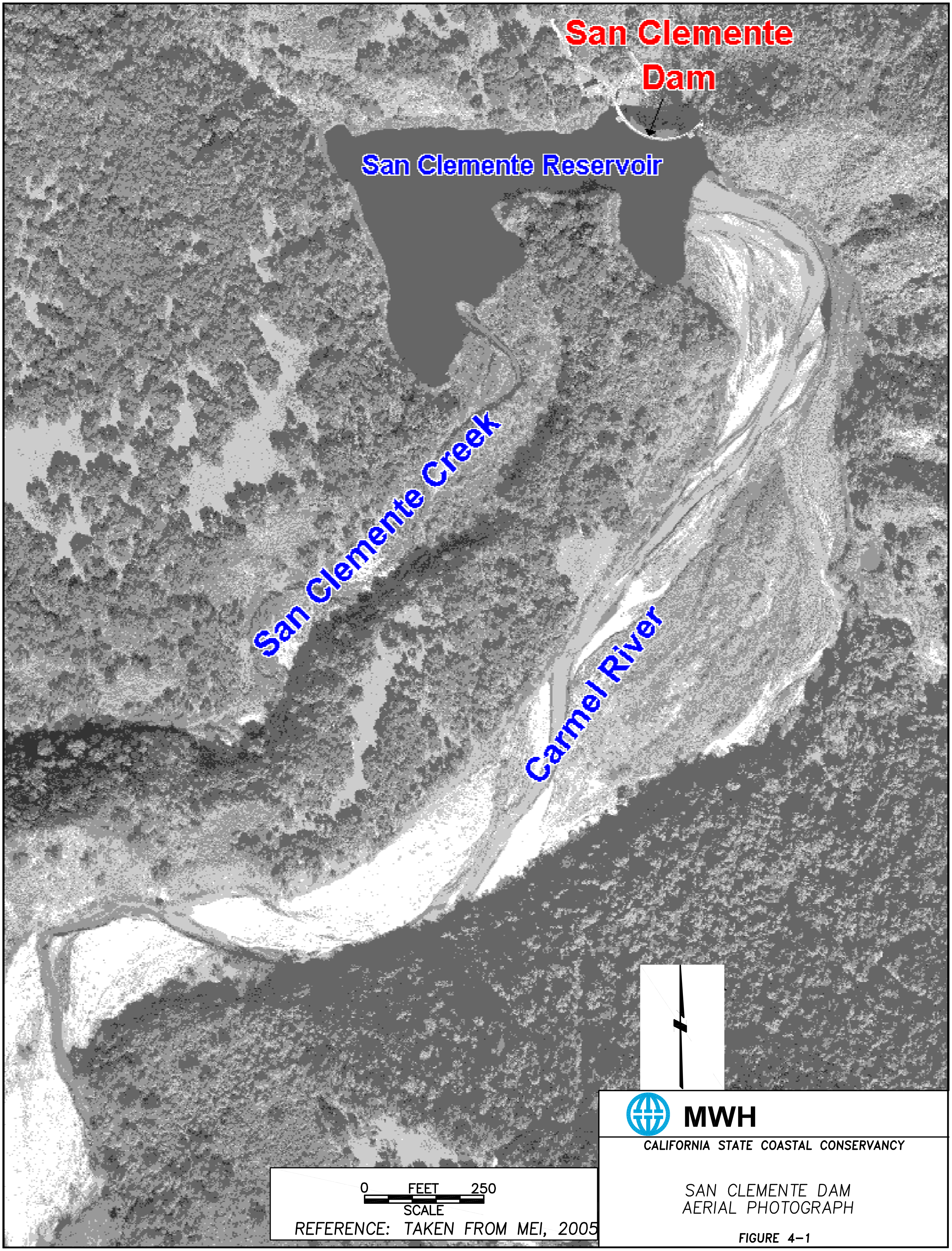
CALIFORNIA STATE COASTAL CONSERVANCY

SAN CLEMENTE DAM
WATERSHED MAP FOR SEDIMENT STOCKPILE
AND STABILIZED SEDIMENT

FIGURE 4-10



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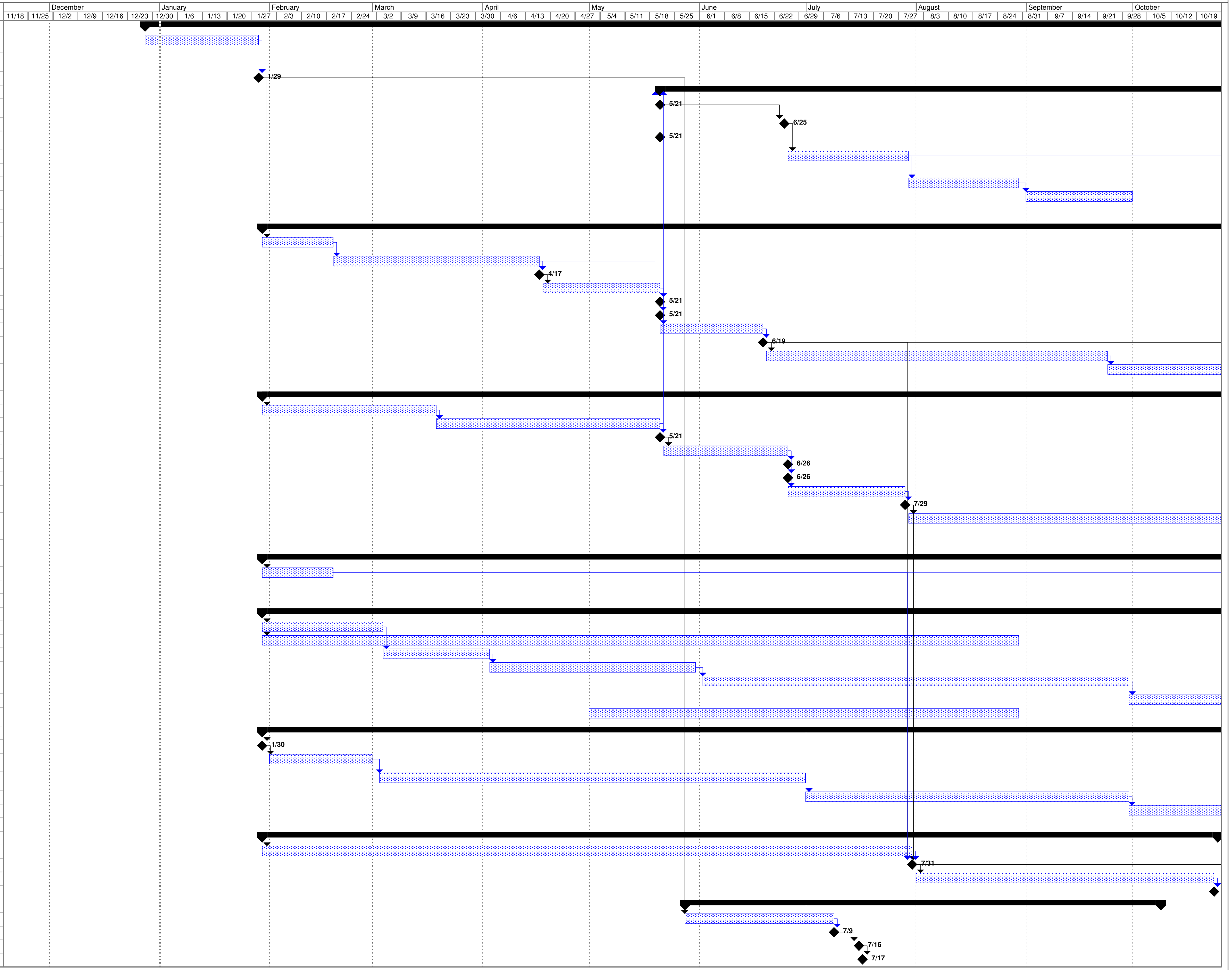
CALIFORNIA STATE COASTAL CONSERVANCY

SAN CLEMENTE DAM
AERIAL PHOTOGRAPH

FIGURE 4–1

San Clemente Dam
Removal and River Re-route
Permitting Schedule

ID	Task Name	Duration	Start	Finish
1	**NEPA/CEQA Final EIR/EIS**	**368 days**	**Fri 12/28/07**	**Tue 5/26/09**
2	DWR file Notice of Determination with State Clearinghouse (30-day clock for court challenges)	22 days	Fri 12/28/07	Mon 1/28/08
3	USACE prepare and sign Federal Record of Decision (after all federal permitting is complete)	20 days	Wed 4/29/09	Tue 5/26/09
4	Permitting Strategy meeting and direction to proceed on permitting	1 day	Tue 1/29/08	Tue 1/29/08
5	**USACE Clean Water Act 404 Permit**	**245 days**	**Wed 5/21/08**	**Tue 4/28/09**
6	ENTRIX submit draft wetland delineation to U.S. Army Corps of Engineers (from existing work)	1 day	Wed 5/21/08	Wed 5/21/08
7	ENTRIX/USACE site visit for delineation verification	1 day	Wed 6/25/08	Wed 6/25/08
8	ENTRIX prepare final wetland determination to U.S. Army Corps of Engineers (assuming minor changes)	1 day	Wed 5/21/08	Wed 5/21/08
9	ENTRIX prepare application for CWA Section 404 Permit	24 days	Thu 6/26/08	Tue 7/29/08
10	Submit CWA 404 Application to USACE	1 day	Tue 4/28/09	Tue 4/28/09
11	USACE 30-day Public Notice (USACE mailing list)	23 days	Wed 7/30/08	Fri 8/29/08
12	Respond to comments received on notice (submit responses to USACE, not circulated to public)	22 days	Mon 9/1/08	Tue 9/30/08
13	USACE designate the LEDPA (after all other federal permitting is complete)	20 days	Mon 11/3/08	Fri 11/28/08
14	**NOAA Fisheries Endangered Species Act Consultation**	**203 days**	**Wed 1/30/08**	**Fri 11/7/08**
15	ENTRIX Consultation Meeting with NOAA Fisheries; coordination with DFG/USFWS. Identify take mechanisms, tools and quantification measures	14 days	Wed 1/30/08	Mon 2/18/08
16	ENTRIX prepare Draft BA	42 days	Tue 2/19/08	Wed 4/16/08
17	Submit Draft BA to NOAA Fisheries for review and comment	1 day	Thu 4/17/08	Thu 4/17/08
18	NOAA Review of Draft BA	23 days	Fri 4/18/08	Tue 5/20/08
19	ENTRIX meet with NOAA to walk through draft BA	1 day	Wed 5/21/08	Wed 5/21/08
20	ENTRIX receive NOAA Comments on Draft BA	1 day	Wed 5/21/08	Wed 5/21/08
21	ENTRIX review comments and prepare final BA	21 days	Wed 5/21/08	Wed 6/18/08
22	Submit Final BA to NOAA	1 day	Thu 6/19/08	Thu 6/19/08
23	NOAA Draft Biological Opinion	68 days	Fri 6/20/08	Tue 9/23/08
24	NOAA- conduct agency review of BO and Final Biological Opinion	32 days	Wed 9/24/08	Thu 11/6/08
25	Receive BO and ITS	1 day	Fri 11/7/08	Fri 11/7/08
26	**USFWS Endangered Species Act Consultation**	**232 days**	**Wed 1/30/08**	**Thu 12/18/08**
27	ENTRIX consult with USFWS on Draft BA for terrestial species	35 days	Wed 1/30/08	Tue 3/18/08
28	ENTRIX prepare Draft BA for terrestrial species	45 days	Wed 3/19/08	Tue 5/20/08
29	Submit Draft BA to USFWS for review and comment	1 day	Wed 5/21/08	Wed 5/21/08
30	USFWS Review of Draft BA for terrestrial species	25 days	Thu 5/22/08	Wed 6/25/08
31	ENTRIX meet with USFWS to walk through Draft BA	1 day	Thu 6/26/08	Thu 6/26/08
32	ENTRIX receive USFWS Comments on Draft BA	1 day	Thu 6/26/08	Thu 6/26/08
33	ENTRIX receive comments and prepare Final BA for terrestrial species	23 days	Thu 6/26/08	Mon 7/28/08
34	Submit Final BA to USFWS	1 day	Tue 7/29/08	Tue 7/29/08
35	USFWS Draft Biological Opinion	68 days	Wed 7/30/08	Fri 10/31/08
36	USFWS- conduct agency review of BO and Final Biological Opinion	33 days	Mon 11/3/08	Wed 12/17/08
37	Receive BO and ITS	1 day	Thu 12/18/08	Thu 12/18/08
38	**CDFG Streambed Alteration Agreement**	**432 days**	**Wed 1/30/08**	**Thu 9/24/09**
39	ENTRIX prepare application for Streambed Alteration Agreement	14 days	Wed 1/30/08	Mon 2/18/08
40	CAW submit final application for Streambed Alteration Agreement	1 day	Wed 4/29/09	Wed 4/29/09
41	CDFG act on application for Streambed Alteration Agreement	106 days	Thu 4/30/09	Thu 9/24/09
42	**California SHPO Section 106 NHPA**	**324 days**	**Wed 1/30/08**	**Mon 4/27/09**
43	ENTRIX develop archealogical field testing plan and obtain SHPO approval	24 days	Wed 1/30/08	Mon 3/3/08
44	ENTRIX/SHPO/Tribes monthly cultural resources consultation meetings	153 days	Wed 1/30/08	Fri 8/29/08
45	ENTRIX archealogical field testing	22 days	Tue 3/4/08	Wed 4/2/08
46	ENTRIX revise Draft Section 106 Technical Report	42 days	Thu 4/3/08	Fri 5/30/08
47	ENTRIX/SHPO develop Memorandum of Agreement (MOA/PA) with stipulations on schedule of required actions	86 days	Mon 6/2/08	Mon 9/29/08
48	ENTRIX Final Section 106 Technincal Report production	150 days	Tue 9/30/08	Mon 4/27/09
49	ENTRIX HABS/HAER documentation for San Clemente Dam (in parallel with final design)	87 days	Thu 5/1/08	Fri 8/29/08
50	**Monterey County Land Use Permit Applications**	**239 days**	**Wed 1/30/08**	**Mon 12/29/08**
51	Request appointment with Monterey County Planning Department	1 day	Wed 1/30/08	Wed 1/30/08
52	ENTRIX/CAW Permit Appointment with Monterey County application packages/County deems applications complete	21 days	Fri 2/1/08	Fri 2/29/08
53	ENTRIX prepares and submits Monterey County application packages/County deems applications complete	86 days	Mon 3/3/08	Mon 6/30/08
54	Monterey County land use permit applications reviewed	65 days	Tue 7/1/08	Mon 9/29/08
55	Monterey County public notice period for Hearing	45 days	Tue 9/30/08	Mon 12/1/08
56	Monterey County issues permits	20 days	Tue 12/2/08	Mon 12/29/08
57	**RWQCB Clean Water Act 401 Certification**	**193 days**	**Wed 1/30/08**	**Fri 10/24/08**
58	Environmental Impact Report reviewed	131 days	Wed 1/30/08	Wed 7/30/08
59	Submit 401 application	1 day	Thu 7/31/08	Thu 7/31/08
60	RWQCB review/prepare certification	60 days	Fri 8/1/08	Thu 10/23/08
61	RWQCB issue 401 certification	1 day	Fri 10/24/08	Fri 10/24/08
62	**Clean Water Act 402**	**96 days**	**Wed 5/28/08**	**Wed 10/8/08**
63	Finalize Stormwater Pollution Prevention Plan	30 days	Wed 5/28/08	Tue 7/8/08
64	NPDES permit	5 days	Wed 7/9/08	Tue 7/15/08
65	Submit application	1 day	Wed 7/16/08	Wed 7/16/08
66	Receive permit conditions	60 days	Thu 7/17/08	Wed 10/8/08



Project: Figure 6-1 Permitting Schedul Date: Tue 1/1/08	Task ▨	Split ⋯	Progress ▬	Milestone ◆	Summary ▬	Project Summary ▬	External Tasks ▬	External Milestone ◆	Deadline ⇩	

FIGURE 6-1

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Removal and River Re-route
Permitting Schedule

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1	**NEPA/CEQA Final EIR/EIS**	**368 days**	**Fri 12/28/07**	**Tue 5/26/09**
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8	ENTRIX prepare final wetland determination to U.S. Army Corps of Engineers (assuming minor changes)	1 day	Wed 5/21/08	Wed 5/21/08
9	ENTRIX prepare application for CWA Section 404 Permit	24 days	Thu 6/26/08	Tue 7/29/08
10	Submit CWA 404 Application to USACE	1 day	Tue 4/28/09	Tue 4/28/09
11	USACE 30-day Public Notice (USACE mailing list)	23 days	Wed 7/30/08	Fri 8/29/08
12	Respond to comments received on notice (submit responses to USACE, not circulated to public)	22 days	Mon 9/1/08	Tue 9/30/08
13	USACE designate the LEDPA (after all other federal permitting is complete)	20 days	Mon 11/3/08	Fri 11/28/08
14	**NOAA Fisheries Endangered Species Act Consultation**	**203 days**	**Wed 1/30/08**	**Fri 11/7/08**
15	ENTRIX Consultation Meeting with NOAA Fisheries; coordination with DFG/USFWS. Identify take mechanisms, tools and quantification measures	14 days	Wed 1/30/08	Mon 2/18/08
16	ENTRIX prepare Draft BA	42 days	Tue 2/19/08	Wed 4/16/08
17	Submit Draft BA to NOAA Fisheries for review and comment	1 day	Thu 4/17/08	Thu 4/17/08
18	NOAA Review of Draft BA	23 days	Fri 4/18/08	Tue 5/20/08
19	ENTRIX meet with NOAA to walk through draft BA	1 day	Wed 5/21/08	Wed 5/21/08
20	ENTRIX receive NOAA Comments on Draft BA	1 day	Wed 5/21/08	Wed 5/21/08
21	ENTRIX review comments and prepare final BA	21 days	Wed 5/21/08	Wed 6/18/08
22	Submit Final BA to NOAA	1 day	Thu 6/19/08	Thu 6/19/08
23	NOAA Draft Biological Opinion	68 days	Fri 6/20/08	Tue 9/23/08
24	NOAA- conduct agency review of BO and Final Biological Opinion	32 days	Wed 9/24/08	Thu 11/6/08
25	Receive BO and ITS	1 day	Fri 11/7/08	Fri 11/7/08
26	**USFWS Endangered Species Act Consultation**	**232 days**	**Wed 1/30/08**	**Thu 12/18/08**
27	ENTRIX consult with USFWS on Draft BA for terrestial species	35 days	Wed 1/30/08	Tue 3/18/08
28	ENTRIX prepare Draft BA for terrestrial species	45 days	Wed 3/19/08	Tue 5/20/08
29	Submit Draft BA to USFWS for review and comment	1 day	Wed 5/21/08	Wed 5/21/08
30	USFWS Review of Draft BA for terrestrial species	25 days	Thu 5/22/08	Wed 6/25/08
31	ENTRIX meet with USFWS to walk through Draft BA	1 day	Thu 6/26/08	Thu 6/26/08
32	ENTRIX receive USFWS Comments on Draft BA	1 day	Thu 6/26/08	Thu 6/26/08
33	ENTRIX receive comments and prepare Final BA for terrestrial species	23 days	Thu 6/26/08	Mon 7/28/08
34	Submit Final BA to USFWS	1 day	Tue 7/29/08	Tue 7/29/08
35	USFWS Draft Biological Opinion	68 days	Wed 7/30/08	Fri 10/31/08
36	USFWS- conduct agency review of BO and Final Biological Opinion	33 days	Mon 11/3/08	Wed 12/17/08
37	Receive BO and ITS	1 day	Thu 12/18/08	Thu 12/18/08
38	**CDFG Streambed Alteration Agreement**	**432 days**	**Wed 1/30/08**	**Thu 9/24/09**
39	ENTRIX prepare application for Streambed Alteration Agreement	14 days	Wed 1/30/08	Mon 2/18/08
40	CAW submit final application for Streambed Alteration Agreement	1 day	Wed 4/29/09	Wed 4/29/09
41	CDFG act on application for Streambed Alteration Agreement	106 days	Thu 4/30/09	Thu 9/24/09
42	**California SHPO Section 106 NHPA**	**324 days**	**Wed 1/30/08**	**Mon 4/27/09**
43	ENTRIX develop archealogical field testing plan and obtain SHPO approval	24 days	Wed 1/30/08	Mon 3/3/08
44	ENTRIX/SHPO/Tribes monthly cultural resources consultation meetings	153 days	Wed 1/30/08	Fri 8/29/08
45	ENTRIX archealogical field testing	22 days	Tue 3/4/08	Wed 4/2/08
46	ENTRIX revise Draft Section 106 Technical Report	42 days	Thu 4/3/08	Fri 5/30/08
47	ENTRIX/SHPO develop Memorandum of Agreement (MOA/PA) with stipulations on schedule of required actions	86 days	Mon 6/2/08	Mon 9/29/08
48	ENTRIX Final Section 106 Technincal Report production	150 days	Tue 9/30/08	Mon 4/27/09
49	ENTRIX HABS/HAER documentation for San Clemente Dam (in parallel with final design)	87 days	Thu 5/1/08	Fri 8/29/08
50	**Monterey County Land Use Permit Applications**	**239 days**	**Wed 1/30/08**	**Mon 12/29/08**
51	Request appointment with Monterey County Planning Department	1 day	Wed 1/30/08	Wed 1/30/08
52	ENTRIX/CAW Permit Appointment with Monterey County application packages/County deems applications complete	21 days	Fri 2/1/08	Fri 2/29/08
53	ENTRIX prepares and submits Monterey County application packages/County deems applications complete	86 days	Mon 3/3/08	Mon 6/30/08
54	Monterey County land use permit applications reviewed	65 days	Tue 7/1/08	Mon 9/29/08
55	Monterey County public notice period for Hearing	45 days	Tue 9/30/08	Mon 12/1/08
56	Monterey County issues permits	20 days	Tue 12/2/08	Mon 12/29/08
57	**RWQCB Clean Water Act 401 Certification**	**193 days**	**Wed 1/30/08**	**Fri 10/24/08**
58	Environmental Impact Report reviewed	131 days	Wed 1/30/08	Wed 7/30/08
59	Submit 401 application	1 day	Thu 7/31/08	Thu 7/31/08
60	RWQCB review/prepare certification	60 days	Fri 8/1/08	Thu 10/23/08
61	RWQCB issue 401 certification	1 day	Fri 10/24/08	Fri 10/24/08
62	**Clean Water Act 402**	**96 days**	**Wed 5/28/08**	**Wed 10/8/08**
63	Finalize Stormwater Pollution Prevention Plan	30 days	Wed 5/28/08	Tue 7/8/08
64	NPDES permit	5 days	Wed 7/9/08	Tue 7/15/08
65	Submit application	1 day	Wed 7/16/08	Wed 7/16/08
66	Receive permit conditions	60 days	Thu 7/17/08	Wed 10/8/08

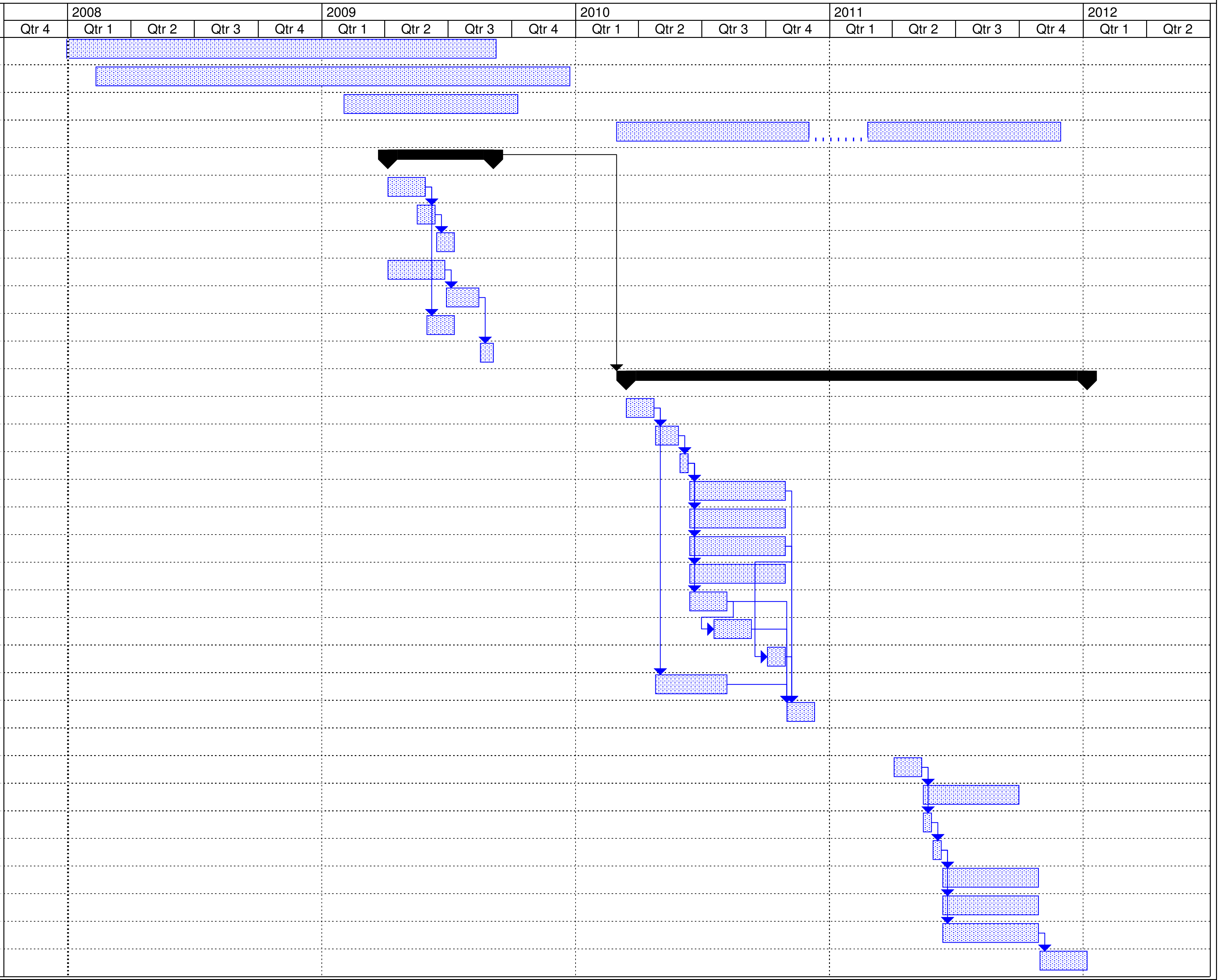
Project: Figure 6-1 Permitting Schedul
Date: Tue 1/1/08

Task	▨	Split	⋯⋯
Progress	▬	Milestone	◆
Summary	▬	Project Summary	▬
External Tasks	▬	External Milestone	◆
Deadline	⇩		

FIGURE 6-1

San Clemente Dam
Removal and River Re-route
Project Schedule

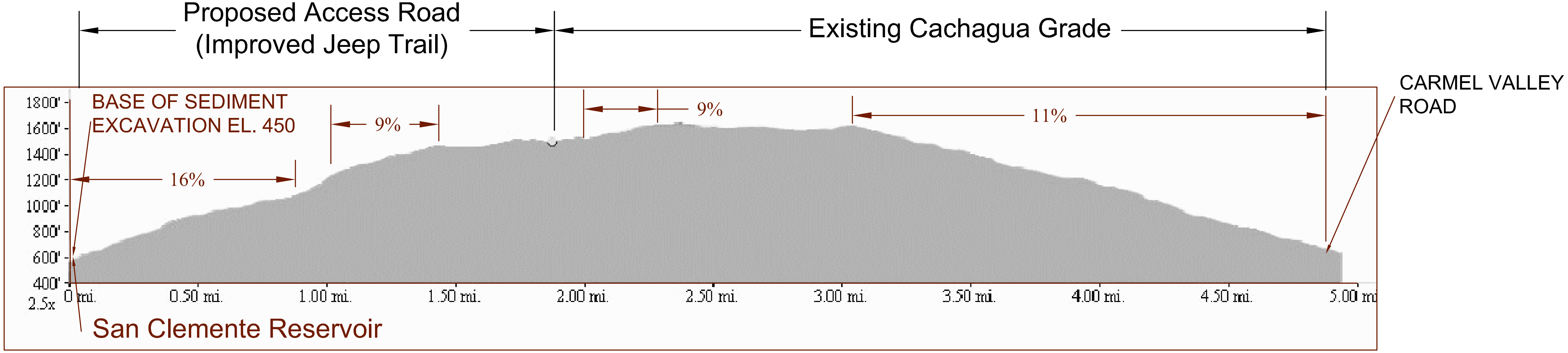
ID	Task Name	Duration
1	PERMITTING	442 days
2	ENGINEERING DESIGN & PERMITTING SUPPORT	488 days
3	SH &CRLF MIT MONTORING PHASE 1	180 days
4	SH &CRLF MIT MONTORING PHASE 2	397 days
5	**PHASE 1**	**110 days**
6	SET-UP STREAM DIVERSION	40 days
7	CLEAR AREA FOR DIVERSION CHANNEL BLASTING	20 days
8	BUILD CUTOFF WALLS	20 days
9	CLEAR & GRUB, GRADE HAUL ROAD TO DISPOSAL AREA	60 days
10	ACCESS ROAD UPGRADE	35 days
11	PREPARE SLOPE STABLIZATION AREA	30 days
12	DEMOBILIZATION	15 days
13	**PHASE 2**	**475 days**
14	MOBILIZATION	30 days
15	INSTALL DEWATERING SYSTEM	25 days
16	DRAWDOWN RESERVOIR	10 days
17	DEWATERING & CARE OF WATER	100 days
18	INSTALL CAL-AM'S WATER DIVERSION INTAKE AND TEMPORARY PIPELINE	100 days
19	SEDIMENT EXCAVATION AND DISPOSAL	100 days
20	SLOPE STABILIZATION OF SEDIMENT	100 days
21	BLAST BYPASS CHANNEL	40 days
22	BUILD DIVERSION DIKE	40 days
23	RIVER RESTORATION	20 days
24	DRILL DAM ABOVE EL. 525 FT	75 days
25	DEMOBILIZATION	30 days
26		
27	MOBILIZATION	30 days
28	INSTALL CAL-AM'S PERMANENT WATER DIVERSION PIPELINE	100 days
29	INSTALL DEWATERING SYSTEM	10 days
30	DRAWDOWN RESERVOIR	10 days
31	DEWATERING & CARE OF WATER	100 days
32	RIVER RESTORATION AND SEDIMENT EXCAVATION	100 days
33	DAM DRILLING & DEMOLITION	100 days
34	DEMOBILIZATION	50 days



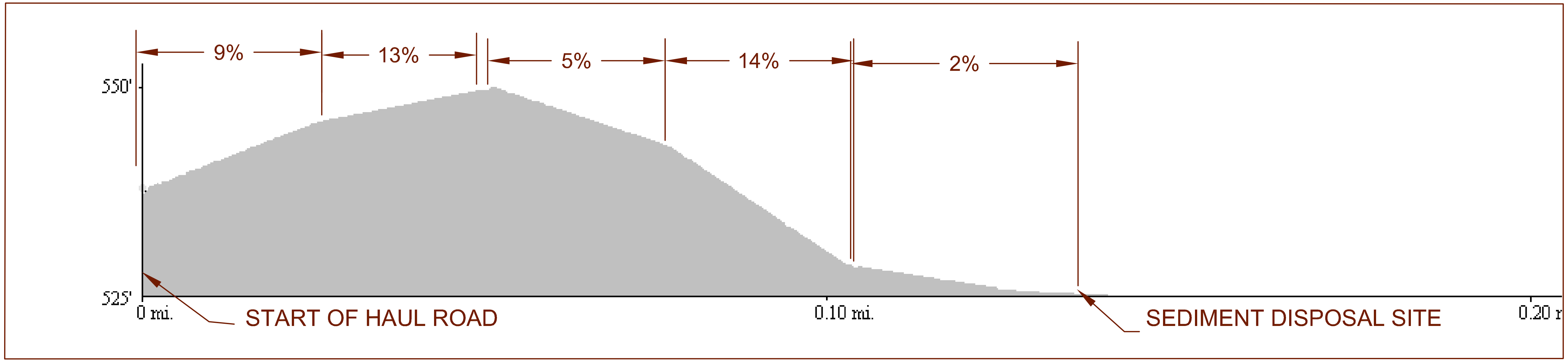
Project: SAN CLEMENTE DAM REMOVAL
Date: Tue 1/1/08

Task	▨	Milestone	◆	Rolled Up Split	⋯⋯	External Tasks	▭	Deadline	⇩
Split	⋯⋯	Summary	▬	Rolled Up Milestone	◇	Project Summary	▬		
Progress	▬	Rolled Up Task	▨	Rolled Up Progress	▬	External Milestone	◆		

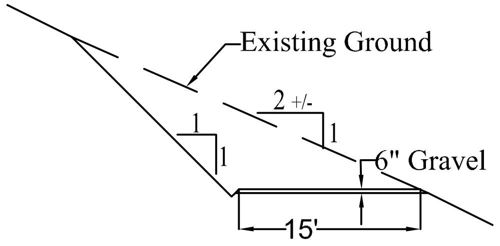
FIGURE 6-2



PROFILE OF ACCESS ROAD TO RESERVOIR SITE



PROFILE OF TEMPORARY HAUL ROAD FROM SAN CLEMENTE CREEK ARM TO CARMEL RIVER ARM



TYPICAL ACCESS ROAD SECTION

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SAN CLEMENTE DAM
PROFILE OF SITE ACCESS AND HAUL ROADS

FIGURE 6-3

APPENDICES

APPENDIX A

Coastal Conservancy

DRAFT Preliminary Geotechnical Report

Carmel River Reroute and San Clemente Dam Removal
Monterey County, California

January 2, 2008

MWH

DRAFT PRELIMINARY GEOTECHNICAL REPORT
CARMEL RIVER REROUTE AND SAN CLEMENTE DAM REMOVAL
MONTEREY COUNTY, CALIFORNIA

Prepared for

CALIFORNIA STATE COASTAL CONSERVANCY

13th Floor, 1330 Broadway, Oakland, CA 94612
(510) 286-1015

January 2, 2008

Prepared by:

MWH AMERICAS INC.
2121 N. California Blvd, Suite 600
Walnut Creek, CA 94596
(925) 627-4500

Draft Preliminary Geotechnical Report
Carmel River Reroute and San Clemente Dam Removal
Monterey County, California

Professional Certification

This report has been prepared by MWH Americas, Inc. (MWH) under the professional supervision of the senior staff whose seals and signatures appear herein. The findings, interpretations of data, recommendations, specifications, or professional opinions are presented within the limits of the available information at the time the report was prepared, in accordance with generally accepted professional engineering and geologic practice and within the requirements of the California State Coastal Conservancy. There is no other warranty, either expressed or implied.

The findings of this report are preliminary and are intended to provide a feasibility-level evaluation of the site. This report is not intended for final design purposes. The findings of this report are based on the readily available data and information obtained from public and private sources. Additional studies (at greater cost) may or may not disclose information which may significantly modify the findings of this report. In the event that there are any changes in the nature, design, or location of the project, or if additional subsurface data are obtained or any future additions are planned, the conclusions and recommendations contained in the report will need to be reevaluated by MWH in light of the proposed changes or additional information obtained.

This report was prepared solely for the benefit of the California State Coastal Conservancy. No other entity or person shall use or rely upon this report or any of MWH's work products unless expressly authorized by MWH. Any use of or reliance upon MWH's work product by any party, other than the California State Coastal Conservancy, shall be solely at their own risk.

Final Report to be signed and stamped by author below.

Vik Iso-Ahola, P.E., PMP
Project Manager

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LIST OF ACRONYMS AND ABBREVIATIONS

ASTM	American Society for Testing and Materials
Bgs	Below ground surface
BOD	Basis of design
Cal-Am	California American Water Company
CRRDR	Carmel River Reroute and San Clemente Dam Removal
DSOD	California Department of Water Resources, Division of Safety of Dams
DWQ	Department of Water Quality
DWR	Department of Water Resources
EIR/EIS	Environmental Impact Report / Environmental Impact Statement
El. XXX	elevation XXX (in XXX feet above mean sea level)
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
g	Unit of Acceleration Equivalent to gravity
gpm	Gallons per minute
ID	Inside diameter
MCE	Maximum credible earthquake
MEI	Mussetter Engineering, Inc.
msl	mean sea level
MWH	MWH Americas, Inc.
NCEER	National Center for Earthquake Engineering Research
NRCS	Natural Resources Conservation Service
pcf	Pounds per cubic foot
PGA	Peak ground acceleration
PMF	Probable maximum flood
psf	Pounds per square foot
PSHA	Probabilistic seismic hazard analysis
Psi	Pounds per square inch
RQD	Rock quality designation
SCC	California State Coastal Conservancy
Site	San Clemente Dam and Reservoir
SPT	Standard penetration test
USACE	United States Army Corps of Engineers
USGS	United States Geologic Survey
USSD	United States Society on Dams
Yrs	Years

1.0 INTRODUCTION

This draft geotechnical report has been prepared on behalf of the California State Coastal Conservancy (SCC) by MWH Americas, Inc. (MWH). This report summarizes the results of a geotechnical investigation and conceptual design evaluation to assess the feasibility of the proposed Carmel River re-route and San Clemente Dam removal project (CRRDR). The project has been presented as an alternative in the Draft Environmental Impact Report/ Environmental Impact Statement (EIR/EIS) titled “Environmental Impact Statement Report for the San Clemente Dam Seismic Retrofit Project” dated April 2006.

The San Clemente Dam is located approximately 3.7 miles south-southeast of Carmel Valley Village in unincorporated Monterey County, California (**Figure 1-1**). The dam is located on the Carmel River at the confluence with San Clemente Creek, approximately 18.8 miles upstream of the Pacific Ocean. The reservoir impounded by the San Clemente Dam is comprised of the San Clemente Arm to the west and the Carmel River Arm to the east. For the purpose of this study, the project site consists of these two reservoir arms and the ridge separating the two arms, which starts about 500 feet upstream of the dam and continues approximately 0.5 miles upstream. A depiction of the project site and the proposed features are shown on **Figure 1-2**.

1.1 Background

The California Department of Water Resources (DWR) Division of Safety of Dams (DSOD) conducted a study that found that the San Clemente Dam did not comply with DSOD’s dam safety requirements. As a result, DSOD requires that California American Water Company (Cal-Am), the owner and operator of the dam, mitigate the potential for instability of the dam with respect to the maximum credible earthquake (MCE) and probable maximum flood (PMF) events.

In response to the DSOD’s requirements, Cal-Am has conducted many studies to evaluate methods to bring the dam into compliance. These previous studies have identified a number of remedial alternatives such as reinforcing the existing dam, removing the dam, replacing the dam, as well as other options. Currently, Cal-Am’s preferred remedial method includes strengthening the dam and stabilizing a portion of the retained sediments.

The proposed dam remediation is subject to the jurisdiction of multiple federal, state, and local agencies, such as the United States Army Corps of Engineers (USACE) and the California Department of Water Quality (DWQ). The lead federal agency, the USACE, has determined that the remediation proposed by Cal-Am may have a significant impact on the quality of the human environment, and as a result, has required Cal-Am to conduct an EIR/EIS to evaluate the proposed remediation, as well as other viable alternates. Four alternate remedial measures were evaluated in the April 2006 Draft EIR/EIS prepared by Entrix, which included:

- Notch the dam and remove a portion of the retained sediments;
- Remove the dam and all the retained sediments;

- Reroute the Carmel River into San Clemente Creek, remove the dam, remove retained sediments in the San Clemente Creek drainage, and stabilize the sediments within the Carmel River drainage (the CRRDR alternate previously described); or

- Do nothing.

The SCC has been appointed as the lead state agency in this process and is spearheading supplemental technical studies to support this effort. The goals for the supplemental studies are to: 1) provide sufficient information to enable consensus among the parties on a feasible strategy for removing the dam, and 2) prepare the CRRDR project for the permitting and final design phases. The intent of this geotechnical report is to conduct a preliminary evaluation of the geotechnical feasibility of the CRRDR alternate.

1.2 Project Description

The CRRDR alternate would meet the seismic and flood related safety goals, improve environmental conditions, and maintain a drinking water supply for Cal-Am. This alternate would include a number of site improvements including removal of the San Clemente Dam, construction of a diversion dike and bypass channel, partial excavation of the impounded sediment, and modification of the lower reaches of San Clemente Creek to accommodate additional water flow from the Carmel River (**Figure 1-2**). A descriptions of the proposed project features, site layout, construction activities required for the CRRDR as described in the Draft EIR/EIS report are provided in the following paragraphs (Entrix and Cal-Am, 2006).

Initially, a temporary sheet pile cofferdam will be constructed approximately 3,000 feet upstream of the dam on the Carmel River Arm. The sheet piling will be driven to bedrock to provide a relatively water-tight barrier, which will reduce subsurface and surface flow into the construction area. Current diversion design assumptions envision that the impounded water behind the cofferdam will be up to about 10 feet deep, although this may change upon detailed evaluation of hydraulics and hydrology. The impounded water will be diverted downstream of the construction site through a temporary pipeline. Once the cofferdam is in place, the sediments located down stream of the cofferdam will be dewatered to facilitate construction activities.

Subsequent to river diversion and site dewatering, a bypass channel located approximately 2,500 feet upstream of the dam will be excavated through the ridge dividing the San Clemente and Carmel River reservoir arms. The bypass channel cut will be approximately 450 feet long, 150 feet wide, and up to 120 feet deep. The rock and gravel excavated from the bypass channel will be reused as fill and slope armoring applications associated with the project.

Much of the rock excavated from bypass channel will be used in a diversion dike to be constructed directly to the east. This dike will redirect flows from the Carmel River into the bypass channel and then into the San Clemente arm of the reservoir. Based on preliminary layouts, the diversion dike will be approximately 75 feet high and will have slopes of 2.5H:1V on the upstream face and 3H:1V on the downstream face.

To reduce the effects of erosion of the adjacent stream, the upstream slope of the diversion dike will be armored with riprap. A cement-bentonite cutoff wall will also be constructed at the upstream toe of the embankment. The cutoff wall will act to reduce undermining at the toe of the embankment and will help retain water within the abandoned section of the Carmel River, where a new wetland area will be constructed.

Modifications to the San Clemente reservoir arm will be made to remove sediments that have accumulated since the installation of the dam. However, additional channel widening will be required to accommodate the additional flow volumes from the Carmel River. Initial estimates call for the removal of sediments that are up to nearly 80 feet deep in the vicinity of the dam. A total of approximately 380,000 cubic yards of sediment are expected to be removed.

Sediments located within the abandoned portion of the Carmel River arm will be left in place. Sediments removed from the San Clemente arm will be placed in the southern portions of the abandoned Carmel River arm.

In the vicinity of the dam, the adjacent Carmel River arm sediments will be graded at a slope of 4H:1V to meet the proposed grade of the San Clemente arm. Deep soil mixing will be used to stabilize the sediment slope. Deep soil mixing is a soil improvement process that uses specialized augers to mix a binding agent with subsurface soil, dramatically improving strength and decreasing permeability.

A series of overlapping deep soil mixing columns will work to form a relatively impermeable barrier, acting to impound water within the abandoned Carmel River arm on the downstream end. The cement-bentonite cutoff wall at the location of the diversion dike will act to maintain water within this abandoned portion, helping to establish a wetland.

Once the Carmel River sediments are stabilized, the San Clemente Dam will be removed. Concrete rubble from the dam will be recycled for use as fill or riprap to help construct and protect the slopes of the stabilized sediment. Following completion of construction activities, the temporary cofferdam and water diversion system will be removed to complete the project.

1.3 Purpose and Scope of Work

The purpose of this geotechnical investigation was to review available geotechnical data and collect field data to provide a basis for assessing the geotechnical feasibility of the CRRDR project as described in the Draft EIR/EIS report (Entrix, 2006). This was done by conducting preliminary geotechnical analyses and evaluations of the site conditions and proposed earthen structures. Where appropriate, suggestions for further analyses and alternate project approaches are made.

Geotechnical analyses and evaluations were based on data collected from two rock core explorations, three soil borings, one hand-excavated test pit, and data contained in reports of previous site evaluations. The reports reviewed included the following:

- Mussetter Engineering, Inc. (MEI), 2003. San Clemente Reservoir and Carmel River Sediment Transport Modeling to Evaluate Potential Impacts of Dam Retrofit Options. April 2003.

- MEI, 2005a. Hydraulic and Sediment-transport Analysis of Carmel River Bypass Option, California. Prepared for California American Water. April 25, 2005.

- Entrix and California American Water, 2006. Draft Environmental Impact Report / Environmental Impact Statement, San Clemente Dam Seismic Safety Project. Prepared for California Department of Water Resources and U.S. Army Corps of Engineers, April 2006. Available for download at: http://www.sjd.water.ca.gov/environmentalservices/sanclemente/index.cfm.Entrix

- Kleinfelder Associates, Inc. (Kleinfelder), 2002. Sediment Characterization Study: San Clemente Reservoir Monterey County, California. Prepared for MEI, November 2002.

Samples of soil and rock were collected from the subsurface explorations at selected locations (**Figure 1-2**). A laboratory testing program was developed to help characterize physical and strength properties of the samples collected. The laboratory testing of soil included moisture content, grain size analyses, percent fines determination, and soil liquid and plasticity indices analyses. Laboratory testing of rock included point load compression index and unconfined compression testing.

A geological site reconnaissance was conducted to evaluate the current conditions at key site locations. This reconnaissance included an evaluation of the proposed diversion dike, the bypass channel, and slopes adjacent to the combined flow portion of San Clemente Creek.

A number of geotechnical analyses were conducted in relation to the proposed bypass channel, diversion dike, stabilized sediment slope, temporary sheet pile cofferdam, combined flow reach, and reservoir dewatering. Preliminary evaluations of slope stability, rock excavation, settlement, seepage, and dewatering were conducted.

The scope of work was designed to address the following main objectives:

- Evaluate the cutslope stability of the proposed bypass channel
- Provide a preliminary design of the proposed bypass channel cut slopes
- Evaluate the suitability of the excavated rock for use as fill in the proposed diversion dike
- Conduct a preliminary evaluation of the proposed diversion dike to identify potential issues that may be encountered during final design
- Conduct a preliminary analysis of the proposed stabilized sediment slope at the northern extent of the abandoned Carmel River Drainage
- Conduct a preliminary analysis to determine the feasibility of a sheet pile cofferdam to temporarily impound the Carmel River upstream of the project site
- Identify potential reservoir dewatering needs and methods of the reservoir and subsurface for construction
- Provide a qualitative assessment of the slopes exposed by sediment excavation within the San Clemente Creek channel with respect to erosion and mass landsliding

To achieve the aforementioned objectives, the following field analyses and engineering tasks were performed:

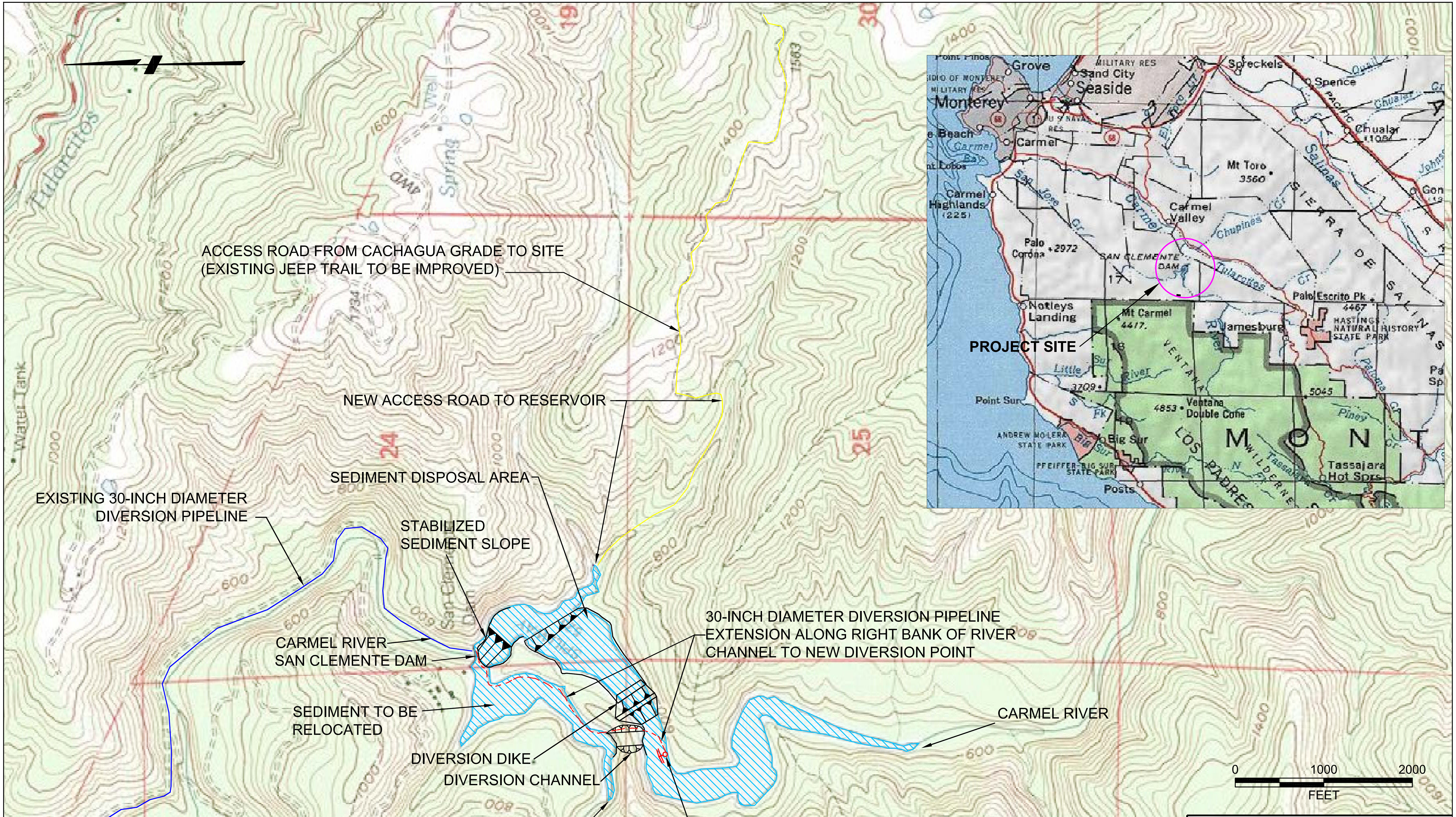
- Advanced two rock core explorations to depths of 90.3 and 120.0 feet
- Advanced three mud-rotary borings to refusal at depths ranging from 17.5 to 47.0 feet
- Completed one hand-dug test pit to a depth of 6.2 feet
- Maintained logs of soil, rock and groundwater conditions encountered in each exploration and obtained soil and rock samples for laboratory tests
- Conducted soil index tests that consisted of moisture content, gradation, and plastic and liquid limit indices in accordance with applicable American Society for Testing and Materials (ASTM) standards
- Evaluated the slope stability of the diversion dike based on anticipated fill materials, expected groundwater and seepage conditions, and data obtained from field explorations and laboratory tests
- Conducted a preliminary liquefaction analysis of the foundation soils that underlie the diversion dike
- Identified potential measures to mitigate the effects of excessive settlement or liquefaction-induced settlement of the diversion dike
- Identified the need for slope protection, granular filters, and seepage control measures on the upstream side of the diversion dike
- Evaluated the stability of the proposed stabilized sediment slope based on anticipated soil conditions
- Provided preliminary geotechnical design criteria for the proposed sheet pile cofferdam based on observed conditions and existing subsurface exploration data
- Identified potential dewatering methods applicable to the site based on the conditions encountered and provided a comparison of the potential dewatering methods based on conditions, capacity, construction needs, and other factors
- Conducted a qualitative assessment of the effects of excavating sediments in San Clemente Creek on the stability of the newly excavated channel walls based on the anticipated increase in stream flow

This report presents the results of the subsurface exploration program, laboratory testing, and preliminary geotechnical engineering analyses related to the proposed CRRDR alternate

1.4 Report Structure

This report is divided into seven sections. **Section 1** introduces the project and provides a description of the project and scope of this report. Descriptions of the methods used to characterize the site are presented in **Section 2**. **Section 3** presents site conditions based on field investigations, previous work at the site by others, and published data. Analysis methods, results, and conclusions are presented in **Section 4**. Typically, brief descriptions of analyses and design methods are presented within the body of the report, and when appropriate, more detailed technical analyses and supporting data are provided in appendices. **Section 5** presents conclusions base on the analyses presented herein. Recommendations for future work in support of the final project design are presented in **Section 6**. Cited references are presented in **Section 7**. In summary, the report is divided into the following sections:

- **Section 1** Introduction
- **Section 2** Site Characterization
- **Section 3** Site Conditions
- **Section 4** Preliminary Geotechnical Analyses and Results
- **Section 5** Conclusions
- **Section 6** Recommendations
- **Section 7** References



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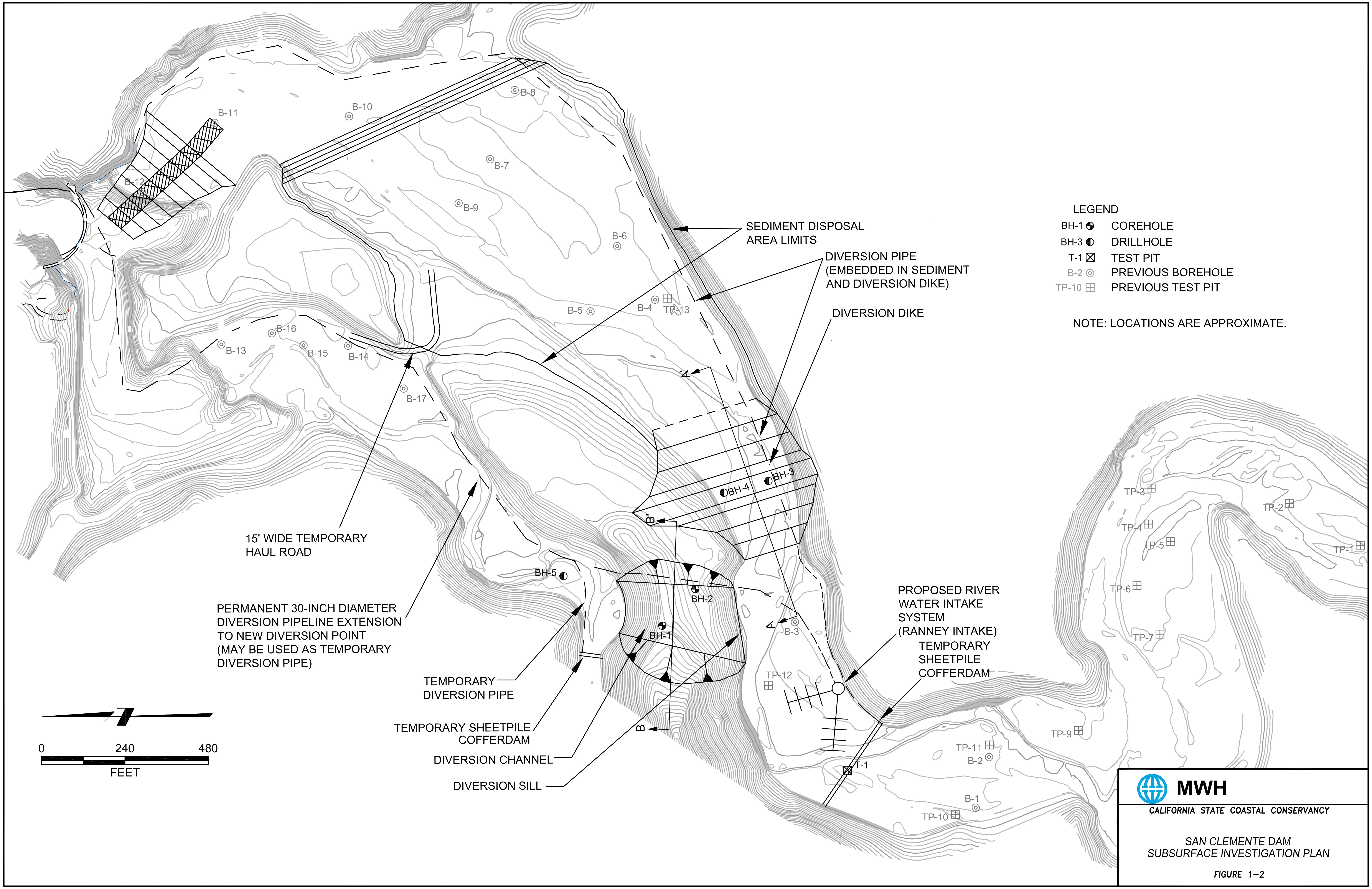
SAN CLEMENTE DAM
SITE LOCATION

FIGURE 1–1



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CALIFORNIA STATE COASTAL CONSERVANCY

SAN CLEMENTE DAM
SUBSURFACE INVESTIGATION PLAN

FIGURE 1–2

2.0 SITE CHARACTERIZATION

2.1 Literature Review

MWH conducted a review of available literature pertaining to the site as part of this preliminary geotechnical investigation. Our review included previous geotechnical and environmental reports on the site, available topographic maps, and other available documents. Primary documents included in this literature review are listed below:

- Entrix Environmental Consultants, 2006. Draft Environmental Impact Report/Environmental Impact Statement, San Clemente Dam Seismic Safety Project. April 21, 2006.
- Kleinfelder, 2002. Sediment Characterization Study, San Clemente Reservoir Monterey County, California. November 5, 2002.
- MEI, 2005a. Hydraulic and Sediment-Transport Analysis of Carmel River Bypass Option, California. Prepared for California American Water. April 25, 2005.
- MEI, 2005b. Preliminary Hydraulic Analysis of the Carmel River Bypass Option for San Clemente Dam Removal, memorandum dated February 22, 2005.
- U.S. Geological Survey (USGS), 1979. Carmel Valley 7.5 Minute Quadrangle.
- Woodward-Clyde Consultants, 1997. Design Memorandum, Seismic Retrofit of San Clemente Dam, Volume 2 of 2. October 10, 2005.

2.2 Field Explorations

2.2.1 Permitting

As part of the geotechnical field explorations, federal, state, and local agencies with jurisdiction over the field exploration activities were consulted to determine and obtain appropriate agreements and permits. Our consultations included teleconferences, an on-site meeting and site walk, email and mail correspondence, and telephone communications. Based on these consultations, a Programmatic Agreement with the USACE and a Streambed Alteration Agreement from the California Department of Fish and Game were obtained.

2.2.2 Site Reconnaissance

A preliminary geological site reconnaissance of the bypass channel was conducted on September 13, 2007. A second geological reconnaissance of the remainder of the project site was conducted on November 1, 2007. The purpose of these reconnaissances was to evaluate and note surface conditions, including grades, vegetation, outcropping soil and rock, visually apparent geologic hazards, and surface water conditions. The geological reconnaissances included areas of the proposed cofferdam, diversion dike, bypass channel, and both the Carmel River and San Clemente arms of the reservoir. The preliminary geological site reconnaissances were conducted by qualified geologists. Our subcontracted geologist's summary of the September 13, 2007 reconnaissance is presented in Appendix C.

2.2.3 Subsurface Investigation

Subsurface investigations included two rock core borings (BH-1 and BH-2), three soil borings (BH-3 through BH-5), and one test pit excavation (T-1). Approximate boring locations with respect to physical site features are depicted on **Figure 1-2**. Logs of each exploration, a description of classification methods, photographs of rock core samples, and a key to the exploration logs are presented in Appendix A. Each subsurface exploration was observed by a qualified geologist or geotechnical engineer.

Explorations BH-1 and BH-2 were advanced within the footprint of the proposed bypass channel. BH-1 and BH-2 were advanced using NQ wire-line coring techniques to depths of 130.0 and 90.3 feet, respectively. Continuous rock core samples were collected from both rock core borings. All core samples were retained for classification purposes. Selected core samples were tested to determine intact rock strength characteristics.

Soil borings BH-3 through BH-5 were advanced to bedrock within the San Clemente and Carmel River reservoir arms. These borings were conducted using mud-rotary drilling techniques with a skid-mounted drill rig. Borings BH-3 and BH-4 were conducted within the footprint of the proposed diversion dike and were advanced to depths of 47 and 36.5 feet, respectively. Boring BH-5 was advanced to a depth of 17 feet within the San Clemente arm, approximately 100 feet down stream of the proposed bypass channel. Relatively disturbed samples were collected at five-foot intervals in each soil boring and were tested to characterize soil index properties.

Test pit exploration T-1 was conducted near the proposed temporary sheet pile cofferdam. Exploration T-1 was advanced using hand excavation methods to a depth of 6.2 feet. One bulk sample was collected from this exploration. The collected bulk sample was analyzed for grain size distribution.

2.2.4 Laboratory Testing Program

Soil and rock samples were collected from the subsurface explorations conducted as part of this preliminary geotechnical evaluation. Continuous rock core was collected from borings BH-1 and BH-2. Disturbed soil samples were collected at selected elevations from soil borings BH-3 through BH-5 using 1.4-inch and 2.0-inch inside diameter (ID) split spoon samplers. A disturbed bulk soil sample was collected from test pit exploration TP-1. Selected rock core samples were tested to determine the point load strength and unconfined compressive strength of the intact rock mass. Each soil sample and rock core sample collected was logged and classified in accordance with the methods described in Appendix A. Laboratory testing was conducted on selected soil samples to determine moisture content, grain size distribution, and liquid and plasticity limits. Results of the laboratory testing program are presented in Appendix B.

2.3 Previous Investigations

A number of site evaluations have been conducted to address potential remedial measures for the San Clemente Dam. The work summarized in this document relies, in part, on the data presented in these reports. Specifically, the boring logs and soil data presented by Kleinfelder (2002) and MEI (2005a, 2005b) were utilized for portions of this preliminary geotechnical evaluation. A more comprehensive list of previous work conducted at the site and an account of the project history is presented by Entrix (2006).

3.0 SITE CONDITIONS

3.1 Surface Conditions

San Clemente Dam is located in a steep V-shaped canyon near the confluence of San Clemente Creek and the Carmel River within the Santa Lucia mountain range. The dam's reservoir is comprised of two arms, which are divided by a steep ridgeline. At the location of the proposed bypass channel, the crest of the ridge rises approximately 120 feet above the reservoir sediment deposits, which are located at approximate elevation 530 feet above msl (El. 530). In general, adjacent slopes dip steeply downward toward the reservoir. In some locations, slopes are estimated to be in excess of 100 percent and reach elevations as high as El. 2,200. These adjacent slopes are covered by variable amounts of vegetation consisting of grasses, brush, shrubs, and occasional oak trees.

Large deposits of recent alluvial sediments have collected within both arms of the reservoir. It is estimated that these sediments have reduce the dam's storage capacity by nearly 90 percent. The recent alluvial sediments have formed relatively flat slopes that dip gently downstream. Within the project site, reservoir sediments generally range from El. 460 to 530. The reservoir sediments are typically sparsely vegetated within the Carmel River arm, and more densely vegetated within the San Clemente Creek arm.

Based on Natural Resource Conservation Service (NRCS, formerly the Soil Conservation Service) maps, soil at the site consists primarily of the Junipero-Sur Complex (NRCS, 2007). This soil is present along the banks of San Clemente Creek and most of the Carmel River, including the ridge dividing the two. This soil unit is formed from the weathered residuum of igneous and metamorphic rock and is found on 50 to 85 percent slopes. Typically, bedrock or weathered bedrock can be found underlying this soil at shallow depths ranging from 24 to 34 inches.

Other notable mapped NRCS soil units include Cieneba fine gravelly sandy loam, 30 to 70 percent slopes, Arroyo Seco gravelly sandy loam, 5 to 9 percent slopes, and rock outcrops. Cieneba fine gravelly sandy loam is mapped at higher elevations and near the left abutment of the San Clemente Dam. Arroyo Seco gravelly sandy loam are present on a bench located approximately 125 feet above the western bank of San Clemente Creek. Soils maps indicate the steep slopes located east of the dam consist of outcropping rock. Impounded reservoir sediments are not included on the NRCS maps.

3.2 Geology

This section summarizes the current understanding of the regional geology, site geology, and tectonic setting and site seismicity.

3.2.1 Regional Geology

San Clemente Dam and Reservoir are located in the Santa Lucia Mountains of the southern Coast Ranges Geomorphic Province. The southern Coastal Ranges are chiefly comprised of a complex juxtaposition of rocks of the Salinian Block, and the Franciscan Complex, by regional faulting related to motion between the North American and Pacific tectonic plates. Rocks of the

Salinian Block consist chiefly of metamorphosed Paleozoic (540-270 million years ago) marine sedimentary rocks, including quartzite, marble, granulite gneiss, granofels, and schist. These metamorphic rocks were intruded by large plutons of granitic magma, ranging from granite to diorite during the Cretaceous (145-65 million years before present). Salinian rocks are overlain in many areas with Cenozoic (65-0 million years before present) sedimentary rocks including shales, siltstones, sandstones, and conglomerates. The Franciscan Complex is comprised of a heterogeneous assemblage of Late Jurassic to Cretaceous (200-65 million years before present) marine sedimentary and volcanic rocks that include, chert, limestone, siltstone, and greenstone (metamorphosed basalt), as well as more highly metamorphosed rocks including blueschist, greenschist, eclogite, and serpentenite.

The Santa Lucia Mountains lie along the western portion of the province and are characterized by a series of rugged, northwest trending ranges, and deeply incised valleys. These topographic features are a result of the tectonic processes at work in the area. This region began to experience rapid uplift that began approximately 6 million years ago and continues today. Rapid uplift of the area has caused deep incision within the river channels, and high denudation rates. Evidence of this rapid uplift can be seen in perched river terraces above active river channels, and the high volumes of young sediments within the active river channels.

3.2.2 Site Geology

The dam site is predominantly underlain by Salinian Block granitic and metamorphic rocks, which form steep cliffs and ridges above the river and stream channels. Granitic rocks in the area are predominantly granodiorite to diorite in composition, containing abundant plagioclase, feldspars, biotite, and quartz, with textures ranging from medium grained to pegmatitic.

Several perched river terraces are present along the Carmel River and San Clemente Creek near the site. Along the Carmel River, these terraces form broad, relatively flat surfaces that are situated at approximately El. 600, about 70 feet above the current river channel. These terraces formed in the ancient river channel, and consist of riverbed deposits. These deposits have since been incised due to regional or localized uplift.

The streambed channels of the Carmel River and San Clemente Creek consist primarily of coarse gravels and sands, deposited during high flows. Sands range from fine to coarse-grained, and are comprised primarily of subangular to angular grains of decomposed granite and other lithic fragments. Coarse clasts within these gravels and sands are generally rounded to subangular clasts of granitic, volcanic, and metamorphic rocks, as well as indurated sedimentary rocks of the Salinian Block.

3.2.3 Tectonic Setting and Site Seismicity

The San Clemente Dam and Reservoir are located approximately 28 miles west of the San Andreas Fault, 15 miles southeast of the Monterey Bay fault zone, and 12 miles northeast of the San Gregorio fault zone. The Tularcitos fault traverses the area about 1.25 miles north of the dam site. The Cachagua fault passes through the ridge south of the dam that separates the Carmel River and San Clemente Creek, and through the main active reservoir, southwest of the dam.

The area surrounding the project site is generally characterized by common seismic events. Based on a search of the USGS 2007 catalog of historical earthquakes (USGS, 2007a) , 1,314 earthquakes occurred within 100 kilometers (62 miles) of the project site with a magnitude of 3.0 or greater between 1735 and June 2007. The majority of these earthquakes (1,129, or 86 percent) were less than magnitude 4.0. A total of 25 (or 2 percent) of these events had magnitudes equal to, or greater than 5.0.

A probabilistic seismic hazard analysis (PSHA) of the site was conducted, which considered two earthquake source types: fault sources and background sources. Fault sources are those that originate from faults known to be active, while background sources are earthquakes that are not associated with known faults. The San Andreas, Tularcitos, Rinconada, San Gregorio, and Calaveras fault zones have been identified as faults that would produce significant ground motions at the project site. Parameters for these faults are listed in **Table 3-1**. No field investigations were performed to confirm or disprove the existence of faults in the area. However, based on review of available aerial photographs, USGS fault data, topographic maps, and geologic maps, the presence of active unidentified faults or fault traces at the site are considered to be unlikely.

Table 3-1: Fault Parameters for San Clemente Dam

Fault	Characteristic Magnitude (M)	Slip Rate (millimeters/year)	Closest Approach to San Clemente Dam (miles)
San Andreas	8.1	>5.0	28
Tularcitos	7.3	0.5	1.5
Rinconada	7.5	1.0	12
San Gregorio	7.3	1.0 to 5.0	8
Calaveras	6.4	15	30

Source: USGS, 2002
Key:
M = Moment Magnitude

3.2.3.1 Design Ground Motion:

The PSHA was used for selection of a design ground motion at the project site. Both fault and background sources within a 100-kilometer radius are included in this PSHA. Sources farther than 100 kilometers from the site were not considered in the analysis due to their negligible effect on the hazard. The attenuation relationships developed by Abrahamson and Silva (1997), Boore, Joyner, and Fumal (1997) and Sadigh, et al. (1997) were chosen to estimate ground motions. These relationships are appropriate for sites in active, shallow crustal regions. The resulting PSHA ground motion computations were calculated for a bedrock substrate. Detailed location-specific analyses of the soil profile to determine ground motion amplification or de-amplification were not conducted as part of this study.

The results of the PSHA are presented on **Figures 3-1** and **3-2**. **Figure 3-1** shows a plot of the uniform hazard curve, which correlates spectral period with spectral acceleration for various return periods. **Table 3-2** summarizes the mean peak horizontal acceleration for 475, 975 and 2,475 year return periods. The results of the PSHA indicate moderate accelerations for these typical return periods.

Table 3-2: Mean Probabilistic Ground Motions on Rock

Probability of Exceedence (percent in 50 years)	Return Period (years)	Mean Peak Ground Acceleration on Rock (g)
10	475	0.28
5	975	0.37
2	2,475	0.52

Key:
g = unit of acceleration equivalent to gravity

The contributions of various seismic sources to peak ground acceleration (PGA) on rock for different return periods are shown on **Figure 3-2**, along with the total hazard curve. The total hazard curve is calculated using all faults and background sources within 100 kilometers of the site. The total hazard curve indicates the annual probability of exceeding a particular ground motion at the project site, regardless of its source. It should be noted that the Tularcitos fault does not control the hazard for return periods less than 1,000 years. The characteristic return period of the Tularcitos fault is between 4,000 and 5,700 years (USGS, 2007a).

A 975 year return period (5 percent probability of exceedence in 50 years) was selected for design of the bypass channel, diversion dike, and stabilized sediment slope. This corresponds to a ground motion of 0.37 g on rock, or a 0.15 g pseudo-static loading factor, which is defined as a "great earthquake" by USACE. Several factors were considered during selection: consequences of potential release of the stabilized sediment, failure of the rock slopes at the project site, and the reduced downstream impact of a failure as compared to a dam failure. The MCE and corresponding ground motion established by Woodward-Clyde is not recommended for design of the sediment slope because the results of the PSHA utilize updated seismicity and attenuation relations. Moreover, MCEs are typically developed for analysis of dams. Using an MCE for design of stabilized slopes is considered highly conservative since the downstream impacts are far less compared to a dam failure.

3.3 Subsurface Conditions

This section summarizes the current understanding of subsurface conditions at the diversion dike and temporary sheet pile cofferdam, the stabilized sediment slope, the San Clemente Creek, and the proposed bypass channel site.

3.3.1 General

Subsurface conditions were explored in the vicinity of the bypass channel and the diversion dike, within the channel of San Clemente Creek, and near the temporary sheet pile cofferdam. Previous explorations conducted by Kleinfelder (2002) also were used to help classify subsurface conditions at various locations across the site. The locations of each of these subsurface explorations are depicted on **Figure 1-2**. A summary of the subsurface conditions at the site are described in further detail in the following paragraphs. Detailed logs and descriptions of the conditions encountered are presented in Appendix A.

3.3.2 Diversion Dike and Temporary Sheet Pile Cofferdam

In the vicinity of the proposed cofferdam and diversion dike, the near surface soil consists of recent alluvium, which is primarily comprised of loose, poorly graded sand with gravel. This alluvial sand unit contains frequent interbeds of sandy gravels with cobbles, sand with silt, and organic debris. This soil unit extends to a depth of 38 feet at the location of BH-3 and 25.3 feet at the location of BH-4. Based on interpretations of previous borings conducted near the proposed sheet pile cofferdam, the alluvial sand unit extends to depths ranging from 12 to 16.5 feet.

Gravel and cobble size particles within this soil unit are typically subrounded, while sand sized particles are more commonly subangular to subrounded. Occasional boulders were observed during previous test pit explorations that were commonly 6 inches in diameter; however, boulders as great as 30 inches in diameter were occasionally encountered. Sporadic, thinly bedded, layers of organic debris, primarily consisting of decaying leaves and small wood fragments, were observed in BH-3 and BH-4 within the near surface poorly graded sand layer. Our laboratory testing program indicates the natural moisture content of this soil unit ranges from 22 to 98 percent. It is believed that the relatively high natural moisture content of this soil is primarily due to the presence of organics.

The poorly graded sand layer was underlain by an organic rich layer of soil consisting of silty sand to silt with sand. It is believed that this layer marks the top of the pre-dam soil deposits. Based on recent explorations, silty soils within this unit range from medium stiff to very stiff in consistency, while sands portions of the soil unit are typically loose. This soil layer was observed to be 9 feet thick at the location of BH-3 and 11.2 feet thick at the location of BH-4. Previous explorations near the proposed cofferdam indicate this soil unit ranges from 5 to 21.5 feet thick. Laboratory testing of samples collected from BH-3 and BH-5 indicate this soil unit has a plastic limit of 60 and a liquid limit of 61.

Bedrock was encountered at the base of the sandy silt to silty sand soil unit in explorations BH-3 and BH-4. However, near the proposed sheet pile cofferdam, a layer of poorly graded sand with gravel and cobbles was encountered below the sandy silt to silty sand soil unit. This lower poorly graded sand layer ranged in thickness from 0.5 to 2.0 feet thick at this location. It is presumed that bedrock underlies the lower poorly graded sand near the proposed cofferdam at depths ranging from 21 to 40 feet.

3.3.3 Stabilized Sediment Slope

No subsurface explorations were conducted within the lower Carmel River arm during the preliminary geotechnical study. Previous explorations near this location indicate the recent alluvial soils consist of sand, silty sand, and sandy silt with thin interbeds of organic rich silt throughout the soil profile. The pre-dam alluvial soil occurs at depths ranging from about 44 to 68 feet below the ground surface. The thickness of the pre-dam alluvium is not known at this reach, but it is assumed that bedrock occurs at a depth of 65 feet based on available 1921 topographic contour maps. Pockets of gas were encountered in some borings located near the dam, which could potentially indicate the presence of decomposing highly organic soil (Kleinfelder, 2002).

3.3.4 San Clemente Creek

Based on the soils encountered in exploration BH-5, near surface soils of the San Clemente arm near the proposed bypass channel consist of recent alluvium consisting of loose, poorly graded sand with gravel to a depth of 15 feet. Sands and gravels in this soil unit are typically subangular to subrounded. Based on one sample, the natural moisture content of this soil unit is 11 percent.

The alluvial sand deposit is underlain by very dense, poorly graded gravel with sand. This soil unit is believed to mark the top of the pre-dam soils at the location of BH-5. This gravel unit extends from a depth of 15 to 17.5 feet below the ground surface where it is presumed to be underlain by bedrock.

3.3.5 Proposed Bypass Channel

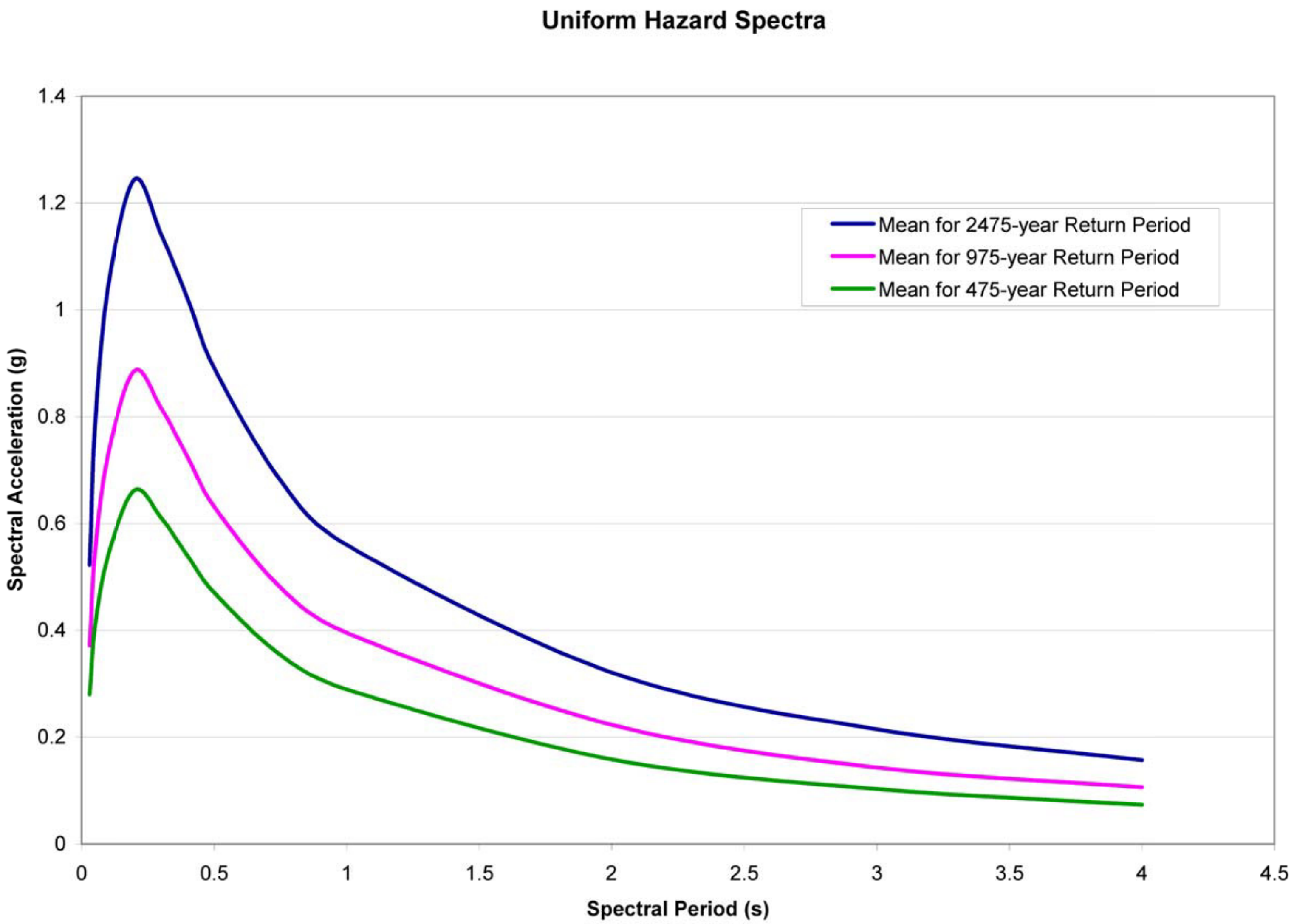
Based on rock core explorations BH-1 and BH-2, overburden soil within the footprint of the bypass channel consists of a soil and cobble strata approximately 14 feet thick. The underlying bedrock consists primarily of biotite rich diorite. Localized portions of the rock encountered were slightly metamorphosed, exhibiting gneissic texture. In general, the intact rock mass is moderately to highly weathered, moderately hard, moderately to very strong, and highly to intensely fractured. Low core sample recoveries were common throughout much of the rock explorations. Rock quality designations (RQDs) ranged from 0 to 77; however, RQDs of 25 or less were prevalent. Varying degrees of magnesium and iron oxide weathering, soil infilling, and chlorite were observed on the joint faces.

Selected core samples of intact rock were tested for unconfined compressive strength and point load compressive index. Laboratory test result indicate the unconfined compressive strength of the rock ranges from 10,241 to 26,312 pounds per square inch (psi) and the point load compression index ranges from 308 to 1,180 psi.

3.4 Groundwater Conditions

Due to the relatively free draining conditions, groundwater is expected to closely mimic the elevations of the reservoir, San Clemente Creek, and the Carmel River. Based on Carmel River data on file with the USGS (2007b), discharge levels at the time of these explorations are near the lowest of the year. Accordingly, the observations made during the explorations are expected to be typical of low groundwater conditions.

Groundwater was observed in exploration BH-3 at a depth of 4.3 feet, 1 day following the completion of the boring. Groundwater observations in explorations advanced using mud-rotary methods can be unreliable; however, this observation corresponded well with the elevation of the Carmel River near the exploration. Groundwater measurements were not taken in the remaining explorations.



MWH

CALIFORNIA STATE COASTAL CONSERVANCY

SAN CLEMENTE DAM
UNIFORM HAZARD SPECTRA

FIGURE 3-1

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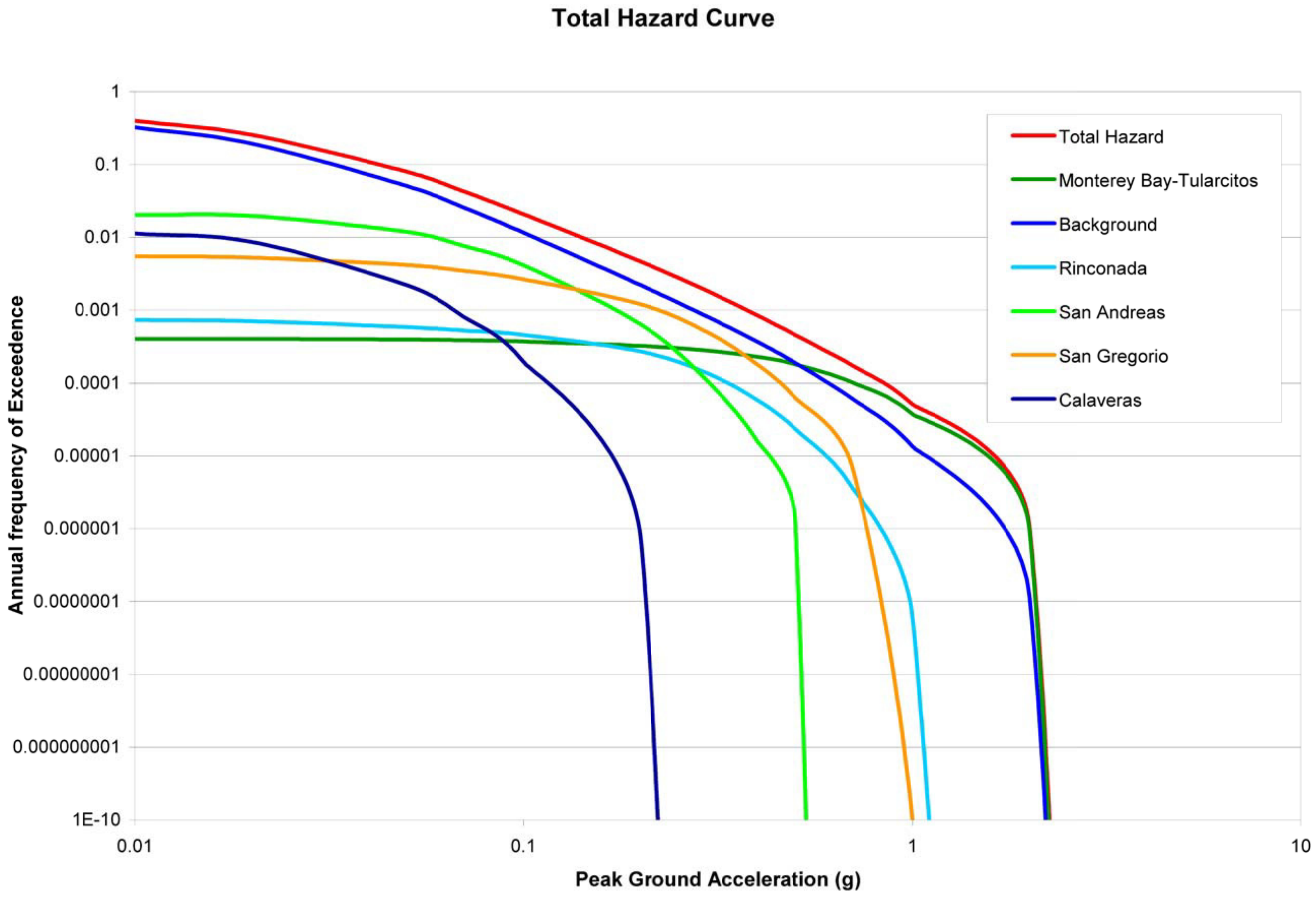


MWH

CALIFORNIA STATE COASTAL CONSERVANCY

SAN CLEMENTE DAM
TOTAL HAZARD CURVE

FIGURE 3–2

4.0 PRELIMINARY GEOTECHNICAL ANALYSES AND RESULTS

4.1 Overview

Geotechnical analyses and results are presented in **Sections 4.2** through **4.6** of this report. These analyses are based on the anticipated project features as described in the Draft EIR/EIS report (Entrix, 2006). Where appropriate, suggestions are made for additional study, more in-depth analyses, or potential project alternatives. As part of this study, analyses on the bypass channel, diversion dike, sediment slope, temporary sheet pile cofferdam, and combined flow reach were conducted. Descriptions of the analyses performed are presented in the following sections. Analyses are described in detail in Appendix D.

4.2 Bypass Channel

4.2.1 General

Based on the Draft EIR/EIS report, the proposed bypass channel will connect the two reservoir arms, approximately 2,500 feet upstream of the dam along the Carmel River (Entrix, 2006). The current channel design has a uniform width of 150 feet, is approximately 450 feet long, and has a downward gradient of 2.7 percent from the southeast to the northwest. The location and plan of the bypass channel are shown on **Figure 1-2**. A typical profile and cross-section are shown on **Figure 4-1**. The width and gradient of the bypass channel were determined based on the results of hydraulic analyses conducted by MEI (2005a and b). Initial designs call for constructing the side slopes of the bypass channel at 1H:1V. Based on this geometry, the bypass channel would require the excavation of approximately 234,000 cubic yards of rock and soil (MEI, 2005a).

The geotechnical analyses of the bypass channel include a preliminary assessment of the side slope stability and a preliminary assessment of rock excavation methods. Subsurface conditions considered for these analyses were based on the soil and rock profiles encountered in explorations BH-1 and BH-2. Soil and rock properties used in the analyses were based on the results of the laboratory testing program, the generalized Hoek-Brown rock strength criterion as determined using Rocscience's software RocLab version 1.0, and published values. Hoek-Brown rock strength parameters were established based on median laboratory test values and anticipated slope geometry, assuming mechanically excavated rock slopes. The seismic hazard potential for the bypass channel is considered to be low based on the classification system presented by USACE (1995), which considers risks such as loss of life, lifelines losses, property losses, and environmental losses. Seismic conditions were evaluated using pseudo-static slope stability methods.

4.2.2 Preliminary Side Slope Stability Analysis

Due to the large number of discontinuities observed in explorations BH-1 and BH-2, a stability analysis was conducted based on soil slope stability methods. This approach is more appropriate than traditional wedge failure rock slope stability analysis methods for highly fractured rock masses (Wyllie and Mah, 2006). Physical and strength properties used in the bypass slope stability analyses are presented in **Table 4-1**.

Based on the results of these analyses, the construction of the proposed bypass channel slopes is generally feasible. These preliminary slope stability analyses were based on limited subsurface information. Additional information will be required for the final slope design.

4.2.3 Rock Excavation Analysis

A preliminary analysis of potential rock excavation methods of the bypass channel was conducted. This analysis was based on the rock core conditions observed in explorations BH-1 and BH-2. Rippability analysis was conducted using the methods outlined by the USACE (1983).

Based on the results of the rippability analysis, most of the subsurface rock within the bypass channel is rippable at a rate of 500 cubic yards per hour using a Caterpillar Model DL8 tractor equipped with a single shank ripper. However, it is possible that blasting excavation techniques will be beneficial in the cost-effective removal of some portions of the rock mass. It is important to note that this analysis was based on empirical relations and limited field explorations. Further, it is recommended that actual excavation methods be determined by the construction contractor based on their equipment, expertise, and experience with similar conditions.

The size of aggregate material excavated from the proposed bypass channel will be highly dependent on the methods used. While discontinuities will control the size of aggregate produced in some portions of the excavations, rather large aggregate sizes will be possible in other portions. At the location of BH-1, it is anticipated that approximately 15 percent of the subsurface profile encountered could potentially be used for large aggregate that is presumed to be suitable for armoring streams and slopes. At the location of BH-2, approximately 65 percent of the subsurface profile is expected to be suitable for producing large aggregates suitable for riprap or armoring purposes.

A very rough estimate of the potential volume of large aggregate that could be excavated from the bypass channel can be conducted by making some substantial assumptions. It was assumed that 50 percent of the presumed suitable rock volume is lost in the production of large aggregate and riprap. Additionally, it was assumed that volume of the rock increased by 30 percent once it is excavated. Based on these assumptions, it is estimated that approximately 60,000 cubic yards of large aggregate or riprap will be produced during the excavation of the bypass channel.

In general, based on the conditions encountered, the proposed bypass channel excavation is expected to provide aggregate that is suitable for both the construction of the proposed diversion dike armoring and stream restoration applications.

4.3 Diversion Dike

4.3.1 General

Based on the proposed layout presented in the Draft EIR/EIS report, the diversion dike will be located in the Carmel River immediately downstream of the bypass channel, diverting the stream flow toward San Clemente Creek (Entrix, 2006). The location and general site plan of the diversion dike are shown on **Figure 1-2** and a typical cross-section is shown on **Figure 4-1**. Initial plans are to construct the diversion dike using rock excavated from the adjacent bypass channel. The diversion dike is currently designed with a 70 feet height (crest at El. 605), 50 feet crest width, and 330 feet base width. The dike was preliminarily envisioned to be constructed with a 2.5H:1V slope on the upstream side and 3H:1V slope on the downstream side.

This proposed layout was developed based on a cut-fill balance with the anticipated rock excavation of the proposed bypass channel, based on the knowledge of site conditions at the time of the Draft EIR/EIS report. Accordingly, adjustments to the proposed layout are expected prior to final design in order to meet the requirements of the diversion dike and based on the actual amount of rock fill available from the proposed bypass channel.

Additional modifications to the diversion dike geometry may be necessary to meet project requirements such as improving aesthetics, minimizing crest elevation, and promoting vegetation growth. For instance, a benched rock fill diversion dike comprised of a shell made of alluvial soils and a rock core would be more likely to promote the growth of vegetation on the dike slopes when compared to the currently envisioned homogenous rock fill dike. However, this type of dike would require a more labor-intensive granular filter construction process, and may require flatter slopes to maintain slope stability. Accordingly, MWH recommends that alternatives evaluations are conducted in the next phase of design to evaluate the dike type and geometric layout that best suits project requirements.

Previous site evaluations have established the PMF elevation at the location of the diversion dike to be El. 566 (MEI, 2005a). This PMF elevation includes additional super-elevation due to the sharp diversion in the stream at this location (MEI, 2005a). The upstream slope of the dike located below will be armored with riprap to protect it from scour resulting from water flow reaching this elevation. A graded granular filter will be required to reduce the risk of internal erosion of the dike fill through the riprap armoring and along the foundation soil-rock fill interface. Specific filter criteria were not analyzed as part of this study. Stream erosion, seepage and internal erosion of the foundation soils may need to be mitigated. One potential mitigation method could include the construction of the currently proposed 2-foot wide cement-bentonite cutoff trench at the upstream toe of the dike. The cutoff trench will be approximately 200 feet long and will extend to bedrock, which is estimated to be up to approximately 50 feet below the current ground surface. The proposed cutoff trench will also act to impound water within the constructed wetland located in the abandoned Carmel River arm.

Several analyses of the proposed diversion dike and foundation were conducted, including bearing capacity, settlement, liquefaction potential, and slope stability. Soil strength parameters were based on collected field data and laboratory testing, and were calculated using established relationships with standard penetration test (SPT) blow counts, relative density, and Atterberg limits. A summary of the soil and rock properties used in the analyses of the diversion dike are presented in **Table 4-3**. For the purpose of these analyses, the seismic hazard potential for the diversion dike is considered to be low based of the classification system presented by USACE (1995), which considers risks such as loss of life, lifelines losses, property losses, and environmental losses.

Table 4-3: Summary of Soil Properties for Diversion Dike Analyses

Soil Unit	Total Unit Weight (pcf)	Friction Angle (degrees)	Friction Angle 20 Percent Reduction for Post Liquefaction Conditions	Cohesion (psf)
Rock Fill	145	42	34	0
GW	116	31	25	0
SP-1	116	31	25	0
SP-SM-1	121	32	26	0
SP-SM-2	130	35	28	0
SM-2	119	31	25	0
ML	132	36	29	0
Cement-Bentonite	122	0	0	1,000

4.3.2 Bearing Capacity

The geotechnical analyses included an evaluation of the bearing capacity of the soil underlying the proposed diversion dike. Bearing capacity calculations were performed following Meyerhof's general bearing capacity equation. Based on the proposed dike geometry and the soil properties listed in **Table 4-3**, the foundation soils have an ultimate bearing capacity of approximately 100 tons per square foot. This results in a factor of safety against bearing capacity failure of 20. Accordingly, the subsurface soil will provide adequate support with respect to bearing capacity. Detailed bearing capacity calculations are presented in Appendix D.

4.3.3 Settlement Analysis

The following conditions were used in the execution of the settlement analysis for the proposed diversion dike:

- The subsurface conditions were based on explorations BH-3 and BH-5, which were conducted within the footprint of the diversion dike.
- Consolidation properties of fine grained soil units were based on soil properties at the locations of the explorations, published values, and engineering relationships. One-dimensional consolidation testing was not conducted on any of the soil units encountered.
- All soil units underlying the diversion dike are assumed to be normally consolidated.
- Stress distributions induced by loads at the ground surface were established using a graphical solution of the Boussinesq's equation for embankments. Boussinesq's equation assumes that stresses are distributed through a homogeneous, elastic, perfectly plastic, semi-infinite half space.

The diversion dike settlement analyses indicate that settlements below the crest of the diversion dike will be on the order of 1.6 feet including immediate settlement, consolidation settlement, and estimated secondary creep. Approximately 0.7 feet of this estimated settlement is expected to occur shortly following the completion of construction. The remaining 0.9 feet of settlement is expected to occur over a prolonged period of time following construction. Detailed settlement calculations are presented in Appendix D.

Given the considerable height of the proposed diversion dike, and its proposed construction using a homogonous rock fill without an impermeable core, this magnitude of settlement is not anticipated to have adverse effects on the dike's performance. Generally, this magnitude of settlement can be accounted for by increasing the constructed elevation of the embankment by the amount of the anticipated settlement. Utilizing this approach, the appropriate crest elevation is achieved once settlement occurs.

The magnitude of settlement could be reduced by lowering the crest of the embankment. Preliminary calculations indicate that by reducing the crest elevation of the diversion dike to El. 570 (4 feet above the elevation of the PMF), the total magnitude of settlement would be reduced by approximately 40 percent. Details of these calculations are presented in Appendix D.

4.3.4 Liquefaction Analysis

Liquefaction is a process where soils undergo significant loss of strength when subjected to large, cyclic ground motions or vibrations associated with earthquakes. Cyclic loading of saturated, non-cohesive soils can lead to a build up of excess pore water pressure in the soil mass. Loads are transferred from the soil grains to the pore water under saturated, undrained conditions during earthquake shaking, consequently reducing the shear strength of the soil.

Saturated, loose, granular soils without cohesive fines such as gravels, sands, and some silts are particularly susceptible to liquefaction. Research suggests that the major factors affecting the potential for soil liquefaction are density; amplitude of loading; confining pressure; past stress history; age of soil deposit; size, shape, and gradation of particles; and the fabric of the soil. Liquefaction induced ground settlement and lateral spreading can cause extensive damage to above-ground structures, foundations, embankments, and pipelines during major earthquakes.

Liquefaction analyses were based on a median PGA on bedrock of 0.37 g with return period of 975 years, as determined by the PSHA (refer to **Section 3.2.3**). A ground surface PGA was calculated to account for the amplification effect of the loose sand substrate using the methods developed by Seed et al. (1994). The site's shallow bedrock is overlain by a primarily cohesionless soil profile that fits a seismic site class B using this method (unrelated to building code site classes). Based on this site class, the soil profile will slightly amplify the mean peak rock ground acceleration, corresponding to a ground surface PGA of 0.40 g.

Susceptibility to liquefaction was determined using the procedures set forth by the 1996 NCEER and 1998 NCEER/NSF workshops, using SPT blow counts from BH-3 and BH-4, and laboratory testing results.

The combination of the proximity of nearby faults, shallow groundwater conditions, and loose alluvial deposits composed of predominately sandy soils, results in a significant potential for liquefaction-induced settlement at the location of the proposed diversion dike, approximately 7 to 8 inches. It should be noted, however, that estimation of liquefaction induced settlements are imperfect and accordingly the dike may settle more or less under actual seismic loading. Therefore, conservative design should be employed when using the estimated settlements. Detailed liquefaction calculations are presented in Appendix D.

Mitigation measures could be implemented to reduce the effects of liquefaction-induced deformations during a design seismic event. Given the proposed construction materials and diversion dike geometry, liquefaction induced settlement, slope instability, or lateral spreading are not likely to have a significant influence on the effectiveness of the diversion dike. If required, potential liquefaction mitigation measures could include methods to increase the density or strength of the foundations soil, or by adjusting the geometry of the diversion dike to account for the effects of liquefaction.

Mitigation methods that increase the density of the foundation soil could include methods such as dynamic compaction, vibro-compaction, stone columns, or vibro-concrete columns. Dynamic compaction, or deep dynamic compaction, is a relatively cost-effective method of densifying subsurface soil that works well in soils with limited amounts of silt and clay. This process consists of dropping a large weight from a crane repetitively. Vibro-compaction methods use a vibration probe to densify cohesionless soils. As the vibration passes through the soil profile, loose, saturated cohesionless soils are rearranged into a more compact state. Similarly, stone columns and vibro-concrete columns utilize a probe to densify the subsurface soil. However, as the probe is extracted, the void left behind by the probe is backfilled with compacted stone or concrete.

Examples of mitigation methods that increase the strength of the foundation soils could include permeation grouting or deep soil mixing. Permeation grouting is conducted by injecting of low viscosity cement grout or chemical fluids into soils pore space at low pressures to bind soil particles together. Deep soil mixing uses specialized construction equipment to mix cement with the subsurface soil to increase the strength of the soil. Both of these methods also have the added benefit of reducing the permeability of the soil, which would help to impound water within the proposed wetland to be located within abandoned portion of the Carmel River arm.

Based on the data presented by MEI (2005a), the depth of the Carmel River near the diversion dike is expected to be 0.3 feet during median flows, and 3.0 feet during the 2-year peak discharge, and 14.3 feet during the 100-year peak discharge. Further, the likelihood that the effective crest height would be reduced to less than 14.3 feet due to liquefaction, given the current geometry, is presumed to be negligible. Accordingly, it is likely that the dike would still perform as intended following liquefaction. Thus, reconstruction of the dike following a liquefaction induced failure should be considered as a viable mitigation option.

Additionally, modifications to the diversion dike's geometry could account for the anticipated liquefaction conditions. Additional analyses may indicate that reducing the slopes of the diversion dike, construction of a rock fill key, or constructing a reinforcing buttress at the toe of the diversion dike, could potentially eliminate the need for more expensive mitigation measures. It is recommended that further analyses be conducted to evaluate the need for liquefaction mitigation and the feasibility of potential mitigation methods.

4.3.5 Diversion Dike Slope Stability

Preliminary slope stability analyses of the diversion dike slopes were conducted using GeoStudio's slope stability software SLOPE/W Version 5.2, using the Morgenstern-Price limit equilibrium method. Analyses were performed assuming the diversion dike geometries presented in the Draft EIR/EIS report (Entrix, 2006).

The following conditions were evaluated during the slope stability analyses of the diversion dike:

- **Static Stability Analyses:** The first analyses of the diversion dike slopes considered static slope stability conditions. The static slope stability analyses assumed that groundwater levels are at normal elevations and that no earthquake-related forces acted on the slopes. Normal groundwater elevations were considered to be at El. 540, based on the data presented by MEI (2005a).

- **PMF Stability Analyses:** The diversion dike was evaluated under PMF conditions. Our analyses were based on the data presented by MEI (2005a), which indicate that water elevations on the upstream side of the diversion dike will reach El. 566, including super elevation of the water due to a sharp bend in the stream.

- **Pseudo-Static Conditions:** Pseudo-static conditions were evaluated for both faces of the proposed diversion dike. These analyses are used to determine the stability of the dike during a design-level earthquake event. For the purpose of these analyses, a return period of 975 years was used to determine a PGA on rock. The PGA was adjusted for the amplification effects of the soil column using a relationship developed by Seed et al. (1994), resulting in a PGA on soil of 0.4. This PGA would correspond to a pseudo-static coefficient ranging from 0.13 to 0.2 g based on the relationships developed by Marcuson and Franklin (Abramson et al., 1996). This corresponds well with the USACE's recommendation for a great earthquake, 0.15 g, which has been adopted for the analyses of the diversion dike slopes.

  For the purpose of the pseudo-static dike stability analyses, a typical groundwater elevation was El. 540 was selected based on the data presented by MEI (2005a).

  Pseudo-static analyses are limited to slopes that are not susceptible to liquefaction. As indicated previously in **Section 4.3.4**, the foundation soils underlying the diversion dike have been determined to be susceptible to liquefaction. Accordingly, these pseudo-static analyses assume that the foundation soils have been mitigated with respect to liquefaction. In is not possible to predict deformations of a slope with liquefied soil during an earthquake event without the use of complex analyses using non-linear finite-element or finite difference codes. This type of analysis is not included as part of the scope of work of this feasibility level report.

- **Post-liquefaction Stability Analyses:** Post-liquefaction stability analyses were conducted on both faces of the proposed diversion dike. This approach is based on the assumption that there are no outside forces acting on the slope, and that excess pore pressures remain within the liquefied soils. Soil strength parameters are reduced by 20 percent for all soil units excluding those subject to liquefaction. Soils susceptible to liquefaction are assigned a lower bound residual shear strength and the slope is then analyzed in accordance with the methods used for static slope stability analysis.

- **Post-earthquake Deformation Analyses:** Post-earthquake deformation analyses of the diversion dike slopes were conducted using Makdisi and Seed's simplified approach to the Newmark method. This simplified approach is used to predict permanent slope displacements due to seismic events. This approach assumes that liquefaction does not occur, and is applicable for slopes that have a factor of safety significantly greater than

Table 4-1: Summary of Soil and Rock Properties for Bypass Channel Side Slopes

Material	Total Unit Weight (pcf)	Angle of Internal Friction (degrees)	Cohesion (psf)
Overburden Soil	129	36	0
Rock Mass	160	44	4,900

The bypass channel side slope stability was analyzed considering two rock slope geometric models. First, rock units were modeled based on initial slope designs using 1H:1V slopes within the rock mass. The second model was conducted with a steeper slope of 0.75H:1V within the rock mass. In both instances, overburden soils were modeled at a slope of 2H:1V.

The slope stability analyses considered both deep-seated failures (failures that extend through the rock mass) and shallow failures (failures occurring primarily through the overburden soil). Stability calculations were conducted using the computer program SLOPE/W Version 5.2 by GeoStudio International following the Morgenstern-Price limit equilibrium method.

The horizontal pseudo-static seismic coefficient was determined based on the PGA of 0.37 g using a return period of 975 years as described in **Section 3.2.3.** Relationships presented by Marcuson and Franklin suggest that pseudo-static coefficients should range from 1/3 to 1/2 of the PGA, resulting in a pseudo-static coefficient of 0.12 to 0.19 g (Abramson et al., 1996). This corresponds well with the USACE's recommendations for a great earthquake, which suggests a pseudo-static coefficient of 0.15 g. For the purpose of this study, the recommendations presented by the USACE for a great earthquake will be adopted. Detailed slope stability calculations, stability plots, and numerical results are presented in Appendix D.

The results of the preliminary bypass channel side slope stability analyses are presented in **Table 4-2**. Results indicate the slope within the overburden soils has a factor of safety of 2.0 under static conditions and 1.4 under pseudo-static conditions. Analyses of deep-seated failures indicate that a rock slope of 1H:1V would have a factor of safety of 3.1 against a deep-seated failure under static conditions and 2.4 under pseudo-static conditions. In comparison, constructing a steeper 0.75H:1V rock slope would have a slightly lower factor of safety of 2.8 under static conditions and 2.3 under pseudo-static conditions. Accordingly, slopes within the rock mass of the bypass channel would be stable at slopes of 0.75H:1V. After additional exploration and analysis, a more detailed slope stability analysis should be conducted. Future analyses could indicate the potential for constructing even steeper slopes, which would reduce excavation volumes and potentially reduce project costs.

Table 4-2: Summary of Preliminary Bypass Channel Side Slope Stability Analysis

Slope	Static Factor of Safety	Pseudo-Static Factor of Safety
1H:1V (Shallow Failure)	2.0	1.4
1H:1V (Deep Failure)	3.1	2.4
0.75H:1V (Shallow Failure)	2.0	1.4
0.75H:1V (Deep Failure)	2.8	2.3
FERC Recommended Factor of Safety Minimum (US Society of Dams (USSD), 2007; Federal Emergency Management Agency [FEMA], 2005)	1.5	>1.0

one following a seismic event. Further, this approach assumes that the seismic event is large enough to reduce the slope's factor of safety to 1.0.

Results of the preliminary slope stability analyses of the diversion dike are presented in **Table 4-4**. A more detailed description of the diversion dike slope stability analyses is presented in Appendix D.

As shown in **Table 4-4**, analyses indicate the diversion dike is not stable under liquefied soil conditions. Due to the limits of the theories applied in these analyses, it is impossible to determine how this instability would influence the ability of the dike to function as designed. However, it should be noted that the diversion dike would not be retaining any significant amounts of water during normal operating conditions. The retention of significant volumes of water would be limited to relatively short periods, such as during a PMF. Further, even during the PMF, water would be directed into the bypass channel, rather than being stored behind the diversion dike. Accordingly, the diversion dike is not a structure that would pose an incremental safety risk downstream if it were to incur significant damage and deformation due to liquefaction during an earthquake.

Should mitigation measures be deemed appropriate for the foundation soils of the diversion dike, potential methods could include adjustments to the dike geometry, over-excavation of liquefiable foundation soils, construction of a key trench, or soil improvement measures. Soil improvement measures could potentially include methods such as dynamic compaction, deep soil mixing, vibro-flotation, stone columns, or other methods.

Based on current understanding of the structure, the proposed diversion dike is generally feasible. It is recommended that additional analyses be conducted to evaluate the suitability of specific diversion dike geometries and soil improvement models prior to finalizing the diversion dike design. Additionally, finite element or finite difference analyses should be conducted to estimate the deformations of the dike under liquefied soil conditions during an earthquake to help determine the final dike geometry and the need for mitigation measures.

Table 4-4: Summary of Preliminary Diversion Dike Slope Assessment

	Condition Analyzed					
Slope	**Static Stability Analysis (Safety Factor)**	**PMF Stability Analysis (Safety Factor)**	**Pseudo-Static Stability Analysis* (Safety Factor)**	**Post-Liquefaction Stability Analysis (Safety Factor)**	**Post Earthquake Deformation* (feet of Permanent Displacement)**	
					Min	**Max**
Down Stream (3H:1V)	2.3	2.1	1.4	0.8	0	0
Upstream (2.5H:1V)	1.8	1.9	1.2	0.7	0.2	1.0
FERC Recommended Factor of Safety Minimum (USSD, 2007; FEMA, 2005)	1.5	1.5	>1.0	1.2	N/A	

* Assumes non-liquefied conditions

4.4 Sediment Slope Stabilization

Based on MWH conceptual design in the Draft EIR/EIS report, sediments within the Carmel River arm located east of the dam will be cut to a slope of 4H:1V. The slope will be graded to match the elevation of the newly realigned stream at the toe and the existing sediment elevations at the slope crest. The resulting slope will be approximately 77 feet high, extending from a toe at El. 450 to a crest at El. 527 (Entrix, 2006).

The slope will be stabilized using deep soil mixing methods as shown on **Figure 4-2**. Deep soil mixing involves mixing a binding agent with the in-place sediments using specialized construction equipment. This method forms high strength, low permeability columns of soil, which can be overlapped to form a relatively impermeable barrier. As seen on **Figure 4-2**, a series of columns, extending to the bedrock surface to form a network of cells, is proposed for the sediment slope. In this configuration, the soil-cement columns provide stability to the slope and form a low permeability barrier. The barrier is intended to retain water in the remaining sediments to facilitate a new wetland within the abandoned Carmel River arm.

Preliminary slope stability analyses of the stabilized sediment slope were conducted using GeoStudio's SLOPE/W Version 5.2 software using the Morgenstern-Price limit equilibrium method. Soil parameters used for these analyses were based on the information presented in Kleinfelder's boring logs (2002), published values presented by FHWA (2000), and relationships with SPT blow counts. Soil properties used in these analyses are presented in **Table 4-5**. Groundwater was El. 530 at the top of the slope. It was assumed that the wall formed by the deep soil mixing columns will effectively reduce the flow of water from the proposed wetland area toward the slope. Accordingly, groundwater elevations within the sediment slope are expected to drop to the elevation of the stream located at the toe of the slope, which corresponds to a groundwater elevation of about 450 (Entrix, 2006).

Table 4-5: Summary of Soil Properties for Stabilized Sediment Slope

Soil Unit	Total Unit Weight (pcf)	Friction Angle (degrees)	Cohesion (psf)
SP-1	108	29	0
ML	112	30	0
SP-2	117	31	0
Soil Concrete Column	130	0	10,000

The stabilized sediment slope was evaluated under both static and seismic conditions. The seismic hazard potential for the sediment slope is considered to be low based of the classification system presented by USACE (1995), which considers risks such as loss of life, lifelines losses, property losses, and environmental losses. Pseudo-static seismic coefficients for the stabilized sediment slope were based on the USACE's recommendations for a great earthquake, resulting in a coefficient of 0.15 g. Detailed slope stability calculations, stability plots, and numerical results are presented in Appendix D. Factors of safety for the stabilized sediment slope under static and pseudo-static conditions are presented in **Table 4-6**.

Table 4-6: Summary of Stabilized Sediment Slope Assessment

Slope	Factor of Safety Condition Analyzed	
	Static	Pseudo-Static
4H:1V	2.4	1.5
FERC Recommended Factor of Safety Minimum (USSD, 2007)	1.5	>1.0

Results of these analyses indicate that the stabilized sediment slope meets the recommended stability criteria set forth by FERC under both static and pseudo-static conditions given the assumptions stated herein.

It is recommended that additional site investigations, laboratory testing, and field testing of soil stabilization be conducted to confirm the conditions assumed in this analysis prior to final design of this slope. Further, it is recommended that additional analyses of the proposed sediment slope be conducted to evaluate alternate slope designs and stabilization methods to determine the most economical approach. Alternate stabilization methods could include, flattening the sediment slope, reinforced slopes, constructing a rock buttress at the base of the slope, soil improvement methods such as stone columns, or reconstructing the slope with on-site materials placed as structural fill.

4.5 STREAM DIVERSION AND DEWATERING

4.5.1 General

The proposed CRRDR project would require temporary stream diversion and dewatering measures. Initially, stream flow from the Carmel River would be impounded by a temporary sheet pile cofferdam. Water impounded by the cofferdam will be collected and pumped down stream of the project for the duration of construction activities. A second temporary cofferdam, likely consisting of sheet piles or a small earthen embankment, would be required to collect the seasonal flows of San Clemente Creek for the duration of the construction project. Similar to the system proposed for the Carmel River arm, water collected by a cofferdam within the San Clemente arm would be pumped downstream of the construction site when stream flow occurs. Analyses of cofferdams within the San Clemente arm were not part of the current scope of work and have not been included as part of this study.

4.5.2 Stream Diversion

Project plans call for constructing a temporary sheet pile cofferdam upstream of the proposed bypass channel and diversion dike to facilitate dewatering within the construction area. A geotechnical analysis of the sheet pile cofferdam was conducted for the purposes of developing a preliminary sheet pile design criteria.

The design soil profile for this analysis consists of poorly graded sands extending from the ground surface to a depth of 12 feet. This soil unit is underlain by poorly graded sand with a silt soil unit that extends to the top of bedrock. A summary of the physical properties and strength parameters used in this analysis is presented in **Table 4-7**. Physical soil properties and strength parameters were based on interpretation of boring logs presented in Kleinfelder's 2002 sediment characterization study, published values, and established relationships with SPT blow counts.

The seismic hazard potential for the temporary stream diversion is considered to be low based of the classification system presented by USACE (1995), which considers risks such as loss of life, lifelines losses, property losses, and environmental losses. No geotechnical borings were conducted at the location of the proposed temporary sheet pile cofferdam as part of this study.

Table 4-7: Summary of Soil Properties for Sheet Pile Cofferdam

Soil Unit	Total Unit Weight (pcf)	Friction Angle (degrees)	Cohesion (psf)
SP	130	31	0
SP-ML	115	28	0

In order to limit the amount of water passing through the cofferdam, the preliminary analysis has all sheet piling driven to bedrock or slightly imbedded into decomposed bedrock. The depth of water impounded by the cofferdam is assumed to be 10 feet above the ground surface or less. All active, passive, and at-rest soil pressures were calculated using Rankine's theory of lateral earth pressures.

Preliminary design criteria for the design of the temporary sheet pile cofferdam are presented on **Figure 4-3**.

It is important to note that these criteria are based on presumed site conditions, which have not been verified by subsurface explorations at the location of the cofferdam. If large materials such as cobbles and boulders are encountered at the location of the proposed cofferdam, alternate cofferdam designs such as earthen cofferdams with an impermeable cutoff trench, may be more easily constructed.

Modifications the sheet pile cofferdam criteria presented herein will be required to account for the conditions encountered during future subsurface explorations. The conditions encountered during explorations may warrant adjustments to the proposed sheet pile cofferdam. One potential sheet pile cofferdam modification could include adding a reinforcing berm to increase the strength and decrease seepage volumes of the proposed cofferdam. Further, additional analyses of alternate cofferdams may reveal a more economical approach.

4.5.3 Dewatering

Once the cofferdams are in place, the reservoir will be dewatered prior to the planned construction activities. Based on the conditions encountered at the site, subsurface soils are conducive to a number of dewatering methods such as wellpoints, suction wells, or deep wells. A comparison of each of these methods is presented in **Table 4-8**.

According to Freeze and Cherry (1979), piping, or internal soil erosion, will likely occur in most soils when the hydraulic gradient is greater than one (unit length per unit length). In general, the USACE (2000) recommends maintaining an exit face gradient of less than 0.5. The sediments present at the site are predominately comprised of granular soil with little to no plastic fines. Granular soils, like those observed at the site, typically have moderate to high permeability and are very sensitive to seepage pressures. These properties can commonly lead to instability of subgrades and unsupported slopes due to piping (Powers, 1992; US Army, et al., 1985).

Accordingly, open pumping dewatering methods, such as dewatering from sumps, ditches, trenches, or excavations, are not recommended for primary dewatering systems based on the conditions encountered at the locations of the subsurface explorations. Open dewatering methods should be used sparingly and limited to dewatering of small localized areas with minimal flows where the consequences resulting from slope failure or subgrade instability are insignificant. However, additional subsurface explorations may indicate that these dewatering methods may be feasible at some locations across the site.

Based on the soil conditions encountered at the site, the anticipated dewatering operations will be feasible using one or more methods. Suitable methods could include, but are not limited to, well points, suction wells, or deep wells as mentioned previously. Selection and design of a dewatering system will depend on a number of factors including the rate of construction, the use of shoring, and the dewatering system used. It is strongly recommended that the dewatering system design be the contractor's responsibility, because the contractor will have control of construction means and methods. This will allow the contractor to provide a dewatering system that is compatible with construction and shoring methods.

Water collected in dewatering systems must be disposed of in an appropriate manner. It is recommended that this water be pumped down stream of the construction site through a temporary pipeline. Typically, some level of water quality treatment to remove silt and debris is necessary prior to discharging the water back into the stream. Additionally, it is likely that permits from local, state, and federal regulatory agencies will be required. It is recommended that additional analyses of water disposal alternatives and water discharge permitting requirements be conducted.

Table 4-8: Comparison of Dewatering Methods*

Characteristic	General Suitability of Dewatering Method		
	Wellpoint Systems	Suction Wells	Deep Wells
Clean Sands	Good	Good	Good
High Permeability Soils	Good	Good	Good
Remote Recharge Source	Good	Good	Good
Rapid Drawdown	OK	OK	Very Poor
Slow Drawdown	OK	OK	OK
Shallow Drawdown (Less Than 20 feet)	OK	OK	OK
Deep Drawdown (Greater Than 20 feet)	OK with Multiple Stages	OK with Multiple Stages	OK
Typical Spacing	5 to 10 feet	20 to 40 feet	Greater than 50 feet
Typical System Capacity	0 to 5,000 gpm	2,000 to 25,000 gpm	0 to 60,000 gpm
Relative Efficiency	Good	Good	Fair

Note:
* Adapted from Powers, 1992.

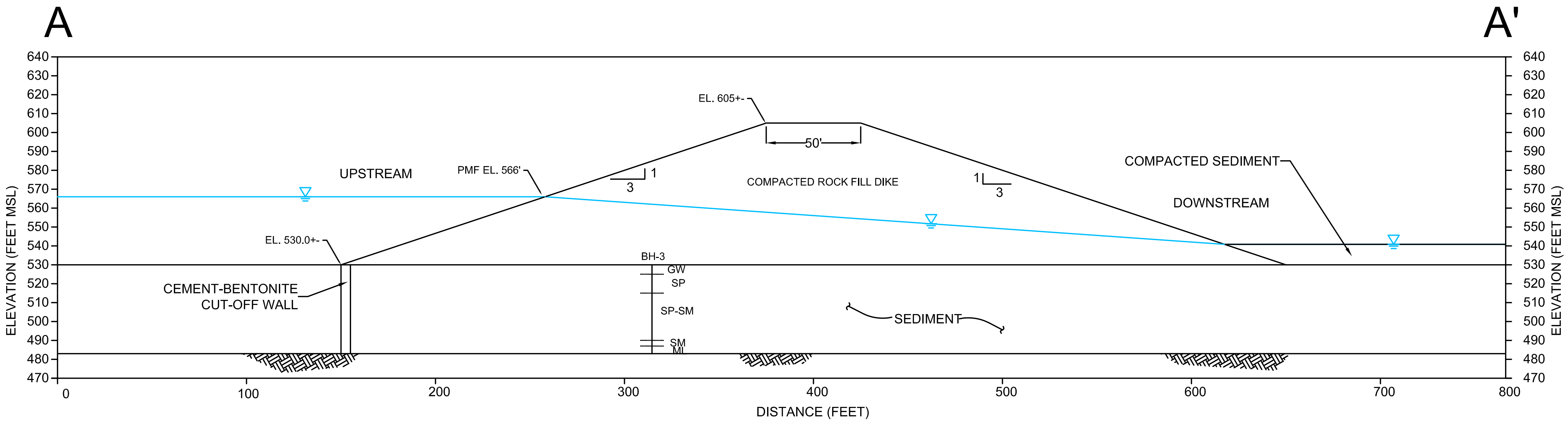
4.6 Combined Flow Reach Qualitative Assessment

A qualitative stability assessment of the San Clemente Creek drainage was conducted between the proposed bypass channel and the San Clemente Dam. The purpose of this qualitative analysis was to provide a preliminary evaluation of the effects that additional water flow through the drainage resulting from the diversion of the Carmel River might have on the stability of the adjacent slopes. The analysis was conducted to address specific concerns regarding erosion or undercutting of sediment, original alluvium (pre-dam soil deposits) and destabilization of rock faces that could potentially result in channel migration, substantial blockage and rerouting of the combined stream, significant turbid water releases, or a combination of two or more of these concerns.

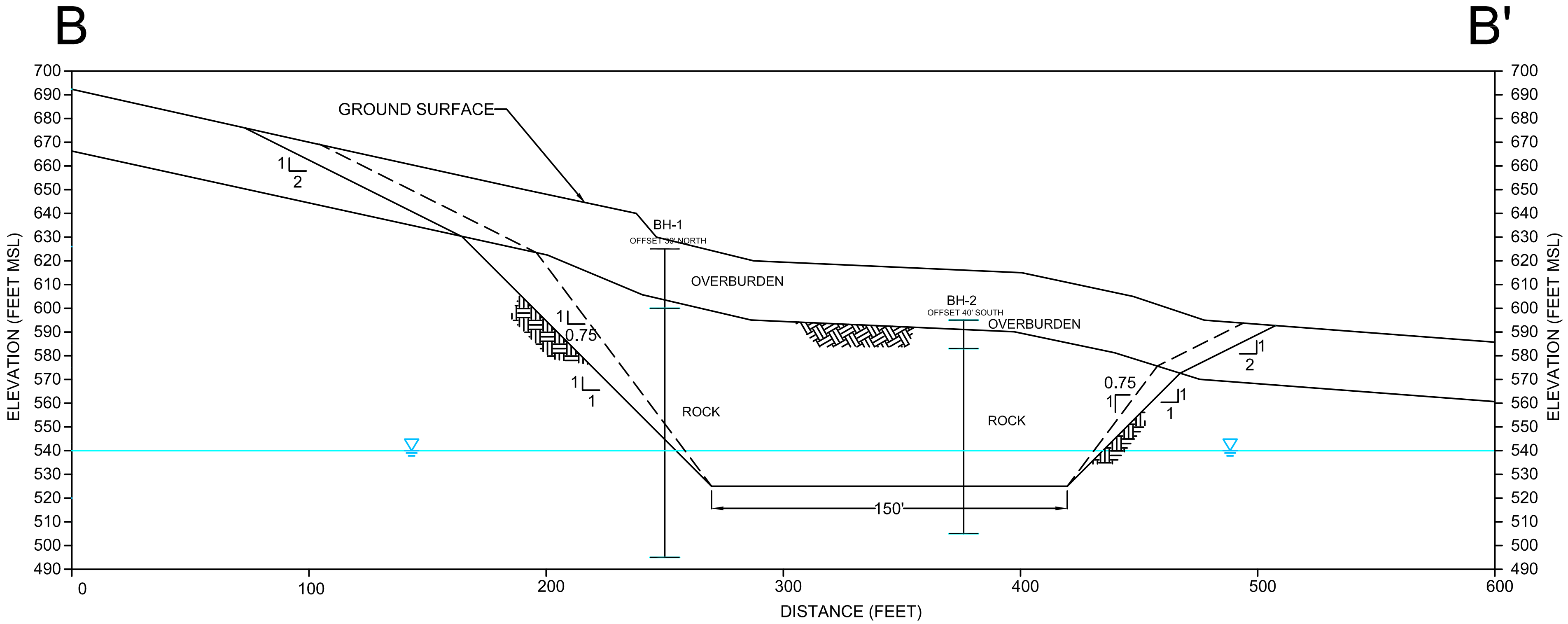
The qualitative slope stability assessment took into consideration the proposed stream channel and channel gradient, steepness of adjacent slopes, geologic conditions, and proposed grading operations with respect to the pre-dam ground surface within the combined flow reach. As part of this assessment, data collected from a geological reconnaissance of the combined flow reach and available published data were utilized to assign impact risk levels. The combined flow reach was divided into 10 areas based on similar properties associated with slope stability and erosion. Each of the areas where then qualitatively evaluated for risk of substantial landsliding or erosion for four categories: stream orientation and gradient, slope steepness, geologic conditions, and proposed channel regrading. Each category was assigned a value with an associated risk level 1 for low risk, 2 for moderate risk, and 3 for high risk of significant landsliding or erosion. The risk values were then summed to provide a total risk level. The total risk level had a possible range from 4 to 12. This potential range was divided into 3 equal categories: 4 to 6.7 for low risk, 6.8 to 9.3 for moderate risk, and 9.4 to 12 for high risk.

The results of the qualitative stability assessment are presented on **Figure 4-4**. The qualitative combined flow reach stability assessment indicates that half of the defined areas qualify as low risk, while the other half qualify as moderate risk. The area located west of the dam, and the areas located directly down stream of the proposed bypass channel were identified as moderate risk areas. The areas generally located near the center and the northern portions of the combined flow reach were identified as low risk.

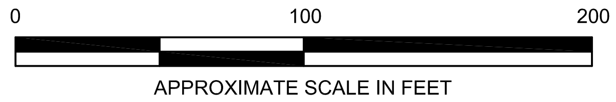
It is important to note that the risk level of each defined area was assessed qualitatively and was based on the likelihood of an event of significant erosion or instability, in comparison to the other defined areas. Accordingly, a classification of low risk would not necessarily indicate that an area is immune to erosion or instability. Further, an area defined as high risk would not necessarily indicate that erosion or instability is imminent.



DIVERSION DIKE AND SEDIMENT PILE TYPICAL CROSS-SECTION



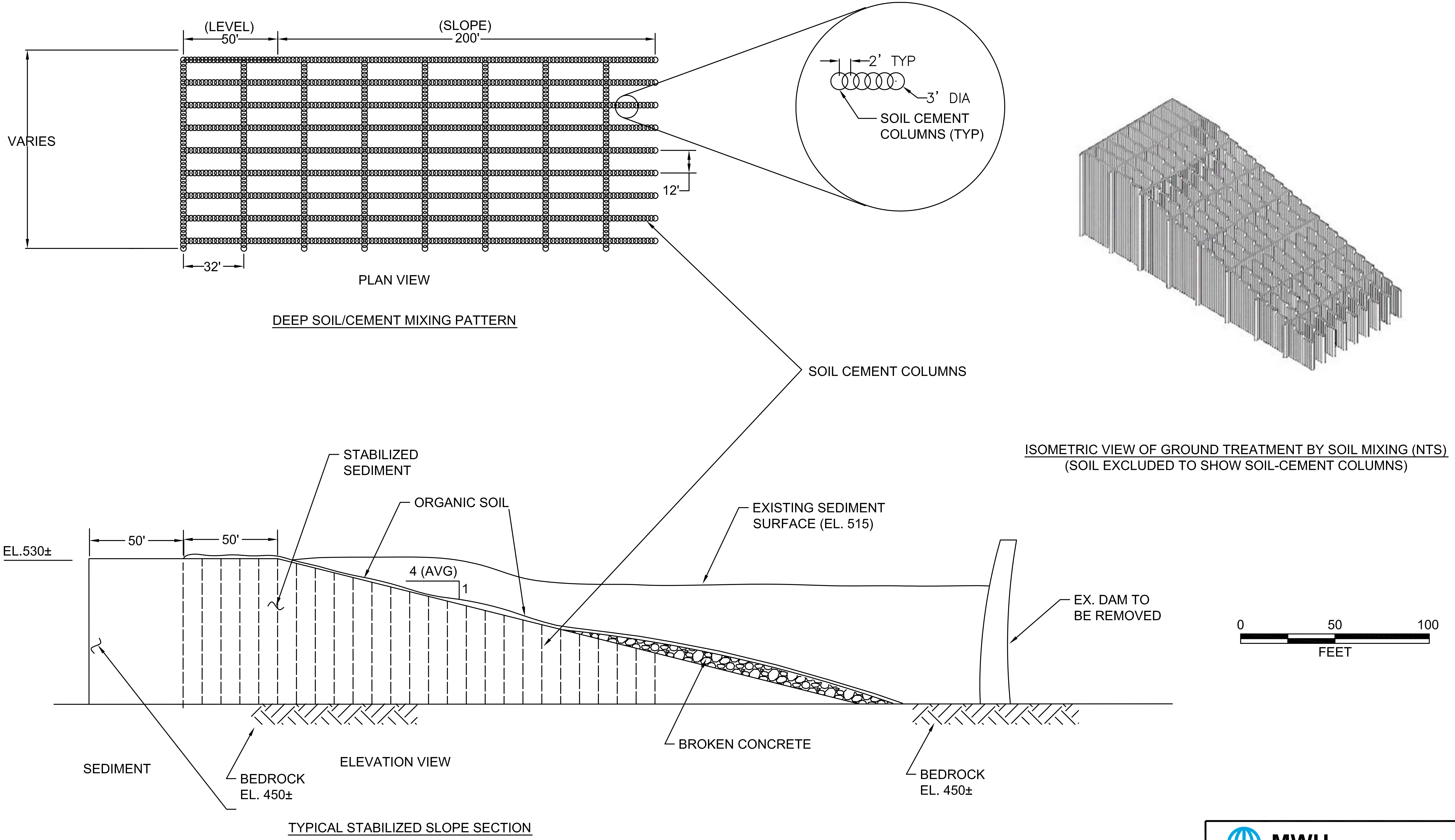
DIVERSION CHANNEL TYPICAL CROSS-SECTION



MWH

CALIFORNIA STATE COASTAL CONSERVANCY

SAN CLEMENTE DAM
DIVERSION DIKE AND BYPASS CHANNEL
TYPICAL CROSS SECTIONS
FIGURE 4-1



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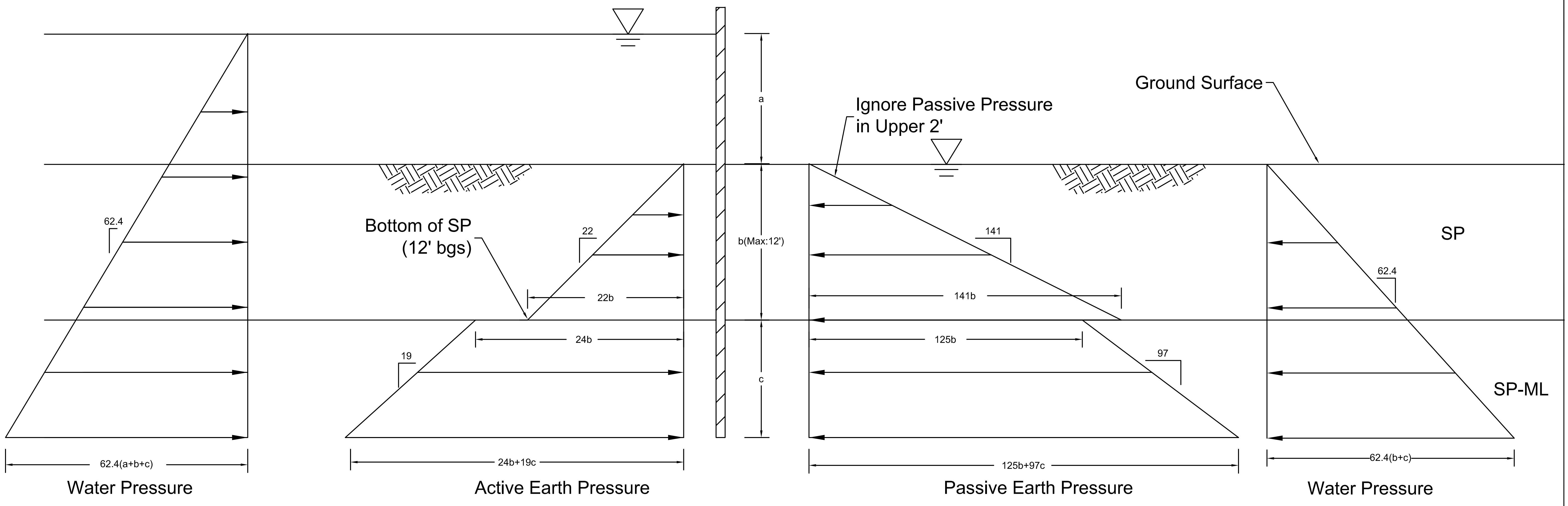
CALIFORNIA STATE COASTAL CONSERVANCY

SAN CLEMENTE DAM
STABILIZED SEDIMENT SLOPE
CROSS SECTION
FIGURE 4–2



Note

1. The values above assume a horizontal ground surface.

2. A factor of safety 1.5 was included in the passive earth pressure coefficients.

3. The pressure diagrams shown above are based on boring logs and SPT data conducted by Kleinfelder (2002).

4. Sheet pile wall embedment depth shall be determined by satisfying moment equilibrium at the bottom of pile.

5. Passive earth pressure in upper 2' shall be ignored.

6. Maximum thickness of upper SP layer shall be restricted to 12'.

7. Soil profiles indicated above shall be confirmed prior to final sheet pile design.

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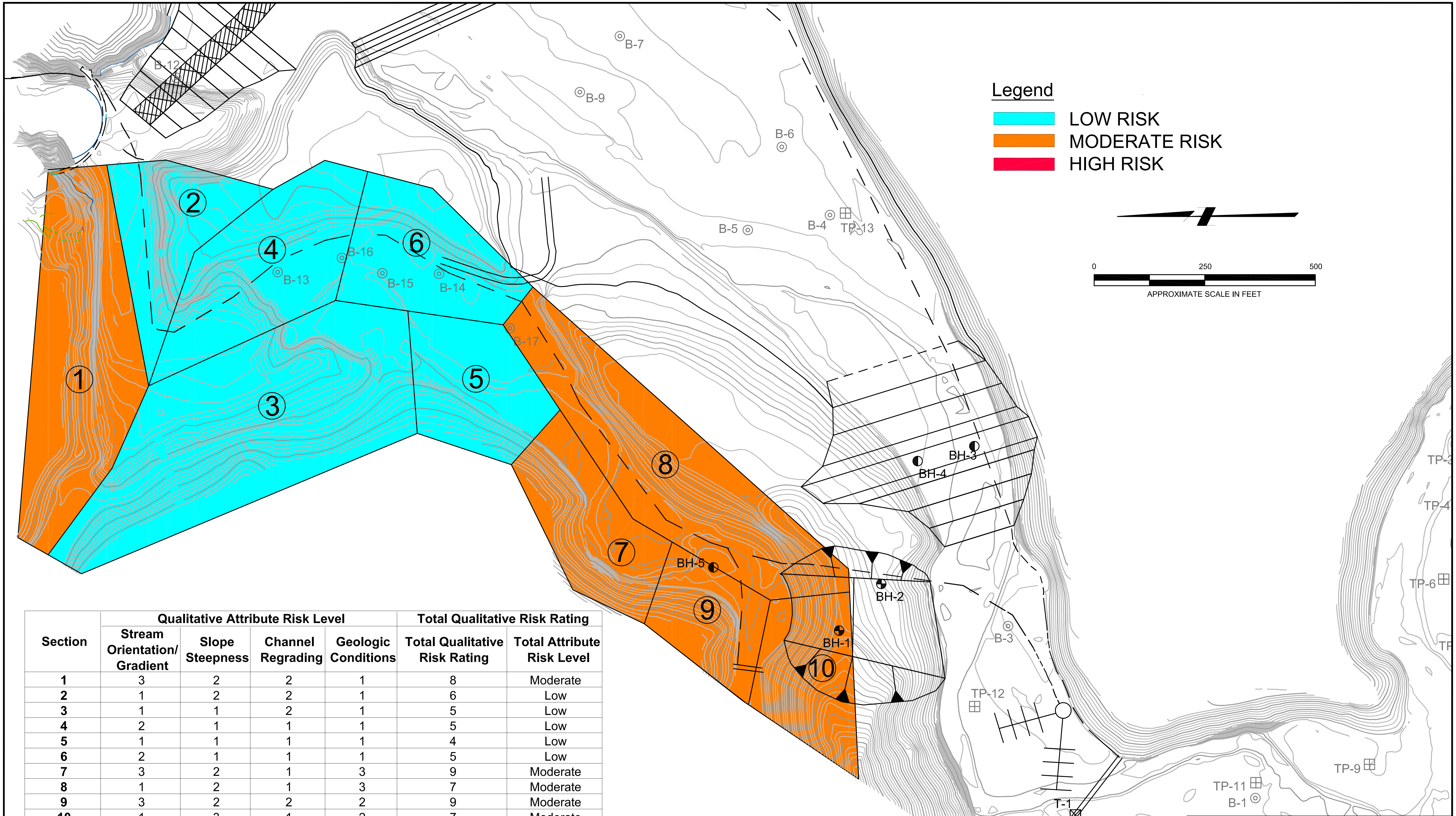
SAN CLEMENTE DAM
TEMPORARY SHEET PILE COFFERDAM
DESIGN CRITERIA
FIGURE 4-3



Section	Qualitative Attribute Risk Level				Total Qualitative Risk Rating	
	Stream Orientation/ Gradient	Slope Steepness	Channel Regrading	Geologic Conditions	Total Qualitative Risk Rating	Total Attribute Risk Level
1	3	2	2	1	8	Moderate
2	1	2	2	1	6	Low
3	1	1	2	1	5	Low
4	2	1	1	1	5	Low
5	1	1	1	1	4	Low
6	2	1	1	1	5	Low
7	3	2	1	3	9	Moderate
8	1	2	1	3	7	Moderate
9	3	2	2	2	9	Moderate
10	1	3	1	2	7	Moderate

Key	
Risk Level	**Attribute Risk Level**
1	Low
2	Moderate
3	High

Total Qualitative Risk Rating	
Risk Rating	**Total Risk Level**
4 to 6.7	Low Risk
6.8 to 9.3	Moderate Risk
9.4 to 12	High Risk

MWH

CALIFORNIA STATE COASTAL CONSERVANCY

SAN CLEMENTE DAM
QUALITATIVE RISK ASSESSMENT OF
COMBINED FLOW REACH SLOPES
FIGURE 4-4

5.0 CONCLUSIONS

This section presents a summary of conclusions for the bypass channel, diversion dike, stabilized sediment slope, stream diversion and dewatering activities, and the combined flow reach.

5.1 Bypass Channel

The bypass channel, as currently proposed, will cut through approximately 120 feet of rock and overburden. Based on preliminary analyses, the proposed 1H:1V slopes are generally feasible for rock slopes. Further analyses indicate that increasing the steepness of these slopes will likely result in savings in construction costs while maintaining slope stability. Slopes within the approximate 14-foot-thick layer of overburden soil will likely need to be graded at slopes of approximately 2H:1V.

Analyses indicate that excavation of the proposed bypass channel is generally feasible using mechanical excavation methods. However, depending on the Construction Contractor's equipment, skills, and experience, alternate methods, such as drilling and blasting, may be more economically feasible.

The rock and overburden soil encountered at the location of the proposed bypass channel are generally suitable as fill materials. Rock excavated from the bypass channel can be used for applications included general fills, rock fill dike construction, and armorment of slopes and streambeds. Overburden soils are suitable for use as general fill when properly moisture conditioned and free of deleterious materials.

5.2 Diversion Dike

The currently proposed diversion dike is generally feasible. Based on calculations, the proposed dike and the underlying foundation soils are stable with respect to bearing capacity and slope stability when the foundation soils are not subject to liquefaction. Calculations indicate that the slopes of the dike will be subject to instability when the foundation soils undergo seismically-induced liquefaction. However, these displacements are likely to have little impact on the functionality of the diversion dike. Further, it is likely that the anticipated liquefaction can be accounted for either by overbuilding the dike, or by mitigating the foundation soils to preclude liquefaction. Settlements of the proposed dike in the current configuration have been calculated to be less than two feet. Given the proposed rock fill dike construction, this magnitude of settlement can be accounted for by overbuilding the dike by the anticipated amount of settlement.

The current configuration of the diversion dike was developed to maintain a cut-fill balance with the anticipated volume of fill from the proposed bypass channel excavation. However, it is anticipated that the proposed height, crest width, and geometry of the dike will likely be reduced upon further evaluation of the project layout.

5.3 Stabilized Sediment Slope

The stabilized sediment slope as currently envisioned will be approximately 80 feet high, extending upward from the proposed re-aligned streambed toward the abandoned Carmel River arm to the southeast. Plans are to stabilize the slope using a series of deep soil mixing columns. Based on this analysis, the proposed stabilized sediment slope is generally feasible with respect to slope stability. However, it is recommended that alternate methods be evaluated to establish the most economical means of meeting project objectives of stabilizing this slope and retaining water within the proposed wetland planned for the abandoned arm of the Carmel River, or evaluate stabilization methods for an alternative objective, where reduction in the water table upstream of the stabilized slope would be implemented and wetland mitigation achieved at an alternate site.

5.4 Stream Diversion and Dewatering

The proposed stream diversion system consists of a sheet pile cofferdam driven to, or slightly embedded in, the underlying bedrock. Based on this analysis, the proposed sheet pile cofferdam is generally feasible; however, further subsurface explorations are required to determine the presence of oversize material at the cofferdam's location. Additional evaluation of alternate methods are recommended to determine the most suitable method of temporarily impounding the flow of the Carmel River.

Within the proposed construction areas, subsurface soils consist primarily of coarse-grained materials that are presumed to be relatively free draining. Evaluations of these soils indicate that several dewatering methods are feasible for the proposed construction procedures. However, based on the nature of these soil types, dewatering by pumping from unsupported, open excavations is not recommended. It is strongly recommended that the design of the dewatering system be the responsibility of the earthwork contractor because this contractor will have control of construction means and methods. Further evaluation of water treatment prior to discharge downstream during dewatering will also be required.

5.5 Combined Flow Reach

The combined flow reach will extend from the proposed bypass channel to the current confluence of the Carmel River with San Clemente Creek. Based on qualitative assessment, the relative risks of significant turbid water releases or landsliding, that would result in significant blockage of the stream because of project construction activities, are low to moderate. Accordingly, the construction of the combined flow reach is generally feasible given the current project layout.

6.0 RECOMMENDATIONS

The preliminary geotechnical investigation for the CRRDR project was completed according to the planned scope, where two rock core borings, three soil borings, and one hand-dug test pit were completed by PC Exploration, Inc., under supervision of MWH field staff. Samples from the field investigation were logged and collected, including submitting appropriate samples for laboratory testing. Laboratory test results were used as inputs into geotechnical analyses of the bypass channel cut and the diversion dike and foundation. Analyses results were used as a basis for evaluating the conceptual design concept as presented in the Draft Basis of Design (BOD) report by MWH (2007).

Based on the evaluation of the geotechnical data obtained during the field investigation and subsequent confirmation through preliminary engineering analyses, the conceptual design as presented in the BOD report is feasible for construction. It should be noted, however, MWH's recommendation is based on conceptual-level design that may change as the project is developed. Design changes and additional investigations may encounter conditions that would modify or change the recommendations.

It is recommended that additional geotechnical investigations be performed once the project design criteria are defined (e.g., level of acceptable risk used in seismic design) and overall project layout are detailed and agreed upon by the SCC, its consultants, and stakeholders. At a minimum, additional geotechnical investigations should be performed prior to an overall project 30-percent-level design in order to provide necessary detail for bypass channel cut, diversion dike, and stabilized sediment slope design. As such, MWH recommends that the following activities be conducted in support of the final design of the proposed project:

- **Bypass Channel**
  - Perform additional investigations of the subsurface soil, rock, and groundwater conditions in support of final cut slope design
  - Conduct additional analyses in support of final rock and soil retention systems
- **Diversion Dike**
  - Evaluate alternate dike layouts, geometries, and construction methods
  - Conduct further analyses of the required diversion dike geometry including dike slopes and crest elevation
  - Conduct additional laboratory testing to evaluate the suitability of the proposed rock fill
  - Conduct an analysis of potential uplift pressures acting on the diversion dike
  - Conduct a detailed seepage analysis of the diversion dike based on the dike, layout, geometry and fill material selected
  - Conduct a detailed analysis and design of required granular filters
  - Conduct analyses in support of the final design of the riprap protection for the upstream slope of the diversion dike
  - Evaluate methods to promote the growth of vegetation on the diversion dike.

  - Evaluate potential alternates to the proposed cement-bentonite cutoff wall
  - Conduct a detailed analysis of the proposed cement-bentonite cutoff wall to determine physical, hydraulic, and strength properties of the final cutoff materials selected
  - Perform additional subsurface investigations to define the subsurface conditions below the footprint of the diversion dike in greater detail
  - Conduct analyses of soil improvement measures for the purpose of mitigating liquefaction of foundation soil and dike settlement
  - Conduct a final design of the proposed diversion dike including analyses of settlement, liquefaction, and slope stability based on the final selection of foundation soil improvement methods
- **Stabilized Sediment Slope**
  - Evaluate alternate methods of stabilizing the sediment slope retaining water within the proposed wetland area to determine the most economically feasible approach
  - Conduct additional subsurface investigations to characterize the soil, rock, and groundwater conditions at the location of the proposed stabilized sediment slope
  - Conduct field and laboratory testing to provide physical and strength characteristic of subsurface soils and soil-cement mixtures in support of the final slope design
  - Conduct a detailed seepage analysis of the sediment slope based on the stabilization methods selected for construction
  - Conduct a final stabilized sediment slope design to provide criteria for soil improvement activities, slope design, and erosion control measures
- **Stream Diversion and Dewatering**
  - Evaluate alternate methods for temporary impounding the Carmel River
  - Evaluate methods for temporarily impounding and diverting the flows of San Clemente Creek during construction
  - Conduct additional subsurface investigations to characterize the soil, rock, and groundwater conditions
  - Conduct additional analyses in support of final sheet pile coffer dam design criteria
  - Conduct a hydrogeological evaluation of the construction site in support of reservoir and construction dewatering criteria
  - Evaluate the need for treatment of diversion water prior to re-introduction to the Carmel River
  - Investigate water disposal alternatives and permit requirements
- **Combined Flow Reach**
  - Conduct analyses of slope stability at locations within the combined flow reach determine to be at a moderate risk level for slope and sediment instability

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APPENDIX A
Subsurface Exploration Procedures and Logs

APPENDIX A
SUBSURFACE EXPLORATION PROCEDURES AND LOGS

MWH conducted six subsurface explorations at the project site, including two rock core borings (BH-1 and BH-2), three mud-rotary borings (BH-3 through BH-5), and one hand dug test pit (T-1). Explorations were conducted between November 5 and 15, 2007. Borings BH-1 and BH-2 were advanced to below the projected excavation depths of 130.0 and 90.3 feet, respectively, using HQ wire line rock coring methods. Down-hole video logging had been planned for boring BH-2; however, this operation was forgone due to caving conditions within the boring, which would likely cause substantial damage to the down-hole video logging equipment. Borings BH-3 through BH-5 were advanced to depths ranging from 17.5 to 47.0 feet using mud-rotary drilling methods. Each boring was conducted using skid-mounted drilling equipment owned and operated by PC Explorations, Inc. of Rocklin, California. In addition, PC Explorations, Inc. advanced T-1 to a depth of 6.2 feet using hand excavation methods. The exploration locations were determined in the field by pacing from features identified on site drawings. Boring elevations shown in the boring logs were based on elevation values shown on available topographic surveys of the site. Boring locations are shown on Figure 1-2. Boring locations and elevations should be considered approximate.

Samples were collected from each subsurface exploration. Continuous rock core samples were collected from boring BH-1 and BH-2. Core recovery and the rock quality designation were calculated in accordance with the methods described by USACE (2001). Relatively disturbed soil samples were obtained from the mud-rotary borings, BH-3 through BH-5 using 1.4- and 2.0-inch ID split spoon samplers. Sampling conducted with 1.4-inch ID split spoon samplers were collected in general accordance with guidelines presented in ASTM D 1586 - Standard Test Method for Penetration Test and Split Barrel Sampling of Soils. Sampling conducted with 2.0-inch ID split spoon samplers were collected following the methods presented in ASTM D 1586, excluding the size of the sampling apparatus. Both samplers were driven into the soil a distance of 18 inches, or to refusal, with a 140-pound hammer free falling a distance of 30 inches. The sum of the blows required to drive the sampler the final two increments of six inches was recorded in the boring logs. If the sampler met refusal, the number of inches driven and the number of blows was recorded.

The subsurface conditions of the site have been interpreted from borings and standard penetration tests. Results of these tests indicate that the site subsurface is a complex configuration of discontinuous horizons whose physical and mechanical properties vary vertically and laterally. Furthermore, even with an array of closely spaced test holes, it is not possible to know precisely the materials beneath any defined point; therefore, the type of material, its thickness, and mechanical properties must be interpolated between the borings.

The discontinuous geometry of strata and highly varied material types beneath the site are typical of river alluvium. The grain size and consistency of river-deposited alluvium varies according to water energy, sediment size, and depositional environment.

Major Divisions		Letter	Symbol		Name
			Hatching	Color	
Coarse-grained Soils	Gravel and Gravelly Soils	GW	▨	Red	Well-graded gravels or gravel-sand mixtures, little or no fines
		GP	▨		Poorly-graded gravels or gravel-sand mixtures, little or no fines
		GM	▨	Yellow	Silty gravels, gravel-sand-silt mixtures
		GC	▨		Clayey gravels, gravel-sand-silt mixtures
	Sand and Sandy Soils	SW	▨	Red	Well-graded sands or gravelly sands, little or no fines
		SP	▨		Poorly-graded sands or gravelly sands, little or no fines
		SM	▨	Yellow	Silty sands, sand-silt mixtures
		SC	▨		Clayey sands, sand-silt mixtures
Fine-grained Soils	Silt, Clay, Silty Soils, Clayey Soils	ML	▨	Green	Inorganic silts & very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity
		CL	▨		Inorganic clays of low to medium plasticity, gravelly clays, sandy or silty clays, lean clays
		OL	▨		Organic silts and organic silt-clays of low plasticity
		MH	▨	Blue	Inorganic silts and organic silt-clays of low plasticity
		CH	▨		Inorganic clays of medium to high plasticity, organic silts
		OH	▨		Peat and other highly organic silts
		Pt	▨	Orange	Peat and other highly organic soils
Bedrock			▨		Sandstone
			▨		Siltstone
			▨		Claystone
			▨		Shale or Chert
Fill			Fill		Fill-landfill refuse

Sample Type	
Standard Penetration Test: split spoon sampler, 2.0" OD/ 1-3/8" ID, driven with 140 lb. weight, 30" drop	T
Modified California Sampler: Split spoon sampler, 3.0" OD, driven with 140 lb. weight, 30" drop	D
Ring Sample: 1.5" ID ring sampler, hand driven	R
Continuous Sample	C
Chemical Test Type	
Total Petroleum Hydrocarbons as gasoline	G
Benzene	B
Toluene	T
Ethylbenzene	E
Xylenes	X
Methtl tertiary-butyl ether	M
Photoionization Detector	PID
Soil concentrations in mg/kg	
Groundwater concentrations in mg/l	
Water level at time of drilling	▽
Equilibrated water level	▼

UNIFIED SOIL CLASSIFICATION SYSTEM AND BORING LOG EXPLANATION

MWH

Geotechnical Investigation Report
San Clemente Dam Removal and Carmel River Reroute
California Coastal Conservancy
Monterey County, California

PROJECT NO.
1881772

FIGURE NO.

DRILLING LOG

DIVISION

INSTALLATION

SHEET 1 OF 15 SHEETS

1. PROJECT
Carmel River Re-route and Dam Removal Prelim Geotech inv.
2. LOCATION (Coordinates or Station)
San Clemente Dam San Clemente Dam
3. DRILLING AGENCY
PC Exploration
4. HOLE NO. *(As shown on drawing title and file number)* BH-1
5. NAME OF DRILLER
Nate Hinkle
6. DIRECTION OF HOLE
☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN 20.0
8. DEPTH DRILLED INTO ROCK 110.0
9. TOTAL DEPTH OF HOLE 130.0

10. SIZE AND TYPE OF BIT NQ
11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)*
MSL
12. MANUFACTURER'S DESIGNATION OF DRILL
UDR-10
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN : DISTURBED : UNDISTURBED
14. TOTAL NUMBER CORE BOXES 9
15. ELEVATION GROUND WATER
16. DATE HOLE : STARTED 11/6/2007 : COMPLETED 11/7/2007
17. ELEVATION TOP OF HOLE +625.0
18. TOTAL CORE RECOVERY FOR BORING %
19. GEOLOGIST
Jennifer Van Pelt

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
+625.0	0.0		Overburden - decomposed granite, cobbles, soil - No Recovery	0	0.0 5.0	Soil and cobbles, driller will stabilize with casing to ~20 feet.
				0	5.0 10.0	

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE
625.0

Hole No. BH-1

PROJECT
Carmel River Re-route and Dam Removal Prelim Geotech inv.

INSTALLATION

SHEET 2
OF 15 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
			Overburden - decomposed granite, cobbles, soil - No Recovery *(continued)*			
				20	Box 1 10.0 15.0	RQD = 0 Drill Rate = 5 ft/15 min
+611.0	14.0					
		+ + + + +	Biotite diorite, gray, medium to coarse grained, moderately to heavily weathered, hard, moderately strong, highly to intensely fractured. 14.4'-15.0' - Joint (10º), moderately rough, moderately weathered with Fe + Mn oxidation.			
+610.0	15.0					
			No recovery	0	Box 1 15.0 16.0	Drill Rate = 1 ft/10 min

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE 625.0	**Hole No. BH-1**	
PROJECT Carmel River Re-route and Dam Removal Prelim Geotech inv.		INSTALLATION	SHEET 3 OF 15 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
+604.9	20.1		No recovery *(continued)*	18	Box 1 16.0 21.0	RQD = 0 Drill Rate = 5 ft/10 min
+604.0	21.0	+ + + + +	Biotite diorite, gray, medium to coarse grained, moderately to heavily weathered, hard, moderately strong, highly to intensely fractured. broken to cobble and gravel sized pieces			
			No recovery	8	Box 1 21.0 26.0	RQD = 0 Drill Rate = 5 ft/10 min

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE 625.0		**Hole No. BH-1**
PROJECT Carmel River Re-route and Dam Removal Prelim Geotech inv.		INSTALLATION	SHEET 4 OF 15 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
+599.4	25.6		No recovery *(continued)*			
+599.0	26.0	+ + +	Biotite diorite, gray, medium to coarse grained, slightly to moderately weathered, hard, moderately strong, highly to intensely fractured. 25.8'-25.9' - Joint (60º), moderately rough, minor Mn oxidation			
+596.0	29.0		No recovery	40	Box 1 26.0 31.0	RQD = 0 Drill Rate = 5 ft/20 min
+594.0	31.0	+ + +	Biotite diorite, gray, medium to coarse grained, moderately to heavily weathered, hard, moderately strong, highly to intensely fractured. 29.2'-29.3' - Joint (50º), rough to moderately rough, moderately weathered with Fe + Mn oxidation. Mechanical break 29.6'- Joint (50º), slightly rough, moderately weathered with Fe + Mn oxidation. 29.6'-30.2' - Broken zone, pebbles to cobbles of heavily weathered granodiorite, moderately weathered with Fe + Mn oxide, and thin sparse soils. Some possible mechanical breakage. 30.4'-30.6' - Joint (40º), slightly to moderately rough. 30.7'-31.0' - Broken zone, pebbles to cobbles of heavily weathered granodiorite, moderately weathered with Fe + Mn oxide, and thin sparse soils. Some possible mechanical breakage.			
+593.0	32.0		No Recovery	67	Box 1 31.0 34.0	RQD = 0 Drill Rate = 3 ft/20 min
+591.7	33.3	+ + +	As above. 32.2' - Joint (85º), very rough. 32.3'-32.4' - Joint (70º), rough to very rough, moderately weathered with Fe oxidation + minor Mn oxidation. 32.4'-32.7' - Incipient fracture (30º), close, 2-4 mm, slightly to moderately rough. 32.7' - Joint (70º), rough to very rough. 32.8' - Joint (80º), rough to very rough, stepped.			
		+ + +	33.0'-33.2' - Joint (30º), slightly to moderately rough, moderately weathered with Fe + Mn oxidation. 33.6'-34.0' - Broken zone, intensely fractured to gravel sized pieces, (1 x 2 cm to 0.5 x 0.5 cm) Some possible mechanical breakage.			

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE 625.0

Hole No. BH-1

PROJECT Carmel River Re-route and Dam Removal Prelim Geotech inv.

INSTALLATION

SHEET 5 OF 15 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
		+ + +	Biotite diorite, gray, medium to coarse grained, slightly to moderately weathered, hard, moderately strong, highly to intensely fractured. *(continued)* 34.0'-34.2' - Joint (20º), smooth to slightly rough, moderately weathered with moderate Fe oxidation + minor Mn oxidation. 34.0'-34.2' - Joint (50º), slightly to moderately rough, moderately weathered with minor Fe oxidation. 34.5'-34.6' - Joint (60º), slightly to moderately rough, slightly weathered. 34.7'-34.9' - Joint (30º), slightly to moderately rough, slightly weathered with Fe oxidation. 35.5'-35.8' - Joint (20º), moderately rough to rough, slightly weathered with Fe oxidation.	96	Box 2 34.0 36.0	RQD = 25% Drill Rate = 2 ft/20 min
+587.9	37.1	+ + +	35.8' - Joint (80º), rough to very rough, stepped. 35.9' - Joint (75º), rough to very rough, stepped. 36.5' - Joint (85º), rough to very rough, slightly weathered with Fe oxidation. 36.7' - Joint (90º), rough to very rough, slightly weathered with Fe oxidation. 36.8' - Joint (90º), rough to very rough, slightly weathered with Fe oxidation. 36.9' - Joint (50º), rough to very rough, slightly weathered with Fe oxidation.	93	Box 2 36.0 41.0	RQD = 10 Drill Rate + 5 ft/25 min
+584.4	40.6	+ + +	As above, becoming gneissic, fine to medium grained, moderately to heavily weathered. 37.1'-37.8' - Broken zone, intensely fractured to gravel sized pieces, (2 x 5 cm to 1 x 1 cm) Some possible mechanical breakage. 38.0' - Joint (90º), rough to very rough. 38.4' - Joint (70º), moderatly rough to rough. 38.4'-39.0' - Broken zone, pervasively fractured to gravel sized pieces, (2 x 6 cm to 1 x 1 cm) Some possible mechanical breakage. 38.0' - Joint (90º), rough to very rough. 39.4'-39.8' - Joint (10º), slightly rough to moderately rough, slightly weathered with Fe + Mn oxidation. 39.8'-40.6' - Broken zone, intensely fractured to gravel sized pieces, (2 x 6 cm to 0.5 x 0.5 cm) Some possible mechanical breakage.			
+584.0	41.0		No recovery			
		+ + +	Biotite diorite, gray, medium to coarse grained, slightly to moderately weathered, hard, moderately strong, highly to intensely fractured. 41.0'-41.7' - Joint (10º), moderately rough, moderately weathered with Fe + Mn oxidation. 41.0'-42.0' - Joint (0º), rough to very rough, slightly to moderately weathered with Fe + Mn oxidation. 42.4' - Joint (90º), rough to very rough, slightly weathered with Fe oxidation. 42.5'-42.7' - Joint (60º), rough to very rough, stepped.	97	Box 2/3 41.0 46.0	RQD = 15 Drill Rate = 5 ft/30 min

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE
625.0

Hole No. BH-1

PROJECT
Carmel River Re-route and Dam Removal Prelim Geotech inv.

INSTALLATION

SHEET 6
OF 15 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
		+ + +	42.9' - Joint (90º), slightly rough, moderately weathered with Fe + Mn oxidation. Biotite diorite, gray, medium to coarse grained, slightly to moderately weathered, hard, moderately strong, highly to intensely fractured. *(continued)* 42.9'-43.4' - Incipient fractures. 43.3'-43.4' - Joint (80º), very rough, stepped, moderately weathered with Fe + Mn oxidation. 43.4'-44.6' - Broken zone, intensely fractured to gravel sized pieces, (4 x 6 cm to 1 x 1 cm) Some possible mechanical breakage. 44.6'-44.7' - Joint (60º), very rough, heavily weathered with Fe oxidation. 44.8'-45.0' - Incipient fracture (60º). 45.3' - Joint (80º), moderately rough, moderately weathered with Fe oxidation. 45.4' - Incipient fracture (60º). 45.8' - Joint (80º), slightly rough, heavy Fe oxide weathering + slight Mn oxidation. 45.7'-45.8' - Joint (70º), slightly rough, heavy Fe oxide weathering + slight Mn oxidation.			
+575.0	50.0	+ + +	46.0'-46.1' - Joint (60º), slightly rough, slightly weathered with Mn oxidation. 46.4'-46.5' - Joint (70º), slightly rough,slightly weathered with Mn oxidation. 46.8'-47.1' - Joint (25º), slightly to moderatly rough, slightly weathered with Fe + Mn oxidation. 47.2' - Joint (80º), moderatly rough, slightly weathered with Mn oxidation. 47.6' - Joint (80º), rough, slightly weathered with Fe + Mn oxidation. 47.7' - Incipient fracture close, <1 mm (0.3 mm). 48.0' - Mechanical Break 48.0'-48.4' - Joint (20º), rough to moderatly rough, thin soil. 48.5'-48.6' - Joint (40º), moderatly rough, moderate weathereing with Mn oxidation + slight Fe oxidation. 48.7'-48.8' - Joint (50º), moderatly rough to rough, minor Fe oxidation. 48.8'-49.0' - Joint (40º), moderatly rough to rough, moderately weathered with Fe oxidation. 49.2'-49.3' - Joint (50º), moderatly rough to rough, moderately weathered with Fe oxidation. 49.4' - Joint (80º), moderatly rough, slightly weathered with Mn oxidation. 49.7' - Joint (70º), moderatly rough, slightly weathered with Fe oxidation.	80	Box 3 46.0 51.0	RQD = 58 Drill Rate = 5 ft/20 min
+573.8	51.2		No recovery			
		+ + +	Biotite diorite, gray, medium to coarse grained, moderately weathered, hard, moderately strong, highly to intensely fractured.	95	Box 3/4 51.0 56.0	RQD = 23 Drill Rate = 5 ft/29 min

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE
625.0

Hole No. BH-1

PROJECT
Carmel River Re-route and Dam Removal Prelim Geotech inv.

INSTALLATION

SHEET 7
OF 15 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
+570.0	55.0	+ + +	Biotite diorite, gray, medium to coarse grained, moderately weathered, hard, moderately strong, highly to intensely fractured. *(continued)* 52.0'-51.1' - Joint (70º), moderatly rough, slightly weathered with Fe + Mn oxidation. 52.1'-52.6' - Joint (10º), slightly to moderatly rough, slightly weathered with Fe oxidation. 52.1'-52.2' - Incipient fracture, slightly rough, slightly weathered. 52.2' - Joint (80º), to moderatly rough, slightly weathered with Fe + Mn oxidation. 52.6'-52.7' - Joint (70º), slightly to moderatly rough. 52.6'-52.9' - Plagioclase rich 52.6'-52.9' - Broken zone, intensely fractured to gravel sized pieces, (3 x 6 cm to 1 x 1 cm) Some possible mechanical breakage. 52.8'-53.0' - Joint (60º), slightly to moderately rough, slightly weathered. 53.1'-53.2' - Joint (60º), slightly to moderately rough, slightly weathered. 53.3' - Joint (80º), moderatly rough, slightly weathered with Mn oxidation. 53.5'-53.7' - Joint (40º), moderately rough, slightly weathered with Fe + Mn oxidation. 53.8'-53.9' - plag vein ~ 2-4 mm wide. 53.9'-54.0' - Joint (50º), moderately rough, moderately weathered with Fe oxidation. 54.0'-54.4' - Broken zone, intensely fractured to gravel sized pieces, some possible mechanical breakage. 54.6'-54.7' - Joint (60º), moderately rough to rough, slightly weathered. 54.8'-54.9' - Joint (60º), moderately rough to rough, slightly weathered. 54.9'-55.0' - Joint (60º), rough, slightly weathered.			
+568.0	57.0	+ + +	As above, with increasing plagioclase, coarse grained, with accessory biotite. 55.0'-55.2' - Joint (60º), moderately rough, slightly weathered with Fe oxidation. 55.0'-55.5' - Joint (15º), moderately rough, slightly weathered with Fe + Mn oxidation. 55.6' - Mechanical break 55.8'-56.0' - Joint (60º), slightly rough, moderate weathered with Fe + Mn oxidation. 55.8'-56.0' - Joint (50º), slightly to moderately rough, slightly weathered with Fe + Mn oxidation. 56.0' - Mechanical break 56.0'-56.2' - Joint (60º), slightly rough, slightly weathered with minor Fe + Mn oxidation. 56.1'-56.4' - Joint (10º), slightly rough, slightly weathered with minor Fe + Mn oxidation. 56.4' - Mechanical break 56.4'-56.7' - Incipient fracture (20º), slightly weathered, close (0-3 mm). 54'-57.0' - Joint (10º), moderately rough, slightly weathered with minor Fe + Mn oxidation.	94	Box 4 56.0 60.0	RQD = 29 Drill Rate = 4 ft/27 min
+567.1	57.9	+ + +	As above with increasing biotite to >50%, medium to coarse grained. 57.0' - Joint (80º), moderately rough, slightly weathered. 57.0'-57.8' - Joint (10º), moderately rough, moderately weathered with Fe + Mn oxidation. 57.4' - Joint (90º), rough, minor weathering. 57.6'-57.8' - Joint (50º), slightly rough, slightly weathered with Fe oxidation. 57.8' - Joint (80º), rough, slightly weathered. 57.9' - Joint (80º), rough, slightly weathered.			
+565.2	59.8	+ + +				
+565.0	60.0					
		+ + +	As above, with decreasing biotite to >20%. 58.3' - Joint (80º), rough, slightly weathered.	95	Box 4/5 60.0 65.0	RQD = 45 Drill Rate = 5 ft/20 min

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE 625.0		**Hole No. BH-1**
PROJECT Carmel River Re-route and Dam Removal Prelim Geotech inv.		INSTALLATION	SHEET 8 OF 15 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS (*Drilling time, water loss, depth weathering, etc., if significant*) g
+563.9	61.1		58.7' - Joint (80º), moderately rough, moderate weathering with Fe oxidation. 58.8'-58.9' - Joint (70º), moderately rough, minor weathering with Fe oxidation. 59.2'-59.5' - Joint (35º), moderately rough, slight weathering with Fe oxidation. 59.2'-59.6' - Broken zone, intensely fractured to gravel sized pieces, (2 x 4 cm to 1 x 1 cm) Some possible mechanical breakage. 59.6' - Joint (85º), very rough, stepped.			
			No recovery			
			60.1' - Joint (90º), moderately rough, slight weathering with Fe oxidation. 60.4' - Joint (85º), moderately rough, moderate weathering with Fe oxidation. 60.6' - Joint (90º), moderately rough, moderate weathering with Fe oxidation. 60.7'-61.0' - Joint (40º), slightly rough, slightly weathered with Fe oxidation. 60.7'-60.9' - Joint (50º), moderately rough, slightly weathered with Fe oxidation. As above, with increaseing biotite, coarse grained. *(continued)*			
			As above with increasing biotite to 50%. 61.1' - Joint (80º), moderately rough, slightly weathered with Fe oxidation. 62.3' - Joint (80º), moderately rough, slightly weathered with Fe oxidation. 63.0'-63.1' - Joint (70º), moderately rough, slightly weathered. 63.2'-63.3' - Joint (70º), moderately rough, slightly weathered. 63.2'-63.8' - Broken zone, intensely fractured to gravel sized pieces, (2 x 3 cm to 4 x 10 cm) Some possible mechanical breakage. 63.8'-63.9' - Joint (70º), moderately rough, slightly weathered. 64.1'-64.3' - Joint (50º), rough, slightly weathered. 64.1'-64.7' - Joints (20/15º), moderately rough, moderately weathered with Fe oxidation. 65.0'-65.7' - Joint (10º), moderately rough, moderately weathered with Fe oxidation. 65.2'-65.4' - Joint (45º), moderately rough, slightly weathered with Fe oxidation. 65.4'-65.5' - Joint (50º), slightly rough, slightly weathered with Fe oxidation. 66.2' - Joint (90º), rough, very slightly weathered. 66.4'-66.5' - Joint (55º), slightly rough, moderately weathered with Fe oxidation. 66.6'-66.8' - Joint (55º), slightly rough, slightly weathered with Fe oxidation. 66.8'-66.9' - Joint (55º), slightly rough, slightly weathered with Fe oxidation. 67.0' - Mechanical break 67.2'-67.3' - Joint (50º), slightly rough, slightly weathered with Fe oxidation.	49	Box 5 65.0 71.0	RQD = 19 Drill Rate = 6 ft/16 min
+557.0	68.0		67.3'-67.5' - Joint (40º), slightly rough, slightly weathered with Fe oxidation. 67.5'-67.8' - Joint (35º), slightly rough, slightly weathered with Fe oxidation. 67.6'-67.9' - Joint (40º), slightly rough, slightly weathered with Fe oxidation.			
			No recovery			

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE 625.0

Hole No. BH-1

PROJECT Carmel River Re-route and Dam Removal Prelim Geotech inv.

INSTALLATION

SHEET 9 OF 15 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			No recovery *(continued)*			
+554.0	71.0					
		+ + +	As above. 71.0'-71.4' - Broken zone, intensely fractured to gravel sized pieces, (2 x 5 cm to 1 x 2 cm) Some possible mechanical breakage. 71.3'-71.5' - Joint (45º), slightly rough, moderately weathered with Fe oxidation. 71.5'-71.8' - Joint (40º), moderately rough, slightly weathered with Fe oxidation. 73.0' - Mechanical break 73.2' - Joint (70º), rough, slightly weathered. 73.6' - Joint (70º), very rough, slightly weathered. 73.8' - Joint (70º), moderately rough, slightly weathered. 73.9'-74.0' - Joint (60º), moderately rough, slightly weathered. 74.0'-74.1' - Joint (70º), moderately rough, moderately weathered with Fe oxidation. 74.5' - Joint (75º), moderately rough, slightly weathered.	90	Box 5 71.0 76.0	RQD = 32 Drill Rate = 5 ft/15 min
+550.4	74.7					
		+ + +	As above with decreasing biotite, >40% 74.7' - Joint (70º), moderately rough, slightly weathered.			
+550.0	75.0					
		+ + +	As above, with increasing biotite to >50% 74.8'-75.3' - Joints (20/15º), moderately rough, moderately weathered with Fe oxidation. 74.9'-75.2' - Broken zone, gravel sized pieces, (1 x 2 cm to 1 x 3 cm) Some possible mechanical breakage.			
+549.7	75.3					
		+ + +	As above, with increasing biotite to >50% 75.3'-75.6' - Broken zone, intensely fractured to gravel sized pieces, (1 x 1.5 cm to 0.5 x 0.5 cm) Some possible mechanical breakage.			
+549.4	75.6					
			No recovery			
+549.0	76.0					
		+ + +	As above, with increasing biotite to >50% 76.2'-76.5' - Joint (40º), moderately rough, slightly weathered. 76.5'-76.6' - Joint (60º), moderately rough, slightly weathered. 76.9'-77.4' - Broken zone, intensely fractured, sand to gravel sized pieces, (3 x 4 cm to 0.25 x 0.25 cm) Some possible mechanical breakage. 76.9'-77.4' - Joint (15º), moderately rough, moderately weathered with Fe oxidation. 77.5'-77.7' - Joints (40º), moderately rough, moderately weathered with Fe oxidation. 77.7'-78.1' - Joint (20º), slightly to moderately rough, moderately weathered with Fe oxidation. 77.8'-79.3' - Broken zone, pervasively fractured, coarse sand to gravel sized pieces, (3 x 7 cm to 0.25 x 0.25 cm) Some possible mechanical breakage.	95	Box 6 76.0 81.0	RQD = 10 Drill Rate = 5 ft/20 min

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE: 625.0

Hole No. BH-1

PROJECT: Carmel River Re-route and Dam Removal Prelim Geotech inv.

INSTALLATION:

SHEET 10 OF 15 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (*Drilling time, water loss, depth weathering, etc., if significant*) g
+544.3	80.7	+ + +	As above, with increasing biotite to >50% *(continued)* 79.3' - Joint (70º), slightly to moderately rough, slightly weathered. 79.4' - Joint (70º), slightly to moderately rough, slightly weathered. 79.6' - Joint (70º), slightly to moderately rough, slightly weathered. 77.8'-79.3' - Broken zone, pervasively fractured, coarse sand to small gravel sized pieces. 79.8' - Joint (70º), moderately rough, slightly weathered. 79.9' - Joint (70º), moderately rough, slightly weathered. 80.3' - Joint (60º), slightly rough, slightly weathered. 80.3'-80.6' - Incipient fracture (0º), tight, <1 mm. 80.5'-80.7' - Joint (40º), slightly rough, slightly weathered with Fe oxidation.			
+539.3	85.7		No Recovery	7	Box 6 81.0 86.0	RQD = 0 Drill Rate = 5 ft/20 min Drill dropping, abundant biotite flakes in recovered water.
+539.0	86.0	+ + +	As above with decreasing biotite, <20% biotite crystals. 85.9'-86.0' - Joint (20º), slightly rough, heavily weathered with Fe oxidation.			
			No recovery	5	Box 6 86.0 91.0	RQD = 0 Drill Rate = 5 ft/20 min Drill dropping, abundant biotite flakes in recovered water.

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE 625.0

Hole No. BH-1

PROJECT Carmel River Re-route and Dam Removal Prelim Geotech inv.

INSTALLATION

SHEET 11 OF 15 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (*Drilling time, water loss, depth weathering, etc., if significant*) g
			No recovery *(continued)*			
+534.3	90.7	+ + + + +	As above with decreasing biotite, <20% biotite crystals. 90.7'-91.0' - Joint (25º), slightly rough, moderately weathered with Fe oxidation.			
+534.0	91.0		No recovery	15	Box 7 91.0 96.0	RQD = 0 Drill Rate = 5 ft/18 min Drill dropping, abundant biotite flakes in recovered water.
+529.8	95.2	+ + + + +	As above with decreasing biotite, <20% biotite crystals. 95.2'-95.5' - Broken zone, intensely fractured, coarse sand to small gravel sized pieces. Mechanical break 90.5' - Joint (90º), very rough, possible mechanical break. 90.5'-91.0 - Joint (0-10º), moderately rough, weathered with Fe oxidation.			
+529.0	96.0		No recovery	5	Box 7 96.0 101.0	RQD = 0 Drill Rate = 5 ft/27 min Drill dropping, abundant biotite flakes in recovered water.

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE
625.0

Hole No. BH-1

PROJECT
Carmel River Re-route and Dam Removal Prelim Geotech inv.

INSTALLATION

SHEET 12
OF 15 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
			No recovery *(continued)*			
+524.3	100.7					
+524.0	101.0	+ + +	As above with decreasing biotite, <20% biotite crystals. 100.7'-101.0' - Broken zone, small gravel sized pieces.			
			No recovery	15	Box 7 101.0 106.0	RQD = 0 Drill Rate = 5 ft/23 min Drill dropping, abundant biotite flakes in recovered water.
+519.8	105.2					
		+ + +	Biotite diorite, gray, medium to coarse grained, moderately to heavily weathered, hard, moderately strong, intensely fractured. 105.2'-107.3' - Broken zone, intensely			

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE 625.0	**Hole No. BH-1**
PROJECT Carmel River Re-route and Dam Removal Prelim Geotech inv.	INSTALLATION	SHEET 13 OF 15 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
			fractured to gravel sized pieces, (5 x 8 cm to 1 x 1 cm) Some possible mechanical breakage. Biotite diorite, gray, medium to coarse grained, moderately to heavily weathered, hard, moderately strong, intensely fractured. *(continued)* 107.2' - Joint (90º), rough, slight weathering with Fe oxidation. 107.0'-107.3' - Joint (10º), moderately rough, heavily weathered with Fe oxidation. 107.3'-107.5' - Joint (40º), slightly rough, slightly weathered. 107.5' - Joint (80º), moderately rough, slightly weathered. 107.5'-107.8' - Joint (30º), slightly rough, moderate weathering with Fe oxidation. 107.8'-107.9' - Joint (50º), slightly rough, moderately weathered with Fe oxidation. 108.0' - Joint (90º), slightly rough, slightly weathered. 108.1'-108.2' - Joint (50º), moderately rough, moderately weathered with Fe oxidation. 108.4' - Joint (90º), rough, moderately weathered with Fe oxidation. 108.4'-108.7' - Broken zone, to small gravel sized pieces. 108.6'-108.7' - Joint (50º), rough, slightly weathered. 108.7'-108.8' - Joint (50º), slightly rough, moderately weathered with Fe oxidation. 108.4' - Joint (90º), very rough, slightly weathered. 108.9'-109.1' - Broken zone, intensely fractured to gravel sized pieces, (2 x 7 cm to 1 x 1 cm) Some possible mechanical breakage. 109.1' - Joint (90º), rough, weathered with Fe oxidation. 109.2' - Joint (80º), rough, weathered with Fe	98	Box 7/8 106.0 111.0	RQD = 6 Drill Rate = 5 ft/43 min
			oxidation. 109.6' - Joint (80º), moderately rough, weathered with Fe oxidation. 109.6'-109.8' - Broken zone, intensely fractured to gravel sized pieces, (2 x 6 cm to 1 x 2 cm) Some possible mechanical breakage. 109.8' - Joint (70º), moderately rough, moderatly weathered with Fe oxidation. 110.0' - Joint (85º), rough, weathered with Fe oxidation. 110.2'-110.4' - Joints (50/70º), moderately rough, moderately weathered with Fe oxidation. 110.4' - Joint (90º), moderately rough, weathered with Fe oxidation. 110.5'-110.7' - Joint (50º), rough, moderately weathered with Fe oxidation. 110.5'-111.1' - Broken zone, intensely fractured to gravel sized pieces, (4 x 6 cm to 1 x 2 cm) Some possible mechanical breakage. 111.1'-111.2 - Joints (80º), moderately rough, moderately weathered with Fe oxidation. 111.5'-110.7' - Joint (50º), rough, moderately weathered with Fe oxidation. 111.5'-110.9' - Joint (25º), moderately rough, moderately weathered with Fe oxidation. 111.8'-115.9' - Broken zone, intensely fractured, generally along foliations planes, to gravel sized pieces, (2 x 7 cm to 1 x 1 cm). Little to no weathering, possible mechanical breakage.	100	Box 8 111.0 116.0	RQD = 0 Drill Rate = 5 ft/50 min

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE 625.0

Hole No. BH-1

PROJECT Carmel River Re-route and Dam Removal Prelim Geotech inv.

INSTALLATION

SHEET 14 OF 15 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
+509.0	116.0	+ + +	Biotite diorite, gray, medium to coarse grained, moderately to heavily weathered, hard, moderately strong, intensely fractured. *(continued)* 115.8'-116.2' - Joint (25º), slightly rough, slightly weathered.			
+504.2	120.8	+ + +	As above with increasing quartz content, some chloritic alteration. 116.1'-116.6' - Joint (20º), slightly rough, slightly weathered. 116.2'-116.6' - Broken zone, intensely fractured, generally along foliations planes, to gravel sized pieces, (1 x 2 cm to 0.5 x 0.5 cm). 116.6' - Joint (90º), rough, stepped, slightly weathered. 116.8'-117.1' - Joint (30º), slightly rough, slightly weathered. 116.8'-117.5' - Broken zone, intensely fractured, coarse sand to gravel sized pieces, (1 x 2 cm to 0.25 x 0.25 cm). 117.5' - Mechanical break 117.5'-118.0' - Joint (0º), slightly to moderately rough, slightly weathered. 118.0' - Mechanical break 118.4'-118.7' - Joint (35º), moderately rough, slightly weathered. 118.5'-118.8' - Joint (40º), moderately rough, slightly weathered. 118.9'-119.2' - Joint (40º), moderately rough, slightly weathered. 118.9'-120.8' - Broken zone, pervasively fractured, generally along foliations planes, to small cobble sized pieces (4 x 8 cm).	87	Box 8/9 116.0 121.0	RQD = 0 Drill Rate = 5 ft/50 min
+504.0	121.0		No recovery			
		+ + +	As above with increasing quartz content, some chloritic alteration. 121.0'-122.0' - Broken zone, intensely fractured, gravel to small cobble sized pieces (4 x 8 cm). 122.1' - Joint (40º), rough, weathered with Fe oxidation. 122.3' - Joint (40º), rough, weathered with Fe oxidation. 122.6'-122.8' - Joint (45º), slightly rough, weathered with Fe oxidation. 123.0'-123.1' - Joint (60º), slightly rough, weathered with Fe oxidation. 123.5'-123.6' - Joint (60º), slightly rough, stepped, slightly weathered.	97	Box 9 121.0 126.0	RQD = 12 Drill Rate = 5 ft/50 min

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE 625.0

Hole No. BH-1

PROJECT Carmel River Re-route and Dam Removal Prelim Geotech inv.

INSTALLATION

SHEET 15 OF 15 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS (*Drilling time, water loss, depth weathering, etc., if significant*) g
+499.0	126.0	+ + +	As above with increasing quartz content, some chloritic alteration. *(continued)* 124.0-124.3' - Joints (40º), slightly rough, weathered with Fe oxidation. 124.2-124.4' - Joint (50º), slightly rough, slightly weathered with quartz precipitation. 124.9-125.0' - Joint (60º), slightly rough, slightly weathered with quartz precipitation. 125.3-125.4' - Joint (60º), rough, slightly weathered with Fe oxidation. 125.5-125.6' - Joint (60º), moderately rough, slightly weathered with Fe oxidation. 125.7-125.8' - Joint (70º), moderately rough. 125.7'-126.0' - Broken zone, intensely fractured to small cobble sized pieces. Some possible mechanical breakage.			
+496.0	129.0	+ + +	As above, medium to coarse grained. 126.0'-126.2' - Joint (40º), moderately rough, slightly weathered with quartz precipitation. 126.0'-126.5' - Joint (10º), moderately rough, slightly weathered with quartz precipitation. 126.4' - Joint (80º), slightly rough, slightly weathered with quartz precipitation. 126.4'-127.3' - Joint (15º), slightly rough, slightly weathered with quartz precipitation. 126.5'-126.8' - Joint (30º), moderately rough, slightly weathered with quartz and pyrite. 126.7'-126.9' - Joint (40º), moderately rough, slightly weathered with quartz and pyrite. 127.3'-127.5' - Joint (60º), rough, stepped, minor pyrite. 127.4'-127.8' - Joint (15º), slightly rough, minor pyrite. 127.7'-127.5' - Joint (60º), slightly rough, minor pyrite. 128.0' - Joint (80º), rough to very rough, slightly weathered. 128.0-128.3' - Joint (30º), slightly rough, slightly weathered with quartz and pyrite. 128.3-128.4' - Joint (60º), moderately rough, slightly weathered with quartz and pyrite. 128.5' - Joint (70º), rough, stepped, slightly weathered with quartz and pyrite. 128.7' - Incipient fracture (70º). 128.7-128.9' - Joint (40º), slightly rough, slightly weathered with quartz and pyrite. 128.9' - Joint (80º), slightly rough, stepped, slightly weathered with quartz and pyrite.	100	Box 9 126.0 130.0	RQD = 17 Drill Rate = 4 ft/20 min
+495.0	130.0	+ + +	As above, coarse grained, with increasing plagioclase >85% 129.0'-130.0' - Incipient fracture (20º) with quartz ~ 1 mm. 129.1-129.3' - Joint (45º), rough, slightly weathered with quartz + Fe oxidation. 129.7-129.8' - Joint (60º), rough.			
			End of Boring, 130.0'			

DRILLING LOG	DIVISION	INSTALLATION	SHEET 1 OF 11 SHEETS

1. PROJECT Carmel River Re-route and Dam Removal Prelim Geotech inv.	10. SIZE AND TYPE OF BIT NQ
2. LOCATION (Coordinates or Station) San Clemente Dam San Clemente Dam	11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* MSL
3. DRILLING AGENCY PC Exploration	12. MANUFACTURER'S DESIGNATION OF DRILL UDR-10
4. HOLE NO. *(As shown on drawing title and file number)* BH-2	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN : DISTURBED : UNDISTURBED
5. NAME OF DRILLER Nate Hinkle	14. TOTAL NUMBER CORE BOXES 8
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE : STARTED 11/12/2007 : COMPLETED 11/14/2007
7. THICKNESS OF OVERBURDEN 13.0	17. ELEVATION TOP OF HOLE +600.0
8. DEPTH DRILLED INTO ROCK 77.0	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE 90.0	19. GEOLOGIST Jennifer Van Pelt

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
+600.0	0.0		No recovery	0	0.0 5.0	Soil and overburden, driller will stabilize with casing
				0	5.0 10.0	

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DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE 600.0	**Hole No. BH-2**	
PROJECT Carmel River Re-route and Dam Removal Prelim Geotech inv.		INSTALLATION	SHEET 2 OF 11 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (*Drilling time, water loss, depth weathering, etc., if significant*) g
			No recovery *(continued)*			
				0	10.0 13.0	
				42	Box 1 13.0 15.0	RQD = 25 Drill Rate = 2 ft/25 min Core blocked off at ~14.5'
+585.8	14.2	+ + +	Biotite diorite, gray, medium to coarse grained, slightly to moderately weathered, hard, moderately strong, highly to intensely fractured. 14.2'-14.6' - Broken zone, highly fractured to gravel sized pieces. Some possible mechanical breakage. 14.5'-14.7' - Joint (25º), rough, slightly weathered with Fe oxidation.			
+585.0	15.0		No recovery	68	Box 1 15.0 20.0	RQD = 53 Drill Rate = 5 ft/17 min

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE 600.0

Hole No. BH-2

PROJECT Carmel River Re-route and Dam Removal Prelim Geotech inv.

INSTALLATION

SHEET 3 OF 11 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
+583.4	16.6		No recovery *(continued)*			
		+ + +	As above with increasing biotite content to ~ 40%. 16.7' - Joint (90º), moderately rough, slightly weathered with Fe oxidation. 18.4'-18.6' - Joint (50º), moderately rough, slightly weathered with Fe oxidation.			
+578.8	21.2	+ + +	20.0' - Mechanical break 20.1'-20.3' - Joint (45º), rough, stepped, slightly weathered with Fe oxidation. 20.1'-20.7' - Joint (15º), moderately rough to rough, moderately weathered with Fe oxidation. 20.4'-20.8' - Joint (10º), moderately rough, slightly weathered with Fe oxidation.	97	Box 1/2 20.0 25.0	RQD = 61 Drill Rate = 5 ft/27 min
+576.1	23.9	+ + +	As above with Increasing biotite content to ~ 20%. 21.2'-21.3' - Joint (60º), moderately rough, slightly weathered with Fe oxidation. 21.9'-22.0' - Joint (40º), slightly rough, slightly weathered with Fe oxidation. 22.0' - Mechanical break 22.0'-22.2' - Broken zone, pervasively fractured to gravel sized pieces (2 x 6 cm to 1 x 3 cm). Some possible mechanical breakage. 22.2' - Joint (80º), moderately rough, slightly weathered with Fe oxidation. 22.2'-22.4' - Joint (30º), slightly rough, slightly weathered with Fe oxidation. 22.4'-22.8' - Joints (30º), slightly rough, slightly weathered with Fe oxidation. 23.1'-23.7' - Joint (30º), slightly rough, moderately weathered with Fe oxidation. 23.2' - Joint (80º), moderately rough, little to no weathering. 23.4'-23.7' - Joint (40º), moderately rough, slightly weathered with Fe oxidation. 23.8'-23.9' - Joint (60º), moderately rough, slightly weathered with Fe oxidation.			
+575.2	24.8	+ + +	As above with increasing biotite content to >50%. 23.8'-24.0' - Broken zone, intensely fractured to gravel sized pieces. Some possible mechanical breakage.			
+575.0	25.0					

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE 600.0	**Hole No. BH-2**	
PROJECT Carmel River Re-route and Dam Removal Prelim Geotech inv.		INSTALLATION	SHEET 4 OF 11 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
			24.1' - Mechanical break No recovery As above with increasing biotite content to >50%. 25.3' - Joint (75º), slightly rough, slightly weathered. 25.4'-25.9' - Joint (20º), slightly rough, moderately weathered with Fe oxidation. 27.5'-27.9 - Joints (40º), slightly rough, moderately weathered with Fe oxidation. 25.9' - Joint (75º), slightly rough, slightly weathered with Fe oxidation. 26.1' - Joint (75º), slightly rough, slightly weathered with Fe oxidation. 26.4' - Joint (75º), slightly rough, slightly weathered with Fe oxidation. 26.4'-26.8' - Broken zone, intensely fractured, coarse sand to gravel sized pieces (2 x 7). Some possible mechanical breakage. 26.8' - Joint (80º), rough, slightly weathered with Fe oxidation. 27.0'-27.2' - Broken zone, intensely fractured. Some possible mechanical breakage. 27.1'-27.3' - Joints (30º), slightly rough, moderately weathered with Fe oxidation.	72	Box 2 25.0 28.0	RQD = 11 Drill Rate = 3 ft/15 min
			28.0'-28.7' - Broken zone, intensely fractured, small pebble to gravel sized pieces (4 x 8 cm to 0.5 x 0.5 cm). Some possible mechanical breakage. 28.7' - Joint (90º), slightly rough, slightly weathered with Fe oxidation. 28.7'-28.8' - Joint (20º), slightly rough, moderately weathered with Fe oxidation. 28.9'-29.2' - Joint (20º), slightly rough, moderately weathered with Fe oxidation. 29.1' - Joint (80º), slightly rough, slightly weathered with Fe oxidation. 29.5' - Joint (90º), slightly rough, slightly weathered with Fe oxidation. 30.2' - Joint (80º), moderately rough, slightly weathered with Fe oxidation. 30.2'-30.6' - Joint (25º), slightly rough, moderately weathered with Fe oxidation. 30.5'-30.6' - Joint (70º), moderately rough, slightly weathered with Fe oxidation. 31.0'-31.2' - Joint (50º), rough, stepped, moderately weathered with Fe oxidation. 31.2'-31.5' - Joint (40º), rough, slightly weathered with Fe oxidation. 31.3'-31.7' - Joint (70º), moderately rough. 32.0'-32.1' - Joint (70º), moderately rough, slightly weathered with Fe oxidation. 32.3'-32.5' - Joint (40º), moderately rough, weathered with Fe oxidation. 32.4'-32.8' - Broken zone, intensely fractured, small pebble to gravel sized pieces (2 x 5 cm to 0.5 x 2 cm). Some possible mechanical breakage.	101	Box 2 28.0 32.8	RQD = 48 Drill Rate = 5 ft/65 min
+567.2	32.8					
			No recovery	0	32.8 35.0	

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE 600.0	**Hole No. BH-2**
PROJECT Carmel River Re-route and Dam Removal Prelim Geotech inv.	INSTALLATION	SHEET 5 OF 11 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			No recovery *(continued)*			
				17	Box 3 35.0 40.0	RQD = 0 Hole collapsing, driller pulled rods to re-case to 40 feet.
+560.8	39.2					
		+ + +	As above with increasing biotite content to >50%. 32.4'-32.8' - Broken zone, intensely fractured, small pebble to gravel sized pieces (2 x 5 cm to 0.5 x 2 cm). Some possible mechanical breakage.			
+560.0	40.0					
			No recovery	80	Box 3 40.0 45.0	RQD = 28 Drill Rate = 5 ft/45 min
+559.0	41.0					
		+ + +	as above with increasing biotite content to >50%. Fine to medium grained. 41.1' - Joint (80º), rough. 41.3'-41.5' - Joint (40º), moderately rough, slightly weathered with Fe oxidation. 41.5' - Joint (80º), moderately rough, slightly weathered with Fe oxidation. 41.7'-41.9' - Joint (20º), moderately rough, slightly weathered. 41.9' - Joint (70º), moderately rough, slightly weathered. 42.2'-42.4' - Joint (50º), moderately rough, moderately weathered with Fe oxidation. 42.2'-43.0' - Joint (10º), moderately rough, moderately weathered with Fe oxidation.			
+557.3	42.7					
+557.0	43.0	+ + +	As above with decreasing biotite content to			

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE 600.0	Hole No. BH-2	
PROJECT Carmel River Re-route and Dam Removal Prelim Geotech inv.	INSTALLATION		SHEET 6 OF 11 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
+556.6	43.4		<40%. Fine to medium grained. 42.8'-43.0' - Joint (40º), moderately rough, moderately weathered with Fe oxidation.			
+556.2	43.8		As above with increasing biotite content to >60%. Fine to medium grained. 43.3' - Joint (80º), moderately rough, slightly weathered.			
			As above with decreasing biotite content to <30%. Fine to medium grained. 43.5' - Joint (80º), moderately rough, slightly weathered.			
+554.6 +554.0	45.4 46.0		As above with increasing biotite content to >60%. Fine to medium grained. 43.5'-44.0' - Broken zone, intensely fractured, small pebble to gravel sized pieces (2 x 4 cm to 0.5 x 1 cm). Some possible mechanical breakage. 44.0' - Joint (90º), rough, stepped, slightly weathered with Fe oxidation. 44.2'-44.3' - Joint (60º), rough, stepped, moderately weathered with Fe oxidation. 44.4' - Joint (90º), moderately rough, stepped, moderately weathered with Fe oxidation. 44.4'-44.7' - Joint (30º), moderately rough, moderately weathered with Fe oxidation. 44.7'-45.0' - Joint (30º), rough, moderately weathered. 45.0' - Mechanical Break 45.0'-45.2' - Broken zone, intesely fractured, small pebble to gravel sized pieces (2 x 4 cm to 0.3 x 1 cm). Some possible mechanical breakage. 45.2' - Incipient fracture (30º), open to ~3 mm, moderate weathering with Fe oxidation. 45.2'-45.3' - Joint (60º), rough, moderately weathered with Fe oxidation.	93	Box 3/4 45.0 50.0	RQD = 58 Drill Rate = 5 ft/50 min
			As above with decreasing biotite content to <50%. Fine to medium grained. 45.3'-45.7' - Joint (30º), rough, slightly weathered with Fe oxidation. 45.4'-45.8' - Incipient fracture (30º), tight. 45.7'-46.0' - Joint (30º), rough, moderately weathered with Fe oxidation.			
+550.5 +549.5	49.5 50.5		As above with increasing biotite content to >60%. Fine to medium grained. 46.1'-46.2' - Joint (30º), moderately rough, slightly weathered with Fe oxidation. 46.2'-46.6' - Broken zone, pervasively fractured. Some possible mechanical breakage. 46.3'-46.6' - Joint (30º), moderately rough, slightly weathered with Fe oxidation. 46.7'-47.2' - Incipient fracture (30º), tight to ~1 mm. 47.0' - Incipient fracture (70º), tight to ~1 mm. 47.2'-47.5' - Joint (30º), moderately rough, slightly weathered with Fe oxidation. 47.4'-47.7' - Joint (30º), moderately rough, slightly weathered with Fe oxidation. 47.7'-47.9' - Incipient fracture (40º), tight. 47.9'-48.1' - Joints (40º), moderately rough, moderately weathered with Fe oxidation. 48.4'-48.7' - Joint (40º), moderately rough, moderately weathered with Fe oxidation. 49.0' - Joint (70º), rough, slightly weathered.	93	Box 4 50.0 55.0	RQD = 70 Drill Rate = 5 ft/35 min
			As above with decreasing biotite content to <40%. Fine to medium grained. 49.6'-50.0' - Joint (30º), very rough, heavily weathered with Fe oxidation. 49.8' - Mechanical break 50.3' - Joint (90º), very rough, slightly weathered.			
			50.9' - Incipient fracture (90º), tight.			

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE
600.0

Hole No. BH-2

PROJECT
Carmel River Re-route and Dam Removal Prelim Geotech inv.

INSTALLATION

SHEET 7
OF 11 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
			51.1' - Joint (70º), rough, moderately weathered with Fe oxidation. 51.7'-51.9' - Joint (40º), moderately rough, moderately weathered with Fe oxidation. As above with increasing biotite content to >60%. Fine to medium grained. *(continued)* 52.0'-52.2' - Joint (40º), moderately rough, slightly weathered. 52.2'-52.5' - Joint (35º), moderately rough, moderately weathered. 52.8'-53.0' - Joint (20º), rough, heavily weathered with Fe oxidation. 53.0'-53.3' - Broken zone, intensely fractured, coarse sand to gravel sized pieces (4 x 8 cm). Some possible mechanical breakage. 53.1' - Joint (90º), very rough. 53.3'-53.5' - Joint (30º), moderately rough, moderately weathered with Fe oxidation. 54.0' - Joint (85º), very rough, slightly weathered.			
+545.0	55.0		55.0' - Mechanical break			
+544.7	55.3		Plagioclase rich vein 55.1'-55.2' - Joints (80/90º), very rough, slightly weathered.	93	Box 4/5 55.0 60.0	RQD = 42 Drill Rate = 5 ft/20 min
+540.7	59.3		Biotite diorite, gray, medium to coarse grained, slightly to moderately weathered, hard, moderately strong, highly to intensely fractured. Biotite content to >50% 55.3'-55.5' - Joint (40º), rough, slighly weathered. 55.7'-55.9' - Joint (40º), moderately rough, slightly weathered. 56.5'-56.6' - Joint (50º), rough, slightly weathered. 56.6'-56.8' - Broken zone, intensely fractured to gravel sized pieces (1 x 3 cm to 2 x 7 cm). Some possible mechanical breakage. 56.7'-57.2' - Joint (20º), moderately rough, moderately weathered. 57.3'-57.7' - Joint (30º), moderately rough, slightly weathered. 57.8' - Joint (70º), moderately rough, slightly weathered. 58.0'-58.1' - Joint (50º), moderately rough, slightly weathered. 58.2'-58.4' - Joints (40º), moderately rough, moderately weathered with Fe oxidation. 58.6' - Joint (70º), moderately rough, moderately weathered. 58.8'-59.2' - Incipient fractue (30º), tight.			
+540.2	59.8		As above with decreasing biotite content to <30%, fine to medium grained. 59.3' - Joint (70º), moderately rough, slightly weathered.			
+540.0	60.0		59.3'-59.6' - Incipient fractues (15º), anastomosing fractures, tight to ~ 1 mm.. 59.6' - Joint (70º), rough, slightly weathered.	100	Box 5 60.0 65.0	RQD = 67 Drill Rate = 5 ft/20 min
+539.5	60.5		No recovery			
			As above with increasing biotite content to >60%. Fine to medium grained. 60.0'-60.1' - Joint (50º), rough, stepped, moderately weathered. 60.6'-60.9' - plagioclase vein ~ 1 cm wide.			

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE 600.0		**Hole No. BH-2**
PROJECT Carmel River Re-route and Dam Removal Prelim Geotech inv.		INSTALLATION	SHEET 8 OF 11 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
+534.8	65.2		As above with decreasing biotite content to <50%. *(continued)* 60.0' - Joint (90º), moderately rough, moderately weathered with Fe oxidation. 60.2'-60.4' - Joint (40º), moderately rough, moderately weathered with Fe oxidation. 62.2'-62.6' - Joints (30º), moderately rough, slightly weathered with Fe oxidation. 62.4'-62.7' - Incipient fracture (30º), tight, <1 mm. 63.1'-63.2' - Joint (60º), moderately rough, stepped, slightly weathered with Fe oxidation. 63.6' - Joint (70º), moderately rough, slightly weathered. 64.2'-64.4' - Joint (40º), moderately rough, moderately weathered with Fe oxidation. 64.9' - Joint (80º), rough, slightly weathered.			
			65.1' - Broken zone, intensely fractured to pebble sized pieces (0.5 x 3 cm). Some possible mechanical breakage.	100	Box 6 65.0 70.0	RQD = 25 Drill Rate = 5 ft/20 min
+533.9	66.1		No recovery			
+532.4	67.6		As above with decreasing biotite content to <50%. 66.15' - Joint (90º). 66.6'-66.8' - Joint (40º), rough, slightly weathered. 66.6'-66.8' - Joint (35º), moderately rough, slightly weathered with Fe oxidation. 66.8'-66.9' - Joint (60º), moderately rough, moderately weathered with Fe oxidation. 67.4' - Joint (80º), rough, moderately weathered.			
+531.0	69.0		As above with increasing biotite content to >60%. Fine to medium grained. 67.5'-67.6' - Joint (60º), moderately rough, slightly weathered. 67.6'-67.8' - Joint (35º), moderately rough, moderately weathered with Fe oxidation. 67.7'-67.9' - Joint (35º), moderately rough, slightly weathered with Fe oxidation. 68.1'-68.2' - Joint (40º), moderately rough, slightly weathered with Fe oxidation. 68.3' - Joint (90º), moderately rough, slightly weathered. 68.4' - Joint (80º), rough, moderately weathered. 68.7' - Mechanical break 68.7'-69.1 - Broken zone, intensely fractured, coarse sand to pebble sized pieces. Some possible mechanical breakage. 69.0'-69.1' - Joint (70º), very rough, slightly			

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE 600.0	**Hole No. BH-2**	
PROJECT Carmel River Re-route and Dam Removal Prelim Geotech inv.	INSTALLATION		SHEET 9 OF 11 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
+527.0	73.0	+ + +	weathered with Fe oxidation. 69.2'-69.4' - Joint (40º), rough, moderately weathered. 69.6' - Joint (90º), very rough, stepped, slightly weathered with Fe oxidation. As above with decreasing biotite content to <50%. Fine to medium grained. *(continued)* 70.0' - Mechanical break 70.5'-70.7' - healed fracture, plagioclase 1-2 mm. 71.5'-71.6' - Joint (70º), slightly rough, moderately weathered with Fe oxidation. 71.7'-71.8' - Joint (60º), rough, slightly weathered. 72.8'-72.9' - Joint (60º), moderately rough, moderately weathered.	93	Box 6 70.0 75.0	RQD = 63 Drill RAte = 5 ft/45 min
+526.3	73.7	+ + +	72.8'-73.0 - Broken zone, intensely fractured, to gravel sized pieces (1 x 2 cm to 4 x 4 cm). Some possible mechanical breakage. As above with decreasing biotite content to <15%. Fine to medium grained.			
+525.0	75.0	+ + +	73.0' - Mechanical break 73.0'-73.5' - Joints (10º), slightly rough, slightly weathered with Fe oxidation. 73.0'-73.5' - Incipient fracture (10º), tight, slightly weathered. 73.5' - Joint (85º), very rough, slightly weathered with Fe oxidation. As above with increasing biotite content to >50%. Fine to medium grained. 74.2'-74.4' - Joint (50º), slightly rough, moderately weathered with Fe oxidation.			
+524.5	75.5		Plagioclase vein along fracture. 74.6' - Joint (80º), moderately rough, moderately weathered with Fe oxidation. 74.4'-74.9' - Incipient fracture. 74.8'-75.0' - Joint (40º), slightly rough, moderately weathered with Fe oxidation. No recovery	90	Box 7 75.0 80.0	RQD = 60 Drill Rate = 5 ft/60 min
		+ + +	As above with increasing biotite content to >50%. Fine to medium grained. 75.5'-75.7' - Joint (40º), slightly rough, slightly weathered. 75.8'-76.2' - Joint (30º), rough, stepped, slightly weathered. 76.5' - Mechanical break 79.3'-79.4' - Joint (60º), slightly rough, moderately weathered with Fe oxidation. 77.6'-78.0' - Joint (30º), moderately rough, moderately weathered with Fe oxidation. 77.7' - Joint (90º), rough. 78.4'-78.5' - Joint (60º), moderately rough, slightly weathered. 78.7' - Joint (70º), moderately rough, slightly weathered with Fe oxidation.			

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE
600.0

Hole No. BH-2

PROJECT
Carmel River Re-route and Dam Removal Prelim Geotech inv.

INSTALLATION

SHEET 10
OF 11 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			78.8'-78.9' - Joint (60º), moderately rough, moderately weathered with Fe oxidation. As above with increasing biotite content to >50%. Fine to medium grained. *(continued)* 78.9'-79.1' - Joint (40º), moderately rough, moderately weathered with Fe oxidation. 79.7'-79.9' - Joints (40/50º), slightly rough, moderately weathered with Fe oxidation.			
+520.0	80.0		79.9'-80.0' - Joint (65º), moderately rough, slightly weathered with Fe oxidation.	95	Box 7/8 80.0 85.0	RQD = 77 Drill Rate = 5 ft/50 min
+519.7	80.3		No recovery			
			As above with increasing biotite content to >50%. Fine to medium grained. 80.9'-81.0' - Incipient fracture (70º), open to ~ 0.5 mm, slightly weathered with Fe oxidation. 81.0' - Joint (80º), moderately rough, moderately weathered with Fe oxidation. 81.3'-81.4' - Joint (60º), slightly rough, moderately weathered with Fe oxidation. 81.5' - Joint (80º), slightly rough, slightly weathered. 81.6'-81.8' - Joint (40º), rough, stepped, slightly weathered with Fe oxidation. 81.6'-81.9' - plagioclase seams (40º), 1 to 3 cm wide. 82.0'-82.1' - Joint (50º), rough, slightly weathered with Fe oxidation. 82.8'-83.0' - Joint (40º), moderately rough, slightly weathered. 83.1'-83.2' - Joint (40º), moderately rough, slightly weathered. 83.3'-83.5' - Joint (40º), moderately rough, slightly weathered. 83.5'-83.6' - Joint (40º), moderately rough, slightly weathered.			
			85.0' - Mechanical break 83.0'-83.2' - Joints (30º), moderately rough, slightly weathered. 85.2'-85.5' - Joint (30º), slightly rough, moderately weathered with Fe oxidation and chloritic alteration. 85.5'-85.8' - Joint (30º), moderately rough, moderately weathered with Fe oxidation. 85.8'-85.9' - Joint (50º), rough, slightly weathered. 86.0' - Joint (90º), rough, slightly weathered with. 86.1' - Joint (80º), slightly rough, stepped, slightly weathered. 86.1'-86.5 - Broken zone, intensely fractured, to gravel sized pieces (0.5 x 2 cm to 2 x 5 cm). Some possible mechanical breakage. 86.4'-86.5' - Joint (40º). 86.7'-86.8' - Joint (40º), rough, slightly weathered. 87.1'-87.3' - Incipient fracture (30º), tight to 0.2 mm, minor weathering.	101	Box 8 85.0 90.3	RQD = 71 Drill Rate = 5 ft/55 min

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE 600.0	**Hole No. BH-2**

PROJECT	INSTALLATION	SHEET
Carmel River Re-route and Dam Removal Prelim Geotech inv.		11 OF 11 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS (*Drilling time, water loss, depth weathering, etc., if significant*) g
			87.9'-88.1' - Incipient fracture (35º), tight to 0.2 mm, minor weathering. As above with increasing biotite content to >50%. Fine to medium grained. *(continued)* 88.0'-88.3' - Joint (35º), moderately rough, slightly weathered. 88.7'-88.9' - Joint (50º), moderately rough, slightly weathered.			
+509.7	90.3		90.1'-90.2' - Joint (40º), moderately rough, slightly weathered.			
			90.1'-90.4' - Broken zone, intensely fractured, to gravel sized pieces (0.5 x 2 cm to 2 x 5 cm). Some possible mechanical breakage. End of boring at 90.3'.			

Customer:	**California State Coastal Conservancy**	**Project Number:**	**1881772**
Site Name:	**San Clemente Dam**	**Site Location:**	**Monterey County, California**

Photograph ID: 1

Date: Nov 2, 2007

Location:
San Clemente Dam

Direction:

Comments:
BH-1 Box#1 10'-34'

Photograph ID: 2

Date: Nov 2, 2007

Location:
San Clemente Dam

Direction:

Comments:
BH-1 Box#2 34'-44'

Customer:	**California State Coastal Conservancy**	**Project Number:**	**1881772**
Site Name:	**San Clemente Dam**	**Site Location:**	**Monterey County, California**

Photograph ID: 3

Date: Nov 2, 2007

Location:
San Clemente Dam

Direction:

Comments:
BH-1 Box#3 44'-54'

Photograph ID: 4

Date: Nov 6, 2007

Location:
San Clemente Dam

Direction:

Comments:
BH-1 Box#4 54'-63'

Customer:	**California State Coastal Conservancy**	**Project Number:**	**1881772**
Site Name:	**San Clemente Dam**	**Site Location:**	**Monterey County, California**

Photograph ID: 5

Date: Nov 6, 2007

Location:
San Clemente Dam

Direction:

Comments:
BH-1 Box#5 63'-76'

Photograph ID: 6

Date: Nov 7, 2007

Location:
San Clemente Dam

Direction:

Comments:
BH-1 Box#6 76'-91'

Customer:	**California State Coastal Conservancy**	**Project Number:**	**1881772**
Site Name:	**San Clemente Dam**	**Site Location:**	**Monterey County, California**

Photograph ID: 7

Date: Nov 7, 2007

Location:
San Clemente Dam

Direction:

Comments:
BH-1 Box#7 91'-110'

Photograph ID: 8

Date: Nov 7, 2007

Location:
San Clemente Dam

Direction:

Comments:
BH-1 Box#8 110'-120'

Customer:	**California State Coastal Conservancy**	**Project Number:**	**1881772**
Site Name:	**San Clemente Dam**	**Site Location:**	**Monterey County, California**

Photograph ID: 9

Date: Nov 7, 2007

Location:
San Clemente Dam

Direction:

Comments:
BH-1 Box#9 120'-130'

Photograph ID: 10

Date: Nov 12, 2007

Location:
San Clemente Dam

Direction:

Comments:
BH-2 Box#1 0'-24'

Customer:	**California State Coastal Conservancy**	**Project Number:**	**1881772**
Site Name:	**San Clemente Dam**	**Site Location:**	**Monterey County, California**

Photograph ID: 11

Date: Nov 13, 2007

Location:
San Clemente Dam

Direction:

Comments:
BH-2 Box#1 24'-32'10"

Photograph ID: 12

Date: Nov 14, 2007

Location:
San Clemente Dam

Direction:

Comments:
BH-2 Box#3 35'-48'

Customer:	**California State Coastal Conservancy**	**Project Number:**	**1881772**
Site Name:	**San Clemente Dam**	**Site Location:**	**Monterey County, California**

Photograph ID: 13

Date: Nov 14, 2007

Location:
San Clemente Dam

Direction:

Comments:
BH-2 Box#4 48'4"-56'9"

Photograph ID: 14

Date: Nov 14, 2007

Location:
San Clemente Dam

Direction:

Comments:
BH-2 Box#5 56'9"-65'2"

Customer:	**California State Coastal Conservancy**	**Project Number:**	**1881772**
Site Name:	**San Clemente Dam**	**Site Location:**	**Monterey County, California**

Photograph ID: 15

Date: Nov 14, 2007

Location:
San Clemente Dam

Direction:

Comments:
BH-2 Box#6 65'-75'

Photograph ID: 16

Date: Nov 14, 2007

Location:
San Clemente Dam

Direction:

Comments:
BH-2 Box#7 75'-83'3"

Customer:	**California State Coastal Conservancy**	**Project Number:**	**1881772**
Site Name:	**San Clemente Dam**	**Site Location:**	**Monterey County, California**

Photograph ID: 17

Date: Nov 14, 2007

Location:
San Clemente Dam

Direction:

Comments:
BH-2 Box#8 83'3"-90'.4"

LOG OF BORING NO.BH-3

DATE DRILLED: Nov. 5 to Nov. 6, 2007 **ELEVATION:** +/- 530 feet msl
EQUIPMENT: Skid-Mounted, Mud-Rotary Drill Rig

DRILLING CONTRACTOR: PC Explorations, Inc.
DRILLER/HELPER: John/Andy
DATE:
PREPARED BY: DH
REVIEWED BY:

SAMPLE NO. / SAMPLE TYPE	BLOWS PER 6 INCHES	SPT-N	INCHES DRIVEN / INCHES RECOVERED	DRY DENSITY (pcf)	DEPTH (feet)	MOISTURE CONTENT (%)	GRAPHIC LOG		TESTS
								Well graded GRAVEL (GW), grayish brown, loose, dry to moist. Subangular to subrounded sand and gravel. Recent alluvium.	
								Poorly graded SAND with gravel (SP), grayish brown, loose, moist. Predominately medium to coarse sand. Subangular to subrounded sand and gravel. Occasional organic interbeds. Recent alluvium.	
1/T(2-in ID)	3	10*	18/6		5				Grain Size
	4								
	6								
2/T	5	6	18/5		10	25.3		-Becomes dark gray and subangular.	
	4								
	2								
								-Becomes loose to medium dense.	Grain Size
3a	3	11*	18/8		15			Silty SAND (SM), dark gray, loose, moist. Predominately fine sand. Occasional organic interbeds.	Grain Size
3b/T(2-in ID)	5								
	6								
						30.6			
4a	2	10	18/14		20	97.6		Poorly graded SAND with silt (SP-SM), dark gray, loose, moist. Fine sand. Non-plastic. Occasional organic interbeds. Recent alluvium.	
4b/T	5								
	5								
5/T(2-in ID)	7	14*	18/12		25			-Becomes wet.	Grain Size
	6								
	8								
6/T	12	20	18/13		30	58.4		-Becomes gray, medium dense, moist, fine to coarse sand.	
	12								
	8								
7/T (2-in ID)	12	20*	18/13		35				Grain Size
	12								
	8								
								Silty SAND with organic fines (SM), gray to black, loose, moist. Non-plastic. Fine sand. Recent alluvium.	

THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF ACTUAL CONDITIO

MWH

CARMEL RIVER REROUTE AND SAN CLEMENTE DAM REMOVAL
CALIFORNIA STATE COASTAL CONSERVANCY
SAN CLEMENTE DAM
MONTEREY COUNTY, CALIFORNIA

PROJECT NO.
1881772

DRAWING NO.

LOG OF BORING NO. BH-3

DATE DRILLED: Nov. 5 to Nov. 6, 2007 **ELEVATION:** +/- 530 feet msl

EQUIPMENT: Skid-Mounted, Mud-Rotary Drill Rig

SAMPLE NO. / SAMPLE TYPE	BLOWS PER 6 INCHES	SPT-N	INCHES DRIVEN / INCHES RECOVERED	DRY DENSITY (pcf)	DEPTH (feet)	MOISTURE CONTENT (%)	GRAPHIC LOG		TESTS
							▦	Poorly graded SAND with silt (SP-SM), gray, medium dense, moist. Fine to coarse sand. Non-plastic. Recent Alluvium.	
							▦	Silty SAND with organic fines (SM), gray to black, loose, moist. Non-plastic. Fine sand. Recent alluvium.	
					40		▦		Grain Size
8/T	4	11	18/16			73.3	▦		
	5						▦		
	6						▦		
							▨	Organic SILT with sand (OH), dark brown to black, very stiff, moist. Highly plastic. Pre-dam deposit.	
					45		▨		P200 PI
9/T (2-in ID)	7	*	16/16				▨		
	13						▨		
	50/4-in							Boring terminated at 17.5 feet below the ground surface due to refusal on bedrock.	
								* Blow counts based on a modifided California split spoon sampler driven with a 140-lb hammer.	
					50				
					55				
					60				
					65				
					70				

DRILLING CONTRACTOR: PC Explorations, Inc.

DRILLER/HELPER: John/Andy

PREPARED BY: DH

REVIEWED BY:

DATE:

THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF ACTUAL CONDITIONS ENCOUNTERED.

MWH

CARMEL RIVER REROUTE AND SAN CLEMENTE DAM REMOVAL
CALIFORNIA STATE COASTAL CONSERVANCY
SAN CLEMENTE DAM
MONTEREY COUNTY, CALIFORNIA

PROJECT NO.
1881772

DRAWING NO.

LOG OF BORING NOBH-4

DATE DRILLED: Nov. 7, 2007
ELEVATION: +/- 530 feet msl
EQUIPMENT: Skid-Mounted, Mud-Rotary Drill Rig

DRILLING CONTRACTOR: PC Explorations, Inc.
DRILLER/HELPER: John/Andy
DATE:
PREPARED BY: DH
REVIEWED BY:

SAMPLE NO. / SAMPLE TYPE	BLOWS PER 6 INCHES	SPT-N	INCHES DRIVEN / INCHES RECOVERED	DRY DENSITY (pcf)	DEPTH (feet)	MOISTURE CONTENT (%)	GRAPHIC LOG		TESTS
								Well graded GRAVEL (GW), grayish brown, loose, dry to moist. Subangular to subrounded sand and gravel. Recent alluvium	
10/T	5	9	18/0		5			-No Recovery.	
	5								
	4							Poorly graded SAND with gravel (SP), grayish brown, loose, wet. Subangular to angular sand and gravel. Predominately fine gravel. Recent alluvium.	
									Grain Size
11a	8	10*	18/12		10			Poorly graded SAND with silt (SP-SM), dark gray, loose, wet. Subangular to angular sand. Gravel up to 1.5-in diameter. Recent alluvium.	Grain Size
11b(2in ID)	5								
	5								
						32.6		-Becomes dark gray and moist.	
12b	6	8	18/14		15	32.6		Poorly graded SAND (SP), dark gray, loose, moist. Subangular to subrounded. Recent alluvium.	
12a/T	4								
	4								
13/T(2-in ID)	7	10*	18/12		20			-4-in thick layer of silty fine sand.	Grain Size
	5							-With gravel.	
	5								
						26.8		-With organic debris (leaves) at 25.0 to 25.5 feet.	
14a	3	7	18/18		25	52.3		Silty SAND (SM), dark brown, loose, moist. Subangular to Subrounded. Course sand. Low placticity fines. Occasional organic debris (wood and leaves). Possible pre-dam deposit.	
14b/T	3								
	4								
								Sandy SILT (SM), dark gray to black, medium stiff, moist. Subangular to subrounded. Moderately plastic fines. Fine sand. Occasional organic debris (wood and leaves). Possible pre-dam deposit.	
15/T(2-in ID)	3	8*	18/18		30				Grain Size
	3								
	5								
16/T	20	33	18/3		35			-As above.	
	20							Boring terminated at 36.5 feet below the ground surface due to refusal on bedrock.	
	13								
								* Blow counts based on a modifided California split spoon sampler driven with a 140 lb hammer.	

THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF ACTUAL CONDITIO

MWH

CARMEL RIVER REROUTE AND SAN CLEMENTE DAM REMOVAL
CALIFORNIA STATE COASTAL CONSERVANCY
SAN CLEMENTE DAM
MONTEREY COUNTY, CALIFORNIA

PROJECT NO.
1881772

DRAWING NO.

LOG OF BORING NO. BH-5

DATE DRILLED: Nov. 12, 2007 **ELEVATION:** +/- 530 feet msl
EQUIPMENT: Skid-Mounted, Mud-Rotary Drill Rig

DRILLING CONTRACTOR: PC Explorations, Inc
DRILLER/HELPER: John/Andy
DATE:
PREPARED BY: DH
REVIEWED BY:

SAMPLE NO. / SAMPLE TYPE	BLOWS PER 6 INCHES	SPT-N	INCHES DRIVEN / INCHES RECOVERED	DRY DENSITY (pcf)	DEPTH (feet)	MOISTURE CONTENT (%)	GRAPHIC LOG	DESCRIPTION	TESTS
							▨	Poorly graded SAND with gravel (SP), brown, loose, moist. Subangular to subrounded sand and gravel. Recent Alluvium.	
					5		▨	-As above.	Grain Size
1/T(2-in ID)	5	10*	18/10				▨		
	4						▨		
	6						▨		
					10	11.1	▨	-Becomes grayish brown and very loose.	
2/T	3	4	18/15				▨		
	2						▨		
	2						▨		
							▨	-With interbeds of loose silty fine sand, wet.	
					15		▨	Poorly graded GRAVEL with sand (GP), dark gray to black, very dense, wet. Subangular to subrounded sand and gravel. Possible pre-dam deposit.	Grain Size
3/T(2-in ID)	3		17/6				▨		
	14						▨		
	50/3-in						▨		
								Boring terminated at 17.5 feet below the ground surface due to refusal on bedrock.	
4/T	50/5-in		5/4					* Blow counts based on a modifided California split spoon sampler driven with a 140 lb hammer.	
					20				
					25				
					30				
					35				

THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF ACTUAL CONDITIONS ENCOUNTERED.

MWH

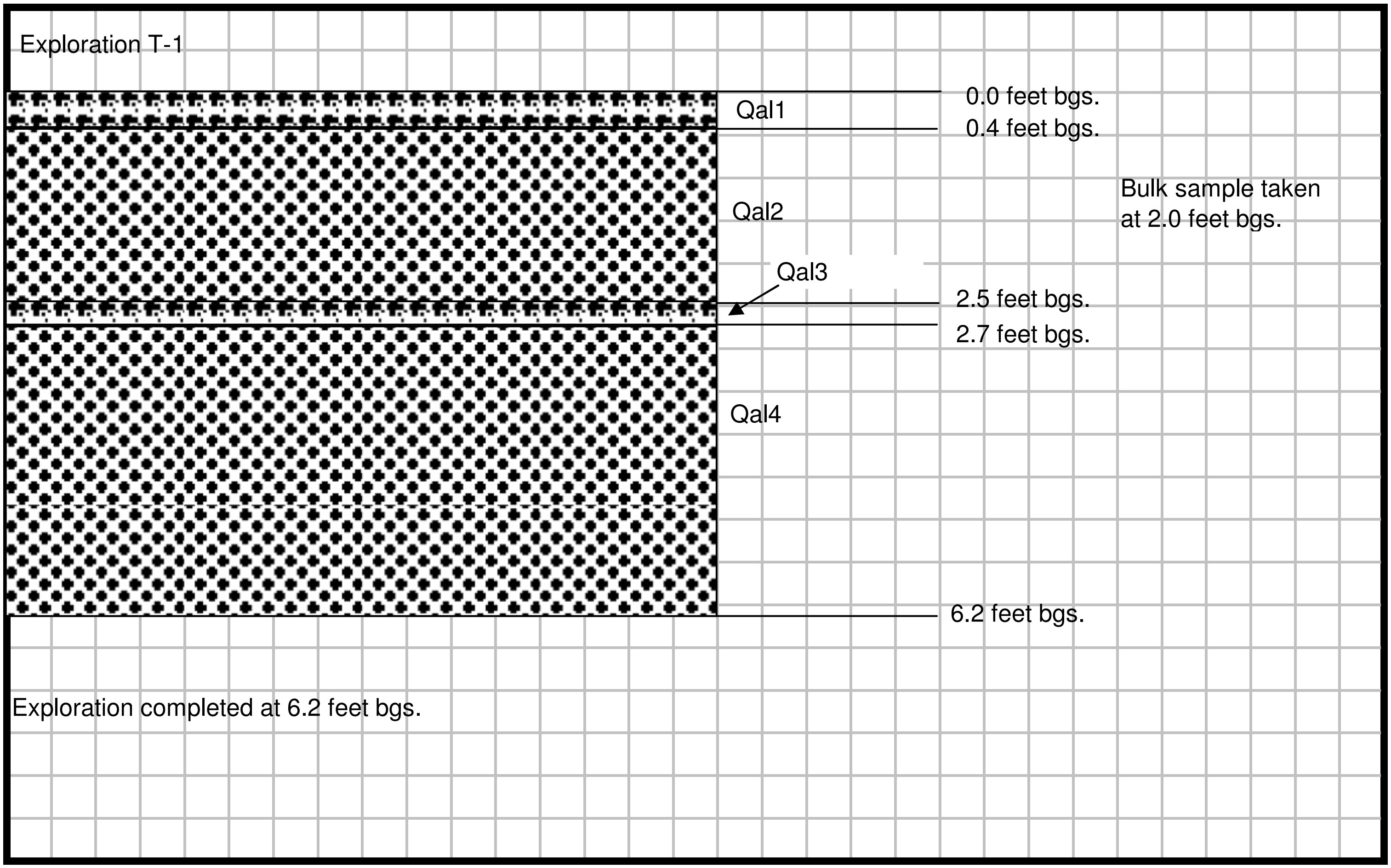
CARMEL RIVER REROUTE AND SAN CLEMENTE DAM REMOVAL
CALIFORNIA STATE COASTAL CONSERVANCY
SAN CLEMENTE DAM
MONTEREY COUNTY, CALIFORNIA

PROJECT NO.
1881772

DRAWING NO.

Project Name:	Carmel River Re-Route and San Clemente Dam Removal	Date:	November 15, 2007
Project Location:	Monterey County, California	Logger:	J. Van Pelt
Project No.:	1881772	Equipment:	Shovel
Trench Location:	T-1 (Proposed Temporary Sheet Pile Cofferdam)	Ground Surface El.:	535 +/-

SAMPLE NO. & TYPE	GEOLOGIC UNIT	MATERIAL DESCRIPTION
	Qal1	Poorly graded GRAVEL with sand (GP), tan to brown, loose, moist. Subrounded gravel and cobbles. Angular to subangular sand. Predominately medium to coarse sand. (Recent alluvium)
1 Bulk	Qal2	Poorly graded SAND with gravel (SP), tan to brown, loose, moist. Predominately medium to coarse sand. Cobbles to 4 inches in diameter. Subrounded gravel and cobbles. Angular to subangular sand. (Recent alluvium)
	Qal3	Poorly graded GRAVEL with sand (GP), dark gray, loose, moist. Subangular. Occasional organic debris (wood). (Recent alluvium).
	Qal4	Poorly graded SAND (SP), brown, loose, moist. (Recent alluvium).
		Notes
		1 Contains some organic debris at 5.0 feet.
		2 Grades slightly coarser below 5.0 feet.
		3 No groundwater seepage observed.
		4 No caving observed



MWH

CARMEL RIVER REROUTE AND SAN CLEMENTE DAM REMOVAL
CALIFORNIA COASTAL CONSERVANCY
SAN CLEMENTE DAM
MONTEREY COUNTY, CALIFORNIA

PROJECT NO.
1881772

DRAWING NO.

APPENDIX B
Laboratory Testing Program

APPENDIX B
LABORATORY TESTING PROGRAM

Laboratory testing was conducted by two subcontracted laboratories. Cooper Testing Labs of Palo Alto, California, conducted all laboratory testing of soil samples. Testing of rock core samples was conducted by Geo Test Unlimited of Nevada City, California. Laboratory tests were conducted in accordance with appropriate ASTM standards. Descriptions of the laboratory tests conducted on selected soil samples are presented below. Test results are presented in the boring logs in Appendix A and are summarized in the following pages.

B.1 Moisture Testing

Moisture content tests were performed on selected samples recovered from soil borings. The results of these tests were used to correlate strength and compressibility data and to aid in evaluating soil properties. Moisture content and density tests were conducted in accordance with ASTM D 2216.

B.2 Sieve Analysis

Sieve analyses (percent passing the No. 200 sieve and full sieve analysis) were performed on selected samples of the subsurface materials. These tests were performed to evaluate the gradation characteristics of the soils and to aid in their classification. These tests were performed in accordance with ASTM D 1140 and ASTM D 422.

B.3 Atterberg Limits Testing (Liquid Limit, Plastic Limit, and Plasticity Index)

Atterberg limits are used primarily for classifying and indexing cohesive soil. The liquid and plastic limits, which are defined as the moisture content of a cohesive soil at established limits for liquid and plastic behavior, respectively, were determined for selected samples in general accordance with guidelines presented in ASTM D 4318. Plasticity index is defined as difference in the water content between the liquid limit and the plastic limit.

B.4 Soil and Rock Classification

Visual soil classifications were conducted on all samples in the field and confirmed by laboratory testing. All soils were classified in general accordance with the Unified Soil Classification System as described by ASTM D 2487, which includes stiffness/relative density, color, major soil type (based on grain size), minor soil types, and relative moisture content. Rock core samples were classified in the field in general accordance with the methods set forth by USACE (1994). Classifications and sampling intervals are shown in the boring logs. The logs indicate the depths at which the soils or their characteristics change, although the change actually could be gradual. If the change occurred between sample locations, the depth was interpreted**.**

B.5 Unconfined Compression Test

Unconfined compression tests were conducted on selected rock core samples. Tests were conducted in general accordance with ASTM D 2938 test methods. Test results were used to establish preliminary rock strength parameters for the purpose of slope stability analysis of the proposed bypass channel.

B.6 Point Load Strength Index Testing

Point load strength index testing was conducted on selected rock core samples. Tests were conducted in general accordance with ASTM D 5731 test methods. Point load strength index tests were used to establish preliminary strength data of rock for evaluating slope stability of the proposed bypass channel.

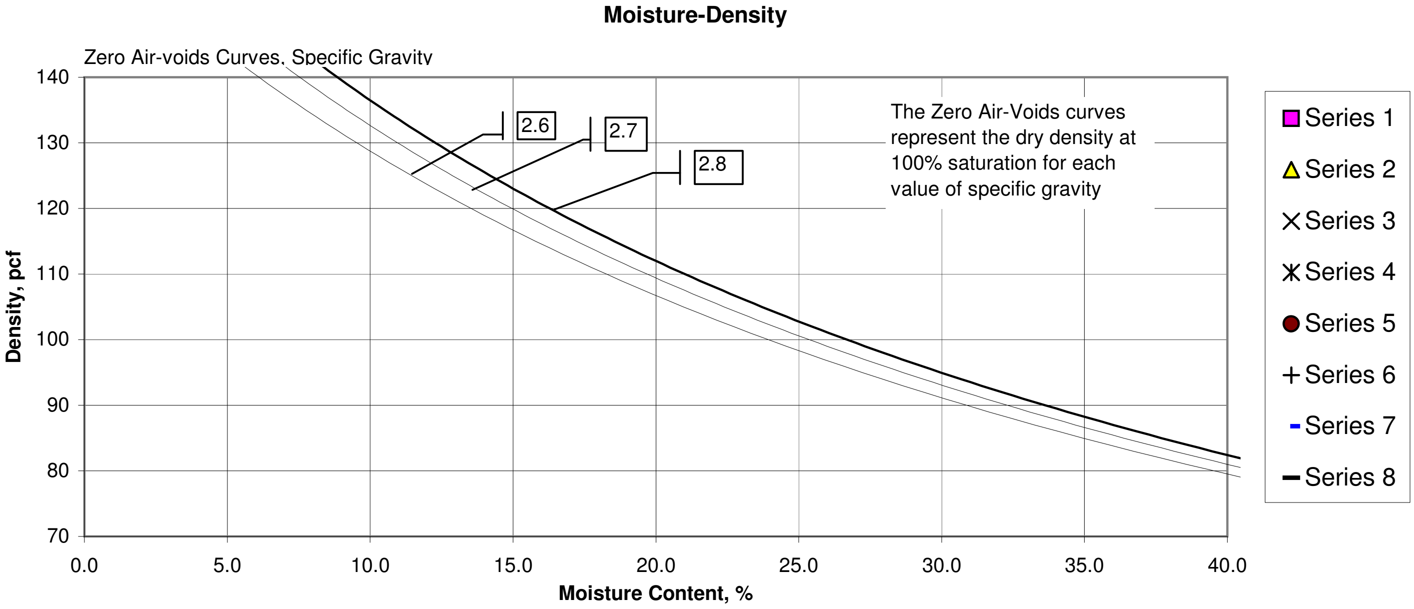
Moisture-Density-Porosity Report

Cooper Testing Labs, Inc.

Job No: 207-057a **Date:** 11/19/07
Client: MWH **By:** RU
Project: San Clemente Dam Removal - 1881772.181602

Boring:	BH-3	BH-3	BH-3	BH-3	BH-3	BH-4	BH-4	BH-4
Sample:	2	4a	4b	6	8	12a	12b	14a
Depth, ft:	10	20	20	30	40	15	15	25
Visual Description:	Dark Gray & Black Silty SAND	Dark Gray SAND	Dark Gray & Black Sandy SILT	Dark Gray & Black SILT w/ organics	Dark Gray & Black SILT w/ organics	Grayish GRAVEL	Dark Gray Silty SAND	Dark Brown SAND w/ Silt
Actual G_s								
Assumed G_s								
Total Vol cc								
Vol Solids,cc								
Vol Voids,cc								
Moisture, %	25.3	30.6	97.6	58.4	73.3	21.8	32.6	26.8
Wet Unit wt, pcf								
Dry Unit wt, pcf								
Saturation, %								
Porosity, %								
Air filled Poros.,%								
Water filled Poros.,%								
Void Ratio								
Series	1	2	3	4	5	6	7	8

Note: If an assumed specific gravity (Gs) was used then the saturation, porosities, and void ratio should be considered approximate.



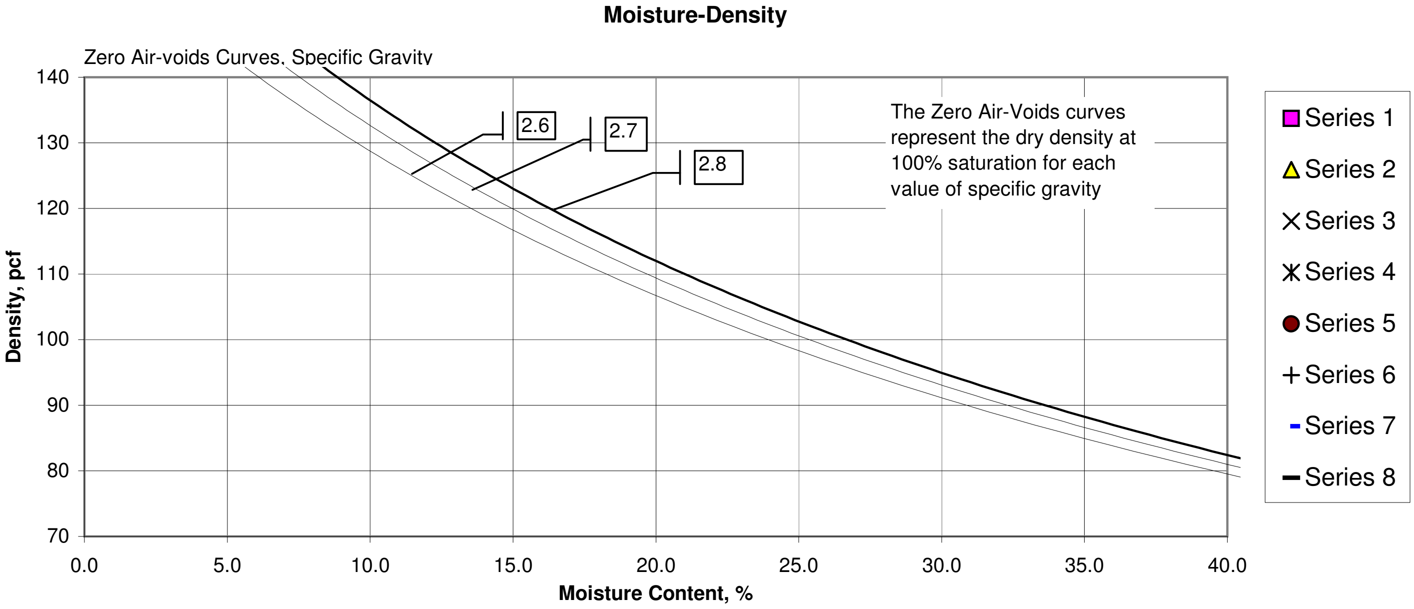
Moisture-Density-Porosity Report

Cooper Testing Labs, Inc.

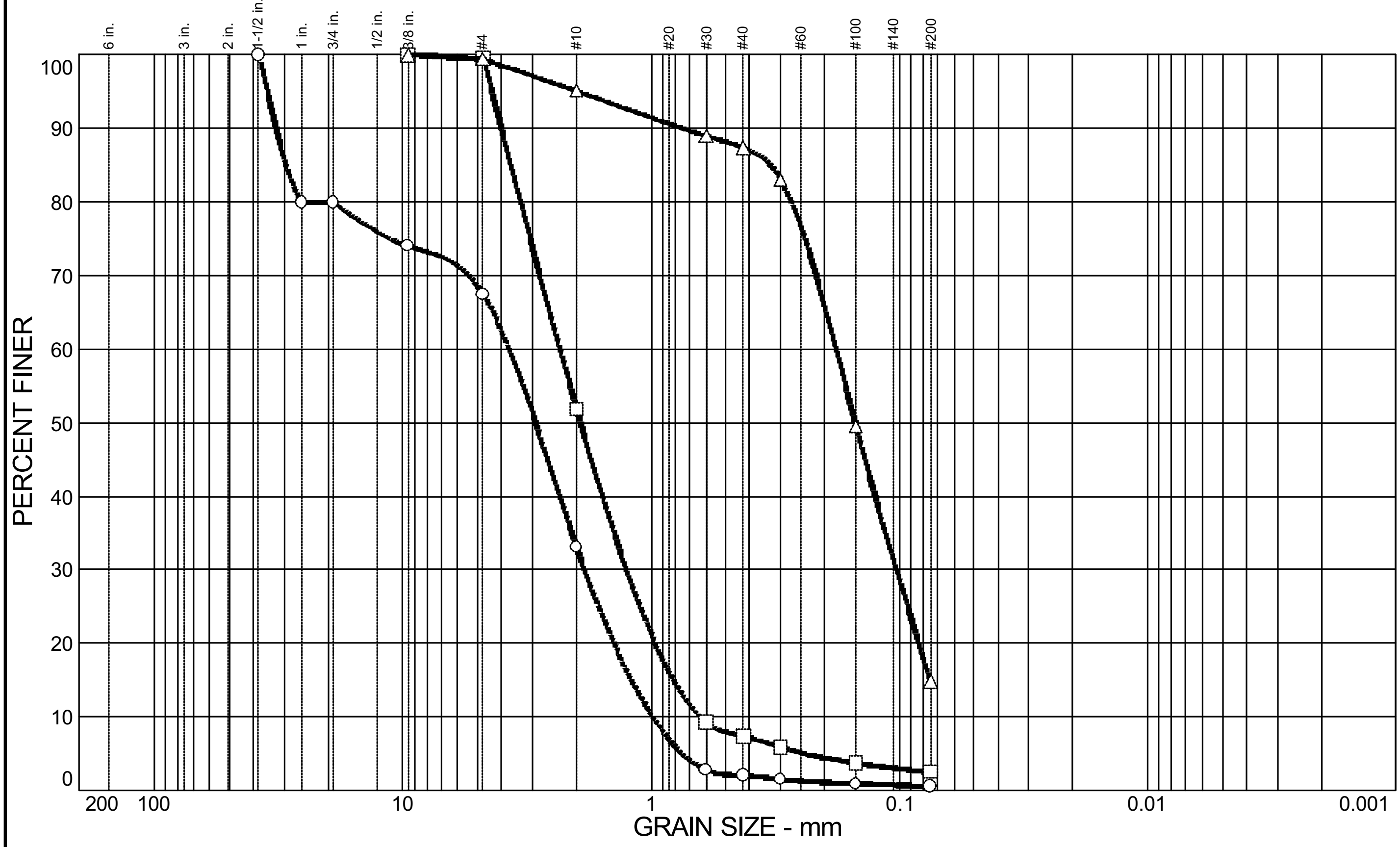
Job No: 207-057b **Date:** 11/19/07
Client: MWH **By:** RU
Project: San Clemente Dam Removal - 1881772.181602

Boring:	BH-4	BH-5						
Sample:	14b							
Depth, ft:	25	10						
Visual Description:	Dark Gray SILT w/ organics	Grayish Brown GRAVEL w/ Silt & Sand						
Actual G_s								
Assumed G_s								
Total Vol cc								
Vol Solids,cc								
Vol Voids,cc								
Moisture, %	52.3	11.1						
Wet Unit wt, pcf								
Dry Unit wt, pcf								
Saturation, %								
Porosity, %								
Air filled Poros.,%								
Water filled Poros.,%								
Void Ratio								
Series	1	2	3	4	5	6	7	8

Note: If an assumed specific gravity (Gs) was used then the saturation, porosities, and void ratio should be considered approximate.



PARTICLE SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		32.6	66.9	0.5					
□		0.5	97.0	2.5					
△		0.6	84.6	14.8					

SIEVE inches size	PERCENT FINER ○	□	△
1.5	100.0		
1	79.9		
3/4	79.9		
3/8	74.0	100.0	100.0
	GRAIN SIZE		
D_{60}	3.73	2.34	0.181
D_{30}	1.86	1.26	0.103
D_{10}	0.988	0.634	
	COEFFICIENTS		
C_c	0.93	1.07	
C_u	3.78	3.69	

SIEVE number size	PERCENT FINER ○	□	△
#4	67.4	99.5	99.4
#10	33.1	51.8	95.1
#30	2.8	9.3	89.0
#40	2.0	7.4	87.4
#50	1.5	5.9	83.0
#100	0.9	3.7	49.5
#200	0.5	2.5	14.8

SOIL DESCRIPTION

○ Grayish Brown Poorly Graded SAND w/ Gravel

□ Gray Poorly Graded SAND

△ Dark Gray Silty SAND

REMARKS:

○

□

△

○ Source: BH-3 Elev./Depth: 5'

□ Source: BH-3 Sample No.: 3a Elev./Depth: 15'

△ Source: BH-3 Sample No.: 3b Elev./Depth: 15'

COOPER TESTING LABORATORY

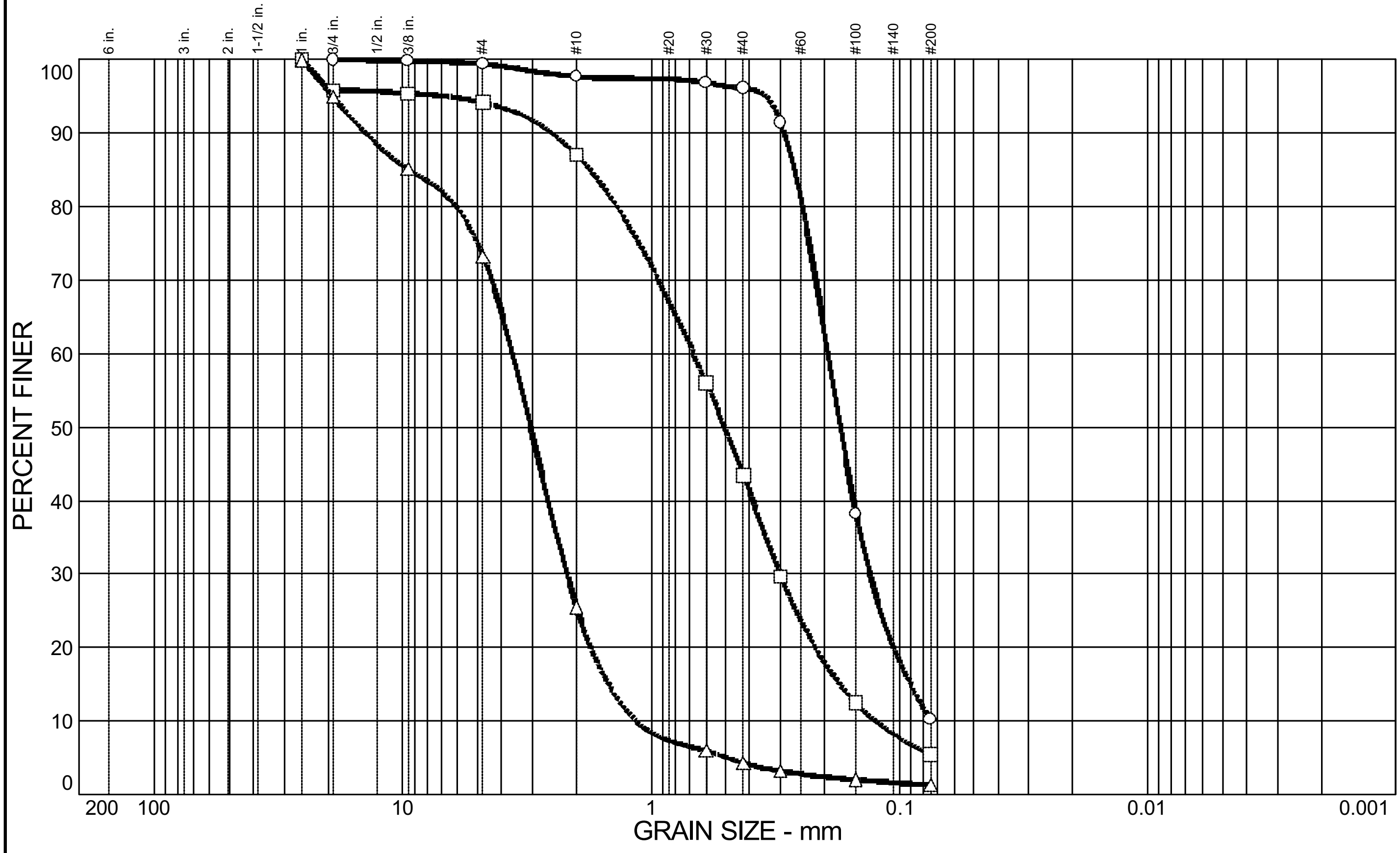
Client: MWH

Project: San Clemente Dam Removal - 1881772.181602

Project No.: 207-057

Figure

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		0.6	89.2	10.2					
□		5.8	88.8	5.4					
△		26.8	71.9	1.3					

SIEVE inches size	PERCENT FINER ○	□	△
1		100.0	100.0
3/4	100.0	95.8	94.9
3/8	99.8	95.4	85.1
	GRAIN SIZE		
D_{60}	0.195	0.676	3.63
D_{30}	0.132	0.302	2.19
D_{10}		0.125	1.15
	COEFFICIENTS		
C_c		1.09	1.15
C_u		5.42	3.16

SIEVE number size	PERCENT FINER ○	□	△
#4	99.4	94.2	73.2
#10	97.7	87.1	25.5
#30	96.9	56.0	6.0
#40	96.1	43.4	4.3
#50	91.4	29.7	3.2
#100	38.2	12.5	2.0
#200	10.2	5.4	1.3

SOIL DESCRIPTION

○ Gray Poorly Graded SAND w/ Silt

□ Gray Poorly Graded SAND w/ Silt

△ Grayish Brown Poorly Graded SAND w/ Gravel

REMARKS:

○

□

△

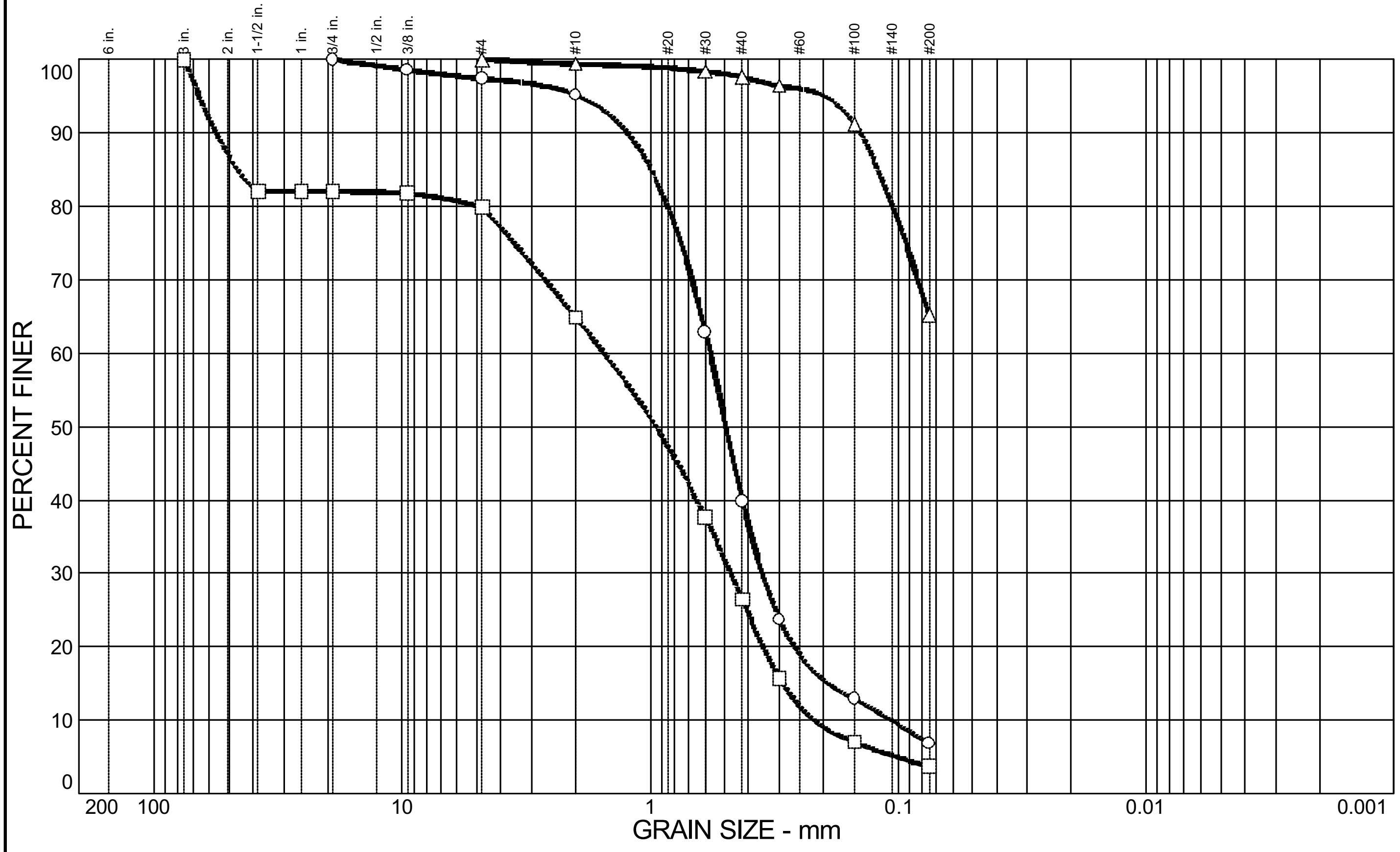
○ Source: BH-3 Sample No.: 5 Elev./Depth: 25'
□ Source: BH-3 Sample No.: 7 Elev./Depth: 35'
△ Source: BH-4 Sample No.: 11a Elev./Depth: 10'

COOPER TESTING LABORATORY

Client: MWH
Project: San Clemente Dam Removal - 1881772.181602

Project No.: 207-057 Figure

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		2.6	90.6	6.8					
□		20.1	76.2	3.7					
△			34.8	65.2					

SIEVE inches size	PERCENT FINER ○	□	△
3		100.0	
1.5		82.0	
1		82.0	
3/4	100.0	82.0	
3/8	98.6	81.8	
	GRAIN SIZE		
D_{60}	0.574	1.54	
D_{30}	0.353	0.473	
D_{10}	0.106	0.218	
	COEFFICIENTS		
C_c	2.04	0.67	
C_u	5.40	7.05	

SIEVE number size	PERCENT FINER ○	□	△
#4	97.4	79.9	100.0
#10	95.2	64.9	99.4
#30	62.8	37.7	98.4
#40	39.8	26.4	97.6
#50	23.7	15.7	96.4
#100	12.9	7.0	91.2
#200	6.8	3.7	65.2

SOIL DESCRIPTION

○ Dark Gray Poorly Graded SAND w/ Silt

□ Dark Gray Poorly Graded SAND w/ Gravel

△ Dark Gray & Black Sandy SILT

REMARKS:

○

□

△

○ Source: BH-4 Sample No.: 11b Elev./Depth: 10'

□ Source: BH-4 Sample No.: 13 Elev./Depth: 20'

△ Source: BH-4 Elev./Depth: 30'

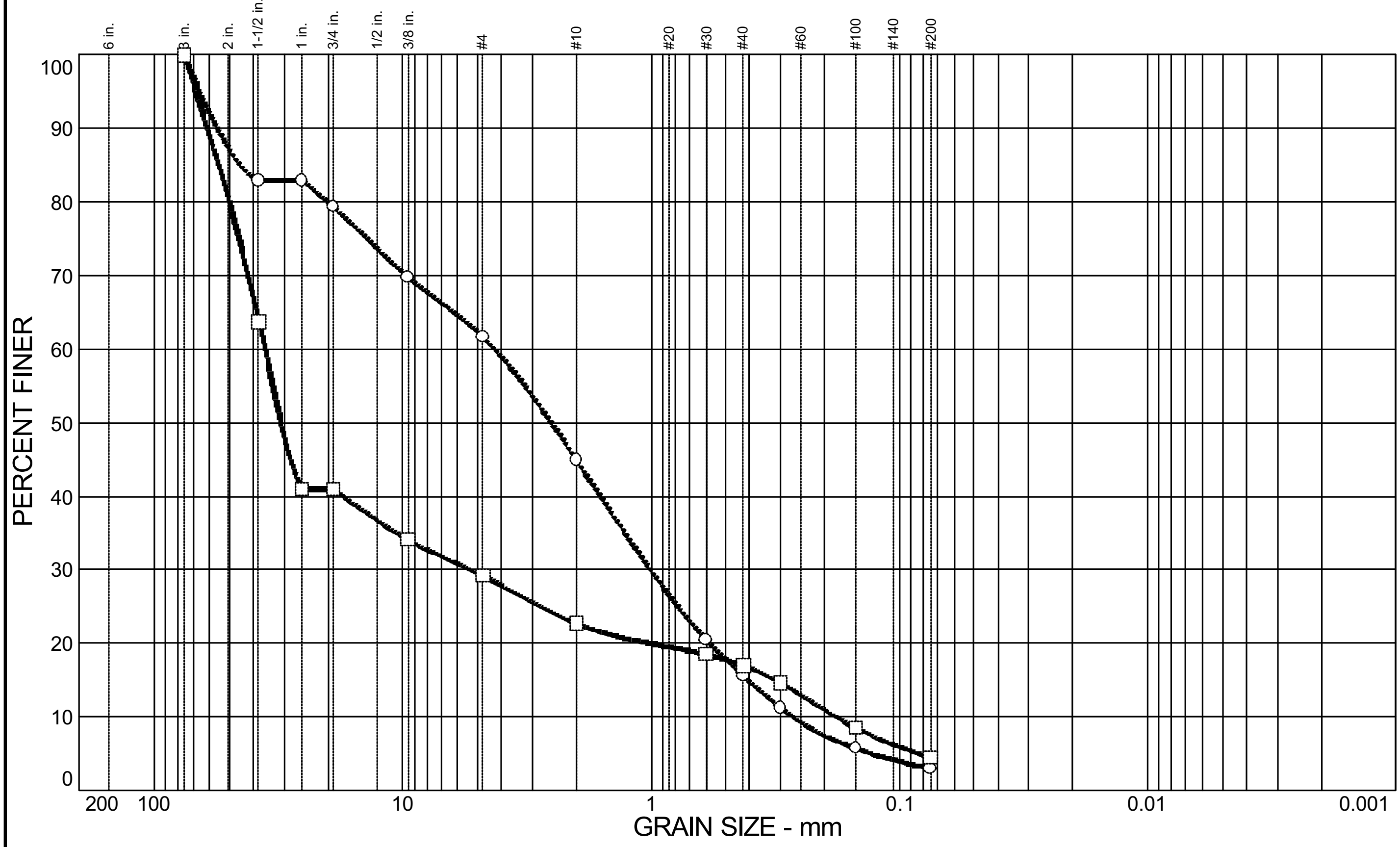
COOPER TESTING LABORATORY

Client: MWH

Project: San Clemente Dam Removal - 1881772.181602

Project No.: 207-057 Figure

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		38.4	58.6	3.0					
□		70.8	24.7	4.5		GP			

SIEVE inches size	PERCENT FINER ○	PERCENT FINER □	
3	100.0	100.0	
1.5	82.9	63.7	
1	82.9	41.0	
3/4	79.4	41.0	
3/8	69.8	34.1	
	GRAIN SIZE		
D_{60}	4.27	36.1	
D_{30}	1.01	5.32	
D_{10}	0.268	0.180	
	COEFFICIENTS		
C_c	0.89	4.37	
C_u	15.95	200.78	

SIEVE number size	PERCENT FINER ○	PERCENT FINER □	
#4	61.6	29.2	
#10	44.9	22.7	
#30	20.5	18.5	
#40	15.6	17.0	
#50	11.2	14.6	
#100	5.7	8.5	
#200	3.0	4.5	

SOIL DESCRIPTION

○ Brown Poorly Graded SAND w/ Gravel

□ Dark Gray & Black Poorly Graded GRAVEL w/ Sand

REMARKS:

○

□

○ Source: BH-5	Sample No.: 1	Elev./Depth: 5'
□ Source: BH-5	Sample No.: 3	Elev./Depth: 15'

COOPER TESTING LABORATORY

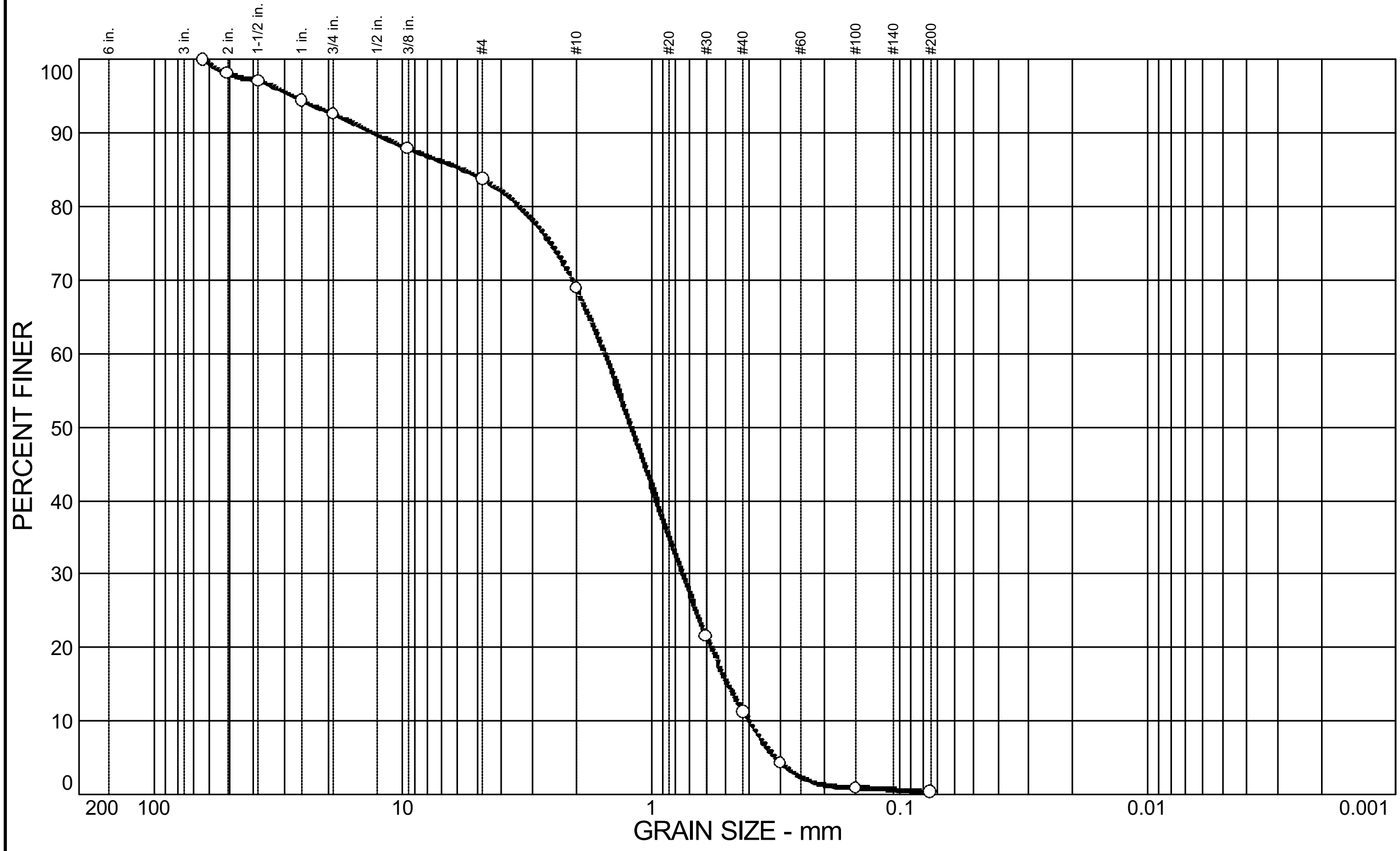
Client: MWH

Project: San Clemente Dam Removal - 1881772.181602

Project No.: 207-057

Figure

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		16.3	83.4	0.3					

SIEVE inches size	PERCENT FINER ○		
2.5	100.0		
2	98.1		
1.5	97.1		
1	94.4		
3/4	92.6		
3/8	87.9		
	GRAIN SIZE		
D_{60}	1.54		
D_{30}	0.749		
D_{10}	0.405		
	COEFFICIENTS		
C_c	0.90		
C_u	3.81		

SIEVE number size	PERCENT FINER ○		
#4	83.7		
#10	68.9		
#30	21.6		
#40	11.2		
#50	4.3		
#100	0.9		
#200	0.3		

SOIL DESCRIPTION

○ Brown Poorly Graded SAND w/ Gravel

REMARKS:

○

○ Source: TP-1

Elev./Depth: 2'

COOPER TESTING LABORATORY

Client: MWH

Project: San Clemente Dam - 1881772

Project No.: 207-059

Figure

COOPER TESTING LABORATORY

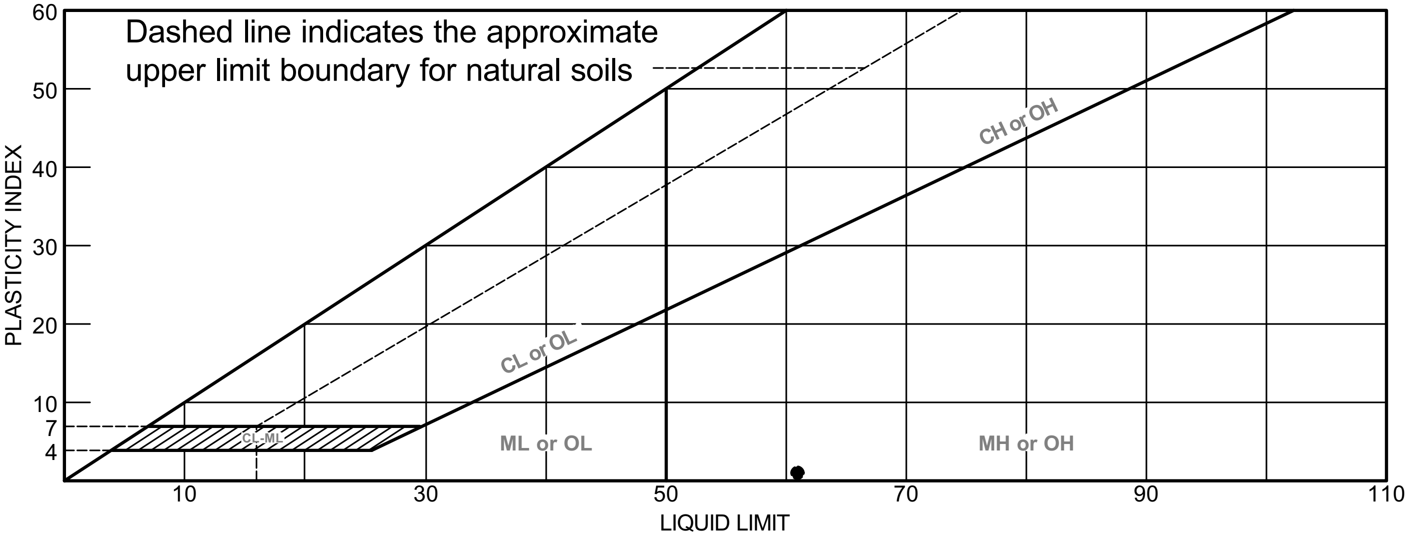
#200 Sieve Wash Analysis
ASTM D 1140

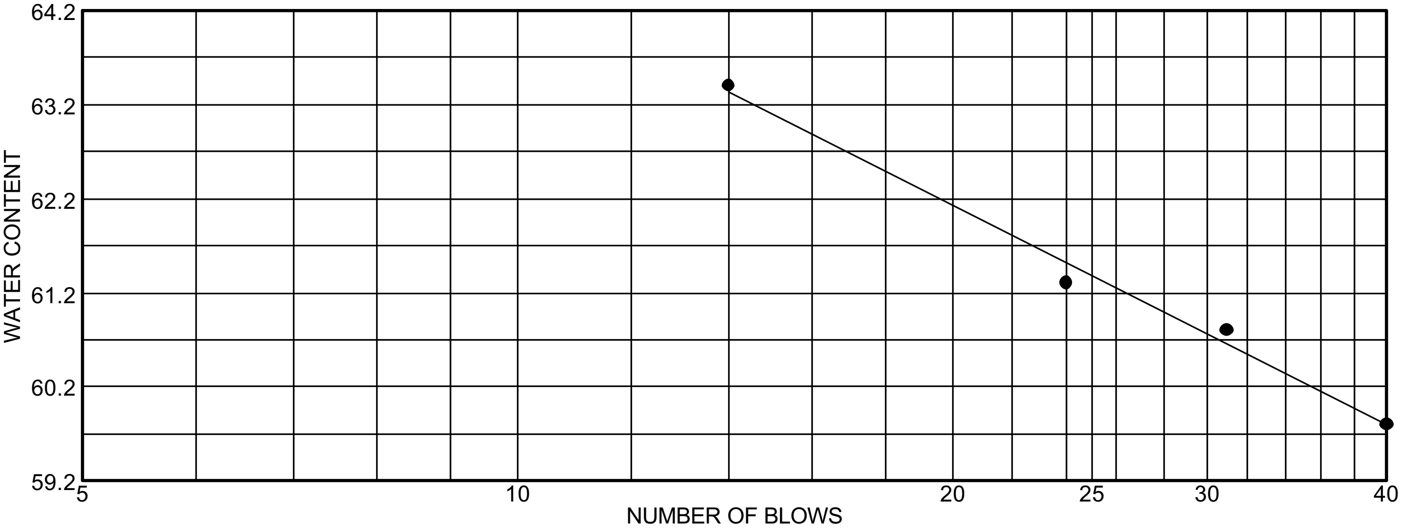
Job No.: 207-057
Client: MWH
Project: San Clemente Dam Removal
Project No.: 1881772.181602
Date: 11/20/2007
Run By: MD
Checked By: DC

Boring: **Sample:** **Depth, ft.:**	BH-3 9 45							
Soil Type:	Black Elastic SILT w/ Sand							
Wt of Dish & Dry Soil, gm	550.0							
Weight of Dish, gm	328.7							
Weight of Dry Soil, gm	221.3							
Wt. Ret. on #4 Sieve, gm	2.2							
Wt. Ret. on #200 Sieve, gm	46.1							
% Gravel	**1.0**							
% Sand	**19.8**							
% Silt & Clay	**79.2**							

Remarks: As an added benefit to our clients, the gravel fraction may be included in this report. Whether or not it is included is dependent upon both the technician's time available and if there is a significant enough amount of gravel. The gravel is always included in the percent retained on the #200 sieve but may not be weighed separately to determine the percentage, especially if there is only a trace amount, (5% or less).

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Black Elastic SILT w/ Sand	61	60	1			

Project No. 207-057 **Client:** MWH

Project: San Clemente Dam Removal - 1881772.181602

● **Source:** BH-3 **Sample No.:** 9 **Elev./Depth:** 45'

Remarks:

●

LIQUID AND PLASTIC LIMITS TEST REPORT

COOPER TESTING LABORATORY

Figure

Geo Test Unlimited GTU

Test Equipment Design & Fabrication
Laboratory & Field Testing
Consulting Services

Dr. Anders Bro

November 27, 2007

San Clemente Dam
Project no: 1881772.181602
Unconfined Compression and Point Load Testing

Jennifer Van Pelt
MWH Americas, Inc.
2121 N. California Blvd., Suite 600
Walnut Creek, CA 94596

Dear Jennifer,

Thank you for using my lab for these tests. This letter summarizes the test results from the unconfined compression and point load tests on the samples that I received from you last week. The raw data sheets, plots, and the standard test procedures are appended to this letter, along with a CD containing the data files and digital photos of the samples both prior to and after testing.

A total of ten unconfined compression tests were performed along with eight point load tests. The samples generally consisted of diorite and were intact with very few fractures. Most fractures that were encountered were quartz-healed.

One of the samples was quite unique. Sample BH1-124 was lighter colored than the other samples and at first sight appeared to be a greenish gray colored granite with some pink feldspar evident at one end. I have classified this rock as granite, but I fear that I am wrong in this description. The first clue that this is a mis-identification is the incredibly high density of 193.2 pcf. When I first calculated this value, I thought that I had made a measurement error as the density was so out of line with any other rock type that I have ever tested. So I returned to the lab and remeasured the sample to find that my initial measurements were correct. I doubt the minerals in this sample could be quartz due to this high density. Secondly, the unconfined compressive strength (26,312 psi) was quite high for granite. I have tested rocks with higher strengths than this, but they are often associated with metamorphosed rocks in which fractures and microfractures are well healed. One possibility is that this rock was granite that had been subjected to a high degree of high grade metamorphism. This geologic process may have resulted in the extremely high density. It may be worthwhile to take another look at this sample and evaluate the rock type as it may have some bearing on the excavatability of this rock.

The only other potential mis-identification is that of Sample BH1-71. The density of this rock (174.6 pcf) is more in line with a more acidic rock and so perhaps this one should be classified as granodiorite?

The testing program was quite straightforward and the samples did not pose any difficulties during preparation or testing. The samples were tested according to the standard test procedures that are appended to this letter.

The test results are as follows:

Unconfined Compression & Point Load Test Results

Sample #	Depth (ft.)	Description	ρ (pcf)	UCS (psi)	PLI (psi)
BH1-29	29.6-30.1	Dark gray diorite with no apparent planes of weakness.	178.9	18,585	na
BH1-44	44.6-45.5	Dark gray diorite.	na	na	308
BH1-61	61.0-62.3	Dark gray diorite with no apparent planes of weakness.	181.2	14,255	883
BH1-62	62.3-63.0	Dark gray diorite with no apparent planes of weakness.	na	na	941
BH1-71	71.9-73.0	Dark gray diorite (granodiorite?) with a few axial quartz healed hairline fractures.	174.6	9691	na
BH1-124	124.2-125.0	Medium greenish gray granite(?), slightly serpentinized with pink minerals near one end and an axial healed joint.	193.2	26,312	na
BH2-16	16.9-18.5	Medium gray granodiorite with no apparent planes of weakness.	168.1	10,819	647
BH2-49	49.0-49.8	Dark gray diorite with no apparent planes of weakness.	180.4	13,118	na
BH2-54	54.0-55.0	Dark gray diorite with no apparent planes of weakness.	181.1	13,713	647
BH2-61	61.1-62.4	Dark gray diorite with no apparent planes of weakness.	180.3	10,780	624
BH2-76	76.5-77.6	Dark gray diorite with no apparent planes of weakness.	182.2	10,241	860
BH2-88	88.8-90.3	Dark gray diorite with no apparent planes of weakness.	179.2	18,393	1180

It should be noted that all of these tests were performed on NQ sized core (nominally 1.875” diameter) and due to the size effect probably exceed the strengths of the same rock but tested using the more standard HQ core size (2.375”diameter).

If you have any questions regarding these test results or the test procedures, please feel free to contact me so that we can discuss any of your concerns.

for GeoTest Unlimited

____

Dr. Anders Bro

Geo Test Unlimited
GTU

Test Equipment Design & Fabrication
Laboratory & Field Testing
Consulting Services

Dr. Anders Bro

November 27, 2007

San Clemente Dam
Project no: 1881772.181602
Unconfined Compression and Point Load Testing

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If you have any questions regarding these test results or the test procedures, please feel free to contact me so that we can discuss any of your concerns.

for GeoTest Unlimited
Anders Bro
Dr. Anders Bro

Geo GTU
Test
Unlimited

Unconfined Compression Test of Rock Core
(in accordance with ASTM D2938)

Test Equipment

The samples are cut to length using an MK saw with a 14 inch diameter continuous rim diamond blade. The ends of the samples are ground flat and parallel to each other using a Norton surface grinder with a diamond grinding wheel.

A Starrett height gauge standing on a flat granite plate is used to measure the sample heights and a Starrett dial gauge mounted to the height gauge is used to determine the planarity of the sample ends. An 8-inch Mitutoyo caliper is used to measure the sample diameters.

GTU's 200 kip loading frame is used to load the specimens. The loading platens consist of one fixed platen and one spherical seat (both made by GTU). The platens have the same diameter as the nominal core diameter.

The pressure is applied to the loading ram using a computer controlled loading system fabricated by GTU. The load is monitored with a suitably sized load cell. Four load cells can be incorporated into the system, a 200 kip cell, a 50 kip cell, a 10 kip cell and a 2 kip cell. The three highest capacity cells are shear web cells made by Interface, Inc. and the 2 kip cell is a shear web cell fabricated by Lebow.

The axial displacement is monitored using a ± 0.1 inch stroke Schaevitz LVDT measuring the displacement between the fixed pedestal just above the load cell and the bottom loading platen immediately adjacent to the specimen. Thus the measured axial displacement includes the deformation of the load cell.

The time, axial load and axial displacements are monitored using a Computer Boards, Inc. Data Acquisition System (CIO-DAS1600/16) which has a 16 bit resolution and can monitor up to 16 channels. The LVDT is conditioned using a Daytronic Model 9130 LVDT conditioner. The load cell is conditioned with a Daytronic Model 9170 DC excitation strain gauge conditioner.

Test Procedure

A representative section of core is identified for testing. It is cut to length (with a length to diameter ratio of a little more than 2:1) and the ends are ground flat and parallel. If the sample is very weak, special techniques need to be used to prepare the sample ends with plaster or capping compound (many innovative procedures are required to prepare a weak rock sample). The sample diameter and lengths are measured for determining the sample area and to evaluate the planarity and parallelness of the surfaced ends.

Power is applied to the data acquisition system and signal conditioners at least one hour prior to testing to permit the electronics to reach thermal equilibrium. Once stabilized, the load cell conditioning system is adjusted with the help of a shunt calibration resistor. The LVDT conditioner is also adjusted (the null, zero, span and symmetry) with the help of a Mitutoyo digital micrometer and LVDT holding jig.

The sample is installed in the loading frame, along with the loading platens and the LVDT is properly positioned to maximize its travel during the test. The loading piston is extended until a small load is applied to the sample.

The acquisition is directed to start acquiring data and the loading ram is slowly advanced under computer control. If failure is catastrophic, the test is terminated immediately after failure. If the failure is plastic, the test continues until a post-peak plateau develops.

The loads and displacements are printed on the computer screen along with a plot of axial load vs. displacement. Thus one has a clear image of the sample behavior at any stage of the test.

All of the data are recorded in a computer data file which includes a title block identifying the client, job, sample and sample dimensions. The data block includes data legends and units along with columns of time, axial load and axial displacement. These files are used to develop computer generated plots of the sample behavior.

Geo GTU
Test
Unlimited

Point Load Test of Rock Core
(in accordance with ASTM D-5731)

Test Equipment

No equipment is required to prepare the samples, although if samples are to be tested parallel to the core axis, a diamond saw can be used to create disks suitable for testing.

A Mitutoyo 8-inch digital caliper with a resolution of 0.0005 inches is used to measure the sample length width and diameter. (Such accuracy is not required in view of the approximate nature of the tests.)

A small portable press fabricated by GTU is used to perform the test. A 5 ton, 10,000 psi ram is used to apply the load and a 10,000 psi pressure transducer is used to measure the load by monitoring the hydraulic pressure in the cylinder. A Newport digital readout with a peak load hold mode is used to capture the peak point load. The transducer/readout device is adjusted to read load directly with the help of a loading frame and calibrated load cell. Spherically pointed cones (See the ASTM Spec for the cone tip geometry.) are mounted to both the loading piston and the base of the point loading frame.

Test Procedure

The diameter and length of the core are first measured and recorded. The preference is for a length to diameter of greater than 1. If the sample is an irregularly shaped piece, then the width of the sample is also recorded.

The peak load indicator is reset and the core inserted between the two cones. The piston is manually advanced until the core is lightly held between the two cones. The piston is then slowly advanced to result in core rupture within 10 to 30 seconds. The peak load is recorded and the mode of failure noted. Often the core will split lengthwise, requiring the use of an equivalent diameter based on the area of the split rather than based on the core diameter. An assessment also needs to be made regarding the suitability of the failure mode. The test result is deemed to be invalid if the failure plane only dislodges a small chip from the sample.

Data Reduction

Following the test, the point load index (the peak load divided by the square of the equivalent diameter squared) is corrected for sample size to a standard 50 mm diameter using the equation:

$I_s(50) = I_s\,(D_e/1.969)^{0.45}$, in which D is the diameter, measured in inches.

ISRM proposes the relationship between the point load and the unconfined compressive strength of rock to be:

UC=22 PL,

for core with a diameter of 50mm. The ASTM specification expands on this generalization for core of other diameters, and suggests using a correlation coefficient of 23 for a core diameter of 50 mm.

Geo Test Unlimited

DATA SHEET
Point Load Test of Rock (in accordance with ASTM D-5731)

Client: MWH Americas, Inc – Clemente
Job: #267 – San [redacted] Dam

Date: 11/26/07
Tester: A. Bro

Sample ID	Sample Description	Type of Test*	Width (W) (in)	Length (L) (in)	Diam. (D) (in)	D_e^2 $=D^2$ or $\frac{4WD}{\pi}$ (in^2)	D_e (in)	Point Load (lb)	Index Strength $I_s = \frac{P}{D_e^2}$ (psi)	Size Correction Factor $F = (\frac{D_e}{1.969})^{0.45}$	Corrected Point Load Index $I_{s(50)} = FI_s$ (psi)
BH1-44 44.6-45.5	Dark gray diorite	d		~4.7	1.838	3.378	1.838	1075	318	.969	308
BH1-61 610-623	"	d		>6"	1.832	3.356	1.832	3063	913	.968	883
BH1-62 623-63'	"	d		>6"	1.832	3.356	1.832	3262	972	.968	941
BH2-16 16.9-18.5'	med gray granodiorite	d		>6"	1.762	3.105	1.762	1543	497	.951	473
BH2-54 540-550	, dark gray diorite	d		5.0	1.759	3.094	1.759	2106	681	.951	647
BH2-61 61.1-62.4'	"	d		>6"	1.763	3.108	1.763	2037	655	.951	624
BH2-76 76.5-77.6	"	d		>6"	1.765	3.115	1.765	2813	903	.952	860
BH2-88 888-90.3	"	d		>6"	1.767	3.122	1.767	3869	1239	.952	1180

* d - diametral
a - axial
b - block
i - irregular lump
⊥ - perpendicular to the planes of weakness
// - parallel to the planes of weakness

27069 N. Bloomfield Rd., Nevada City, CA 95959 Tel/Fax (530)470-0583 email: abro.gtu@gmail.com

Geo Test Unlimited GTU

DATA SHEET
Unconfined Compression Test of Rock (ASTM D2938)

Date: 11/26/07
Technician: A.Bro

Client: MWH Americas, Inc.
Job: #267 – San[redacted] Dam clemente
Sample ID: BH1-29 (Boring BH-1)
Sample Description: Dark gray diorite w/ no apparent planes of weakness.

Sample Depth: 29.6-30.1' Sample Condition: received & tested dry

(x 0.0001")

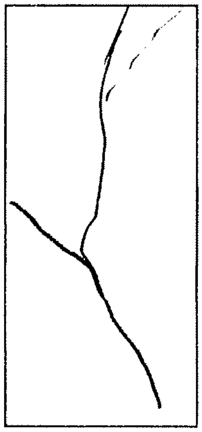
d_1	d_2
1.760	1.760
↓	1.759
	1.760
	↓

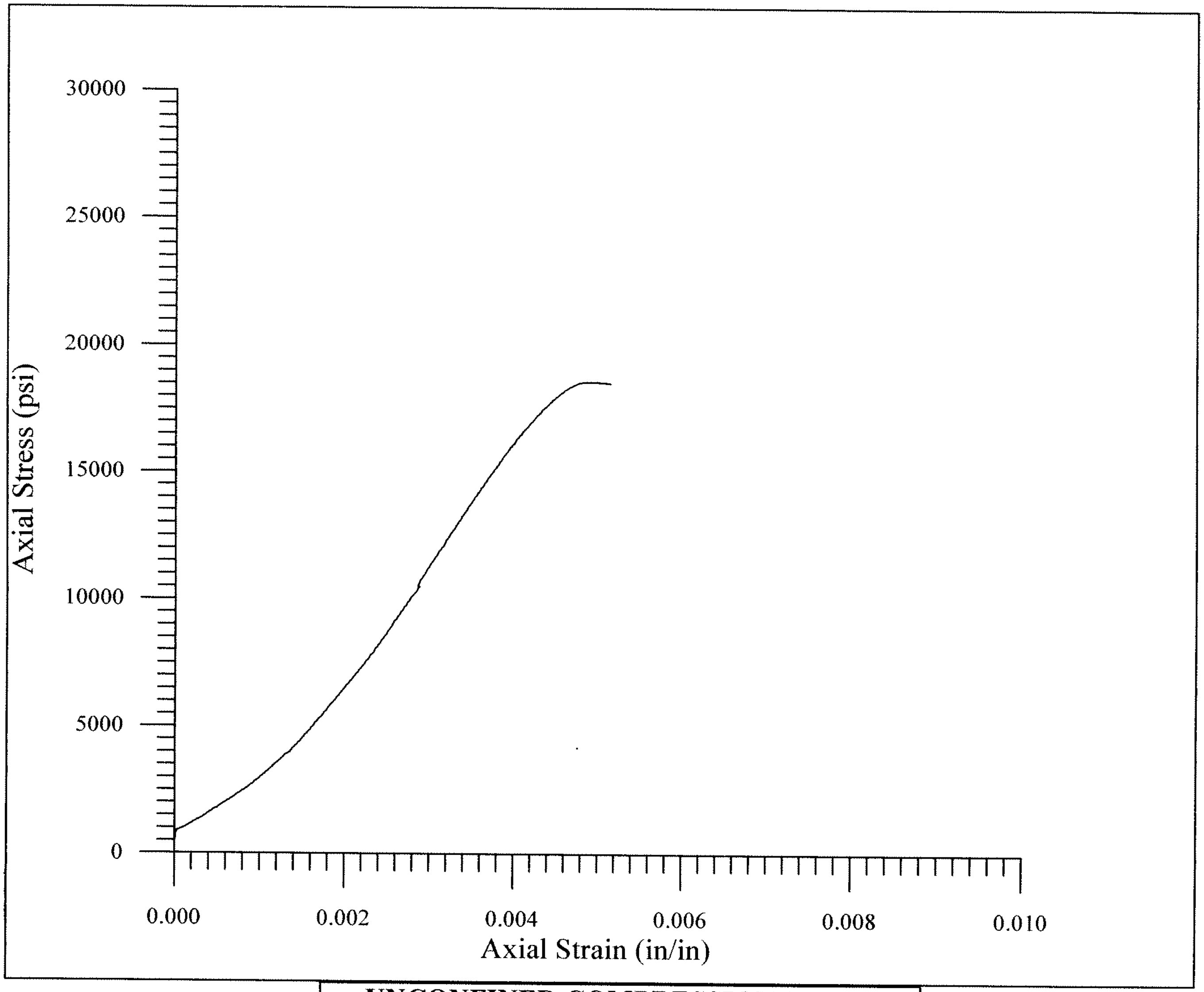
l_1	l_2
+14	0
+8	0
±1	±1
−8	0
−16	0

Avg. diameter : 1.760
Avg. length : 4.139
Sample area : 2.433
l/d ratio : 2.35
Sample volume(in^3) : 10.070
Sample weight (g) : 472.88
Density : 46.958/in^3= 178.9 pcf (1 g/in^3=3.8095lb/ft^3)

Comments:

Failed by shear





UNCONFINED COMPRESSION TEST
Axial Stress vs. Strain

Sample: BH1-29
Boring: BH-1
Depth: 29.6-30.1'

DESCRIPTION

Dark gray diorite with no apparent planes of weakness.

Density: 178.9 pcf
Strength: 18,585 psi

Geo Test Unlimited

27069 N. Bloomfield Rd.
Nevada City, CA 95959

Client: **MWH Americas, Inc.**
2121 N. California Blvd., Suite 600
Walnut Creek, CA 94596

Project: San Clemente Dam

Project No: 1881772.181602

Test Date: November 26, 2007

Geo Test Unlimited

DATA SHEET
Unconfined Compression Test of Rock (ASTM D2938)

Date: 11/26/07
Technician: A.Bro

Client: MWH Americas, Inc. clemente
Job: #267 – San [redacted] Dam
Sample ID: BH1-61 Boring BH-1
Sample Description: Dark gray diorite with no apparent planes of weakness.

Sample Depth: 61.0-62.3'
Sample Condition: received & tested dry

d1	d2
1.826	1.828
1.827	1.827
1.827	1.826
1.827	1.827
1.823	1.825

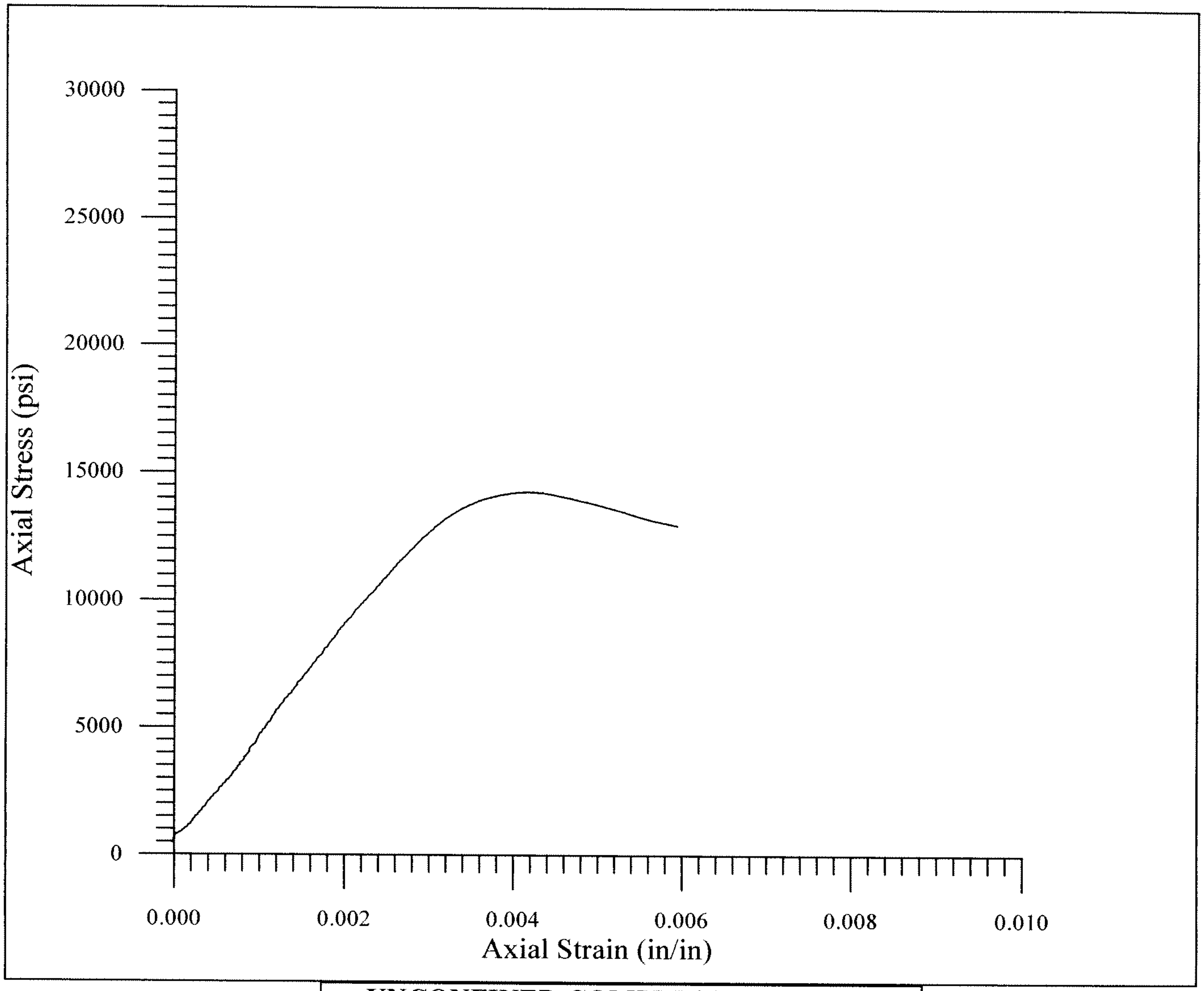
(x 0.0001")

l1	l2
+11	+3
+6	+2
±1	±1
-7	-1
-12	-2

Avg. diameter : 1.826
Sample area : 2.619
Sample volume(in^3) : 10.847
Sample weight (g) : 515.8g
Density : 47.55g/in³ 181.2pcf
Avg. length : 4.142
l/d ratio : 2.27
(1 g/in^3=3.8095lb/ft^3)

Comments:

Failed by shear



UNCONFINED COMPRESSION TEST
Axial Stress vs. Strain

Sample: BH1-61
Boring: BH-1
Depth: 61.0-62.3'

DESCRIPTION

Dark gray diorite with no apparent planes of weakness.

Density: 181.2 pcf
Strength: 14,255 psi

Geo Test Unlimited ***GTU***

27069 N. Bloomfield Rd.
Nevada City, CA 95959

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2121 N. California Blvd., Suite 600
Walnut Creek, CA 94596

Project: San Clemente Dam

Project No: 1881772.181602

Test Date: November 26, 2007

DATA SHEET
Unconfined Compression Test of Rock (ASTM D2938)

Date: 11/26/07
Technician: A.Bro

Client: MWH Americas, Inc.
Job: #267 – San [redacted] Dam Clemente
Sample ID: BH1-71 Boring BH-1
Sample Description: Dark gray diorite with a few axial quartz healed axial fractures (very Fine)

Sample Depth: 71.9-73.0 Sample Condition: received & tested dry

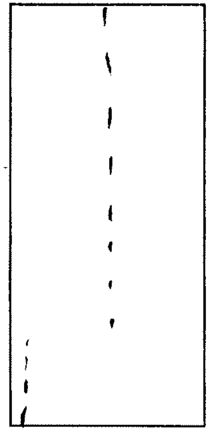
(x 0.0001")

d$_1$	d$_2$
1.836	1.833
1.835	1.834
1.835	1.835
1.835	1.834
1.834	1.834

l$_1$	l$_2$
+8	+5
+4	+3
±1	±1
-3	-3
-6	-5

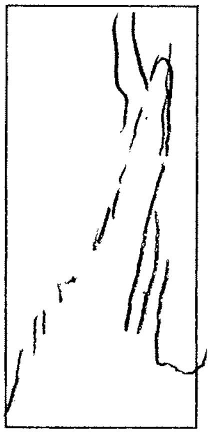
Avg. diameter : 1.835
Avg. length : 4.293
Sample area : 2.645
l/d ratio : 2.34
Sample volume(in^3) : 11.353
Sample weight (g) : 520.38
Density : 45.838/in^3= 174.6pcf (1 g/in^3=3.8095lb/ft^3)

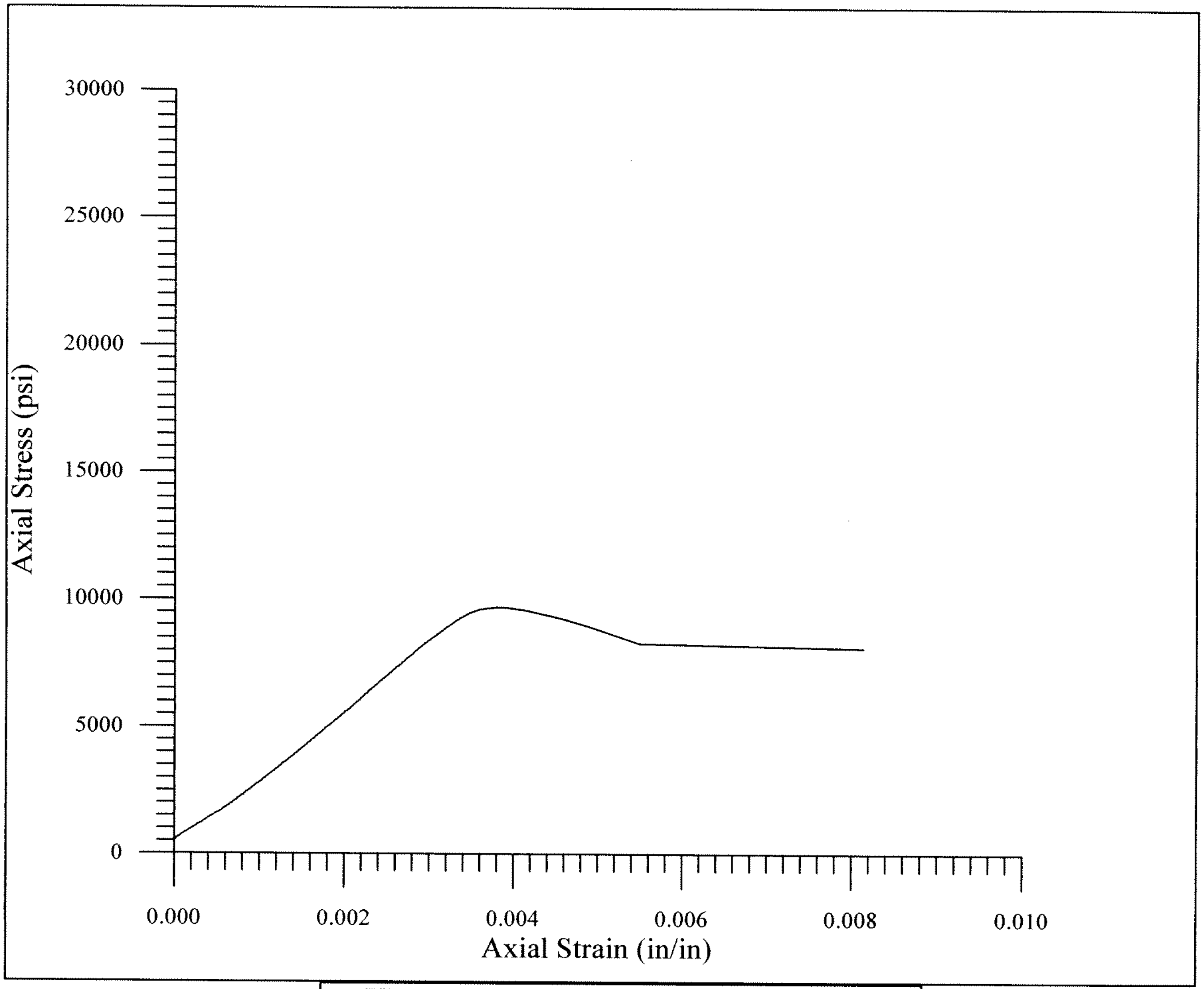
Qz healed hairline Fractures



Comments:

Failed by wedge shear





UNCONFINED COMPRESSION TEST
Axial Stress vs. Strain

Sample: BH1-71
Boring: BH-1
Depth: 71.9-73.0'

DESCRIPTION

Dark gray diorite with a few axial quartz healed hairline fractures.

Density: 174.6 pcf
Strength: 9691 psi

Geo Test Unlimited GTU
27069 N. Bloomfield Rd.
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2121 N. California Blvd., Suite 600
Walnut Creek, CA 94596

Project: San Clemente Dam

Project No: 1881772.181602

Test Date: November 26, 2007

Geo Test Unlimited

DATA SHEET
Unconfined Compression Test of Rock (ASTM D2938)

Date: 11/26/07
Technician: A.Bro

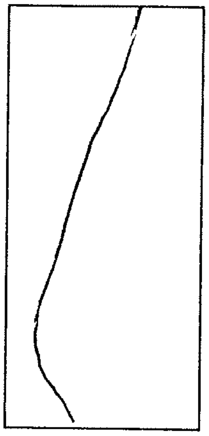
Client: MWH Americas, Inc.
Job: #267 – San [redacted] Dam Clemente
Sample ID: BH1-124 Boring BH-1
Sample Description: Med greenish gray granite* slightly serpentinized? with pink feldspar near one end and an axial healed joint

Sample Depth: 124.2-125.0' Sample Condition: received & tested dry

d1	d2
1.875	1.872
1.874	1.871
1.875	1.871
1.873	1.873
1.872	1.873

(x 0.0001")

l1	l2
+6	+1
+4	0
±1	±1
-4	0
-7	0

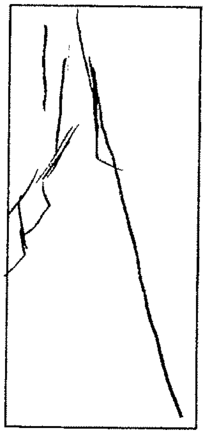


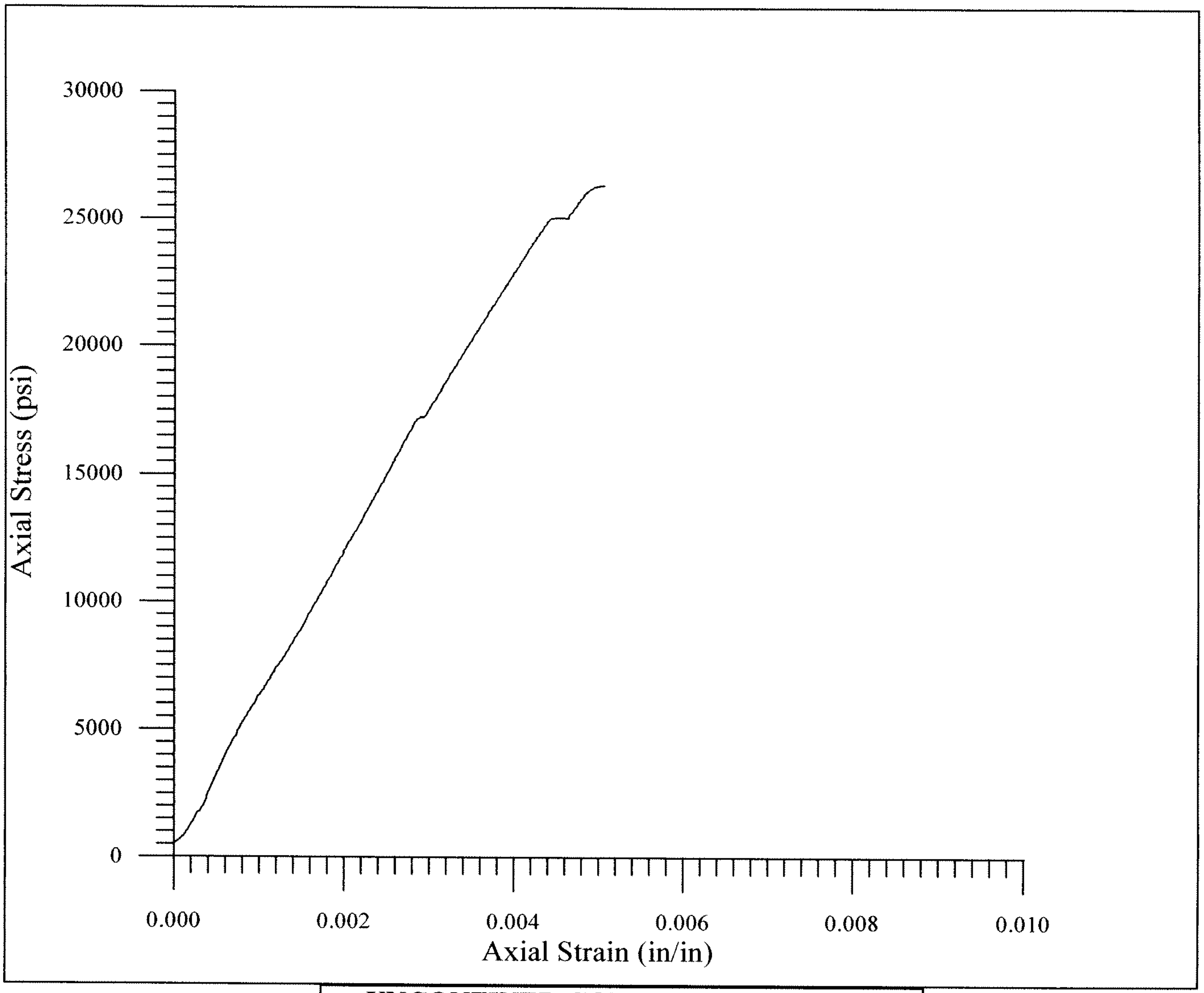
double checked → Avg. diameter : 1.873
Sample area : 2.755
Sample volume(in^3) : 11.467
Sample weight (g) : 581.6g ← double checked!
! → Density : 50.72 g/in³ = 193.2 pcf (1 g/in³=3.8095lb/ft³)

Avg. length : 4.162 ← double checked
l/d ratio : 2.22

Comments: *This is NOT granite! Way too dense!

Failed by wedge shear and axial splitting





UNCONFINED COMPRESSION TEST
Axial Stress vs. Strain

Sample: BH1-124
Boring: BH-1
Depth: 124.2-125.0'

DESCRIPTION

Medium greenish gray granite(??), slightly serpentinized with pink minerals near one end, and an axial healed joint.

Density: 193.2 pcf
Strength: 26,312 psi

Geo Test Unlimited

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Nevada City, CA 95959

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Project: San Clemente Dam

Project No: 1881772.181602

Test Date: November 26, 2007

DATA SHEET
Unconfined Compression Test of Rock (ASTM D2938)

Date: 11/26/07
Technician: A.Bro

Client: MWH Americas, Inc.
Job: #267 – San [redacted] Dam Clemente
Sample ID: BH2 - 16
Sample Description: Med gray granodiorite with no apparent planes of weakness

Sample Depth: 16.9-18.5' Sample Condition: received & tested dry

d1	d2
1.759	1.759
1.759	1.758
1.757	1.756
1.759	1.757
1.758	1.757

(x 0.0001")

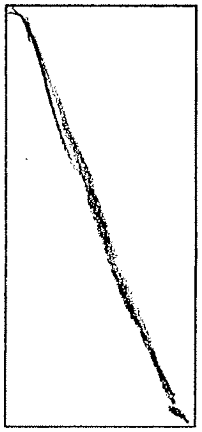
l1	l2
+3	0
+2	0
±1	±1
-3	0
-5	-1

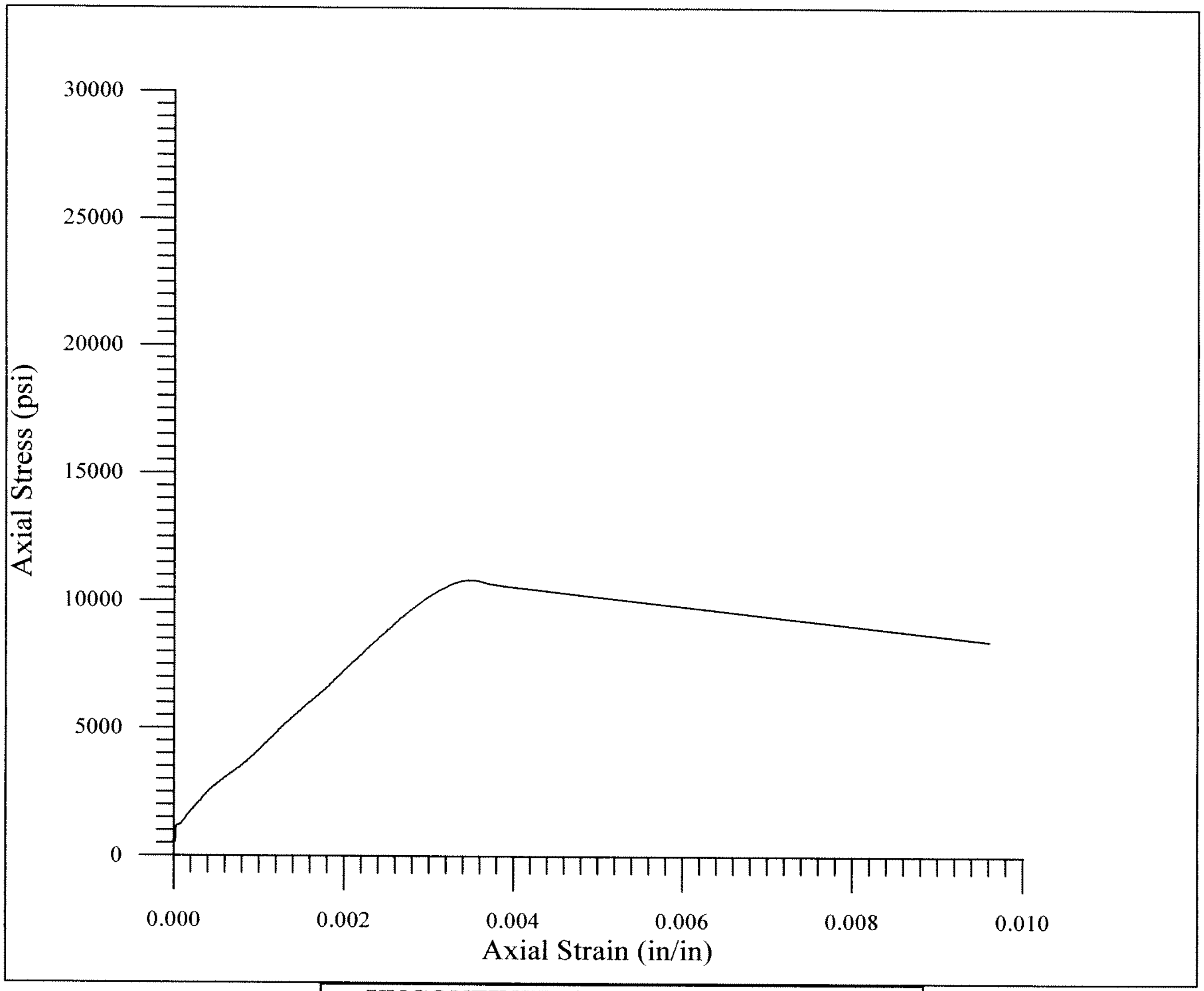
Avg. diameter : 1.758
Sample area : 2.427
Sample volume(in³) : 10.306
Sample weight (g) : 454.78g
Density : 44.128/in³ = 168.1 pcf (1 g/in³=3.8095lb/ft³)

Avg. length : 4.246"
l/d ratio : 2.42

Comments:

Failed by shear





UNCONFINED COMPRESSION TEST
Axial Stress vs. Strain

Sample: BH2-16
Boring: BH-2
Depth: 16.9-18.5'

DESCRIPTION

Medium gray granodiorite with no apparent planes of weakness.

Density: 168.1 pcf
Strength: 10,819 psi

Geo Test Unlimited

27069 N. Bloomfield Rd.
Nevada City, CA 95959

Client: MWH Americas, Inc.
2121 N. California Blvd., Suite 600
Walnut Creek, CA 94596

Project: San Clemente Dam

Project No: 1881772.181602

Test Date: November 26, 2007

Geo Test Unlimited GTU

DATA SHEET
Unconfined Compression Test of Rock (ASTM D2938)

Date: 11/26/07
Technician: A.Bro

Client: MWH Americas, Inc.
Job: #267 – San [redacted] Dam Clemente
Sample ID: BH2-49 Boring BH-2
Sample Description: Dark gray diorite with no apparent planes of weakness.

Sample Depth: 49.0-49.8' Sample Condition: received & tested dry

d1	d2
1.754	1.755
1.754	1.755
1.757	1.758
1.757	1.755
1.757	1.757

(x 0.0001")

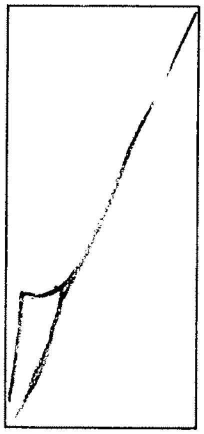
l1	l2
+1	0
+1	+1
±1	±1
-1	-1
-3	-2

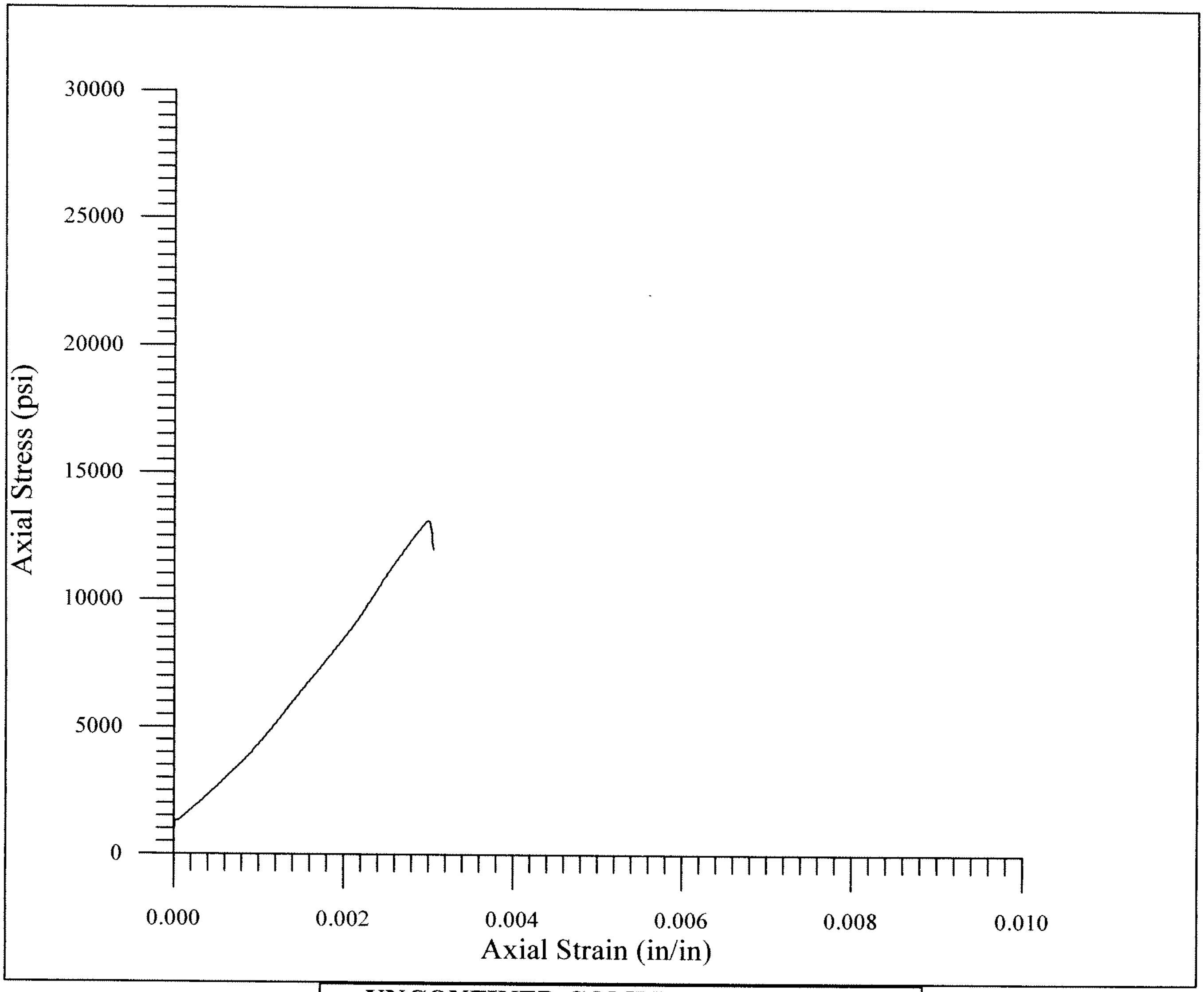
Avg. diameter : 1.756
Sample area : 2.422
Sample volume(in^3) : 10.210
Sample weight (g) : 483.5 g
Density : 47.35 g/in³ = 180.4 pcf (1 g/in^3=3.8095lb/ft^3)

Avg. length : 4.216
l/d ratio :

Comments:

Failed by shear





UNCONFINED COMPRESSION TEST
Axial Stress vs. Strain

Sample: BH2-49
Boring: BH-2
Depth: 49.0-49.8'

DESCRIPTION

Dark gray diorite with
no apparent planes of weakness.

Density: 180.4 pcf
Strength: 13,118 psi

Geo Test Unlimited
27069 N. Bloomfield Rd.
Nevada City, CA 95959

Client: MWH Americas, Inc.
2121 N. California Blvd., Suite 600
Walnut Creek, CA 94596

Project: San Clemente Dam

Project No: 1881772.181602

Test Date: November 26, 2007

Geo Test Unlimited GTU

DATA SHEET
Unconfined Compression Test of Rock (ASTM D2938)

Date: 11/26/07
Technician: A.Bro

Client: MWH Americas, Inc.
Job: #267 – San [redacted] Clemente Dam
Sample ID: BH2-54 Boring BH-2
Sample Description: Dark gray diorite with no apparent planes of weakness.

Sample Depth: 54.0-55.0' Sample Condition: received & tested dry

d1	d2
1.758	1.758
1.758	1.758
1.757	1.756
1.758	1.757
1.757	1.757

(x 0.0001")

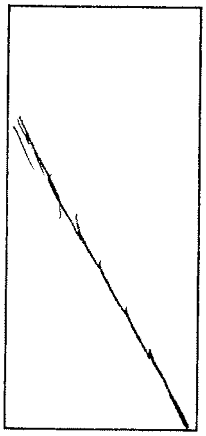
l1	l2
+6	+3
+3	+2
±1	±1
-2	-1
-4	-3

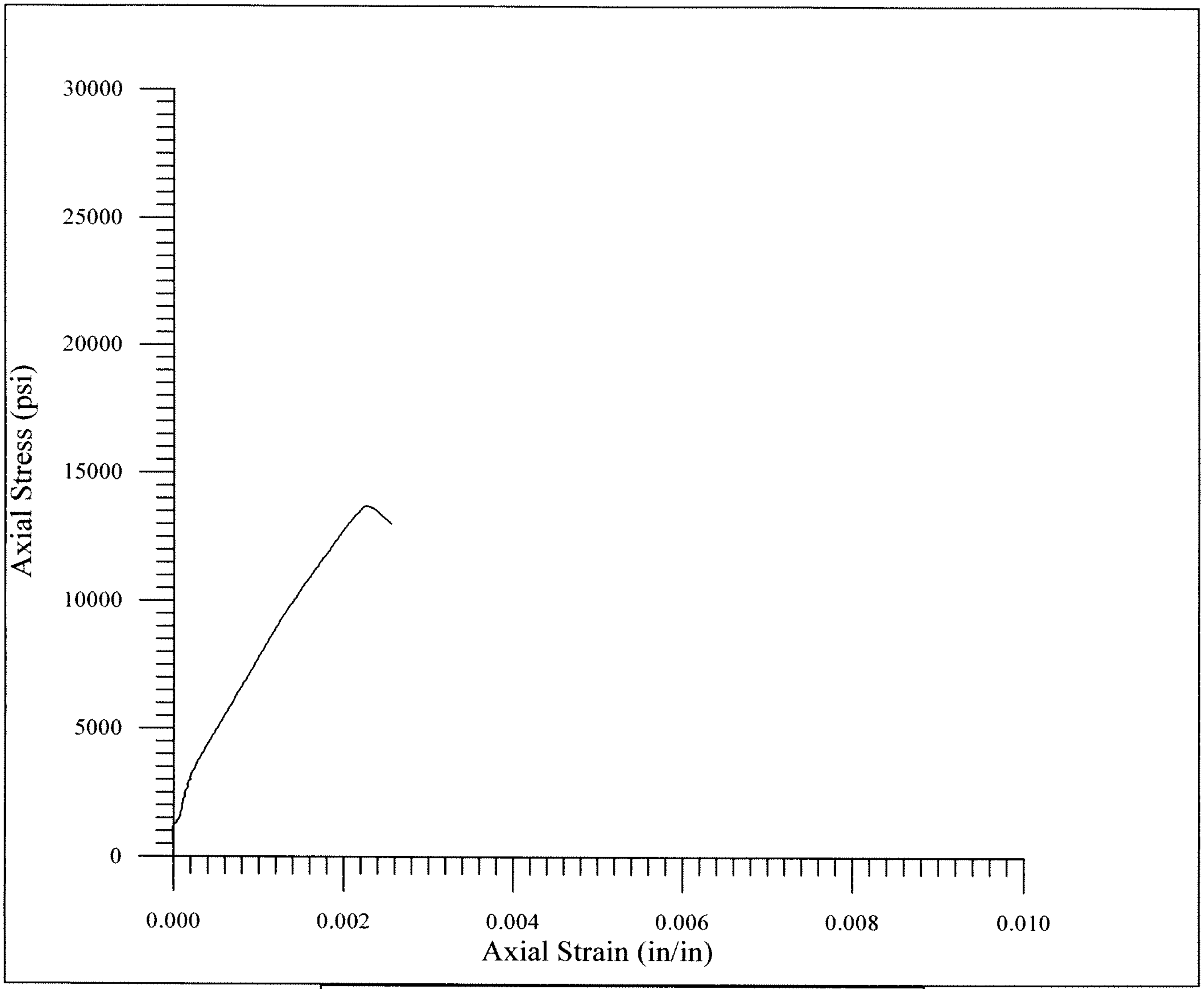
Avg. diameter : 1.757
Sample area : 2.425
Sample volume(in^3) : 10.261
Sample weight (g) : 487.7 g
Density : 47.53 g/in^3 = 181.1 pcf (1 g/in^3=3.8095lb/ft^3)

Avg. length : 4.232
l/d ratio : 2.41

Comments:

Failed by shear





UNCONFINED COMPRESSION TEST
Axial Stress vs. Strain

Sample: BH2-54
Boring: BH-2
Depth: 54.0-55.0'

DESCRIPTION

Dark gray diorite with
no apparent planes of weakness.

Density: 181.1 pcf
Strength: 13,713 psi

Geo Test Unlimited GTU

27069 N. Bloomfield Rd.
Nevada City, CA 95959

Client: **MWH Americas, Inc.**
2121 N. California Blvd., Suite 600
Walnut Creek, CA 94596

Project: San Clemente Dam

Project No: 1881772.181602

Test Date: November 26, 2007

Geo Test Unlimited GTU

DATA SHEET
Unconfined Compression Test of Rock (ASTM D2938)

Date: 11/26/07
Technician: A.Bro

Client: MWH Americas, Inc.
Job: #267 – San ~~Vicente~~ Clemente Dam
Sample ID: BH2-61 Boring BH-2
Sample Description: Dark gray diorite with no apparent planes of weakness.

Sample Depth: 61.1-62.4 Sample Condition: received & tested dry

d1	d2
1.760	1.760
1.761	1.760
1.760	1.761
1.760	1.759
1.760	1.759

(x 0.0001")

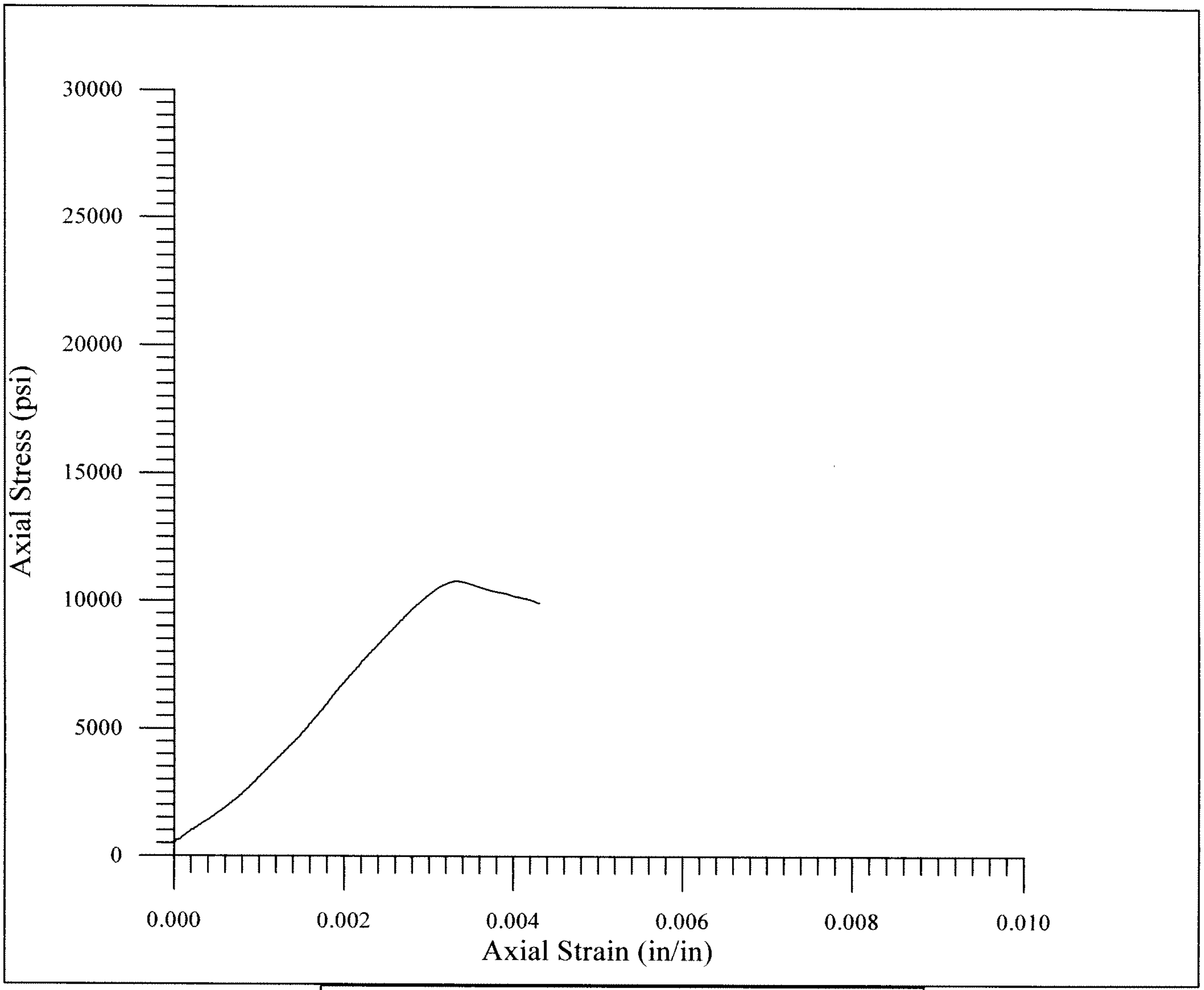
l1	l2
+9	+2
+5	+1
±1	±1
-5	0
-10	0

Avg. diameter : 1.760
Sample area : 2.433
Sample volume(in^3) : 10.347
Sample weight (g) : 489.8 g
Density : 47.34 g/in^3 = 180.3 pcf (1 g/in^3=3.8095lb/ft^3)

Avg. length : 4.253
l/d ratio : 2.42

Comments:

Failed by shear wedge



UNCONFINED COMPRESSION TEST
Axial Stress vs. Strain

Sample: BH2-61
Boring: BH-2
Depth: 61.1-62.4'

DESCRIPTION

Dark gray diorite with
no apparent planes of weakness.

Density: 180.3 pcf
Strength: 10,780 psi

Geo Test Unlimited GTU
27069 N. Bloomfield Rd.
Nevada City, CA 95959

Client: **MWH Americas, Inc.**
2121 N. California Blvd., Suite 600
Walnut Creek, CA 94596

Project: San Clemente Dam

Project No: 1881772.181602

Test Date: November 26, 2007

Geo Test Unlimited GTU

DATA SHEET
Unconfined Compression Test of Rock (ASTM D2938)

Date: 11/26/07
Technician: A.Bro

Client: MWH Americas, Inc.
Job: #267 – San [redacted] Dam Clemente
Sample ID: BH2-76 Boring BH-2
Sample Description: Dark gray diorite with no apparent planes of weakness.

Sample Depth: 76.5-77.6'
Sample Condition: received & tested dry

d1	d2
1.764	1.761
1.763	1.763
1.763	1.763
1.763	1.762
1.763	1.763

(x 0.0001")

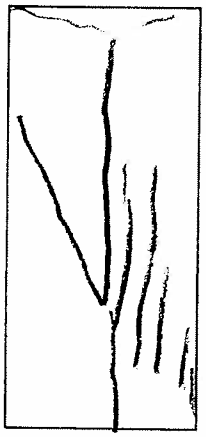
l1	l2
+8	+3
+4	+1
±1	±1
-4	-1
-7	-2

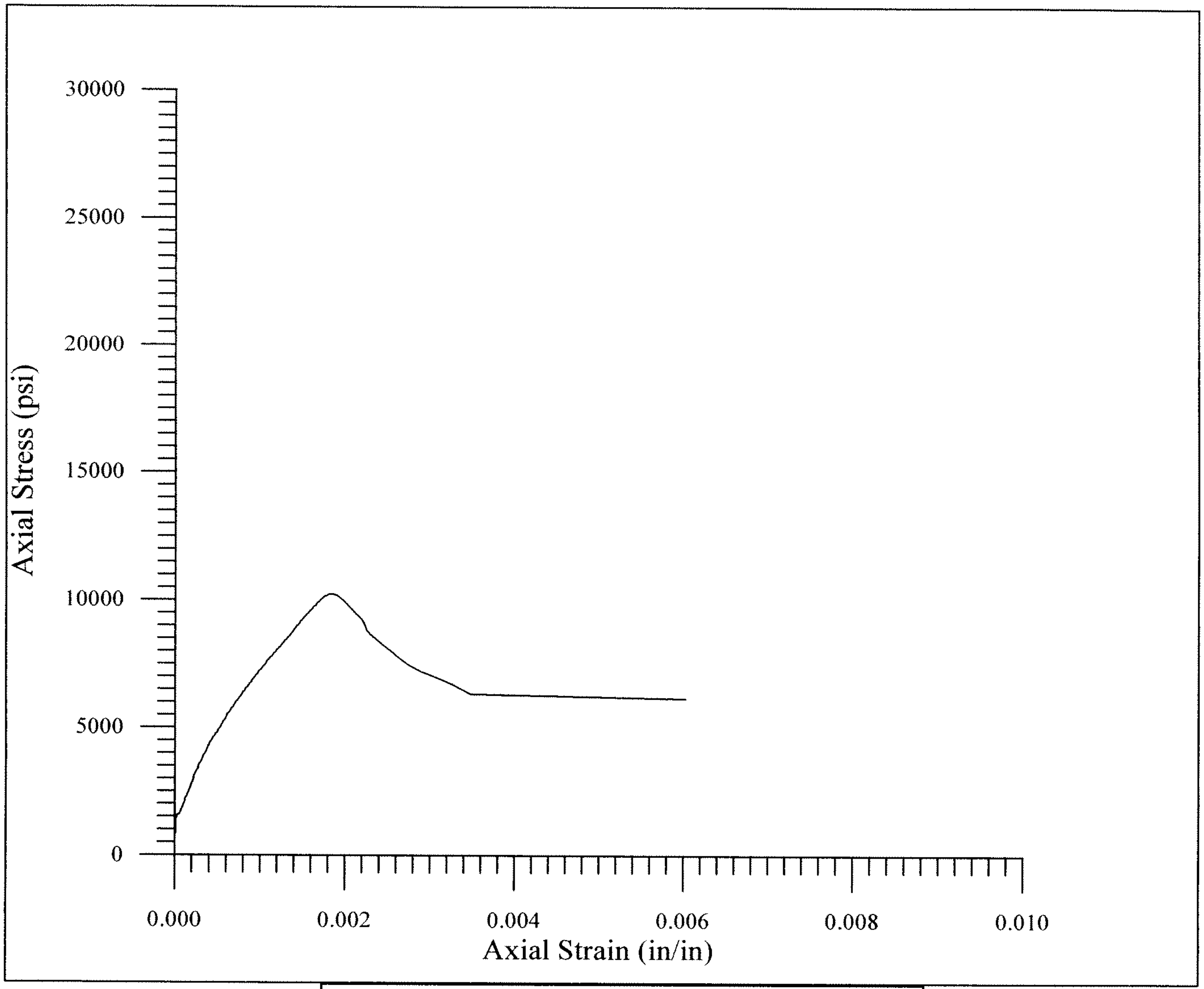
Avg. diameter : 1.763
Sample area : 2.441
Sample volume(in^3) : 10.116
Sample weight (g) : 483.8g
Density : 47.828/in^3 = 182.2 pcf (1 g/in^3=3.8095lb/ft^3)

Avg. length : 4.144
l/d ratio : 2.35

Comments:

Failed by axial splitting and shear





UNCONFINED COMPRESSION TEST
Axial Stress vs. Strain

Sample: BH2-76
Boring: BH-2
Depth: 76.5-77.6'

DESCRIPTION

Dark gray diorite with
no apparent planes of weakness.

Density: 182.2 pcf
Strength: 10,241 psi

Geo Test Unlimited

27069 N. Bloomfield Rd.
Nevada City, CA 95959

Client: **MWH Americas, Inc.**
2121 N. California Blvd., Suite 600
Walnut Creek, CA 94596

Project: San Clemente Dam

Project No: 1881772.181602

Test Date: November 26, 2007

Geo Test Unlimited GTU

DATA SHEET
Unconfined Compression Test of Rock (ASTM D2938)

Date: 11/26/07
Technician: A.Bro

Client: MWH Americas, Inc. Clemente
Job: #267 – San [redacted] Dam
Sample ID: BH2-88 Boring BH-2
Sample Description: Dark gray diorite with no apparent planes of weakness.

Sample Depth: 88.8-90.3′ Sample Condition: received & tested dry

d₁	d₂
1.765	1.765
1.764	1.765
1.764	1.764
1.763	1.765
1.765	1.765

(x 0.0001")

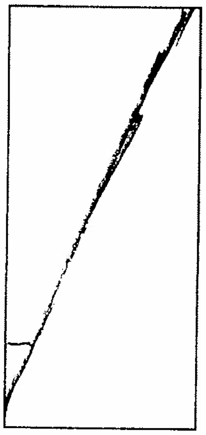
l₁	l₂
+7	+2
+4	+2
±1	±1
-2	+2
-5	+1

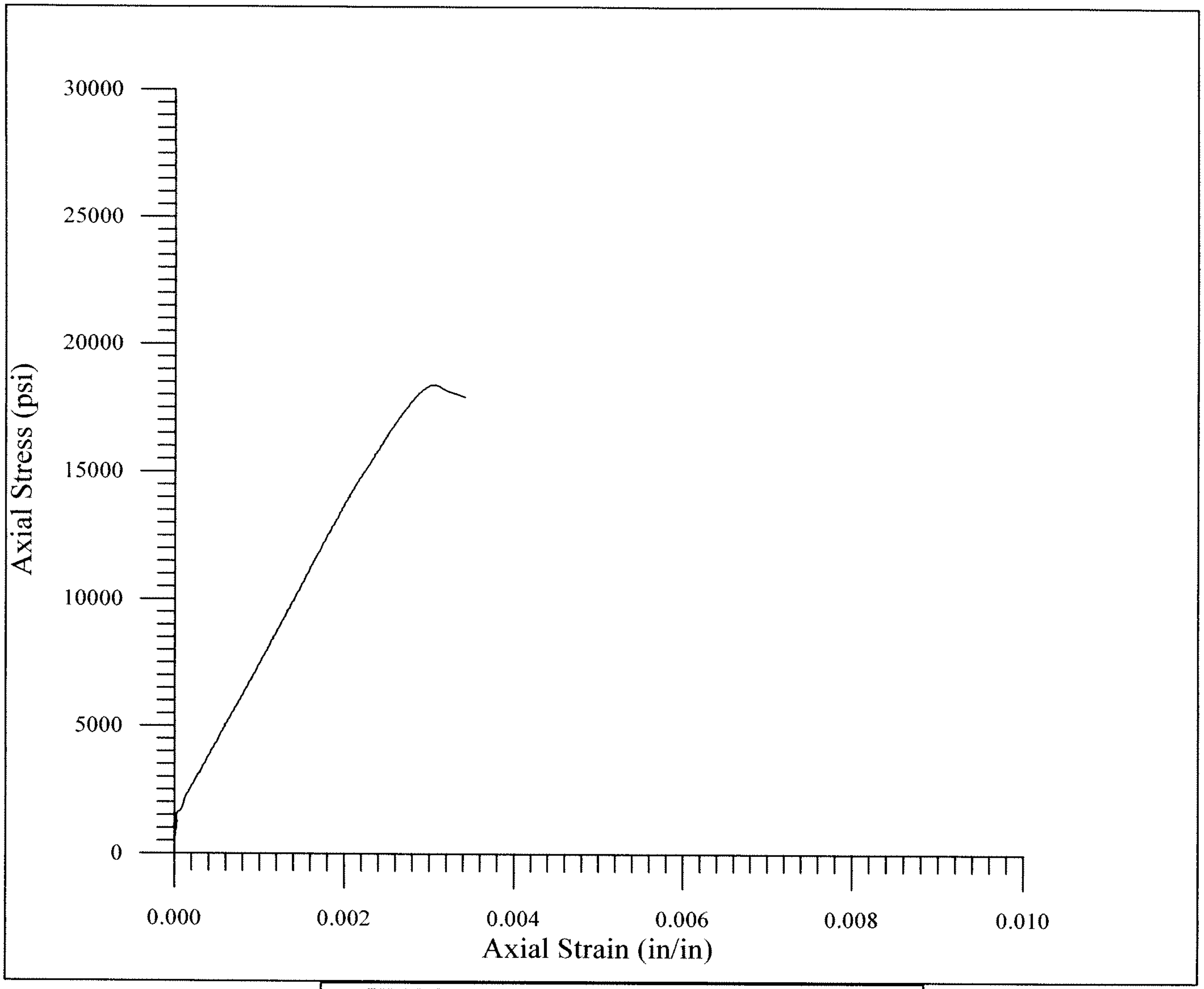
Avg. diameter : 1.765
Sample area : 2.447
Sample volume(in^3) : 10.203
Sample weight (g) : 480.0 g
Density : 47.05 g/in³ = 179.2 pcf (1 g/in^3=3.8095lb/ft^3)

Avg. length : 4.170
l/d ratio : 2.36

Comments:

Failed by shear





UNCONFINED COMPRESSION TEST
Axial Stress vs. Strain

Sample: BH2-88
Boring: BH-2
Depth: 88.8-90.3'

DESCRIPTION

Dark gray diorite with
no apparent planes of weakness.

Density: 179.2 pcf
Strength: 18,393 psi

Geo Test Unlimited

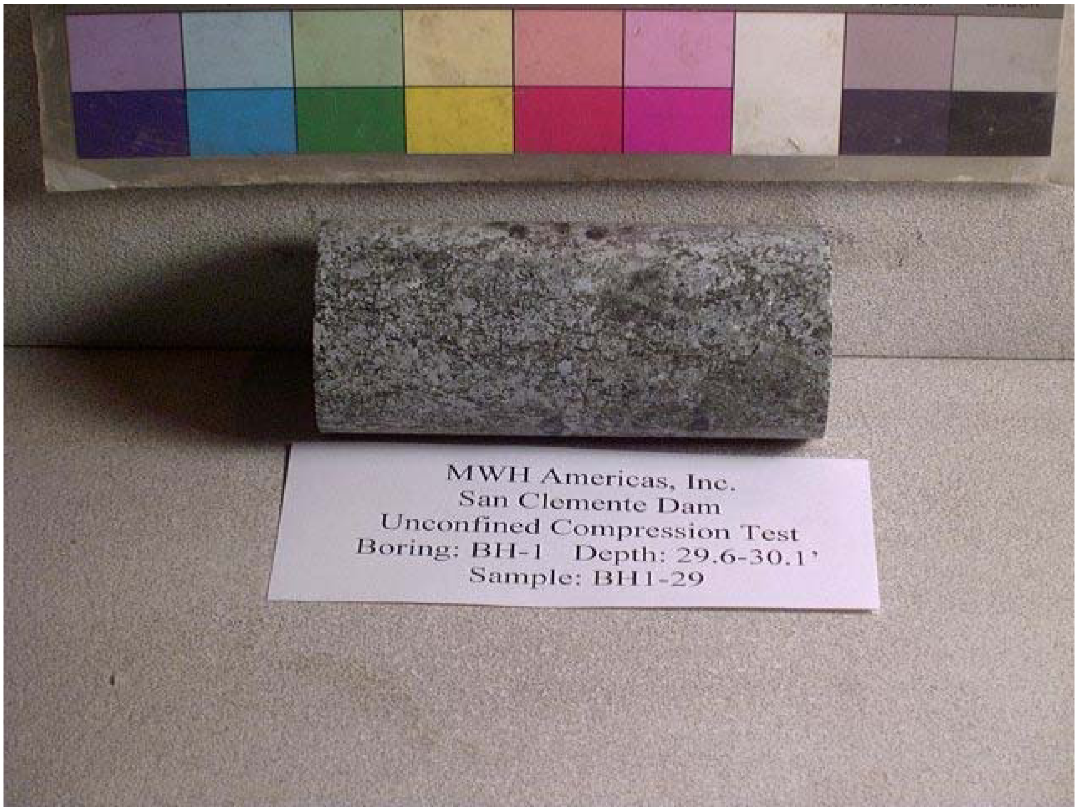
27069 N. Bloomfield Rd.
Nevada City, CA 95959

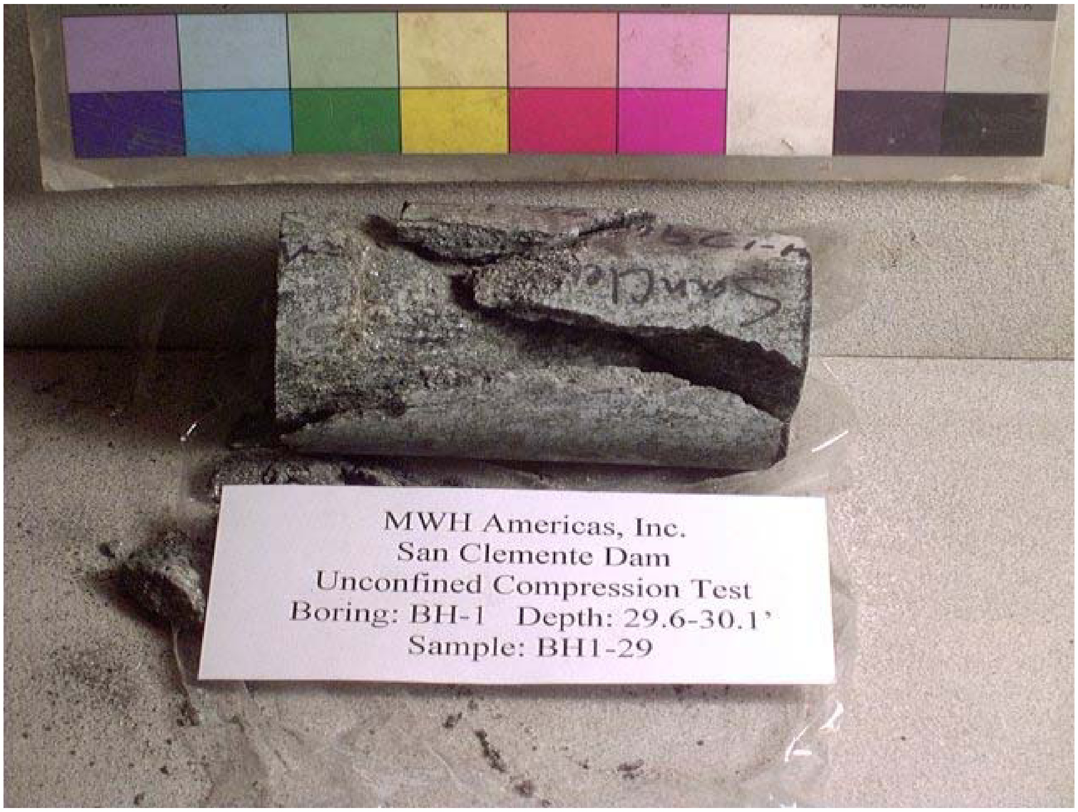
Client: MWH Americas, Inc.
2121 N. California Blvd., Suite 600
Walnut Creek, CA 94596

Project: San Clemente Dam

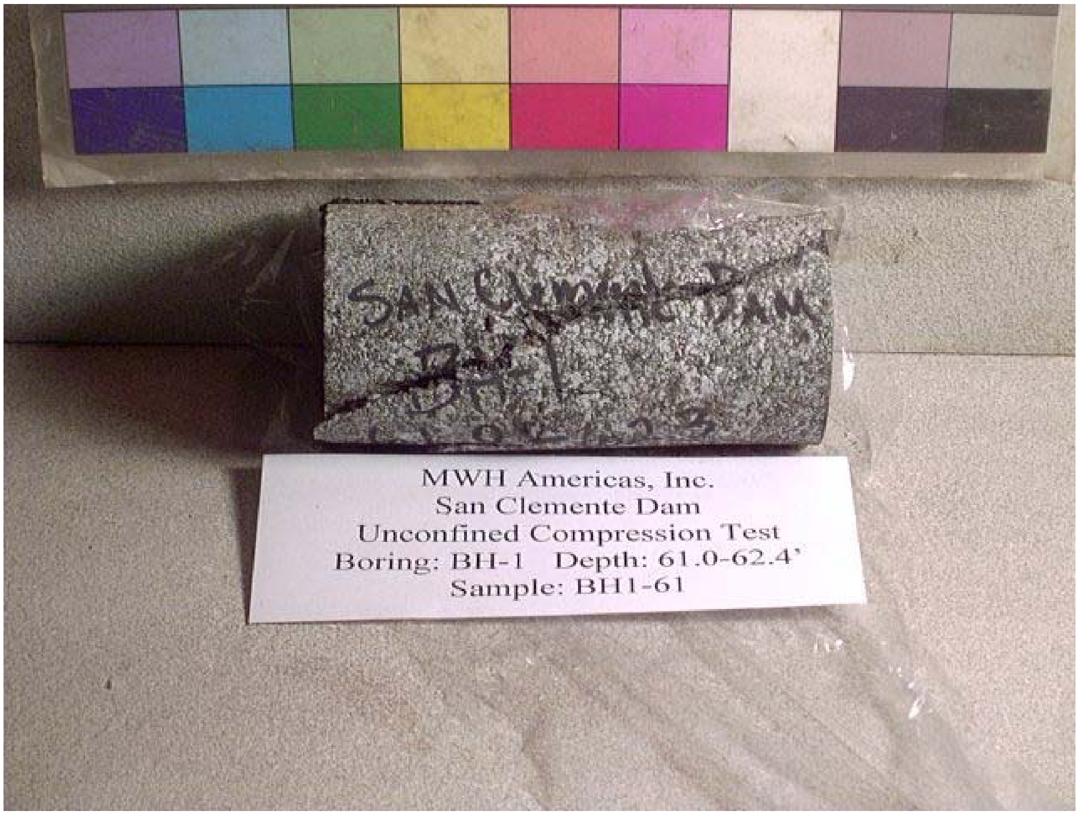
Project No: 1881772.181602

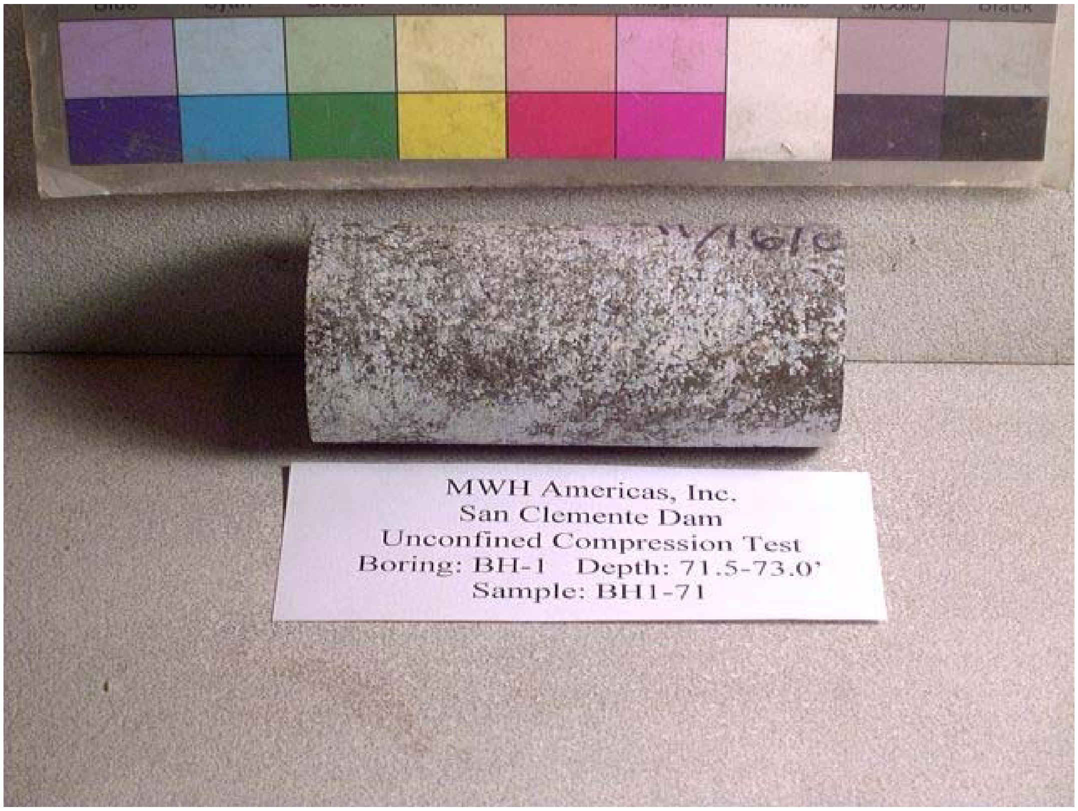
Test Date: November 26, 2007


MWH Americas, Inc.
San Clemente Dam
Unconfined Compression Test
Boring: BH-1 Depth: 29.6-30.1'
Sample: BH1-29

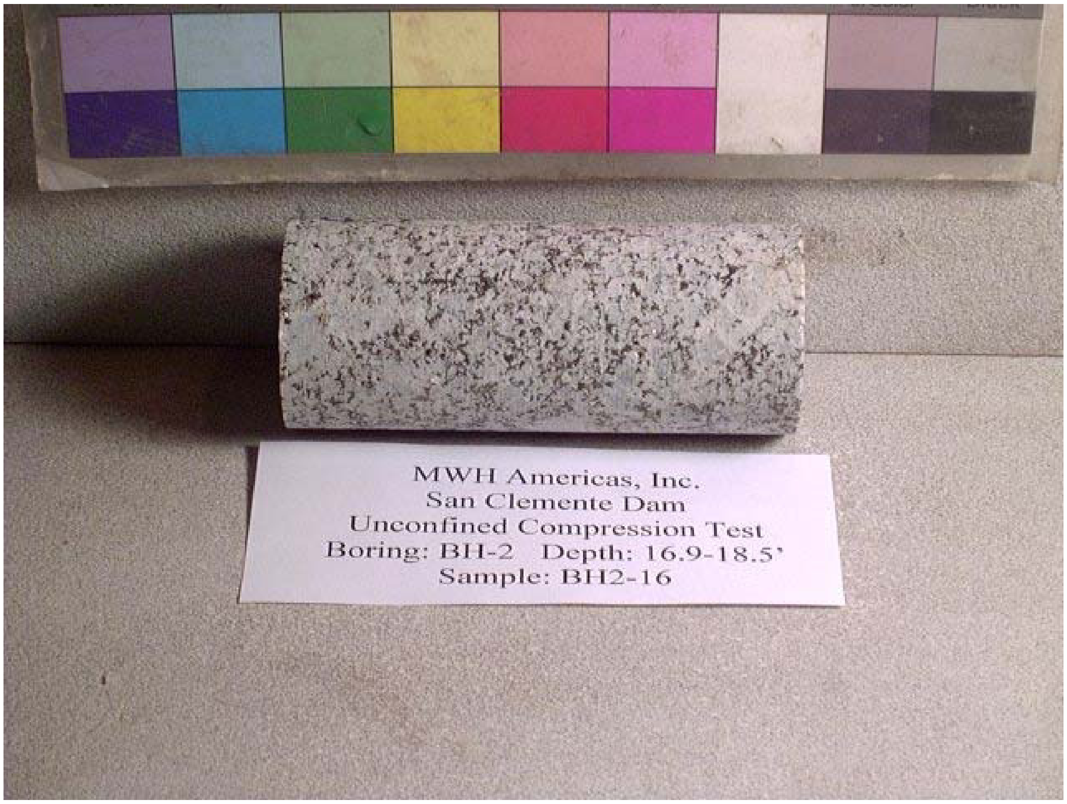

MWH Americas, Inc.
San Clemente Dam
Unconfined Compression Test
Boring: BH-1 Depth: 29.6-30.1'
Sample: BH1-29

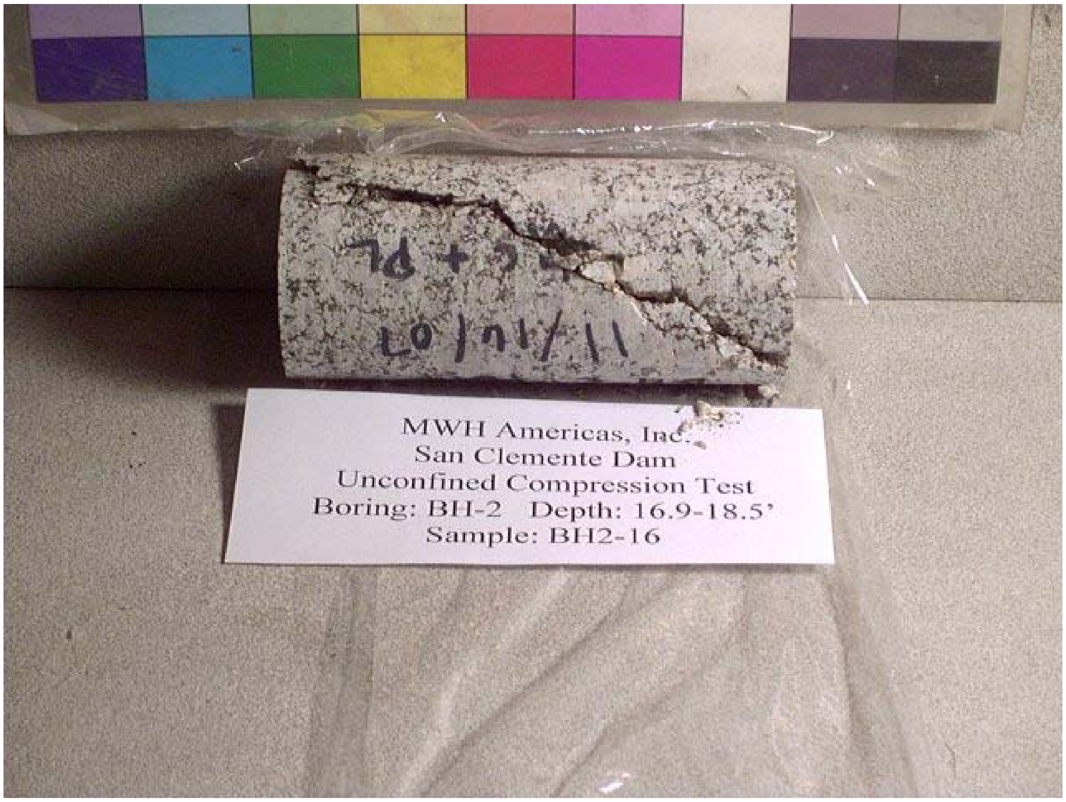

MWH Americas, Inc.
San Clemente Dam
Unconfined Compression Test
Boring: BH-1 Depth: 61.0-62.4'
Sample: BH1-61

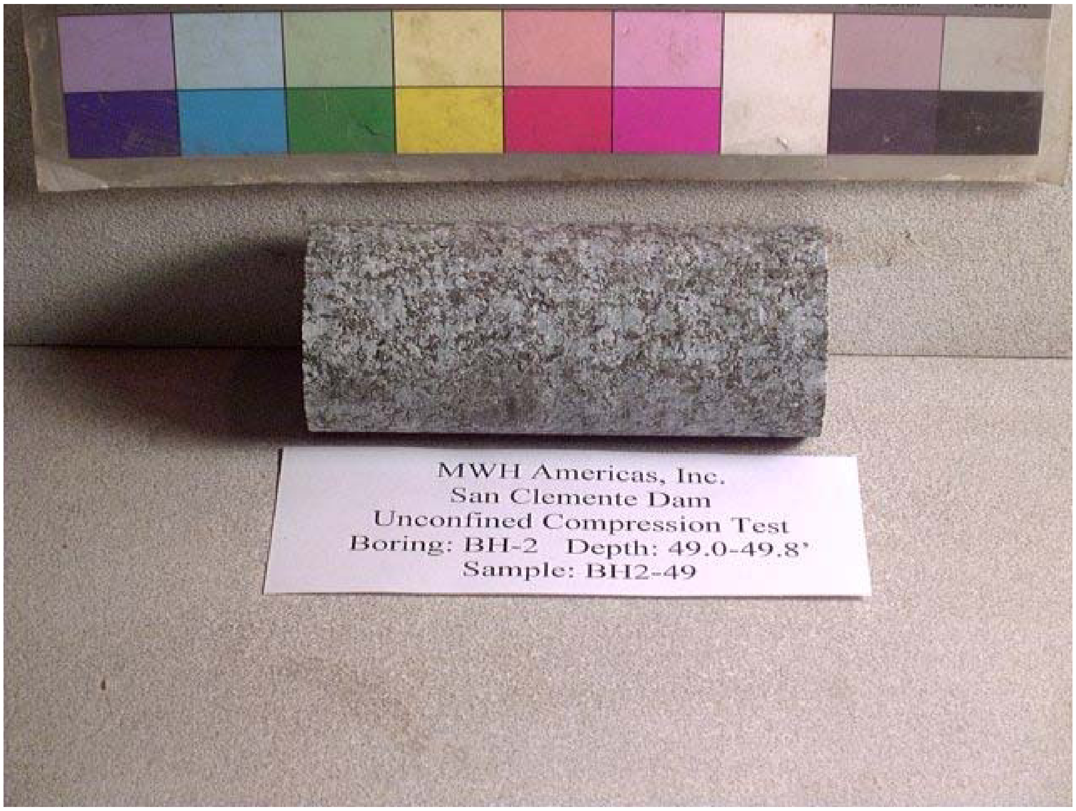

San Clemente Dam
BH-1
MWH Americas, Inc.
San Clemente Dam
Unconfined Compression Test
Boring: BH-1 Depth: 61.0-62.4'
Sample: BH1-61

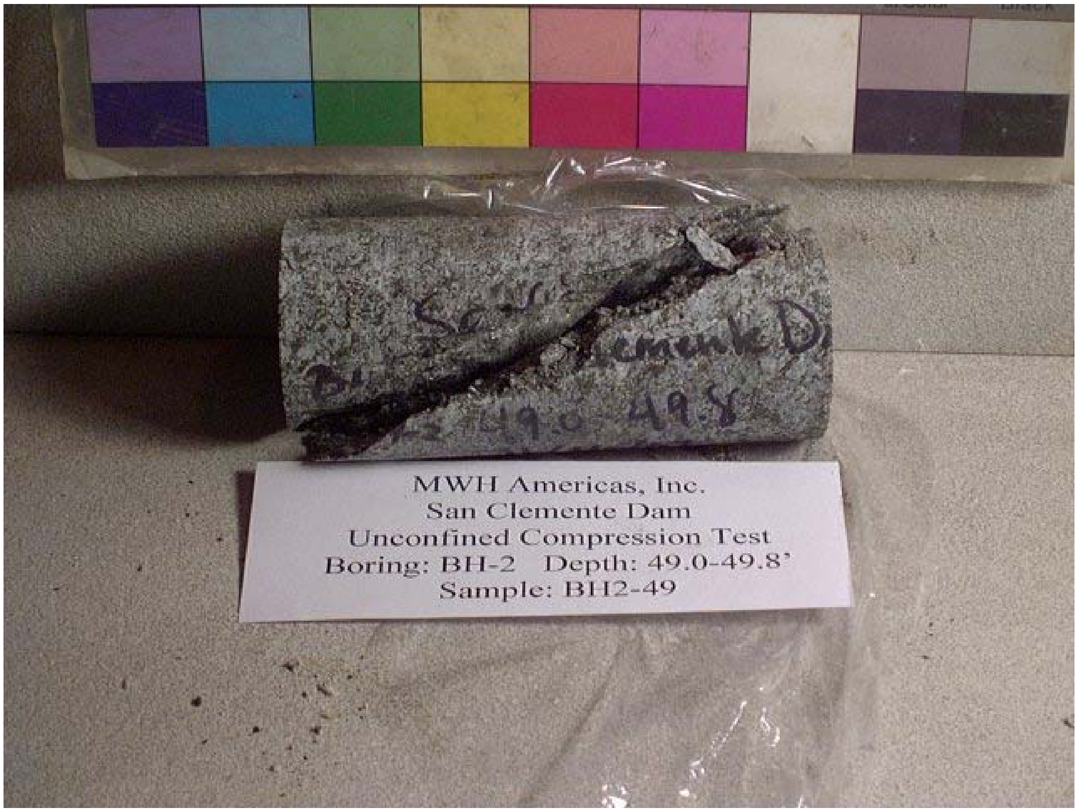

MWH Americas, Inc.
San Clemente Dam
Unconfined Compression Test
Boring: BH-1 Depth: 71.5-73.0'
Sample: BH1-71

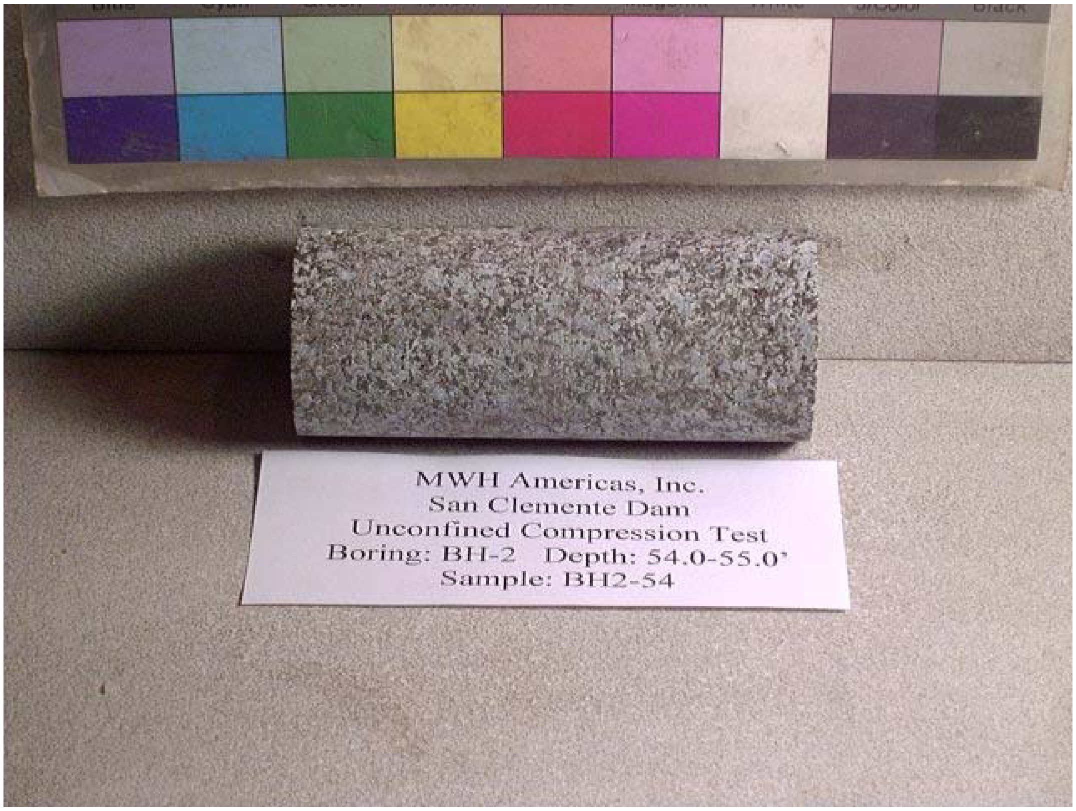

MWH Americas, Inc.
San Clemente Dam
Unconfined Compression Test
Boring: BH-1 Depth: 71.5-73.0'
Sample: BH1-71

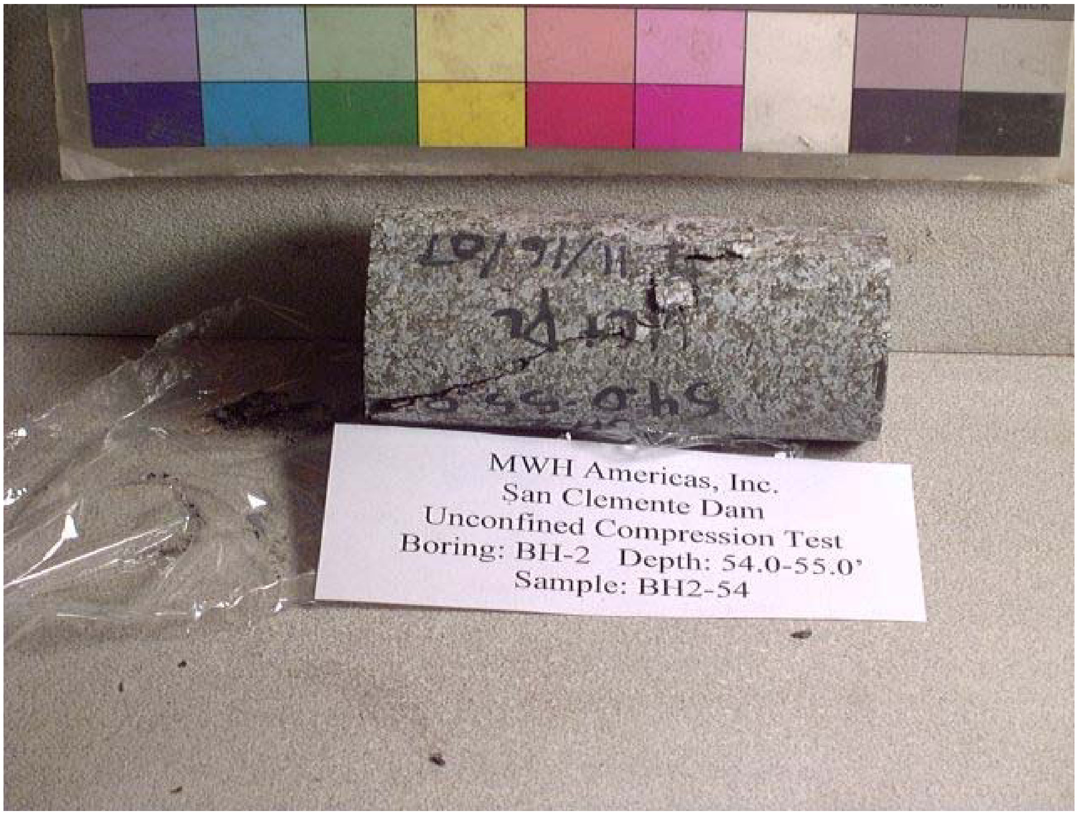

MWH Americas, Inc.
San Clemente Dam
Unconfined Compression Test
Boring: BH-2 Depth: 16.9-18.5'
Sample: BH2-16


11/14/07
MWH Americas, Inc.
San Clemente Dam
Unconfined Compression Test
Boring: BH-2 Depth: 16.9-18.5'
Sample: BH2-16


MWH Americas, Inc.
San Clemente Dam
Unconfined Compression Test
Boring: BH-2 Depth: 49.0-49.8'
Sample: BH2-49


49.0 49.8
MWH Americas, Inc.
San Clemente Dam
Unconfined Compression Test
Boring: BH-2 Depth: 49.0-49.8'
Sample: BH2-49

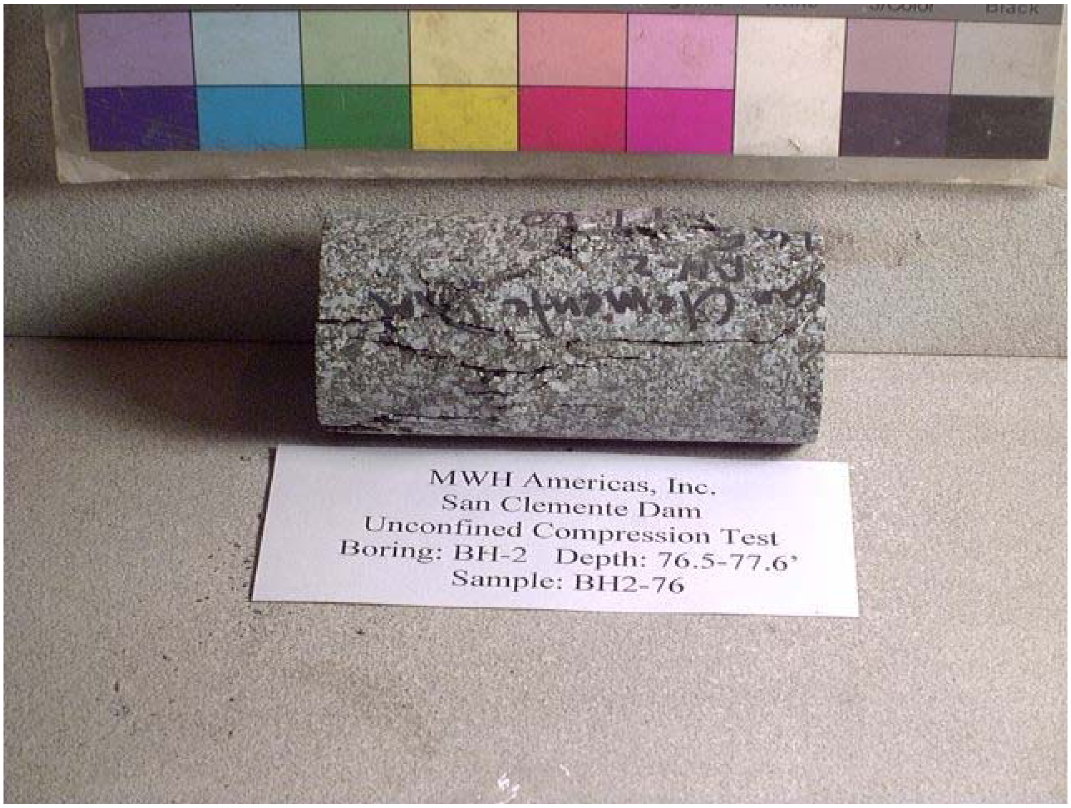

MWH Americas, Inc.
San Clemente Dam
Unconfined Compression Test
Boring: BH-2 Depth: 54.0-55.0'
Sample: BH2-54

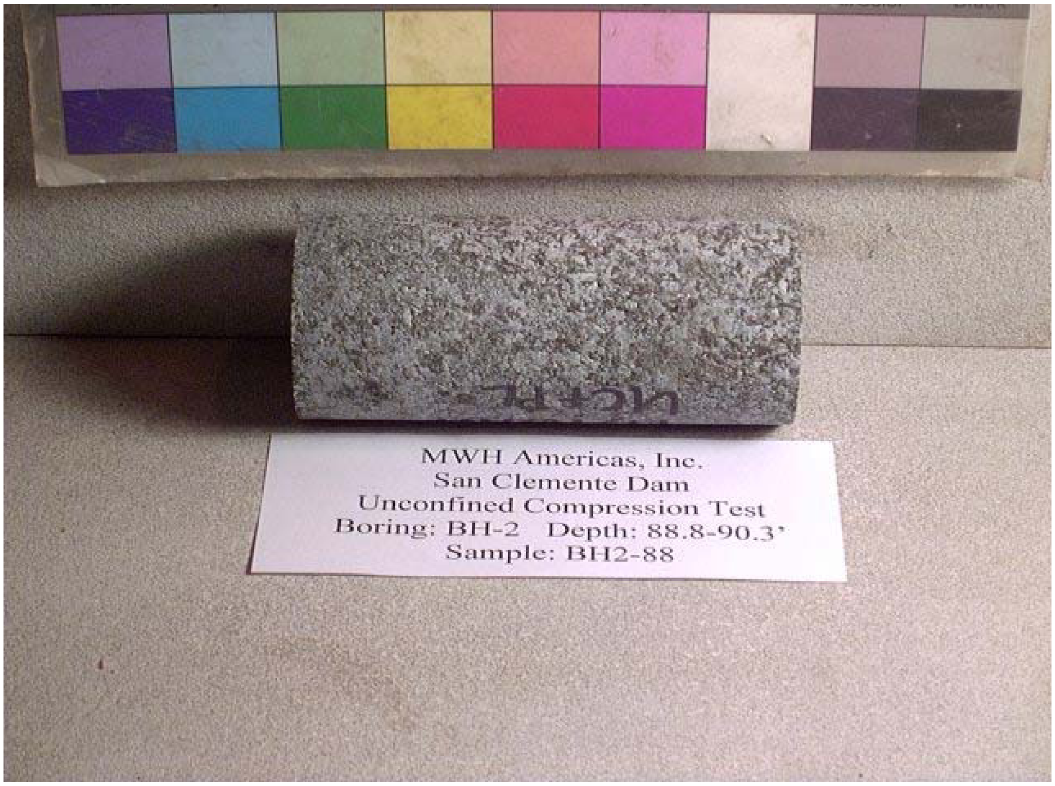

11/16/07
54.0-55.0
MWH Americas, Inc.
San Clemente Dam
Unconfined Compression Test
Boring: BH-2 Depth: 54.0-55.0'
Sample: BH2-54

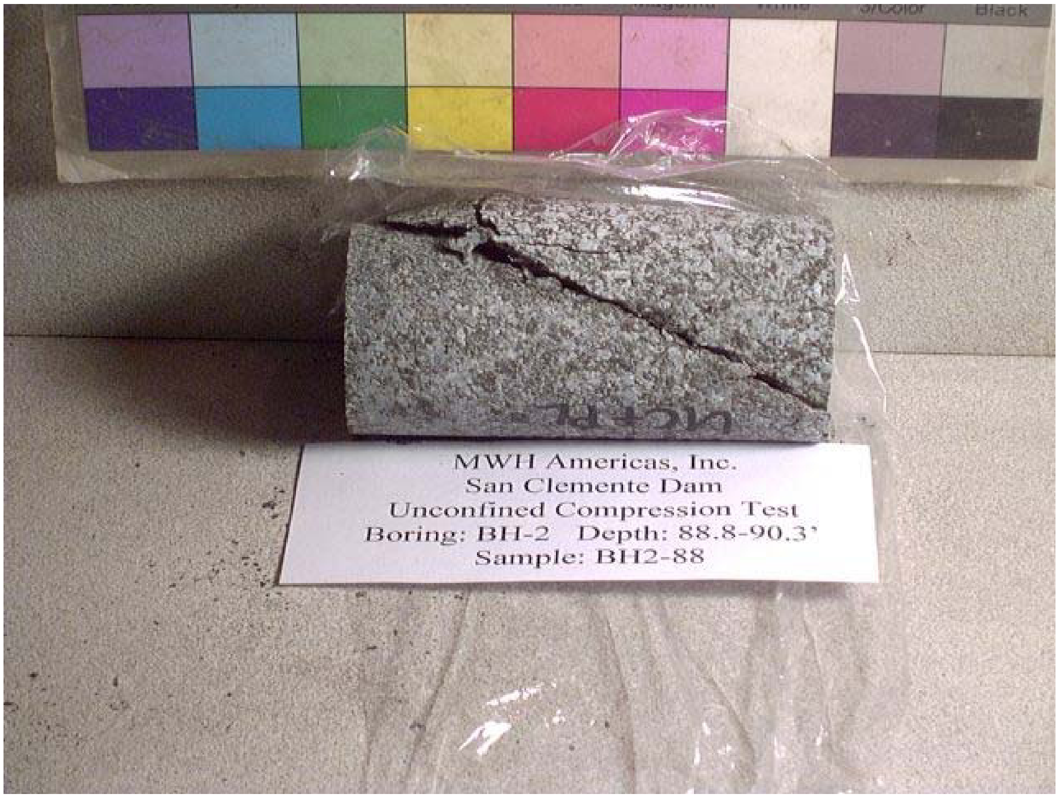

MWH Americas, Inc.
San Clemente Dam
Unconfined Compression Test
Boring: BH-2 Depth: 61.1-62.4'
Sample: BH2-61


MWH Americas, Inc.
San Clemente Dam
Unconfined Compression Test
Boring: BH-2 Depth: 61.1-62.4'
Sample: BH2-61


MWH Americas, Inc.
San Clemente Dam
Unconfined Compression Test
Boring: BH-2 Depth: 76.5-77.6'
Sample: BH2-76


MWH Americas, Inc.
San Clemente Dam
Unconfined Compression Test
Boring: BH-2 Depth: 76.5-77.6'
Sample: BH2-76


MWH Americas, Inc.
San Clemente Dam
Unconfined Compression Test
Boring: BH-2 Depth: 88.8-90.3'
Sample: BH2-88


MWH Americas, Inc.
San Clemente Dam
Unconfined Compression Test
Boring: BH-2 Depth: 88.8-90.3'
Sample: BH2-88

APPENDIX C
Geological Reconnaissance Report

September 18, 2007

Memo to: Jennifer Van Pelt

From: Ross Wagner

Subject: Geologic Reconnaissance of the proposed excavation near San Clemente Dam

The San Clemente Dam is located in Monterey County, near the confluence between the Carmel River and San Clemente Creek. It is approximately 2 to 3 miles upstream of the city of Carmel Valley. An excavation has been proposed near the confluence of these two streams. The proposed excavation would remove a part of the ridge that separates the Carmel River from San Clemente Creek. The excavation would allow the diversion of water from the Carmel River into the lower part of San Clemente Creek.

On Thursday, September 13, 2007 an approximately 2 hour geologic reconnaissance was conducted at the site of the proposed excavation near the San Clemente Dam. The goal of this effort was to establish the kind of rock that is present at the proposed excavation, and to assess the engineering geologic properties of the rock.

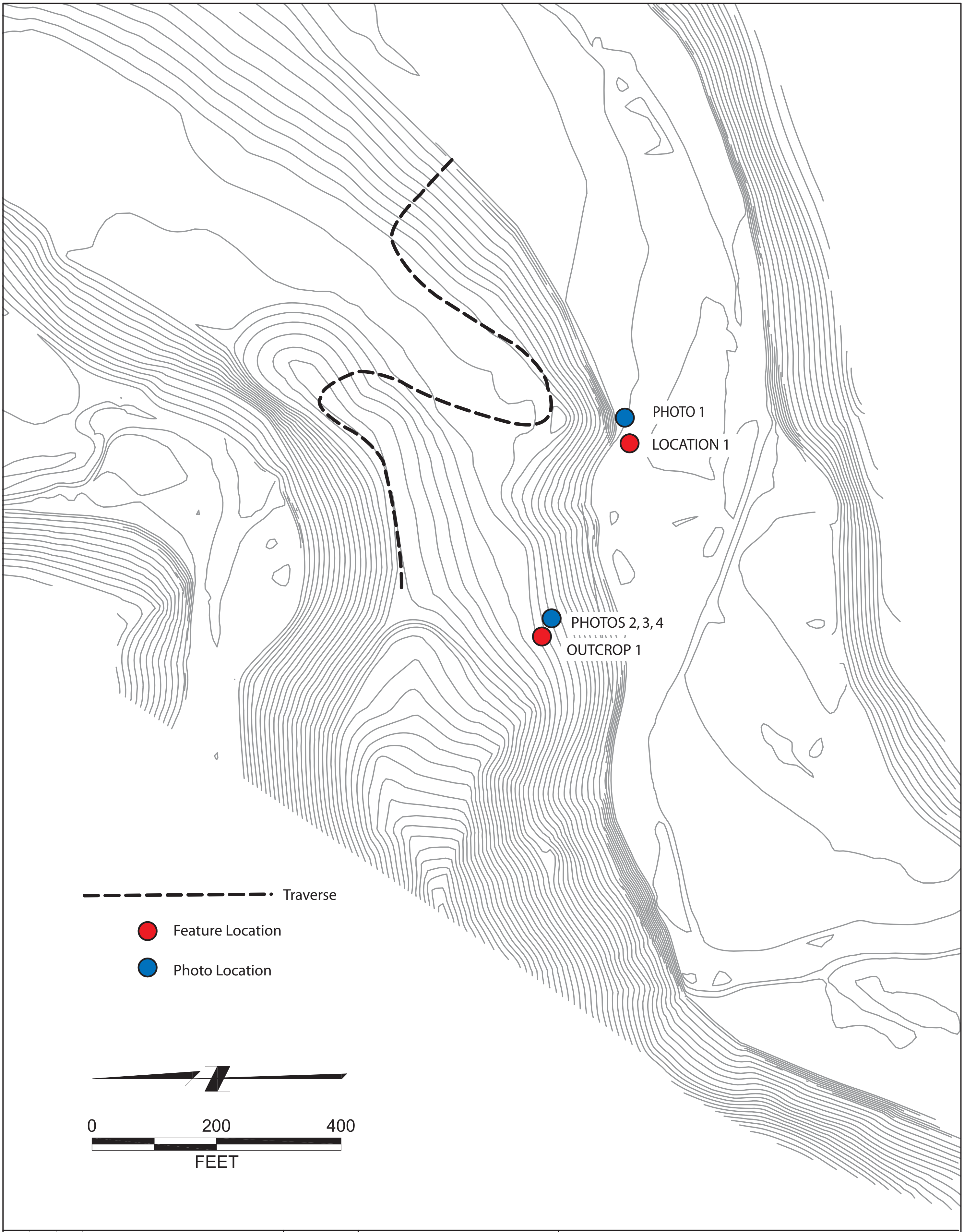
An existing geologic map, obtained by Jennifer Van Pelt, showed the site of the proposed excavation to be underlain by a coarse-grained hornblende gabbro, but the map also showed granodiorite to be present just north and south of the proposed excavation. In contrast to the existing geologic map, an inspection of exposures along the north bank of the Carmel River at Location 1 (see Figure 1) showed the rock just east of the proposed excavation to consist of a granodiorite. The granodiorite consists of equant crystals of quartz and feldspar, with biotite being the major mafic mineral. Locally biotite makes up almost 10 percent of the rock. The diameter of crystals in the granodiorite is typically about 1/10 of an inch.

Locally the granodiorite contains pegmatite dikes. The dikes consist of quartz and orthoclase (?) crystals with crystal size commonly being greater near the center of the dike than near the edge. Biotite is also present locally within the dikes. Crystals in the pegmatite dikes locally reach approximately 1 inch in diameter. As exposed near Location 1 (Figure 1) the dikes are typically less than one foot thick. Judging from the outcrop at Location 1, the orientation of the dikes is highly variable, ranging from a strike of north-south and a vertical dip, to a strike of east-west with a dip of 25 degrees to the north. Photo 1 shows some of the dikes at Location 1.

The strike of joints exposed at Location 1 range from approximately N15E to N25E and the dips are variable, but close to vertical. Photo 1 shows one of the joints. The joint surfaces are rough to medium rough and the spacing between the joints ranges from 6 feet to less than one foot.

A hammer blow to rocks at Location 1 shows the rock to be moderately strong. It is unclear whether this characteristic can be generalized to the rest of the rocks in the area of the proposed excavation. This is because in most of the area observed during this reconnaissance, outcrops were absent.

Insufficient time was available to assess whether all of the proposed excavation is underlain by granodiorite, and additional field work should be conducted to assess the distribution of lithology at the proposed excavation. Float and minor outcrops along a traverse on the top of the ridge that separates San Clemente Creek and the Carmel River (shown as Traverse 1 on Figure 1) showed only grandodiorite and pegmatite dikes. However, an outcrop further to the west along the ridge (shown as Outcrop 1 on Figure 1) may be a different lithology. Outcrop 1 was not visited, but from a distance it has a slightly olive color. The olive color is different from the gray color that is commonly associated with granodiorite, and the olive color may indicate that Outcrop 1 is composed of a gabbro. Photos 2, 3 and 4 show Outcrop 1.



REV	DATE	BY	DESCRIPTION

MWH
Walnut Creek
California

CALIFORNIA COASTAL CONSERVANCY
CARMEL RIVER BYPASS & SAN CLEMENTE DAM REMOVAL

SITE RECONNASSIANCE MAP

Customer:	**Coastal Conservancy**	**Project Number:**	**1881772**
Site Name:	**San Clemente Dam**	**Site Location:**	**Carmel River**

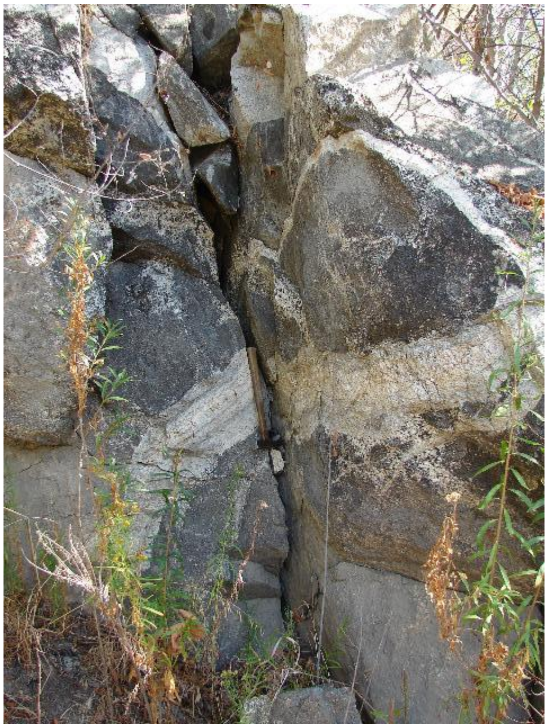
Photograph ID: 1

Date: Sep 13, 2007

Location:
San Clemente Dam. Out crop along Carmel River

Direction:
View looking north

Comments:
Dikes in granodiorite at location one



Photograph ID: 2

Date: Sep 13, 2007

Location:
San Clemente Dam. View of outcrop along the Carmel River

Direction:
View looking east

Comments:
Outcrop 1

Customer:	**Coastal Conservancy**	**Project Number:**	**1881772**
Site Name:	**San Clemente Dam**	**Site Location:**	**Carmel River**

Photograph ID: 3

Date: Sep 13, 2007

Location:
San Clemente Dam. Closer view of outcrop along the Carmel River

Direction:
View looking east

Comments:
Outcrop 1

Photograph ID: 4

Date: Sep 13, 2007

Location:
San Clemente Dam. Close up of outcrop along the Carmel River

Direction:
View looking east

Comments:
Outcrop 1

APPENDIX D
Geotechnical Analyses

Purpose:

The purpose of this analysis is to evaluate static and seismic stability of the San Clemente diversion dike and stabilized sediment slope.

References:

- Geo-Slope International Ltd., "SLOPE/W" Computer Program, Version 5, Alberta, Canada.
- Geotechnical Earthquake Engineering, Steven L. Kramer.
- Slope Stability and Stabilization Methods, Lee W. Abramson

Slope Stability Analysis Design Category:

- Cross sections for this analysis were developed based on data presented Entrix's Draft EIR/EIS report (2006).
- PGA on the bedrock was determined to be 0.37g with a return period of 975 year, and a corresponding PGA on the ground surface was 0.40g using amplification ratios developed by Seed et al. (1994). Marcurson and Franklin (1983) suggested using a seismic coefficient of 1/3 to 1/2 of PGA on the ground surface with a minimum factor of safety requirement of 1.0 for pseudo static analysis, which results in a seismic coefficient ranging from 0.13 to 0.20. Using a seismic coefficient of 0.15g with a minimum factor of safety requirement of 1.0 as recommended by US Army Corps of Engineers for great earthquake would be appropriate for pseudo static slope stability analyses because typical seismic coefficient in California ranges from 0.05 to 0.15 (Abramson).
- The Morgenstern-Price Limit Equilibrium method analysis was used to calculate critical failure surfaces and the corresponding factors of safety.
- For diversion dike slope stability analyses, water elevation of 540.0 ft was assumed for both upstream and downstream side during normal conditions.
- For diversion dike slope stability analyses, water elevation of 566.0ft including super elevation (MEI 2005) and 540.0ft were used upstream and downstream, respectively, during Probable Maximum Flood (PMF) condition.
- Total unit weight of 145 pcf and friction angle of 42 degrees was used based on typical values published by NAVFAC (1986) for the dike rock fill material shear strength parameters.

- Total unit weight of 130 pcf, friction angle of 0 degrees, and cohesion of 10,000 psf were assumed for Soil Concrete Column shear strength parameters of the stabilized sediment slope based on recommendations presented by the Federal Highway Administration.
- Shear strength values of foundation material were estimated based on established correlations with SPT blow counts.
- Preliminary liquefaction potential analyses indicated that foundation material is susceptible to liquefaction. Hence, without any implementation of liquefaction mitigation measures, the pseudo-static slope stability would have lower factor of safety results presented herein.
- Shear Strength parameters used in slope stability analyses are based on conditions observed during subsurface explorations and boring logs presented by Kleinfelder (2002). Increased shear strength values due to the liquefaction mitigation measures, such as stone column or deep soil mixing, may result in higher factor of safety.
- Friction angle of 44 degrees and cohesion of 4,900 psf were used for rock shear strength parameters of bypass channel based on the estimated using Hoek-Brown rock strength criteria as determined using RocLab 1.031 software.
- For overburden shear strength parameters of diversion channel, friction angle of 36 degrees and total unit weight of 129 pcf were assumed.
- Post liquefaction residual strength values were estimated using a simplified method proposed by Seed and Harder (1990) and using the lower bound of residual soil strength resulting in undrain strength of 600 pounds per square foot.
- Potentially liquefiable layers identified at BH-3 were considered for post liquefaction slope stability analyses.

Table 1 Summary of Soil Strength Parameters

Material		Friction Angle (degree)	Cohesion (psf)	Total Density (pcf)
Diversion Dike	Rock Fill	42	0	145
	GW	31	0	116
	SP	31	0	116
	SP-SM_1	32	0	121
	SP-SM_2	35	0	130
	SM	31	0	119
	ML	36	0	132
	Cutoff Wall	0	1000	122
Stabilized Sediment	SP	29	0	108
	ML	30	0	112
	SP_2	31	0	117
	Soil Concrete Column	0	10,000	130
Diversion Channel	Overburden (GW)	36	0	129
	Rock	44	4900	160

Table 2 Slope Stability Analyses Results

Conditions	Diversion Dike				Stabilized Sediment Slope		Bypass Channel							
	Downstream 3.0:1 Slope		Upstream				1:1 Rock Slope				0.75:1 Rock Slope			
			2.5:1 Slope				Shallow Failure		Deep Failure		Shallow Failure		Deep Failure	
	Static	Pseudo Static	Static	Pseudo Static	Static	Pseudo Static	Static	Pseudo Static	Static	Pseudo Static	Static	Pseudo Static	Static	Pseudo Static
Normal Condition	2.3	1.4	1.8	1.2	3.5	2.0	2.0	1.4	3.1	2.4	2.0	1.4	2.8	2.3
PMP Condition	2.1	-	1.9	-										

Table 3 Post Liquefaction Slope Stability Analyses

Circular Failure Mode

Conditions		Diversion Dike	
		Downstream 3.0:1 Slope	Upstream
			2.5:1 Slope
Post Liquefaction Slope Stability	Low Bound Su (600psf)	0.8	0.7

Wedge-Shaped Failure Mode

Conditions		Diversion Dike	
		Downstream 3.0:1 Slope	Upstream
			2.5:1 Slope
Post Liquefaction Slope Stability	Low Bound Su (600psf)	0.8	0.6

Table 4 Makdisi-Seed Deformation Analyses

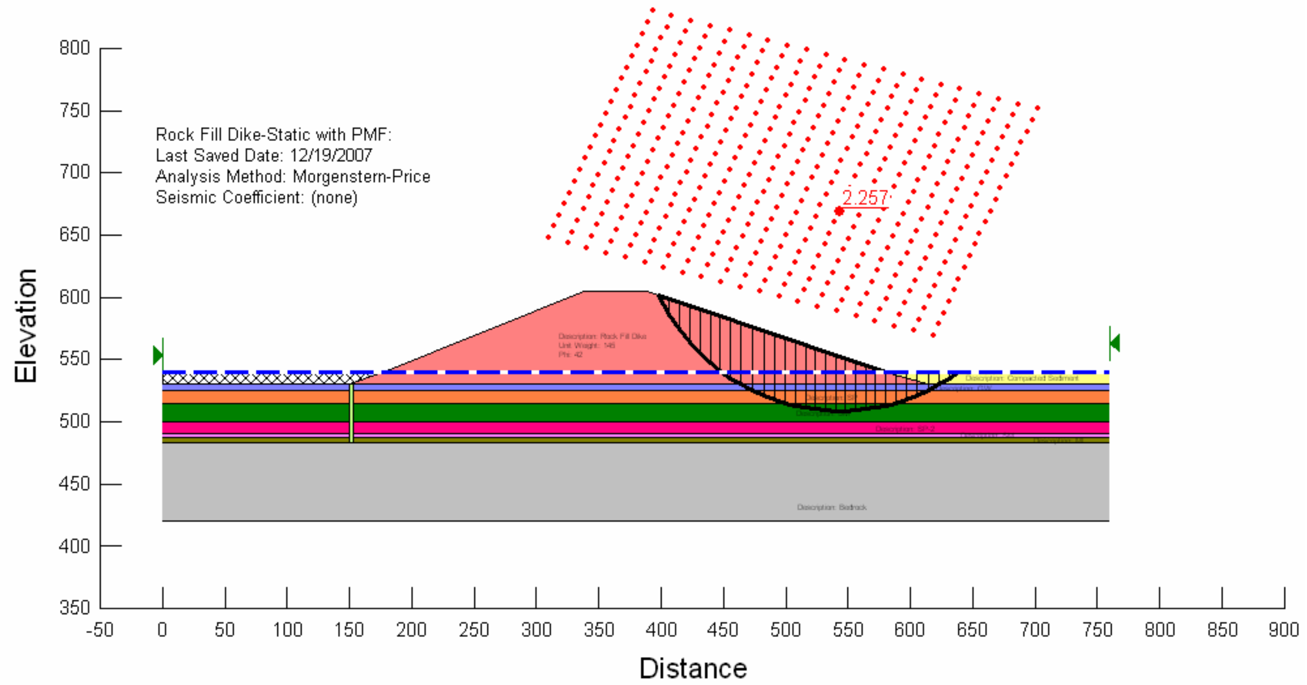
Locations	Height (h)	Height of Failure (y)	y/h	kmax/umax	umax	kmax	ky	FS	ky/kmax	Displacement			
										min (cm)	max (cm)	min (ft)	max (ft)
Down Stream (3.0:1.0) Slope	75	75	1.0	0.35	0.4	0.14	0.175	1.028	1.25	0	0	0.0	0.0
Upstream Slope (3.0:1.0)	75	52	0.7	0.48	0.4	0.19	0.13	1.015	0.68	1	8	0.0	0.3
Upstream Slope (2.5:1.0)	75	47	0.6	0.53	0.4	0.21	0.1	1.034	0.47	7	30	0.2	1.0

Diversion Dike

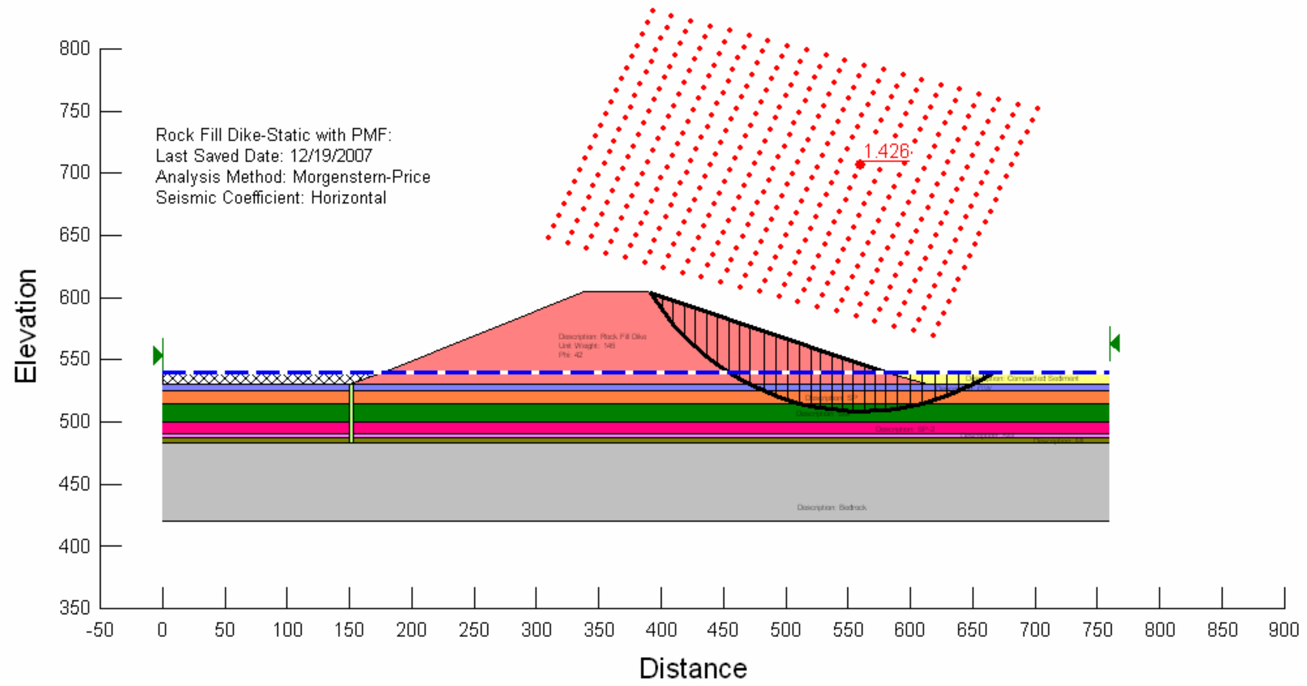
Normal Condition

Downstream Slope (3.0H:1.0L)

Static


Rock Fill Dike-Static with PMF:
Last Saved Date: 12/19/2007
Analysis Method: Morgenstern-Price
Seismic Coefficient: (none)

Pseudo Static

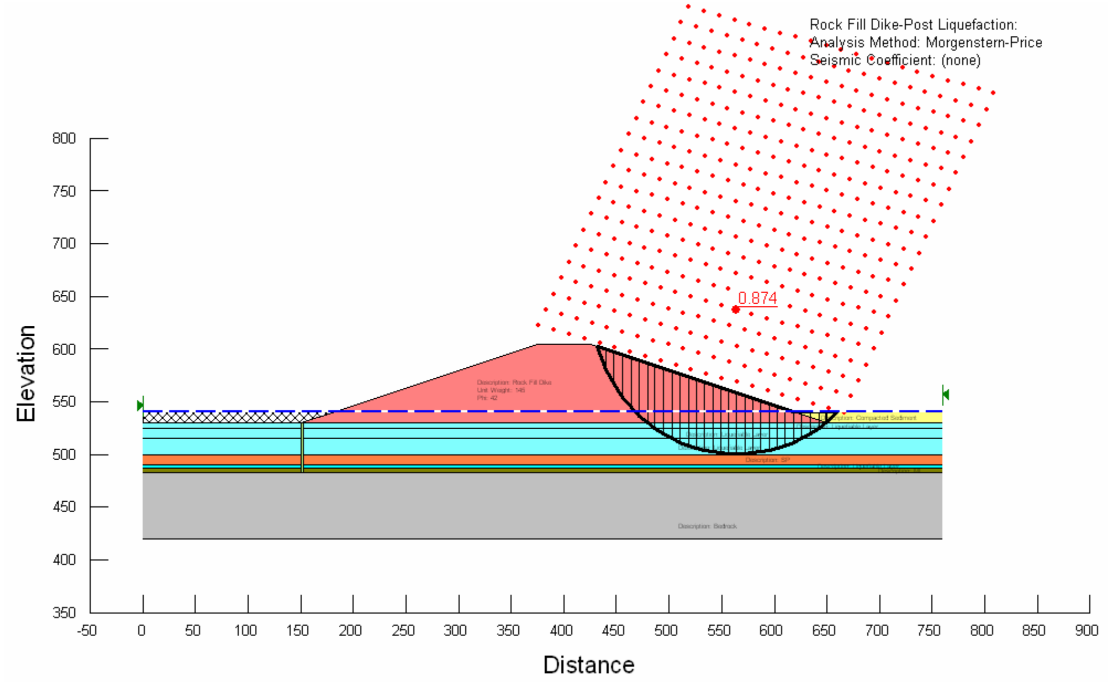

Rock Fill Dike-Static with PMF:
Last Saved Date: 12/19/2007
Analysis Method: Morgenstern-Price
Seismic Coefficient: Horizontal

MWH
MONTGOMERY WATSON HARZA

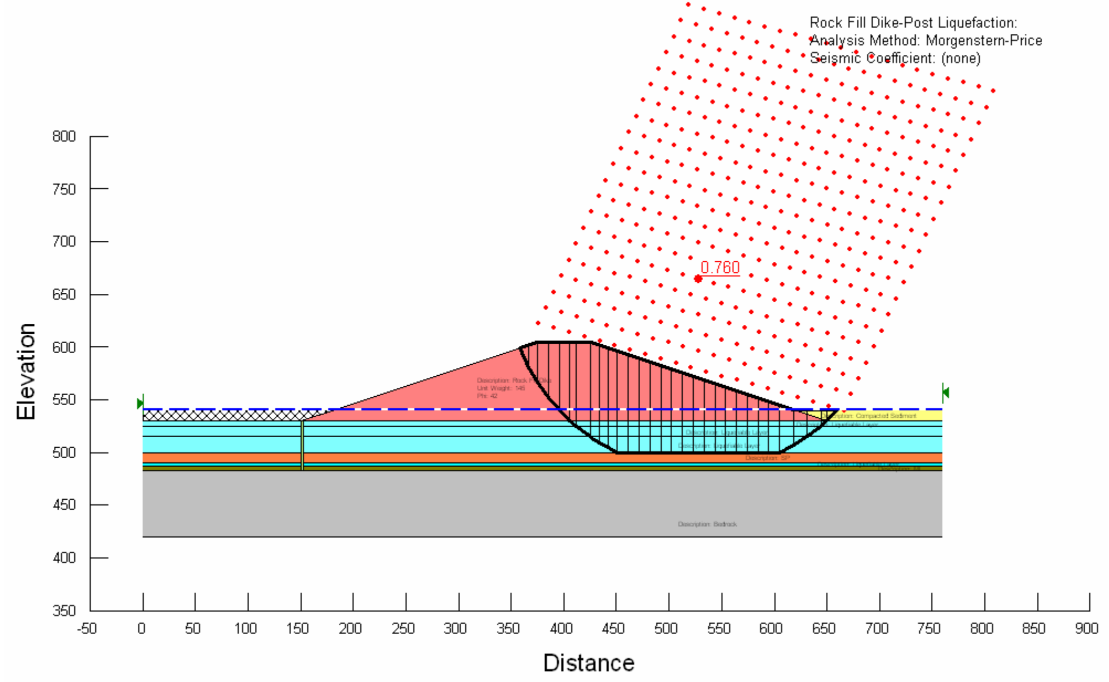
By *M.Kim* Date *Dec. 20* Client *California State Coastal Conservancy* Sheet *6* of 14

Chkd. By *H.Yang* Description ***San Clemente Slope Stability Analyses*** Job # *1881772*

Post Liquefaction Slope Stability
Low Bound Undrained Shear Strength (600psf)
Circular Failure

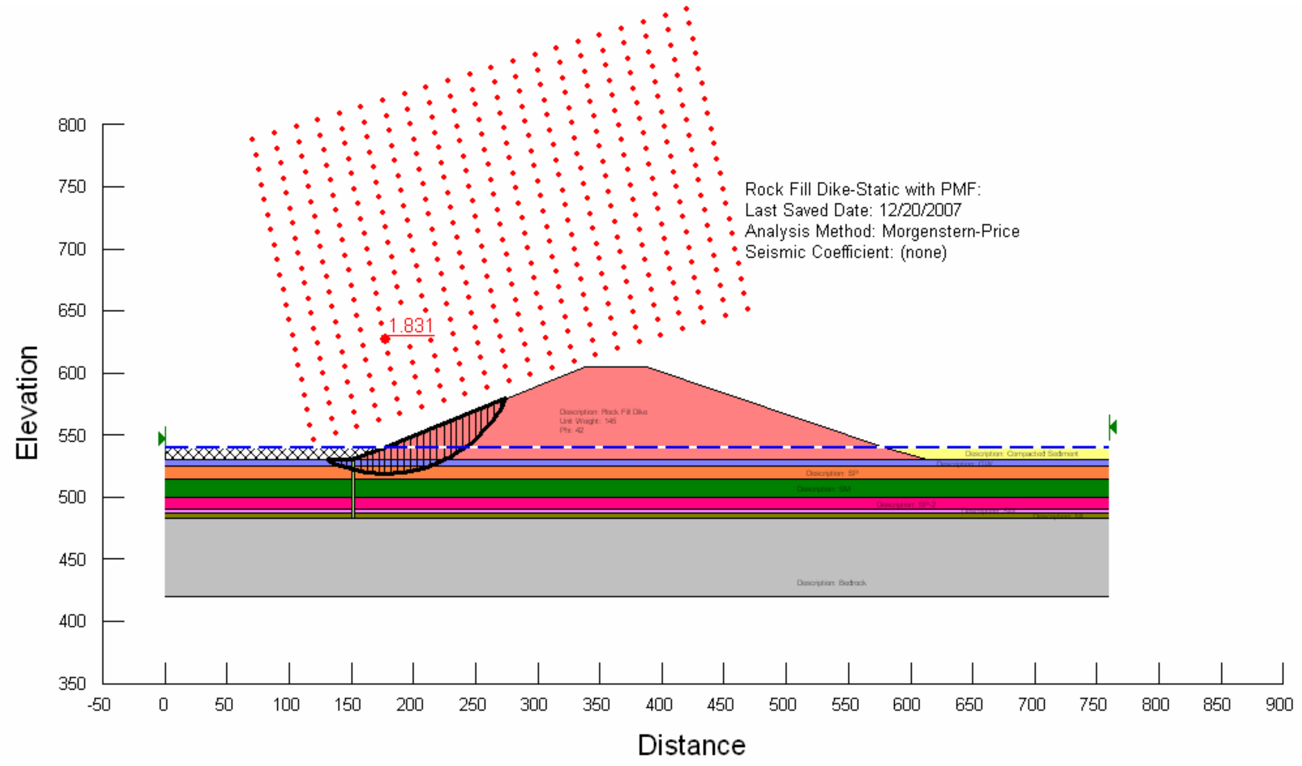


Wedge Shaped Failure



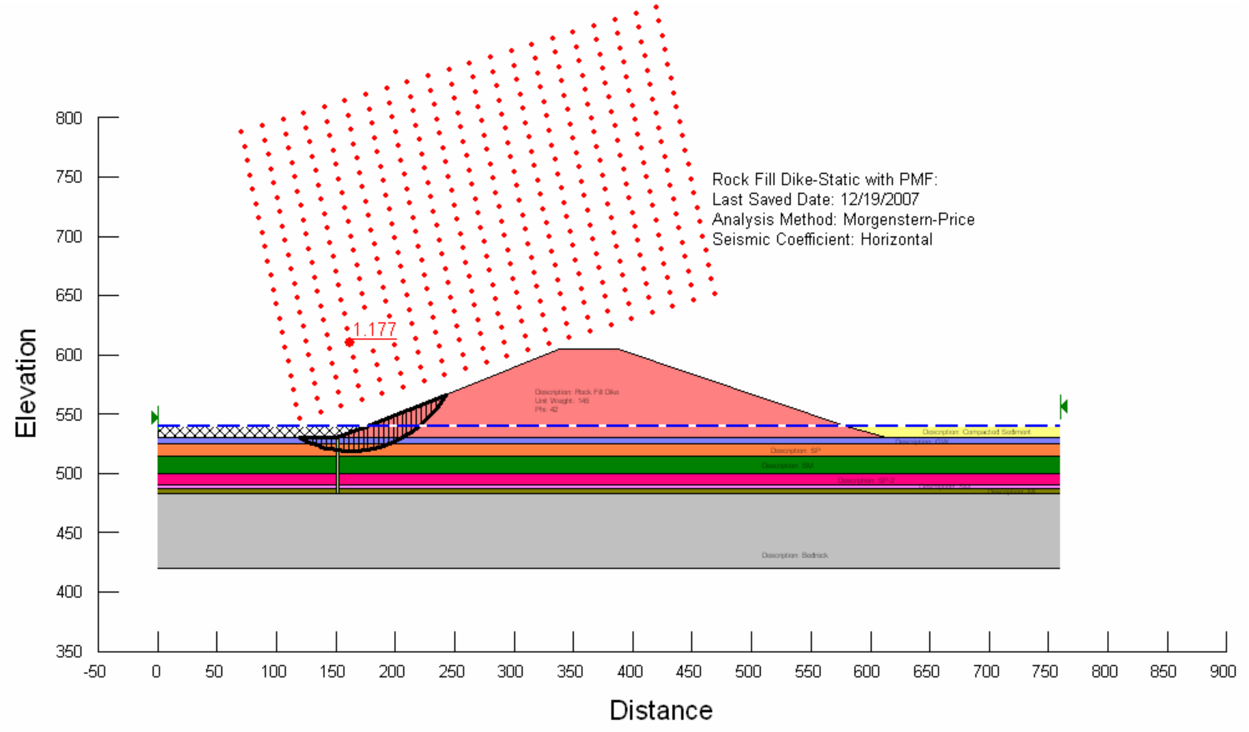
Upstream Slope (2.5H:1.0L)

Static



Rock Fill Dike-Static with PMF:
Last Saved Date: 12/20/2007
Analysis Method: Morgenstern-Price
Seismic Coefficient: (none)

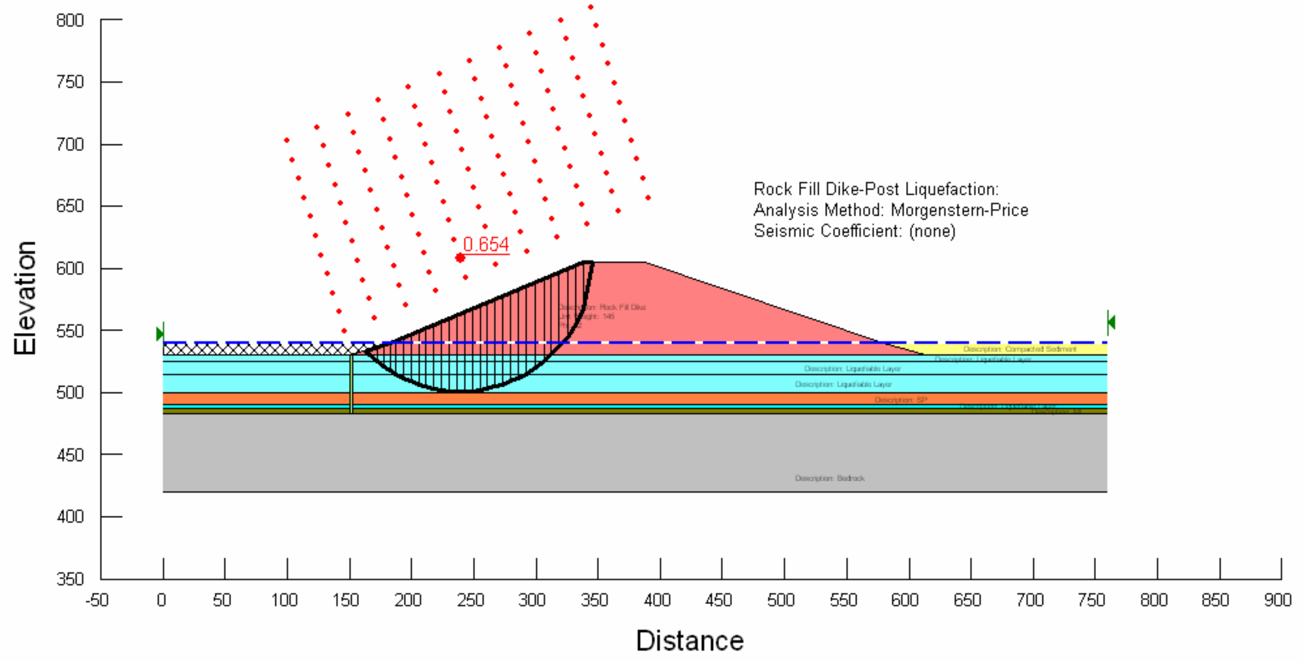
Pseudo Static



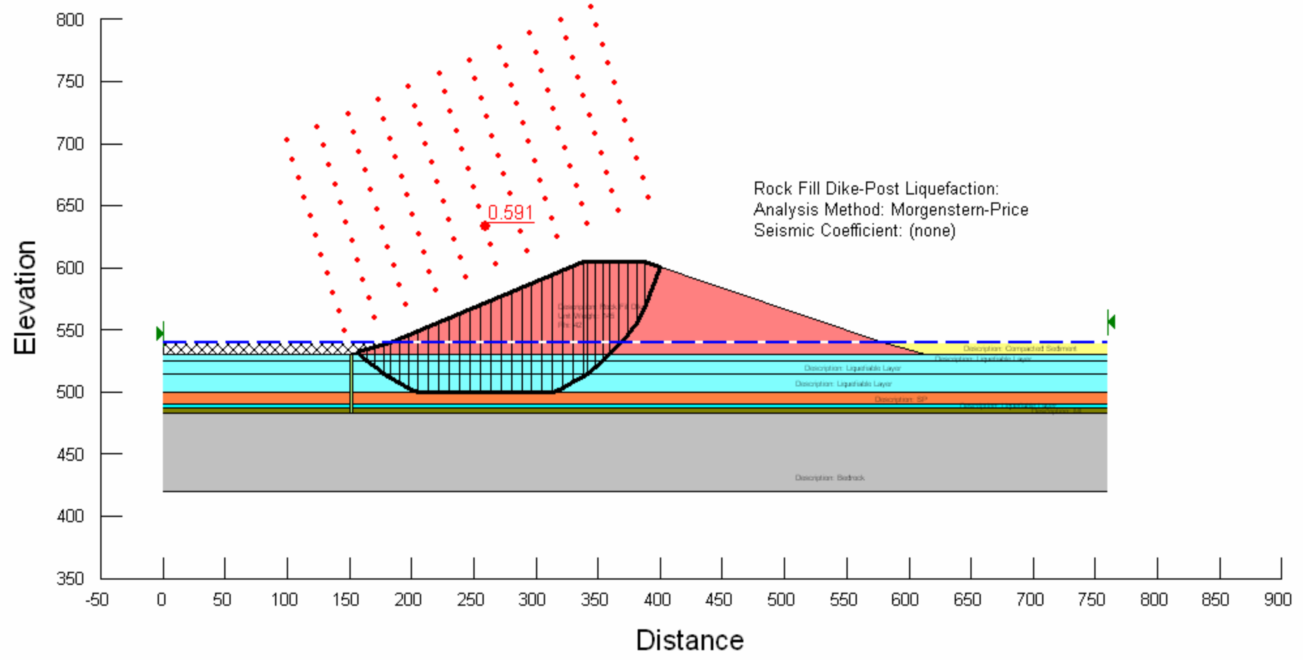
Rock Fill Dike-Static with PMF:
Last Saved Date: 12/19/2007
Analysis Method: Morgenstern-Price
Seismic Coefficient: Horizontal

Post Liquefaction Slope Stability
Low Bound Undrained Shear Strength (600psf)

Circular Failure



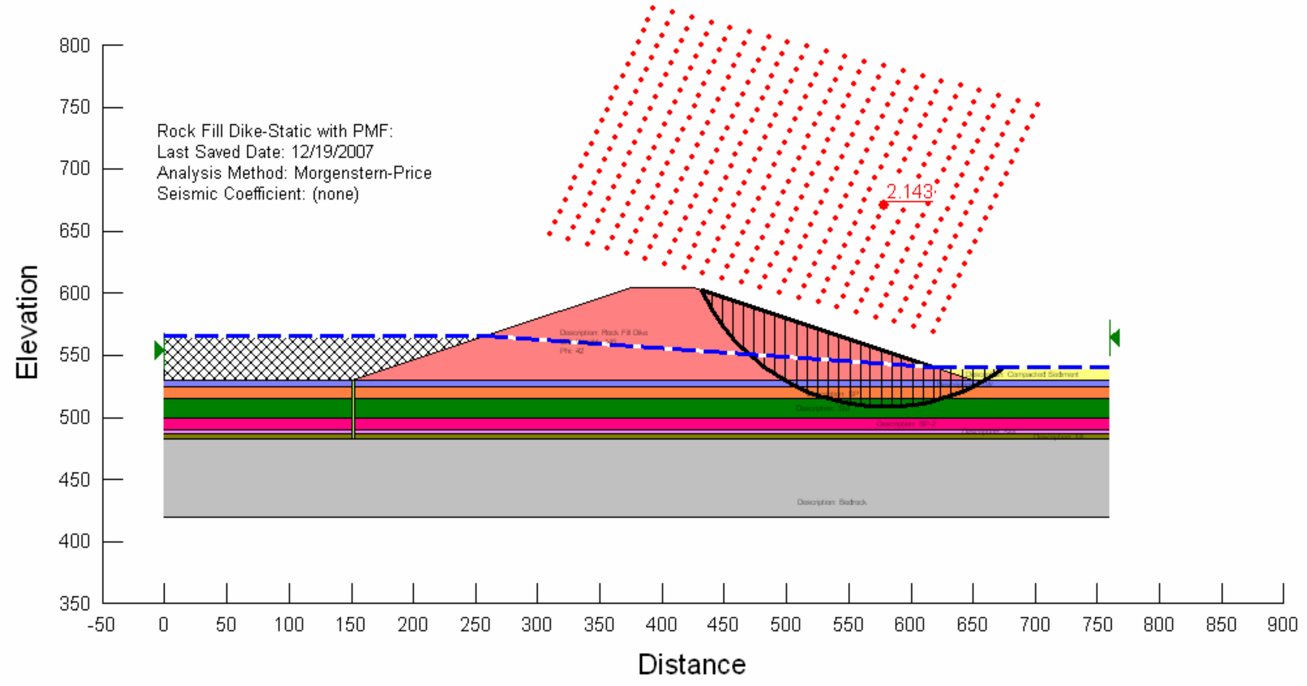
Wedge Shaped Failure



Probable Maximum Flood Condition

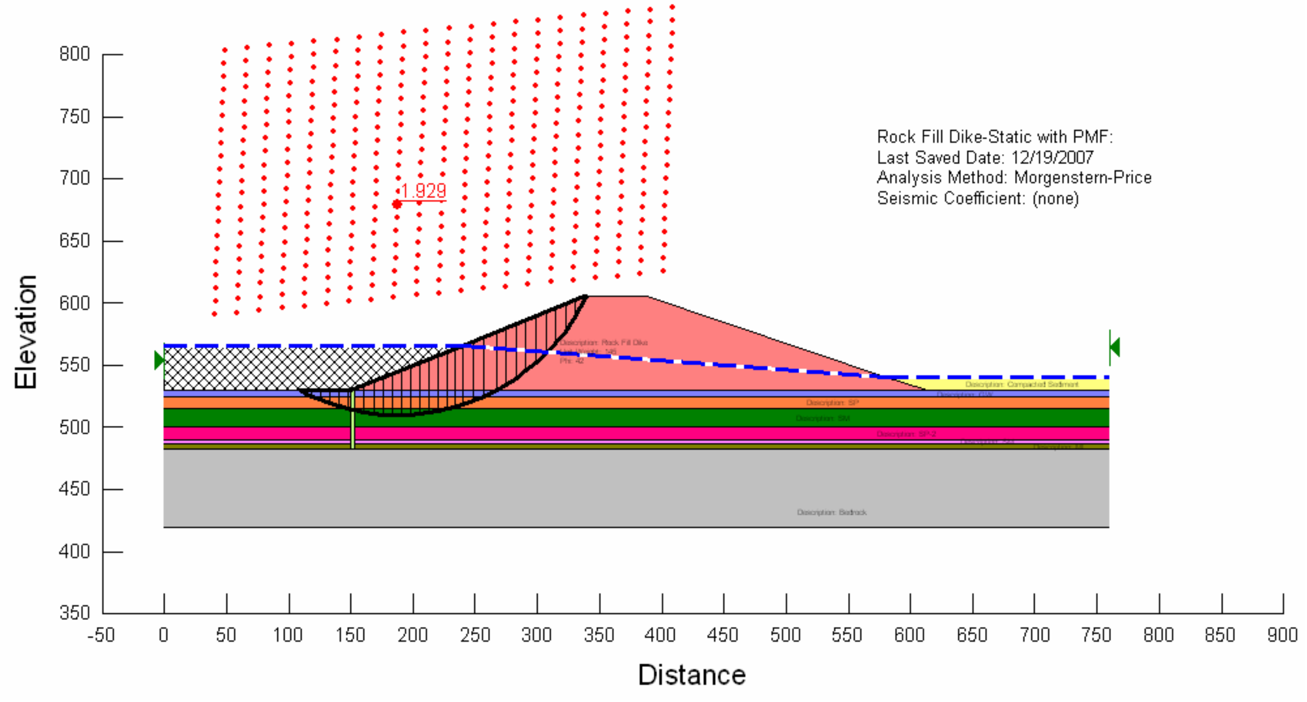
Downstream Slope (3.0H:1.0L)

Static



Upstream Slope (2. 5H:1.0L)

Static

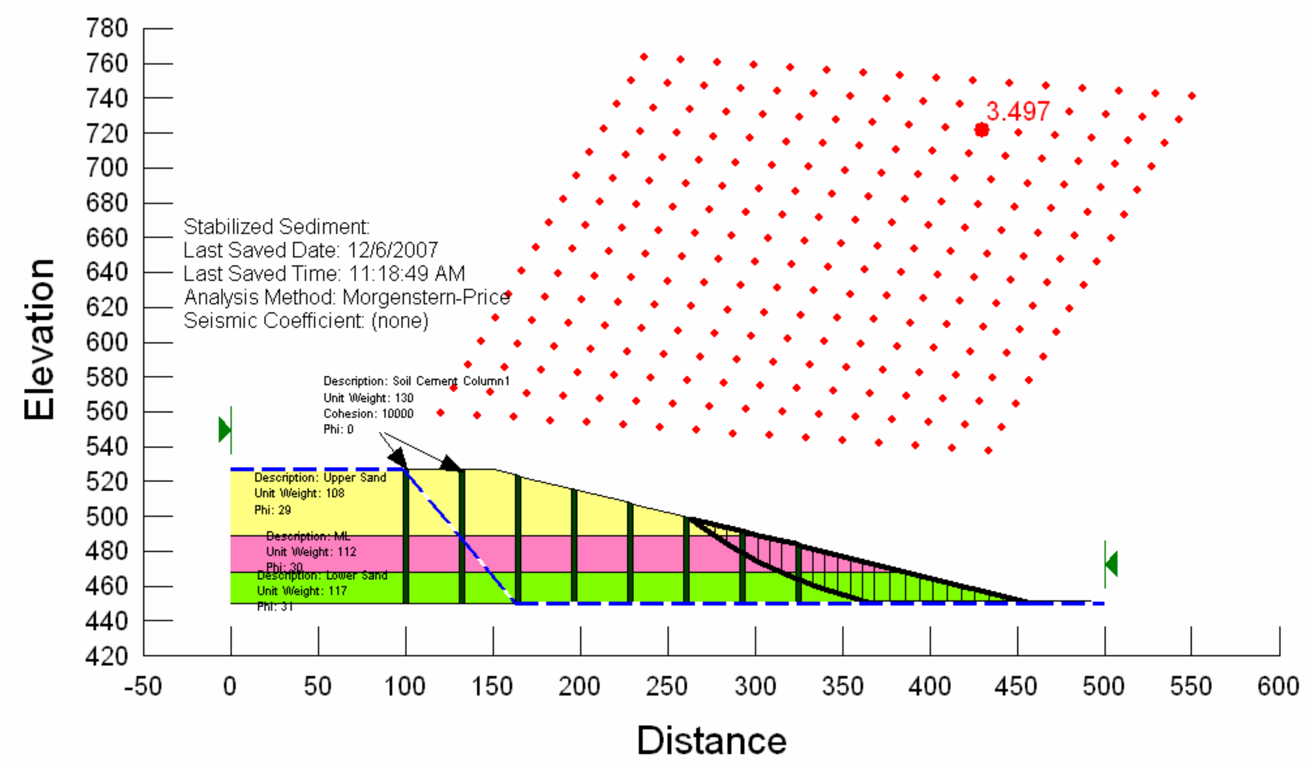


By **M.Kim** Date Dec. 20 Client California State Coastal Conservancy Sheet 10 of 14

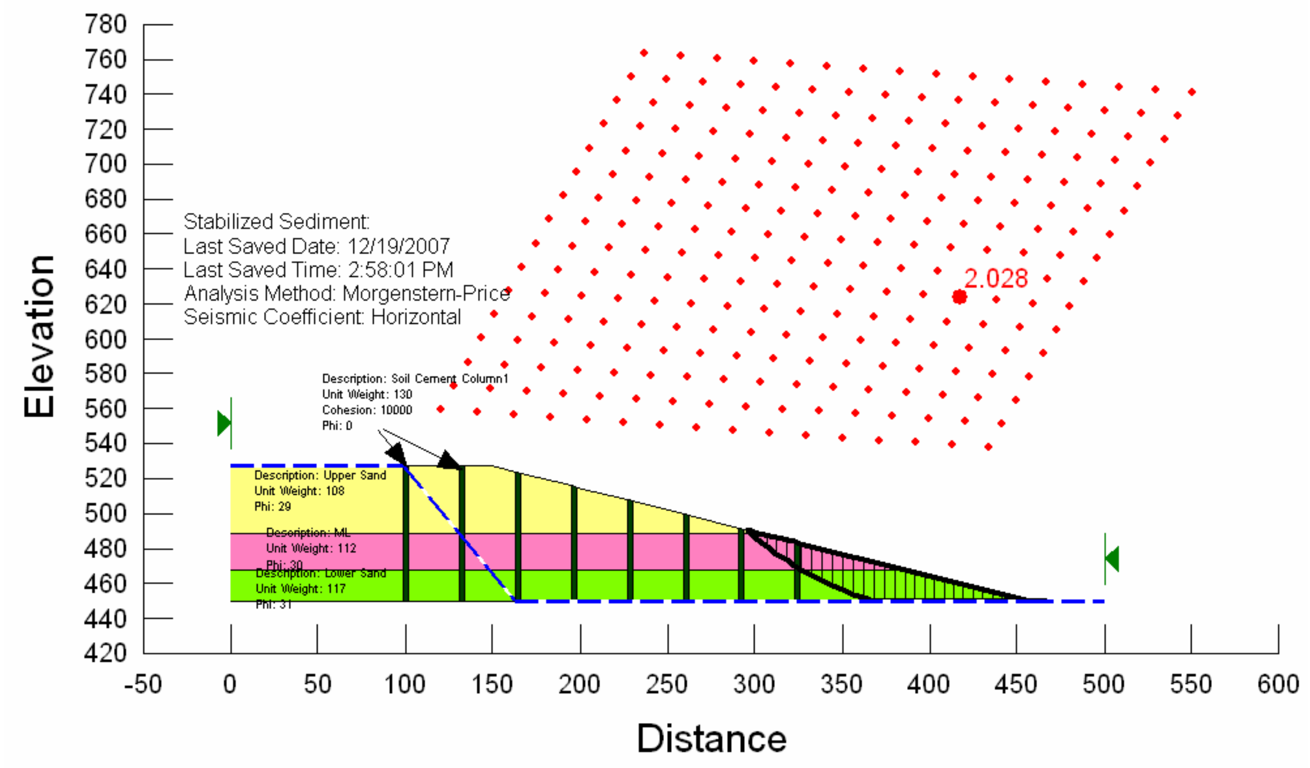
Chkd. By **H.Yang** Description **San Clemente Slope Stability Analyses** Job # 1881772

Stabilized Sediment Slope

Static



Pseudo Static



MWH
MONTGOMERY WATSON HARZA

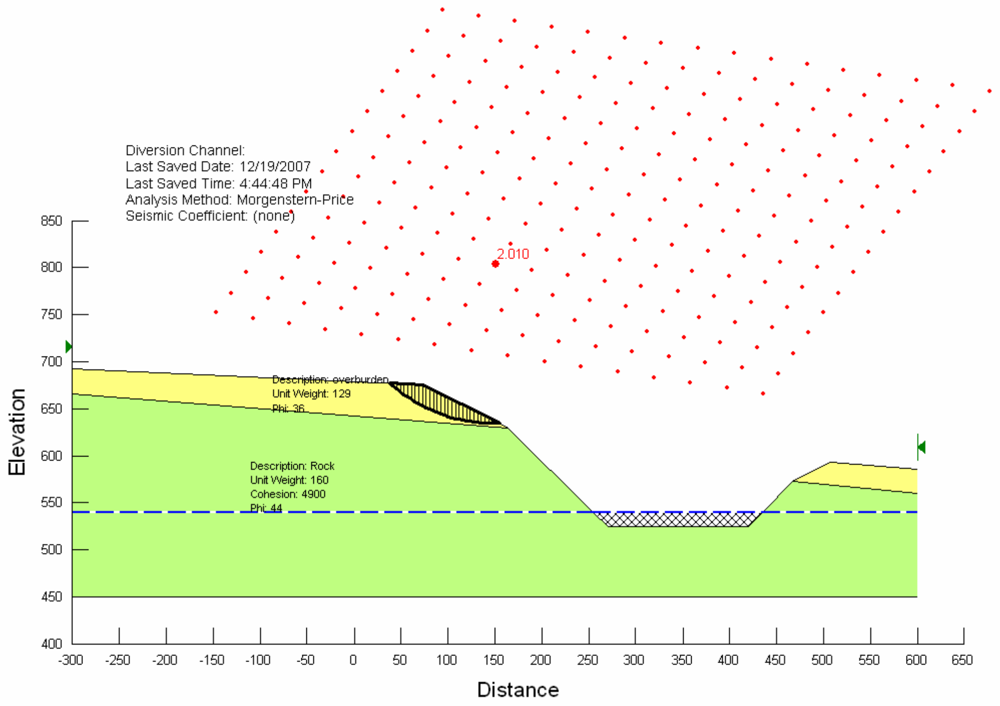
By *M.Kim* Date *Dec. 20* Client *California State Coastal Conservancy* Sheet *11* of 14
Chkd. By ***H.Yang*** Description ***San Clemente Slope Stability Analyses*** Job # *1881772*

Bypass Channel

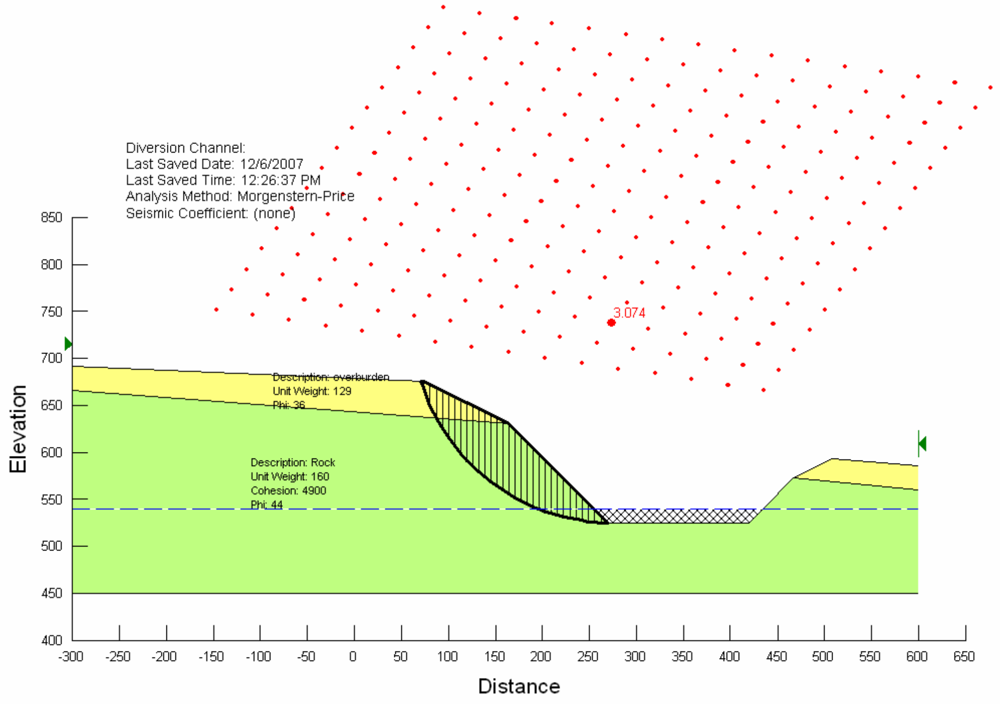
1.0H:1.0L Rock Slope

Static

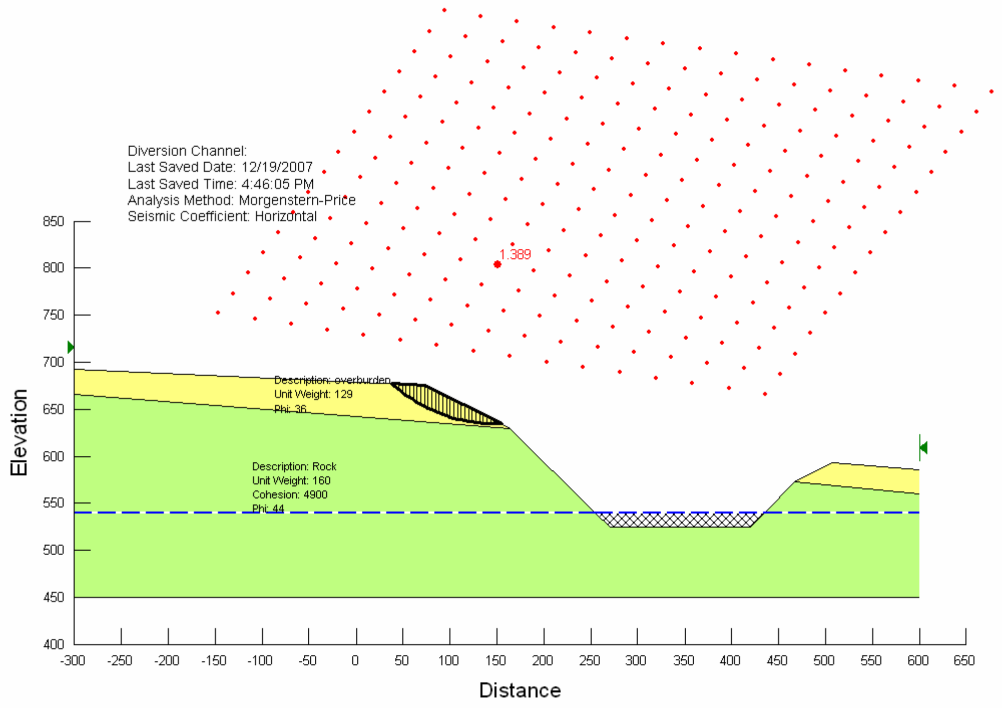
Shallow Failure



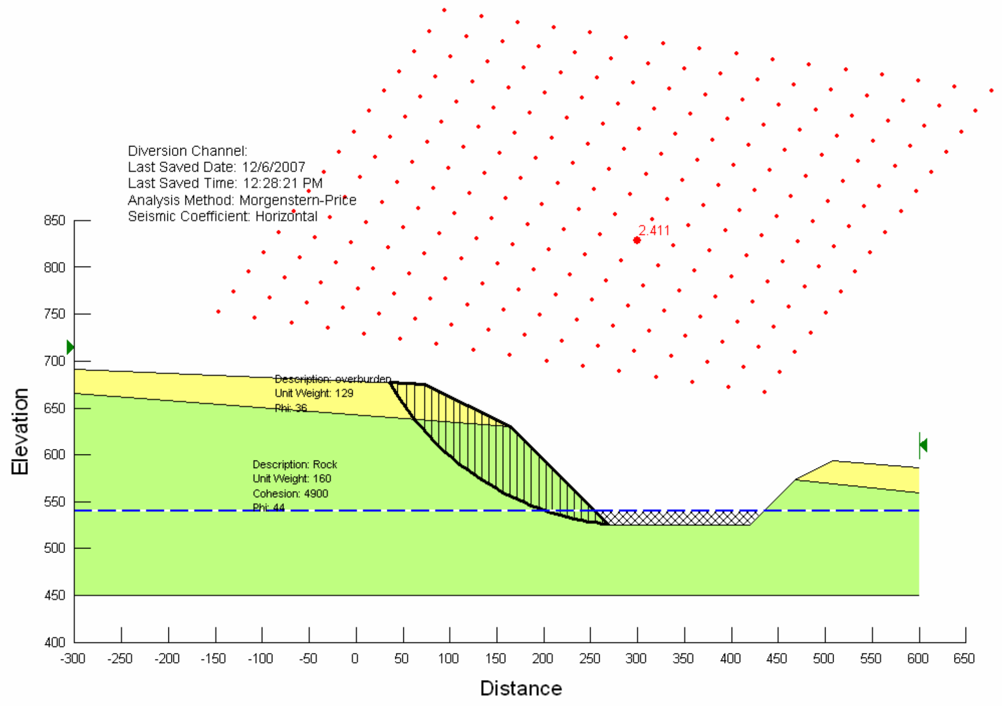
Deep Failure



Pseudo Static
Shallow Failure



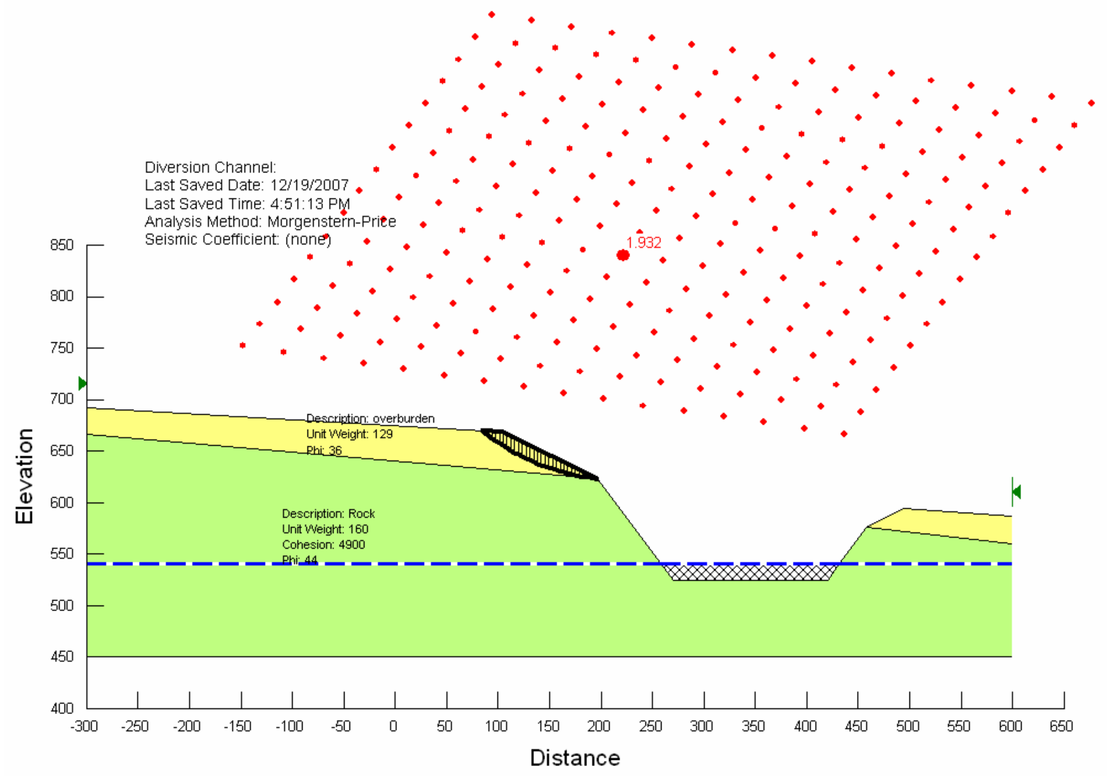
Deep Failure



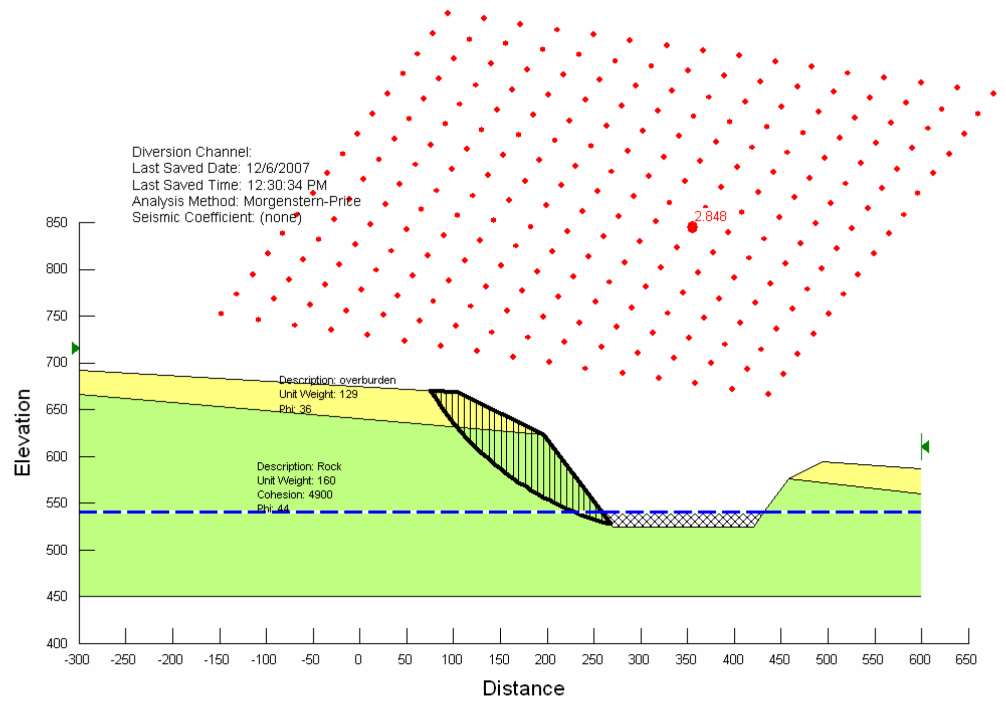
By **M.Kim** Date Dec. 20 Client California State Coastal Conservancy Sheet 13 of 14

Chkd. By **H.Yang** Description **San Clemente Slope Stability Analyses** Job # 1881772

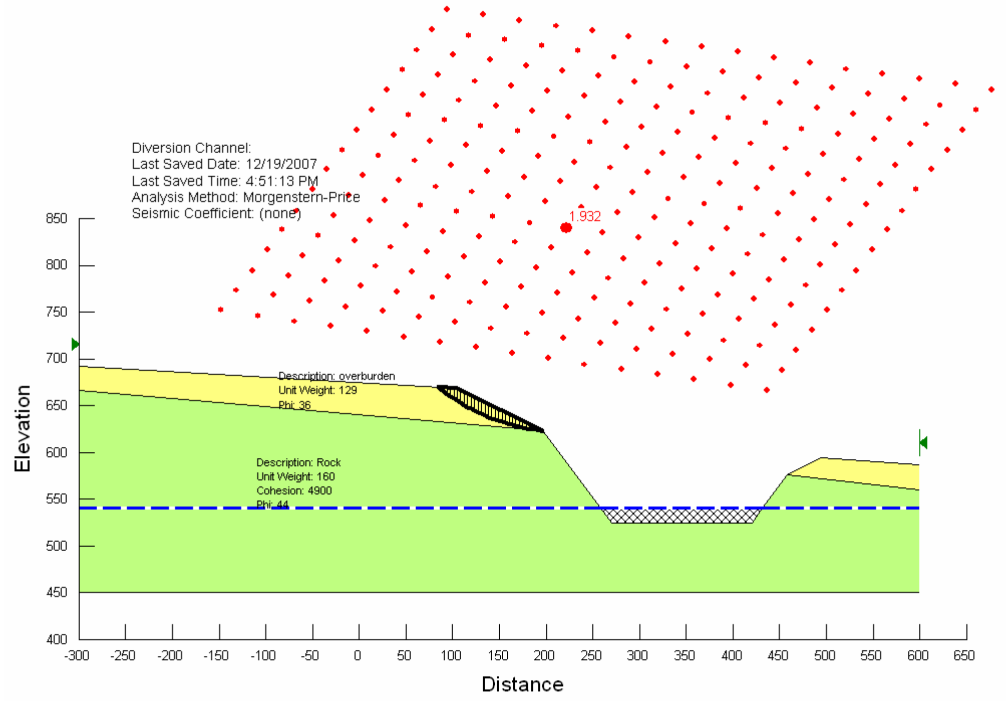
0.75H:1.0L Rock Slope
Static
Shallow



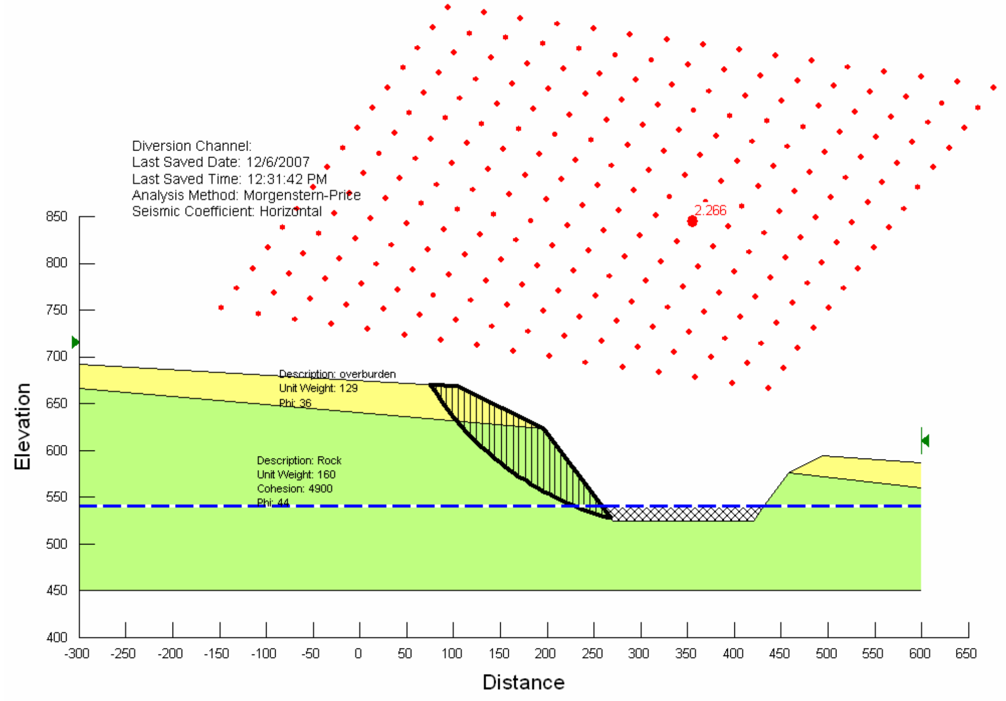
Deep



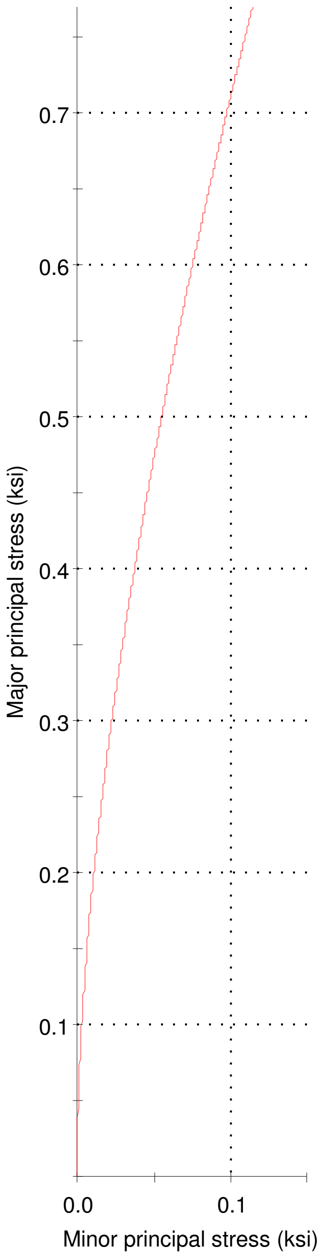
Pseudo Static
Shallow



Deep



Analysis of Rock Strength using RocLab



Hoek-Brown Classification

intact uniaxial comp. strength (sigci) = 13.1 ksi
GSI = 25 mi = 25 Disturbance factor (D) = 0.7
intact modulus (Ei) = 4257.5 ksi
modulus ratio (MR) = 325

Hoek-Brown Criterion

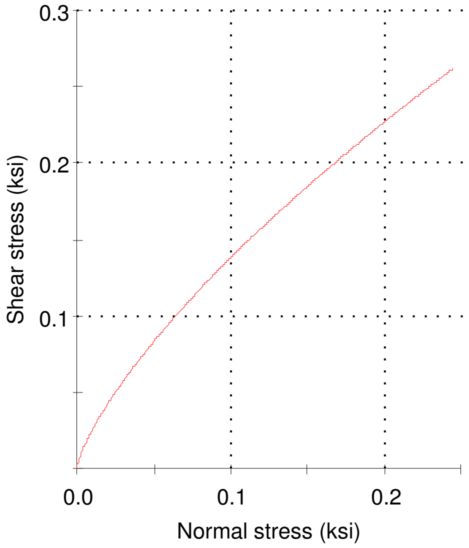
mb = 0.406 s = 1.9e-5 a = 0.531

Mohr-Coulomb Fit

cohesion = 0.034 ksi friction angle = 44.50 deg

Rock Mass Parameters

tensile strength = -0.001 ksi
uniaxial compressive strength = 0.041 ksi
global strength = 0.940 ksi
deformation modulus = 128.68 ksi



Simplified Liquefaction Analysis

Project Name: San Clemente Dam

Project Number:

M =	7.3
a_{max} =	0.4 g
MSF=	1.07

Depth to GWT	0.0 ft.
Unit Wt. of Water, γ_w =	0.0624 kcf
Height of Future Dike	0 ft.
Unit Wt. of Dike	0 kcf

Description : BH-3 Dike Toe Area

For SPT blow counts corrections, overburden stresses at the time of exploration were considered.

For CSR calculations, future dike overburden stresses were considered.

Blow counts for non-standard sampler were modified based on equation proposed by LaCroix and Horn (1973).

Layer	Material Type	Depth to Top of Layer (ft)	Depth to Middle of Layer (ft)	Depth to Bottom of Layer (ft)	Dry Unit Weigth, γ_d (kcf)	Moisture Content, w (%)	Void Ratio, e	Moist Unit Weight, γ_m (kcf)	Sat. Unit Weight, γ_{sat} (kcf)	Test or Hammer Type	Sampler Inner diameter (in)	Borehole Diameter (in)	**Field SPT Blow Count, N**	**SPT Blow Count, N**	Fines Content, FC (%)	Total Vertical Stress, σ_{vo} (ksf)	Pore Pressure, u (ksf)	Effective Vertical Stress, σ_{vo}' (ksf)	Overburden Pressure Coeff., C_N	Energy Ratio Coeff., C_E	Borehole Diameter Coeff., C_B	Rod Length Coeff., C_R	Sampling Method Coeff., C_S	Fines Content Coeff.		Corrected Standard Penetration Resistance, $(N_1)_{60cs}$	Cyclic Resistance Ratio w/M=7.5, $CRR_{7.5}$	Cyclic Resistance Ratio, CRR	Stress Reduction Coeff., r_d	Average Cyclic Shear Stress, τ_{avg} (ksf)	Cyclic Stress Ratio, CSR	**Factor of Safety against Liquefaction, FS_L****
																								α	β							
1	SP	0.00	3.75	7.50	0.10	25%	0.61	0.13	0.13	*Rope Pulley, Unlined*	*2*	*4*	*10*	**13**	*0.5*	0.48	0.23	0.25	1.70	*1.17*	*1.00*	0.75	*1.1*	0.00	1.00	**21**	0.228	0.245	0.99	0.124	0.502	**0.5**
2	SP	7.50	10.00	12.50	0.10	25%	0.76	0.12	0.12	*Rope Pulley, Unlined*	*1.4*	*4*	*6*	**6**	*0.5*	1.27	0.62	0.64	1.70	*1.17*	*1.00*	0.80	*1.1*	0.00	1.00	**10**	0.113	0.121	0.98	0.322	0.500	**0.2**
3	SP	12.50	15.00	17.50	0.11	25%	0.60	0.13	0.13	*Rope Pulley, Unlined*	*2*	*4*	*11*	**14**	*8.65*	1.90	0.94	0.96	1.47	*1.17*	*1.00*	0.85	*1.1*	0.46	1.02	**24**	0.273	0.293	0.97	0.476	0.495	**0.6**
4	SM	17.50	20.00	22.50	0.10	30%	0.66	0.13	0.13	*Rope Pulley, Unlined*	*1.4*	*4*	*10*	**10**	*10*	2.54	1.25	1.29	1.27	*1.17*	*1.00*	0.95	*1.1*	0.87	1.02	**17**	0.181	0.194	0.95	0.628	0.488	**0.4**
5	SM	22.50	25.00	27.50	0.11	30%	0.55	0.14	0.13	*Rope Pulley, Unlined*	*2*	*4*	*14*	**18**	*10*	3.18	1.56	1.62	1.14	*1.17*	*1.00*	0.95	*1.1*	0.87	1.02	**27**	0.338	0.362	0.94	0.778	0.481	**0.8**
6	SP	27.50	30.00	32.50	0.11	30%	0.53	0.14	0.13	*Rope Pulley, Unlined*	*1.4*	*4*	*20*	**20**	*10*	3.83	1.87	1.96	1.03	*1.17*	*1.00*	0.95	*1.1*	0.87	1.02	**27**	0.338	0.362	0.93	0.927	0.473	**0.8**
7	SP	32.50	35.00	37.50	0.11	30%	0.47	0.15	0.13	*Rope Pulley, Unlined*	*2*	*4*	*20*	**26**	*5*	4.50	2.18	2.32	0.95	*1.17*	*1.00*	1.00	*1.1*	0.00	1.00	**32**	N.L.	N.L.	0.89	1.040	0.449	**N.L.**
8	SM	37.50	40.00	42.50	0.10	30%	0.63	0.13	0.13	*Rope Pulley, Unlined*	*1.4*	*4*	*11*	**11**	*10*	5.15	2.50	2.66	0.89	*1.17*	*1.00*	1.00	*1.1*	0.87	1.02	**14**	0.150	0.161	0.85	1.137	0.428	**0.4**
9	ML	42.50	44.75	47.00	0.11	30%	0.42	0.15	0.13	*Rope Pulley, Unlined*	*2*	*4*	*20*	**26**	*80*	5.77	2.79	2.98	0.84	*1.17*	*1.00*	1.00	*1.1*	5.00	1.20	**38**	N.L.	N.L.	0.81	1.215	0.408	**N.L.**

KEY: N.A. = Not applicable to soils above the groundwater table.

****The factor of safety against liquefaction was calculated based on the simplified procedure outlined by 1996 and 1998 NCEER Workshops (Youd, et al., 2001).**

N.L. = Soils with a $(N_1)_{60cs}$ greater or equal to 30 are too dense to liquefy (Youd, et al., 2001).

Simplified Liquefaction Analysis

Project Name: San Clemente Dam

Project Number:

Description : BH-3 Dike Crest

Depth to GWT	0.0	ft.
Unit Wt. of Water, γ_w =	0.0624	kcf
Height of Embankment	75	ft.
Unit Wt. of Embankment (Pervious Fill)	0.12	kcf
Depth to GWT from Embankment	48	ft.

M =	7.3	
a_{max} =	0.4	g
MSF=	1.07	

For SPT blow counts corrections, overburden stresses at the time of exploration were considered.

For CSR calculations, future dike overburden stresses were considered.

Blow counts for non-standard sampler were modified based on equation proposed by LaCroix and Horn (1973).

Layer	Material Type	Depth to Top of Layer (ft)	Depth to Middle of Layer (ft)	Depth to Bottom of Layer (ft)	Dry Unit Weigth, γ_d (kcf)	Moisture Content, w (%)	Void Ratio, e	Moist Unit Weight, γ_m (kcf)	Sat. Unit Weight, γ_{sat} (kcf)	Test or Hammer Type	Sampler Inner diameter (in)	Borehole Diameter (in)	**Field SPT Blow Count, N**	**SPT Blow Count, N**	Fines Content, FC (%)	Total Vertical Stress, σ_{vo} (ksf)	Pore Pressure, u (ksf)	Effective Vertical Stress, σ_{vo}' (ksf)	Overburden Pressure Coeff., C_N	Energy Ratio Coeff., C_E	Borehole Diameter Coeff., C_B	Rod Length Coeff., C_R	Sampling Method Coeff., C_S	Fines Content Coeff.		Corrected Standard Penetration Resistance, $(N_1)_{60cs}$	Cyclic Resistance Ratio w/M=7.5, $CRR_{7.5}$	Cyclic Resistance Ratio, CRR	Stress Reduction Coeff., r_d	Average Cyclic Shear Stress, τ_{avg} (ksf)	Cyclic Stress Ratio, CSR	**Factor of Safety against Liquefaction, FS_L****
																								α	β							
1	SP	0.00	3.75	7.50	0.10	25%	0.66	0.13	0.13	*Rope Pulley, Unlined*	*2*	*4*	*10*	**13**	*0.5*	0.47	0.23	0.24	1.70	*1.17*	*1.00*	0.75	*1.1*	0.00	1.00	**21**	0.228	0.245	0.54	1.337	0.177	**1.4**
2	SP	7.50	10.00	12.50	0.10	25%	0.76	0.12	0.12	*Rope Pulley, Unlined*	*1.4*	*4*	*6*	**6**	*0.5*	1.25	0.62	0.63	1.70	*1.17*	*1.00*	0.80	*1.1*	0.00	1.00	**10**	0.113	0.121	0.53	1.415	0.178	**0.7**
3	SP	12.50	15.00	17.50	0.10	25%	0.63	0.13	0.13	*Rope Pulley, Unlined*	*2*	*4*	*11*	**14**	*8.65*	1.88	0.94	0.94	1.49	*1.17*	*1.00*	0.85	*1.1*	0.46	1.02	**24**	0.273	0.293	0.52	1.466	0.178	**1.6**
4	SM	17.50	20.00	22.50	0.10	30%	0.66	0.13	0.13	*Rope Pulley, Unlined*	*1.4*	*4*	*10*	**10**	*10*	2.51	1.25	1.26	1.29	*1.17*	*1.00*	0.95	*1.1*	0.87	1.02	**17**	0.181	0.194	0.51	1.515	0.177	**1.1**
5	SM	22.50	25.00	27.50	0.11	30%	0.60	0.14	0.13	*Rope Pulley, Unlined*	*2*	*4*	*14*	**18**	*10*	3.15	1.56	1.59	1.15	*1.17*	*1.00*	0.95	*1.1*	0.87	1.02	**27**	0.338	0.362	0.50	1.580	0.177	**2.0**
6	SP	27.50	30.00	32.50	0.11	30%	0.53	0.14	0.13	*Rope Pulley, Unlined*	*1.4*	*4*	*20*	**20**	*10*	3.80	1.87	1.93	1.04	*1.17*	*1.00*	0.95	*1.1*	0.87	1.02	**27**	0.338	0.362	0.50	1.664	0.180	**2.0**
7	SP	32.50	35.00	37.50	0.11	30%	0.53	0.14	0.13	*Rope Pulley, Unlined*	*2*	*4*	*20*	**26**	*5*	4.46	2.18	2.28	0.96	*1.17*	*1.00*	1.00	*1.1*	0.00	1.00	**32**	N.L.	N.L.	0.50	1.750	0.182	**N.L.**
8	SM	37.50	40.00	42.50	0.10	30%	0.63	0.13	0.13	*Rope Pulley, Unlined*	*1.4*	*4*	*11*	**11**	*10*	5.11	2.50	2.61	0.89	*1.17*	*1.00*	1.00	*1.1*	0.87	1.02	**14**	0.150	0.161	0.50	1.834	0.185	**0.9**
9	ML	42.50	44.75	47.00	0.11	30%	0.48	0.14	0.13	*Rope Pulley, Unlined*	*2*	*4*	*20*	**26**	*80*	5.72	2.79	2.93	0.84	*1.17*	*1.00*	1.00	*1.1*	5.00	1.20	**39**	N.L.	N.L.	0.50	1.913	0.187	**N.L.**

KEY: **N.A. = Not applicable to soils above the groundwater table.**

****The factor of safety against liquefaction was calculated based on the simplified procedure outlined by 1996 and 1998 NCEER Workshops (Youd, et al., 2001).**

N.L. = Soils with a $(N_1)_{60cs}$ greater or equal to 30 are too dense to liquefy (Youd, et al., 2001).

Simplified Liquefaction Analysis

Project Name: San Clemente Dam

Project Number:

Description : BH-3 Dike Downstream Slope Area

Depth to GWT	0.0 ft.
Unit Wt. of Water, γ_w =	0.0624 kcf
Height of Embankment	37.5 ft.
Unit Wt. of Embankment (Pervious Fill)	0.12 kcf
Depth to GWT from Embankment	26 ft.

M =	7.3	
a_{max} =	0.4	g
MSF=	1.07	

For SPT blow counts corrections, overburden stresses at the time of exploration were considered.

For CSR calculations, future dike overburden stresses were considered.

Blow counts for non-standard sampler were modified based on equation proposed by LaCroix and Horn (1973).

Layer	Material Type	Depth to Top of Layer (ft)	Depth to Middle of Layer (ft)	Depth to Bottom of Layer (ft)	Dry Unit Weigth, γ_d (kcf)	Moisture Content, w (%)	Void Ratio, e	Moist Unit Weight, γ_m (kcf)	Sat. Unit Weight, γ_{sat} (kcf)	Test or Hammer Type	Sampler Inner diameter (in)	Borehole Diameter (in)	**Field SPT Blow Count, N**	**SPT Blow Count, N**	Fines Content, FC (%)	Total Vertical Stress, σ_{vo} (ksf)	Pore Pressure, u (ksf)	Effective Vertical Stress, σ_{vo}' (ksf)	Overburden Pressure Coeff., C_N	Energy Ratio Coeff., C_E	Borehole Diameter Coeff., C_B	Rod Length Coeff., C_R	Sampling Method Coeff., C_S	Fines Content Coeff.		Corrected Standard Penetration Resistance, $(N_1)_{60cs}$	Cyclic Resistance Ratio w/M=7.5, $CRR_{7.5}$	Cyclic Resistance Ratio, CRR	Stress Reduction Coeff., r_d	Average Cyclic Shear Stress, τ_{avg} (ksf)	Cyclic Stress Ratio, CSR	**Factor of Safety against Liquefaction, FS_L****
																								α	β							
1	SP	0.00	3.75	7.50	0.10	25%	0.66	0.13	0.13	*Rope Pulley, Unlined*	*2*	*4*	*10*	**13**	*0.5*	0.47	0.23	0.24	1.70	*1.17*	*1.00*	0.75	*1.1*	0.00	1.00	**21**	0.228	0.245	0.81	1.045	0.260	**0.9**
2	SP	7.50	10.00	12.50	0.10	25%	0.76	0.12	0.12	*Rope Pulley, Unlined*	*1.4*	*4*	*6*	**6**	*0.5*	1.25	0.62	0.63	1.70	*1.17*	*1.00*	0.80	*1.1*	0.00	1.00	**10**	0.113	0.121	0.77	1.148	0.260	**0.5**
3	SP	12.50	15.00	17.50	0.10	25%	0.63	0.13	0.13	*Rope Pulley, Unlined*	*2*	*4*	*11*	**14**	*8.65*	1.88	0.94	0.94	1.49	*1.17*	*1.00*	0.85	*1.1*	0.46	1.02	**24**	0.273	0.293	0.73	1.205	0.255	**1.1**
4	SM	17.50	20.00	22.50	0.10	30%	0.66	0.13	0.13	*Rope Pulley, Unlined*	*1.4*	*4*	*10*	**10**	*10*	2.51	1.25	1.26	1.29	*1.17*	*1.00*	0.95	*1.1*	0.87	1.02	**17**	0.181	0.194	0.69	1.250	0.248	**0.8**
5	SM	22.50	25.00	27.50	0.11	30%	0.60	0.14	0.13	*Rope Pulley, Unlined*	*2*	*4*	*14*	**18**	*10*	3.15	1.56	1.59	1.15	*1.17*	*1.00*	0.95	*1.1*	0.87	1.02	**27**	0.338	0.362	0.65	1.283	0.239	**1.5**
6	SP	27.50	30.00	32.50	0.11	30%	0.53	0.14	0.13	*Rope Pulley, Unlined*	*1.4*	*4*	*20*	**20**	*10*	3.80	1.87	1.93	1.04	*1.17*	*1.00*	0.95	*1.1*	0.87	1.02	**27**	0.338	0.362	0.60	1.304	0.228	**1.6**
7	SP	32.50	35.00	37.50	0.11	30%	0.53	0.14	0.13	*Rope Pulley, Unlined*	*2*	*4*	*20*	**26**	*5*	4.46	2.18	2.28	0.96	*1.17*	*1.00*	1.00	*1.1*	0.00	1.00	**32**	N.L.	N.L.	0.56	1.313	0.217	**N.L.**
8	SM	37.50	40.00	42.50	0.10	30%	0.63	0.13	0.13	*Rope Pulley, Unlined*	*1.4*	*4*	*11*	**11**	*10*	5.11	2.50	2.61	0.89	*1.17*	*1.00*	1.00	*1.1*	0.87	1.02	**14**	0.150	0.161	0.55	1.371	0.214	**0.8**
9	ML	42.50	44.75	47.00	0.11	30%	0.48	0.14	0.13	*Rope Pulley, Unlined*	*2*	*4*	*20*	**26**	*80*	5.72	2.79	2.93	0.84	*1.17*	*1.00*	1.00	*1.1*	5.00	1.20	**39**	N.L.	N.L.	0.54	1.429	0.213	**N.L.**

KEY: N.A. = Not applicable to soils above the groundwater table.

N.L. = Soils with a $(N_1)_{60cs}$ greater or equal to 30 are too dense to liquefy (Youd, et al., 2001).

****The factor of safety against liquefaction was calculated based on the simplified procedure outlined by 1996 and 1998 NCEER Workshops (Youd, et al., 2001).**

Simplified Liquefaction Analysis

Project Name: San Clemente Dam

Project Number:

Description : BH-3 Dike Upstream Slope Area

Depth to GWT	0.0 ft.
Unit Wt. of Water, γ_w =	0.0624 kcf
Height of Embankment	37.5 ft.
Unit Wt. of Embankment (Pervious Fill)	0.12 kcf
Depth to GWT from Embankment	2 ft.

M =	7.3	
a_{max}=	0.4	g
MSF=	1.07	

For SPT blow counts corrections, overburden stresses at the time of exploration were considered.

For CSR calculations, future dike overburden stresses were considered.

Blow counts for non-standard sampler were modified based on equation proposed by LaCroix and Horn (1973).

Layer	Material Type	Depth to Top of Layer (ft)	Depth to Middle of Layer (ft)	Depth to Bottom of Layer (ft)	Dry Unit Weigth, γ_d (kcf)	Moisture Content, w (%)	Void Ratio, e	Moist Unit Weight, γ_m (kcf)	Sat. Unit Weight, γ_{sat} (kcf)	Test or Hammer Type	Sampler Inner diameter (in)	Borehole Diameter (in)	**Field SPT Blow Count, N**	**SPT Blow Count, N**	Fines Content, FC (%)	Total Vertical Stress, σ_{vo} (ksf)	Pore Pressure, u (ksf)	Effective Vertical Stress, σ_{vo}' (ksf)	Overburden Pressure Coeff., C_N	Energy Ratio Coeff., C_E	Borehole Diameter Coeff., C_B	Rod Length Coeff., C_R	Sampling Method Coeff., C_S	Fines Content Coeff.		Corrected Standard Penetration Resistance, $(N_1)_{60cs}$	Cyclic Resistance Ratio w/M=7.5, $CRR_{7.5}$	Cyclic Resistance Ratio, CRR	Stress Reduction Coeff., r_d	Average Cyclic Shear Stress, τ_{avg} (ksf)	Cyclic Stress Ratio, CSR	**Factor of Safety against Liquefaction, FS_L****
																								α	β							
1	SP	0.00	3.75	7.50	0.10	25%	0.66	0.13	0.13	*Rope Pulley, Unlined*	*2*	*4*	*10*	**13**	*0.5*	0.47	0.23	0.24	1.70	*1.17*	*1.00*	0.75	*1.1*	0.00	1.00	**21**	0.228	0.245	0.81	1.045	0.414	**0.6**
2	SP	7.50	10.00	12.50	0.10	25%	0.76	0.12	0.12	*Rope Pulley, Unlined*	*1.4*	*4*	*6*	**6**	*0.5*	1.25	0.62	0.63	1.70	*1.17*	*1.00*	0.80	*1.1*	0.00	1.00	**10**	0.113	0.121	0.77	1.148	0.394	**0.3**
3	SP	12.50	15.00	17.50	0.10	25%	0.63	0.13	0.13	*Rope Pulley, Unlined*	*2*	*4*	*11*	**14**	*8.65*	1.88	0.94	0.94	1.49	*1.17*	*1.00*	0.85	*1.1*	0.46	1.02	**24**	0.273	0.293	0.73	1.205	0.373	**0.8**
4	SM	17.50	20.00	22.50	0.10	30%	0.66	0.13	0.13	*Rope Pulley, Unlined*	*1.4*	*4*	*10*	**10**	*10*	2.51	1.25	1.26	1.29	*1.17*	*1.00*	0.95	*1.1*	0.87	1.02	**17**	0.181	0.194	0.69	1.250	0.352	**0.5**
5	SM	22.50	25.00	27.50	0.11	30%	0.60	0.14	0.13	*Rope Pulley, Unlined*	*2*	*4*	*14*	**18**	*10*	3.15	1.56	1.59	1.15	*1.17*	*1.00*	0.95	*1.1*	0.87	1.02	**27**	0.338	0.362	0.65	1.283	0.331	**1.1**
6	SP	27.50	30.00	32.50	0.11	30%	0.53	0.14	0.13	*Rope Pulley, Unlined*	*1.4*	*4*	*20*	**20**	*10*	3.80	1.87	1.93	1.04	*1.17*	*1.00*	0.95	*1.1*	0.87	1.02	**27**	0.338	0.362	0.60	1.304	0.310	**1.2**
7	SP	32.50	35.00	37.50	0.11	30%	0.53	0.14	0.13	*Rope Pulley, Unlined*	*2*	*4*	*20*	**26**	*5*	4.46	2.18	2.28	0.96	*1.17*	*1.00*	1.00	*1.1*	0.00	1.00	**32**	N.L.	N.L.	0.56	1.313	0.288	**N.L.**
8	SM	37.50	40.00	42.50	0.10	30%	0.63	0.13	0.13	*Rope Pulley, Unlined*	*1.4*	*4*	*11*	**11**	*10*	5.11	2.50	2.61	0.89	*1.17*	*1.00*	1.00	*1.1*	0.87	1.02	**14**	0.150	0.161	0.55	1.371	0.280	**0.6**
9	ML	42.50	44.75	47.00	0.11	30%	0.48	0.14	0.13	*Rope Pulley, Unlined*	*2*	*4*	*20*	**26**	*80*	5.72	2.79	2.93	0.84	*1.17*	*1.00*	1.00	*1.1*	5.00	1.20	**39**	N.L.	N.L.	0.54	1.429	0.274	**N.L.**

KEY: N.A. = Not applicable to soils above the groundwater table.

N.L. = Soils with a $(N_1)_{60cs}$ greater or equal to 30 are too dense to liquefy (Youd, et al., 2001).

****The factor of safety against liquefaction was calculated based on the simplified procedure outlined by 1996 and 1998 NCEER Workshops (Youd, et al., 2001).**

Simplified Liquefaction Analysis

Project Name: San Clemente Dam

Project Number:

Description : BH-4 Dike Toe Area

Depth to GWT	0.0 ft.
Unit Wt. of Water, γ_w =	0.0624 kcf
Height of Future Dike	0 ft.
Unit Wt. of Dike	0 kcf

M =	7.3
a_{max}=	0.4 g
MSF=	1.07

For SPT blow counts corrections, overburden stresses at the time of exploration were considered.

For CSR calculations, future dike overburden stresses were considered.

Blow counts for non-standard sampler were modified based on equation proposed by LaCroix and Horn (1973).

Layer	Material Type	Depth to Top of Layer (ft)	Depth to Middle of Layer (ft)	Depth to Bottom of Layer (ft)	Dry Unit Weigth, γ_d (kcf)	Moisture Content, w (%)	Void Ratio, e	Moist Unit Weight, γ_m (kcf)	Sat. Unit Weight, γ_{sat} (kcf)	Test or Hammer Type	Sampler Inner diameter (in)	Borehole Diameter (in)	**Field SPT Blow Count, N**	**SPT Blow Count, N**	Fines Content, FC (%)	Total Vertical Stress, σ_{vo} (ksf)	Pore Pressure, u (ksf)	Effective Vertical Stress, σ_{vo}' (ksf)	Overburden Pressure Coeff., C_N	Energy Ratio Coeff., C_E	Borehole Diameter Coeff., C_B	Rod Length Coeff., C_R	Sampling Method Coeff., C_S	Fines Content Coeff.		Corrected Standard Penetration Resistance, $(N_1)_{60cs}$	Cyclic Resistance Ratio w/M=7.5, $CRR_{7.5}$	Cyclic Resistance Ratio, CRR	Stress Reduction Coeff., r_d	Average Cyclic Shear Stress, τ_{avg} (ksf)	Cyclic Stress Ratio, CSR	**Factor of Safety against Liquefaction, FS_L****
																								α	β							
1	SP	0.00	3.75	7.50	0.10	21%	0.68	0.12	0.13	*Rope Pulley, Unlined*	*1.4*	*4*	*9*	**9**	*1*	0.47	0.23	0.24	1.70	*1.17*	*1.00*	0.75	*1.1*	0.00	1.00	**15**	0.160	0.171	0.99	0.121	0.513	**0.3**
2	SP	7.50	10.00	12.50	0.10	21%	0.61	0.13	0.13	*Rope Pulley, Unlined*	*2*	*4*	*10*	**13**	*7*	1.26	0.62	0.64	1.70	*1.17*	*1.00*	0.80	*1.1*	0.12	1.01	**23**	0.257	0.275	0.98	0.320	0.503	**0.5**
3	SP	12.50	15.00	17.50	0.10	21%	0.71	0.12	0.12	*Rope Pulley, Unlined*	*1.4*	*4*	*8*	**8**	*7*	1.89	0.94	0.96	1.48	*1.17*	*1.00*	0.85	*1.1*	0.12	1.01	**13**	0.141	0.151	0.97	0.475	0.496	**0.3**
4	SP	17.50	20.00	22.50	0.10	21%	0.61	0.13	0.13	*Rope Pulley, Unlined*	*2*	*4*	*10*	**13**	*4*	2.52	1.25	1.28	1.28	*1.17*	*1.00*	0.95	*1.1*	0.00	1.00	**20**	0.215	0.231	0.95	0.626	0.490	**0.5**
5	SP	22.50	25.00	27.50	0.10	21%	0.74	0.12	0.12	*Rope Pulley, Unlined*	*1.4*	*4*	*7*	**7**	*4*	3.15	1.56	1.59	1.14	*1.17*	*1.00*	0.95	*1.1*	0.00	1.00	**10**	0.113	0.121	0.94	0.772	0.484	**0.3**
6	ML	27.50	30.00	32.50	0.10	27%	0.64	0.13	0.13	*Rope Pulley, Unlined*	*2*	*4*	*8*	**10**	*65*	3.78	1.87	1.91	1.05	*1.17*	*1.00*	0.95	*1.1*	5.00	1.20	**21**	0.228	0.245	0.93	0.914	0.479	**0.5**
7	ML	32.50	33.75	35.00	0.12	27%	0.41	0.15	0.14	*Rope Pulley, Unlined*	*1.4*	*4*	*33*	**33**	*65*	4.27	2.11	2.16	0.98	*1.17*	*1.00*	1.00	*1.1*	5.00	1.20	**55**	N.L.	N.L.	0.90	0.999	0.461	**N.L.**

KEY: N.A. = Not applicable to soils above the groundwater table.

****The factor of safety against liquefaction was calculated based on the simplified procedure outlined by 1996 and 1998 NCEER Workshops (Youd, et al., 2001).**

N.L. = Soils with a $(N_1)_{60cs}$ greater or equal to 30 are too dense to liquefy (Youd, et al., 2001).

Simplified Liquefaction Analysis

Project Name: San Clemente Dam

Project Number:

Description : BH-4 Dike Crest

Depth to GWT	0.0	ft.
Unit Wt. of Water, γ_w =	0.0624	kcf
Height of Embankment	75	ft.
Unit Wt. of Embankment (Pervious Fill)	0.12	kcf
Depth to GWT from Embankment	48	ft.

M =	7.3	
a_{max}=	0.4	g
MSF=	1.07	

For SPT blow counts corrections, overburden stresses at the time of exploration were considered.

For CSR calculations, future dike overburden stresses were considered.

Blow counts for non-standard sampler were modified based on equation proposed by LaCroix and Horn (1973).

Layer	Material Type	Depth to Top of Layer (ft)	Depth to Middle of Layer (ft)	Depth to Bottom of Layer (ft)	Dry Unit Weigth, γ_d (kcf)	Moisture Content, w (%)	Void Ratio, e	Moist Unit Weight, γ_m (kcf)	Sat. Unit Weight, γ_{sat} (kcf)	Test or Hammer Type	Sampler Inner diameter (in)	Borehole Diameter (in)	**Field SPT Blow Count, N**	**SPT Blow Count, N**	Fines Content, FC (%)	Total Vertical Stress, σ_{vo} (ksf)	Pore Pressure, u (ksf)	Effective Vertical Stress, σ_{vo}' (ksf)	Overburden Pressure Coeff., C_N	Energy Ratio Coeff., C_E	Borehole Diameter Coeff., C_B	Rod Length Coeff., C_R	Sampling Method Coeff., C_S	Fines Content Coeff.		Corrected Standard Penetration Resistance, $(N_1)_{60cs}$	Cyclic Resistance Ratio w/M=7.5, $CRR_{7.5}$	Cyclic Resistance Ratio, CRR	Stress Reduction Coeff., r_d	Average Cyclic Shear Stress, τ_{avg} (ksf)	Cyclic Stress Ratio, CSR	**Factor of Safety against Liquefaction, FS_L****
																								α	β							
1	SP	0.00	3.75	7.50	0.10	21%	0.68	0.12	0.13	*Rope Pulley, Unlined*	*1.4*	*4*	*9*	**9**	*1*	0.47	0.23	0.24	1.70	*1.17*	*1.00*	0.75	*1.1*	0.00	1.00	**15**	0.160	0.171	0.54	1.337	0.177	**1.0**
2	SP	7.50	10.00	12.50	0.10	21%	0.61	0.13	0.13	*Rope Pulley, Unlined*	*2*	*4*	*10*	**13**	*7*	1.26	0.62	0.64	1.70	*1.17*	*1.00*	0.80	*1.1*	0.12	1.01	**23**	0.257	0.275	0.53	1.416	0.178	**1.5**
3	SP	12.50	15.00	17.50	0.10	21%	0.71	0.12	0.12	*Rope Pulley, Unlined*	*1.4*	*4*	*8*	**8**	*7*	1.89	0.94	0.96	1.48	*1.17*	*1.00*	0.85	*1.1*	0.12	1.01	**13**	0.141	0.151	0.52	1.468	0.178	**0.8**
4	SP	17.50	20.00	22.50	0.10	21%	0.61	0.13	0.13	*Rope Pulley, Unlined*	*2*	*4*	*10*	**13**	*4*	2.52	1.25	1.28	1.28	*1.17*	*1.00*	0.95	*1.1*	0.00	1.00	**20**	0.215	0.231	0.51	1.517	0.177	**1.3**
5	SP	22.50	25.00	27.50	0.10	21%	0.74	0.12	0.12	*Rope Pulley, Unlined*	*1.4*	*4*	*7*	**7**	*4*	3.15	1.56	1.59	1.14	*1.17*	*1.00*	0.95	*1.1*	0.00	1.00	**10**	0.113	0.121	0.50	1.580	0.177	**0.7**
6	ML	27.50	30.00	32.50	0.10	27%	0.64	0.13	0.13	*Rope Pulley, Unlined*	*2*	*4*	*8*	**10**	*65*	3.78	1.87	1.91	1.05	*1.17*	*1.00*	0.95	*1.1*	5.00	1.20	**21**	0.228	0.245	0.50	1.661	0.180	**1.4**
7	ML	32.50	33.75	35.00	0.12	27%	0.41	0.15	0.14	*Rope Pulley, Unlined*	*1.4*	*4*	*33*	**33**	*65*	4.27	2.11	2.16	0.98	*1.17*	*1.00*	1.00	*1.1*	5.00	1.20	**55**	N.L.	N.L.	0.50	1.725	0.182	**N.L.**

KEY: N.A. = Not applicable to soils above the groundwater table.

N.L. = Soils with a $(N_1)_{60cs}$ greater or equal to 30 are too dense to liquefy (Youd, et al., 2001).

****The factor of safety against liquefaction was calculated based on the simplified procedure outlined by 1996 and 1998 NCEER Workshops (Youd, et al., 2001).**

Simplified Liquefaction Analysis

Project Name: San Clemente Dam

Project Number:

Description : BH-4 Dike Downstream Slope Area

Depth to GWT	0.0	ft.
Unit Wt. of Water, γ_w =	0.0624	kcf
Height of Embankment	37.5	ft.
Unit Wt. of Embankment (Pervious Fill)	0.12	kcf
Depth to GWT from Embankment	26	ft.

M =	7.3	
a_{max}=	0.4	g
MSF=	1.07	

For SPT blow counts corrections, overburden stresses at the time of exploration were considered.

For CSR calculations, future dike overburden stresses were considered.

Blow counts for non-standard sampler were modified based on equation proposed by LaCroix and Horn (1973).

Layer	Material Type	Depth to Top of Layer (ft)	Depth to Middle of Layer (ft)	Depth to Bottom of Layer (ft)	Dry Unit Weigth, γ_d (kcf)	Moisture Content, w (%)	Void Ratio, e	Moist Unit Weight, γ_m (kcf)	Sat. Unit Weight, γ_{sat} (kcf)	Test or Hammer Type	Sampler Inner diameter (in)	Borehole Diameter (in)	**Field SPT Blow Count, N**	**SPT Blow Count, N**	Fines Content, FC (%)	Total Vertical Stress, σ_{vo} (ksf)	Pore Pressure, u (ksf)	Effective Vertical Stress, σ_{vo}' (ksf)	Overburden Pressure Coeff., C_N	Energy Ratio Coeff., C_E	Borehole Diameter Coeff., C_B	Rod Length Coeff., C_R	Sampling Method Coeff., C_S	Fines Content Coeff.		Corrected Standard Penetration Resistance, $(N_1)_{60cs}$	Cyclic Resistance Ratio w/M=7.5, $CRR_{7.5}$	Cyclic Resistance Ratio, CRR	Stress Reduction Coeff., r_d	Average Cyclic Shear Stress, τ_{avg} (ksf)	Cyclic Stress Ratio, CSR	**Factor of Safety against Liquefaction, FS_L****
																								α	β							
1	SP	0.00	3.75	7.50	0.10	21%	0.68	0.12	0.13	Rope Pulley, Unlined	1.4	4	9	9	1	0.47	0.23	0.24	1.70	1.17	1.00	0.75	1.1	0.00	1.00	15	0.160	0.171	0.81	1.044	0.260	0.7
2	SP	7.50	10.00	12.50	0.10	21%	0.61	0.13	0.13	Rope Pulley, Unlined	2	4	10	13	7	1.26	0.62	0.64	1.70	1.17	1.00	0.80	1.1	0.12	1.01	23	0.257	0.275	0.77	1.149	0.260	1.1
3	SP	12.50	15.00	17.50	0.10	21%	0.71	0.12	0.12	Rope Pulley, Unlined	1.4	4	8	8	7	1.89	0.94	0.96	1.48	1.17	1.00	0.85	1.1	0.12	1.01	13	0.141	0.151	0.73	1.207	0.255	0.6
4	SP	17.50	20.00	22.50	0.10	21%	0.61	0.13	0.13	Rope Pulley, Unlined	2	4	10	13	4	2.52	1.25	1.28	1.28	1.17	1.00	0.95	1.1	0.00	1.00	20	0.215	0.231	0.69	1.252	0.248	0.9
5	SP	22.50	25.00	27.50	0.10	21%	0.74	0.12	0.12	Rope Pulley, Unlined	1.4	4	7	7	4	3.15	1.56	1.59	1.14	1.17	1.00	0.95	1.1	0.00	1.00	10	0.113	0.121	0.65	1.284	0.239	0.5
6	ML	27.50	30.00	32.50	0.10	27%	0.64	0.13	0.13	Rope Pulley, Unlined	2	4	8	10	65	3.78	1.87	1.91	1.05	1.17	1.00	0.95	1.1	5.00	1.20	21	0.228	0.245	0.60	1.301	0.229	1.1
7	ML	32.50	33.75	35.00	0.12	27%	0.41	0.15	0.14	Rope Pulley, Unlined	1.4	4	33	33	65	4.27	2.11	2.16	0.98	1.17	1.00	1.00	1.1	5.00	1.20	55	N.L.	N.L.	0.58	1.332	0.224	N.L.

KEY: N.A. = Not applicable to soils above the groundwater table.

N.L. = Soils with a $(N_1)_{60cs}$ greater or equal to 30 are too dense to liquefy (Youd, et al., 2001).

****The factor of safety against liquefaction was calculated based on the simplified procedure outlined by 1996 and 1998 NCEER Workshops (Youd, et al., 2001).**

Simplified Liquefaction Analysis

Project Name: San Clemente Dam

Project Number:

Description : BH-4 Dike Toe Upstream Slope Area

For SPT blow counts corrections, overburden stresses at the time of exploration were considered.

For CSR calculations, future dike overburden stresses were considered.

Blow counts for non-standard sampler were modified based on equation proposed by LaCroix and Horn (1973).

Depth to GWT	0.0	ft.
Unit Wt. of Water, γ_w =	0.0624	kcf
Height of Embankment	37.5	ft.
Unit Wt. of Embankment (Pervious Fill)	0.12	kcf
Depth to GWT from Embankment	2	ft.

M =	7.3	
a_{max}=	0.4	g
MSF=	1.07	

Layer	Material Type	Depth to Top of Layer (ft)	Depth to Middle of Layer (ft)	Depth to Bottom of Layer (ft)	Dry Unit Weigth, γ_d (kcf)	Moisture Content, w (%)	Void Ratio, e	Moist Unit Weight, γ_m (kcf)	Sat. Unit Weight, γ_{sat} (kcf)	Test or Hammer Type	Sampler Inner diameter (in)	Borehole Diameter (in)	**Field SPT Blow Count, N**	**SPT Blow Count, N**	Fines Content, FC (%)	Total Vertical Stress, σ_{vo} (ksf)	Pore Pressure, u (ksf)	Effective Vertical Stress, σ_{vo}' (ksf)	Overburden Pressure Coeff., C_N	Energy Ratio Coeff., C_E	Borehole Diameter Coeff., C_B	Rod Length Coeff., C_R	Sampling Method Coeff., C_S	Fines Content Coeff.		Corrected Standard Penetration Resistance, $(N_1)_{60cs}$	Cyclic Resistance Ratio w/M=7.5, $CRR_{7.5}$	Cyclic Resistance Ratio, CRR	Stress Reduction Coeff., r_d	Average Cyclic Shear Stress, τ_{avg} (ksf)	Cyclic Stress Ratio, CSR	**Factor of Safety against Liquefaction, FS_L****
																								α	β							
1	SP	0.00	3.75	7.50	0.10	21%	0.68	0.12	0.13	*Rope Pulley, Unlined*	*1.4*	*4*	*9*	**9**	*1*	0.47	0.23	0.24	1.70	*1.17*	*1.00*	0.75	*1.1*	0.00	1.00	**15**	0.160	0.171	0.81	1.044	0.414	**0.4**
2	SP	7.50	10.00	12.50	0.10	21%	0.61	0.13	0.13	*Rope Pulley, Unlined*	*2*	*4*	*10*	**13**	*7*	1.26	0.62	0.64	1.70	*1.17*	*1.00*	0.80	*1.1*	0.12	1.01	**23**	0.257	0.275	0.77	1.149	0.393	**0.7**
3	SP	12.50	15.00	17.50	0.10	21%	0.71	0.12	0.12	*Rope Pulley, Unlined*	*1.4*	*4*	*8*	**8**	*7*	1.89	0.94	0.96	1.48	*1.17*	*1.00*	0.85	*1.1*	0.12	1.01	**13**	0.141	0.151	0.73	1.207	0.372	**0.4**
4	SP	17.50	20.00	22.50	0.10	21%	0.61	0.13	0.13	*Rope Pulley, Unlined*	*2*	*4*	*10*	**13**	*4*	2.52	1.25	1.28	1.28	*1.17*	*1.00*	0.95	*1.1*	0.00	1.00	**20**	0.215	0.231	0.69	1.252	0.352	**0.7**
5	SP	22.50	25.00	27.50	0.10	21%	0.74	0.12	0.12	*Rope Pulley, Unlined*	*1.4*	*4*	*7*	**7**	*4*	3.15	1.56	1.59	1.14	*1.17*	*1.00*	0.95	*1.1*	0.00	1.00	**10**	0.113	0.121	0.65	1.284	0.331	**0.4**
6	ML	27.50	30.00	32.50	0.10	27%	0.64	0.13	0.13	*Rope Pulley, Unlined*	*2*	*4*	*8*	**10**	*65*	3.78	1.87	1.91	1.05	*1.17*	*1.00*	0.95	*1.1*	5.00	1.20	**21**	0.228	0.245	0.60	1.301	0.310	**0.8**
7	ML	32.50	33.75	35.00	0.12	27%	0.41	0.15	0.14	*Rope Pulley, Unlined*	*1.4*	*4*	*33*	**33**	*65*	4.27	2.11	2.16	0.98	*1.17*	*1.00*	1.00	*1.1*	5.00	1.20	**55**	N.L.	N.L.	0.58	1.332	0.299	**N.L.**

KEY: N.A. = Not applicable to soils above the groundwater table.

****The factor of safety against liquefaction was calculated based on the simplified procedure outlined by 1996 and 1998 NCEER Workshops (Youd, et al., 2001).**

N.L. = Soils with a $(N_1)_{60cs}$ greater or equal to 30 are too dense to liquefy (Youd, et al., 2001).

Bearing Capacity and Settlement Calculations for Proposed Diversion Dike

Input Data

2-1-1 Geometry

Width of Dike : $B := 230$ ft effective width at base of valley - reduced due to rock slopes.

Depth of Dike: $D := 0$ ft

Length of Dike: $Lf := 460$ ft

Height of Dike: $Hd := 75$ ft

Unit Weight of Dike: $\gamma bd := 135$ pcf

Load inclination: $\theta m := 0deg$

2-1-2 Soil Parameters

1. GW

Unit Weight: $\gamma bf1 := 127$ psf Friction angle: $\phi 1 := 31deg$

Cohesion: $c1 := 0deg$ $Es1 := 410545$ psf

Depth: $D1 := 2.5$ feet (Es was estimated based on equation from Foundation Design Principles and Practices, Coduto, equation 7.17, page 233)

2.SP

Unit Weight: $\gamma bf2 := 127$ psf Friction angle: $\phi 2 := 31deg$

Cohesion: $c2 := 0deg$ $Es2 := 410545$ psf

Depth: $D2 := 12.5$ feet

3 SM

Unit Weight: $\gamma bf3 := 129$ psf Friction angle: $\phi 3 := 32deg$

Cohesion: $c3 := 0deg$ $Es3 := 247273$ psf

Depth: $D3 := 15$ feet

4 SP

Unit Weight: $\gamma bf4 := 133$ psf Friction angle: $\phi 4 := 35deg$

Cohesion: $c4 := 0deg$ $Es4 := 743636$ psf

Depth: $D4 := 10$ feet

5 SM

Unit Weight: $\gamma bf5 := 127\ psf$ Friction angle: $\phi 5 := 31deg$

Cohesion: $c5 := 0deg$ $Es5 := 204000$ psf

Depth: $D5 := 3$ feet

6 OH

Unit Weight: $\gamma bf6 := 133\ psf$ Friction angle: $\phi 6 := 31deg$

Cohesion: $c6 := 0deg$

Depth: $D6 := 4$ feet

1. Bearing Capacity

Average Friction Angle

$$\phi := \frac{\phi 1 \cdot D1 + \phi 2 \cdot D2 + \phi 3 \cdot D3 + \phi 4 \cdot D4 + \phi 5 \cdot D5 + \phi 6 \cdot D6}{D1 + D2 + D3 + D4 + D5 + D6}$$

$\phi = 32\,deg$

Average Unit Weight

$$\gamma bf := \frac{\gamma bf1 \cdot D1 + \gamma bf2 \cdot D2 + \gamma bf3 \cdot D3 + \gamma bf4 \cdot D4 + \gamma bf5 \cdot D5 + \gamma bf6 \cdot D6}{D1 + D2 + D3 + D4 + D5 + D6}$$

$\gamma bf = 129$ pcf

Using Meyerhof's Bearing Capacity Equation
(Foundation Analysis and Design, Joseph E. Bowles, Table 4-1 and 4-3)

$$Nq := e^{\pi \cdot \tan(\phi)} \cdot \tan\left(45deg + \frac{\phi}{2}\right)^2$$

$$Nc := (Nq - 1) \cdot \cot(\phi)$$

$$N\gamma := (Nq - 1) \cdot \tan(1.4 \cdot \phi)$$

$Nq = 24$ $Nc = 36$ $N\gamma = 23$

Passive earth pressure coefficiednt: Kp

$$Kp := \frac{1 + \sin(\phi)}{1 - \sin(\phi)}$$

$$Kp = 3$$

Shape, Depth and inclination Factors

Shape Factor

$$sc := 1 + 0.2 \cdot Kp \cdot \frac{B}{Lf}$$

$$sq := \left| \begin{array}{ll} 1 & \text{if } \phi = 0 \\ 1 + 0.1 \cdot Kp \cdot \frac{B}{Lf} & \text{otherwise} \end{array} \right.$$

$$s\gamma := sq$$

$$sc = 1.33 \qquad s\gamma = 1.16 \qquad sq = 1.16$$

Depth Factor

$$dc := 1 + 0.2 \cdot \sqrt{Kp} \cdot \frac{D}{B}$$

$$dq := \left| \begin{array}{ll} 1 & \text{if } \phi = 0 \\ 1 + 0.1 \cdot \sqrt{Kp} \cdot \frac{D}{B} & \text{otherwise} \end{array} \right.$$

$$d\gamma := dq$$

$$dc = 1.00 \qquad dq = 1.00 \qquad d\gamma = 1.00$$

Inclination Factor

$$ic := \left(1 - \frac{\theta m}{90deg}\right)^2$$

$$iq := ic$$

$$i\gamma := \left| \begin{array}{ll} 0 & \text{if } \phi = 0 \\ \left(1 - \frac{\theta m}{\phi}\right)^2 & \text{otherwise} \end{array} \right.$$

$$ic = 1.00 \qquad iq = 1.00 \qquad i\gamma = 1.00$$

Ultimate bearing capacity

$$\mathrm{qult} := \mathrm{c1 \cdot Nc \cdot sc \cdot dc} + (\gamma \mathrm{bf1} - 62.4) \cdot \mathrm{D \cdot sq \cdot dq \cdot Nq} + 0.5 \cdot ((\gamma \mathrm{bf} - 62.4)) \cdot \mathrm{B \cdot N\gamma \cdot s\gamma \cdot d\gamma}$$

$\mathrm{qult} = 203424$ psf

Bearing Pressure

$\mathrm{qapp} := \mathrm{Hd} \cdot \gamma \mathrm{bd}$ $\mathrm{qapp} = 10125$ psf

Factor of Safety

$$\mathrm{FS} := \frac{\mathrm{qult}}{\mathrm{qapp}}$$

$\mathrm{FS} = 20$

2. Settlement Calculation

1. Immediate Settlement Calculation

Using Theory of Elasticity proposed by Timoshenko and Goodier(1951)

qapp=intensity of contact pressure in unit of Es
n= number of contributing corners
B'=least lateral diment of contributing area
I1 and I2 = influence factors
Es = elastic Modulus
u= Poisson's ratio
H=influence depth (H=5B)

1.1 Influence Depth Calculation

$\mathrm{H} := 5 \cdot \mathrm{B}$
$\mathrm{H} = 1150$ feet

1.2 Average Es Calculation

$$\mathrm{Es} := \frac{\mathrm{D1 \cdot Es1 + D2 \cdot Es2 + D3 \cdot Es3 + D4 \cdot Es4 + D5 \cdot Es5}}{\mathrm{D1 + D2 + D3 + D4 + D5}}$$

$\mathrm{Es} = 416643$ psf

1.3 Poisson's ratio

From Foundation Analysis and Design
, Joseph E. Bowles, Table 2-7

$\mathrm{u} := 0.3$

1.4 Number of contributing corners

$\mathrm{m} := 4$ (center of dike)

1.5 Influence factors

From Foundation Analysis and Design
, Joseph E. Bowles, Table 5-2 and Figure 5-7

$I1 := 0.027$
$I2 := 0.073$
$If := 1$

1.6 Immediate Settlement Calculation

From Foundation Analysis and Design
, Joseph E. Bowles, Equation 5-16 and 5-16a

$B2 := \frac{B}{2}$ (center of fooring)

$$Si := qapp \cdot B2 \cdot \frac{1 - u^2}{Es} \cdot \left[I1 + \frac{(1 - 2u) \cdot I2}{1 - u} \right] \cdot If \cdot m$$

$Si = 0.699$ feet

2. Primary Consolidation Settlement

2.1 OH

$LL := 61$ Initial Void Ratio: $e1 := 0.9$ (Based on Holtz and Kovacs - typical values)

$Cc1 := 0.009 \cdot (LL - 0.5)$ (From An Introduction to Geotechnical Engineering , Holtz and Kovacs, Table 8-2)

$Cc1 = 0.54$

$I := 0.96$ From Holtz and Kovacs Table 8.23

σ=In-Situ effective stress at the middle of each layer

Δσ=increase of stress at the middle of each layer

$\Delta\sigma1 := qapp \cdot I$

$\Delta\sigma1 = 9720$ psf $\sigma1 := 2980$ psf

$$Sc := Cc1 \cdot \frac{D6 \cdot \log\left(\frac{\sigma1 + \Delta\sigma1}{\sigma1}, 10\right)}{1 + e1}$$

$Sc = 0.722$ ft

3. Secondary Consolidation Settlement

Assuming that 30% of consoildation Settlement

$Ss := Sc \cdot 0.3$

$Ss = 0.22$ ft

4. Total Settlement

$St := Si + Sc + Ss$

$St = 1.64$ ft

Bearing Capacity and Settement of 40-foot high Diversion Dike

Input Data

2-1-1 Geometry

Rectangular shape of dike was assumed for conservative analyses

Width of Dike : $B := 230$ ft — effective width due to rock slopes at edges of valley

Depth of Dike: $D := 0$ ft

Length of Dike: $Lf := 290$ ft

Height of Dike: $Hd := 40$ ft

Unit Weight of Dike: $\gamma bd := 135$ pcf

Load inclination: $\theta m := 0deg$

2-1-2 Soil Parameters

1. GW

Unit Weight: $\gamma bf1 := 127$ psf — Friction angle: $\phi 1 := 31deg$

Cohesion: $c1 := 0deg$ — $Es1 := 410545$ psf

Depth: $D1 := 2.5$ feet

(Es was estimated based on equation from Foundation Design Principles and Practices, Coduto, equation 7.17, page 233)

2.SP

Unit Weight: $\gamma bf2 := 127$ psf — Friction angle: $\phi 2 := 31deg$

Cohesion: $c2 := 0deg$ — $Es2 := 410545$ psf

Depth: $D2 := 12.5$ feet

3 SM

Unit Weight: $\gamma bf3 := 129$ psf — Friction angle: $\phi 3 := 32deg$

Cohesion: $c3 := 0deg$ — $Es3 := 247273$ psf

Depth: $D3 := 15$ feet

4 SP

Unit Weight: $\gamma bf4 := 133$ psf — Friction angle: $\phi 4 := 35deg$

Cohesion: $c4 := 0deg$ — $Es4 := 743636$ psf

Depth: $D4 := 10$ feet

5 SM

Unit Weight: $\gamma bf5 := 127\ psf$ Friction angle: $\phi 5 := 31deg$

Cohesion: $c5 := 0deg$ $Es5 := 204000$ psf

Depth: $D5 := 3$ feet

6 OH

Unit Weight: $\gamma bf6 := 133\ psf$ Friction angle: $\phi 6 := 31deg$

Cohesion: $c6 := 0deg$

Depth: $D6 := 4$ feet

1. Bearing Capacity

Average Friction Angle

$$\phi := \frac{\phi 1 \cdot D1 + \phi 2 \cdot D2 + \phi 3 \cdot D3 + \phi 4 \cdot D4 + \phi 5 \cdot D5 + \phi 6 \cdot D6}{D1 + D2 + D3 + D4 + D5 + D6}$$

$\phi = 32\,deg$

Average Unit Weight

$$\gamma bf := \frac{\gamma bf1 \cdot D1 + \gamma bf2 \cdot D2 + \gamma bf3 \cdot D3 + \gamma bf4 \cdot D4 + \gamma bf5 \cdot D5 + \gamma bf6 \cdot D6}{D1 + D2 + D3 + D4 + D5 + D6}$$

$\gamma bf = 129$ pcf

Using Meyerhof's Bearing Capacity Equation
(Foundation Analysis and Design, Joseph E. Bowles, Table 4-1 and 4-3)

$$Nq := e^{\pi \cdot \tan(\phi)} \cdot \tan\left(45deg + \frac{\phi}{2}\right)^2$$

$$Nc := (Nq - 1) \cdot \cot(\phi)$$

$$N\gamma := (Nq - 1) \cdot \tan(1.4 \cdot \phi)$$

$Nq = 24$ $Nc = 36$ $N\gamma = 23$

Passive earth pressure coefficiednt: Kp

$$Kp := \frac{1 + \sin(\phi)}{1 - \sin(\phi)}$$

$$Kp = 3$$

Shape, Depth and inclination Factors

Shape Factor

$$sc := 1 + 0.2 \cdot Kp \cdot \frac{B}{Lf}$$

$$sq := \left| \begin{array}{l} 1 \quad \text{if } \phi = 0 \\ 1 + 0.1 \cdot Kp \cdot \frac{B}{Lf} \quad \text{otherwise} \end{array} \right.$$

$$s\gamma := sq$$

$$sc = 1.52 \qquad s\gamma = 1.26 \qquad sq = 1.26$$

Depth Factor

$$dc := 1 + 0.2 \cdot \sqrt{Kp} \cdot \frac{D}{B}$$

$$dq := \left| \begin{array}{l} 1 \quad \text{if } \phi = 0 \\ 1 + 0.1 \cdot \sqrt{Kp} \cdot \frac{D}{B} \quad \text{otherwise} \end{array} \right.$$

$$d\gamma := dq$$

$$dc = 1.00 \qquad dq = 1.00 \qquad d\gamma = 1.00$$

Inclination Factor

$$ic := \left(1 - \frac{\theta m}{90deg}\right)^2$$

$$iq := ic$$

$$i\gamma := \left| \begin{array}{l} 0 \quad \text{if } \phi = 0 \\ \left(1 - \frac{\theta m}{\phi}\right)^2 \quad \text{otherwise} \end{array} \right.$$

$ic = 1.00 \quad iq = 1.00 \quad i\gamma = 1.00$

Ultimate bearing capacity

$$qult := c1 \cdot Nc \cdot sc \cdot dc + (\gamma bf1 - 62.4) \cdot D \cdot sq \cdot dq \cdot Nq + 0.5 \cdot ((\gamma bf - 62.4)) \cdot B \cdot N\gamma \cdot s\gamma \cdot d\gamma$$

$qult = 220215$ psf

Bearing Pressure

$qapp := Hd \cdot \gamma bd \qquad qapp = 5400$ psf

Factor of Safety

$$FS := \frac{qult}{qapp}$$

$FS = 41$

2. Settlement Calculation

1. Immediate Settlement Calculation

Using Theory of Elasticity proposed by Timoshenko and Goodier(1951)

qapp=intensity of contact pressure in unit of Es
n= number of contributing corners
B'=least lateral diment of contributing area
I1 and I2 = influence factors
Es = elastic Modulus
u= Poisson's ratio
H=influence depth (H=5B)

1.1 Influence Depth Calculation

$H := 5 \cdot B$
$H = 1150$ feet

1.2 Average Es Calculation

$$Es := \frac{D1 \cdot Es1 + D2 \cdot Es2 + D3 \cdot Es3 + D4 \cdot Es4 + D5 \cdot Es5}{D1 + D2 + D3 + D4 + D5}$$

$Es = 416643$ psf

1.3 Poisson's ratio

From Foundation Analysis and Design
, Joseph E. Bowles, Table 2-7

$u := 0.3$

1.4 Number of contributing corners

$m := 4$ (center of dike)

1.5 Influence factors

From Foundation Analysis and Design
, Joseph E. Bowles, Table 5-2 and Figure 5-7

$I1 := 0.027$
$I2 := 0.073$
$If := 1$

1.6 Immediate Settlement Calculation

From Foundation Analysis and Design
, Joseph E. Bowles, Equation 5-16 and 5-16a

$B2 := \frac{B}{2}$ (center of fooring)

$$Si := qapp \cdot B2 \cdot \frac{1 - u^2}{Es} \cdot \left[I1 + \frac{(1 - 2u) \cdot I2}{1 - u} \right] \cdot If \cdot m$$

$Si = 0.373$ feet

2. Primary Consolidation Settlement

2.1 OH

$LL := 61$ Initial Void Ratio: $e1 := 0.9$ (Based on Holtz and Kovacs - typical values)

$Cc1 := 0.009 \cdot (LL - 0.5)$ (From An Introduction to Geotechnical Engineering , Holtz and Kovacs, Table 8-2)

$Cc1 = 0.54$

$I := 0.91$ (From Holtz and Kovacs Table 8.23)

σ=In-Situ effective stress at the middle of each layer

Δσ=increase of stress at the middle of each layer

$\Delta\sigma1 := qapp \cdot I$

$\Delta\sigma1 = 4914$ psf $\sigma1 := 2980$ psf

$$Sc := Cc1 \cdot \frac{D6 \cdot \log\left(\frac{\sigma1 + \Delta\sigma1}{\sigma1}, 10\right)}{1 + e1}$$

$Sc = 0.485$ ft

3. Secondary Consolidation Settlement

Assuming that 30% of consoildation Settlement

$Ss := Sc \cdot 0.3$

$Ss = 0.15$ ft

4. Total Settlement

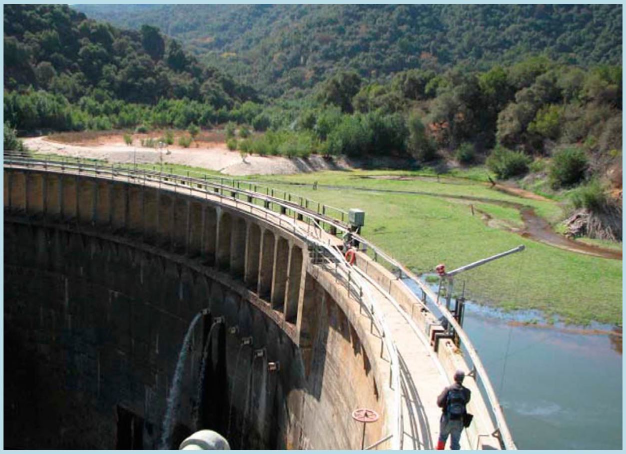
$St := Si + Sc + Ss$

$St = 1.00$ ft

APPENDIX B

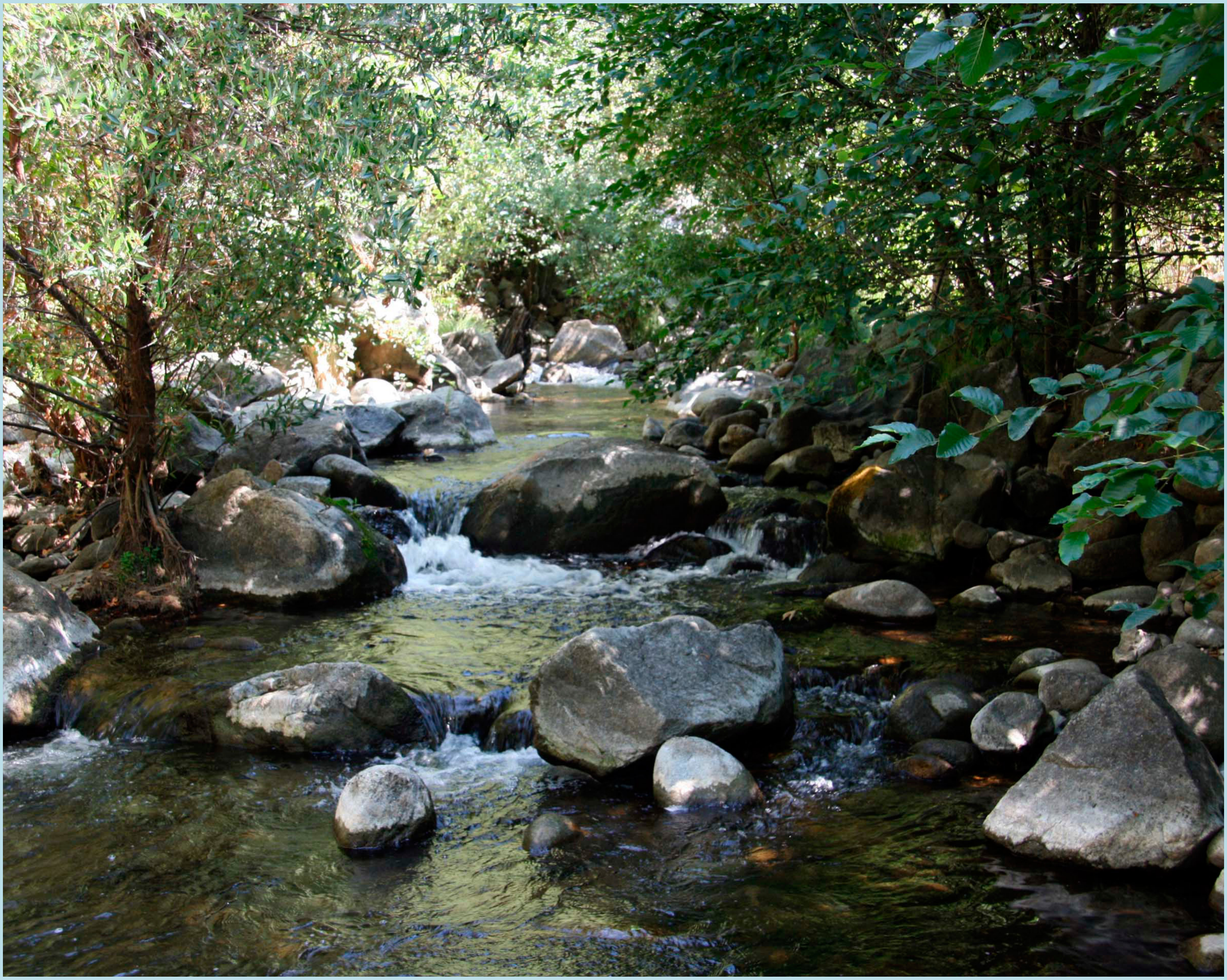
December 13, 2007

An Alternatives Assessment & Conceptual Design for the San Clemente Dam Removal: Carmel River Reroute and Removal Option



Prepared for

CALIFORNIA COASTAL CONSERVANCY



Prepared by PHILIP WILLIAMS & ASSOCIATES WITH H.T.HARVEY & ASSOCIATES

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

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ENVIRONMENTAL HYDROLOGY

#1908

AN ALTERNATIVES ASSESSMENT AND CONCEPTUAL DESIGN FOR THE SAN CLEMENTE DAM REMOVAL: CARMEL RIVER REROUTE AND REMOVAL OPTION

Prepared for

California Coastal Conservancy

Prepared by

Philip Williams & Associates, Ltd.

with

H.T. Harvey & Associates

December 13th 2007

PWA Ref. #1908 CC Ref. # 07-032

Services provided pursuant to this Agreement are intended solely for the use and benefit of the California Coastal Conservancy.

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1. PROJECT BACKGROUND

1.1 SCOPE OF REPORT

Major modifications are required to the San Clemente Dam as a result of seismic and flood safety issues. A group of agencies and stakeholders organized by the California Coastal Conservancy seeks to remove the San Clemente Dam and restore a naturally-functioning river channel around the reservoir, with a particular focus on restoring migration conditions for steelhead trout (Oncorhynchus mykiss) and developing a channel that is geomorphically self-sustaining. The group is collaborating with the dam owners, California American Water Company (CAW), to develop an economically feasible project alternative to accomplish these goals. Montgomery Watson Harza (MWH) previously developed a conceptual alternative for this project (MWH, 2005) that was evaluated for hydraulic and sediment transport function by Mussetter Engineering, Inc. (MEI, 2005). This plan was subsequently analyzed as one of the alternatives in a Draft EIR/EIS of dam safety options (ENTRIX, 2006).

In 2007 the Conservancy prepared a scope of work and selected a consultant team consisting of Philip Williams & Associates (PWA) and H.T. Harvey & Associates (HTH) to assess the relocation alternative for geomorphic stability and fish migration performance, and to refine a series of alternatives to improve fish passage and geomorphic performance. The PWA team was also scoped to develop revised cost estimates for the channel restoration elements. The Conservancy selected Interfluve to provide additional technical assistance and guidance.

1.2 PROJECT SETTING AND CONTEXT

The Carmel River drains a 255 square mile watershed in the Coastal Range to the Pacific Ocean at Carmel in Monterey County, California. A more detailed description of the watershed is contained in MEI, 2002a and a brief summary only is included here. The watershed is underlain by resistant crystalline igneous and metamorphic rocks (dominated near the project site by granite) overlain in places by weak, surficial Tertiary sedimentary rocks. Recent and ongoing uplift has produced steep, rugged terrain with high rates of erosion by episodic mass wasting and more frequent gully and surface erosion. This is exacerbated by the Mediterranean climate (summer drought combined with highly variable winter rainfall patterns) and associated propensity for fires and erosion.

In 1921 the San Clemente Dam was constructed at River Mile 18.6 (from the mouth) to supply drinking water to downstream users (Figure 1-1). The watershed area upstream of the dam is 125 square miles (110 square miles above the confluence with San Clemente Creek). The dam is a 106-foot high concrete arch structure and, despite the construction of a fish ladder, poses a considerable barrier to the migration of adult and juvenile steelhead trout that spawn and rear in the Carmel River and its tributaries. The San Clemente Dam blocks the Carmel River immediately downstream of its confluence with San Clemente Creek, a steep channel with a 16-square mile watershed. Following construction the dam rapidly filled with sediment (a mixture of sand and gravel) and has lost 90% of its original 1,425 acre-foot capacity (Kleinfelder, 2002). In 1992 a study by the California Department of Water Resources (CDWR), Division of Safety of Dams, found that the dam does not meet minimum stability requirements during the predicted Maximum Credible Earthquake (MCE), and that in addition the Probable Maximum Flood (PMF) would overtop the dam and potentially cause scour of the foundations. CDWR required the dam owner and operator CAW to either buttress, lower or remove the dam to meet the stability criteria for MCE and PMF events.

Several alternatives were evaluated including full dam removal and progressive notching to allow the stored sediment to be transported downstream, and mechanically removing the stored sediment and retaining it in a nearby upland storage site. A sediment transport study by MEI (2002b) found that releasing the majority of the historically-stored sediment downstream following dam removal posed an unacceptably high risk of channel aggradation, loss of flow conveyance and subsequent flooding. The cost of the sediment removal alternative was considered uneconomical.

Attention has shifted to the “Carmel River Reroute and Dam Removal Alternative” (Reroute Alternative), which is the focus of this report. Key features of the Reroute Alternative are shown in Figures 1-2 and 1-3. The approach taken by the Reroute Alternative is to excavate a notch through the low rock divide separating the Carmel River from San Clemente Creek and reroute the Carmel River through a newly created Diversion Reach into the pre-dam San Clemente Creek. The San Clemente Creek valley will be excavated down to its pre-dam morphology and the accumulated dam sediment relocated into the Lower Carmel River Reach. The combined Carmel River and San Clemente Creek will bypass most of the sediment trapped by the dam, rejoining the pre-dam Carmel River at the former confluence. Sediment in the Lower Carmel River Reach will be regraded and stabilized in place.

The Lower Carmel River Reach (Lower Carmel Reach) is approximately 2,900 feet long and runs from the San Clemente Dam upstream to the upstream entrance of the proposed Diversion Reach. It is completely within the backwater area of the reservoir, and the former river valley is buried beneath between 80 and 50 feet of sediment. Prior to sedimentation from the dam, this reach had a valley gradient of 1.1%. Upstream of the proposed Diversion Reach the Upper Carmel River Reach (Upper Carmel Reach) continues in the reservoir backwater for approximately 2,900 feet before intersecting the pre-dam channel and natural channel. The Upper Carmel Reach was formerly around 200 feet wide at the valley floor, and as it has filled with sediment is has widened to around 300 feet. The Upper and Lower Carmel Reaches are currently occupied by low gradient sand dominated channels in the backwater area of the dam, transitioning to a natural channel with an average gradient of around 1-2% upstream. The Lower San Clemente Creek Reach runs from the dam to the downstream end of the proposed Diversion Reach. The Lower

San Clemente Reach is more confined than the Carmel Reaches, having been formed by a much smaller and steeper creek with approximately a tenth of the watershed area of the Carmel River. The Lower San Clemente Reach valley floor has a gradient of approximately 2.5% buried beneath between 12 and 36 feet of sediment. Based on historic maps the buried valley floor varies from around 30 to 70 feet wide.

MWH and MEI developed a conceptual plan for a bypass channel (MWH, 2005, MEI, 2005) hereafter know as the MWH/MEI plan. The historic Lower San Clemente Creek Reach has a gradient of 2.52% following excavation, based on the 1921 topography. The bedrock diversion channel through the ridge was initially planned with a gradient of approximately 2.7% so as to connect the thalweg of the former San Clemente Creek channel with the thalweg of the Carmel River over the shortest possible distance. While their plan provided an initial conceptual approach for the Reroute Alternative, stakeholders identified a need to further confirm the viability of the design in terms of fish passage and geomorphic stability. In addition, stakeholders requested additional alternatives that would further restore sediment continuity between the upper and lower watersheds as a result of the project. As a result, the current effort was initiated.

The current study represents a refinement of the Reroute Alternative, which forms the basis of Alternative 1 in this report. A second alternative has been developed in response to stakeholder requests. A project team including the Coastal Conservancy, a Technical Review Team and the consultant team has developed a focused series of project goals and objectives. We have conducted geomorphic and biological investigations of the site and have used existing data to refine the plan so that it better meets those objectives. These studies focused primarily on two closely related issues: the ability of the proposed channel reaches to sustain passage for migrating steelhead trout and the long-term geomorphic stability of the channel. These issues were addressed by analyzing existing fish migration behavior in the Carmel River, and by looking at how reaches of the river that are at similar gradients to those required by project constraints function geomorphically. Supporting both components of the analysis was a detailed one-dimensional hydraulic model of two proposed alternatives. The model was used to analyze flow conditions during likely periods of fish migration, and to predict the geomorphic stability of the channel. We also conducted an assessment of the long-term geomorphic evolution of the channel, since the sustainability of the system is a key criteria.

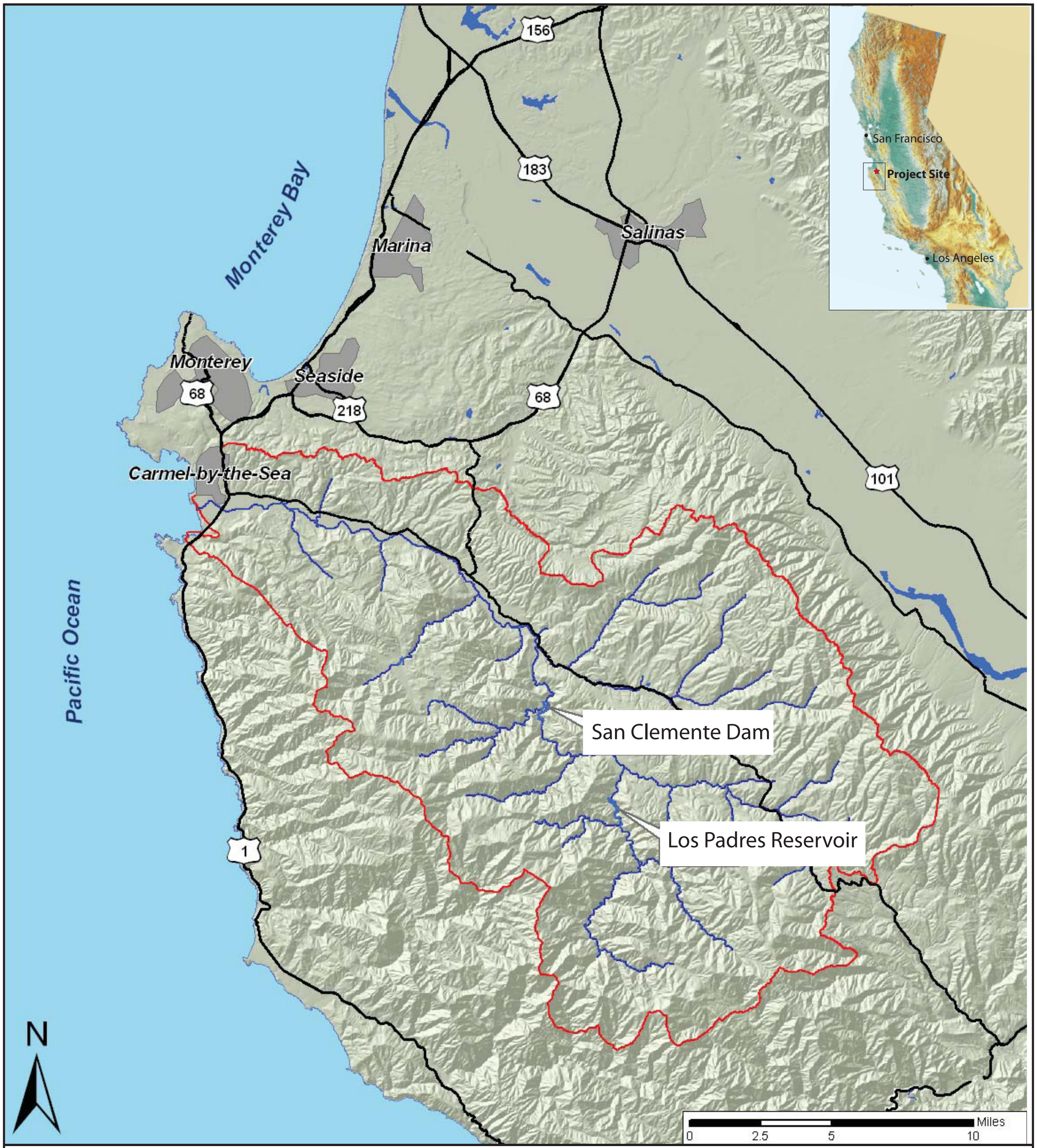

figure *1-1*

San Clemente Dam Removal

Carmel River Watershed

#1908

PWA

Source: photo credit Cal Am

figure 1-2

San Clemente Dam Removal

Reach Labels for the Carmel River and San Clemente Creek

PWA Ref# 1908

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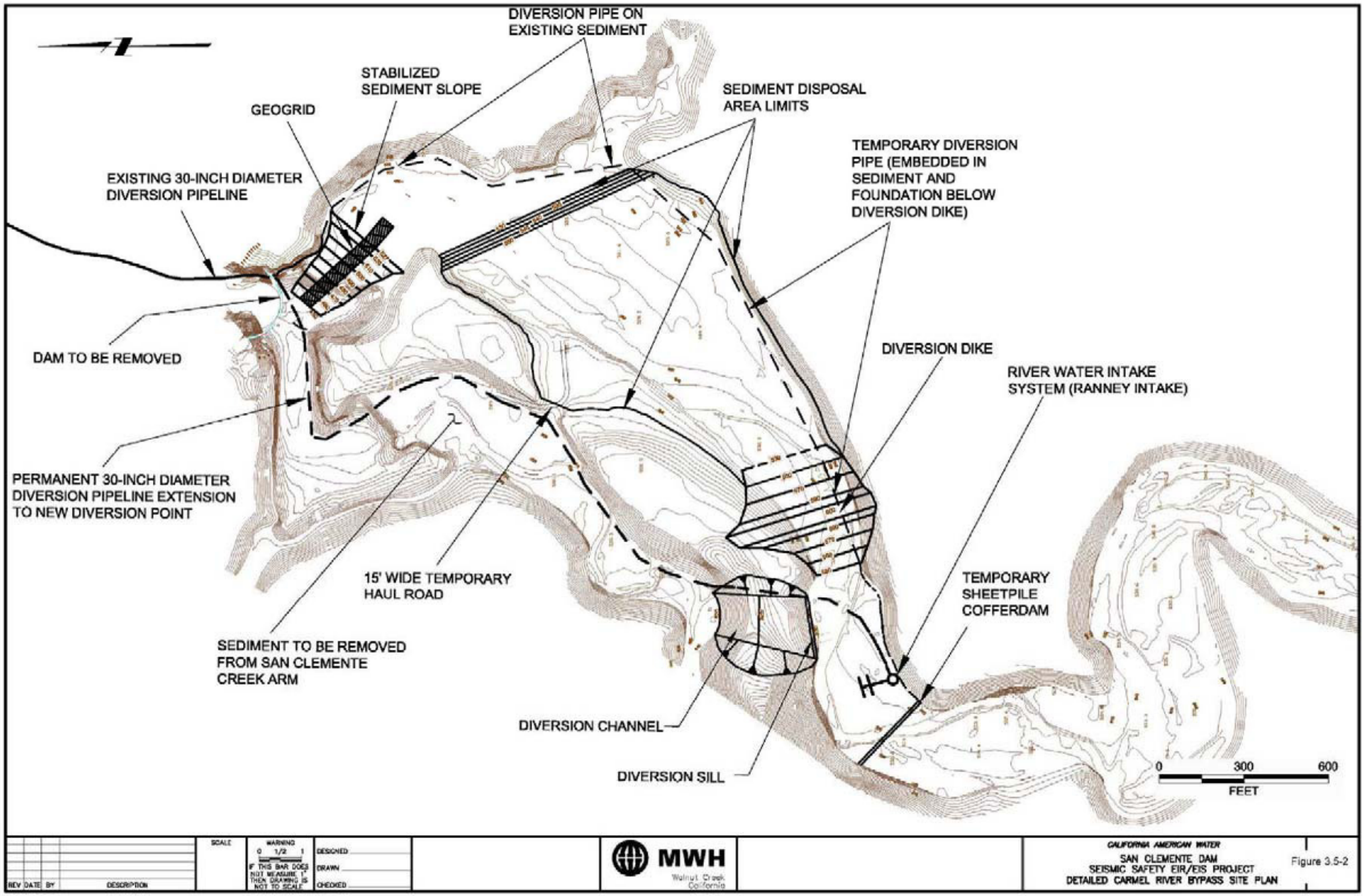

Source: MWH, 2005

figure *1-3*
San Clemente Dam Removal

Project Elements of the Reroute and Removal Alternative

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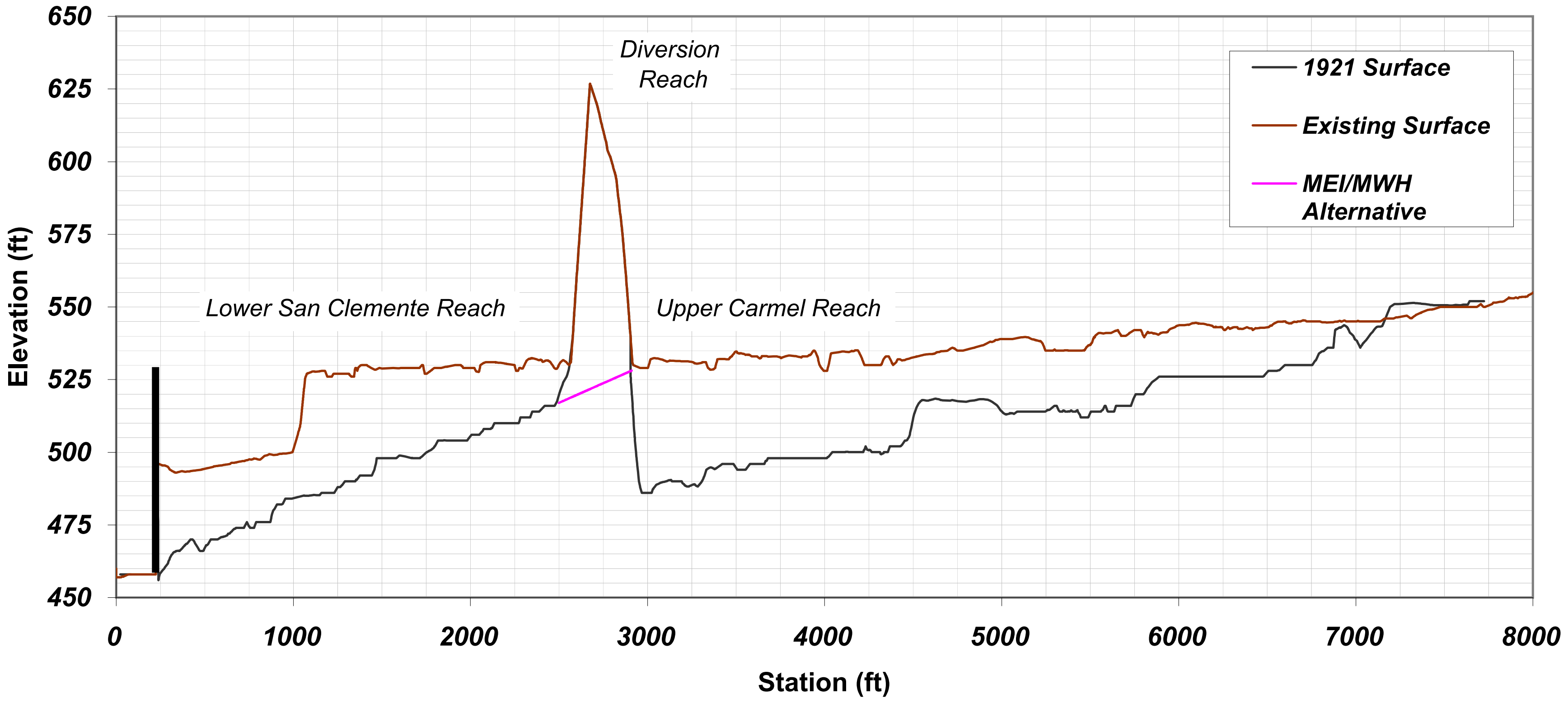

Source: 1921 USGS Topo overlaid with 2006 topographic surface. Both data sets courtesy of Montgomery Watson Harza.

figure 1-4

San Clemente Dam Removal

Long Profile Showing Existing Conditions and the MEI/MWH Proposed Diversion

PWA Ref# 1908

PWA

Fig1-4Profile.xls / HorzFigureBox

2. PROJECT GOALS AND OBJECTIVES

2.1 TECHNICAL REVIEW TEAM

The Conservancy and consultant team assembled a Technical Review Team (TRT) to provide advice on the project. The TRT met at a kickoff meeting on September 28th 2007 to agree upon a series of goals and objectives for the project, to develop performance standards for fish migration, and to identify potential project alternatives. A second meeting was held on October 25th 2007 to discuss a possible third alternative and to review progress. The TRT meeting participants were:

Joyce Ambrosius (NOAA Fisheries), Mike Burke (Interfluve), Trish Chapman (Coastal Conservancy), Brian Cluer (NOAA Fisheries), Andy Collison (PWA), Frank Emerson (Carmel River Steelhead Association), Laura Engeman (Coastal Conservancy), Blair Greimann (US Bureau of Reclamation), Jeff Haltiner (PWA), Larry Hampson (Monterey Peninsula Water Management District (MPWMD)), Monica Hunter (Planning and Conservation League), John Klein (CAW), Matt Kondolf (U.C. Berkeley), Sharon Kramer (HTH), Paula Landis (CDWR), Kevan Urquhart (MPWMD), and Marcin Whitman (California Dept. of Fish & Game).

2.2 PROJECT GOALS

While recognizing the large number of desirable goals for the project, three goals emerged from the kickoff meeting as primary foci, with a series of secondary goals that are desirable but that should only be pursued if they do not conflict with the primary goals. The alternatives considered in this study were evaluated against these goals, objectives and performance criteria.

2.2.1 Primary Goals

1. To achieve and maintain fish passage in a sustainable manner, with an emphasis on upstream migration of **adult steelhead** and downstream migration of **smolts**. While easing passage of juveniles through the project reaches to optimize summer rearing opportunities is a desirable secondary goal (see below), it should not lead to actions that undermine the primary goals (e.g. if maintaining stability of the channel morphology requires rocks that are larger than those that produce small steps optimal for juvenile migration, the stability goal outweighs the juvenile migration goal).

2. Design and construct the restored reaches in such a way that they are in **dynamic equilibrium with the surrounding rivers and watershed, and that they maintain geomorphic stability so that maintenance and repair is not needed following construction**. Specifically, design reaches so that they can be naturally resupplied with coarse bedload of the size needed to maintain the bed and channel structure. The

approach should minimize geomorphic risk. We recognize that full sediment continuity will not be achieved for many decades after project implementation, and that before this occurs there is a risk that channel features will have to be repaired rather than naturally restabilized from upstream sediment.

3. Design the relocated CAW water intake so that existing **head, influent flow, and water quality** criteria are met.

2.2.2 Secondary Goals

1. Restore riparian habitat so that wildlife connectivity is maximized, to provide shade for the restored river reaches, and to provide large woody debris and organic inputs to the system.
2. Achieve fish passage for all steelhead life stages to the greatest extent possible.
3. Create spawning habitat in appropriate restored reaches (e.g. Carmel River upstream of diversion reach).
4. Restore sediment continuity downstream so that spawning size gravel is transported to the Carmel River downstream of the dam, and so that channel incision is reduced.
5. Design the project so that some spawning gravels exposed during excavation of the San Clemente Creek branch are temporarily stored alongside the channel and gradually ‘metered out’ into the Carmel River to replenish spawning sites downstream without increasing flood risk.
6. Provide a fish resting pool at the confluence of the Carmel River and San Clemente Creek confluence so that spawning steelhead have time to make a decision (to encourage fish to return to their natal streams, including San Clemente Creek).
7. Create red legged frog habitat along the river corridor where geomorphically and biologically appropriate, and avoid creating bull frog habitat.

2.3 FISH PASSAGE OBJECTIVES AND PERFORMANCE CRITERIA

Fish passage objectives and performance criteria were developed by HTH to provide an objective method of assessing the performance of potential project alternatives.

2.3.1 Hydraulic Criteria for Fish Passage

The channel reaches should conform to the standards synthesized from the literature (see Table 2-1) with the qualifiers from the TRT described below.

Table 2-1. Basic Hydraulic Performance Criteria for Fish Passage in the San Clemente Dam Removal Project

- Max velocity for distance of >300 feet is 2-3 feet per second (fps).
  Steelhead velocity criteria based on Oregon Dept. of Fish and Wildlife, Washington Dept. of Fish and Wildlife, California Department of Fish and Game, and National Marine Fisheries Service guidelines for culvert passage.
- Reach Length <60 feet, velocity max 6 fps
- Reach Length 60-100 feet, velocity max 5 fps
- Reach Length 100-200 feet, velocity max 4 fps
- Reach Length 200-300 feet, velocity max 3 fps
- Min depth 1 foot
- Max hydraulic drop 1 foot

2.3.2 Additional Performance Objectives and Criteria

Velocity and depth criteria in Table 2-1 assume that there will be resting pools (i.e. criteria developed for short reaches should not be applied over the entire project length). Pools should be created approximately every 200 ft. Pools should have sufficient space protected from the fastest velocity zones that fish can rest even during flows at approx. the 2-5 year recurrence interval.

Step heights[1] should be minimized and should not exceed 1 ft where possible. Ideally step heights should be kept below 6 inches, though the TRT recognized that step height is related to the size of ‘nucleus rocks’ that form step-pools, and that the desire for steps smaller than 1 ft may conflict with the priority goal of geomorphic stability. We recognize also that step height and other dimensions will likely evolve over time as sediment enters and leaves reaches and as particles realign.

Pool dimensions. Pools should be at least 2 feet deep below jumps, or 1.5 times the jump height, whichever is larger. Pools should be at least 6 ft long unencumbered by hydraulic transitions (e.g. nappes from upstream steps.)

Channel dimensions. Channels should have a compound cross section so that at high flows there will be shallow zones and off-channel refugia.

Hydraulic analysis. Though the TRT endorsed the approach of using one-dimensional HEC-RAS hydraulic analysis as a relative metric of velocity and depth performance between alternatives, and as a means of assessing the sensitivity of performance metrics to design details,

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[1] Note: the case for selecting a step-pool design is made in Section 4.1.2. For clarity in the report we present what was in fact a somewhat iterative project process in a more linear manner.

the TRT, client and consultant teams recognize that step-pool hydraulics is a three-dimensional problem and we should avoid over-inferring conclusions from the one-dimensional HEC-RAS hydraulic analysis. The analysis should overlay quantitative data on qualitative understanding of the system to synthesize a final conclusion about the proposed alternative.

2.3.3 Fish Migration Timing Criteria

The hydraulic analysis should focus on likely times of fish migration. The majority of adult steelhead upstream migration occurs from January through Mid-April, although migration can occur from November through June, and smolt outmigration occurs primarily from February through May (ENTRIX, 2006). A more detailed analysis of adult steelhead upstream migration is included in Chapter 3.

2.4 GEOMORPHIC OBJECTIVES AND PERFORMANCE CRITERIA

2.4.1 Geomorphic Objectives

The project should construct a channel that is geomorphically-appropriate to the setting, and that minimizes the risk of a failure occurring that is not self-repairing[2]. There are two potential failure mechanisms if boulders and cobbles used to construct a step-pool system are transported out of the project reach before replacement boulders can be delivered from upstream. Loss of the nucleus boulders effectively converts the step-pool reach into a plane bed reach. Loss of smaller ‘plugging’ particles (small boulders and cobbles) increases the porosity of step-pools, reducing their ability to retain deep pools and compromising their function for fish passage and resting. This risk can be reduced if the project is constructed so that the diversion reach connects directly to a source of large cobbles and boulders at a gradient that permits relatively frequent delivery (e.g. by the 2-5 year flood). If the project does not connect to a cobble/boulder source the material comprising the step-pools should be of a size that it will not be transported until aggradation of the Carmel reach upstream of the diversion channel creates a channel of sufficient gradient to reestablish sediment supply.

It is important to note that the Reroute Alternative will not restore sediment transport to pre-dam levels for a considerable period of time. The dam created a backwater area that extends for approximately 1 mile upstream. The backwater area has trapped sediment to create an almost flat delta over the original channel. The diversion channel alternative proposed in the EIR (and in Alternative 1 of this report) has its upstream end in this flat area approximately 2,900 feet downstream of where the natural river profile is found. Upstream of this hinge point the channel steepens to its original gradient and delivers sediment naturally, but from the backwater limit to the diversion channel most coarse sediment (cobble and boulder size material) will continue to be

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[2] See Footnote 1. The decision to adopt a step-pool system was made at the same time as geomorphic objectives were developed. This approach is justified in Section 4.1.2.

trapped and will not be transported to the diversion reach for a considerable period of time (decades to hundreds of years). Eventually deposition of coarse sediment will build up and steepen the channel around the hinge point until it reaches equilibrium grade, at which point natural sediment delivery will be restored to the diversion reach and downstream. The further up the backwater area project alternatives are extended, the sooner equilibrium and natural sediment transport will be achieved.

2.4.2 Geomorphic Performance Criteria

Based on these objectives the geomorphic performance criteria are as follows:

1. Nucleus boulders used in step-pool construction should be sized to remain in place for as long as feasible without producing step sizes that endanger fish passage

2. In at least one project alternative the diversion reach should access a reasonably large supply of 6-24 inch cobbles and boulders that can be mobilized by flows in the 2-5 year recurrence interval

2.5 CAW WATER INTAKE OBJECTIVES AND PERFORMANCE CRITERIA

CAW has an existing water right, part of which is currently exercised through a diversion at the San Clemente dam. This will be continue to be met using a Ranney collector (a system of steel infiltration pipes under and adjacent to the Carmel River channel upstream of the diversion reach, connected to a well and then to a 30 inch pipeline). The system must have a capacity of 16 cubic feet per second (cfs) and an intake elevation of 525 feet, in order to provide sufficient head to drive water through the filters and clearwell into the distribution system.

2.6 RIPARIAN OBJECTIVES AND PERFORMANCE CRITERIA

2.6.1 Riparian Habitat Restoration Objectives

The primary objective for the riparian habitat restoration is to create self-sustaining riparian habitat dominated by native species that provide food, shelter and shade functions for salmonids, as well as other aquatic and terrestrial organisms. This will be accomplished by creating hydrogeomorphic conditions that support riparian habitat. With creation of soil and hydrologic conditions that support riparian habitat, restoration will rely on natural recruitment from surrounding source populations as the primary means of establishing and maintaining riparian habitat. Natural recruitment processes will be supplemented (jump-started) by selective active planting of riparian tree species. These new riparian communities will develop into important components of salmonid habitat. The riparian forest will also help to stabilize the channel and eventually contribute woody debris to the system.

Upland habitat should be created in areas above the 10-year floodplain in order to stabilize the soil. The upland areas will be seeded to provide immediate cover to prevent erosion, and over time upland woody species will naturally establish.

Although the project's primary focus is salmonid habitat, it should also strive to create appropriate habitat to sustain red-legged frogs. The project should establish off-channel ponds adjacent to the Carmel River Reach and step-pools within the Diversion Reach and San Clemente Creek Reaches appropriate for California red-legged frog. The pools should be deep enough to provide refuge habitat for red-legged frogs and wetland vegetation should naturally establish along the edges. The off-channel ponds along the Carmel River are expected to be temporary in nature due to the predicted sediment deposition and channel migration. Over time the channel will likely naturally migrate, depositing sediment within these pools and scouring out other pools elsewhere that will support red-legged frogs.

2.6.2 Riparian Habitat Performance Criteria

The following performance criteria will be used to indicate if riparian restoration objectives are being met.

1. As the restored riparian vegetation communities develop over time they will show a trend toward developing species composition, structure, and percent vegetative cover similar to the undisturbed reaches up and downstream from the project.

2. Upland habitats should develop sufficiently to stabilize and allow for the eventual recruitment of native woody species.

3. Red-legged frog habitat should be created by establishing instream pools and off-channel ponds that maintain 20 inches of ponding through July in an average year. Wetland vegetation should naturally establish along the edges of the pools in the Diversion and San Clemente Creek Reaches. Natural river migration and disturbance processes will destroy and regenerate habitat resulting in an approximately stable quantity and quality of habitat over time.

3. BIOLOGICAL BASIS OF DESIGN

Chapter 3 lays out the biological basis of design for the project. Biological considerations were focused on determining characteristics of discharge during periods when adult steelhead are moving upstream, based on existing discharge and adult steelhead daily count information from San Clemente and Los Padres dams, and evaluating the potential to revegetate the restored reaches. The alternatives are then assessed relative to the project goals and performance criteria in Chapter 6.

3.1 ASSESSMENT OF EXISTING FISH PASSAGE DATA AND IDENTIFICATION OF THE FISH MIGRATION WINDOW

Substantial information exists within the Carmel River basin on steelhead and discharge. Daily counts of steelhead taken at the San Clemente Dam, daily counts of steelhead taken at the Los Padres Dam, and discharge measured at USGS gage 11143200, located on the Carmel River at Robles del Rio (River Mile 14.4, downstream of San Clemente Dam) were used to evaluate adult steelhead run timing, relationships between run timing and discharge, and run timing at San Clemente Dam compared to Los Padres Dam.

Data on daily adult steelhead counts at San Clemente Dam were available online from November 1999 through May 2007 on the Monterey Peninsula Water Management District's website http://www.mpwmd.dst.ca.us/fishcounter/fishcounter.htm. Although other count data exist they were not provided in time to be addressed in this report; additional data could potentially modify the windows of migration and flows. Daily fish counts from Los Padres Dam were obtained from the Monterey Peninsula Water Management District (K. Urquhart, pers. comm.). Daily peak discharge data were obtained from the USGS Gage 11143200 (Carmel River at Robles del Rio).

Run timing was determined by plotting daily counts of steelhead at San Clemente Dam for the period of record (Figure 3-1). Although the start and end dates for run counts varied, in general counts were recorded starting either November 1, December 1, or January 1, and counts were ceased either May 15 or May 31, except for 2007 when the last count date was April 1. Because the count data stopped early in 2007, the run timing information for the years 1999-2000 through 2005-2006 was used to evaluate general timing for the period of record. For years 1999-2006, the first fish reached San Clemente Dam the last week of December, with approximately 50% of the run at San Clemente Dam by early March, and approximately 95% one month later (Figure 3-1). Counts had generally ceased by the end of May at both dams; however, steelhead could still be moving upstream in June so the analysis of alternatives for the ability to pass fish included June. Some of the variability observed in run timing was explained by discharge, as described below.

For adult steelhead to enter the Carmel River, initial flows must be sufficient to breach the sand bar at the mouth. After the bar is breached and after an increase in flow, adult steelhead take on average approximately 4 days to reach San Clemente Dam (approximate travel rate 5 miles/day) (Dettman and Kelley 1986). Dettman and Kelley (1986) observed that individual riffles presented flow-dependent barriers to migrating adults. The volume of water necessary for fish passage varies with changing channel configurations, but, based on the measurements and observations of Dettman and Kelley (1986) and on the run and flow data from 1999-2006 (Figure 3-2), flows between 40 and 800 cfs are a reasonable core range.

Adult steelhead counts tend to peak at San Clemente Dam after or during the descending limb of a peak flow event, or in some years during winter baseflows (Figure 3-2). While fish counts increase dramatically with flows over 40 cfs (Figure 3-3), fewer fish appear to arrive at San Clemente Dam when discharges are greater than 800 cfs (Figure 3-2, Figure 3-3); discharges greater than 800 cfs are relatively infrequent (Figure 3-4). Discharges of 40-800 cfs were used to evaluate the design alternatives and their ability to support upstream adult steelhead passage (see Chapter 5) using the design criteria in Table 2-1. It is worth noting that 800 cfs represents a considerably higher value than the upper limit often employed in fish passage assessments (e.g. Q10% which is 200 cfs) and we therefore believe this fish passage assessment to be somewhat conservative.

Adult steelhead arrive at Los Padres Dam subsequent to their appearance at San Clemente Dam (Figure 3-5). The lag between these appearances, however, show no clear correlation with flow conditions. Anecdotal information (B. Chaney, pers. comm.) suggests that, in years with low flow, fish are less likely to spawn in the tributaries outside of the main channel as access is then limited. During years with abundant water, steelhead may be more likely to spawn in tributaries outside of the main channel. This could affect the discrepancies in number and timing of fish at the two dams.

3.2 RIPARIAN AND UPLAND REVEGETATION APPROACH

3.2.1 Habitat Restoration Approach

Resources available for the habitat restoration/revegetation elements of the project should be concentrated on establishing the abiotic (soils, hydrology, etc.) conditions necessary for the establishment of the target plant associations, with active plant installation and maintenance components given secondary importance. In many areas providing suitable conditions for natural recruitment will be the most effective means of establishing vegetation. If resources are available and faster vegetation development is desired, a more active habitat restoration approach can be employed that includes planting of container stock, control of weeds, browse protection, dead plant replacement and potentially providing periodic supplemental irrigation. These optional active habitat restoration methods are summarized in Section 5.5.1.6.

Habitat resources will focus on the establishment of White Alder Riparian Forest within 25-30 feet of the bankfull discharge with some “starter” plantings within the broader floodplain. Prioritizing the establishment of riparian vegetation in this zone will provide the highest habitat benefits for salmonids, California red-legged frog and will aid in the establishment of a geomorphically-stable channel. The primary method for establishing new riparian habitat in these areas will include the use of salvaged alder and willow root wads (see Section 5.5.1.2), installation of willow posts, poles and cuttings and through natural recruitment. From the outside edge of the White Alder Riparian Forest to the elevations that would be reached during a 10-year flood event, habitat restoration actions will rely primarily on natural recruitment. However, pockets of riparian vegetation will be established within these broader floodplain areas using similar techniques as described above. Upland habitats will establish beyond the 10-year flood event/valley floor. For this project, the restoration actions will include the seeding of uplands with a native grass seed mix and allowing natural recruitment to establish woody vegetation in these areas through time.

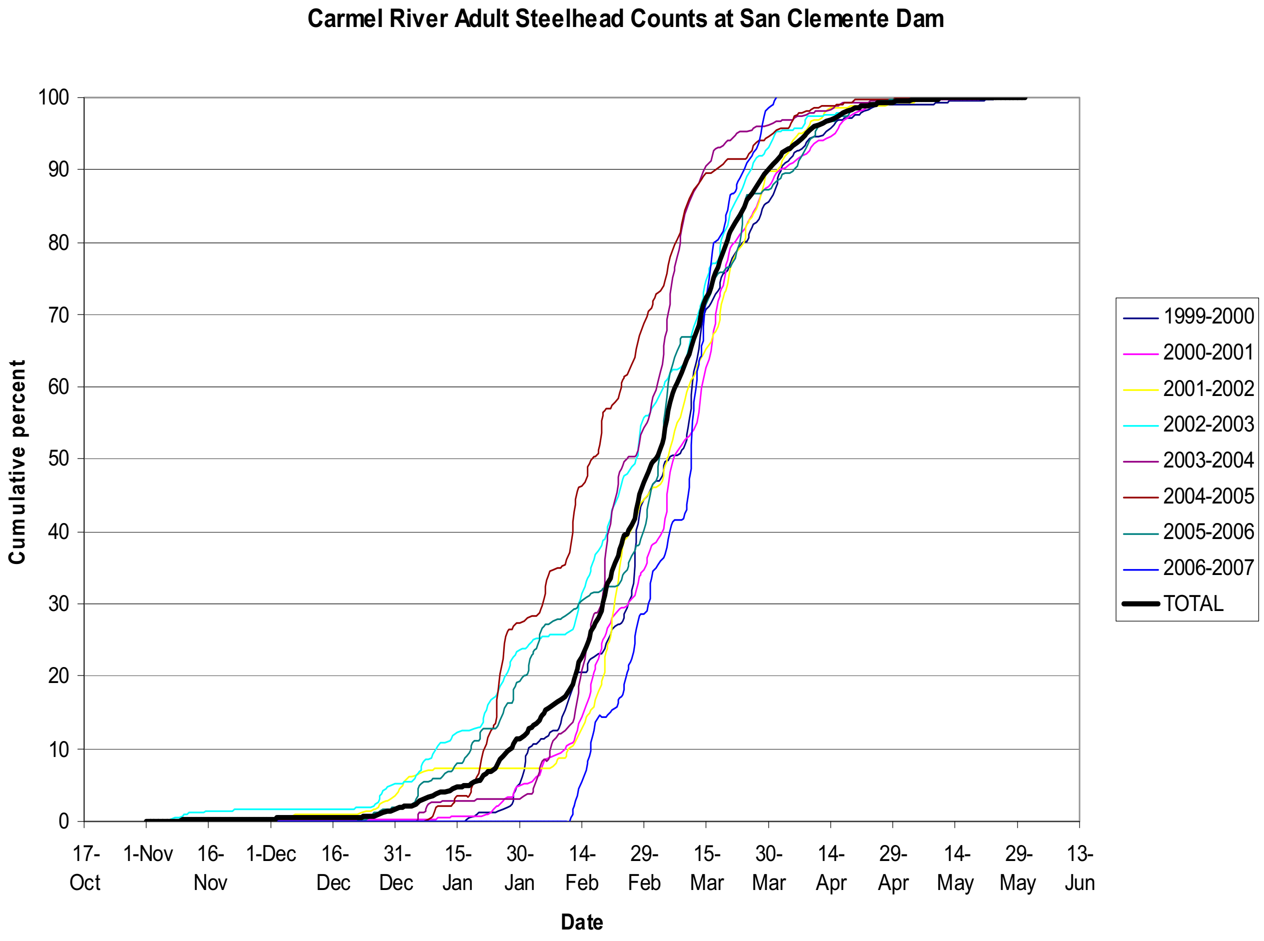
3.2.2 Location and Size of Restoration Areas

For the purposes of this study, it is assumed that riparian vegetation will ultimately establish between approximately the outside edge of the bankfull discharge (1-2 year flood event) to roughly the 10-year flood event. Below the bankfull discharge it is assumed that regular flood events would scour out riparian vegetation that may temporarily establish and that beyond the 10 year flood event (which is above the valley floor in most cases) the influence of the stream on the recruitment and sustainability of riparian vegetation will be minimal. This predicted zonation of riparian vegetation corresponds well with the conditions observed in the undisturbed reaches of the Carmel River upstream of the reservoir footprint. Above the 10-year flood event waterline, it is assumed that upland plant communities will establish. These upland plant communities are likely to include native and non-native grasslands, oak woodland and coastal scrub depending up the soils present, aspect and the number of years after restoration implementation.

3.2.3 Target Habitat Types

The riparian habitat targeted for restoration along San Clemente Creek and the Carmel River will include White Alder Riparian Forest and Mixed Riparian Forest. The White Alder Riparian Forest will occur primarily along the edge of the bankfull discharge and will be dominated by white alder (*Alnus rhombifolia*). It will also include scattered willow species such as red willow (*Salix laevigata),* arroyo willow (*Salix lasiolepis)* and shining willow (*Salix lucida).* This habitat type will transition to Mixed Riparian Forest away from the creek channel. This habitat type will include black cottonwood (*Populus balsamifera* ssp. *trichocarpa*), California sycamore (*Platanus racemosa),* white alder, red, arroyo and shining willow. Other species that may occur within this habitat type, especially in areas furthest from the channel, include coast live oak (*Quercus agrifolia),* valley oak (*Quercus lobata),* California buckeye (*Aesculus californica),* and big leaf maple (*Acer macrophyllum)*. It is assumed that this assemblage of riparian plant communities and species will be common through each of the three restoration reaches.

The upland plant communities will likely include native and non-native grasslands, oak woodland, and coast scrub. The specific upland plant communities that establish will depend upon the soils present, the site's aspect and the number of years after restoration implementation. For the purposes of this report, the restoration actions will predominantly involve the seeding of a native grass seed mix primarily for erosion control purposes as described in section 3.2.4.6.



Source: MPWMD fish counter database

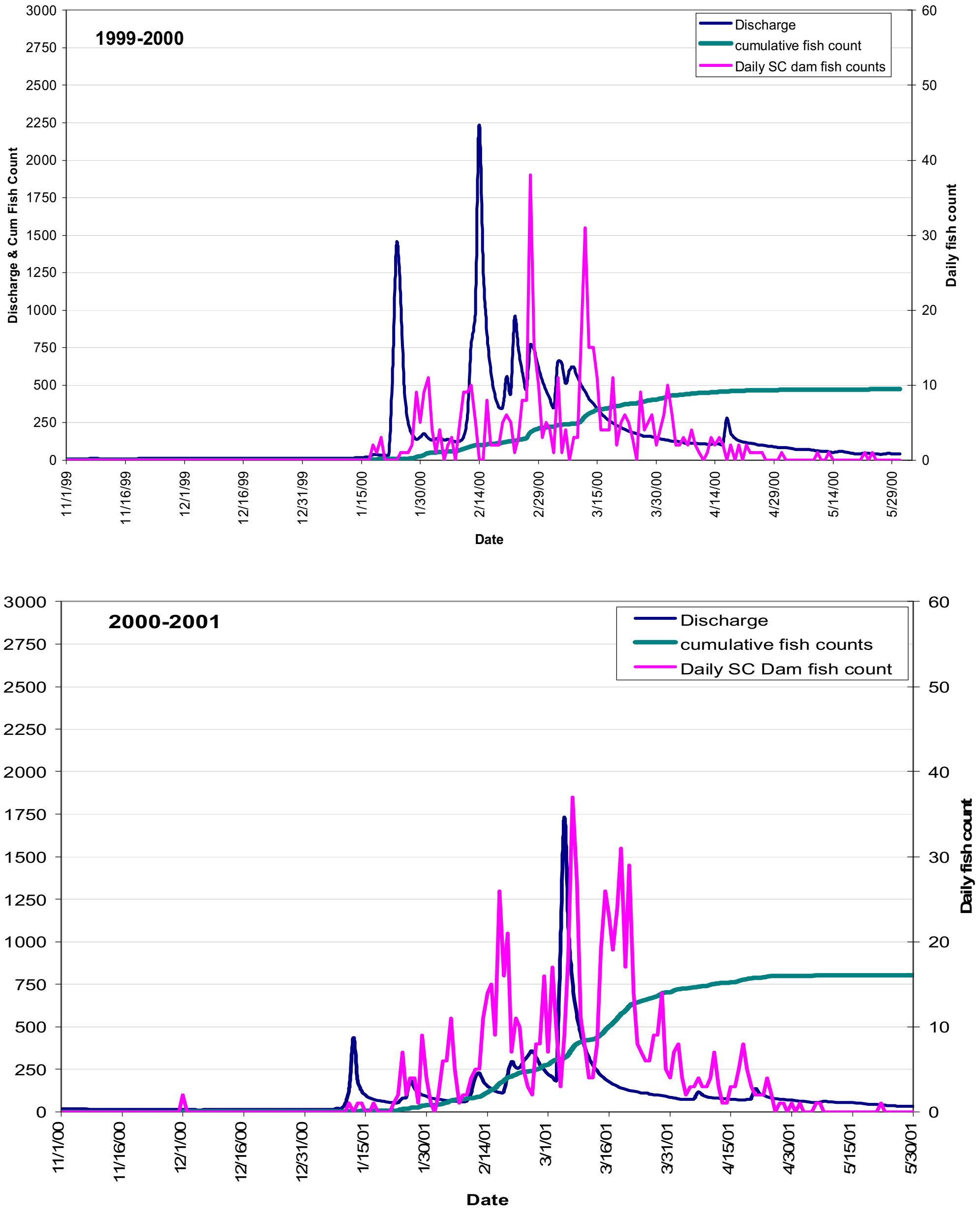
http://www.mpwmd.dst.ca.us/fishcounter/fishcounter.html

figure 3-1

San Clemente Dam Removal

Cumulative Adult Steelhead Daily Run Timing, San Clemente Dam, November 1999-April 2007

PWA Ref# 1908



Source: MPWMD fish counter database

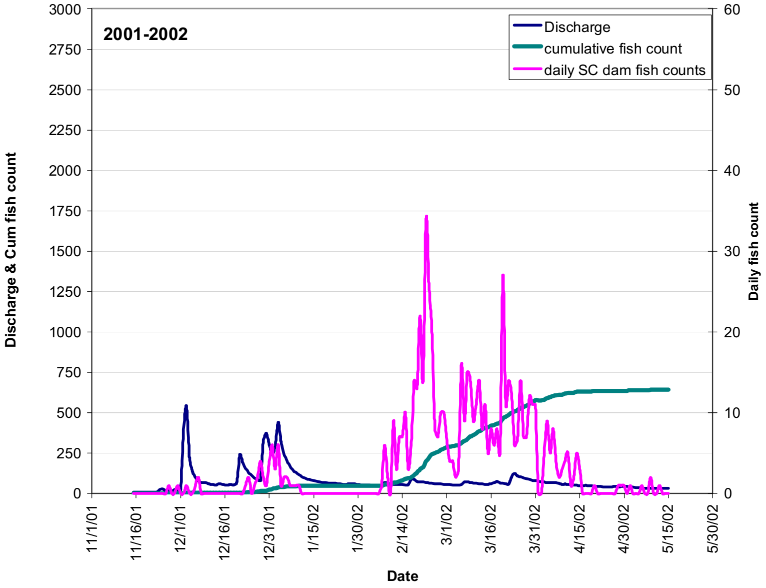
http://www.mpwmd.dst.ca.us/fishcounter/fishcounter.htm

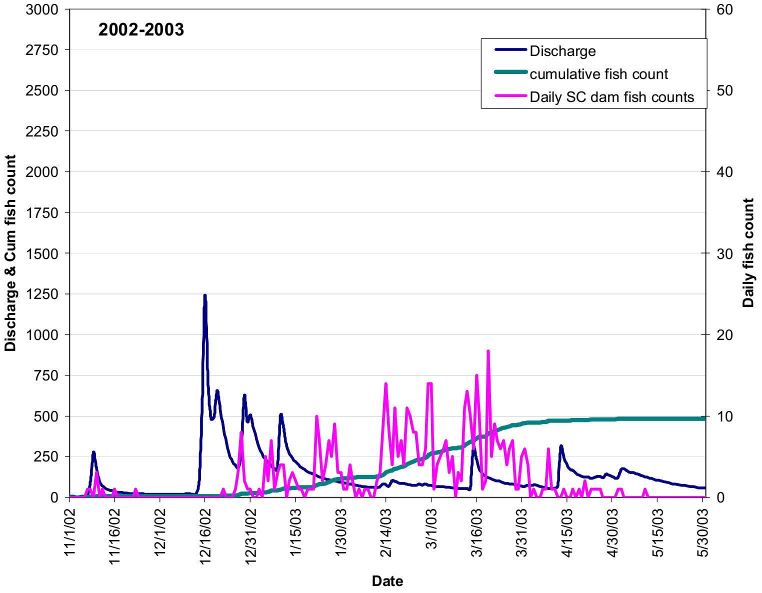
figure 3-2a and 3-2b

San Clemente Dam Removal

Monthly Adult Steelhead Runs and Daily Discharge by Year, San Clemente Dam

PWA Ref# 1908





Source: MPWMD fish counter database

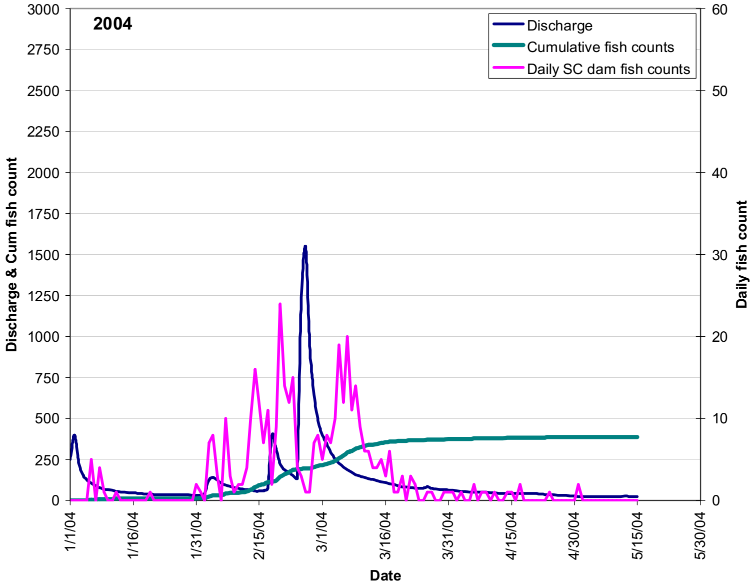
http://www.mpwmd.dst.ca.us/fishcounter/fishcounter.htm

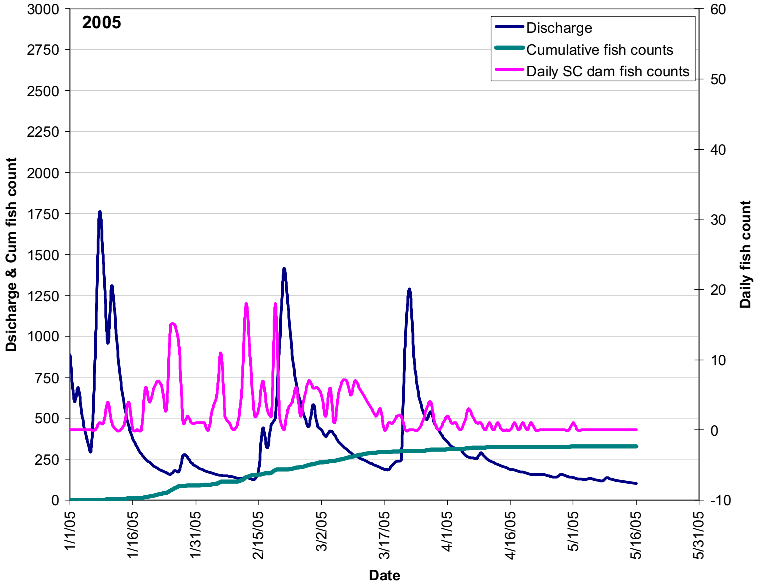
figure 3-2c and 3-2d

San Clemente Dam Removal

Monthly Adult Steelhead Runs and Daily Discharge by Year, San Clemente Dam

PWA Ref# 1908



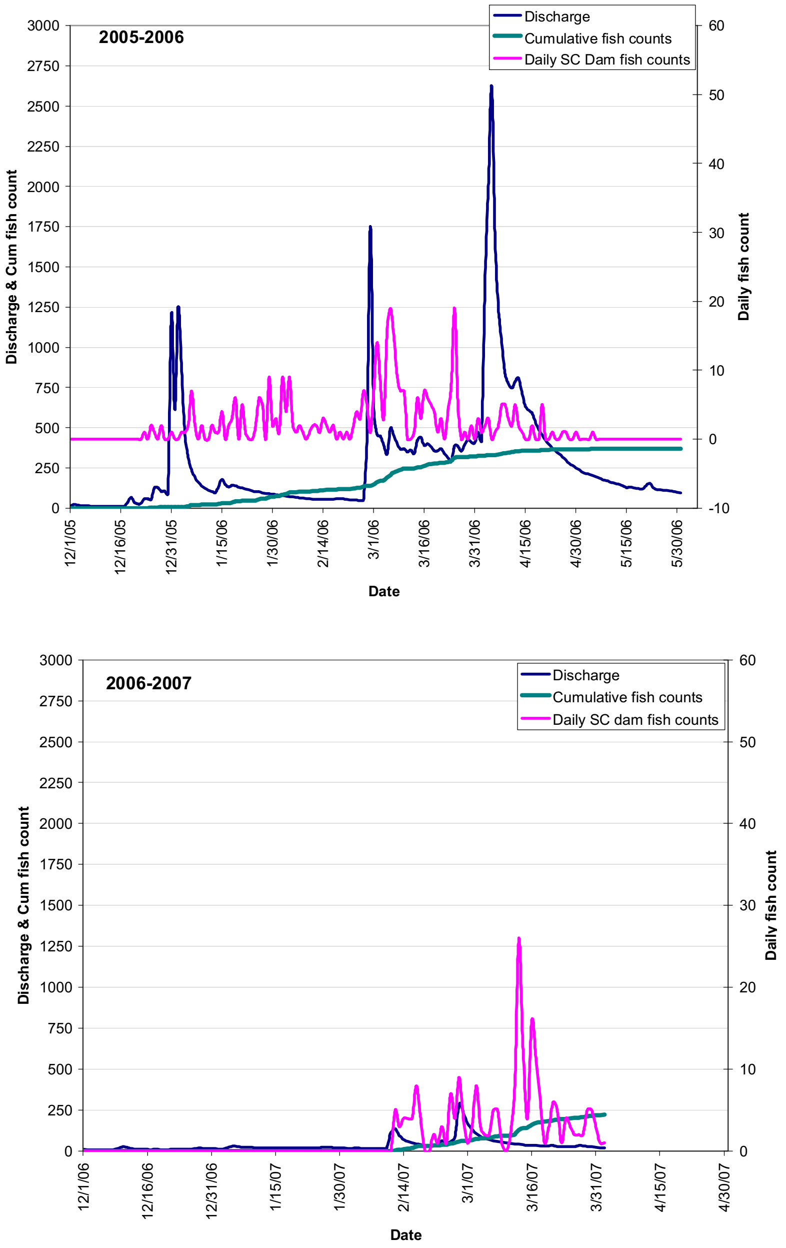


Source: MPWMD fish counter database
http://www.mpwmd.dst.ca.us/fishcounter/fishcounter.htm

figure 3-2e and 3-2f
San Clemente Dam Removal

Monthly Adult Steelhead Runs and Daily Discharge by Year, San Clemente Dam

PWA Ref# 1908



Source: MPWMD fish counter database

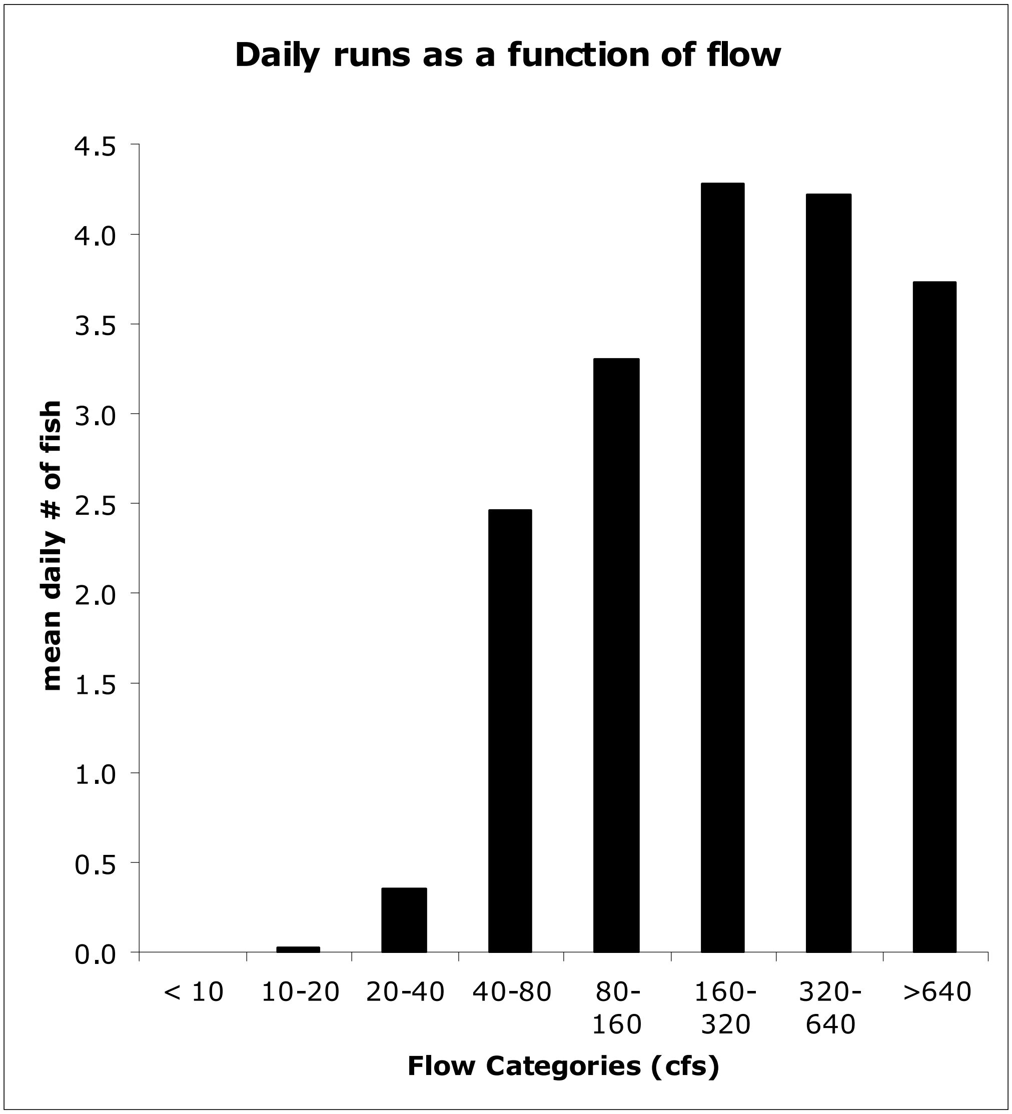
http://www.mpwmd.dst.ca.us/fishcounter/fishcounter.htm

figure 3-2g and 3-2h

San Clemente Dam Removal

Monthly Adult Steelhead Runs and Daily Discharge by Year, San Clemente Dam

PWA Ref# 1908



Source: MPWMD fish counter database

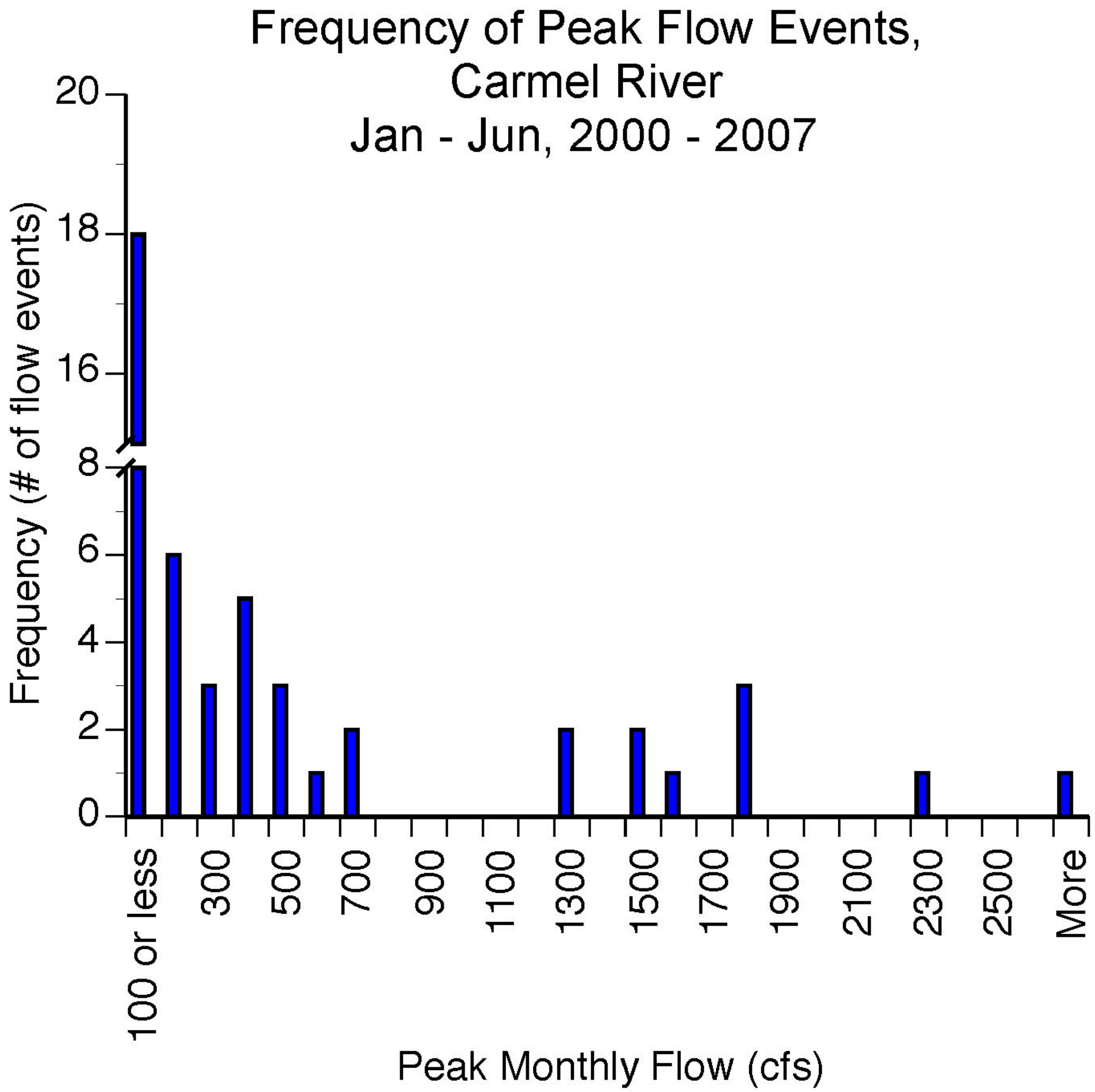
http://www.mpwmd.dst.ca.us/fishcounter/fishcounter.htm

figure *3-3*

San Clemente Dam Removal

Mean Daily Number of Adult Steelhead by Discharge, San Clemente Dam

PWA Ref# 1908

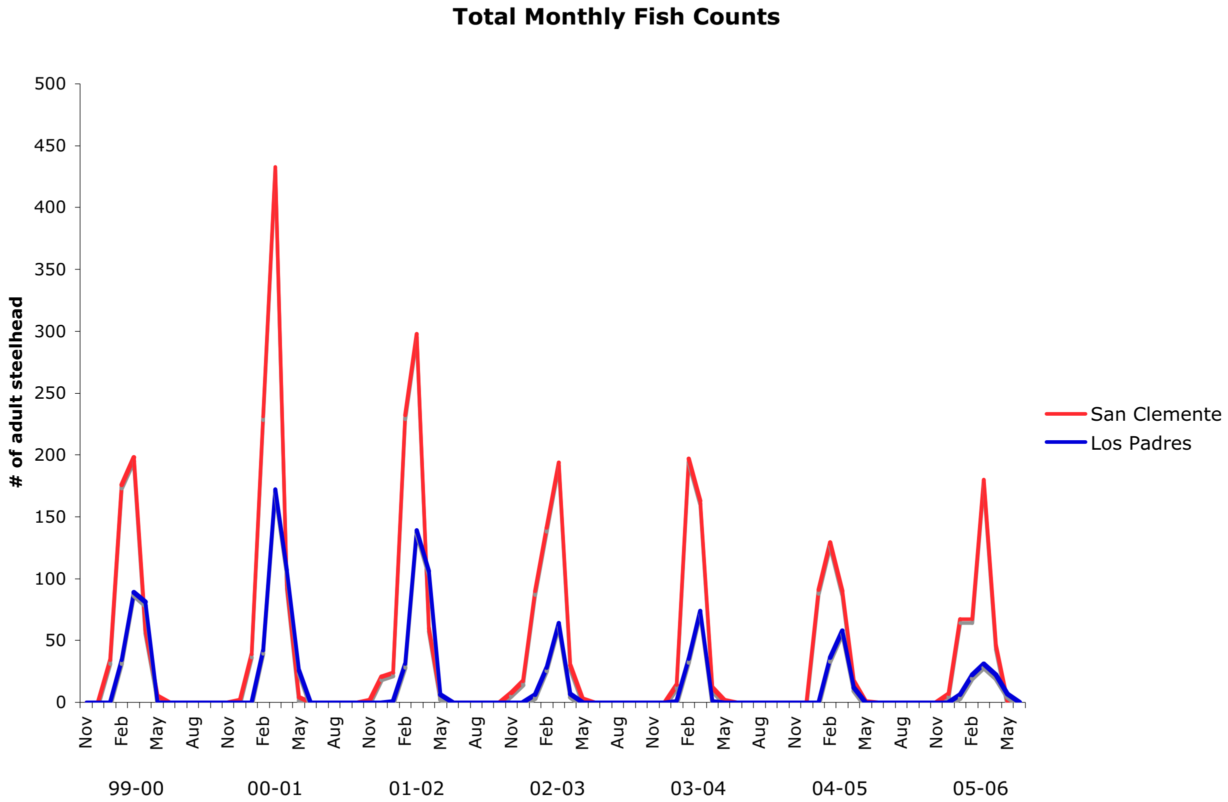


Source: USGS gage 11143200 – Carmel River at Robles Del Rio

figure 3-4
San Clemente Dam Removal

Peak Flow Frequencies During the Months of January Through June, 2000 - 2007

PWA Ref# 1908



Source: MPWMD fish counter database
http://www.mpwmd.dst.ca.us/fishcounter/fishcounter.htm

figure 3-5

San Clemente Dam Removal

Total Monthly Fish Counts at San Clemente and Los Padres Dams, Nov. 1999-May 2006

PWA Ref# 1908

4. GEOMORPHIC BASIS OF DESIGN FOR PROJECT ALTERNATIVES

Chapter 4 lays out the basis of design for the different project alternatives. The alternatives are then assessed relative to the project goals and performance criteria in Chapter 6.

Channel morphology is largely controlled by channel gradient, with flow regime, sediment inputs, valley confinement and the presence or absence of large woody debris exercising a significant secondary influence. When designing a channel the first step is usually to determine the equilibrium gradient and sediment regime, from which the corresponding channel type can be determined and channel and structural element dimensions then calculated (the so-called 'slope first' approach). Final channel dimensions are then tested and, if necessary refined, using a hydraulic simulation model. This is the approach taken in this project.

4.1 EQUILIBRIUM GRADIENT AND CHANNEL MORPHOLOGY

4.1.1 Selection of Equilibrium Gradient

4.1.1.1 Upper and Lower San Clemente Reach (All Alternatives) and the Diversion Reach (Alternative 1)

The channel gradients for Alternative 1 were fixed constraints for this project, based on the previous work carried out by MEI and MWH. The gradient of the Lower San Clemente Reach in both Alternative 1 and 2 (2.52%) is also fixed owing to the pre-dam gradient of the bedrock channel and the narrow nature of the canyon, unless significantly more rock excavation is contemplated. Thus, the Lower San Clemente Reach will be designed to 2.52% for all alternatives. The Upper San Clemente Reach above the diversion channel will be exhumed to the former valley floor (pre-dam gradient of 2.52%. This configuration should be stable since channel morphology, flow and sediment regime will all be in their pre-dam configurations. The Diversion Reach will be constructed to 2.7%.

4.1.1.2 Diversion Reach and Upper Carmel Reach (Alternative 2)

The consultant team scope called for additional alternatives to be considered that are at equilibrium grade where possible, and to be connected to a location in the backwater sediment area where cobble and boulders can be supplied and entrained downstream to sustain the steeper reaches below. Equilibrium slope is the channel gradient at which, over a period of decades or longer, sediment inputs match sediment outputs so that erosion and deposition are balanced. To determine equilibrium grade for the Carmel River in the project reaches we examined the 1921 pre-dam USGS map and for wider context compared it with a long profile constructed from the USGS Digital Terrain Model. The long profile shows the classic concave profile with an average gradient of 1.1% through the San Clemente Dam (Figure 4-1). This number is confirmed by the 1921 topographic data, and is in close agreement with the value of 1% for the channel between San Clemente Dam and Sleepy Hollow cited by MEI (MEI, 2002a). It is possible that sediment supply reductions from Los Padres Dam have caused a reduction in equilibrium grade from this value, which represents historic conditions, but there is no field evidence of extensive channel incision in the 3 miles upstream of the San Clemente Dam, which would indicate adjustment to a flatter channel from the diminished sediment regime. There appears to be sufficient coarse sediment reaching the river from adjacent landslides and from several large tributaries for the historic equilibrium slope to remain valid in the medium to long term. As a result we have selected 1.1% as a representative equilibrium grade for alluvial reaches of the Carmel River. We have selected this value for the Diversion and Upper Carmel River Reaches in Alternative 2, in keeping with the goal of developing a more geomorphically-stable channel. We should note that the sediment in the Upper Carmel Reach close to the Diversion Reach is somewhat finer than historic conditions due to sediment trapping in the reservoir delta area. As a result we expect the Upper Carmel Reach to adjust somewhat by channel incision, until it self armors by creating a coarser gravel layer. This process could be hastened by adding a coarse armor layer during construction.

4.1.2 Selection of Channel Type

The alternatives call for reaches of 2.52% (San Clemente historic channel gradient), 2.7% (Alternative 1 Diversion Reach), and 1.1% (Carmel River equilibrium gradient).

4.1.2.1 Lower San Clemente Reach (Both Alternatives) and Diversion Reach (Alternative 1)

Following the classification scheme of Montgomery-Buffington (Montgomery and Buffington, 1997) channels with gradients between approximately 3-10% tend towards a step-pool form, with channels between 1-3% having plane bed morphology and channels of less than 2% tending towards riffle-pool morphology. However, these distinctions vary with the inputs of water and sediment, and with valley confinement in a specific environment, and where appropriate reference reaches can be found in the watershed under discussion it is generally more appropriate to use these rather than applying a form based on a classification approach. By ‘appropriate’ we mean that the potential reference reaches should have similar flow regimes, available sediment size and load, and be in valley settings with similar degrees of confinement. We conducted a field reconnaissance to look for suitable reference conditions in the Carmel River in the three miles upstream of the San Clemente Dam, and found examples of all three channel types. We found step-pool, plane bed and riffle-pool morphologies in channels with a gradient of approximately 2.5% and with flows that should be within approximately 10% of those found in both the Diversion Reach and Lower San Clemente Reaches (see figures 4-2, 4-3 and 4-4). We conducted a basic thalweg survey of a typical step-pool sequence and a typical riffle-pool sequence to identify channel dimensions. The difference in channel morphology between the three reaches appears to be a function of the size and spatial density of the largest particles, the so-called nucleus boulders, the average particle size, and the valley confinement.

In the step-pool reference reach (located 3 miles upstream of San Clemente Dam) a large landslide has confined the valley while supplying numerous nucleus boulders in the 4-6 foot size range. These have been organized by flow to form a series of steps and pools. A partial control on the formation of a step-pool system in this location appears to be the tabular nature of these nucleus boulders, which permits them to interlock more effectively than rounded boulders. This in turn appears due to the jointing pattern of the source granite and their proximity to the landslide source.

The plane bed reaches appear to have a supply of moderate sized boulders (2-4 feet) that are not as large, tabular or plentiful enough to lock together and form well organized steps, but that have broken up the channel into a series of boulder clusters that provide some fish shelter.

The riffle-pool reaches appear to have formed where there is little supply of large boulders or cobble, and on wider, flatter reaches.

Assuming appropriate sediment supply from either upstream or in-situ, a case could be made for constructing each of the three channel types in these reaches. However, it is important to appreciate that with the exception of the step-pool reach which has formed where a landslide is adjacent to the river, the proposed channel will be significantly more confined than the Carmel River references reaches (minimum valley floor of 30-40 feet in the Lower San Clemente Reach compared with 200 feet in much of the Carmel River valley). The confinement of the Lower San Clemente Reach poses a significant challenge in constructing plane-bed or riffle-pool reaches that will remain stable, especially where the channel will be constructed close to bedrock. High velocities during large flows will tend to entrain the more exposed and smaller particles found in riffle-pool and plane bed channels, scouring the channel down to bedrock. Although San Clemente Creek's channel foundation was at some point naturally formed in bedrock (and subsequently partially backfilled with cobble and alluvium) it is important to remember that the diversion of the Carmel River will add flows to the channel that are an order of magnitude greater than those that formed it, making fish passage challenging. It is the opinion of the authors that a riffle-pool channel is not sustainable in the confined portions of the Lower San Clemente Reach. A plane bed channel is more sustainable than a riffle-pool channel, but as will be seen in the rock sizing exercise, exposed rocks of the size found in the Carmel River are relatively easily mobilized and a new source of material from upstream is required to sustain a plane bed. This material will not be readily resupplied until the Upper Carmel Reach achieves equilibrium.

In terms of fish passage and rearing qualities, and geomorphic stability, the step-pool reaches appear to provide the most desirable characteristics by absorbing a lot of excess shear stress on the immovable boulders, lowering average velocities and providing many fish resting areas. Even if rocks are moved and steps 'fail', rocks in the 4-6 foot range are unlikely to be entrained long distances and thus will likely reform steps downstream. Based on the field assessment and experience on other projects we recommend that the proposed 2.5 – 2.7% channel reaches be constructed as step-pool systems with large, tabular nucleus boulders similar in size to those found upstream. Although it is not our intent to create a plane bed channel, if the step-pools do fail in a large flow event and do not reform or are lost downstream, we might expect a plane bed form to replace them. HTH's field assessment suggests that a plane bed condition would be less desirable than a step-pool system for upstream fish migration because for any given discharge the velocity would be higher, but that though undesirable this would not be a fatal flaw.

The boulders required to form step-pool conditions will not be readily resupplied from upstream; such boulders are generally supplied by landslides close to the channel edge. For the project we propose that boulders are quarried during removal of the rock ridge, and that a supply of similar sized replacement boulders is stacked along the edge of the channel in the form of simulated landslides. These may require a matrix of smaller particles to facilitate mobilization during large flows.

4.1.2.2 Diversion Reach (Alternative 2) and Upper Carmel Reach (Alternative 2)

In Alternative 2 the Diversion Reach is not constrained to the gradient developed in the MWH/MEI Plan, and is designed for the equilibrium gradient of 1.1%. Based on the field reconnaissance and literature, the appropriate channel type at this gradient and in a non-confined setting is a riffle-pool form. This form has the advantage of being sustainable at a 1.1% gradient given the current supply of sediment from upstream.

4.2 CHANNEL DIMENSIONS

Having determined the gradient and channel form for the different reaches we can then calculate stable channel dimensions. We primarily used field reference reach data to develop conceptual channel dimensions, supported by empirical relationships from academic studies of step-pool and riffle-pool morphology. The channel dimensions were then simulated in a hydraulic model to assess hydraulic performance, and where necessary, varied.

4.2.1 Observed Channel Dimensions in the Field

Observed channel bankfull width in the step-pool reference reaches was in the range of 15-48 feet with an average of 25 feet. Pool spacing typically varied from 37 to 63 feet (average of 50 feet) with one pool of only 14 feet (see Figure 4-5). Bankfull depth varied from 1.9 to 4.0 feet, with an average of 2.6 feet. Crest heights were typically 1 foot above the bed. Several studies have shown that step height is controlled by the size of the nucleus boulders (e.g. Curran, 2007), with step height approximating 1.2 times the particle diameter for step-pools in the Santa Monica Mountains (Chin, 1999). In many areas the bankfull channel was found to be flanked by a secondary (and in some cases tertiary) channel that appeared to be active at high flows, and composed of cobbles. Typical secondary channels were 20 feet wide, with a thalweg elevation close to the bankfull height but separated by vegetated banks that were 1-2 feet high. One point of geomorphic interest concerns the bankfull dimensions measured relative to flow recurrence interval. Modeling typical bankfull dimensions from the step-pool reach in a one-dimensional hydraulic model showed the flow associated with bankfull conditions to be much lower than the 1.3 – 5 year flow typically described in other studies. Calculating dimensions that conformed to more typical values produced dimensions much larger than those observed in the field, though the 2-year flood was found to just occupy the step-pool and secondary channel combined. It is important to note that bankfull geometry relationships are typically measured in lower gradient streams with riffle-pool or flatter forms and may not apply to step-pool and cascade systems as consistently. In addition, the step-pool reference reach valley floor was constricted by the presence of the landslide, as will be the case in the constructed reaches. In this project we have placed more confidence in reference conditions where suitable, rather than empirical relationships derived in different stream systems.

The riffle-pool reach measured in the field was somewhat atypical of proposed conditions due to its high gradient (2.5% versus 1.1% for the proposed reach) so we have not used these data to size the riffle-pool reach. Instead we propose using the existing channel dimensions in the upper Carmel River reach as a starting point and allowing the channel to adjust through erosion and deposition of the gravel and sand. Unlike the step-pool reach which is heavily armored and where the initial channel sizing will be hard to adjust, the gravel and sand bed and banks of the riffle-pool reach will be easily adjusted by the river.

4.2.2 Channel Dimensions Used in the Alternatives Analysis

From the basis of design described above we developed conceptual channel dimensions for the hydraulic model and cost estimation. Given the wide variability in observed pool dimensions we adapted some pool dimensions to better meet the fish passage and resting criteria developed with the TRT. For the 2.7% diversion reach and 2.52% San Clemente Creek reach we used a typical channel width of 30 feet at the widest point in the pool, pinching to 20 feet at the crest to force flow expansions and contractions that would dissipate energy. Pools were designed to be approximately 50-60 feet long with steps of 1.5 feet. This provides average gradients between 2.5 and 3.0% and pool length to channel width ratios of approximately 2:1. Many studies have shown that step-pools have a spacing between 1-2 times channel width (Chin, 1999). Chin's work in the Santa Monica Mountains of California (Chin, 1989) found a mean step-pool spacing of 1.9 channel widths, while Whittaker (1987) reported spacings of 2.7 channel widths for streams in New Zealand. Maximum pool depth was set at 4.5 feet for three out of every four pools (to meet the TRT's request for pools to have a depth 1.5 times step height) with every fourth pool slightly oversized to provide better resting characteristics every 200 feet. The resting pools were made deeper by 2 feet and wider by 10 feet to provide more backwater areas. Where space on the valley floor permits we propose constructing a secondary channel to provide a high flow alternative migration path and refugia.

The riffle-pool reach was designed with pool spacings of 200 feet for the conceptual study, though field evidence from the Upper Carmel Reach suggests a slightly wider spacing that may be refined during the design phase (e.g. 300 feet). Riffles were designed with a top width of 50 feet and a depth of 2 feet, while pools were 40 feet wide and 4 feet deep. Through the Diversion Reach the riffle-pool channel will take a slightly sinuous course along the centerline of the excavated notch. Upstream in the Upper Carmel Reach the riffle-pool planform will approximately follow the existing Carmel River with an adjustment made to avoid a very sharp turn into the diversion channel. Note that due to the increase in channel gradient under an equilibrium condition, we anticipate that over time sinuosity may decrease slightly in the Upper Carmel Reach through lateral bank erosion.

4.3 PRELIMINARY ROCK DIMENSIONS

A rock sizing exercise was conducted as part of the performance evaluation (see Section 6.3.2). However, preliminary rock sizing was carried out based on field observations of the largest boulders in the project area. The rocks forming the step-pools typically had a long axis of approximately 6 feet, with secondary axes of around 3-4 feet and tertiary axes of 2-3 feet.

4.4 SUPPLYING COBBLES AND BOULDERS TO THE DIVERSION AND SAN CLEMENTE CREEK REACHES

4.4.1 Identifying a Source of Cobbles and Boulders

The TRT expressed concern that the diversion reach channel in Alternative 1 has its upstream boundary in backwater sediment (sand and gravel) that would not supply sufficient cobbles and boulders to replace those transported out of the diversion or San Clemente Creek reaches[3]. This raises the possibility that 'plugging' particles could be lost from the step-pools, making them too porous and undermining their performance as fish refuges. The consultant team was asked to develop additional alternatives that would reach upstream to a location where coarser sediment in the backwater area indicated that cobbles and boulders could be periodically delivered by the Carmel River. To assess this PWA analyzed the reservoir sediment study carried out by Kleinfelder (2002). This report shows several boreholes and test pits in the Carmel River branch

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[3] The restored San Clemente Creek channel will join the diverted Carmel River at the downstream end of the diversion channel reach. Since San Clemente Creek will be exhumed to its original 2.5% upstream of the confluence, eliminating any flat depositional channel formed in the reservoir backwater, we expect San Clemente Creek to deliver cobble and boulder to the lower San Clemente Creek reach and partially compensate for the flat, depositional reach of the Carmel River upstream. However, given the smaller size of the San Clemente Creek watershed and the potential for a localized flood in the Carmel River but not San Clemente Creek it is not certain that San Clemente Creek will provide sufficient additional coarse particles to the combined river downstream.

of the reservoir between the diversion ridge breach and the upstream limit of backwater effects. PWA examined test pit logs from TP12, 11, 3 and 2 (progressively further upstream). The location of the boreholes and test pits is shown in Figure 4-6 and individual test pit logs are shown in Figures 4-7 to 4-10. TP12 is located close to the upstream location where the Alternative 1 diversion reach meets the backwater deposits of the Carmel branch, and at the near-surface is composed of poorly graded sand with gravel and traces of cobbles up to 8 inches in diameter (Kleinfelder, 2002). This alignment does not meet the geomorphic criteria requested by the TRT in terms of cobble and boulder availability. Projecting a 1.1% channel upstream from the same 'hinge point' at the boundary of the San Clemente Creek and diversion reaches produces an alignment that 'daylights' against the existing Carmel River thalweg approximately 1,000 feet upstream of the bedrock ridge, close to TP11. The near-surface sediment here is defined as sandy gravel with 10% sub angular to sub rounded cobbles and boulders (Kleinfelder, 2002), better meeting the TRT's criteria for channel stability. **On the basis of eliminating the steepest gradients in the diversion reach (lowered from 2.7% to 1.1%) and reaching a more abundant cobble and boulder supply this alignment was adopted as Alternative 2.**

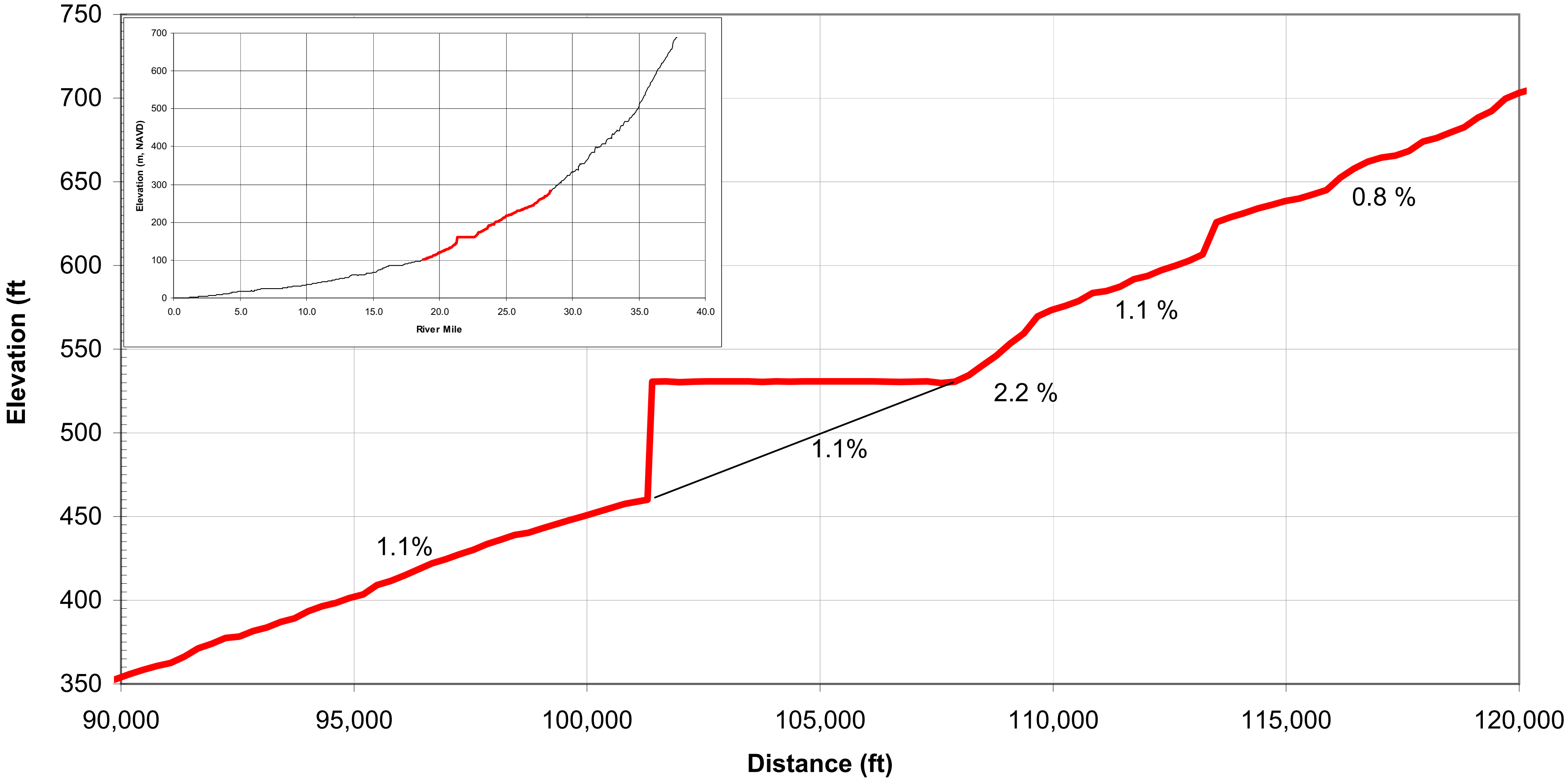
4.4.2 Transporting Cobbles and Boulders to the Diversion and San Clemente River Reaches

To ensure that the proposed channel could transport the cobbles and boulders encountered in Alternative 2 PWA performed an entrainment analysis (included as Appendix 1 to this report.) The results are summarized in Table 4-1.

Table 4-1. Slope and Water Depth Required to Entrain Particles of Different Sizes

Boulder Size, inch	Slope required for Q2	Water depth or required bankfull depth for Q2 (ft)	Slope required for Q5	Water depth or required bankfull depth for Q5 (ft)
6	0.5%	5.3	0.3%	10.2
12	1.2%	4.2	0.6%	8.5
18	2.1%	3.6	1.0%	7.5
24	3.0%	3.3	1.5%	6.7
30	4.1%	3.1	2.0%	6.2

The results show that the proposed 1.1% diversion and upper Carmel River reaches in Alternative 2 will readily transport material on the cobble/boulder boundary (8 inches diameter) during the 2-year flow. Boulders 18 inches in diameter will be entrained during the 5-year flow.



Source: USGS National Elevation Dataset - 10 m DEM
Note: River Mileage on profile derived from USGS DTM does not conform to mileages used by MPWMD and is included for relative scale only.

figure 4-1
San Clemente Dam Removal

DTM-Derived Profile of Carmel River Through San Clemente Dam

PWA Ref# 1908

PWA

ChannelProfile1.xls / ProfilePlot (ft) (Fig4-1)

a) Step-pool sequence
b) Detail of step and nucleus boulder
c) Landslide source of large boulders

figure 4-2
San Clemente Dam Removal

Step-Pool Reference Reach at River Mile 23.6

PWA Ref# 1908

PWA

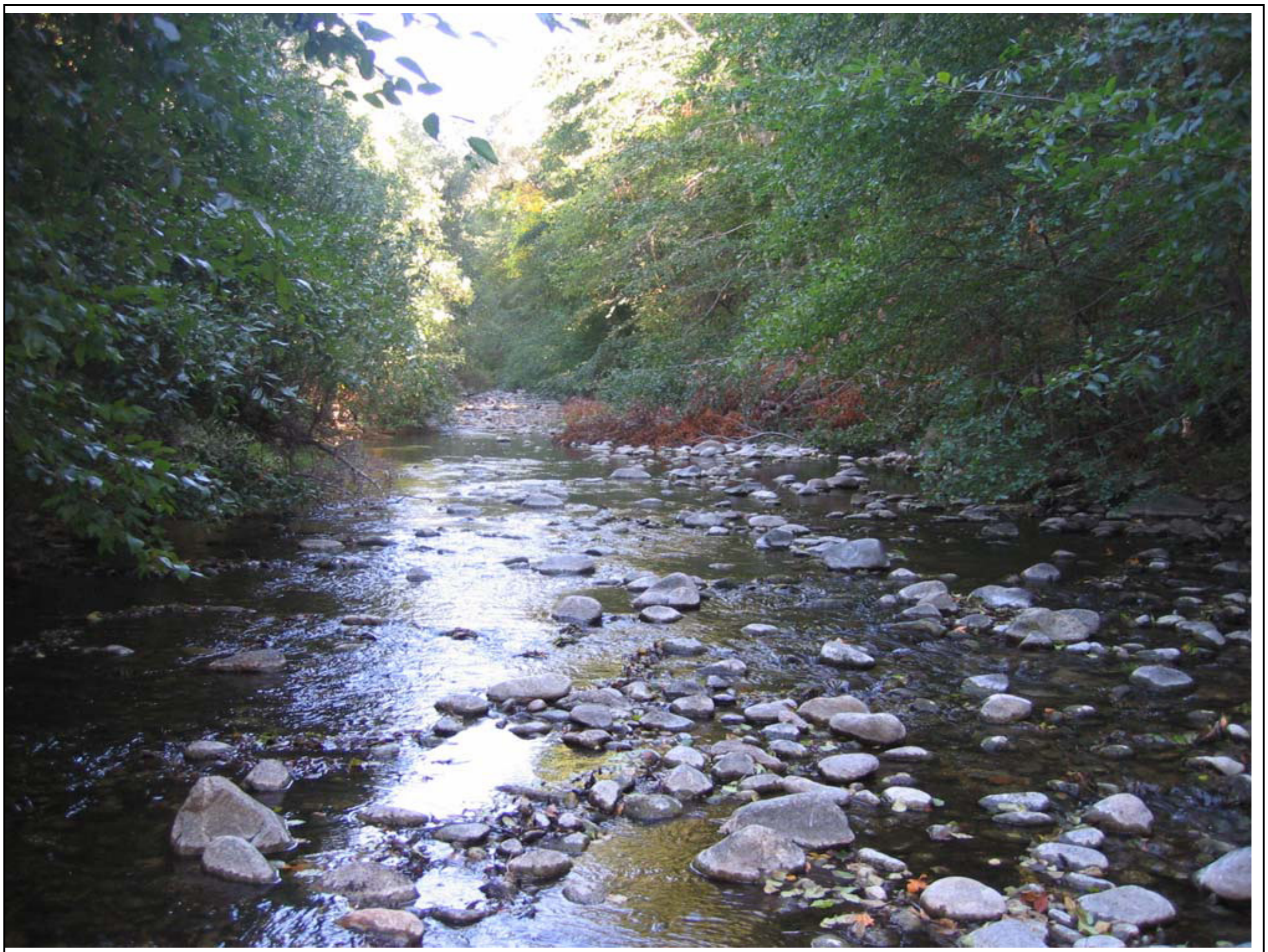


figure *4-3*

San Clemente Dam Removal

Plane Bed Reference Reach at Approximately River Mile 23

PWA Ref# 1908

PWA

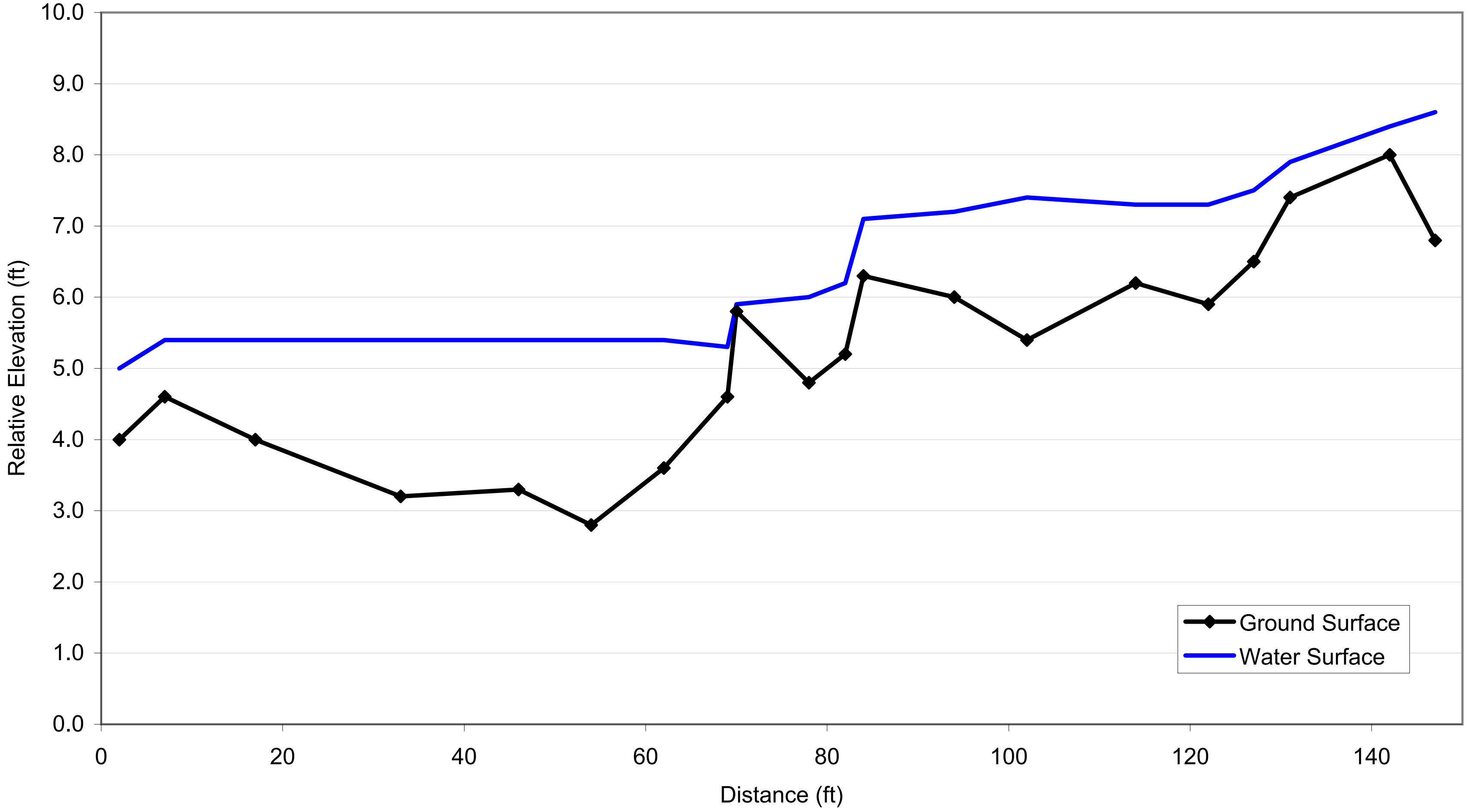
figure 4-4

San Clemente Dam Removal

Riffle-Pool Reference Reaches on the Carmel River Upstream of San Clemente Dam

PWA Ref# 1908

PWA



Notes: Data from PWA field survey of Carmel River upstream of San Clemente Dam. Elevations are based on arbitrary datum.

figure 4-5

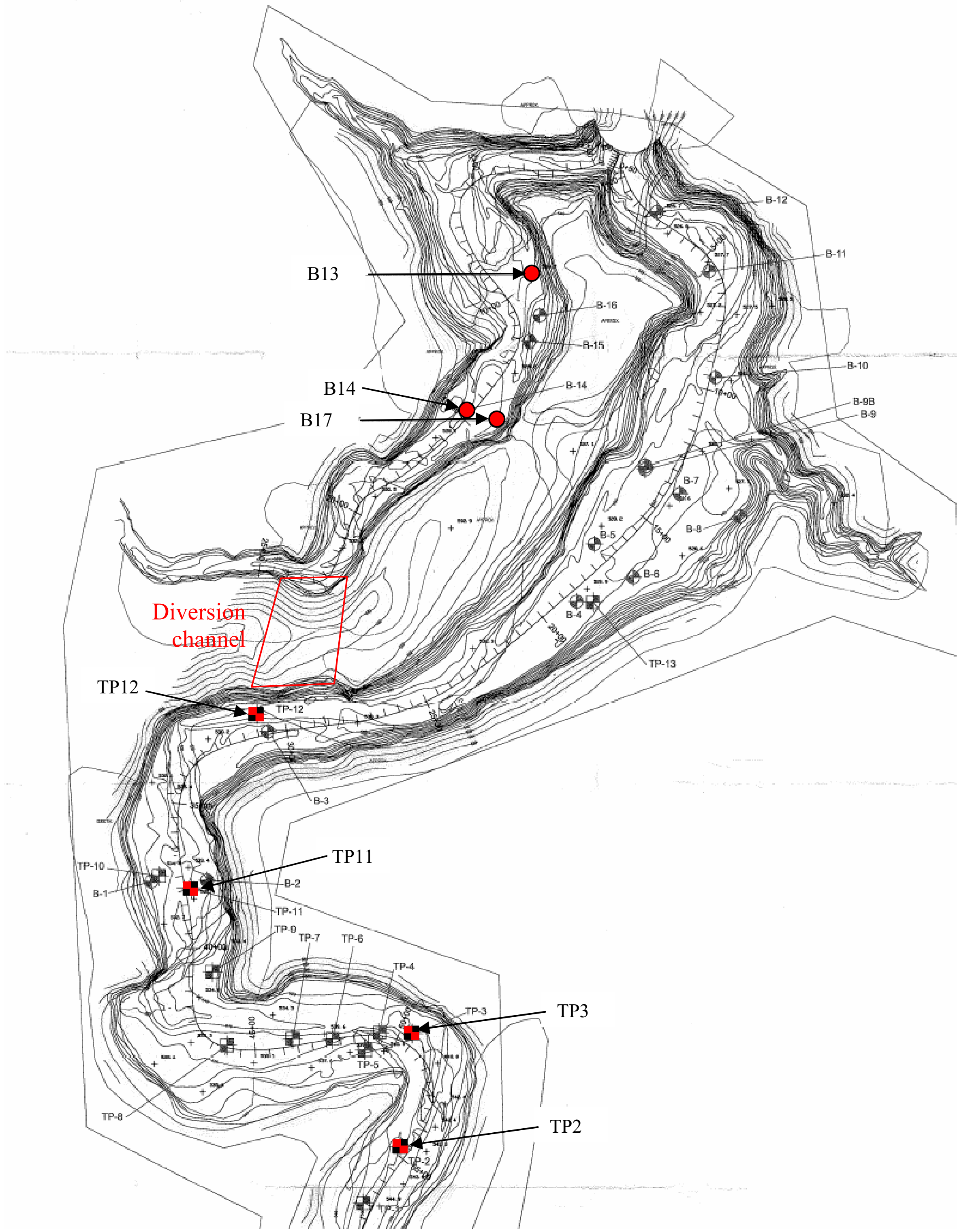
San Clemente Dam Removal

Channel Profile of Reference Step-Pool Reach in Carmel River

PWA Ref# 1908

PWA

Figure_4-5-SurveyStepPool.xls / FIG- US pool



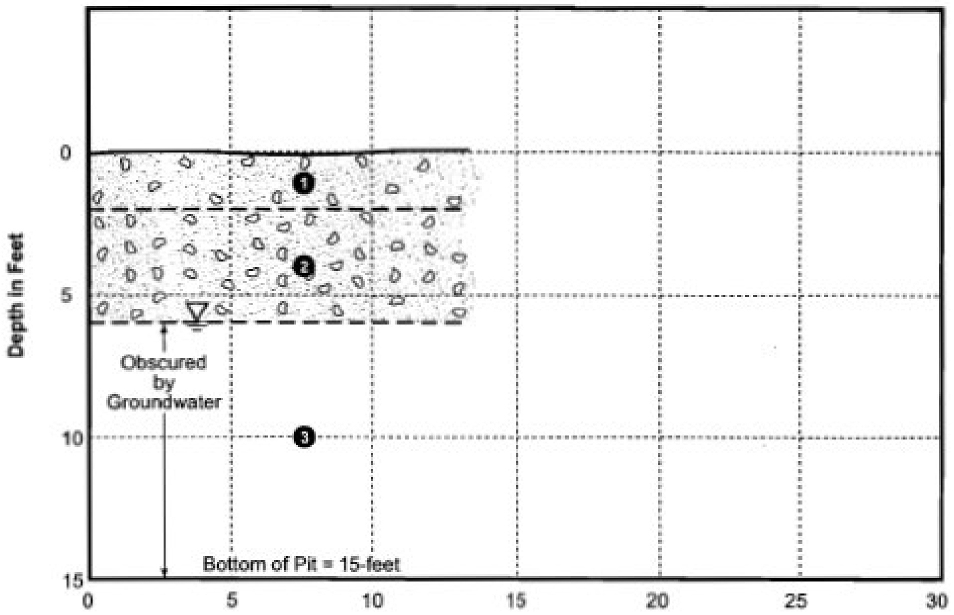
Source: Adapted from Kleinfelder, 2002

figure 4-6
San Clemente Dam Removal

Location of Boreholes and Test Pits

PWA Ref# 1908

PWA



DEPTH	UNIT NO.	MATERIAL DESCRIPTION
0-2'	❶	**Poorly Graded SAND with gravel and trace cobbles and boulders:** Light brown, moist, loose, 75% fine to coarse subangular sand, 25% fine to coarse subrounded gravel, trace subrounded cobbles and boulders to 8-inches
2'-6'	❷	**Poorly Graded Gravelly SAND**: Gray, moist, loose, 75% fine to coarse sand, about 25% fine to coarse subangular to subrounded gravel, cross bedded
6'		**Groundwater**
6'-10'	❸	**SAND with gravel and trace organic silt**: Light brown and gray, wet, loose, 85% fine to coarse grained sand, 15% subrounded to rounded gravel to 1.5-inches

Logged by: Pete Holland

KLEINFELDER

Drawn By: D. Shelhart
Project No. 18923-1

Date: 9-23-2002
Filename: 2721m.fh10

LOG OF TEST PIT TP-12
SAN CLEMENTE RESERVOIR
MONTEREY COUNTY, CALIFORNIA

PLATE
A-13

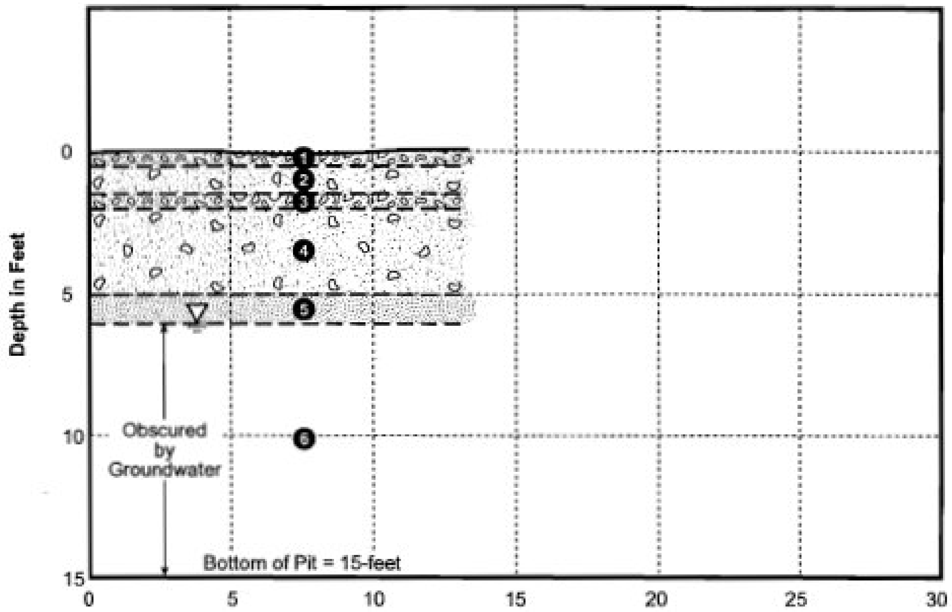
Source: Kleinfelder, 2002

figure 4-7
San Clemente Dam Removal

Log for Test Pit 12

PWA Ref# 1908

PWA



DEPTH	UNIT NO.	MATERIAL DESCRIPTION
0-0.5'	①	**Poorly Graded Sandy GRAVEL:** Light brown, moist, loose, 60% fine to coarse subangular gravel, 30% fine to coarse sand, 10% subangular to subrounded cobbles and boulders
0.5'-1.5'	②	**Poorly Graded SAND with some gravel:** Light brown, moist, loose, 90% fine to coarse sand, about 10% fine to coarse gravel, trace cobbles
1.5'-2'	③	**Poorly Graded Sandy GRAVEL with some cobbles and boulders:** Light brown, moist, loose, 60% fine to coarse subangular gravel, 30% fine to coarse sand, 10% subangular to subrounded cobbles and boulders
2'-5'	④	**Poorly Graded SAND with some gravels:** 90% fine to coarse sand, about 10% subrounded to rounded gravel, trace cobbles
5'-6'	⑤	**Clayey SAND:** Light gray, moist to wet, loose, 60% fine to coarse grained sand, 40% subrounded to rounded gravel, trace rounded cobbles
6'		**Groundwater**
6'-15'	⑥	**Gravelly SAND with some cobbles:** Light brown, wet, loose, 55% fine to coarse grained sand, 40% subrounded to rounded gravel, 5% subrounded cobbles

Logged by: Pete Holland

KLEINFELDER

Drawn By: D. Shelhart
Project No. 18923-1

Date: 9-23-2002
Filename: 2721I.fh10

LOG OF TEST PIT TP-11
SAN CLEMENTE RESERVOIR
MONTEREY COUNTY, CALIFORNIA

PLATE
A-12

Source: Kleinfelder, 2002

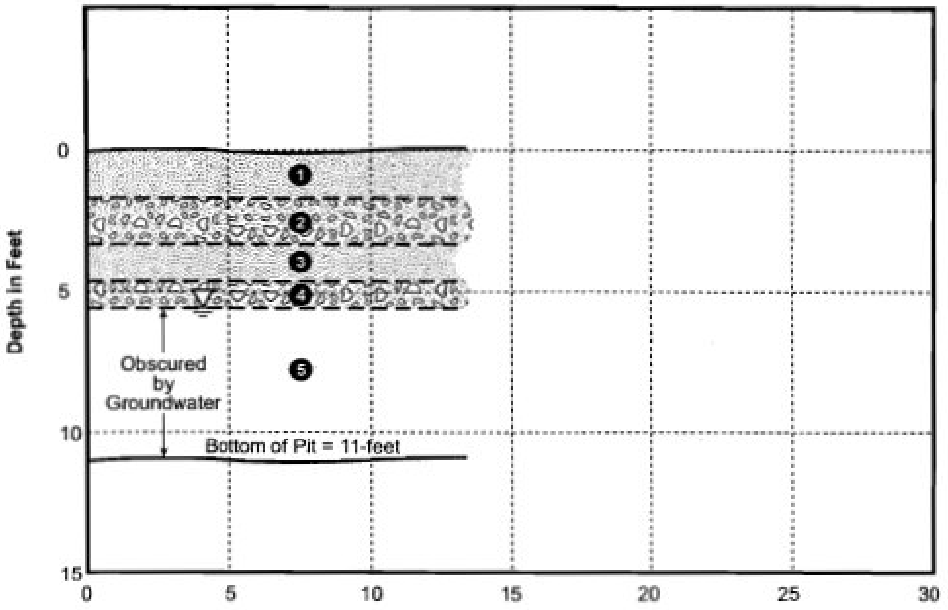
figure 4-8
San Clemente Dam Removal

Log for Test Pit 11

PWA Ref# 1908

PWA

Surface Conditions: Sand



DEPTH	UNIT NO.	MATERIAL DESCRIPTION
0-1'	①	**SAND with gravel:** Light brown, moist, fine to coarse sand, fine to coarse rounded gravel to 3-inches
1'-2.5'	②	**COBBLES with sand and gravel:** Light brown, moist, fine to coarse sand, subrounded to rounded gravels and cobbles
2.5'-5'	③	**SAND with gravel:** Light brown, moist, fine to coarse sand, fine to coarse rounded gravel
5'-6'	④	**COBBLES and GRAVELS with sand:** Light brown, moist, 25% fine to coarse sand, 75% subrounded to rounded gravel, cobbles and boulders to 30-inches
6'		**Groundwater**
6'-11'	⑤	**GRAVEL with cobbles, boulders, and sand:** Light brown, wet loose, 35% fine to coarse grained sand, 55% gravels, 10% cobbles and boulders, subrounded to rounded

Logged by: Michael Clark

KLEINFELDER

Drawn By: D. Shelhart
Project No. 18923-1

Date: 9-20-2002
Filename: 2721d.fh10

LOG OF TEST PIT TP-3
SAN CLEMENTE RESERVOIR
MONTEREY COUNTY, CALIFORNIA

PLATE
A-6

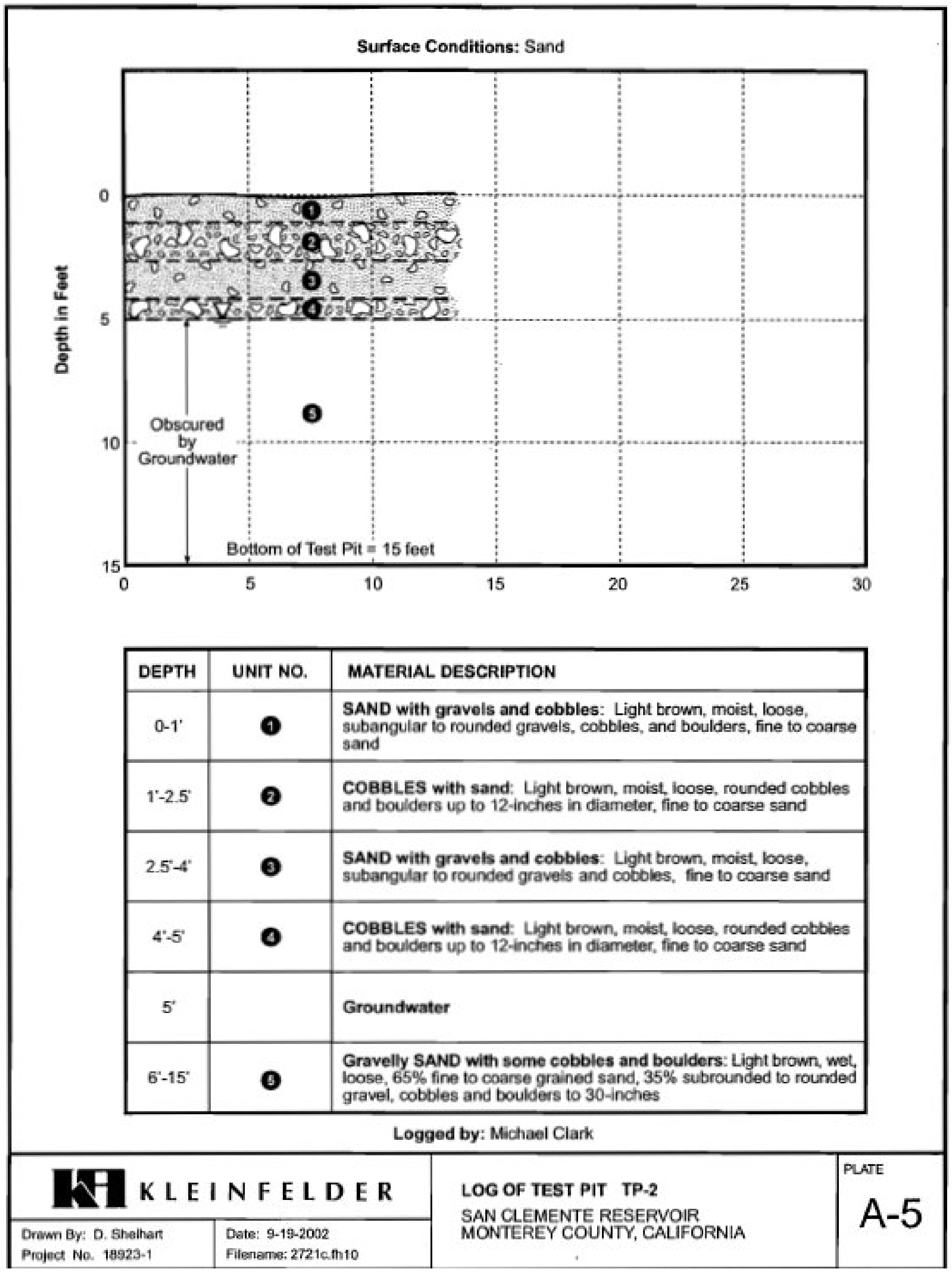
Source: Kleinfelder, 2002

figure 4-9
San Clemente Dam Removal

Log for Test Pit 3

PWA Ref# 1908

PWA



DEPTH	UNIT NO.	MATERIAL DESCRIPTION
0-1'	❶	**SAND with gravels and cobbles:** Light brown, moist, loose, subangular to rounded gravels, cobbles, and boulders, fine to coarse sand
1'-2.5'	❷	**COBBLES with sand:** Light brown, moist, loose, rounded cobbles and boulders up to 12-inches in diameter, fine to coarse sand
2.5'-4'	❸	**SAND with gravels and cobbles:** Light brown, moist, loose, subangular to rounded gravels and cobbles, fine to coarse sand
4'-5'	❹	**COBBLES with sand:** Light brown, moist, loose, rounded cobbles and boulders up to 12-inches in diameter, fine to coarse sand
5'		**Groundwater**
6'-15'	❺	**Gravelly SAND with some cobbles and boulders:** Light brown, wet, loose, 65% fine to coarse grained sand, 35% subrounded to rounded gravel, cobbles and boulders to 30-inches

Logged by: Michael Clark

KLEINFELDER

Drawn By: D. Shelhart
Project No. 18923-1

Date: 9-19-2002
Filename: 2721c.fh10

LOG OF TEST PIT TP-2
SAN CLEMENTE RESERVOIR
MONTEREY COUNTY, CALIFORNIA

PLATE
A-5

Source: Kleinfelder, 2002

figure 4-10
San Clemente Dam Removal

Log for Test Pit 2

PWA Ref# 1908

PWA

5. PROPOSED PROJECT ALTERNATIVES

5.1 PHYSICAL PROJECT ALTERNATIVES

Based on the goals and objectives developed at the TRT Kickoff Meeting and the sediment assessment described above, the consultant team refined two physical project alternatives. The planform, long profile, cross sections and typical details are shown in Figures 5-1 to 5-5 and described below. The revegetation approach is almost identical for both alternatives and is described in Section 5.5.

Alternative 1 is a refinement of the alternative developed by MWH and MEI. The reaches are described from downstream to upstream.

Lower San Clemente Reach. Between the San Clemente Dam and the contact between the San Clemente Creek channel thalweg and the bedrock ridge (approximately 2,200 feet) the valley and channel will be exhumed down to bedrock, with an approximate gradient of 2.52%. Nucleus boulders (approximately 6 feet in the long axis) will be used to form step-pools with a pool length of approximately 60 feet and a step height of approximately 1.5 feet. Steps will be placed on bedrock, with a layer of alluvial material replaced. Where velocities are too high for nucleus rocks to remain stable bedrock will be excavated to form steps. Smaller boulders and cobbles will be used to fill gaps in the steps and create diverse secondary pathways, while gravel and sand will form the substrate. On San Clemente Creek upstream of the confluence with the diversion reach the valley will be exhumed to the alluvial contact (believed to be 2-3 feet above bedrock).

Upper San Clemente Reach. The San Clemente Creek valley upstream of the confluence with the Diversion Reach will be excavated to the pre-dam alluvial layer and restored in-situ.

Diversion Reach. The bedrock ridge will be excavated to an elevation of approximately 520 feet on the downstream side and 530 feet on the upstream side, so that it ties in with the excavated bedrock channel of San Clemente Creek and the thalweg of the Carmel River. The diversion will have a length of 450 feet, a downstream width of 150 feet and an upstream width of 215 feet. The side slopes will be graded at 1:1. The channel will have a gradient of 2.7% assuming the 1 foot sill proposed in the MEI report is excluded. Large boulders or bedrock protuberances will be used to construct a step-pool channel in 2-3 feet of imported alluvial material, as per the San Clemente Creek reach.

Upper Carmel Reach. No action will be taken on the Carmel Reach upstream of the Diversion Reach. The diversion dike will be shaped to direct the Carmel River into the Diversion Reach.

Ranney Collector. The Ranney Collector used to replace the existing flow diversion structure will be located upstream of the diversion reach per the MWH report (MWH, 2006).

Diversion Dike. A diversion dike will be constructed per the MWH report (MWH, 2006) to keep the Carmel River from overtopping the diversion channel and flowing over its former course and the sediment stockpile. The dike will be sized to prevent the PMF from overtopping. The dike will have an impermeable cutoff wall that extends to bedrock (approximately 40 feet) to prevent dewatering of the Upper Carmel Reach.

Alternative 2. Alternative 2 was developed by the PWA team to eliminate the steepest reach (a potential fish migration barrier) and to extend the diversion channel upstream closer to areas where cobble and boulders are delivered across the depositional upper Carmel backwater area. The reaches are described from downstream to upstream.

Lower San Clemente Reach. This reach will be the same as for Alternative 1.

Upper San Clemente Reach. This reach will be the same as for Alternative 1.

Diversion Reach. The diversion reach will have the same downstream location and elevation as Alternative 1, starting at the contact between the rock ridge and the bedrock channel thalweg of San Clemente Creek. However, it will be graded at the average Carmel River gradient of 1.1% rather than at 2.7% as in Alternative 1, requiring some additional bedrock excavation. The channel will be a riffle-pool morphology constructed in 2-3 feet of backfill placed over the bedrock channel, with some nucleus boulders or bedrock protuberances to both provide fish shelter and increase sediment retention during high flows. It will exit the bedrock ridge and enter backwater sediment deposits approximately 8 feet below existing grade.

Carmel River Reach. From the point at which the diversion channel emerges from the ridge upstream into the backwater reservoir deposits of the Carmel River branch it will continue upstream at a gradient of 1.1% until it intersects the existing thalweg of the Carmel River approximately 1,000 feet upstream of the diversion reach. The channel will be a riffle-pool morphology.

Ranney Collector. The Ranney Collector used to replace the existing flow diversion structure will be located upstream of the Carmel River Reach, approximately 440 feet upstream of the location proposed in the MWH report (MWH, 2006).

Diversion Dike. A diversion dike will be constructed per the MWH report (MWH, 2006) to keep the Carmel River from overtopping the diversion channel and flowing over its former course and the sediment stockpile. The dike will be sized to prevent the PMF from overtopping. The dike will have an impermeable cutoff wall that extends to bedrock (approximately 40 feet) to prevent dewatering of the Upper Carmel Reach.

5.2 POTENTIAL PROJECT ALTERNATIVES CONSIDERED AND REJECTED

PWA assessed several additional potential alternatives to determine if it was feasible to extend a diversion channel further upstream than Alternative 2, to both increase the supply of cobbles/boulders and to reduce the time to reach equilibrium. Extending a channel further upstream requires either a lower gradient from the same starting 'hinge point' at the San Clemente Creek reach upstream limit, or deepening the bedrock cut of the diversion channel. Reducing the gradient would create an aggradational channel that filled in until it reached equilibrium gradient, increasing the time taken to reach equilibrium compared with both alternatives and ultimately resembling Alternative 2. Deepening the cut requires not just increasing the depth and therefore width of the bedrock excavation in the diversion channel but extending the length of bedrock excavation both down and up the San Clemente Creek reach either side of the confluence with the diversion reach. In addition to the increased excavation cost, extending excavation into the San Clemente Valley potentially undercuts the canyon side walls and would require a geotechnical assessment that is beyond the scope of this project. Lowering the confluence would also steepen the San Clemente Creek channel upstream, requiring additional measures to maintain fish passage. The TRT and Conservancy determined that at this point it is not practical or economic to develop such an alternative.

5.3 PROPOSED PROJECT SUB-ALTERNATIVES

Within Alternatives 1 and 2 there are several potential sub-alternatives for the channel upstream of the diversion reach, and these were analyzed further in lieu of a third project alternative.

1. Alternatives 1 & 2. Placing sediment excavated from the San Clemente branch of the reservoir in the Carmel branch upstream of the diversion channel inlet rather than downstream.

   This sub-alternative would use the sediment from the San Clemente branch to jump start the aggradation process that will eventually bring the Carmel River into equilibrium through the former backwater area. This action would reduce the time taken to bring the project to equilibrium, hastening sediment continuity downstream to the project reach and beyond.

Alternative 2 requires the Carmel River reach to be lowered by 8 feet at the inlet of the diversion reach. This can be achieved several ways:

2. Lowering the diversion channel inlet by 8 feet and allowing the Carmel River to erode a new channel by headcutting up the existing Carmel River until it reaches equilibrium grade. This would generate sediment to line the step-pools downstream and would remove the need for equipment in the 1,000 feet of channel upstream. It would also lower construction costs. The initial channel would be incised, but due to the ease with which

the sediment (gravelly sand) can be mobilized by frequently occurring flows it would rapidly widen and form a stable channel. The process of incision and widening would generate additional sediment for transport downstream.

3. Lowering the existing Carmel River course by 8 feet at the diversion inlet and grading the channel out to the anticipated final dimensions. This would involve removing sediment to create an inset floodplain bench on one side while preserving the riparian cover on the other side.

4. An interim option between 2 and 3 involving lowering the Carmel River course by 8 feet at the diversion inlet and grading the channel out at 2%, allowing some sediment to erode downstream to 'prime' the step-pools with some fine plugging sediment.

The TRT discussed several options for adding cobbles, boulders and spawning gravel to the Carmel River to improve the function of the step-pools and to provide spawning gravel for reaches downstream of the San Clemente Dam.

5. Stockpiling cobbles and boulders in riffles and in cones alongside the Upper Carmel Reach for passive entrainment. Suitable sized material found during the excavation of the San Clemente Creek reaches could be stored in the bed and banks of the upper Carmel River reach so that during high flow events some would be entrained and transported downstream.

6. Stockpiling spawning gravel in GeoTubes or other sediment cells alongside the upper Carmel River Reach for metered release. Sediment could be released by opening cells up when permittable downstream.

5.4 DESIGN OF STEP-POOLS

The step-pools are critical to the long term stability of the project, and the final design of the steps will be an important phase of the overall project. We attach the following guidance for step-pool design.

The steps should be designed using nucleus boulders that are set on bedrock or large foundation rocks that can resist scour, so that they do not roll into scour pools that form after construction. Nucleus boulders should be carefully placed and interlocked so that there are as many points of contact as possible between rocks. The upstream face of the nucleus boulders should be partially buried to reduce the force acting on them and increase rock stability. The steps should form an upstream facing arc to distribute stresses and cause the rocks to be forced together during high flows. It is important to create irregularities and heterogeneity within the steps, since this will create different preferential flow and fish migration paths at different flow rates. These heterogeneities can include wedging smaller boulders amongst larger ones to break up steps, creating cracks and paths of different sizes, placing large shelter rocks within pools etc.

5.5 RESTORATION AND REVEGETATION PLAN

5.5.1 Riparian Restoration Design Elements Common to All Reaches

There are several habitat restoration design elements that are common to each of the proposed restoration reaches. These common elements are discussed below. Figures 5-6, 5-7 and 5-8 provide typical cross-sections within the 3 restoration reaches.

5.5.1.1 Soils

To the extent feasible, existing topsoil within that grading footprint should be salvaged and re-spread across riparian restoration areas. In general, the more soil that can be retained, the increased likelihood for riparian vegetation to establish and persist. In addition, riparian forest productivity will be directly tied to the volume of soil present.

Retention of these soils in the first several years after construction will be a key issue that needs to be carefully considered as the design process moves forward since a substantial portion of these soils could be lost if large flood events occur prior to significant vegetation establishment. Although potentially costly, use of erosion control blankets, placement of partially buried logs and strategic positioning of boulders to aid in the retention of soils early in the process should be considered.

At this time importing soils is not considered necessary to successful riparian vegetation establishment, and it would also be extremely costly. Additional soils discussions are provided for the San Clemente Reach in Section 5.5.2 and the Diversion Reach in Section 5.5.3.2. Since placement of soil is not planned for the Upper Carmel Reach and 3 feet of alluvium will be spread on the Diversion Reach, the soils work as described above would occur along the San Clemente Reaches.

5.5.1.2 Willow and Alder Plant Material

Site grading will remove many willow and alder trees that can be salvaged as live planting material (cuttings, sapling transplants), live root wads, or woody debris. These can all be used extensively in the riparian restoration design. Live trees and live root wads, if harvested properly and temporarily held in appropriate wetted locations, can be installed in strategic locations where standard planting methods are cost prohibitive or ineffective. These plant materials if harvested, stored and installed properly can establish new riparian habitat relatively rapidly. Given the gravel and cobble substrate expected along much of the new channel, it will likely be necessary to rely on large live plant material and natural recruitment to re-establish streamside vegetation.

Thus the active revegetation effort may primarily rely on large (8-24 inches diameter at breast height) willow and alder trees that are harvested with the main root wad and 6-8 feet of trunk intact.

5.5.1.3 Diversion Channel Excavation Materials (woody material, soil, seedbank)

The land within the footprint of the proposed diversion channel has a variety of materials that could be utilized in the restoration effort. The numerous large trees can be harvested and re-used in the channel restoration design, as stabilizing elements and also as core habitat for aquatic organisms (steelhead, California red-legged frog, etc.). The existing woodland and scrub habitat also provides a source of topsoil and a seedbank to be salvaged and re-used in the restoration areas. These soils likely contain a substantial viable seedbank of scrub species. If these soils can be harvested in a cost-effective manner, they could serve as the primary means to establish similar habitat along the slopes of the newly excavated diversion channel. Use of these soils to create appropriate conditions to establish coastal scrub habitat is discussed in additional detail in Section 5.5.3.

5.5.1.4 Control of Non-native Species

Implementation of the proposed restoration will create a highly disturbed landscape that will be susceptible to invasion by non-native invasive plants. As a result, the habitat restoration planning for the site should include a program to eradicate non-native invasive plant species during the first 3-5 years following restoration to allow the restored vegetation to establish and better compete with the invasive species.

5.5.1.5 Herbaceous Vegetation and Erosion Control

Establishment of herbaceous vegetation will be important early in the restoration process to control erosion. Table 5-1 provides herbaceous species that can hydroseeded in both upland and riparian habitat areas, except where soils are so mineral or coarse that seeding will be ineffective. This seeding would occur in the San Clemente Reaches where new soils with a potentially higher percentage of fines may be placed.

Table 5-1. Herbaceous Vegetation Species to be Seeded on Site

Common Name	Scientific Name
California brome	*Bromus carinatus*
California oatgrass	*Danthonia californica*
blue wild rye	*Elymus glaucus*
slender wheat grass	*Elymus trachycaulus*
meadow barley	*Hordeum brachyantherum*
June grass	*Koeleria macrantha*
creeping wildrye	*Leymus triticoides*
Purple Needlegrass	*Nassella pulchra*
three week fescue	*Vulpia microstachys*

5.5.1.6 Optional Active Habitat Restoration

In the event that additional resources are available for habitat restoration purposes and more rapid establishment of riparian habitat is desired, more intensive habitat restoration actions can be implemented. These would include more intensive planting accompanied by weed control, browse protection, dead plant replacement and potentially supplemental irrigation. This approach, if adopted, would primarily be applied to the Diversion and San Clemente Reaches as the predicted dynamic and depositional nature of the Carmel River Reach would likely wash away and/or bury much of the optional active planting actions. However, we consider it likely that natural recruitment and selective revegetation as described above will be successful, and conversely that the additional planting efforts described below may be severely compromised by coarse soil and flooding.

5.5.1.6.1 Optional Planting Plan

A planting plan for the San Clemente and Diversion Reaches of the project would include planting woody riparian species at a density of approximately 400-500 plants per acre. All propagules used for restoration would be of local (Monterey County) origin. Thus, a contract with a native plant nursery to custom collect and grow the plants a minimum of one year in advance of the planting would be required.

The plants would be established in groups of 3-5 by species to mimic the typical natural distribution of riparian vegetation. Table 5-2 provides the species, on-center spacing and container sizes proposed for each plant association.

Table 5-2. Optional Planting Plan

Planting Association	Common Name	Scientific Name	On-Center Spacing (Feet)	Container Size
White Alder Riparian Forest	white alder*	*Alnus rhombifolia**	12	Treepot
	red willow	*Salix laevigata*	16	Treepot or cutting
	shining willow	*Salix lucida*	12	Treepot or cutting
	arroyo willow	*Salix lasiolepis*	12	Treepot or cutting
	mugwort	*Artemisia douglasiana*	8	Tree band
	California blackberry	Rubus ursinus	8	Treeband
Mixed Riparian Forest	black cottonwood*	*Populus balsamifera* ssp. *trichocarpa**	25	acorn or treepot
	California sycamore*	*Platanus racemosa**	20	Treepot
	white alder	*Alnus rhombifolia*	12	Treepot
	red willow	*Salix laevigata*	16	Treepot or cutting
	shining willow	*Salix lucida*	12	Treepot or cutting
	arroyo willow	*Salix lasiolepis*	12	Treepot or cutting
	coast live oak	*Quercus agrifolia*	16	Acorn or Treepot
	valley oak	*Quercus lobata*	16	Acorn or Treepot
	California buckeye	*Aesculus californica*	12	Seed or Treepot
	big leaf maple	*Acer macrophyllum*	14	Treepot
	mugwort	*Artemisia douglasiana*	8	Tree band
	California blackberry	*Rubus ursinus*	8	Treeband

*Dominant species in plant association

5.5.1.6.2 Weed Control

Weeds around individual plants would be controlled in these active floodplain areas with use of weed mats or rice straw both of which tend to stay in place better in areas subject to flooding than wood chip mulch. In addition, weeds throughout the planting areas would be controlled through a 3-year maintenance period.

5.5.1.6.3 Plant Protection

Foliage protection cages would be installed over all woody species subject to browse (most species proposed). Foliage protection cages would be installed flush to the ground, be approximately 4 feet high and 3 feet in diameter and supported by rebar or t-posts. The protective cages will be installed immediately following planting. Tree shelters could serve as optional foliage protection devices for valley and coast live oak plantings. The tree shelters would both reduce browsing pressure and increase soil moisture in the vicinity of the oak plantings. Tree shelters should be 4.25 inches in diameter, 4 feet long and anchored with 5.5-foot wooden or metal posts. Because these foliage protection devices would likely be damaged with periodic floods, the benefits associated with their installation would need to be balanced with the risk of them being damaged.

5.5.1.6.4 Irrigation

Irrigation of the installed plants would substantially increase the plants' growth and survival. However, if a temporary irrigation system were installed it would likely be substantially damaged by winter floods. Thus, the potential benefits of establishing an irrigation system would have to be carefully weighed against the potential losses that would occur with floods. As an option, less frequent irrigation during the initial plant establishment period via water truck and/or pumping from the river could be implemented to increase survival and growth without the risk associated with loosing an irrigation system to floods. Irrigation of riparian plantings typically occurs during the dry season of a 3 year maintenance period.

5.5.1.6.5 Dead Plant Replacement

Dead plants would be replaced each year during the 3 year maintenance period. The species chosen for installation would be based upon an analysis of what is successfully growing in similar environments on the project site.

5.5.1.6.6 Maintenance Schedule

Typically, revegetation sites are maintained for a minimum of 3 years. Thus, weed control, foliage protection cages and potentially irrigation would be implemented over a 3-5 year time period.

5.5.2 Riparian Restoration Design Elements Specific to the San Clemente Reaches

5.5.2.1 San Clemente Reach Soils

The restoration plan for the San Clemente Reaches calls for the removal of the accumulated sediment down to the pre-dam topography. Because these soils have been subject to anaerobic conditions for more than 80 years they may not be appropriate for use in plant establishment. However, if some or all of the soils could be used it could provide a potentially substantial cost saving for the project. Thus, it is recommend that these soils be tested to determine if they are potentially suitable, could be made suitable with amendments or mixed with new soils to create suitable conditions. It may also be necessary to remove them from the project site if their toxicity is found to be acute.

5.5.2.2 Proposed Step-Pools

Due to the relatively steep channel gradient, the proposed channel calls for the creation of 4-foot deep pools in the San Clemente Creek Reach. These deep pools will provide potential high quality foraging and breeding habitat for California red-legged frog as well as providing refugia from predators for this species. To assist in channel stabilization and maximize the habitat values of these pools for salmonids and California red-legged frog, the channel design should incorporate substantial coarse woody debris to increase the habitat complexity of the pools.

5.5.3 Restoration Design Elements Specific to Diversion Reach

5.5.3.1 Proposed Step-Pools

Due to the relatively steep channel gradient, the proposed channel calls for the creation of 4-foot deep pools in the Diversion Reach in Alternative 1. These deep pools will provide high quality salmonid habitat and foraging, breeding and refuge habitat for California red-legged frog. To assist in channel stabilization and maximize the habitat values of these pools for salmonids and California red-legged frog, the channel design should incorporate substantial coarse woody debris to increase the habitat complexity of these pools

5.5.3.2 Optional Restoration of Coastal Scrub Habitat

The rocky 1:1 side slopes that will be created within the Diversion Reach provide a particularly challenging environment for vegetation establishment. The placement and retention of soil in this area will be key to establishing vegetation. It is anticipated that the faces of these steep slopes will be irregular with numerous small ridges and cracks that provide potential pockets where soils may be placed and retained. The coastal scrub habitat that currently occupies the Carmel River Valley slopes that will be impacted with the project provides a potential source of Coast Scrub habitat soils that likely include a rich seed bank of Coastal Scrub species. We recommend that these soils be salvaged for subsequent placement over the new slopes to create potential conditions where Coastal Scrub can establish. It may be possible to apply the soils to the slopes by simply dumping them onto the slopes from the top of the bank, if equipment can access these areas. The logistics of salvaging these soils may make this cost prohibitive so other soil sources may have to be considered for this area. Following soil placement, the slopes may be seeded with a seed mix containing Coastal Scrub species that are found within the vicinity of the project. The seed mix would include California sage (*Artemisia californica),* black sage (*Salvia mellifera*) and sticky monkey flower (*Mimulus aurantiacus)* at a minimum.

It should be noted that the resources required to establish Coastal Scrub habitat in this area will be substantial and that Coastal Scrub habitat restoration will not provide significant habitat benefits for salmonids or California red-legged frog. Thus, revegetation efforts in this location should be considered optional especially if it will reduce the resources that can be applied to restoring riparian habitat.

5.5.4 Riparian Restoration Design Elements Specific to the Upper Carmel Reach

5.5.4.1 Off Channel Red-legged Frog Pond

There are several existing off-channel ponds that provide suitable breeding, foraging and refugia habitat for California red-legged frog in the Carmel River Reach of the project. Although the Upper Carmel Reach is anticipated to be a very dynamic environment with channel migration and substantial aggradation there are opportunities to create off-channel ponds that could significantly enhance habitat for California red-legged frog. These ponds would be designed to provide breeding habitat for California red-legged frog and would be a minimum of 3-feet deep in their deepest locations. They would be designed to maintain 20 inches of ponding through July on an average year so California red-legged frog larvae can complete their life cycle. These ponds would be planted with salvaged alder and willow root wads will be placed along the banks of these ponds to facilitate habitat establishment and increase the pond’s complexity.

Due to the dynamic nature of the Carmel River Reach, it is assumed that many of these ponds would fill with sediment through time and be created elsewhere by natural fluvial processes. Thus, the creation of these off-channel ponds would serve as temporary habitat for California red-legged frogs. There is only a minimal risk that juvenile steelhead would be stranded in these off channel ponds as steelhead are less likely to use off channel habitat than other salmonids (Quinn 2005).

5.5.4.2 Existing Riparian Habitat to Be Preserved

The Upper Carmel Reach currently supports substantial stands of riparian habitat, many of which will be preserved as part of the restoration design. Thus, the Upper Carmel Reach will have fairly good riparian habitat values immediately after construction and these stands are likely to spread laterally as well as provide good seed sources to hasten natural recruitment.

5.5.4.3 Minimal Active Habitat Restoration

The Upper Carmel Reach of the project is anticipated to be the most dynamic of the reaches with channel migration and substantial aggradation expected. These natural processes would likely bury and/or wash away the optional active habitat actions described in Section 5.5.1.6 if implemented. They will also create conditions where natural recruitment of native riparian species will readily occur. Thus, substantial active habitat restoration in this reach is not recommended.

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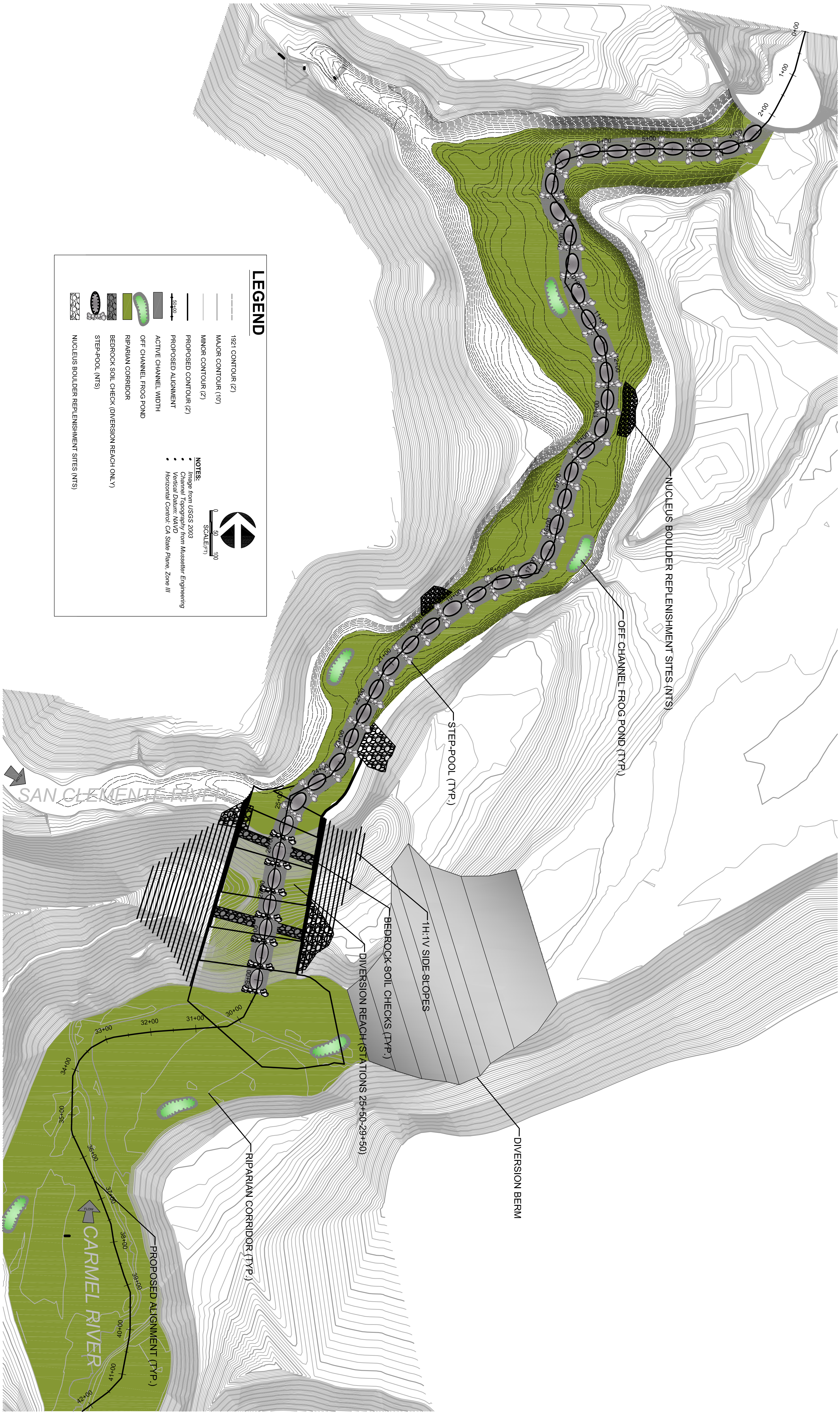
PRELIMINARY
NOT FOR CONSTRUCTION



DESIGNED BY RAB, AP

DRAWN BY RAB

CHECKED BY 000

IN CHARGE 000

APPROVED

DATE

APPROVED

DATE

CERTIFICATIONS:

FIGURE
5-1

ALTERNATIVE 1 CONCEPT PLAN

SCALE	DATE	JOB NO.	CONTOUR INTERVAL	DATUM
1" = 100'	11/14/07	1908-00	2 Feet	NAVD

SAN CLEMENTE DAM REMOVAL

PREPARED BY:

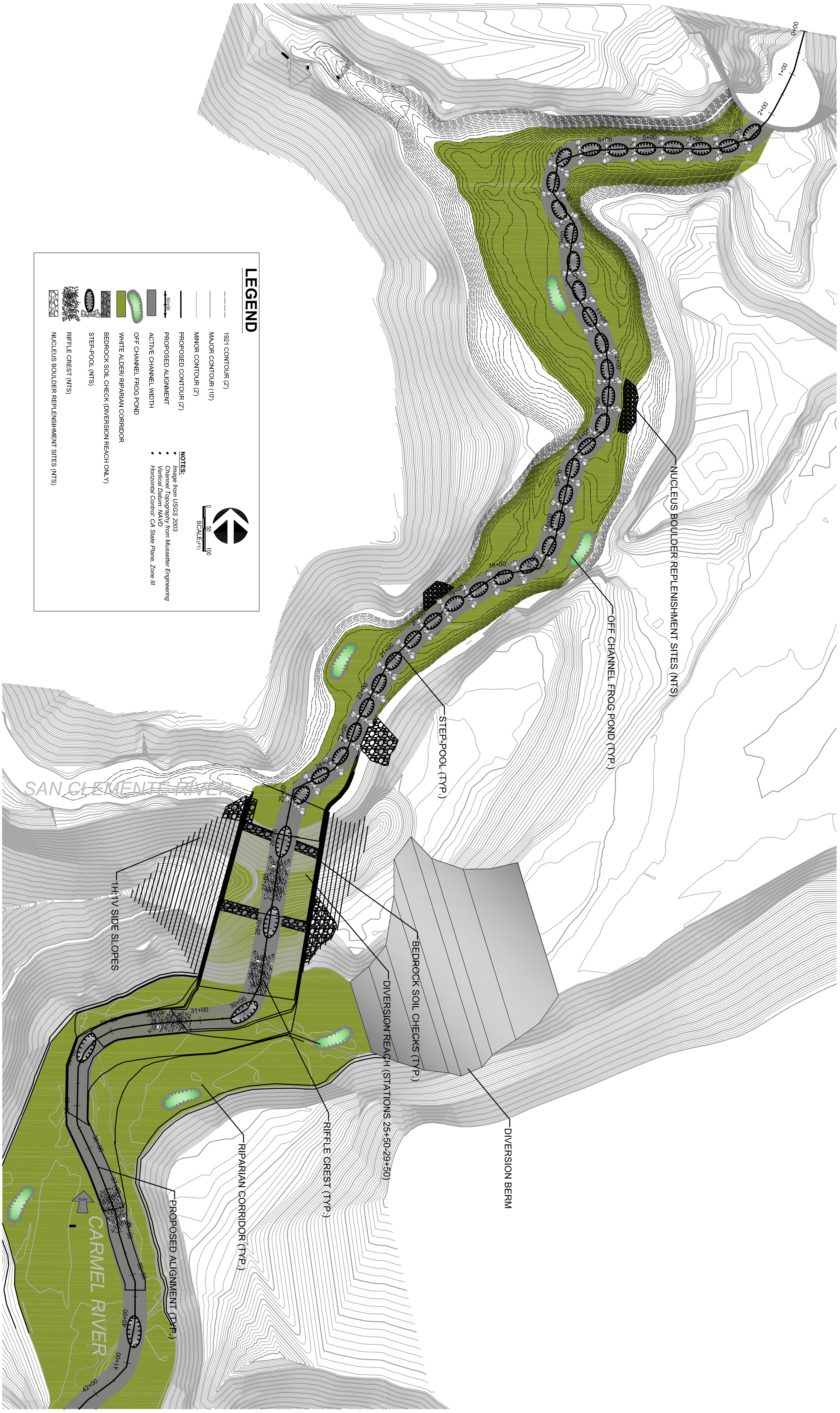
PWA

PHILIP WILLIAMS & ASSOCIATES, LTD.
720 CALIFORNIA STREET, SUITE 600
SAN FRANCISCO, CALIFORNIA 94108-2404
PHONE (415) 262-2300 FAX (415) 262-2303

IN COOPERATION WITH:

NO.	DATE	BY	DESCRIPTION
1	12-11-07	RAB	ADDED ADDITIONAL BOULDER SITES

PRELIMINARY
NOT FOR CONSTRUCTION



NOTES:
- Image from USGS 2003
- Channel Topography from Mussetter Engineering
- Vertical Datum: NAVD
- Horizontal Control: CA State Plane, Zone III

DESIGNED BY
RAB, AP
DRAWN BY
RAB
CHECKED BY
000
IN CHARGE
000
APPROVED
DATE
APPROVED
DATE
CERTIFICATIONS:

FIGURE
5-2

ALTERNATIVE 2 CONCEPT PLAN

SCALE	DATE	JOB NO.	CONTOUR INTERVAL	DATUM
1" = 100'	11/14/07	1908–00	2 Feet	NAVD

SAN CLEMENTE DAM REMOVAL

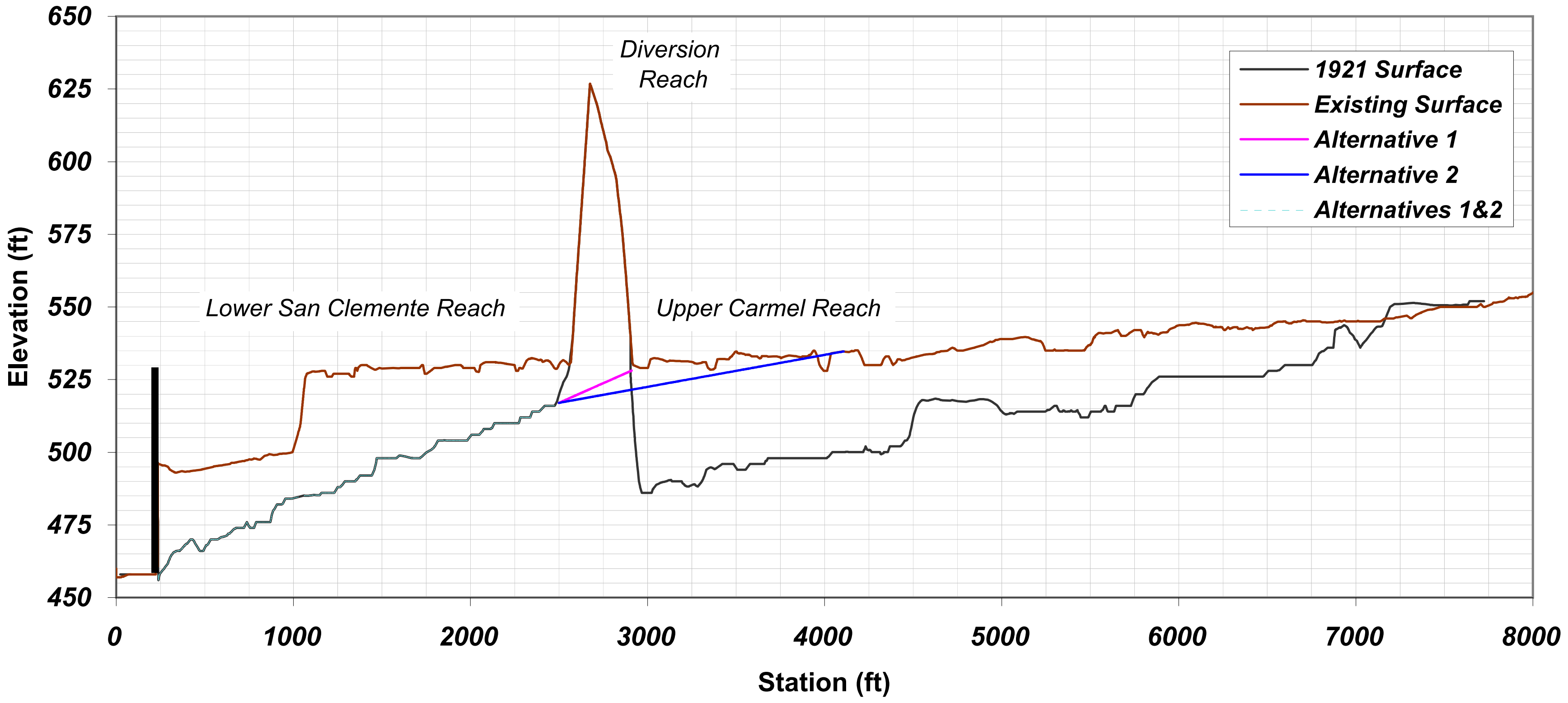
PREPARED BY:

PWA

PHILIP WILLIAMS & ASSOCIATES, LTD.
720 CALIFORNIA STREET, SUITE 600
SAN FRANCISCO, CALIFORNIA 94108-2404
PHONE (415) 262-2300 FAX (415) 262-2303

IN COOPERATION WITH:

NO.	DATE	BY	DESCRIPTION
1	12-11-07	RAB	ADDED ADDITIONAL BOULDER SITES



Source: 1921 USGS Topo overlaid with 2006 topographic surface. Both data sets courtesy of Montgomery Watson Harza.

figure 5-3

San Clemente Dam Removal

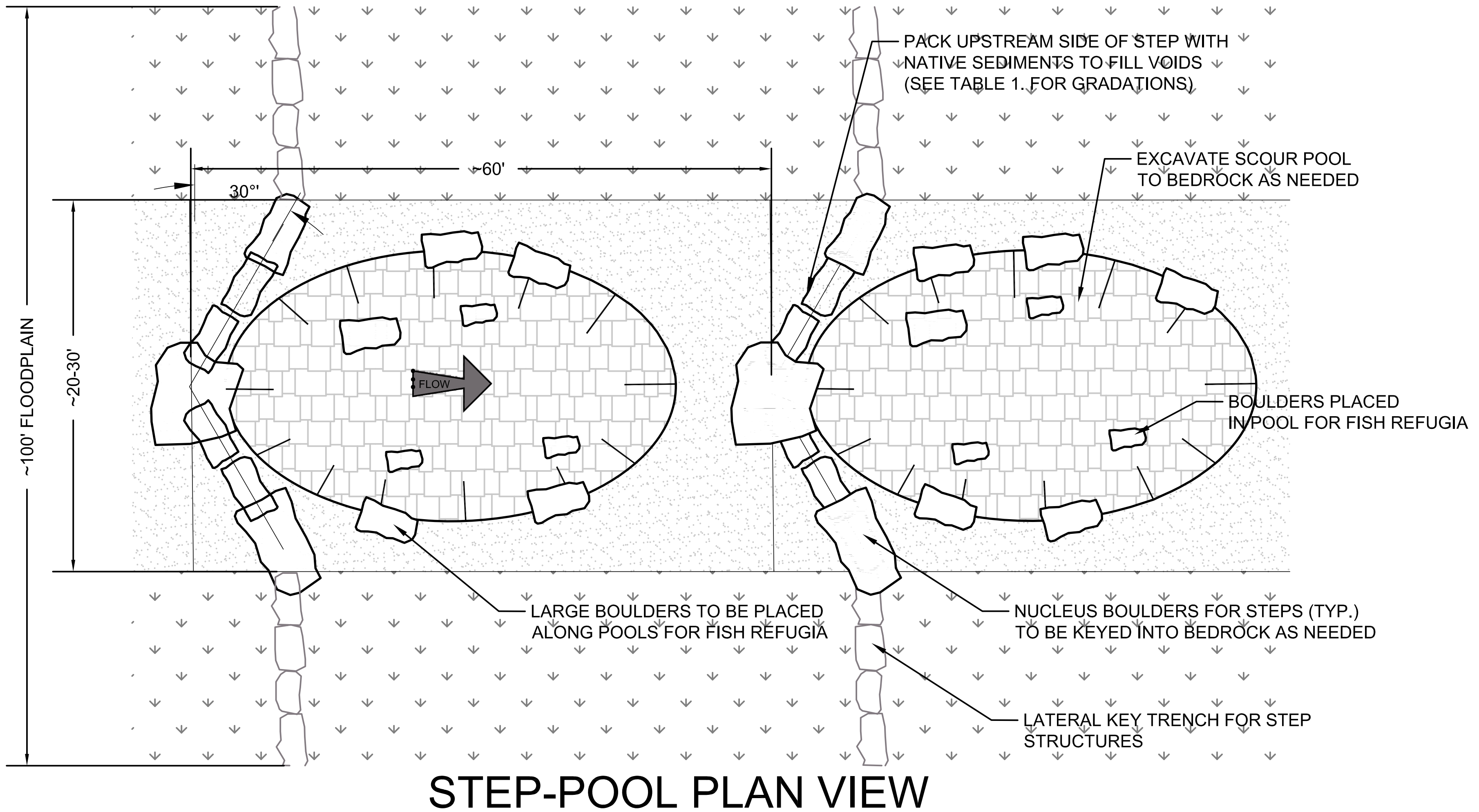
Long Profile Showing Existing and Proposed Conditions

PWA Ref# 1908

PWA

Fig5-3LongProfile.xls / HorzFigureBox

PRELIMINARY
NOT FOR CONSTRUCTION

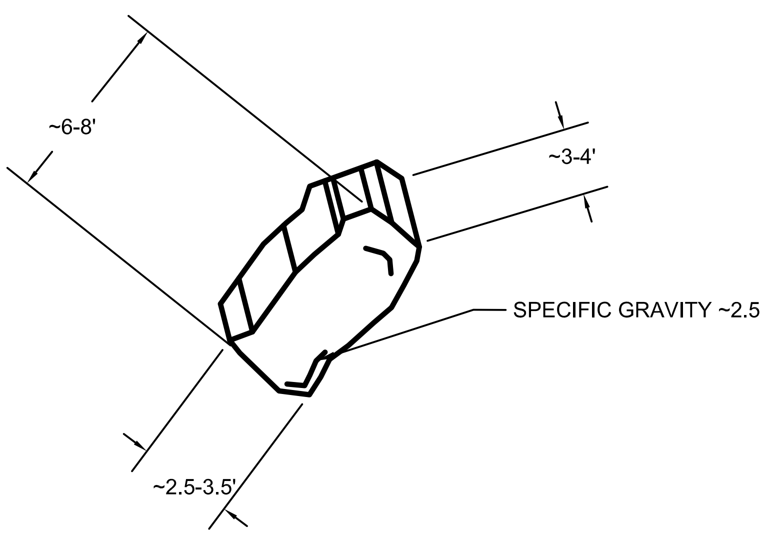


STEP-POOL PLAN VIEW

NOT TO SCALE

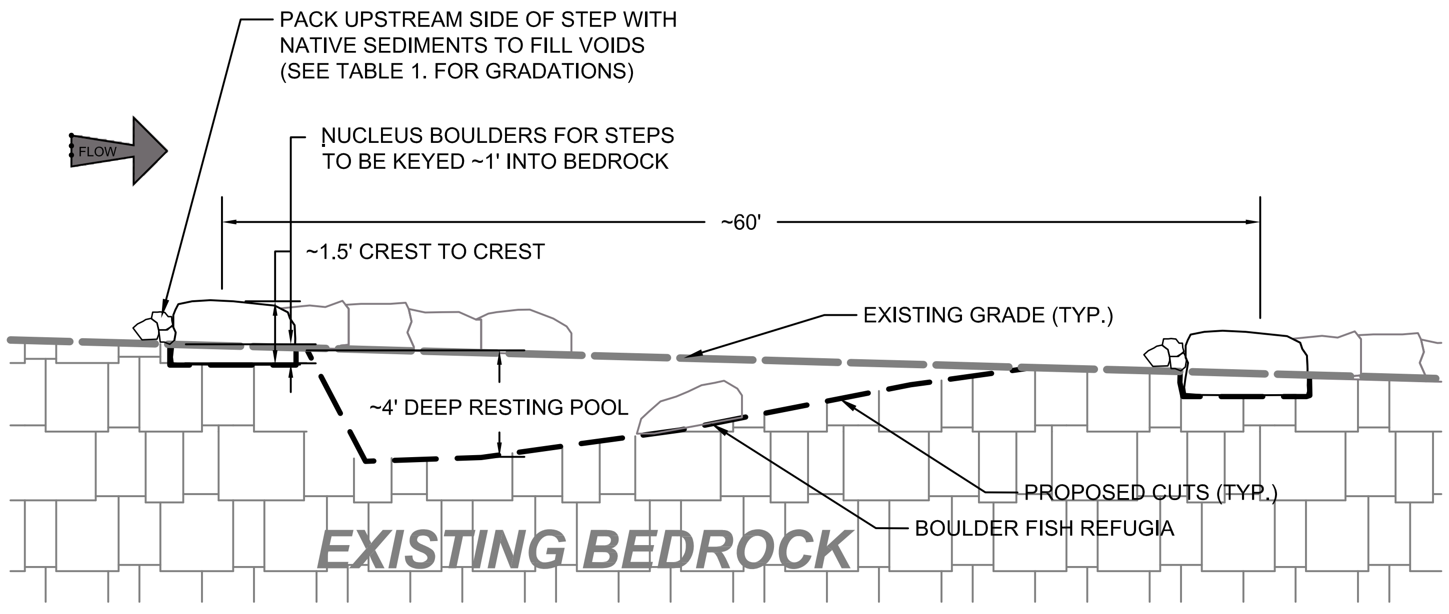
Table 1. Nucleus Boulder Backfill Gradations

Relative Percentage	Material Type
25	Small Boulders (6-24")
25	Large Gravels (4-6")
25	Small Gravels (1-3")
25	Sand and Silt Mixture



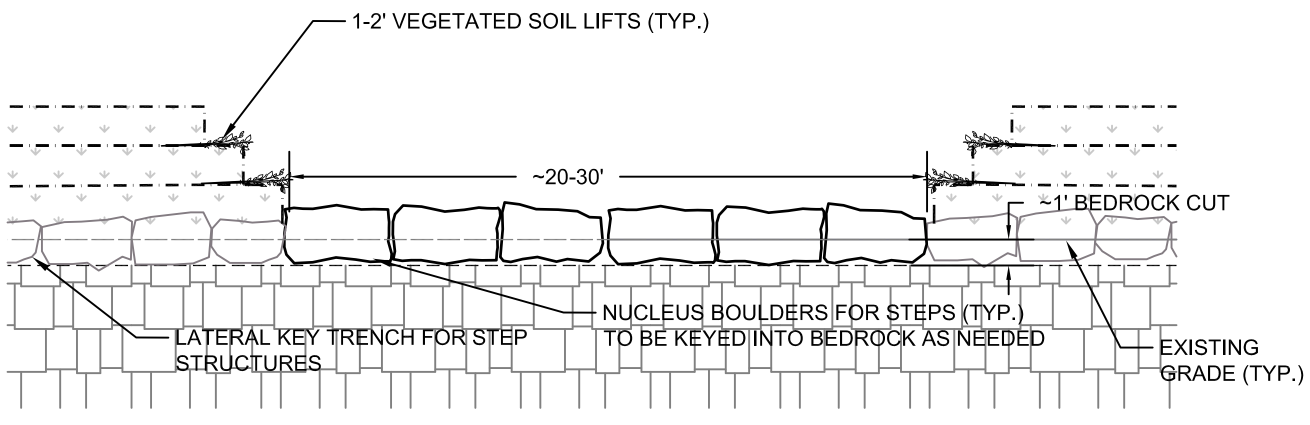
TYPICAL NUCLEUS BOULDER

NOT TO SCALE



STEP-POOL PROFILE

NOT TO SCALE



STEP-POOL SECTION

NOT TO SCALE

NO.	DATE	BY	DESCRIPTION
1	12-11-07	RAB	ADDED BOULDER REFUGIA AND MODIFIED GRADATIONS

PREPARED BY:

PWA

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IN COOPERATION WITH:

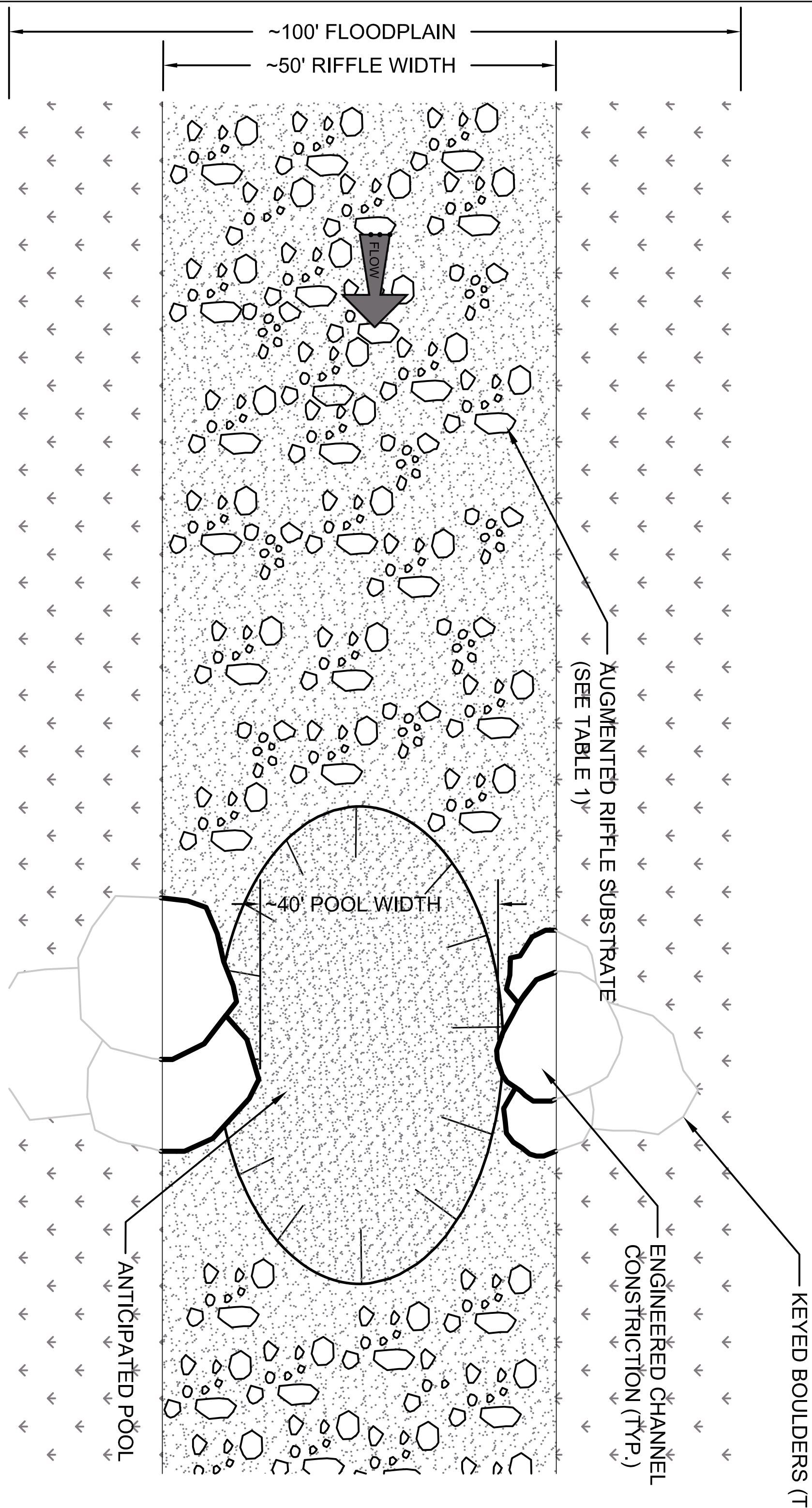
SAN CLEMENTE DAM REMOVAL

CONCEPTUAL STEP-POOL DETAIL

SCALE	DATE	JOB NO.	CONTOUR INTERVAL	DATUM
NTS	11/28/07	1908-00	NA	NAVD

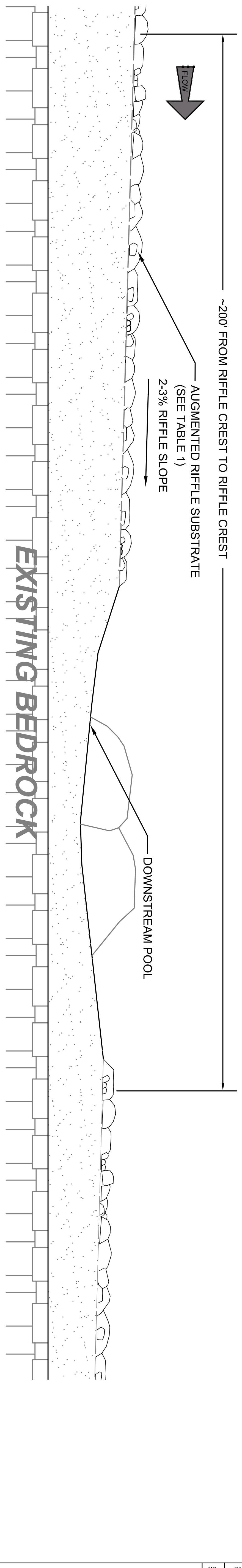
FIGURE
5-4

Q:\Projects\1908_SanClementeDam\dataIN\BASE\CONCEPT DETAILS.dwg 12-11-07 10:07:18 AM r.brown



RIFFLE-POOL PLAN VIEW

NOT TO SCALE

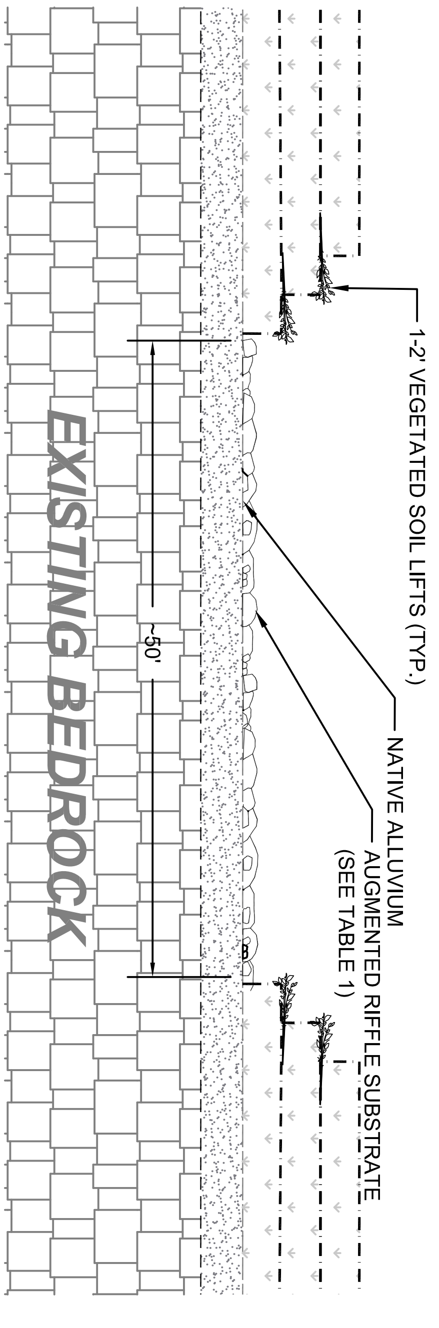


RIFFLE-POOL PROFILE

NOT TO SCALE

Table 1. Riffle Augmentation Gradations

Size Class	Size (ft)
D_{84}	0.60
D_{50}	0.25
D_{16}	0.08



RIFFLE CREST SECTION

NOT TO SCALE

PRELIMINARY
NOT FOR CONSTRUCTION

FIGURE
5-5

CONCEPTUAL
RIFFLE-POOL DETAIL

SCALE	DATE	JOB NO.	CONTOUR INTERVAL	DATUM
NTS	11/28/07	1908-00	NA	NAVD

SAN CLEMENTE
DAM REMOVAL

PREPARED BY:

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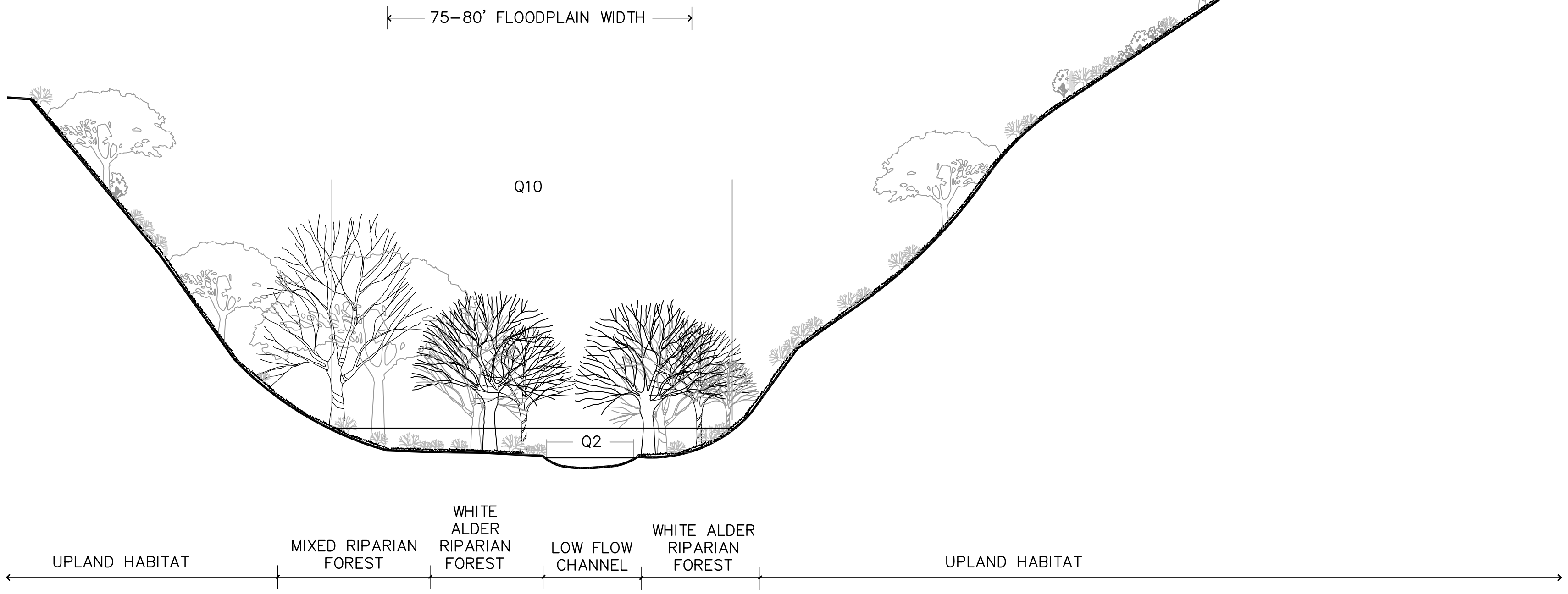
PHONE (415) 262-2300 FAX (415) 262-2303

IN COOPERATION WITH:

NO.	DATE	BY	DESCRIPTION
1	12-11-07	RAB	ADDED BOULDER KEYS

Plant Species Associations

Mixed Riparian Forest	White Alder Riparian Forest
arroyo willow big leaf maple black cottonwood buckeye California sycamore coast live oak red willow shining willow valley oak white alder	arroyo willow red willow shining willow white alder



Vegetation/Revegetation Zones

A	B	C
Existing Habitat	Natural Recruitment	Active Revegetation

San Clemente Dam Removal Project: Lower San Clemente Reach Restored Habitat Cross Section at Station 12+00

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

December 2007

Figure 5.6

Proj No. 2860-01

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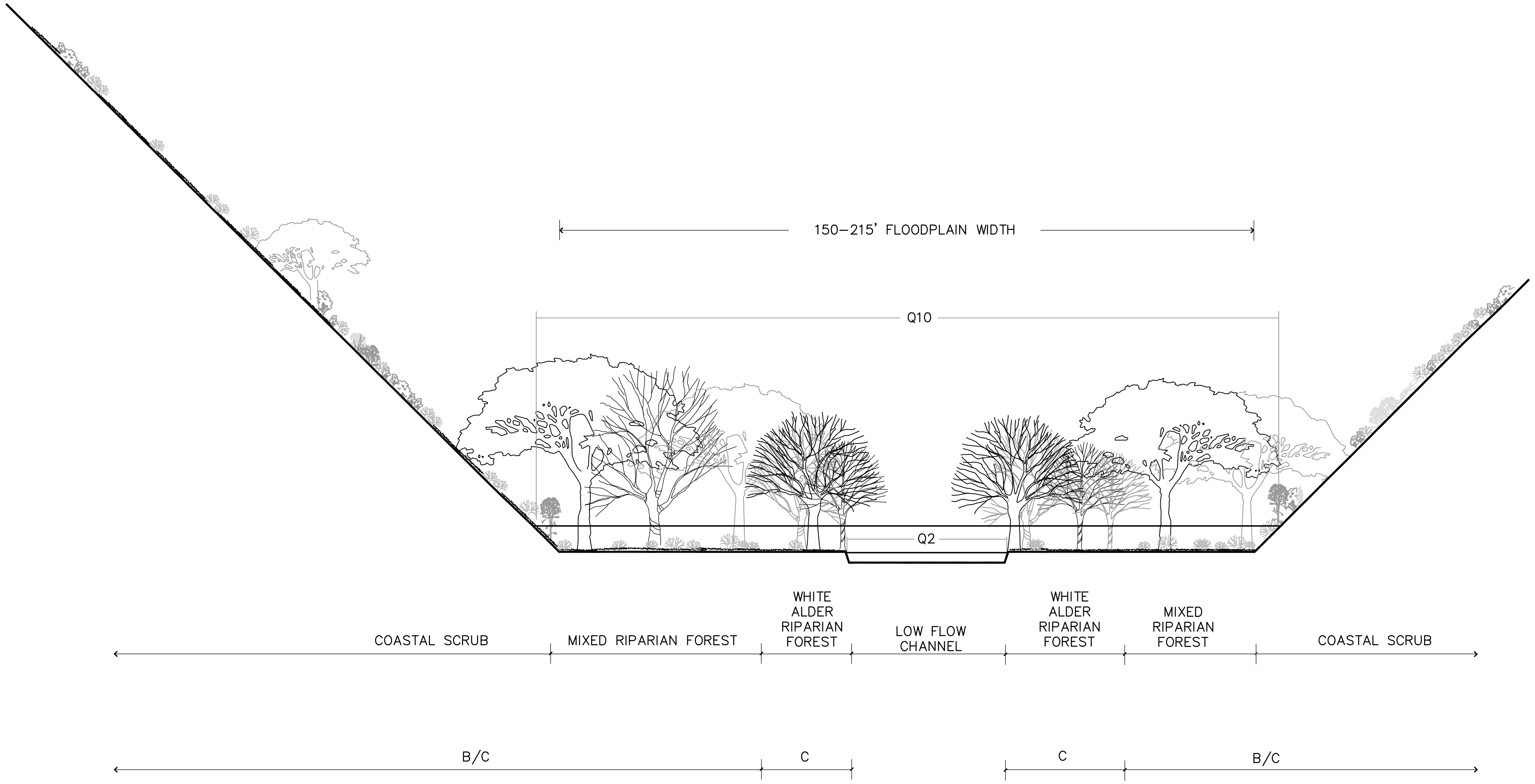
Plant Species Associations

Coastal Scrub	Mixed Riparian Forest	White Alder Riparian Forest
black sage California sage sticky monkeyflower yucca	arroyo willow big leaf maple black cottonwood buckeye California sycamore coast live oak red willow shining willow valley oak white alder	arroyo willow red willow shining willow white alder



Vegetation/Revegetation Zones

A	B	C
Existing Habitat	Natural Recruitment	Active Revegetation

San Clemente Dam Removal Project: Diversion Reach Restored Habitat Cross Section at Station 20+00

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

December 2007

Figure 5.7

Proj No. 2860-01

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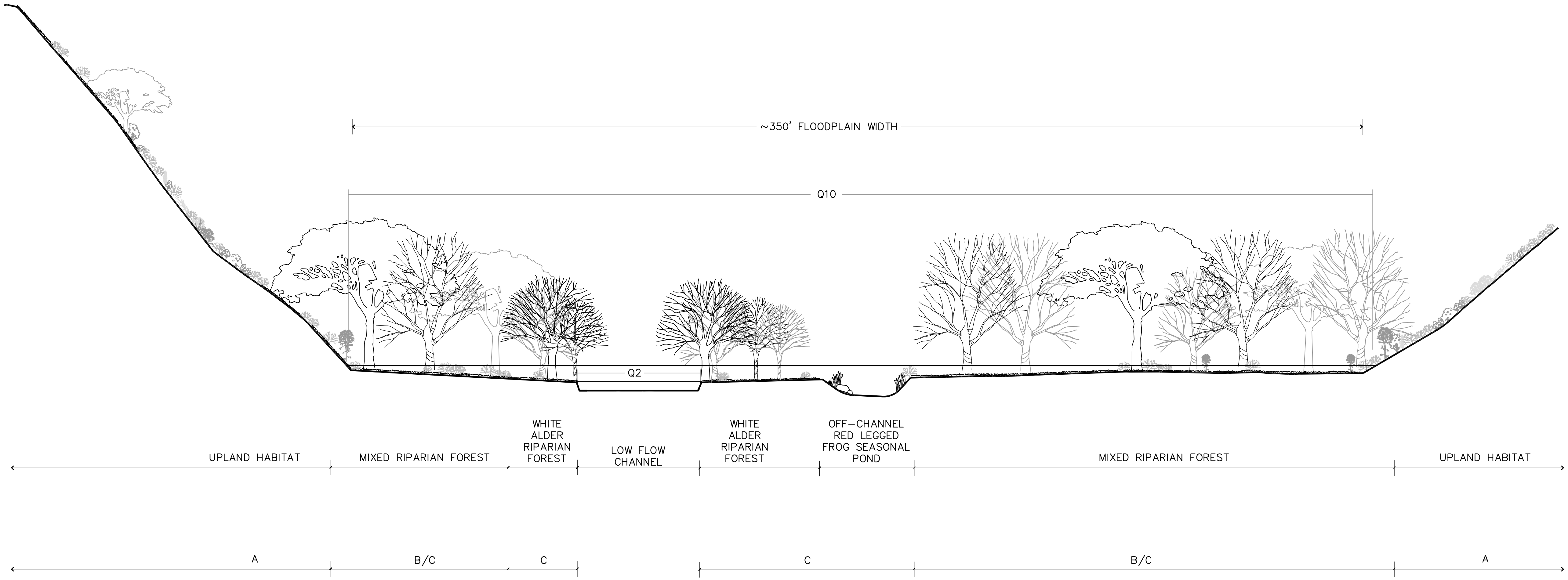
Plant Species Associations

Mixed Riparian Forest	White Alder Riparian Forest
arroyo willow big leaf maple black cottonwood buckeye California sycamore coast live oak red willow shining willow valley oak white alder	arroyo willow red willow shining willow white alder



Vegetation/Revegetation Zones

A	B	C
Existing Habitat	Natural Recruitment	Active Revegetation

San Clemente Dam Removal Project: Carmel River Reach Restored Habitat Cross Section at Station 27+00

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

December 2007

Figure 5.8

Proj No. 2860-01

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6. ASSESSMENT OF ALTERNATIVES

The purpose of this chapter is to evaluate the project alternatives and sub-alternatives laid out in Chapter 5 with the performance goals and objectives established in Chapter 2. The key tool used in this assessment is a hydraulic simulation model constructed to predict the flow conditions of the design channel for their biological and geomorphic functions. An important feature of this study is the use of unsteady or continuous hydraulic modeling to assess fish passage conditions. Using continuous simulation allows us to look at the whole range of flows during which migration may be occurring, rather than running a few key flows such as the 10% exceedence flow or the two-year flow, therefore allowing a conservative estimate of the fish passage performance of this project.

6.1 DEVELOPMENT OF HYDRAULIC MODEL OF ALTERNATIVES

Hydraulic modeling of the Carmel River in the vicinity of San Clemente Dam was performed using HEC-RAS, one-dimensional hydraulic modeling software developed by the U.S. Army Corps of Engineers. An existing HEC-RAS model built by MEI was adapted for use in this analysis by updating the model’s geometry to reflect Alternatives 1 and 2 and by changing the model’s boundaries to include unsteady flow conditions.

6.1.1 Limitations in Hydraulic Modeling for Fish Passage Assessments

Step-pools are complex three dimensional hydraulic systems and we recognize the inherent limitations of using a one-dimensional model to represent them. In addition to the dimensional complexity of step-pools, we recognize that individual step-pools will vary from one another, and evolve over time as smaller boulders move in and out of reaches. For example, the real step-height and velocity may well be less than predicted by the model in some parts of a step-pool, and greater in others, due to placement of boulders, gaps between nucleus boulders etc. This heterogeneity is likely to produce pathways that fish can exploit, and we encourage the creation of heterogeneity in the step-pool final design so that at different flows different pathways will be created.

We also recognize that fish passage is a complex behavioral process and that fish passage criteria are simplified approximations of reality. However, we are proceeding on the basis that the model and fish passage criteria at least provide metrics for comparing and refining different alternatives and assessing the sensitivity of flow parameters relevant to fish passage and geomorphic stability to changes in channel design.

6.1.2 San Clemente Reach for Alternatives 1 and 2

The step pool geometry for the Lower San Clemente Reach consists of 38 step pools spaced approximately 60 feet apart with an overall channel gradient of 2.52%. Step pool dimensions were consistent with field observations of the Carmel River, upstream of the backwater effect of the San Clemente Dam. Each step pool is represented in the model by five cross sections, which are shown in planform (Figure 6-1) and long profile (Figure 6-2) and summarized in Table 6-1.

Table 6-1. Cross Section Descriptions for the Five Cross Sections Constituting each Step Pool in the San Clemente Creek Reach

Cross Section Name	Cross Section Description	Distance The Next Cross Section Downstream	Top Bank Width	Channel Depth Below Crest
CS1 – Downstream pool	The downstream portion of the pool, just upstream of the next pool's CS5	3.0' to next step pool's cross section 5	20'	3'
CS2 – Middle pool	The middle of the pool at its deepest and widest location	22.64' to cross section 1	30' (40' for resting pools)	4' (5' for resting pools)
CS3 – Upstream pool	The upstream portion of the pool, just downstream of the drop structure	22.64' to cross section 2	20'	3'
CS4 – Downstream crest	The crest of the drop structure where water plunges into the pool downstream	9.04' to cross section 3	20'	na
CS5 – Upstream crest	The upstream part of the crest, just downstream of the next upstream pool's CS1	3.0' to cross section 4	20'	na

These cross sections are shown graphically in Figure 6-3 and 6-4.

For each step pool, the elevation of the two crest cross sections (CS4 and CS5) were the same and were determined based on the design channel slope. To simulate the flow that may occur between the boulders of the step structures, a triangular notch was added to each crest that was one foot wide and one foot below the design crest elevation. The upstream and downstream pool cross sections (CS1 and CS3) were 4.5 feet below the crest upstream and 3 feet below the next downstream crest. The cross section representing the middle of the pool (CS2) was typically 10 feet wider and one foot deeper than CS1/CS3, however, every fourth pool was designed as a resting pool and was 20 feet wider and 2 feet deeper than those in CS1/CS3.

Floodplain and hillside elevations were extracted from the 1921 topographic surface of the San Clemente Creek valley as cross sections at 30 foot intervals. For a given step pool structure, it was assumed that a valley cross section was representative of CS5, CS4, and CS3 as well as the next upstream step pool's CS1. The next valley cross section taken 30 feet downstream was used for the step pool's CS2. This process was continued for each 60 foot long step pool sequence. At the appropriate location in the floodplain, the crest or pool geometries were spliced into the valley cross section. High-flow secondary channels that were one foot below the floodplain elevation and separated from the main channel by a riparian strip are included in the design cross sections where the historic valley widths were wide enough.

Roughness values were estimated during site visits and based on engineering judgment of long-term vegetated conditions. The crests and pools in the main channel are set at Manning's n-value of 0.065 to account for the form roughness associated with large cobbles and boulders in the main flow path. Floodplain and valley side n-values are set at 0.08 and 0.09, respectively, to account for the expected level of vegetation and form roughness. When incorporated, the high-flow channel's n-value is 0.05 and the riparian strip separating the high-flow and low-flow channel is set at 0.12 to account for dense willow vegetation.

6.1.3 Diversion Reach for Alternative 1

For Alternative 1, the diversion reach consists of eight step pool structures, including two resting pools and an overall channel slope of 2.7%. The cross section design and layout of the step pools in this reach are similar to those described above for the San Clemente Reach, with one major exception being the distance between structures is approximately 56 feet. The distance between CS2 and CS3 and between CS3 and CS4 is 20.60 feet, while all other distances between cross sections are the same as those shown in Table 6-1 above. Roughness values are also consistent with those described for the San Clemente Reach.

The floodplain and valley slope geometry was determined from the anticipated excavation profile of the ridge. As determined in the MEI design, floodplain widths range from 215 feet at the upstream end of the diversion to 150 feet at the downstream end. The floodplains slope from the channel banks to the valley toe at 1% and the valley sides slope at 1:1. Secondary channels are included in all cross sections of the diversion reach. These high-flow channels are 20 feet wide and one foot below the floodplain elevation and separated from the main channel by a 15 feet wide riparian fringe.

6.1.4 Diversion Reach and Upper Carmel River Reach for Alternative 2

The Diversion and Upper Carmel Reaches for Alternative 2 are designed in the HEC-RAS model to represent a riffle-pool system at a 1.1% channel slope. Riffle-pool sequences are 200 feet in length, with some variability in the Carmel River reach to accommodate the existing cross section spacing. For riffle cross sections, the channel depth below the banks is 2 feet and the top width is 50 feet and for pool sections, the channel depth is 4 feet and the top width is 40 feet.

Diversion reach floodplain and valley geometry is consistent with that described above for Alternative 1. For the Carmel River reach, the design riffle and pool cross sections were spliced into the existing conditions cross sections at the location of the existing low flow channel. A 25 foot wide low floodplain was included on both sides of the channel and the design sections were tied into the existing floodplain and valley geometry at 3:1 slopes. Secondary channels are included in the diversion reach, but not in the Carmel River reach. Roughness values are consistent with the alternatives described above.

6.1.5 Steady-state Simulation Hydrology

Peak flood event flows for the Carmel River above and below its junctions with San Clemente Creek are shown in Table 6-2. Additionally, the return interval for 40 cfs and 800 cfs (fish passage flow boundaries) were estimated from the flood frequency curve developed for the Carmel River at Robles Del Rio (MEI, 2002a).

Table 6-2. Peak Flow Values Used in Steady-state HEC-RAS Modeling

Return Interval	Carmel River Flow Above San Clemente Creek (cfs)	Carmel River Flow Below San Clemente Creek (cfs)
2-year	1,932	2,250
5-year	5,446	6,200
10-year	8,601	9,680
50-year	16,498	18,700
100-year	19,983	22,700
PMF	70,400	81,200
~1.01-year	40	40
~1.25-year	800	800

6.1.6 Unsteady Simulation Hydrology

Unsteady boundary conditions for the Carmel River and San Clemente Creek were based on historic measurements from USGS stream flow gage 11143200 (Carmel River at Robles Del Rio), located approximately four miles downstream of San Clemente Dam. While it is not ideal to estimate hydrology for two disproportionate watersheds from a gage located downstream of the confluence and downstream of a flow impediment (the San Clemente Dam), it was deemed appropriate for this screening level analysis. Based on a ratio of peak flow events, Carmel River and San Clemente Creek flows were estimated as 85% and 15% of the Robles Del Rio gage data, respectively. The peak flow values used to establish this ratio were taken from MEI's HEC-RAS model (MEI, 2005) for the Carmel River upstream of San Clemente Creek, the Carmel River downstream of San Clemente Creek, and San Clemente Creek upstream of the Carmel River (see Table 6-2). Peak flows for the Carmel River below San Clemente Creek corresponded to published values (MEI, 2002a). Flows for San Clemente Creek were applied to the model as a lateral inflow hydrograph just downstream of the bypass reach and therefore reached the San Clemente Reach of the Carmel River before upstream flows. While this study did not investigate the affects of hydrograph timing from the two watersheds, it should be reviewed in future analyses.

The unsteady HEC-RAS model was run for the period of December 15th of the previous year to May 30th for the years 2000 through 2007 (e.g. 12/15/99 to 5/30/00) representing the period of time for which we had high resolution fish passage data. Simulation time steps ranged from two seconds to one minute and model output data was recorded daily. The HEC-RAS input hydrology for the Carmel River and San Clemente Creek can be seen in Figure 6-5.

6.2 FISH PASSAGE PERFORMANCE OF ALTERNATIVES 1 AND 2

Based on the fish passage criteria, the San Clemente, Diversion, and Carmel River reaches for Alternatives 1 and 2 were evaluated using results from the unsteady HEC-RAS simulations. Data was extracted from different pool, crest, and riffle cross sections that were characteristic of either typical or high velocity conditions. Cross sections were considered passable if the flow was between 40 and 800 cfs and if the channel velocity was below 3 fps in pools or 6 fps in crests or riffles. Secondary channel and floodplain conditions were assessed separately with conditions considered passable if the depth was greater than 1 foot and the velocity met the channel requirements described above. Table 6-3 summarizes this analysis for seven years covering a wide range of flow conditions. Note that the yearly values (in Appendix 2) vary little from the mean annual figures.

Table 6-3. Average Percentage of Time Fish Passage Criteria are Met During Potential Migration Events, 2000-2007

Percent Time Fish Passage Criteria Met During Potential Migration Events[1]						
	Both Alts		**Alt 1**		**Alt 2**	
	2.5% San Clemente reach	**2.5% San Clemente reach plus secondary channel[2]**	**2.7% Diversion reach**	**2.7% Diversion reach plus secondary channel[2]**	**1.1% Diversion and Carmel reaches**	**1.1% Diversion and Carmel reaches plus secondary channel[2]**
Highest velocity pool[3]	99%	99%	97%	100%	na[5]	na[5]
Highest velocity crest/riffle[4]	5%	5%	0%	1%	100%	100%

Typical pool	99%	99%	98%	100%	100%	100%
Typical resting pool	100%	100%	100%	100%	na[5]	na[5]

[1] Velocity criteria – flows must be slower than 3 feet/second for pools, slower than 6 feet/second for crests or riffles

[2] Secondary channel is deemed passable when velocity is less than 3 feet/second and flow depth exceeds 1 foot on the secondary channel

[3] Selected as the highest velocity pool at a flow of 800 cfs

[4] Selected as the highest velocity crest at a flow of 800 cfs

[5] All riffles and pools in the riffle-pool reach are identical so no highest velocity values are shown

The Lower San Clemente Creek Reach meets upstream passage velocity criteria except for the step crests, which frequently have velocities that exceed 6 feet per second (as expected). However, when crest velocity exceeds 6 feet per second the crest height is jumpable for adult steelhead (1-2 feet) and can therefore be avoided. In reality for many of the steps we would also expect fish to find some gaps between nucleus boulders that support migration by swimming at burst velocities. This reach is approximately 2,200 ft long with a 2.52% gradient, resulting in 38 step pools of approximately 60 feet in length. Although the riffle crests exceed velocity criteria, the intervening pools should provide resting habitat. Secondary channels do not appear to be feasible in all the critical reaches due to the confined nature of the San Clemente Reach, though we believe from examination of the 1921 topography that improvements can be made to the channel at the next design phase that will eliminate or improve some of the key limiting reaches in this conceptual level hydraulic model.

In the Diversion Reach, the higher gradient Alternative 1 channel also meets upstream passage criteria except for the crest velocity criteria, as noted in the Lower San Clemente Reach. The diversion reach is approximately 450 feet long in Alternative 1 with a gradient of approximately 2.7%; pools meeting resting habitat criteria will be constructed although typical pools in the reach are anticipated to meet velocity criteria. The Carmel River upstream of the diversion reach for Alternative 1 is anticipated to meet all velocity criteria. Secondary channels in the diversion reach are anticipated to provide only incremental improvements to upstream passage.

For the lower gradient Alternative 2 (1.1%), it is estimated that upstream passage of adult steelhead is unimpeded (meets all velocity criteria) in both the diversion and Carmel River reaches. Secondary channels in the diversion reach are not necessary to meet passage criteria.

6.2.1 Summary of Fish Passage Performance for Alternatives 1 and 2

Adult steelhead upstream passage criteria are met for almost all flows between 40-800 cfs in both alternatives, and in all reaches. For both alternatives the most limiting conditions are found in the lower San Clemente Creek Reach where confined valley conditions constrain the channel width and create high velocity zones, although intervening pools meet resting criteria. We believe that some of the apparent constraints can be eliminated during preliminary design and during construction by 'tweaking' and field-fitting the standard step-pool design to better fit topography.

Although specific criteria for downstream migration of steelhead smolts were not used or evaluated, downstream smolt passage is not anticipated to be impeded by any of the alternatives. However, upstream passage of juvenile steelhead (as a secondary goal), may be impeded due to the size of the drops anticipated; NMFS fish ladder design criteria specifies drops of 6 inches from pool to pool, whereas the design alternatives will likely have pool to pool drops of 1 foot or greater, particularly in the San Clemente Creek reach and Alternative 1 in the diversion reach. However, upstream passage for juvenile steelhead could be provided by microhabitats that are anticipated to occur as boulders and gravels adjust over time.

6.3 GEOMORPHIC PERFORMANCE OF ALTERNATIVES 1 AND 2

6.3.1 Estimated Time Required to Reach Equilibrium in the Upper Carmel River Reach

As described in the geomorphic objectives and the project sub-alternatives sections, the Carmel River will aggrade upstream of the diversion reach until equilibrium is reached (net balance between sediment volume entering and leaving the reach). Until this happens there will be a higher risk of poor project performance as cobbles and boulders needed in the Diversion and Upper San Clemente Reaches will be trapped upstream. To determine the risk exposure time and to assess the potential for using the sediment from the San Clemente Creek branch of the reservoir to hasten the equilibration process, we undertook a rough grading exercise.

Extending a 1.1% floodplain slope upstream intersects existing grade around 16,000 feet upstream of the diversion channel for Alternative 1 and 9,500 feet upstream for Alternative 2. An average valley floor width of 323 feet was measured in the backwater area, and 143 feet in the upper canyon area. By measuring the difference in vertical elevation between the existing profile (taken from the USGS DTM – see Figure 6-6) and the assumed 1.1% equilibrium slope and multiplying by the relevant floodplain width we can estimate the volume of sediment required to reach equilibrium. For Alternative 1 the volume is 2,439,500 cubic yards whereas for Alternative 2 the volume is 1,094,907 cubic yards. According to MEI (2003) the Carmel River delivers an average of 24,523 cubic yards of sediment per year. At a trap efficiency of 100% this would create an equilibrium slope in 99 years for Alternative 1 and 45 years for Alternative 2. However, the current trap efficiency of the San Clemente Dam is estimated to be 75% and this will be reduced to 35% for gravel once the dam is removed and the bypass constructed (MEI, 2005). It will reduce further as the channel and floodplain slope builds up. Using this efficiency suggests that the site will reach equilibrium in approximately 400 years for Alternative 1 and 180 years for Alternative 2 (Table 6-3). There are several factors complicating this simple analysis. Firstly, as the valley floor fills it will become steeper and trap efficiency will fall, so that the rate of filling will have an asymptotic form (approaching but never attaining equilibrium). Secondly, our calculation is based on a period in which Los Padres reservoir was trapping sediment. Los Padres reservoir is expected to fill within 40-50 years (Larry Hampson, Pers. Comm. 2007). As the reservoir fills its trap efficiency will fall and more sediment will be delivered to the project reach.

Table 6-3. Estimated Sediment Volume and Time Required to Reach Equilibrium

		Alt 1	**Alt 2**
Volume for valley floor to reach 1.1% gradient			
~upper canyon area	cubic yards	585,241	436,944
~reservoir backwater area	cubic yards	1,854,259	657,963
Total Volume	cubic yards	2,439,500	1,094,907
Difference between Alt 1 and Alt 2	cubic yards	1,344,593	~
Sediment input from Carmel River per year	cubic yards	24,523	24,523
Time to reach equilibrium at 100% trap efficiency	years	99	45
Time to reach equilibrium at 35% trap efficiency	years	398	179

6.3.2 Rock Sizing for Step-Pool Nucleus Boulders

The nucleus boulders are central to the geomorphic sustainability and fish passage performance of the project. Unlike gentler gradient channels that are typically formed by flows around the 1.5 – 5 year recurrence interval, step-pool systems generally form under flows that occur less frequently than every 30 years (Curran, 2007). In most step-pool environments nucleus boulders that are transported out of a reach during a high flow are replaced from upstream, and new steps form in the falling hydrographs of the same events that break up the old steps. Most commonly, new steps form around bed irregularities such as rough sections of bedrock, relics of former steps, or clusters of larger particles (Curran, 2007). However, the existing steps in the Carmel River may be somewhat different in that they appear to have formed in isolated locations where there are atypical inputs of large nucleus boulders from landslides or bank undercutting. Given the likely time scale for the channel to reach equilibrium (see section 6.3.1) it is desirable that the nucleus boulders are stable during at least the 100-year flood and ideally the Probable Maximum Flood (PMF).

The rock sizing assessment involves assessing the five principal forces acting on a rock: gravity (resisting motion) and buoyancy, drag and lift (driving motion). We used flow velocity data from the hydraulic model (described in section 6.1). The balance of these forces is taken to calculate a Factor of Safety (FoS) for the rocks in flows of different magnitude. The FoS is the ratio of resisting to driving forces, with values greater than 1 indicating stability. Typically we add a margin of error to this, seeking a FoS of 1.2 or 1.3. We performed two types of stability assessment: one using tabular rocks (rocks with flat surfaces and right angle corners, typical of fresh landslide debris) and one for elliptical boulders (sub-rounded rocks typical of older landslide debris that has been partially rounded in a river over time). Results and working methods are presented in Appendix 3.

It is important to note that the rock sizing assessment is considered conservative in that it assumes a rock is fully exposed to flows and does not receive support or friction from surrounding rocks, or have portions of the rock buried in the bed. In reality we would design steps so that each rock has at least three points of contact with other rocks, increasing resistance. We would also expect some deposition on the upstream side of the boulders, partially shielding them from the full force of flow. In addition, there are inaccuracies associated with extracting velocities from one-dimensional hydraulic models during events such as the 100-year flood or the PMF. The few field measurements made during such large events tend to show lower velocities than those predicted by hydraulic models (see for example Trieste and Jarrett, 1987) and bed velocities that act on particles are typically lower than mean velocities.

Rocks that are 6 feet long (perpendicular to flow) by 4 feet (base width) by 2.5 feet high with 1 foot buried (similar size to those observed in the step-pool reference reach) appear to be marginally stable at the 50-year flood using either analytical approach. For a tabular rock the FoS is 1.01 during the 100-year flood and 0.76 during the PMF. For an elliptical rock the corresponding FoS values are 1.03 for the 100-year flood and 1.18 for the PMF. This is consistent with literature reports reporting that steps typically mobilize and reform during events in the 30-50 year frequency, but suggests that such rocks may be too small for some of the critical reaches of the Lower San Clemente Reach unless well keyed in or partially buried in the bed.

6.3.3 Potential Failure Mechanisms and Consequences

During very large flood events the step-pool system may ‘fail’ by mobilization of nucleus rocks. In a natural system such mobilization is matched by step reformation on the falling limb of the hydrograph. Steps typically reform around disturbances such as bed irregularities or large particles. Step mobilization and reformation is not regarded as a fatal flaw for this project, since the new steps will likely have suitable characteristic for fish passage provided that they are composed of material shown to have formed such steps in the reference reach. However, evacuation of large numbers of boulders from the project reach would drive the system to a plane bed form that would have less desirable fish passage attributes. For this reason we recommend the placement of simulated landslides at key locations in the channel to replenish the step-pool system in the event of failure. In addition, if rocks are entrained during a very large flood event the largest nucleus boulders will tend to act as roughness elements that trap rocks from failed steps upstream, recreating the step-pool form on the falling limb of the hydrograph.

6.3.4 Sediment Transport Characteristics of the Two Alternatives

A full sediment transport assessment of the project alternatives will be carried out by MEI as part of a separate scope of work. As described above, PWA carried out an entrainment analysis to ensure that cobbles and boulders that are already deposited on the upper Carmel River reach can be transported to the diversion reach and beyond during 2-year flows, and a rock sizing analysis to ensure that the nucleus boulders remain in place during a 100-year flow and PMF.

6.4 PERFORMANCE OF THE PROPOSED CAW WATER INTAKE

In all alternatives the CAW water intake will be reconfigured as a Ranney Collector (a vertical shaft with lateral collectors that takes subsurface water from the sand and gravel sediment of the backwater area and pipes it to the current dam location under gravity). MWH proposed locating the intake approximately 500 feet upstream of the diversion reach, in order to maintain an intake elevation of 525 feet. Under Alternative 1 the Ranney Collector will function as proposed by MWH. In Alternative 2 the Carmel River channel at the collector will be approximately 4 feet below existing grade, potentially lowering the water table by a similar amount and threatening the water intake. In order to maintain the desired head of water above the steel intake pipes the Ranney Collector should be relocated an additional 440 feet upstream.

The MWH alternative proposes running the pipeline through the San Clemente Creek reach, which includes several very constrained sections with high velocities (28 feet per second) during the 100-year flood. We recommend that this alternative be reconsidered during preliminary design and that as an alternative the pipeline should be relocated to the Carmel arm of the reservoir.

6.5 ASSESSMENT OF SUB-ALTERNATIVES

6.5.1 Placing Sediment Excavated From the Lower San Clemente Arm of the Reservoir in the Upper Carmel River Arm

This sub-alternative calls for using the sediment removed from the San Clemente arm of the reservoir to speed up the process of aggrading the upper Carmel River reach to equilibrium grade by placing it there rather than in the lower Carmel River branch.

380,000 cubic yards of sediment represents 30% of the volume required to reach equilibrium under Alternative 1 and 48% under Alternative 2. Assuming this material remained in place it would reduce the time required to reach equilibrium by approximately 62 years for each alternative. However, most of the sediment from the San Clemente arm of the reservoir is significantly finer than the average grain size delivered by the Carmel River and has a lower equilibrium gradient. For example, the average grain size (d50) for the borehole samples collected from the San Clemente Creek arm of the reservoir are 0.37mm, 0.78mm and 0.52 mm for boreholes B13, B14 and B17 respectively (Kleinfelder, 2002), whereas the average grain size in Test Pit 1 (the test pit closest to the edge of the backwater in the Carmel River arm of the reservoir) is 9.5mm. Sediment taken from the San Clemente Creek arm of the reservoir is unlikely to remain in storage when exposed to flows at a 1.1% valley floor gradient. We would expect a lot of this sediment to wash out and deposit downstream of the dam, with undesirable consequences. There would also likely be significant impacts on red legged frog and riparian habitat that would require mitigation.

This sub-alternative does not therefore appear to be advisable.

6.5.2 Grading the Alternative 2 Upper Carmel River Reach Versus Allowing it to Erode into Shape

These sub-alternatives use different degrees of excavation to create the 1.1% reach connecting the diversion reach to the Carmel River. The options range from allowing the reach to erode to the diversion reach thalweg until it equilibrates, to pre-forming the channel. We conducted a grading exercise in AutoCAD to assess the volume of sediment required to fully form a channel close to equilibrium for this reach, to provide the maximum volume of cut required. The channel cross section was produced by copying the existing cross sections and lowering them to the thalweg elevation conforming to a 1.1% equilibrium gradient channel projected from the diversion reach. This generated a volume of 11,000 cubic yards. Cutting an initial pilot channel 50 feet wide at 2%, as suggested by some TRT members, generates a cut of 3,700 cubic yards. If the pilot channel eroded out to the assumed equilibrium dimensions the volume of sediment generated would be 7,300 cubic yards (the difference between the two numbers above). To assess the impact of this on the restored reach we calculated the volume of the pools in the step-pool reaches. With a length of 2,300 feet, width of 30 feet and average depth of 4 feet, and assuming 10% of the pool volume is occupied by nucleus boulders, the pools have a volume of approximately 9,200 cubic yards. Thus, cutting a 2% pilot channel would initially fill the pools with sand and gravel to a depth of over 3 feet, initially making the system impassible for fish. To ensure passage for fish during this time, trap and haul would need to be used to move adult steelhead from the ladder at San Clemente Dam to above this blockage. The sand and gravel would likely scour out after the next large flow of the year leaving cobbles and boulder plugging particles behind, with subsequent deposition of the finer sediment downstream of the dam. With the project site currently receiving 24,523 cubic yards of sediment and the reservoir having a trap efficiency of 85% (MEI, 2005) this sediment represents approximately 2 years of average annual sediment supply under existing conditions, and 46% of the average annual sediment load under post-project conditions (assuming 35% trap efficiency after dam removal).

The advantage of this sub-alternative would be slightly lower construction costs and the benefits of plugging the downstream pools in a natural manner with the eroded sediment, compared to hand placing the step-pool matrix material. This sub-alternative appears relatively feasible as an alternative to constructing the step-pools ‘fully formed’, though it may delay fish migration for as long as one year until the pools have filled and flushed, depending on the number and timing of high flows during the winter after construction.

6.5.3 Placing Gravel, Cobble and Boulders in the Upper Carmel River Reach to Meter Sediment Downstream

Placing sediment either in the channel or alongside the channel appears to be a viable way of metering sediment out to replenish step-pools downstream and to supply spawning reaches. However, any plan involving large volumes of sediment placement (in the order of thousands of cubic yards) will require a monitoring and adaptive management program involving monumented cross sections and repeat surveys to ensure that critical cross sections downstream of the dam do not lose flood capacity. Several suggestions have been made for possible gravel placement, including placement in piles to be mobilized during floods, placement in the channel itself, and placement alongside the channel in GeoTubes. This latter idea is one of the most controllable approaches, in that as long as cross sections downstream preserve their flood capacity additional GeoTubes can be cut open using a chain saw to generate more sediment. If the channel approaches a predetermined threshold no more sediment is released until the sediment wave has passed. Given the sensitivity to channel conveyance and flooding downstream the idea of a closely monitored and controlled approach may be more realistic than simply dumping sediment for entrainment in less controlled circumstances.

The TRT made recommendations concerning gathering gravel and cobble during the construction process, including mining and stockpiling selective sediment layers that meet the project needs as they emerge, rather than sieving sediment, to reduce costs.

The TRT also drew attention to the possibility of placing spawning gravel in specific sites near the reservoir (e.g. immediately downstream of the dam). Though not included in the scope of this project, a plan for gravel augmentation and river restoration downstream of the dam may be merited given the large volume of suitable materials found on site.

6.6 SUMMARY OF ALTERNATIVES ASSESSMENT

The predicted performance of the two alternatives is summarized below, and in Table 6-4.

1. Both alternatives assessed meet the Primary Goals of the project: fish will be able to migrate upstream through the project under the vast majority of conditions under which migration currently takes place; the reaches can be constructed to be geomorphically-stable if either sufficiently large rock or bedrock is used to construct a step-pool channel; and the CAW water intake can be relocated to meet the required standards.

2. In the event of failure of the step-pool structures two outcomes are possible: reformation of the step-pools around nucleus boulders or destruction of the step-pools to a plane-bed channel form. While the step-pool form would provide more desirable fish passage

performance (fish passage in a wider range of flow conditions), the plane bed form would not be a fatal project flaw.

3. The most limiting reach for fish passage and geomorphic stability in both alternatives is the Lower San Clemente Reach owing to the confined nature of the valley floor. Some of these constraints may be reduced during the preliminary design phase by looking for opportunities to locally widen the floodplain adjacent to the channel.

4. Alternative 2 provides immediate post-construction supply of larger cobble and boulder-sized particles that play a crucial role in plugging step-pools, creating heterogeneity and improving their fish passage and resting performance.

5. Alternative 2 requires approximately half the time of Alternative 1 to reach geomorphic equilibration. Combined with Point 3 above, this reduces the risk of project failure for Alternative 2.

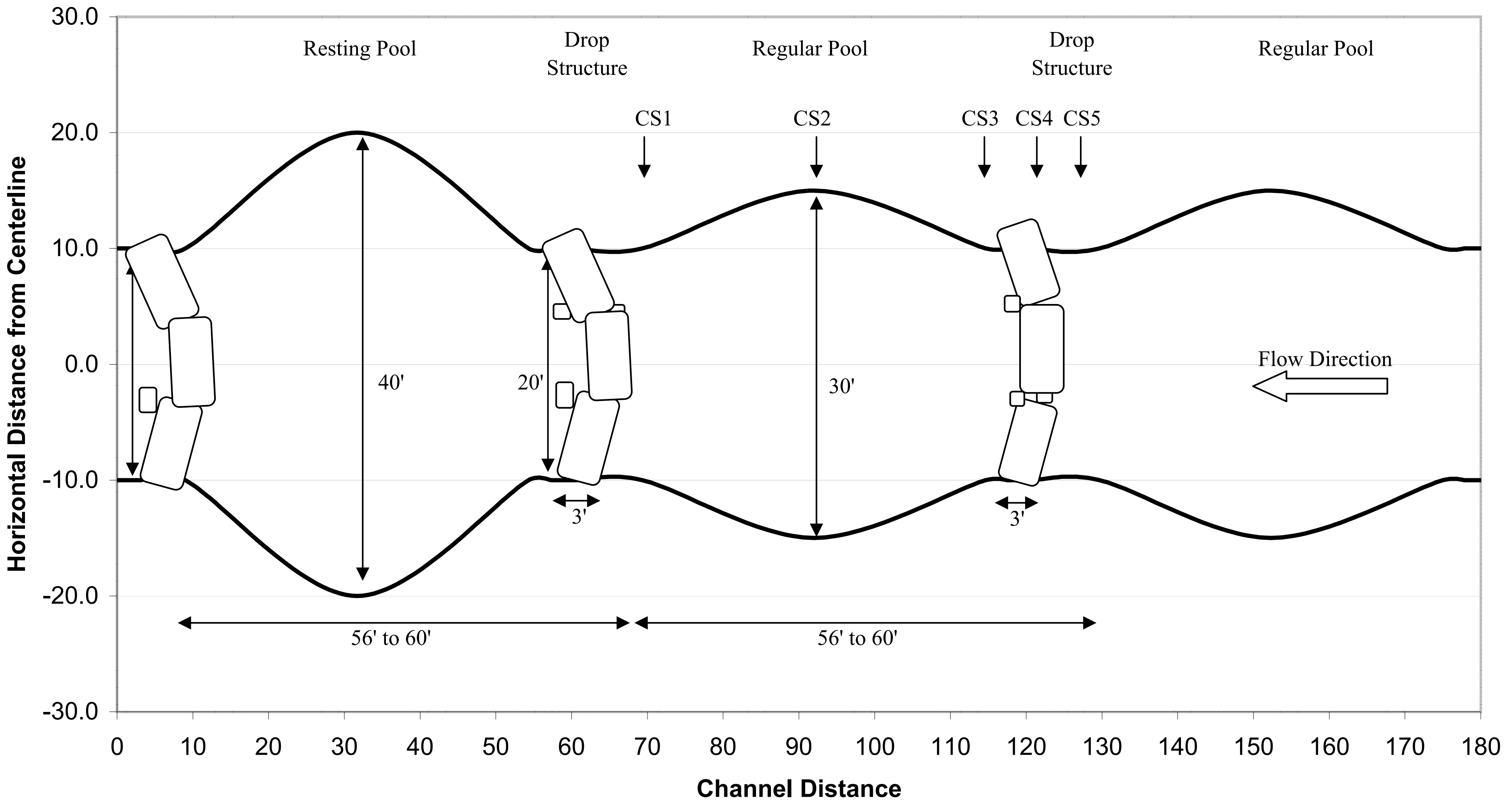
6. Overall, Alternative 2 offers significant benefits over Alternative 1 in terms of shortening the critical fish passage reaches, the supply of coarse sediment and the time taken for the project to reach geomorphic equilibrium. The cost difference (see Section 7.9) is small relative to the overall project costs and performance benefits.

7. Because of the high entrainment forces found in the Lower San Clemente Reach, particular care should be paid in designing the step pools. Steps should be designed using large, tabular nucleus boulders and placed to encourage particles to knit together. In critical reaches steps may be constructed directly by blasting bedrock.

8. There are inherent risks associated with diverting a river fed by a 125 square mile watershed down a steeper and more confined valley cut by a river with a 16 square mile watershed. Given this situation, and the long time required to reach equilibrium, the final plan should make contingencies and allocate budget to repair steps that fail during large flood events.

Table 6-4. Comparison of Anticipated Project Performance for the Alternatives

	Primary Goals	**Alternative 1**	**Alternative 2**	**Differences between Alt 1 and Alt 2**
A1	Achieve and maintain passage for adult steelhead and smolts	Criteria met. San Clemente Creek reach crests are limiting factor.	Criteria met. San Clemente Creek reach crests are limiting factor.	Alt 2 is slightly superior due to fewer steps, but critical locations for passage are same in both alts.
A2	Maintain a stable, sustainable channel in dynamic equilibrium	Nucleus boulders stable to 100 year flood. Diversion channel <u>not</u> connected to significant cobble/boulder supply. Full sediment continuity after 400 years.	Nucleus boulders stable to 100 year flood. Diversion channel connected to significant cobble/boulder supply. Full sediment continuity after 180 years.	Alt 2 is better connected to cobble/boulder supply than Alt 1, and will reach equilibrium 120 years sooner than Alt 1.
A3	Maintain existing criteria for CAW water intake	Head, influent flow and water quality criteria can be met.	Head, influent flow and water quality criteria can be met.	440 foot longer pipeline required in Alt 2. Otherwise identical performance characteristics.
	Secondary Goals			
B1	Restore riparian habitat	Achievable	Achievable	No difference
B2	Achieve fish passage for all steelhead life stages	Upstream migration of juveniles may be challenging due to step height.	Upstream migration of juveniles may be challenging due to step height.	Alt 2 is slightly superior due to fewer steps, but critical locations for passage are same in both alts.
B3	Create spawning habitat upstream of diversion reach	Field assessment suggests this goal is unlikely to be met due to low gradient and depositional character of reach.	1.1% riffle-pool channel in upper Carmel River reach should provide spawning habitat.	Alt 2 is superior to Alt 1.
B4	Restore sediment continuity downstream	Full sediment continuity will be restored after approximately 400 years.	Full sediment continuity will be restored after approximately 180 years.	Alt 2 is superior to Alt 1.
B5	Meter out spawning sediment following construction	Feasible with Alt 1 but locations constrained to diversion reach.	Feasible for Alt 2 with locations in either diversion reach or upper Carmel River reach.	Feasible in both alternatives, slightly easier to implement in Alt 2.
B6	Provide fish resting pool at Carmel/San Clemente confluence	Achievable	Achievable	No difference
B7	Create red legged frog habitat along the river corridor	Achievable	Achievable	No difference



Note: Step-pool geometry used in HEC-RAS modeling. Pool spacing is 60' in 2.5% reach and 56' in 2.7% reach. CS1 through CS5 correspond to the HEC-RAS cross section numbers as described in the report.

figure 6-1

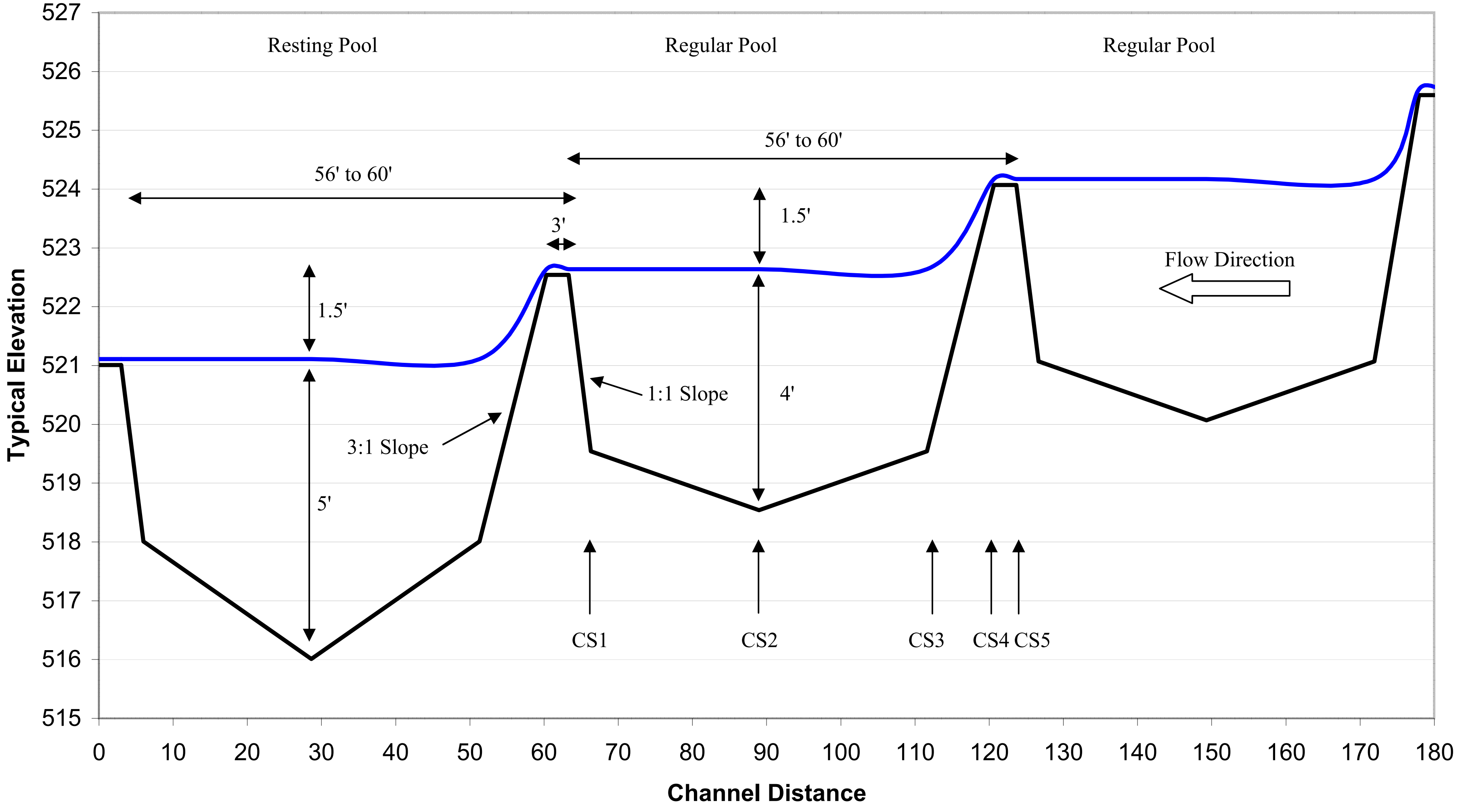
San Clemente Dam Removal

Typical Step-Pool Plan for 2.5% and 2.7% Reaches

PWA Ref# 1908.00

PWA

Fig6-1StepPoolPlan.xls / TypicalDropStructure (Plan)



Note: Step-pool geometry used in HEC-RAS modeling. Pool spacing is 60' in 2.5% reach and 56' in 2.7% reach. CS1 through CS5 correspond to the HEC-RAS cross section numbers as described in the report.

figure 6-2

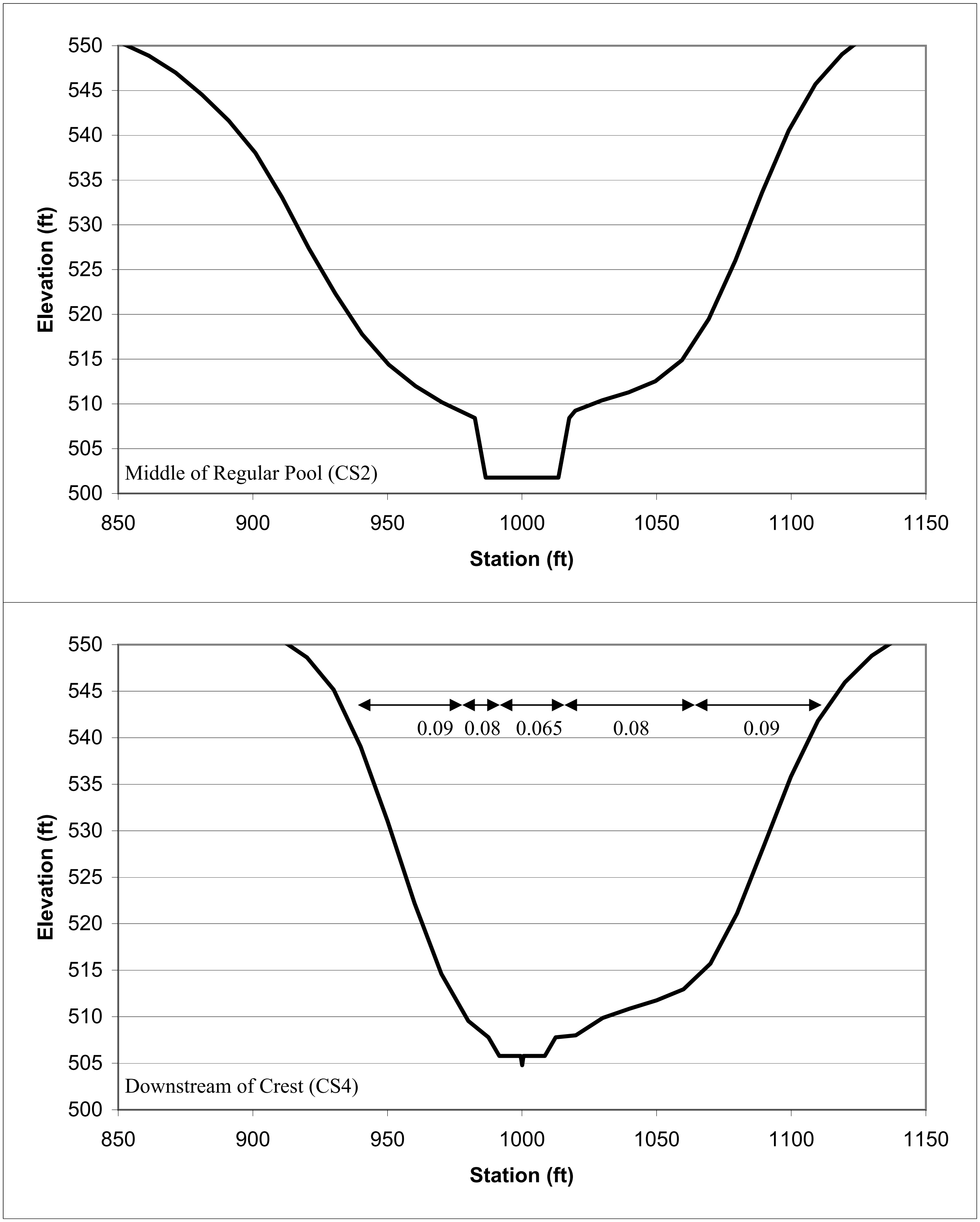
San Clemente Dam Removal

Typical Step-Pool Profile for 2.5% and 2.7% Reaches

PWA Ref# 1908.00

PWA

Fig6-2-StepPoolProfile.xls / Figure



Notes: Constricted pool and crest cross sections through San Clemente Reach. Manning's n values are shown on the top and are typical of the reach. Roughness values vary depending on geometry of the floodplain.

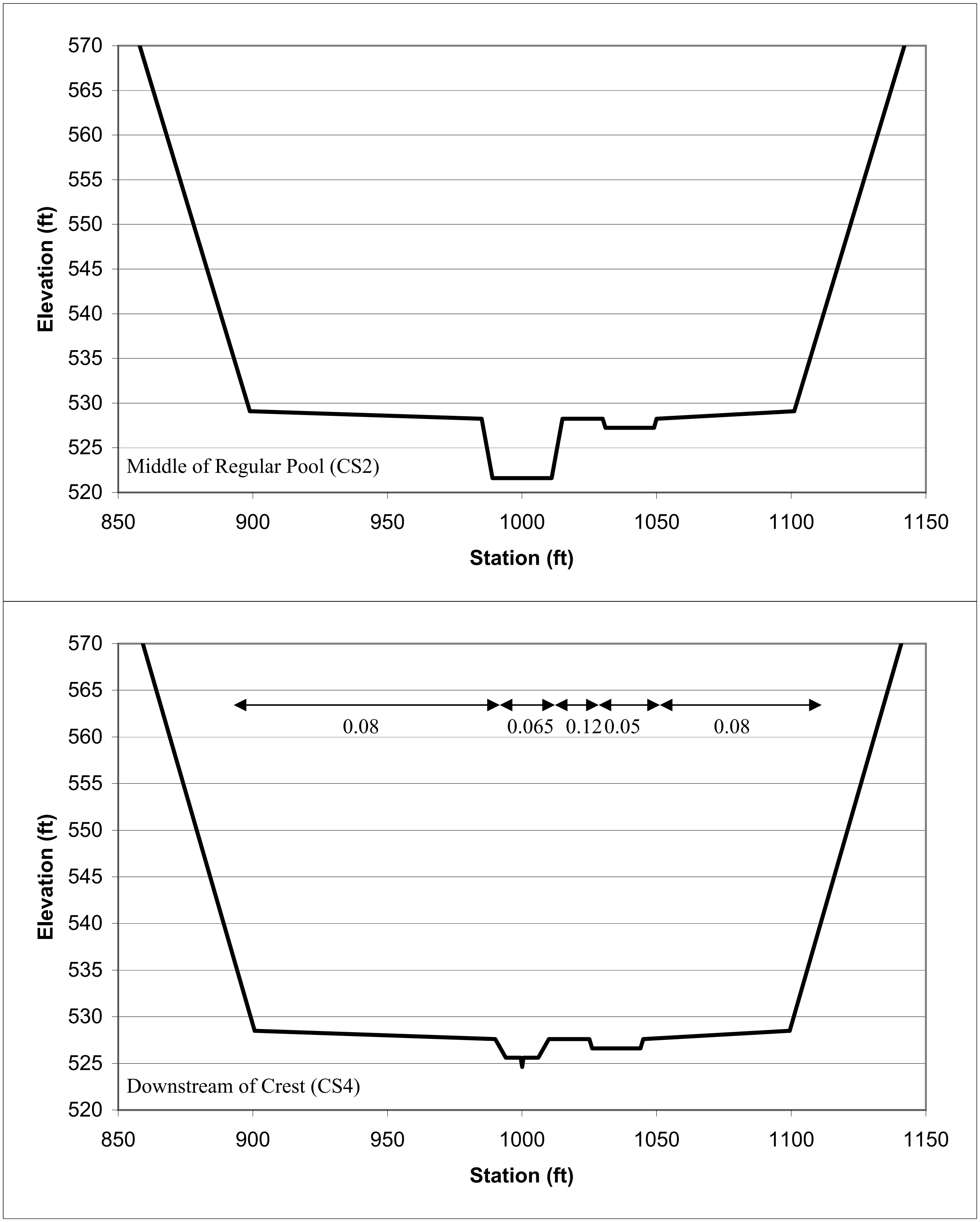
figure 6-3

San Clemente Dam Removal

Pool & Crest Cross Sections in San Clemente Reach

PWA Ref# 1908-00

PWA



Notes: Typical pool and crest cross sections through Diversion Reach. Manning's n values are shown on the top and are consistent for both pools and riffles. Valley hillslopes have a n value of 0.09.

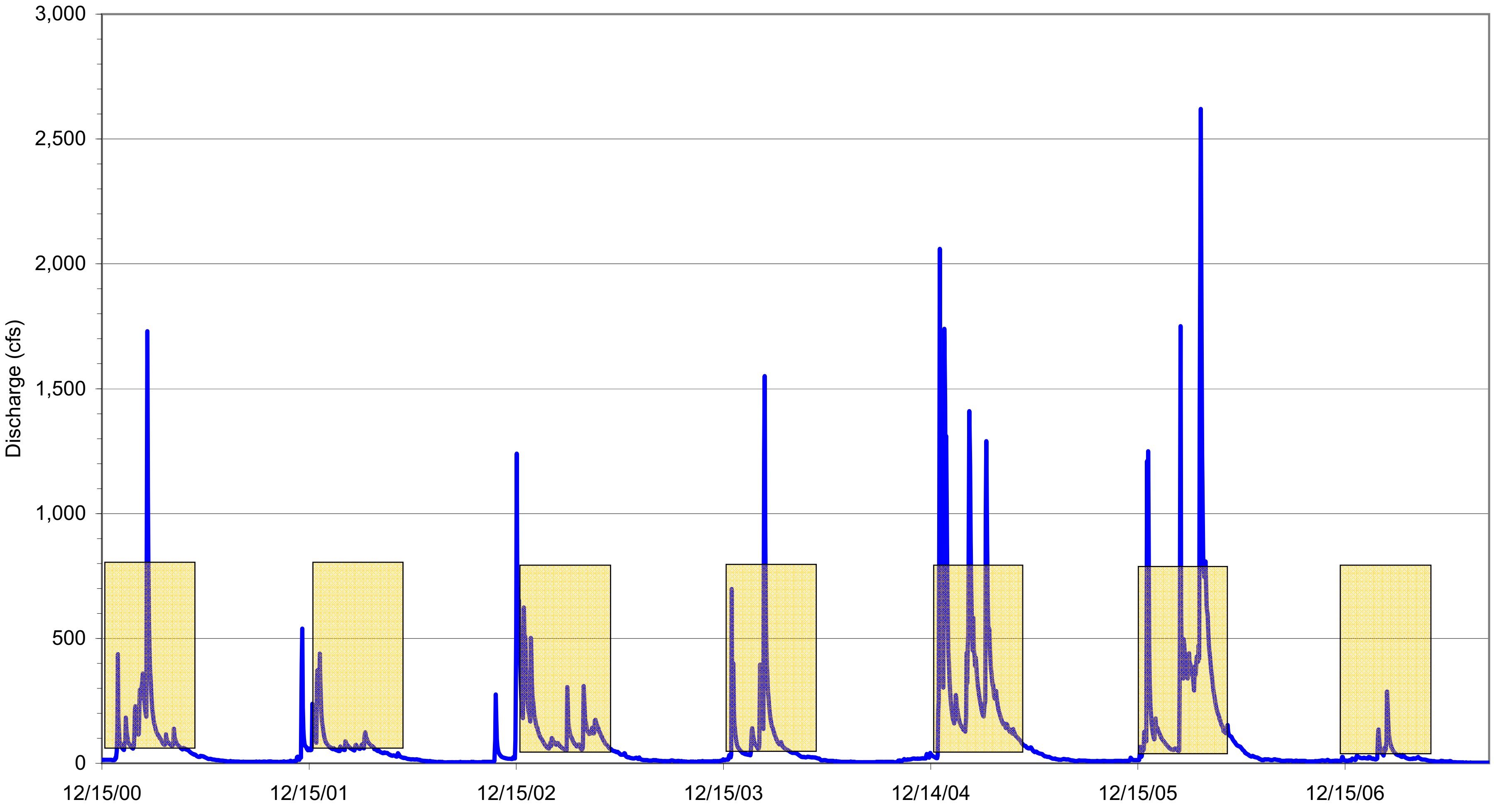
figure 6-4

San Clemente Dam Removal

Pool and Crest Cross Sections in Alt1 Diversion Reach

PWA Ref# 1908-00

PWA



Notes: Boxes represent steelhead migration window, based on timing (December 15 to June 15) and flow requirements (between 40 and 800 cfs). Blue line is Carmel River flow from USGS gage 11143200, located below confluence of Carmel River and San Clemente Creek.
Source: USGS

figure 6-5

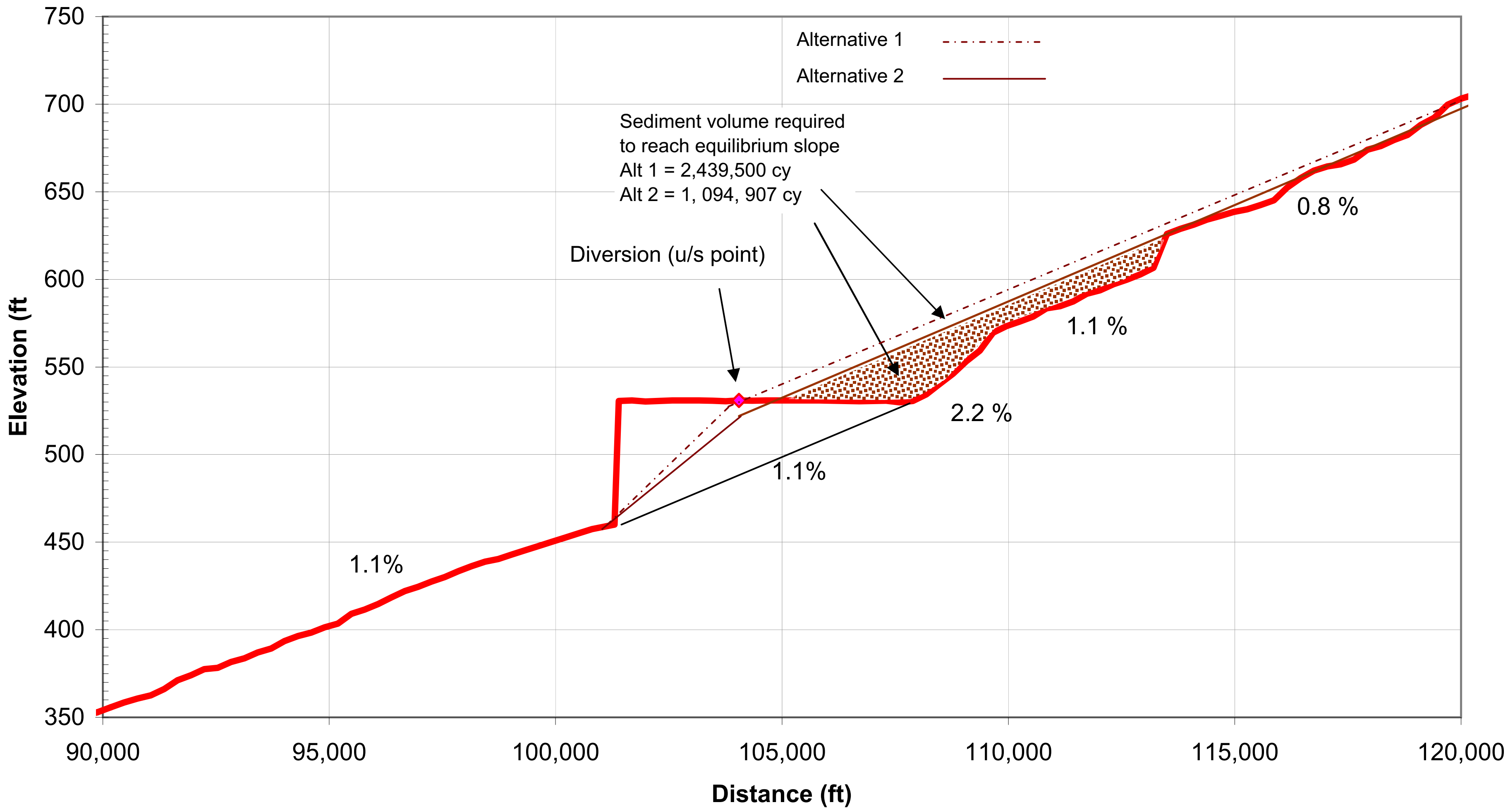
San Clemente Dam Removal

Carmel River Flow and Steelhead Migration Window

PWA Ref# 1908

PWA

Fig6-5-Hydrology.xls / Figure



Source: USGS National Elevation Dataset - 10 m DEM

figure 6-6

San Clemente Dam Removal

Volume of Sediment Required to Reach Equilibrium Gradient

PWA Ref# 1908

PWA

Fig6-6EquilProfile.xls / ProfilePlot (ft) (Fig6-6)

7. CONSTRUCTION COST ESTIMATE, CONSTRUCTION ISSUES, AND MONITORING & MAINTENANCE PLAN

We have developed the following cost estimate based on the data used by MWH (2005) and our experience on recent channel restoration projects.

7.1 BEDROCK EXCAVATION

The volume of bedrock was calculated by taking the existing topography (MWH) and 1921 USGS DTM and producing a composite terrain model of the post-project surface that included the exhumed San Clemente Creek canyon and the existing Carmel River reach. PWA cut the proposed MEI/MWH diversion channel through the ridgeline tying in with a location 3 feet below the 1921 surface (based on the observation of 3 feet of alluvium above the bedrock contact from the Kleinfelder borehole logs). We also lowered the diversion by 2 feet to ensure that there would not be a ‘hanging’ join at the junction of the San Clemente and diversion reaches. This difference produced a slightly larger excavated volume than MWH’s for Alternative 1. For Alternative 2 we projected a 1.1% channel from the junction point. We maintained a 1:1 side slope, so the rock cut is both wider and deeper than that proposed by MWH. Our unit bedrock cost was taken by dividing MWH’s total cost for the bedrock excavation and diversion dike placement and dividing by their total volume of rock. We used the same unit cost and multiplied by our new volumes. The true cost may be slightly higher than estimated since the original MWH estimate assumed rock blasting to produce relatively small boulders (1 foot diameter). We are assuming that approximately 500 nucleus boulders will be quarried from the ridge, with a size of approximately 6 feet by 4 feet by 2 feet (approximately 1,500 cubic yards of rock allowing for replacement boulders – see below). Quarrying and transporting these rocks may be more expensive than the assumed unit cost used, and should be revised following the geotechnical report. As an alternative to the use of boulder steps, in some reaches it may be desirable to create steps directly from bedrock during blasting. Such steps should conform with the hydraulic model (1.5 foot steps located every 50-60 feet with 4 foot deep pools, plus arrangements for larger resting pools).

Where boulder steps are used, we assume that the bedrock diversion reach will be constructed with an irregular floor to increase boulder stability and to encourage step reformation in the event of a failure. We envisage either that large rocks (2-3 feet diameter) will be placed in transverse ribs across the diversion reach floor at 50 foot intervals to help secure alluvial sediment for floodplain plantings, or that the rock excavation will be carried out in a manner that creates bedrock ribs.

7.2 STEP-POOLS

For the step-pools we took construction costs for similarly sized boulder step-pools and added a factor for inflation. This number will be sensitive to the quality and size of the rock that can be quarried out of the diversion reach, and should be revised following the geotechnical report. As an alternate approach in the reaches with the highest entrainment forces, it may be desirable to create the steps directly in the bedrock. This approach would require a more detailed cost estimate involving cutting rock with a high degree of precision. Steps should be designed with considerable flow heterogeneity so that at different flows different fish migration pathways open up (e.g. using a range of different rock sizes and shapes).

7.3 SIMULATED LANDSLIDES

We recommend that replacement boulders be placed at intervals along the channel so that if nucleus boulders are washed out there is a source of new material, simulating the processes that would occur in a landslide. The boulders should be stacked at the angle of repose alongside the valley wall so that they will be undercut in a 50 year event.

7.4 CHANNEL GRADING

For the channel grading costs in Alternative 2 we took the MWH total grading cost and back calculated a unit cost. We then multiplied this by the volume of the channel, assuming that both a channel and floodplain bench would be graded. If natural channel erosion is used (per the sub-alternatives) this cost may be ignored.

7.5 CHANNEL STABILIZATION

We assume that the alluvial channel banks above the step-pools and in the riffle-pool reaches will be stabilized using a system of vegetated soil lifts (VSLs). VSLs involve laying down successive 1 foot lifts of soil in a biodegradable coir fabric with live cuttings of alder or other appropriate material between each lift. We assume 4 feet of lifts on both banks along the entire project length. This replaces the channel restoration item in the MWH report.

7.6 RANNEY INTAKE SYSTEM

Alternative 1 will be identical to the MWH Alternative. Alternative 2 will require the intake to be relocated 440 feet upstream. We backcalculated the cost of the 30 inch pipeline and the cost of backfilling the additional length of pipe from the MWH tables, and pro-rated this by the additional length to estimate the total cost.

7.7 CONTINGENCIES AND UNCERTAINTIES

It is important to understand the degree of uncertainty concerning the condition of the historic channel in the Lower San Clemente Reach, and the effect that this may have on the final channel construction. There will have to be an element of ‘field fitting’ or even ‘field redesign’ of the final channel once sediment is removed from the valley and the former channel is revealed. On excavation of the valley it is possible that the channel form may either be already suited for the project (e.g. appropriately sized bedrock step-pools may be present under the alluvial layers) or extensive modification including rock blasting may be necessary. It is highly likely that there may be local valley gradient changes that necessitate changing the step-pool dimensions, or if the wider reaches are flatter, moving to a riffle-pool design for some sub-reaches. We have not budgeted for issues such as the need for additional bedrock blasting in the Lower San Clemente Reach. Note that the costing adapted from MWH included items such as mobilization and demobilization, de-watering, erosion control etc as well as standard contingencies for cost overruns and unanticipated events.

7.8 REVEGETATION

HTH developed two cost estimates based on the relative area of each habitat type under Alternatives 1 and 2. The basis for the cost estimate is included in Appendix 4.

7.9 PRELIMINARY COST ESTIMATE

	MEI/MWH Alternative	**Alternative 1**	**Alternative 2**
Volume of bedrock excavation	240,000	291,023	313,843
Cost per cubic yard	$ 24	$ 24	$ 24
Cost of bedrock excavation	**$ 5,760,000**	**$ 6,984,552**	**$ 7,532,232**
Step pools		46	38
Cost per step-pool		$ 60,000	$ 60,000
Cost of step-pools		**$ 2,760,000**	**$ 2,280,000**
Channel grading above diversion (cubic yards)			11,000
Cost per yard			$ 5.31
Cost of grading			**$ 58,410**
Stabilize banks and floodplain terrace (square feet along channel side)		15,600	15,600

	MEI/MWH Alternative	**Alternative 1**	**Alternative 2**
Cost per square foot		$ 90	$ 90
Cost of stabilization		**$ 1,404,000**	**$ 1,404,000**
Revegetation		$ 1,090,235	$ 1,218,107
Cost of channel restoration[1]	$ 1,000,000		
Total Restoration Cost	**$ 6,760,000**	**$ 12,238,787**	**$ 12,434,339**
Ranney Collector	**$ 3,200,000**	**$ 3,200,000**	**$ 3,347,000**
TOTAL COST OF RESTORATION	**$ 9,960,000**	**$ 15,438,787**	**$ 15,781,339**

[1] Cost of channel restoration in MWH 2005 appears to include all channel and revegetation activities

7.10 MONITORING AND MAINTENANCE PLAN

Although we have endeavored to design a stable channel, there is inherent risk in any channel restoration project, especially where a river is to be relocated. We recommend that the project is monitored for performance and stability as described below or by some other methods that obtain the same results. The monitoring program should be explicitly tied back to the project goals and objectives.

Fish passage (Note: This should be taken as the ultimate indicator of project performance.)

Monitoring activity. Conduct redd surveys during migration period upstream of the project area or spawner survey to visually assess whether adult steelhead are capable of moving through the project area and reaching upstream spawning habitat.

Frequency. Biweekly between December 15th and May 31st for 5 years after the project implementation, then at least once every 5 years or after a 5-year flow event.

Trigger for action. If fish passage is blocked within or below the project reach intervention will be required.

Management response. Reconstruction of step-pools or other modification of fish passage barrier as appropriate.

The project should consider designing a portion of the channel that concentrates adult steelhead moving upstream so they can be enumerated, potentially using a DIDSON (Dual frequency

Identification SONar) or other methods for counting fish in turbid water; ideally fish monitoring should include a telemetry study using radio or acoustic methodology.

Nucleus boulder stability

Monitoring activity. Visually assess structural stability, look for evidence of outflanking, rocks rolling into scour pools, rocks becoming aligned downstream rather than across the channel, steps becoming too porous so that medium size boulders and cobbles are no longer retained.

Frequency: Annually for first 3 years, then every 5 years or following flows greater than 10-year flow.

Trigger for action: If the nucleus boulders appear too spread out and unconnected to each other to reform during a large event and the channel is transforming into a plane-bed system it should be closely scrutinized for fish passage. Local movement and realignment of rocks that does not appear to be affecting fish passage should not immediately trigger repair work. If fish passage is affected repair work should be triggered.

Management response. Reconstruction of step-pools or other modification of fish passage barrier as appropriate. Add additional boulders if existing rock appears too dispersed to support step-pool stability.

Channel migration or avulsion

Monitoring activity. Visually inspect for evidence of channel blockages that may trigger an avulsion around the step-pool reaches in the San Clemente and Alternative 1 Diversion Reaches (avulsions of the Carmel Reach or Alternative 2 Diversion Reach are not viewed as a problem).

Frequency: Annually for first 3 years, then every 5 years or following flows greater than 10-year flow.

Trigger for action: If the main channel is aggrading and there is evidence of secondary flow lines scouring so the thalweg elevations are converging.

Management response. If an avulsion threatened to completely outflank the step-pool system and flow for a considerable distance down the floodplain it is recommended that boulders be placed in the floodplain to act as grade control, and that if dense vegetation is becoming established in the mainstem this is cleared (e.g. stems smaller than 6 inches cut).

Bank stability

Monitoring activity. Visually inspect banks for evidence of excessive erosion.

Frequency: Annually for first 3 years.

Trigger for action: If the banks appear to be eroding before vegetation recruitment stabilizes them then action should be considered.

Management response. Patch or revegetate banks. If persistent erosion occurs consider adding harder protection e.g. large woody debris or rock protection.

Vegetation Establishment

Monitoring activity. Visually inspect riparian restoration areas for evidence of increasing vegetation establishment.

Frequency: Annually for first 10 years.

Trigger for action: Lack of trend towards increasing vegetation establishment.

Management response. Implement active revegetation efforts.

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APPENDIX 1

Entrainment Analysis

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APPENDIX 1

Date:	10/2/2007
From:	Phairot Chatanantavet
PWA Project #:	1908
PWA Project Name:	San Clemente Dam Removal
Subject:	Calculation of particle entrainment thresholds for Upper Carmel Reach

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Goal: estimate the combinations of channel gradient and water depth that will entrain particles of different sizes into the Carmel River and deliver them to the Diversion Reach.

Assumptions

1. 1-D double trapezoidal open channel as shown below
2. D90 is ~ 10 inch cobble

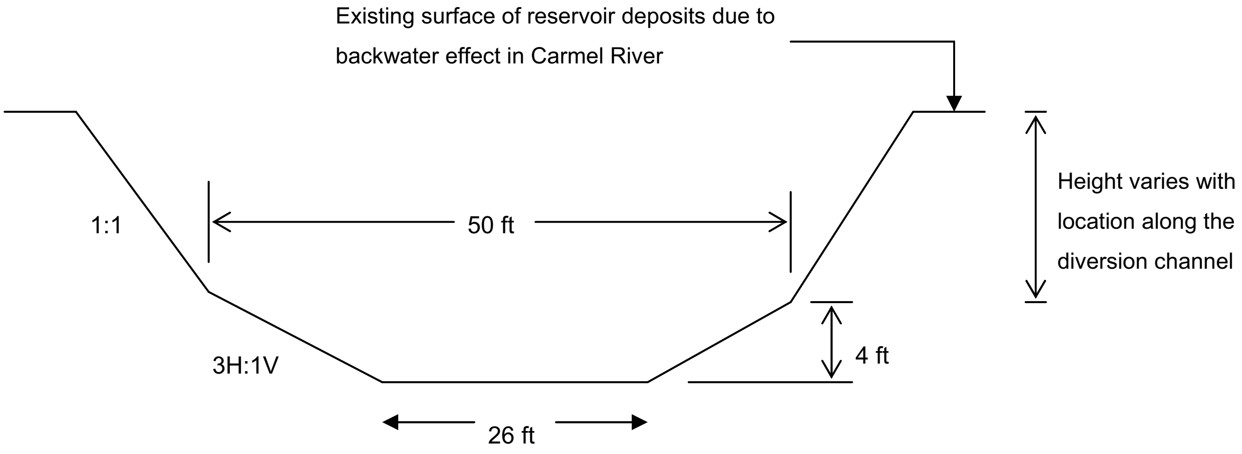

Figure A.1 Cross-section through the diversion channel in the Upper Carmel Reach

Equations used:

$$q_t = \sqrt{RgD}\, D\, \alpha_t \left\{ \left[\left(\frac{k_s^{1/3} q_w^2}{\alpha_r^2 g} \right)^{3/10} \frac{S^{7/10}}{RD} \right] - \tau_c^* \right\}^{n_t}$$

$$H = \left(\frac{k_s^{1/3} q_w^2}{\alpha_r^2 g S} \right)^{3/10} \qquad \text{where} \quad k_s = 2\ D_{90}$$

where q_t is volumetric sediment transport per unit width, R is nondimensional buoyant density = $(\rho_s/\rho) - 1$, ρ_s is rock density, ρ is density of water, g is gravitational acceleration, D is mean grain size, α_t is a coefficient in Meyer-Peter & Muller-type equation, n_t is an exponent in Meyer-Peter & Muller-type equation, k_s is roughness height (analogous to Manning coefficient), q_w is water discharge per unit width, α_r is a constant in the Manning-Strickler roughness relation, S is channel slope, τ_c* is critical Shields number, H is water depth, and D_{90} is grain size such that 90 percent of the sediment is finer.

Note: For water discharge per unit width q_w, it is already taken into account that it is a double trapezoidal shape channel (rather than rectangular).

Values used:
τ_c* = 0.03 (recommended by Sklar and Dietrich, 2004, for mountain streams, concluded from Buffington and Montgomery, 1997), α_t = 5.7, n_t = 1.5 from Fernandez Luque & van Beek (1976); α_r = 8.1 for gravel streams (Parker, 1991); D_{90} = 10 inch, Q2 = 1932 cfs, Q5 = 5445 cfs.

Method: calculate S based on other specified parameters so that sediment transport for that grain size > 0.

For Q2:

Boulder Size, inch	Slope required for Q2	Water depth or required bankfull depth for Q2 (ft)	Water depth (ft) in case of S = 0.01: alternative 2
6	0.005	5.3	4.4
12	0.012	4.2	(particles not moved)
18	0.021	3.6	(particles not moved)
24	0.03	3.3	(particles not moved)
30	0.041	3.1	(particles not moved)

For Q5:

Boulder Size, inch	Slope required for Q5	Water depth or required bankfull depth for Q5 (ft)	Water depth in case of S = 0.01: alternative 2
6	0.003	10.2	7.5
12	0.006	8.5	7.5
18	0.01	7.5	7.5
24	0.015	6.7	(particles not moved)
30	0.02	6.2	(particles not moved)

Summary:
If we use a 1% slope (per Alternative 2) so that the upstream end of the 1% diversion channel will be at the downstream limit of cobbles, within the magnitude of 5-year floods, boulder sizes of up to 18 inches will be entrained. However, in order to move sizes 24 and 30 inches, a flow higher than Q5 is needed for S = 0.01.

Assuming the double trapezoidal cross section in Figure A1. For S = 1.0%, in order to move size 24 inches, Q = 9400 cfs is required (flow depth = 9.9 ft). For S = 1.1%, in order to move size 24 inches, Q = 8200 cfs is required (flow depth = 9.0 ft). Note that the depth from excavation may not be deep enough to confine the flow.

References

Buffington, J.M. and Montgomery, D.R. (1997) A systematic analysis of eight decades of incipient motion studies, with special reference to gravel-bedded rivers, Water Resources Research, 33, 1993-2029.

Sklar, L.S., and Dietrich, W.E. (2004) A mechanistic model for river incision into bedrock by saltating bed load, Water Resources Research, 40, W06301.

APPENDIX 2

Percentage of Time Fish Passage Criteria are Met During Potential Migration Events for Years 2000 through 2007

WY 2000
12/15 to 5/30

Max Passable Flow	800	cfs
Min Passable Flow	40	cfs
Max Pool Velocity	3	fps
Max Crest Velocity	6	fps

Codes

1	Meets flow range and channel velocity requirements
2	Meets flow range requirement and fails channel velocity requiren
3	Fails flow range requirement
4	Meets flow range and overbank depth and velocity requirements and fails channel velocity requirement
5	Meets flow range and overbank depth requirements and fails channel and overbank velocity requirements

Channel Only	slope	1	2	3	4	5	**% time passable**
Highest velocity pool[3]	2.5	116	4	48			**97%**
Highest velocity crest[4]	2.5	9	111	48			**8%**
Typical pool	2.5	116	4	48			**97%**
Typical resting pool	2.5	120	0	48			**100%**
Highest velocity pool[3]	2.7	105	8	55			**93%**
Highest velocity crest[4]	2.7	0	113	55			**0%**
Typical pool	2.7	105	8	55			**93%**
Typical resting pool	2.7	113	0	55			**100%**
Typical Pool	1.1	112	0	56			**100%**
Typical Riffle	1.1	112	0	56			**100%**

Channel and FP	slope	1	2	3	4	5	
Highest velocity pool[3]	2.5	116	4	48	0	0	**97%**
Highest velocity crest[4]	2.5	9	111	48	0	0	**8%**
Typical pool	2.5	116	4	48	0	0	**97%**
Typical resting pool	2.5	120	0	48	0	0	**100%**
Highest velocity pool[3]	2.7	105	0	55	8	0	**100%**
Highest velocity crest[4]	2.7	0	107	55	0	6	**0%**
Typical pool	2.7	105	0	55	8	0	**100%**
Typical resting pool	2.7	113	0	55	0	0	**100%**
Typical Pool	1.1	112	0	56	0	0	**100%**
Typical Riffle	1.1	112	0	56	0	0	**100%**

WY 2001
12/15 to 5/30

Max Passable Flow	800	cfs
Min Passable Flow	40	cfs
Max Pool Velocity	3	fps
Max Crest Velocity	6	fps

Codes	
1	Meets flow range and channel velocity requirements
2	Meets flow range requirement and fails channel velocity requiren
3	Fails flow range requirement
4	Meets flow range and overbank depth and velocity requirements and fails channel velocity requirement
5	Meets flow range and overbank depth requirements and fails channel and overbank velocity requirements

Channel Only	slope	1	2	3	4	5	**% time passable**
Highest velocity pool[3]	2.5	130	1	36			**99%**
Highest velocity crest[4]	2.5	4	127	36			**3%**
Typical pool	2.5	130	1	36			**99%**
Typical resting pool	2.5	131	0	36			**100%**
Highest velocity pool[3]	2.7	126	2	39			**98%**
Highest velocity crest[4]	2.7	0	128	39			**0%**
Typical pool	2.7	126	2	39			**98%**
Typical resting pool	2.7	128	0	39			**100%**
Typical Pool	1.1	128	0	39			**100%**
Typical Riffle	1.1	128	0	39			**100%**

Channel and FP	slope	1	2	3	4	5	
Highest velocity pool[3]	2.5	130	1	36	0	0	**99%**
Highest velocity crest[4]	2.5	4	127	36	0	0	**3%**
Typical pool	2.5	130	1	36	0	0	**99%**
Typical resting pool	2.5	131	0	36	0	0	**100%**
Highest velocity pool[3]	2.7	126	0	39	2	0	**100%**
Highest velocity crest[4]	2.7	0	126	39	0	2	**0%**
Typical pool	2.7	126	0	39	2	0	**100%**
Typical resting pool	2.7	128	0	39	0	0	**100%**
Typical Pool	1.1	128	0	39	0	0	**100%**
Typical Riffle	1.1	128	0	39	0	0	**100%**

WY 2002
12/15 to 5/30

Max Passable Flow	800	cfs
Min Passable Flow	40	cfs
Max Pool Velocity	3	fps
Max Crest Velocity	6	fps

Codes

1 Meets flow range and channel velocity requirements
2 Meets flow range requirement and fails channel velocity requiren
3 Fails flow range requirement
4 Meets flow range and overbank depth and velocity requirements and fails channel velocity requirement
5 Meets flow range and overbank depth requirements and fails channel and overbank velocity requirements

Channel Only	slope	1	2	3	4	5	**% time passable**
Highest velocity pool[3]	2.5	138	0	29			**100%**
Highest velocity crest[4]	2.5	12	126	29			**9%**
Typical pool	2.5	138	0	29			**100%**
Typical resting pool	2.5	138	0	29			**100%**
Highest velocity pool[3]	2.7	126	0	41			**100%**
Highest velocity crest[4]	2.7	0	126	41			**0%**
Typical pool	2.7	126	0	41			**100%**
Typical resting pool	2.7	126	0	41			**100%**
Typical Pool	1.1	125	0	42			**100%**
Typical Riffle	1.1	125	0	42			**100%**

Channel and FP	slope	1	2	3	4	5	
Highest velocity pool[3]	2.5	138	0	29	0	0	**100%**
Highest velocity crest[4]	2.5	12	126	29	0	0	**9%**
Typical pool	2.5	138	0	29	0	0	**100%**
Typical resting pool	2.5	138	0	29	0	0	**100%**
Highest velocity pool[3]	2.7	126	0	41	0	0	**100%**
Highest velocity crest[4]	2.7	0	126	41	0	0	**0%**
Typical pool	2.7	126	0	41	0	0	**100%**
Typical resting pool	2.7	126	0	41	0	0	**100%**
Typical Pool	1.1	125	0	42	0	0	**100%**
Typical Riffle	1.1	125	0	42	0	0	**100%**

WY 2003
12/15 to 5/30

Max Passable Flow	800	cfs
Min Passable Flow	40	cfs
Max Pool Velocity	3	fps
Max Crest Velocity	6	fps

Codes

1	Meets flow range and channel velocity requirements
2	Meets flow range requirement and fails channel velocity requiren
3	Fails flow range requirement
4	Meets flow range and overbank depth and velocity requirements and fails channel velocity requirement
5	Meets flow range and overbank depth requirements and fails channel and overbank velocity requirements

Channel Only	slope	1	2	3	4	5	**% time passable**
Highest velocity pool[3]	2.5	165	1	1			**99%**
Highest velocity crest[4]	2.5	0	166	1			**0%**
Typical pool	2.5	165	1	1			**99%**
Typical resting pool	2.5	166	0	1			**100%**
Highest velocity pool[3]	2.7	164	2	1			**99%**
Highest velocity crest[4]	2.7	0	166	1			**0%**
Typical pool	2.7	164	2	1			**99%**
Typical resting pool	2.7	166	0	1			**100%**
Typical Pool	1.1	166	0	1			**100%**
Typical Riffle	1.1	166	0	1			**100%**

Channel and FP	slope	1	2	3	4	5	
Highest velocity pool[3]	2.5	165	1	1	0	0	**99%**
Highest velocity crest[4]	2.5	0	166	1	0	0	**0%**
Typical pool	2.5	165	1	1	0	0	**99%**
Typical resting pool	2.5	166	0	1	0	0	**100%**
Highest velocity pool[3]	2.7	164	0	1	2	0	**100%**
Highest velocity crest[4]	2.7	0	166	1	0	0	**0%**
Typical pool	2.7	164	0	1	2	0	**100%**
Typical resting pool	2.7	166	0	1	0	0	**100%**
Typical Pool	1.1	166	0	1	0	0	**100%**
Typical Riffle	1.1	166	0	1	0	0	**100%**

WY 2004
12/15 to 5/30

Max Passable Flow	800	cfs
Min Passable Flow	40	cfs
Max Pool Velocity	3	fps
Max Crest Velocity	6	fps

Codes
1 Meets flow range and channel velocity requirements
2 Meets flow range requirement and fails channel velocity requiren
3 Fails flow range requirement
4 Meets flow range and overbank depth and velocity requirements and fails channel velocity requirement
5 Meets flow range and overbank depth requirements and fails channel and overbank velocity requirements

Channel Only	slope	1	2	3	4	5	**% time passable**
Highest velocity pool[3]	2.5	99	1	68			**99%**
Highest velocity crest[4]	2.5	16	84	68			**16%**
Typical pool	2.5	99	1	68			**99%**
Typical resting pool	2.5	100	0	68			**100%**
Highest velocity pool[3]	2.7	82	2	84			**98%**
Highest velocity crest[4]	2.7	0	84	84			**0%**
Typical pool	2.7	82	2	84			**98%**
Typical resting pool	2.7	84	0	84			**100%**
Typical Pool	1.1	84	0	84			**100%**
Typical Riffle	1.1	84	0	84			**100%**

Channel and FP	slope	1	2	3	4	5	
Highest velocity pool[3]	2.5	99	1	68	0	0	**99%**
Highest velocity crest[4]	2.5	16	84	68	0	0	**16%**
Typical pool	2.5	99	1	68	0	0	**99%**
Typical resting pool	2.5	100	0	68	0	0	**100%**
Highest velocity pool[3]	2.7	82	0	84	2	0	**100%**
Highest velocity crest[4]	2.7	0	84	84	0	0	**0%**
Typical pool	2.7	82	0	84	2	0	**100%**
Typical resting pool	2.7	84	0	84	0	0	**100%**
Typical Pool	1.1	84	0	84	0	0	**100%**
Typical Riffle	1.1	84	0	84	0	0	**100%**

WY 2005
12/15 to 5/30

Max Passable Flow	800	cfs
Min Passable Flow	40	cfs
Max Pool Velocity	3	fps
Max Crest Velocity	6	fps

Codes

1	Meets flow range and channel velocity requirements
2	Meets flow range requirement and fails channel velocity requiren
3	Fails flow range requirement
4	Meets flow range and overbank depth and velocity requirements and fails channel velocity requirement
5	Meets flow range and overbank depth requirements and fails channel and overbank velocity requirements

Channel Only	slope	1	2	3	4	5	**% time passable**
Highest velocity pool[3]	2.5	165	1	1			**99%**
Highest velocity crest[4]	2.5	0	166	1			**0%**
Typical pool	2.5	165	1	1			**99%**
Typical resting pool	2.5	166	0	1			**100%**
Highest velocity pool[3]	2.7	135	4	28			**97%**
Highest velocity crest[4]	2.7	0	139	28			**0%**
Typical pool	2.7	139	0	28			**100%**
Typical resting pool	2.7	136	3	28			**98%**
Typical Pool	1.1	144	0	23			**100%**
Typical Riffle	1.1	144	0	23			**100%**

Channel and FP	slope	1	2	3	4	5	
Highest velocity pool[3]	2.5	165	0	1	1	0	**100%**
Highest velocity crest[4]	2.5	0	0	1	166	0	**100%**
Typical pool	2.5	165	0	1	1	0	**100%**
Typical resting pool	2.5	166	0	1	0	0	**100%**
Highest velocity pool[3]	2.7	135	0	28	4	0	**100%**
Highest velocity crest[4]	2.7	0	0	28	139	0	**100%**
Typical pool	2.7	139	0	28	0	0	**100%**
Typical resting pool	2.7	136	0	28	3	0	**100%**
Typical Pool	1.1	144	0	23	0	0	**100%**
Typical Riffle	1.1	144	0	23	0	0	**100%**

WY 2006
12/15 to 5/30

Max Passable Flow	800	cfs
Min Passable Flow	40	cfs
Max Pool Velocity	3	fps
Max Crest Velocity	6	fps

Codes

1	Meets flow range and channel velocity requirements
2	Meets flow range requirement and fails channel velocity requiren
3	Fails flow range requirement
4	Meets flow range and overbank depth and velocity requirements and fails channel velocity requirement
5	Meets flow range and overbank depth requirements and fails channel and overbank velocity requirements

Channel Only	slope	1	2	3	4	5	**% time passable**
Highest velocity pool[3]	2.5	145	4	18			**97%**
Highest velocity crest[4]	2.5	0	149	18			**0%**
Typical pool	2.5	145	4	18			**97%**
Typical resting pool	2.5	149	0	18			**100%**
Highest velocity pool[3]	2.7	144	8	15			**95%**
Highest velocity crest[4]	2.7	0	152	15			**0%**
Typical pool	2.7	144	8	15			**95%**
Typical resting pool	2.7	152	0	15			**100%**
Typical Pool	1.1	152	0	15			**100%**
Typical Riffle	1.1	152	0	15			**100%**

Channel and FP	slope	1	2	3	4	5	
Highest velocity pool[3]	2.5	145	4	18	0	0	**97%**
Highest velocity crest[4]	2.5	0	149	18	0	0	**0%**
Typical pool	2.5	145	4	18	0	0	**97%**
Typical resting pool	2.5	149	0	18	0	0	**100%**
Highest velocity pool[3]	2.7	144	0	15	8	0	**100%**
Highest velocity crest[4]	2.7	0	146	15	0	6	**0%**
Typical pool	2.7	144	0	15	8	0	**100%**
Typical resting pool	2.7	152	0	15	0	0	**100%**
Typical Pool	1.1	152	0	15	0	0	**100%**
Typical Riffle	1.1	152	0	15	0	0	**100%**

WY 2007
12/15 to 5/30

Max Passable Flow	800	cfs
Min Passable Flow	40	cfs
Max Pool Velocity	3	fps
Max Crest Velocity	6	fps

Codes

1	Meets flow range and channel velocity requirements
2	Meets flow range requirement and fails channel velocity requir
3	Fails flow range requirement
4	Meets flow range and overbank depth and velocity requirements and fails channel velocity requirement
5	Meets flow range and overbank depth requirements and fails channel and overbank velocity requirements

Channel Only	slope	1	2	3	4	5	**% time passable**
Highest velocity pool[3]	2.5	29	0	138			**100%**
Highest velocity crest[4]	2.5	5	24	138			**17%**
Typical pool	2.5	29	0	138			**100%**
Typical resting pool	2.5	29	0	138			**100%**
Highest velocity pool[3]	2.7	24	0	143			**100%**
Highest velocity crest[4]	2.7	0	24	143			**0%**
Typical pool	2.7	24	0	143			**100%**
Typical resting pool	2.7	24	0	143			**100%**
Typical Pool	1.1	24	0	143			**100%**
Typical Riffle	1.1	24	0	143			**100%**

Channel and FP	slope	1	2	3	4	5	
Highest velocity pool[3]	2.5	29	0	138	0	0	**100%**
Highest velocity crest[4]	2.5	5	24	138	0	0	**17%**
Typical pool	2.5	29	0	138	0	0	**100%**
Typical resting pool	2.5	29	0	138	0	0	**100%**
Highest velocity pool[3]	2.7	24	0	143	0	0	**100%**
Highest velocity crest[4]	2.7	0	24	143	0	0	**0%**
Typical pool	2.7	24	0	143	0	0	**100%**
Typical resting pool	2.7	24	0	143	0	0	**100%**
Typical Pool	1.1	24	0	143	0	0	**100%**
Typical Riffle	1.1	24	0	143	0	0	**100%**

APPENDIX 3

Nucleus Boulder Sizing Analysis

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APPENDIX 3

Date: 12/13/2007
From: Rocko A. Brown
PWA Project #: 1908
PWA Project Name: San Clemente Dam Removal
Subject: Nucleus Boulder Sizing Analysis

Purpose:

This appendix presents the methodology, assumptions, and results for the preliminary sizing of nucleus boulders for constructed step-pools using force balance approaches outlined by Helley (1969), Graf (1971), and Chanson (2005). This approach was used because many common particle stability analyses assume a perfect sphere, which may not be valid as large boulders supplied from quarrying are typically irregular in nature. Moreover, inspection of the principal forces on a submerged boulder under flowing water (drag, lift, boulder weight) reveals that overall boulder size needed for stability can be reduced using shapes that reduce the surface area, A_s, in which drag and lift are effective, while maintaining sufficient weight and volume (V_s) for stability.

Assumptions:

1. Boulders will be either tabular or elliptical in shape (see figures A.3.1 and A.3.2).
2. There are no other structural points of contact for the boulder
3. 1' of boulder is buried below bed and thus bed slope is negligible
4. Boulder length perpendicular to flow is equal to W_s.
5. The length, Ls, of the boulders was kept at 6 feet.
6. 1D uniform flow

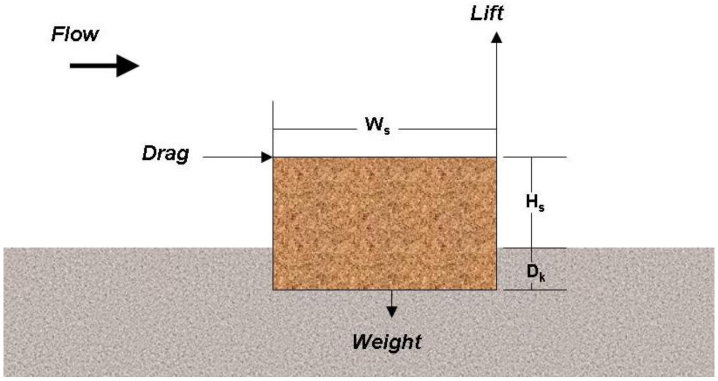

Figure A.3.1 Force balance on tabular boulder

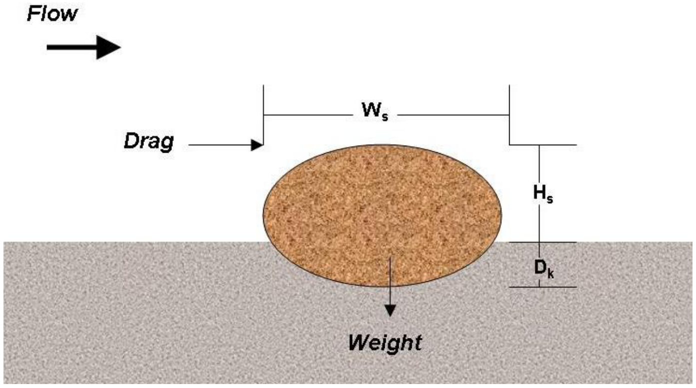

Figure A.3.2 Force balance on elliptical boulder

Equations Used:

For a Tabular Boulder

$$F_S = \left(\frac{(\rho_s - \rho) g V_s (W_s / 2)}{C_D \rho A_s (U^2 / 2) H_s + C_L \rho A_s (U^2 / 2) H_s} \right)$$

For an Elliptical Boulder

$$U_c = 3.276 \sqrt{\left(\frac{(SG - 1) L_s (H_s + W_s) MRL }{(C'_D H_s L_s MRD + 0.178 * W_s L_s MRL)} \right)}$$

$$F_S = \left(\frac{U_c}{U}\right)$$

Where ρ_s = sediment density, ρ = water density, g = gravity, Vs = stone volume, W_s = boulder width parallel to flow, A_s = boulder area perpendicular to flow, U = design velocity, H_s = height of stone above bed, Ls = length of boulder perpendicular to flow, SG = specific gravity, C_D =drag coefficient, C'_D = modified drag coefficient, C_L = lift coefficient, MRD = drag turning arm (see Helley, 1969 for derivation), MRL = lift turning arm (see Helley, 1969 for derivation), U_c = critical velocity, F_s = factor of safety.

Note: Factors of safety for elliptical stones are may be less than tabular stones, which is counterintuitive. This is attributed to the modified drag coefficient used in the derivation for critical velocity by Helley (1969).

Values used:
ρ_s = 155 lbs/ ft^3, ρ = 62.4 lbs/ ft^3, g = 32.2 ft/s^2, SG = 2.65, C_D =.75 (Munson et al., 2005), C'_D = $(1-H_s/1)*C_D$ (Helley, 1969), C_L = 0.2 (Munson et al., 2005), U= design velocities from HEC-RAS.

Method: Using design velocities determine range of stable nucleus boulder sizes associated with recurrence interval discharges to achieve a satisfactory factor of safety. Channel hydraulics were simulated using HEC-RAS and the assumptions of 1D uniform flow should be noted. Moreover, for rock sizing purposes the roughness coefficients used in HEC-RAS were modified by a factor of 2.2 as recommended by Trieste and Jarrett (1987). This was done because using typical roughness values in the model areas of super critical flow were found and this was interpreted as unrealistic for large floods.

Results:

Table A.3.1 – Factor of Safety for tabular and elliptical rock sizing for rocks that are 6 feet long (perpendicular to flow) by 4 feet (base width) by 1.5 feet high (2.5 feet high, buried to a depth of 1 foot).

Flow Event	Discharge (ft^3/s)	Velocity (ft/s)	Depth at highest velocity location (ft)	Factor of Safety (tabular)	Factor of Safety (elliptical)
10-year	9,680	19.36	16.95	1.43	1.68
50-year	18,700	22.85	20.83	1.03	1.42

100-year	22,700	23.05	23.47	1.01	1.19
PMF	81,200	26.50	40.13	0.76	1.03

Summary:
Stable nucleus boulders will need to be roughly 4 feet wide by 6 feet long by 2.5 feet high, with a bed key of at least one foot. Pending further design refinement, nucleus boulder geometries can be refined to meet overall project objectives. Further design sizing exercises may want to assume additional points of contact to more realistically simulate anticipated design conditions.

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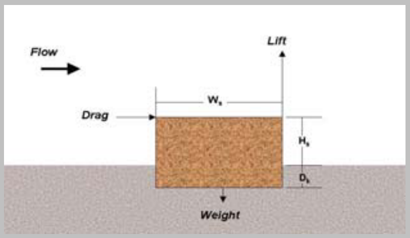
Helley EJ. 1969. Field Measurements of the Initiation of Large Bed Particle Motion in Blue Creek Near Klamath, California. USGS Professional Paper 562-G.

Munson BR, Young DF, Okiishi TH. 2005. Fundamentals of Fluid Mechanics. 5th Ed. Wiley. USA.

Trieste DJ, Jarrett RD. 1987. Roughness Coefficients of Large Floods. Irrigation and Drainage Division Specialty Conference. Portland Or.

Input
Output

Rock/Clast Inputs			
Rock Height	H_s	2.5	ft
Rock Length (Perpendicular to stream flow)	L_s	6	ft
Rock Width	W_s	4	ft
Depth Keyed	D_k	1	ft
Rock Volume	V_s	60	ft^3
Rock Area	A_s	15	ft^2



Design Event	PMF

Hydraulic Inputs

Velocity	U	26.50	ft/s
Depth	D	40.13	ft/s

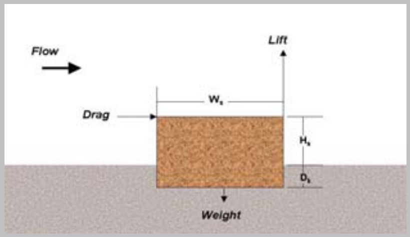
	Forces			Moment Arm		Moment	
Resisting	***Gravity***	$(p_s - p)\,gV_s$	178,903	$W_s/2$	*2*	$(p_s - p)\,gV_s(Ws/2)$	*357,806*
Driving	***Drag***	$C_d p A_s U^2/2$	246,490	$H_s - D_k$	*1.5*	$C_d p A_s(U^2/2)H_s$	*369,735*
	Lift	$C_L p A_s U^2/2$	65,731	$H_s - D_k$	*1.5*	$C_L p A_s(U^2/2)W_s$	*98,596*

	Stable	**NO**
Factor of Safety	**$M_W/(M_{FD}+M_{FL})$**	**0.76**

Based on force balance analyses presented by Graf (Mechanics of Sediment Transport, 1971) and Chanson (The Hydraulics of Open Channel Flows; 2004)

Input
Output

Rock/Clast Inputs			
Rock Height	H_s	2.5	ft
Rock Length (Perpendicular to stream flow)	L_s	6	ft
Rock Width	W_s	4	ft
Depth Keyed	D_k	1	ft
Rock Volume	V_s	60	ft^3
Rock Area	A_s	15	ft^2



Design Event — 100 Yr

Hydraulic Inputs			
Velocity	U	23.05	ft/s
Depth	D	23.47	ft/s

	Forces			Moment Arm		Moment	
Resisting	**Gravity**	$(p_s - p_{)}\, gV_s$	178,903	$W_s/2$	2	$(p_s - p_{)}\, gV_{s(}Ws/2)$	357,806
Driving	**Drag**	$C_d p\, A_s U^2/2$	186,487	$H_s - D_k$	1.5	$C_d p\, A_s(U^2/2)H_s$	279,731
	Lift	$C_L p\, A_s U^2/2$	49,730	$H_s - D_k$	1.5	$C_L p\, A_s(U^2/2)W_s$	74,595

	Stable	**YES**
Factor of Safety	**$M_W/(M_{FD}+M_{FL})$**	**1.01**

Design Event — 50 Yr

Hydraulic Inputs			
Velocity	U	22.85	ft/s
Depth	D	20.83	ft/s

	Forces			Moment Arm		Moment	
Resisting	**Gravity**	$(p_s - p_{)}\, gV_s$	178,903	$W_s/2$	2	$(p_s - p_{)}\, gV_{s(}Ws/2)$	357,806
Driving	**Drag**	$C_d p\, A_s U^2/2$	183,265	$H_s - D_k$	1.5	$C_d p\, A_s(U^2/2)H_s$	274,897
	Lift	$C_L p\, A_s U^2/2$	48,871	$H_s - D_k$	1.5	$C_L p\, A_s(U^2/2)W_s$	73,306

	Stable	**YES**
Factor of Safety	**$M_W/(M_{FD}+M_{FL})$**	**1.03**

Design Event — 10 Yr

Hydraulic Inputs			
Velocity	U	19.36	ft/s
Depth	D	16.95	ft/s

	Forces			Moment Arm		Moment	
Resisting	**Gravity**	$(p_s - p_{)}\, gV_s$	178,903	$W_s/2$	2	$(p_s - p_{)}\, gV_{s(}Ws/2)$	357,806
Driving	**Drag**	$C_d p\, A_s U^2/2$	131,558	$H_s - D_k$	1.5	$C_d p\, A_s(U^2/2)H_s$	197,337
	Lift	$C_L p\, A_s U^2/2$	35,082	$H_s - D_k$	1.5	$C_L p\, A_s(U^2/2)W_s$	52,623

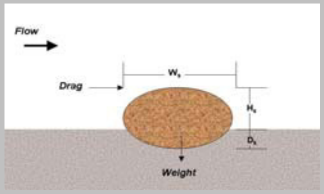
	Stable	**YES**
Factor of Safety	**$M_W/(M_{FD}+M_{FL})$**	**1.43**

Based on force balance analyses presented by Graf (Mechanics of Sediment Transport, 1971) and Chanson (The Hydraulics of Open Channel Flows; 2004)

Input
Output

Rock/Clast Inputs

Rock Height	H_s	1.5	ft
Rock Length (Perpendicular to stream flow)	L_s	6	ft
Rock Width	W_s	4	ft
Depth Keyed	D_k	1	ft
Modified Drag Based on Depth Keyed	C'_D	0.25	
Stone Angle (Angle of W_s to bed)	θ_B	0.00	Degrees
	θ_B	0.0	Radians



Design Event PMF

Hydraulic Inputs

Velocity	U	26.50	ft/s

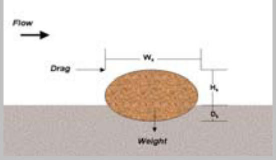
LiftTurning Arm	MRL	1.00
Drag Turning Arm	MRD	0.80
Critical Velocity	U_c	27.24
Factor of Safety	$\boldsymbol{U_c/U}$	1.03

$$u_c = 3.276\sqrt{\left(\frac{(SG-1)*\gamma*(H_s+W_s)*MRL}{(C_D*H_s*\gamma*MRD+0.178*\beta*\gamma*MRL)}\right)}$$

Source: Based on "Field Measurements of the Initian of Large Bed Particle Motion in Blue Creek Near Klamath, California." USGS Professional Paper 562-G. 1969.

Input
Output

Rock/Clast Inputs			
Rock Height	H_s	1.5	ft
Rock Length (Perpendicular to stream flow)	L_s	6	ft
Rock Width	W_s	4	ft
Depth Keyed	D_k	1	ft
Modified Drag Based on Depth Keyed	C'_D	0.25	
Stone Angle (Angle of W_s *to bed)*	θ_B	0.00	Degrees
	θ_B	0.0	Radians



Design Event *100YR*

Hydraulic Inputs

Velocity	U	23.05	ft/s

LiftTurning Arm	MRL	1.00
Drag Turning Arm	MRD	0.80
Critical Velocity	U_c	27.24
Factor of Safety	***U_c/U***	1.18

$$u_c = 3.276\sqrt{\left(\frac{(SG-1)*\gamma*(H_s+W_s)*MRL)}{(C_D*H_s*\gamma*MRD+0.178*\beta*\gamma*MRL)}\right)}$$

Design Event *50 YR*

Hydraulic Inputs

Velocity	U	22.85	ft/s

LiftTurning Arm	MRL	1.00
Drag Turning Arm	MRD	0.80
Critical Velocity	U_c	32.47
Factor of Safety	***U_c/U***	1.42

$$u_c = 3.276\sqrt{\left(\frac{(SG-1)*\gamma*(H_s+W_s)*MRL)}{(C_D*H_s*\gamma*MRD+0.178*\beta*\gamma*MRL)}\right)}$$

Design Event *10 YR*

Hydraulic Inputs

Velocity	U	19.36	ft/s

LiftTurning Arm	MRL	1.00
Drag Turning Arm	MRD	0.80
Critical Velocity	U_c	32.47
Factor of Safety	***U_c/U***	1.68

$$u_c = 3.276\sqrt{\left(\frac{(SG-1)*\gamma*(H_s+W_s)*MRL)}{(C_D*H_s*\gamma*MRD+0.178*\beta*\gamma*MRL)}\right)}$$

Source: Based on "Field Measurements of the Initian of Large Bed Particle Motion in Blue Creek Near Klamath, California." USGS Professional Paper 562-G. 1969.

APPENDIX 4

Revegetation Cost Estimate

SAN CLEMENTE DAM RESTORATION COST ESTIMATE- ALTERNATIVE 1

12/13/2007

AREA	LENGTH OF REVEGETATION AREA	NUMBER OF CHANNEL SIDES	# SRA REVEGETATION UNITS*	# FLOODPLAIN REVEGETATION UNITS*	RU COST	TOTAL COST
San Clemente Creek Reach SRA***	2900	2	22.0		$4,320	$190,080
San Clemente Creek Reach Floodplain**	2900	2		9.7	$4,320	$83,520
Diversion Reach SRA	450	2	4.5		$4,320	$38,880
Diversion Reach Floodplain**	450	2		1.5	$4,320	$12,960
Carmel River Reach SRA	0				$4,320	$4,320
Carmel River Reach Floodplain**	0				$4,320	$4,320
TOTALS			**26.5**	**11.2**		**$334,080**

* A Revegetation Unit consists of an area 25 ft x 100ft installed with 6 live root wads 20 ft o.c. and 100 live cuttings

	Unit Cost	#	Cost
Root wad harvest/salvage	280	6	$1,680
Root wad storage 6 mos.	100	6	$600
Root wad installation	280	6	$1,680
Cutting harvest and installation	3.6	100	$360
		Total	$4,320

** For floodplain planting areas assume installation of one Revegetation Unit every 300 linear feet

*** San Clemente reach length: 700 ft upper San Clemente and 2200 ft lower San Clemente

Soils Costs:

San Clemente Reach- salvage 1 foot of topsoil, stockpile and respread
Diversion Channel respread some soil on slopes from onsite salvage soils

	Length	Width	Depth	Cu Yds	Unit Cost	Total Cost
San Clemente Reach	2900	300	1	32222	$15	**$483,333**
Diversion Channel	450	200	0.5	1667	$15	**$25,000**
					Total	**$508,333**

Hydroseeding:	Length	Width	Area (acres)	Cost/Acre	Cost
San Clemente Reach	2900	300	20	$3,000	$59,917
Diversion Channel Banks	450	200	2	$3,000	$6,198
				Total	**$66,116**

TOTALS	
Revegetation	$334,080
Soils	$508,333
Hydroseeding	$66,116
20% contingency	$181,706
TOTAL	**$1,090,235**

SAN CLEMENTE DAM RESTORATION COST ESTIMATE- ALTERNATIVE 2

AREA	LENGTH OF REVEGETATION AREA	NUMBER OF CHANNEL SIDES	# SRA REVEGETATION UNITS*	# FLOODPLAIN REVEGETATION UNITS*	RU COST	TOTAL COST
San Clemente Creek Reach SRA***	2900	2	22.0		$4,320	$190,080
San Clemente Creek Reach Floodplain**	2900	2		9.7	$4,320	$83,520
Diversion Reach SRA	450	2	4.5		$4,320	$38,880
Diversion Reach Floodplain**	450	2		1.5	$4,320	$12,960
Carmel River Reach SRA	1000	2	10.0		$4,320	$86,400
Carmel River Reach Floodplain**	1000	2		3.3	$4,320	$28,800
TOTALS			**36.5**	**14.5**		**$440,640**

* A Revegetation Unit consists of an area 25 ft x 100ft installed with 6 live root wads 20 ft o.c. and 100 live cuttings

	Unit Cost	**#**	**Cost**
Root wad harvest/salvage	280	6	$1,680
Root wad storage 6 mos.	100	6	$600
Root wad installation	280	6	$1,680
Cutting harvest and installation	3.6	100	$360
		Total	$4,320

** For floodplain planting areas assume installation of one Revegetation Unit every 300 linear feet

*** San Clemente reach length: 700 ft upper San Clemente and 2200 ft lower San Clemente

Soils Costs:

San Clemente Reach- salvage 1 foot of topsoil, stockpile and respread

Diversion Channel respread some soil on slopes from onsite salvage soils

	Length	Width	Depth	Cu Yds	Unit Cost	Total Cost
San Clemente Reach	2900	300	1	32222	$15	**$483,333**
Diversion Channel	450	200	0.5	1667	$15	**$25,000**
					Total	**$508,333**

Hydroseeding:	Length	Width	Area (acres)	Cost/Acre	Cost
San Clemente Reach	2900	300	20	$3,000	$59,917
Diversion Channel Banks	450	200	2	$3,000	$6,198
				Total	**$66,116**

TOTALS	
Revegetation	$440,640
Soils	$508,333
Hydroseeding	$66,116
20% contingency	$203,018
TOTAL	**$1,218,107**

APPENDIX C

www.mwhglobal.com

MWH

California State Coastal Conservancy

Opinion of Probable Construction Cost

Contract No
Carmel River Reroute and San Clemente Dam Removal Project

Detailed Construction Cost Estimate

Submitted Date: **20-Dec-07**

AACE Class:	**Level 4**
Accuracy:	**-20% to +35%**
Currency:	**USD**
Estimator:	**ECC**
QC:	**JLL**
Office:	**WCK-1**

Basis of Estimate Report

Estimate: **Carmel River Reroute and San Clemente Dam Removal Project**

Currency :	**USD - United States Dollar**	**Date:**	12/20/2007

General Information:

Client:	California State Coastal Conservancy	**Address:**	
Project:	Carmel River Reroute and San Clemente Dam Removal Project	**PM:**	Vik Iso-Ahola
Description:	River Rerouting and Dam Removal	**Phone:**	925-627-4619

Estimate Criteria:

AACE Type:	Level 4	**Methodology:**	Detailed Unit Cost with Detailed Take-off
Design:	15%	**Accuracy Range:**	-20% to +35%
End Usage:	Concept Screening / Initial Budget	**Prep Effort:**	n/a

Reference Documents:

1	Advance Basis of Design Report.	**6**	
2		**7**	
3		**8**	
4		**9**	
5		**10**	

Estimate Scope:

The project involves the rerouting of Carmel River Bypass and removal of existing concrete arch dam. The bypassed portion of the Carmel River would be used as sediment disposal site for the accumulated sediment behind the dam. The project also involves the excavation of a diversion channel and construction of river water intake systemand permanent access road.

General Estimate Assumptions:

1	Pricing basis is 3rd quarter of 2007, Caltrans Price Index = 309.9 (12 mo rolling)	**6**	
2	Pricing excludes escalation. (Escalation added in the main report)	**7**	
3	Pricing assumes competitive conditions at time of tender (+3 bidders).	**8**	
4	Pricing is based on Davis Bacon wage rates (CA20070029)	**9**	
5	MWH completed a detailed quantity take-off of known scope elements.	**10**	

Specific Estimate Assumptions:

1	Work hours = 7:00am to 6:00pm.	**11**	
2	Work schedule = 5 days/week - Monday through Friday.	**12**	
3		**13**	
4		**14**	
5		**15**	
6		**16**	
7		**17**	
8		**18**	
9		**19**	
10		**20**	

Markup Summary

Estimate: **Carmel River Reroute and San Clemente Dam Removal Project**

Currency : **USD - United States Dollar** **Date:** 12/20/2007

General Information:

	Labor	Equipment	Job Matls	Perm Matls	Subcontract	Allowance	Plug	% Total
Direct Costs:	$ 7,114,291	$ 5,178,660	$ 780,338	$ 1,489,460	$ 13,873,196	$ -	$ 1,415,000	100%
Indirect Costs:	$ -	$ -	$ -	$ -	$ -	$ -	$ -	0%
Subtotal (D + I):	**$ 7,114,290** 1	**$ 5,178,660** 2	**$ 780,340** 3	**$ 1,489,460** 4	**$ 13,873,200** 5	**$ -** 6	**$ 1,415,000** 7	**100%**

Grand Total (1-7):	**$ 29,850,950**	8		
	$ 64,380	9	**8.25%**	**Materials Sales Tax on Job Materials (% of 3)**
	$ 122,880	10	**8.25%**	**Materials Sales Tax on Permanent Materials (% of 4)**
	$ 2,080,980	11	**15.00%**	**Subcontractor Markup Allowance (% of 5)**
	$ 346,830	12	**2.50%**	**Subcontractor Bonds (% of 5)**
	$ 355,710	13	**5.00%**	**Small Tool Expense (% of Labor)**
	$ -	14	**0.00%**	**Equipment Maintenance or Surcharge Factor (% of 2)**
Subtotal (8-14):	**$ 32,821,730**	15		
	$ 984,650	16	**3.00%**	**Contractor Insurance Program (Includes bonds, genl liability, bldrs risk, % of 15)**
	$ -	17	**0.00%**	**Market Conditions / Owner Reputation Allowance (% of 15 - 16)**
	$ 5,916,120	18	**17.50%**	**General Contractor H/O OH&P (% of 15 - 17)**
	$ -	19	**0.00%**	**Estimating Accuracy / Scope Contingency (% of 15 - 18)**
0.0 years	**$ -**	20	**0.00%**	**Escalation Allowance to Estimated MPC (% of 15 - 18)**
Grand Total:	**$ 39,722,500**	21	**33.07%**	**Markup Factor**

AACE International CLASS 4 Cost Estimate - Class 4 estimates are generally prepared based on limited information and subsequently have fairly wide accuracy ranges. Typically, engineering is 10% to 40% complete. They are typically used for project screening, determination of feasibility, concept evaluation, and preliminary budget approval. Virtually all Class 4 estimates use stochastic estimating methods such as cost curves, capacity factors, and other parametric and modeling techniques. Expected accuracy ranges are from -15% to -30% on the low side and +20% to 50% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances. As little as 20 hours or less to perhaps more than 300 hours may be spend preparing the estimate depending on the project and estimating methodology (AACE International Recommended Practices and Standards).

MWH OPCC Disclaimer - The client acknowledges that MWH has no control over costs of labor, materials, competitive bidding environments and procedures, unidentified field conditions, financial and/or market conditions, or any other factors likely to affect the OPCC of this project, all of which are and will unavoidably remain in a state of change, especially in light of the high volatility if the market attributable to Act of Gods and other market event beyond the control of the parties. Client further acknowledges that this OPCC is a "snapshot in time" and that the reliability of this OPCC will degrade over time. Client agrees that MWH cannot and does not make any warranty, promise, guarantee or representation, either express or implied. that proposals, bids, project construction costs, or cost of O&M functions will not vary significantly from MWH's good faith Class 4 OPCC.

Bid Form

Estimate: - Carmel River Reroute and San Clemente Dam Removal Project

Currency: United States

Grand Total Price:		39,722,500.00
Value Added Tax:	0.00 %	0.00
Total Price:		39,722,500.00

Client Item	Client Description	Quantity	UOM	Unit Price	Final Price
	River Bypass/Dam Removal	**1.00**	**LS**	**39,722,500.00**	**39,722,500.00**
001010	Equipment Mobilization / Management	1.00	LS	735,516.62	735,516.62
001020	Contractor Indirects	1.00	LS	2,469,091.55	2,469,091.55
001030	Traffic Controls	250.00	HRS	137.67	34,417.50
001040	Construction Permits/Plans	1.00	LS	252,947.00	252,947.00
001050	Improve Dam Access Roads	32,000.00	SY	0.65	20,800.00
001060	Cachagua Grade Access Rd to Site 4	15,000.00	SY	26.87	403,050.00
001070	Site 4 to Dam Haul Road	8,325.00	SY	69.98	582,583.50
001080	Sediment Disposal Site Preparation	5.00	AC	10,259.70	51,298.50
002010	Site Dewatering	1.00	LS	2,273,209.79	2,273,209.79
002012	Cutoff Walls	500.00	CY	1,226.19	613,095.00
002015	Channel/Dike Construction	417,411.00	CY	17.52	7,313,400.00
002017	Sediment Stabilization	50,000.00	CY	106.94	5,347,000.00
002020	Sediment Removal	381,000.00	CY	8.24	3,139,440.00
002040	Utility/Facility Relocation	1.00	LS	9,685.21	9,685.21
002045	Demo Existing Fish Ladder	400.00	CY	768.83	307,532.00
002050	Stream/Reservoir Restoration	20.00	AC	365,649.06	7,312,981.20
002060	Sediment Disposal Site Closure	1.00	LS	57,072.66	57,072.66
002070	Haul/Access Rd Restoration	10,000.00	SY	2.86	28,600.00
002090	Restore Construction Staging/Laydown Areas	15,000.00	SY	2.33	34,950.00
003000	Demobilization & Cleanup	1.00	LS	91,277.92	91,277.92
004000	Dam Removal By Blasting	7,500.00	CY	358.25	2,686,875.00
004002	Dam Notching - OCRD	1.00	CY	106,878.10	106,878.10
004020	Ranney Intake System	1.00	LS	2,386,988.83	2,386,988.83
004500	Unidentified Items	1.00	LS	3,228,402.50	3,228,402.50
005000	O&M Cost Allowance	1.00	LS	235,407.12	235,407.12

INSTRUCTIONS

1 In the EXPORTED IPE BID FORM report, copy the needed CELLS ONLY. i.e., from A1 to the last cell.
2 Go to cell A1 of this (Bid) worksheet and Paste the copied cells from step 1
3 Adjust Print Area to accommodate all cells
4 Page Break Preview and Adjust Breaks

Item Cost Summary

Estimate: - Carmel River Reroute and San Clemente Dam Removal Project

Currency: USD-United States-Dollar

Item	Description	Quantity	UOM	ManHr	Labor	Equip	Job Mat	Perm Mat	Sub/Plug	Total Cost
	River Bypass/Dam Removal									
001010	Equipment Mobilization / Management	1.00	LS	1,501	178,345	353,135	21,000			552,480
					178,345.00	*353,135.00*	*21,000.00*			*553,981.00*
001020	Contractor Indirects	1.00	LS	1	1,144,248	202,176	388,223		120,000	1,854,647
					1,144,248.00	*202,176.00*	*388,223.00*		*120,000.00*	*1,854,648.00*
001030	Traffic Controls	250.00	HRS	250	15,353	10,500				25,853
					61.41	*42.00*				*104.41*
001040	Construction Permits/Plans	1.00	LS						190,000	190,000
									190,000.00	*190,000.00*
001050	Improve Dam Access Roads	32,000.00	SY	160	9,962	5,724				15,686
					0.31	*0.18*				*0.50*
001060	Cachagua Grade Access Rd to Site 4	15,000.00	SY	715	44,035	29,309		79,200	150,175	302,719
					2.94	*1.95*		*5.28*	*10.01*	*20.23*
001070	Site 4 to Dam Haul Road	8,325.00	SY	1,950	120,378	93,527		54,910	168,800	437,615
					14.46	*11.23*		*6.60*	*20.28*	*52.80*
001080	Sediment Disposal Site Preparation	5.00	AC	378	23,479	15,054				38,533
					4,695.75	*3,010.77*				*7,782.20*
002010	Site Dewatering	1.00	LS	7,533	519,210	302,777	250,000	580,525	55,000	1,707,511
					519,209.60	*302,776.70*	*250,000.00*	*580,525.00*	*55,000.00*	*1,715,044.27*
002012	Cutoff Walls	500.00	CY	930	153,313	24,711	5,000	67,500	210,000	460,524
					306.63	*49.42*	*10.00*	*135.00*	*420.00*	*922.91*
002015	Channel/Dike Construction	417,411.00	CY	15,952	974,094	1,343,351			3,175,930	5,493,376
					2.33	*3.22*			*7.61*	*13.20*
002017	Sediment Stabilization	50,000.00	CY	647	39,827	26,514			3,950,000	4,016,341
					0.80	*0.53*			*79.00*	*80.34*
002020	Sediment Removal	381,000.00	CY	13,714	832,079	1,524,841				2,356,920
					2.18	*4.00*				*6.22*
002040	Utility/Facility Relocation	1.00	LS	1	2,775	2,000			2,500	7,275
					2,775.00	*2,000.00*			*2,500.00*	*7,276.00*
002045	Demo Existing Fish Ladder	400.00	CY	555	111,000	80,000			40,000	231,000
					277.50	*200.00*			*100.00*	*578.89*
002050	Stream/Reservoir Restoration	20.00	AC	10,194	325,266	244,288	69,000		4,854,559	5,493,113
					16,263.28	*12,214.42*	*3,450.00*		*242,727.95*	*275,165.33*
002060	Sediment Disposal Site Closure	1.00	LS	413	25,675	17,195				42,870
					25,675.00	*17,194.88*				*43,282.38*
002070	Haul/Access Rd Restoration	10,000.00	SY	120	7,523	4,949			9,000	21,472
					0.75	*0.49*			*0.90*	*2.16*
002090	Restore Construction Staging/Laydown Areas	15,000.00	SY	180	11,285	7,424			7,500	26,209
					0.75	*0.49*			*0.50*	*1.76*
003000	Demobilization & Cleanup	1.00	LS	1	48,563	10,000			10,000	68,563
					48,563.00	*10,000.00*			*10,000.00*	*68,564.39*
004000	Dam Removal By Blasting	7,500.00	CY	28,934	99,766	93,481			1,825,000	2,018,247
					13.30	*12.46*			*243.33*	*272.96*
004002	Dam Notching - OCRD	35.00	CY	24,281	24,281	35,000	3,500		17,500	80,281
					693.74	*1,000.00*	*100.00*		*500.00*	*2,987.49*
004020	Ranney Intake System	1.00	LS	469,266	667,834	297,705	43,615	696,500	102,232	1,807,887
					667,834.49	*297,705.31*	*43,615.00*	*696,500.00*	*102,232.00*	*2,277,152.80*
004500	Unidentified Items	1.00	LS	1	1,625,000	400,000			400,000	2,425,000
					1,625,000.00	*400,000.00*			*400,000.00*	*2,425,001.00*
005000	O&M Cost Allowance	1.00	LS	1	111,000	55,000		10,825		176,825
					111,000.00	*55,000.00*		*10,825.00*		*176,826.00*
	Section Totals:	1.00	LS	577,677	7,114,291	5,178,660	780,338	1,489,460	15,288,196	29,850,945
					7,114,290.57	*5,178,660.38*	*780,338.00*	*1,489,460.00*	*15,288,196.00*	*29,850,944.95*
	Grand Totals:	0.00		577,677	7,114,291	5,178,660	780,338	1,489,460	15,288,196	29,850,945

Estimate Line Detail
Estimate: - Carmel River Reroute and San Clemente Dam Removal Project
Currency: USD-United States-Dollar

Item	Description	Quantity	UOM	Rate	ManHrs	Labor	Equip	Job Mat	Perm Mat	Sub/Plug	Total Cost
	River Bypass/Dam Removal	**1.00**	**LS**		**577,677**	**7,114,291**	**5,178,660**	**2,269,798**		**15,288,196**	**29,850,945**
					577,677.30	7,114,290.57	5,178,660.38	2,269,798.00		15,288,196.00	29,850,944.95
001010	Equipment Mobilization / Management	1.00	LS		1,501	178,345	353,135	21,000			552,480
					1,501.00	178,345.00	353,135.00	21,000.00			552,480.00
A	Rolling Equip Mobe/Demob	1,500.00	HRS		1,500	87,105	78,135				165,240
					1.00	58.07	52.09				110.16
	25 loads x 3 seasons x 2(I/O) x 10 hrs										
	Prod=1.00 HRS/hour, 1.000MH/HRS, 1.00 HRS/MH, 1,500.00 hour										
	Mob/Demob Crew	*1.00*	*EA*	*110.16*							165,240
	Truck Driver	1.0		58.07		87,105					
	50 Ton Lowboy	1.0		52.09			78,135				
B	Equip Service/Maintenance	1.00	LS		1	91,240	275,000	21,000			387,240
					1.00	91,240.00	275,000.00	21,000.00			387,240.00
	Labor	1.0	EA	91,240.00		Prod=1.00 LS/hour, 1.00 hour					91,240
	Equipment Rental	1.0	EA	275,000.00		Prod=1.00 LS/hour, 1.00 hour					275,000
	Construction Material	1.0	LS	21,000.00				21,000			
001020	Contractor Indirects	1.00	LS		1	1,144,248	202,176	388,223		120,000	1,854,647
					1.00	1,144,248.00	202,176.00	388,223.00		120,000.00	1,854,647.00
A	Contractor Indirects	1.00	LS		1	1,144,248	202,176	388,223		120,000	1,854,647
					1.00	1,144,248.00	202,176.00	388,223.00		120,000.00	1,854,647.00
	Labor	1.0	EA	1,144,248.00		Prod=1.00 LS/hour, 1.00 hour					1,144,248
	Equipment Rental	1.0	EA	202,176.00		Prod=1.00 LS/hour, 1.00 hour					202,176
	Construction Materials	1.0	LS	388,223.00				388,223			
	Subcontract	1.0	ls	120,000.00						120,000	
001030	Traffic Controls	250.00	HRS		250	15,353	10,500				25,853
					1.00	61.41	42.00				103.41
A	Furnish Flaggers/TC Devices	250.00	HRS		250	15,353	10,500				25,853
					1.00	61.41	42.00				103.41
	Minor need of flaggers for equip mobes via Cachagua. 1 Flageer x 1 week x 2 times x 2.5 seasons x 9 hours = 225hrs say 250hrs										
	Unskilled Labor	1.0	EA	61.41		Prod=1.00 HRS/hour, 250.00 hour					15,353
	TC Device	1.0	EA	500.00		Prod=1.00 MO/hour, 21.00 hour					10,500

Currency: USD-United States-Dollar

Item	Description	Quantity	UOM	Rate	ManHrs	Labor	Equip	Job Mat	Perm Mat	Sub/Plug	Total Cost
001040	Construction Permits/Plans	1.00	LS							190,000	190,000
										190,000.00	190,000.00
A	Secure Construction Permits	1.00	LS							40,000	40,000
										40,000.00	40,000.00
	Subcontractors	1.0	LS	40,000.00						40,000	
B	Engineering Design Services	1.00	LS							150,000	150,000
										150,000.00	150,000.00
	Item provides an allowance for engineeing services associated with the new haul road design, various environmental work plans and permits.										
	Subcontractors	1.0	LS	150,000.00						150,000	
001050	Improve Dam Access Roads	32,000.00	SY		160	9,962	5,724				15,686
					0.01	0.31	0.18				0.49
A	Grade/Improve (E) Dam Access Roads	32,000.00	SY		160	9,962	5,724				15,686
					0.01	0.31	0.18				0.49
	26000LF x 11' =32,000syrebuild for low volume PU and vehicle access to the lower dam area										
	Prod=1,000.00 SY/hour, 0.005MH/SY, 200.00 SY/MH, 32.00 hour										
	Road Grading Crew	*1.00*	*EA*	*490.19*							15,686
	Equipment Foreman	1.0		69.32		2,218					
	Grader Operator	1.0		64.92		2,077					
	Loader Operator	1.0		63.56		2,034					
	Roller Operator	1.0		55.43		1,774					
	Water Truck Driver	1.0		58.07		1,858					
	200 Hsp Grader (Cat 14G)	1.0		87.75			2,808				
	Roller 12 ton (Cat CB 634C)	1.0		45.85			1,467				
	3/4 Ton Pickup Truck 4x4	1.0		12.00			384				
	5000 Gallon Watertanker	1.0		33.29			1,065				

Currency: USD-United States-Dollar

Item	Description	Quantity	UOM	Rate	ManHrs	Labor	Equip	Job Mat	Perm Mat	Sub/Plug	Total Cost
001060	Cachagua Grade Access Rd to Site 4	15,000.00	SY		715	44,035	29,309		79,200	150,175	302,719
					0.05	2.94	1.95		5.28	10.01	20.18
A	Access Road Excavation	6,800.00	CY		272	16,694	16,359				33,053
					0.04	2.46	2.41				4.86
	Prod=200.00 CY/hour, 0.040MH/CY, 25.00 CY/MH, 34.00 hour										
	Road Grading Crew	*1.00*	*EA*	*972.14*							33,053
	Equipment Foreman	1.0		69.32		2,357					
	Grader Operator	1.0		64.92		2,207					
	Loader Operator	1.0		63.56		2,161					
	Dozer Operator	1.0		63.56		2,161					
	Roller Operator	1.0		55.43		1,885					
	Water Truck Driver	1.0		58.07		1,974					
	Articulated Truck Driver	2.0		58.07		3,949					
	170 Hsp Bulldozer (Cat D6)	1.0		68.57			2,331				
	4.5 CY Loader (Cat 966)	1.0		71.10			2,417				
	200 Hsp Grader (Cat 14G)	1.0		87.75			2,984				
	25 Ton Articulated Truck (Cat D250)	2.0		81.29			5,528				
	Roller 12 ton (Cat CB 634C)	1.0		45.85			1,559				
	3/4 Ton Pickup Truck 4x4	1.0		12.00			408				
	5000 Gallon Watertanker	1.0		33.29			1,132				
B	Remove Trees	20.00	EA		160	9,826	2,244				12,070
					8.00	491.28	112.20				603.48
	Prod=0.50 EA/hour, 8.000MH/EA, 0.13 EA/MH, 40.00 hour										
	Light Clearing Crew	*1.00*	*EA*	*301.74*							12,070
	Unskilled Labor	4.0		61.41		9,826					
	16 Ton Sideboom 120 hsp (Cat 561)	1.0		56.10			2,244				

Currency: USD-United States-Dollar

Item	Description	Quantity	UOM	Rate	ManHrs	Labor	Equip	Job Mat	Perm Mat	Sub/Plug	Total Cost
C	Road Drainage	200.00	LF		80	5,001	1,718		13,200		19,919
					0.40	25.00	8.59		66.00		99.59
	Prod=20.00 LF/hour, 0.400MH/LF, 2.50 LF/MH, 10.00 hour										
	Exc Lay Bkfill Drainage Crew	*1.00*	*EA*	*671.86*							6,719
	General Labour Foreman	1.0		62.41		624					
	Unskilled Labor	4.0		61.41		2,456					
	Backhoe Operator	1.0		63.56		636					
	Grader Operator	1.0		64.92		649					
	Loader Operator	1.0		63.56		636					
	4.5 CY Loader (Cat 966)	1.0		71.10			711				
	2.0 CY Backhoe (Cat 330)	1.0		80.43			804				
	Jumping Jack Handheld Packer	2.0		4.12			82				
	3/4 Ton Pickup Truck 4x4	1.0		12.00			120				
	Pitrun Gravel	500.0	ton	20.00					10,000		
	450 mm (18") x 2.8 mm Corrugated Steel Pipe (68r	200.0	lf	16.00					3,200		
D	Place Road Gravel	3,000.00	TN		53	3,176	3,622		66,000		72,798
					0.02	1.06	1.21		22.00		24.27
	Prod=200.00 TN/hour, 0.018MH/TN, 57.14 TN/MH, 15.00 hour										
	Place Road Gravel	*1.00*	*EA*	*453.18*							6,798
	Equipment Foreman	0.5		69.32		520					
	Dozer Operator	1.0		63.56		953					
	Roller Operator	1.0		55.43		831					
	Water Truck Driver	1.0		58.07		871					
	170 Hsp Bulldozer (Cat D6)	1.0		68.57			1,029				
	200 Hsp Grader (Cat 14G)	1.0		87.75			1,316				
	Roller 12 ton (Cat CB 634C)	1.0		45.85			688				
	3/4 Ton Pickup Truck 4x4	0.5		12.00			90				
	5000 Gallon Watertanker	1.0		33.29			499				
	25mm (1") Aggregate Base	3,000.0	ton	22.00					66,000		

Currency: USD-United States-Dollar

Item	Description	Quantity	UOM	Rate	ManHrs	Labor	Equip	Job Mat	Perm Mat	Sub/Plug	Total Cost
E	Fine Grade Road Base	15,000.00	SY		150	9,339	5,367				14,706
					0.01	0.62	0.36				0.98
	Prod=500.00 SY/hour, 0.010MH/SY, 100.00 SY/MH, 30.00 hour										
	Fine Grade Road Base Crew	*1.00*	*EA*	*490.19*							14,706
	Equipment Foreman	1.0		69.32		2,080					
	Grader Operator	1.0		64.92		1,948					
	Loader Operator	1.0		63.56		1,907					
	Roller Operator	1.0		55.43		1,663					
	Water Truck Driver	1.0		58.07		1,742					
	200 Hsp Grader (Cat 14G)	1.0		87.75			2,633				
	Roller 12 ton (Cat CB 634C)	1.0		45.85			1,376				
	3/4 Ton Pickup Truck 4x4	1.0		12.00			360				
	5000 Gallon Watertanker	1.0		33.29			999				
F	Cut Slope Stabilization	150.00	CY							100,000	100,000
										666.67	666.67
	Soil Nails -10'	550.0	ea	100.00						55,000	
	Shotcrete	150.0	cy	300.00						45,000	
G	Double Chip Seal Road	115,000.00	SF							39,675	39,675
										0.35	0.35
	Double Chip Seal Road	132,250.0	SF	0.30						39,675	
I	Seeding	7.00	AC							10,500	10,500
										1,500.00	1,500.00
	Hydroseeding	7.0	AC	1,500.00						10,500	
001070	Site 4 to Dam Haul Road	8,325.00	SY		1,950	120,378	93,527		54,910	168,800	437,615
					0.23	14.46	11.23		6.60	20.28	52.57
A	Clear Trees	40.00	EA		320	19,651	4,488				24,139
					8.00	491.28	112.20				603.48
	Prod=0.50 EA/hour, 8.000MH/EA, 0.13 EA/MH, 80.00 hour										
	Light Tree Clearing Crew	*1.00*	*EA*	*301.74*							24,139
	Unskilled Labor	4.0		61.41		19,651					
	16 Ton Sideboom 120 hsp (Cat 561)	1.0		56.10			4,488				

Currency: USD-United States-Dollar

Item	Description	Quantity	UOM	Rate	ManHrs	Labor	Equip	Job Mat	Perm Mat	Sub/Plug	Total Cost
B	Clearing	4.00	AC		88	5,617	3,070				8,687
					22.00	1,404.16	767.54				2,171.70
	Prod=0.25 AC/hour, 22.000MH/AC, 0.05 AC/MH, 16.00 hour										
	Clearing Crew	*1.00*	*EA*	*542.925*							8,687
	Unskilled Labor	2.0		61.41		1,965					
	Equipment Foreman	1.0		69.32		1,109					
	Backhoe Operator	0.5		63.56		508					
	Loader Operator	1.0		63.56		1,017					
	Dozer Operator	1.0		63.56		1,017					
	170 Hsp Bulldozer (Cat D6)	1.0		68.57			1,097				
	4.5 CY Loader (Cat 966)	1.0		71.10			1,138				
	2.0 CY Backhoe (Cat 330)	0.5		80.43			643				
	3/4 Ton Pickup Truck 4x4	1.0		12.00			192				
C	Access Road Excavation	30,000.00	CY		1,200	73,650	72,171				145,821
					0.04	2.46	2.41				4.86
	Prod=200.00 CY/hour, 0.040MH/CY, 25.00 CY/MH, 150.00 hour										
	Excavation Crew	*1.00*	*EA*	*972.14*							145,821
	Equipment Foreman	1.0		69.32		10,398					
	Grader Operator	1.0		64.92		9,738					
	Loader Operator	1.0		63.56		9,534					
	Dozer Operator	1.0		63.56		9,534					
	Roller Operator	1.0		55.43		8,315					
	Water Truck Driver	1.0		58.07		8,711					
	Articulated Truck Driver	2.0		58.07		17,421					
	170 Hsp Bulldozer (Cat D6)	1.0		68.57			10,286				
	4.5 CY Loader (Cat 966)	1.0		71.10			10,665				
	200 Hsp Grader (Cat 14G)	1.0		87.75			13,163				
	25 Ton Articulated Truck (Cat D250)	2.0		81.29			24,387				
	Roller 12 ton (Cat CB 634C)	1.0		45.85			6,878				
	3/4 Ton Pickup Truck 4x4	1.0		12.00			1,800				
	5000 Gallon Watertanker	1.0		33.29			4,994				

Currency: USD-United States-Dollar

Item	Description	Quantity	UOM	Rate	ManHrs	Labor	Equip	Job Mat	Perm Mat	Sub/Plug	Total Cost
D	Haul Clearing to Disposal	1,650.00	LF		66	4,290	3,632				7,922
					0.04	2.60	2.20				4.80
	Prod=100.00 LF/hour, 0.040MH/LF, 25.00 LF/MH, 16.50 hour										
	Haul/Clearing Crew	*1.00*	*EA*	*480.1*							7,922
	Equipment Foreman	1.0		69.32		1,144					
	Backhoe Operator	1.0		63.56		1,049					
	Loader Operator	1.0		63.56		1,049					
	Dozer Operator	1.0		63.56		1,049					
	170 Hsp Bulldozer (Cat D6)	1.0		68.57			1,131				
	4.5 CY Loader (Cat 966)	1.0		71.10			1,173				
	2.0 CY Backhoe (Cat 330)	1.0		80.43			1,327				
E	Road Grading	10,000.00	SY		50	3,126	1,789				4,915
					0.01	0.31	0.18				0.49
	Prod=1,000.00 SY/hour, 0.005MH/SY, 200.00 SY/MH, 10.00 hour										
	Fine Grading Crew	*1.00*	*EA*	*491.49*							4,915
	Grademan Roadwork	1.0		64.86		649					
	Equipment Foreman	1.0		69.32		693					
	Grader Operator	1.0		64.92		649					
	Roller Operator	1.0		55.43		554					
	Water Truck Driver	1.0		58.07		581					
	200 Hsp Grader (Cat 14G)	1.0		87.75			878				
	Roller 12 ton (Cat CB 634C)	1.0		45.85			459				
	3/4 Ton Pickup Truck 4x4	1.0		12.00			120				
	5000 Gallon Watertanker	1.0		33.29			333				
F	Road Drainage	235.00	LF		94	5,875	2,018		3,760		11,654
					0.40	25.00	8.59		16.00		49.59
	Prod=20.00 LF/hour, 0.400MH/LF, 2.50 LF/MH, 11.75 hour										
	Exc Lay Bkfill Drainage Crew	*1.00*	*EA*	*671.8*							7,894
	Grademan Roadwork	1.0		64.86		762					
	General Labour Foreman	1.0		62.41		733					
	Unskilled Labor	4.0		61.41		2,886					
	Backhoe Operator	1.0		63.56		747					
	Loader Operator	1.0		63.56		747					
	4.5 CY Loader (Cat 966)	1.0		71.10			835				
	2.0 CY Backhoe (Cat 330)	1.0		80.43			945				
	Jumping Jack Handheld Packer	2.0		4.12			97				
	3/4 Ton Pickup Truck 4x4	1.0		12.00			141				
	450 mm (18") x 2.8 mm Corrugated Steel Pipe (68r	235.0	lf	16.00					3,760		

Currency: USD-United States-Dollar

Item	Description	Quantity	UOM	Rate	ManHrs	Labor	Equip	Job Mat	Perm Mat	Sub/Plug	Total Cost
G	Place Road Gravel	2,325.00	Tons		49	2,964	3,380		51,150		57,495
					0.02	1.27	1.45		22.00		24.73
	Prod=166.07 Tons/hour, 0.021MH/Tons, 47.45 Tons/MH, 14.00 hour										
	Place Road Gravel	*1.00*	*EA*	*453.18*							6,345
	Equipment Foreman	0.5		69.32		485					
	Dozer Operator	1.0		63.56		890					
	Roller Operator	1.0		55.43		776					
	Water Truck Driver	1.0		58.07		813					
	170 Hsp Bulldozer (Cat D6)	1.0		68.57			960				
	200 Hsp Grader (Cat 14G)	1.0		87.75			1,229				
	Roller 12 ton (Cat CB 634C)	1.0		45.85			642				
	3/4 Ton Pickup Truck 4x4	0.5		12.00			84				
	5000 Gallon Watertanker	1.0		33.29			466				
	25mm (1") Aggregate Base	2,325.0	ton	22.00					51,150		
I	Fine Grade Road	8,325.00	SY		83	5,205	2,979				8,183
					0.01	0.63	0.36				0.98
	Prod=500.00 SY/hour, 0.010MH/SY, 100.00 SY/MH, 16.65 hour										
	Fine Grade Road Crew	*1.00*	*EA*	*491.49*							8,183
	Grademan Roadwork	1.0		64.86		1,080					
	Equipment Foreman	1.0		69.32		1,154					
	Grader Operator	1.0		64.92		1,081					
	Roller Operator	1.0		55.43		923					
	Water Truck Driver	1.0		58.07		967					
	200 Hsp Grader (Cat 14G)	1.0		87.75			1,461				
	Roller 12 ton (Cat CB 634C)	1.0		45.85			763				
	3/4 Ton Pickup Truck 4x4	1.0		12.00			200				
	5000 Gallon Watertanker	1.0		33.29			554				
J	Cut Slope Stabilization	35,000.00	SF							140,000	140,000
										4.00	4.00
	Cut Slope Stabilization	35,000.0	sf	4.00						140,000	
K	Double Chip Seal Road	81,000.00	SF							24,300	24,300
										0.30	0.30
	Double Chip Seal Road	81,000.0	SF	0.30						24,300	
L	Seeding	3.00	AC							4,500	4,500
										1,500.00	1,500.00
	Hydroseeding	3.0	AC	1,500.00						4,500	

Currency: USD-United States-Dollar

Item	Description	Quantity	UOM	Rate	ManHrs	Labor	Equip	Job Mat	Perm Mat	Sub/Plug	Total Cost
001080	Sediment Disposal Site Preparation	5.00	AC		378	23,479	15,054				38,533
					75.67	4,695.75	3,010.77				7,706.52
A	Clear Trees	25.00	EA		100	6,141	1,403				7,544
					4.00	245.64	56.10				301.74
	Prod=1.00 EA/hour, 4.000MH/EA, 0.25 EA/MH, 25.00 hour										
	Light Tree Clearing Crew	*1.00*	*EA*	*301.74*							7,544
	Unskilled Labor	4.0		61.41		6,141					
	16 Ton Sideboom 120 hsp (Cat 561)	1.0		56.10			1,403				
B	Clearing	5.00	AC		55	3,510	1,919				5,429
					11.00	702.08	383.77				1,085.85
	Prod=0.50 AC/hour, 11.000MH/AC, 0.09 AC/MH, 10.00 hour										
	Clearing Crew	*1.00*	*EA*	*542.925*							5,429
	Unskilled Labor	2.0		61.41		1,228					
	Equipment Foreman	1.0		69.32		693					
	Backhoe Operator	0.5		63.56		318					
	Loader Operator	1.0		63.56		636					
	Dozer Operator	1.0		63.56		636					
	170 Hsp Bulldozer (Cat D6)	1.0		68.57			686				
	4.5 CY Loader (Cat 966)	1.0		71.10			711				
	2.0 CY Backhoe (Cat 330)	0.5		80.43			402				
	3/4 Ton Pickup Truck 4x4	1.0		12.00			120				
C	Strip/Stockpile 6" Topsoil	2,500.00	CY		133	8,185	8,021				16,206
					0.05	3.27	3.21				6.48
	Prod=149.97 CY/hour, 0.053MH/CY, 18.75 CY/MH, 16.67 hour										
	Topsoil Crew	*1.00*	*EA*	*972.14*							16,206
	Equipment Foreman	1.0		69.32		1,156					
	Grader Operator	1.0		64.92		1,082					
	Loader Operator	1.0		63.56		1,060					
	Dozer Operator	1.0		63.56		1,060					
	Roller Operator	1.0		55.43		924					
	Water Truck Driver	1.0		58.07		968					
	Articulated Truck Driver	2.0		58.07		1,936					
	170 Hsp Bulldozer (Cat D6)	1.0		68.57			1,143				
	4.5 CY Loader (Cat 966)	1.0		71.10			1,185				
	200 Hsp Grader (Cat 14G)	1.0		87.75			1,463				
	25 Ton Articulated Truck (Cat D250)	2.0		81.29			2,710				
	Roller 12 ton (Cat CB 634C)	1.0		45.85			764				
	3/4 Ton Pickup Truck 4x4	1.0		12.00			200				
	5000 Gallon Watertanker	1.0		33.29			555				

Currency: USD-United States-Dollar

Item	Description	Quantity	UOM	Rate	ManHrs	Labor	Equip	Job Mat	Perm Mat	Sub/Plug	Total Cost
D	Develop In-stream Haul Roads	3,000.00	LF		90	5,642	3,712				9,354
					0.03	1.88	1.24				3.12
	Prod=200.00 LF/hour, 0.030MH/LF, 33.33 LF/MH, 15.00 hour										
	Haul Road Crew	*1.00*	*EA*	*623.62*							9,354
	Grademan Roadwork	1.0		64.86		973					
	Equipment Foreman	1.0		69.32		1,040					
	Grader Operator	1.0		64.92		974					
	Dozer Operator	1.0		63.56		953					
	Roller Operator	1.0		55.43		831					
	Water Truck Driver	1.0		58.07		871					
	170 Hsp Bulldozer (Cat D6)	1.0		68.57			1,029				
	200 Hsp Grader (Cat 14G)	1.0		87.75			1,316				
	Roller 12 ton (Cat CB 634C)	1.0		45.85			688				
	3/4 Ton Pickup Truck 4x4	1.0		12.00			180				
	5000 Gallon Watertanker	1.0		33.29			499				
002010	Site Dewatering	1.00	LS		7,533	519,210	302,777	250,000	580,525	55,000	1,707,511
					7,532.97	519,209.60	302,776.70	250,000.00	580,525.00	55,000.00	1,707,511.30
A	Mobe/Demobe SP Equipment	1.00	LS							15,000	15,000
										15,000.00	15,000.00
	Included elsewhere										
B	Build Upstream Cofferdams	2,000.00	CY		160	9,820	9,623				19,443
					0.08	4.91	4.81				9.72
	Prod=100.00 cy/hour, 0.080MH/cy, 12.50 cy/MH, 20.00 hour										
	Excavation Crew	*1.00*	*EA*	*972.14*							19,443
	Equipment Foreman	1.0		69.32		1,386					
	Grader Operator	1.0		64.92		1,298					
	Loader Operator	1.0		63.56		1,271					
	Dozer Operator	1.0		63.56		1,271					
	Roller Operator	1.0		55.43		1,109					
	Water Truck Driver	1.0		58.07		1,161					
	Articulated Truck Driver	2.0		58.07		2,323					
	170 Hsp Bulldozer (Cat D6)	1.0		68.57			1,371				
	4.5 CY Loader (Cat 966)	1.0		71.10			1,422				
	200 Hsp Grader (Cat 14G)	1.0		87.75			1,755				
	25 Ton Articulated Truck (Cat D250)	2.0		81.29			3,252				
	Roller 12 ton (Cat CB 634C)	1.0		45.85			917				
	3/4 Ton Pickup Truck 4x4	1.0		12.00			240				
	5000 Gallon Watertanker	1.0		33.29			666				

Currency: USD-United States-Dollar

Item	Description	Quantity	UOM	Rate	ManHrs	Labor	Equip	Job Mat	Perm Mat	Sub/Plug	Total Cost
C	Upstream Sheetpile	7,500.00	SF		2,000	121,490	62,728		91,125		275,343
					0.27	16.20	8.36		12.15		36.71
	Prod=30.00 sf/hour, 0.267MH/sf, 3.75 sf/MH, 250.00 hour										
	Sheetpile Crew	*1.00*	*EA*	*736.87*							184,218
	Pile Driving Foreman	1.0		66.51		16,628					
	Pile Driver	5.0		65.77		82,213					
	Crane Operator Class A	1.0		36.54		9,135					
	Oiler	1.0		54.06		13,515					
	150 Ton Crawler Crane (American 9260)	1.0		163.08			40,770				
	225,000 Ft-Lb Pile Hammer (Delmag D100)	1.0		87.83			21,958				
	PZ 27 Sheetpile	7,500.0	sf	12.15					91,125		
D	Rem/Repl SP Sections For Winter SD	2,000.00	SF		400	24,298	12,546		12,150		48,994
					0.20	12.15	6.27		6.08		24.50
	Prod=40.00 sf/hour, 0.200MH/sf, 5.00 sf/MH, 50.00 hour										
	Sheetpile Crew	*1.00*	*EA*	*736.87*							36,844
	Pile Driving Foreman	1.0		66.51		3,326					
	Pile Driver	5.0		65.77		16,443					
	Crane Operator Class A	1.0		36.54		1,827					
	Oiler	1.0		54.06		2,703					
	150 Ton Crawler Crane (American 9260)	1.0		163.08			8,154				
	225,000 Ft-Lb Pile Hammer (Delmag D100)	1.0		87.83			4,392				
	PZ 27 Sheetpile	1,000.0	sf	12.15					12,150		
E	Operate Dewatering System at Dam	200.00	CD							40,000	40,000
										200.00	200.00
	Operate Dewater System	200.0	DA	200.00						40,000	

Currency: USD-United States-Dollar

Item	Description	Quantity	UOM	Rate	ManHrs	Labor	Equip	Job Mat	Perm Mat	Sub/Plug	Total Cost
F	Clear/Grade Pad For Temp Pipelines	8,800.00	LF		192	12,037	7,919				19,956
					0.02	1.37	0.90				2.27
	Prod=275.00 lf/hour, 0.022MH/lf, 45.83 lf/MH, 32.00 hour										
	Rough Grade Road	*1.00*	*EA*	*623.62*							19,956
	Grademan Roadwork	1.0		64.86		2,076					
	Equipment Foreman	1.0		69.32		2,218					
	Grader Operator	1.0		64.92		2,077					
	Dozer Operator	1.0		63.56		2,034					
	Roller Operator	1.0		55.43		1,774					
	Water Truck Driver	1.0		58.07		1,858					
	170 Hsp Bulldozer (Cat D6)	1.0		68.57			2,194				
	200 Hsp Grader (Cat 14G)	1.0		87.75			2,808				
	Roller 12 ton (Cat CB 634C)	1.0		45.85			1,467				
	3/4 Ton Pickup Truck 4x4	1.0		12.00			384				
	5000 Gallon Watertanker	1.0		33.29			1,065				
G	Install Temp 18"/36" HDPE Diver Piping	8,800.00	LF		1,980	114,723	88,200		477,250		680,174
					0.23	13.04	10.02		54.23		77.29
	Large Dia. Polyethylene Fusion Machine	30.0	EA	1,100.00		Prod=1.00 DA/hour, 1.00 hour					33,000
	Prod=40.00 lf/hour, 0.225MH/lf, 4.44 lf/MH, 220.00 hour										
	HDPE Installation Crew	*1.00*	*EA*	*772.38*							169,924
	General Labour Foreman	1.0		62.41		13,730					
	Unskilled Labor	6.0		61.41		81,061					
	Crane Operator Class A	1.0		36.54		8,039					
	Oiler	1.0		54.06		11,893					
	150 Ton Crawler Crane (American 9260)	1.0		163.08			35,878				
	225,000 Ft-Lb Pile Hammer (Delmag D100)	1.0		87.83			19,323				
	HDPE Pipe 18"	3,800.0	ft	36.00					136,800		
	HDPE Pipe 36"	5,000.0	ft	65.00					325,000		
	HDPE 90/45 deg 18"	10.0	ea	225.00					2,250		
	HDPE 45deg 36"	16.0	ea	600.00					9,600		
	HDPE 90 deg 36"	4.0	ea	900.00					3,600		

Currency: USD-United States-Dollar

Item	Description	Quantity	UOM	Rate	ManHrs	Labor	Equip	Job Mat	Perm Mat	Sub/Plug	Total Cost
I	Build/Maintain Gravity Drainage Channel	8,500.00	LF		544	33,388	32,718				66,106
					0.06	3.93	3.85				7.78
	Prod=125.00 lf/hour, 0.064MH/lf, 15.63 lf/MH, 68.00 hour										
	Gravity Channel Crew	*1.00*	*EA*	*972.14*							66,106
	Equipment Foreman	1.0		69.32		4,714					
	Grader Operator	1.0		64.92		4,415					
	Loader Operator	1.0		63.56		4,322					
	Dozer Operator	1.0		63.56		4,322					
	Roller Operator	1.0		55.43		3,769					
	Water Truck Driver	1.0		58.07		3,949					
	Articulated Truck Driver	2.0		58.07		7,898					
	170 Hsp Bulldozer (Cat D6)	1.0		68.57			4,663				
	4.5 CY Loader (Cat 966)	1.0		71.10			4,835				
	200 Hsp Grader (Cat 14G)	1.0		87.75			5,967				
	25 Ton Articulated Truck (Cat D250)	2.0		81.29			11,055				
	Roller 12 ton (Cat CB 634C)	1.0		45.85			3,118				
	3/4 Ton Pickup Truck 4x4	1.0		12.00			816				
	5000 Gallon Watertanker	1.0		33.29			2,264				
J	Remove Upstream Sheetpile	7,500.00	SF		1,200	72,894	37,637				110,531
					0.16	9.72	5.02				14.74
	Prod=50.00 sf/hour, 0.160MH/sf, 6.25 sf/MH, 150.00 hour										
	Sheetpile Crew	*1.00*	*EA*	*736.87*							110,531
	Pile Driving Foreman	1.0		66.51		9,977					
	Pile Driver	5.0		65.77		49,328					
	Crane Operator Class A	1.0		36.54		5,481					
	Oiler	1.0		54.06		8,109					
	150 Ton Crawler Crane (American 9260)	1.0		163.08			24,462				
	225,000 Ft-Lb Pile Hammer (Delmag D100)	1.0		87.83			13,175				
K	Remove Upstream 18"/36" HDPE Piping	8,800.00	LF		1,056	61,184	1,408				62,592
					0.12	6.95	0.16				7.11
	Prod=75.00 lf/hour, 0.120MH/lf, 8.33 lf/MH, 117.33 hour										
	HDPE Installation Crew	*1.00*	*EA*	*533.47*							62,592
	General Labour Foreman	1.0		62.41		7,323					
	Unskilled Labor	6.0		61.41		43,231					
	Crane Operator Class A	1.0		36.54		4,287					
	Oiler	1.0		54.06		6,343					
	3/4 Ton Pickup Truck 4x4	1.0		12.00			1,408				

Currency: USD-United States-Dollar

Item	Description	Quantity	UOM	Rate	ManHrs	Labor	Equip	Job Mat	Perm Mat	Sub/Plug	Total Cost
L	Filtration System	1.00	LS		1	69,375	50,000	250,000			369,375
					1.00	69,375.00	50,000.00	250,000.00			369,375.00
	Labor	1.0	EA	69,375.00	Prod=1.00 LS/hour, 1.00 hour						69,375
	Equipment Rental	1.0	EA	50,000.00	Prod=1.00 LS/hour, 1.00 hour						50,000
	Construction Material	1.0	LS	250,000.00				250,000			
002012	Cutoff Walls	500.00	CY		930	153,313	24,711	5,000	67,500	210,000	460,524
					1.86	306.63	49.42	10.00	135.00	420.00	921.05
A	Building Working Platform for Slurry Walls	5,000.00	CY		200	12,275	12,029				24,304
					0.04	2.46	2.41				4.86
	Prod=200.00 cy/hour, 0.040MH/cy, 25.00 cy/MH, 25.00 hour										
	Slurry Wall Platform Crew	*1.00*	*EA*	*972.14*							24,304
	Equipment Foreman	1.0		69.32		1,733					
	Grader Operator	1.0		64.92		1,623					
	Loader Operator	1.0		63.56		1,589					
	Dozer Operator	1.0		63.56		1,589					
	Roller Operator	1.0		55.43		1,386					
	Water Truck Driver	1.0		58.07		1,452					
	Articulated Truck Driver	2.0		58.07		2,904					
	170 Hsp Bulldozer (Cat D6)	1.0		68.57			1,714				
	4.5 CY Loader (Cat 966)	1.0		71.10			1,778				
	200 Hsp Grader (Cat 14G)	1.0		87.75			2,194				
	25 Ton Articulated Truck (Cat D250)	2.0		81.29			4,065				
	Roller 12 ton (Cat CB 634C)	1.0		45.85			1,146				
	3/4 Ton Pickup Truck 4x4	1.0		12.00			300				
	5000 Gallon Watertanker	1.0		33.29			832				
B	Exc Conc Cutoff Wall	500.00	CY		36	2,288	2,682				4,970
					0.07	4.58	5.36				9.94
	235'L x 10'D x 5'W = 437 x 1.1 (waste) = 480cy say 500										
	Prod=33.33 cy/hour, 0.060MH/cy, 16.67 cy/MH, 18.00 hour										
	Excavation Crew	*1.00*	*EA*	*276.12*							4,970
	Backhoe Operator	1.0		63.56		1,144					
	Dozer Operator	1.0		63.56		1,144					
	170 Hsp Bulldozer (Cat D6)	1.0		68.57			1,234				
	2.0 CY Backhoe (Cat 330)	1.0		80.43			1,448				

Currency: USD-United States-Dollar

Item	Description	Quantity	UOM	Rate	ManHrs	Labor	Equip	Job Mat	Perm Mat	Sub/Plug	Total Cost
C	Build Soil-Bentonite Cutoff Wall	13,200.00	SF							165,000	165,000
										12.50	12.50
	Slurry Wall	13,200.0	sf	12.50						165,000	
D	Build Conc Cutoff Wall	500.00	CY		694	138,750	10,000	5,000	67,500	45,000	266,250
					1.39	277.50	20.00	10.00	135.00	90.00	532.50
	Labor	1.0	EA	200.00		Prod=0.72 cy/hour, 693.75 hour					138,750
	Equipment Rental	1.0	EA	20.00		Prod=1.00 cy/hour, 500.00 hour					10,000
	Construction Materials	500.0	cy	10.00				5,000			
	Permanent Materials	500.0	cy	135.00					67,500		
	Subcontract	500.0	cy	90.00						45,000	
002015	Channel/Dike Construction	417,411.00	CY		15,952	974,094	1,343,351			3,175,930	5,493,376
					0.04	2.33	3.22			7.61	13.16
A	Pre-Split Channel Walls (Sub)	2,500.00	VLF							37,500	37,500
										15.00	15.00
	Drill 4" pre-split holes at 15'oc = 2500VLF (250/15 x 75') 2										
	Pre-Split Drilling	2,500.0	VLF	15.00						37,500	
B	Drill & Shoot Channel Exc (Sub)	313,843.00	CY							3,138,430	3,138,430
										10.00	10.00
	Drill & Shoot	313,843.0	cy	10.00						3,138,430	
C	Slot Doze Shoot Material to Dike <500'	417,411.00	CY		3,965	248,597	634,882				883,480
					0.01	0.60	1.52				2.12
	Prod=400.00 CY/hour, 0.010MH/CY, 105.26 CY/MH, 1,043.53 hour										
	Slot Doze Crew	*1.00*	*EA*	*846.628*							883,480
	General Labour Foreman	1.0		62.41		65,127					
	Unskilled Labor	1.0		61.41		64,083					
	Dozer Operator	1.8		63.56		119,388					
	405 Hsp Bulldozer (Cat D9)	1.0		181.39			189,285				
	570 Hsp Bulldozer (Cat D10)	0.8		238.55			199,147				
	Ripper Attachment D10	1.0		13.35			13,931				
	200 Hsp Grader (Cat 14G)	1.0		87.75			91,570				
	100 KW Diesel Generator Set	4.0		24.16			100,846				
	Tower 8-Lights 20 Hsp	4.0		7.25			30,262				
	1/2 Ton Pickup Truck 4x4	1.0		9.43			9,840				

Currency: USD-United States-Dollar

Item	Description	Quantity	UOM	Rate	ManHrs	Labor	Equip	Job Mat	Perm Mat	Sub/Plug	Total Cost
D	Place/Compact Shoot Materials At Dike	417,411.00	CY		11,921	721,302	694,611				1,415,913
					0.03	1.73	1.66				3.39
	Prod=350.15 CY/hour, 0.029MH/CY, 35.02 CY/MH, 1,192.08 hour										
	Slurry Wall Platform Crew	*1.00*	*EA*	*1187.77*							1,415,913
	Grademan Roadwork	1.0		64.86		77,318					
	General Labour Foreman	1.0		62.41		74,398					
	General Labourer	1.0		61.41		73,205					
	Grader Operator	1.0		64.92		77,390					
	Dozer Operator	2.0		63.56		151,537					
	Roller Operator	3.0		55.43		198,230					
	Water Truck Driver	1.0		58.07		69,224					
	305 Hsp Bulldozer (Cat D8)	1.0		136.76			163,028				
	405 Hsp Bulldozer (Cat D9)	1.0		181.39			216,231				
	200 Hsp Grader (Cat 14G)	1.0		87.75			104,605				
	Vibratory Compactor (CAT CS-533)	2.0		44.11			105,165				
	Roller 12 ton (Cat CB 634C)	1.0		45.85			54,657				
	1/2 Ton Pickup Truck 4x4	1.0		9.43			11,241				
	5000 Gallon Watertanker	1.0		33.29			39,684				
F	Place Shoot Rubble at Upstream Dike Face	3,300.00	CY		66	4,195	13,858				18,053
					0.02	1.27	4.20				5.47
	Place +1' blasted rubble at upstream dike face at 2' thk										
	Prod=100.00 cy/hour, 0.020MH/cy, 50.00 cy/MH, 33.00 hour										
	Doze to surge pile 500'	*1.00*	*EA*	*547.06*							18,053
	Dozer Operator	2.0		63.56		4,195					
	405 Hsp Bulldozer (Cat D9)	1.0		181.39			5,986				
	570 Hsp Bulldozer (Cat D10)	1.0		238.55			7,872				

Currency: USD-United States-Dollar

Item	Description	Quantity	UOM	Rate	ManHrs	Labor	Equip	Job Mat	Perm Mat	Sub/Plug	Total Cost
002017	Sediment Stabilization	50,000.00	CY		647	39,827	26,514			3,950,000	4,016,341
					0.01	0.80	0.53			79.00	80.33
A	Provide Working Platform for Rigs	6,500.00	CY		347	21,275	20,848				42,123
					0.05	3.27	3.21				6.48
	Item provides 25ea 20' long benches down the slope of the stabilization area for access by drill rigs...										
	Prod=150.01 CY/hour, 0.053MH/CY, 18.75 CY/MH, 43.33 hour										
	Working Platform Crew	*1.00*	*EA*	*972.14*							42,123
	Equipment Foreman	1.0		69.32		3,004					
	Grader Operator	1.0		64.92		2,813					
	Loader Operator	1.0		63.56		2,754					
	Dozer Operator	1.0		63.56		2,754					
	Roller Operator	1.0		55.43		2,402					
	Water Truck Driver	1.0		58.07		2,516					
	Articulated Truck Driver	2.0		58.07		5,032					
	170 Hsp Bulldozer (Cat D6)	1.0		68.57			2,971				
	4.5 CY Loader (Cat 966)	1.0		71.10			3,081				
	200 Hsp Grader (Cat 14G)	1.0		87.75			3,802				
	25 Ton Articulated Truck (Cat D250)	2.0		81.29			7,045				
	Roller 12 ton (Cat CB 634C)	1.0		45.85			1,987				
	3/4 Ton Pickup Truck 4x4	1.0		12.00			520				
	5000 Gallon Watertanker	1.0		33.29			1,442				
B	Sediment Stabilization (Sub)	50,000.00	CY							3,950,000	3,950,000
										79.00	79.00
	1 rig @ 300cy/shift x 2 shifts = 600cy/day										
	Stabilization Extra	1.0	LS	200,000.00						200,000	
	Cement Stabilization	50,000.0	CY	75.00						3,750,000	
C	Geogrid Spillway	21,000.00	SF		300	18,552	5,666				24,218
					0.01	0.88	0.27				1.15
	Prod=350.00 sf/hour, 0.014MH/sf, 70.00 sf/MH, 60.00 hour										
	Light Density Clearing of Trees	*1.00*	*EA*	*403.63*							24,218
	Unskilled Labor	4.0		61.41		14,738					
	Loader Operator	1.0		63.56		3,814					
	2.0 CY Loader (CAT IT28)	1.0		38.33			2,300				
	16 Ton Sideboom 120 hsp (Cat 561)	1.0		56.10			3,366				

Currency: USD-United States-Dollar

Item	Description	Quantity	UOM	Rate	ManHrs	Labor	Equip	Job Mat	Perm Mat	Sub/Plug	Total Cost
002020	Sediment Removal	381,000.00	CY		13,714	832,079	1,524,841				2,356,920
					0.04	2.18	4.00				6.19
A	Bld Scraper Haul Road	1.00	LS		128	7,856	7,698				15,554
					128.00	7,856.00	7,698.24				15,554.24
	Prod=0.06 LS/hour, 128.000MH/LS, 0.01 LS/MH, 16.00 hour										
	Excavation Crew	*1.00*	*EA*	*972.14*							15,554
	Equipment Foreman	1.0		69.32		1,109					
	Grader Operator	1.0		64.92		1,039					
	Loader Operator	1.0		63.56		1,017					
	Dozer Operator	1.0		63.56		1,017					
	Roller Operator	1.0		55.43		887					
	Water Truck Driver	1.0		58.07		929					
	Articulated Truck Driver	2.0		58.07		1,858					
	170 Hsp Bulldozer (Cat D6)	1.0		68.57			1,097				
	4.5 CY Loader (Cat 966)	1.0		71.10			1,138				
	200 Hsp Grader (Cat 14G)	1.0		87.75			1,404				
	25 Ton Articulated Truck (Cat D250)	2.0		81.29			2,601				
	Roller 12 ton (Cat CB 634C)	1.0		45.85			734				
	3/4 Ton Pickup Truck 4x4	1.0		12.00			192				
	5000 Gallon Watertanker	1.0		33.29			533				
B	Strip/Stockpile Topsands/Topsoil	1,000.00	CY		64	3,928	3,849				7,777
					0.06	3.93	3.85				7.78
	Strip top soils/soils and stockpile approx 1ac at SC Creek =1000cy										
	Prod=125.00 CY/hour, 0.064MH/CY, 15.63 CY/MH, 8.00 hour										
	Excavation Crew	*1.00*	*EA*	*972.14*							7,777
	Equipment Foreman	1.0		69.32		555					
	Grader Operator	1.0		64.92		519					
	Loader Operator	1.0		63.56		508					
	Dozer Operator	1.0		63.56		508					
	Roller Operator	1.0		55.43		443					
	Water Truck Driver	1.0		58.07		465					
	Articulated Truck Driver	2.0		58.07		929					
	170 Hsp Bulldozer (Cat D6)	1.0		68.57			549				
	4.5 CY Loader (Cat 966)	1.0		71.10			569				
	200 Hsp Grader (Cat 14G)	1.0		87.75			702				
	25 Ton Articulated Truck (Cat D250)	2.0		81.29			1,301				
	Roller 12 ton (Cat CB 634C)	1.0		45.85			367				
	3/4 Ton Pickup Truck 4x4	1.0		12.00			96				
	5000 Gallon Watertanker	1.0		33.29			266				

Currency: USD-United States-Dollar

Item	Description	Quantity	UOM	Rate	ManHrs	Labor	Equip	Job Mat	Perm Mat	Sub/Plug	Total Cost
C	HL Sediments to Carmel River - 627s At 1300'	381,000.00	CY		5,080	320,154	848,462				1,168,616
					0.01	0.84	2.23				3.07
	Prod=300.00 CY/hour, 0.013MH/CY, 75.00 CY/MH, 1,270.00 hour										
	HL Sediments Crew	*1.00*	*EA*	*920.17*							1,168,616
	Unskilled Labor	1.0		61.41		77,991					
	Dozer Operator	1.0		63.56		80,721					
	Scraper Operator	2.0		63.56		161,442					
	405 Hsp Bulldozer (Cat D9)	1.0		181.39			230,365				
	18 CY Tandem Scraper (Cat 627)	2.0		180.37			458,140				
	100 KW Diesel Generator Set	4.0		24.16			122,733				
	Tower 4-Lights 12 Hsp	4.0		4.97			25,248				
	1/2 Ton Pickup Truck 4x4	1.0		9.43			11,976				
E	Dragline/Clam Shell Operation at Dam Muck	50,000.00	CY		1,750	92,970	147,933				240,903
	Exc wet muck near dam with clasmshell or dragline...rehandle to promote drainage. Move demi drained muck to dump site with 627' at approx 500'				0.04	1.86	2.96				4.82
	Prod=100.00 cy/hour, 0.035MH/cy, 28.57 cy/MH, 500.00 hour										
	Dragline Excavation	*1.00*	*EA*	*481.805*							240,903
	Crane Operator Class A	1.0		36.54		18,270					
	Dozer Operator	1.0		63.56		31,780					
	Scraper Operator	0.5		63.56		15,890					
	Oiler	1.0		54.06		27,030					
	220 Hsp Bulldozer (Cat D7)	1.0		93.22			46,610				
	2.0 CY Dragline	1.0		106.40			53,200				
	Clam Bucket	1.0		6.06			3,030				
	18 CY Tandem Scraper (Cat 627)	0.5		180.37			45,093				
F	Confined Sediment Excavations	20,000.00	CY		200	12,712	16,727				29,439
					0.01	0.64	0.84				1.47
	Allowance for tight sediment excavations near stream banks and other undefined areas....										
	Prod=200.00 CY/hour, 0.010MH/CY, 100.00 CY/MH, 100.00 hour										
	Surgical Excavation @ stream banks	*1.00*	*EA*	*294.39*							29,439
	Backhoe Operator	1.0		63.56		6,356					
	Dozer Operator	1.0		63.56		6,356					
	170 Hsp Bulldozer (Cat D6)	1.0		68.57			6,857				
	2.6 CY Backhoe (Cat 350)	1.0		98.70			9,870				

Currency: USD-United States-Dollar

Item	Description	Quantity	UOM	Rate	ManHrs	Labor	Equip	Job Mat	Perm Mat	Sub/Plug	Total Cost
W	Place/Compact Sediments	381,000.00	CY		6,096	370,119	476,242				846,361
					0.02	0.97	1.25				2.22
	Prod=500.00 cy/hour, 0.016MH/cy, 62.50 cy/MH, 762.00 hour										
	Sediment	*1.00*	*EA*	*1110.71*							846,361
	Equipment Foreman	1.0		69.32		52,822					
	Grader Operator	1.0		64.92		49,469					
	Dozer Operator	2.0		63.56		96,865					
	Roller Operator	3.0		55.43		126,713					
	Water Truck Driver	1.0		58.07		44,249					
	305 Hsp Bulldozer (Cat D8)	1.0		136.76			104,211				
	405 Hsp Bulldozer (Cat D9)	1.0		181.39			138,219				
	200 Hsp Grader (Cat 14G)	1.0		87.75			66,866				
	Vibratory Compactor (CAT CS-533)	3.0		44.11			100,835				
	100 KW Diesel Generator Set	1.0		24.16			18,410				
	Tower 4-Lights 12 Hsp	4.0		4.97			15,149				
	1/2 Ton Pickup Truck 4x4	1.0		9.43			7,186				
	5000 Gallon Watertanker	1.0		33.29			25,367				
X	Maintain Haul Roads	150.00	HRS		300	18,449	18,156				36,605
					2.00	122.99	121.04				244.03
	1/4 time...100wd /4 =25wd...say 20wd ...or 1mo										
	Prod=1.00 HRS/hour, 2.000MH/HRS, 0.50 HRS/MH, 150.00 hour										
	Road Maintenance	*1.00*	*EA*	*244.03*							36,605
	Grader Operator	1.0		64.92		9,738					
	Water Truck Driver	1.0		58.07		8,711					
	200 Hsp Grader (Cat 14G)	1.0		87.75			13,163				
	5000 Gallon Watertanker	1.0		33.29			4,994				

Currency: USD-United States-Dollar

Item	Description	Quantity	UOM	Rate	ManHrs	Labor	Equip	Job Mat	Perm Mat	Sub/Plug	Total Cost
Z	Rem Scraper HL Road	1.00	LS		96	5,892	5,774				11,666
					96.00	5,892.00	5,773.68				11,665.68
	Prod=0.08 LS/hour, 96.000MH/LS, 0.01 LS/MH, 12.00 hour										
	Excavation Crew	*1.00*	*EA*	*972.14*							11,666
	Equipment Foreman	1.0		69.32		832					
	Grader Operator	1.0		64.92		779					
	Loader Operator	1.0		63.56		763					
	Dozer Operator	1.0		63.56		763					
	Roller Operator	1.0		55.43		665					
	Water Truck Driver	1.0		58.07		697					
	Articulated Truck Driver	2.0		58.07		1,394					
	170 Hsp Bulldozer (Cat D6)	1.0		68.57			823				
	4.5 CY Loader (Cat 966)	1.0		71.10			853				
	200 Hsp Grader (Cat 14G)	1.0		87.75			1,053				
	25 Ton Articulated Truck (Cat D250)	2.0		81.29			1,951				
	Roller 12 ton (Cat CB 634C)	1.0		45.85			550				
	3/4 Ton Pickup Truck 4x4	1.0		12.00			144				
	5000 Gallon Watertanker	1.0		33.29			399				
002040	Utility/Facility Relocation	1.00	LS		1	2,775	2,000			2,500	7,275
					1.00	2,775.00	2,000.00			2,500.00	7,275.00
A	Bldg/Utility Demo and Rebuild Allowance	1.00	LS		1	2,775	2,000			2,500	7,275
					1.00	2,775.00	2,000.00			2,500.00	7,275.00
	Demo / dispose of existing bldg at left dam abutment										
	Labor	1.0	EA	2,775.00		Prod=1.00 LS/hour, 1.00 hour					2,775
	Equipment Rental	1.0	EA	2,000.00		Prod=1.00 LS/hour, 1.00 hour					2,000
	Subontractors	1.0	ls	2,500.00						2,500	
002045	Demo Existing Fish Ladder	400.00	CY		555	111,000	80,000			40,000	231,000
					1.39	277.50	200.00			100.00	577.50
A	Hand Demo/Blast Old Fish Ladder	400.00	CY		555	111,000	80,000			40,000	231,000
					1.39	277.50	200.00			100.00	577.50
	Labor	1.0	EA	200.00		Prod=0.72 CY/hour, 555.00 hour					111,000
	Equipment Rental	1.0	EA	200.00		Prod=1.00 CY/hour, 400.00 hour					80,000
	Subontractors	400.0	CY	100.00						40,000	

Currency: USD-United States-Dollar

Item	Description	Quantity	UOM	Rate	ManHrs	Labor	Equip	Job Mat	Perm Mat	Sub/Plug	Total Cost
002050	Stream/Reservoir Restoration	20.00	AC		10,194	325,266	244,288	69,000		4,854,559	5,493,113
					509.69	16,263.28	12,214.42	3,450.00		242,727.95	274,655.64
A	Grade/Contour Stream Bed	6,900.00	LF		9,574	287,213	207,000	69,000		138,000	701,213
					1.39	41.63	30.00	10.00		20.00	101.63
	Labor	1.0	EA	30.00		Prod=0.72 LF/hour, 9,573.77 hour					287,213
	Equipment Rental	1.0	EA	30.00		Prod=1.00 LF/hour, 6,900.00 hour					207,000
	Construction Material	6,900.0	LF	10.00				69,000			
	Subontractors	6,900.0	LF	20.00						138,000	
B	Revegetate/Plant Stream Banks	1.00	LS							1,036,559	1,036,559
										1,036,559.00	1,036,559.00
	Subontractors	1.0	LS	1,036,559.00						1,036,559	
C	Step Pools	38.00	EA							2,280,000	2,280,000
										60,000.00	60,000.00
	Step Pools	38.0	cy	60,000.00						2,280,000	
D	Channel Grading Above Diversion	11,000.00	CY		620	38,053	37,288				75,341
					0.06	3.46	3.39				6.85
	Prod=141.94 CY/hour, 0.056MH/CY, 17.74 CY/MH, 77.50 hour										
	Excavation Crew	*1.00*	*EA*	*972.14*							75,341
	Equipment Foreman	1.0		69.32		5,372					
	Grader Operator	1.0		64.92		5,031					
	Loader Operator	1.0		63.56		4,926					
	Dozer Operator	1.0		63.56		4,926					
	Roller Operator	1.0		55.43		4,296					
	Water Truck Driver	1.0		58.07		4,500					
	Articulated Truck Driver	2.0		58.07		9,001					
	170 Hsp Bulldozer (Cat D6)	1.0		68.57			5,314				
	4.5 CY Loader (Cat 966)	1.0		71.10			5,510				
	200 Hsp Grader (Cat 14G)	1.0		87.75			6,801				
	25 Ton Articulated Truck (Cat D250)	2.0		81.29			12,600				
	Roller 12 ton (Cat CB 634C)	1.0		45.85			3,553				
	3/4 Ton Pickup Truck 4x4	1.0		12.00			930				
	5000 Gallon Watertanker	1.0		33.29			2,580				

Currency: USD-United States-Dollar

Item	Description	Quantity	UOM	Rate	ManHrs	Labor	Equip	Job Mat	Perm Mat	Sub/Plug	Total Cost
E	Stabilize Banks and Floodplain Terrace	1.00	LS							1,400,000	1,400,000
										1,400,000.00	1,400,000.00
002060	Sediment Disposal Site Closure	1.00	LS		413	25,675	17,195				42,870
					412.50	25,675.00	17,194.88				42,869.88
A	Replace 6" Topsoil From Stkpls	2,500.00	CY		100	6,138	6,014				12,152
					0.04	2.46	2.41				4.86
	Prod=200.00 CY/hour, 0.040MH/CY, 25.00 CY/MH, 12.50 hour										
	Excavation Crew	*1.00*	*EA*	*972.14*							12,152
	Equipment Foreman	1.0		69.32		867					
	Grader Operator	1.0		64.92		812					
	Loader Operator	1.0		63.56		795					
	Dozer Operator	1.0		63.56		795					
	Roller Operator	1.0		55.43		693					
	Water Truck Driver	1.0		58.07		726					
	Articulated Truck Driver	2.0		58.07		1,452					
	170 Hsp Bulldozer (Cat D6)	1.0		68.57			857				
	4.5 CY Loader (Cat 966)	1.0		71.10			889				
	200 Hsp Grader (Cat 14G)	1.0		87.75			1,097				
	25 Ton Articulated Truck (Cat D250)	2.0		81.29			2,032				
	Roller 12 ton (Cat CB 634C)	1.0		45.85			573				
	3/4 Ton Pickup Truck 4x4	1.0		12.00			150				
	5000 Gallon Watertanker	1.0		33.29			416				
B	Final Grade/Contour Disposal Site	62,500.00	SY		313	19,538	11,181				30,718
					0.01	0.31	0.18				0.49
	Prod=1,000.00 SY/hour, 0.005MH/SY, 200.00 SY/MH, 62.50 hour										
	Grade/Contour Crew	*1.00*	*EA*	*491.49*							30,718
	Grademan Roadwork	1.0		64.86		4,054					
	Equipment Foreman	1.0		69.32		4,333					
	Grader Operator	1.0		64.92		4,058					
	Roller Operator	1.0		55.43		3,464					
	Water Truck Driver	1.0		58.07		3,629					
	200 Hsp Grader (Cat 14G)	1.0		87.75			5,484				
	Roller 12 ton (Cat CB 634C)	1.0		45.85			2,866				
	3/4 Ton Pickup Truck 4x4	1.0		12.00			750				
	5000 Gallon Watertanker	1.0		33.29			2,081				

Currency: USD-United States-Dollar

Item	Description	Quantity	UOM	Rate	ManHrs	Labor	Equip	Job Mat	Perm Mat	Sub/Plug	Total Cost
002070	Haul/Access Rd Restoration	10,000.00	SY		120	7,523	4,949			9,000	21,472
					0.01	0.75	0.49			0.90	2.15
A	Scarify/Grade Haul Roads	10,000.00	SY		120	7,523	4,949				12,472
					0.01	0.75	0.49				1.25
	Prod=500.00 SY/hour, 0.012MH/SY, 83.33 SY/MH, 20.00 hour										
	Scarify/Grade Crew	*1.00*	*EA*	*623.62*							12,472
	Grademan Roadwork	1.0		64.86		1,297					
	Equipment Foreman	1.0		69.32		1,386					
	Grader Operator	1.0		64.92		1,298					
	Dozer Operator	1.0		63.56		1,271					
	Roller Operator	1.0		55.43		1,109					
	Water Truck Driver	1.0		58.07		1,161					
	170 Hsp Bulldozer (Cat D6)	1.0		68.57			1,371				
	200 Hsp Grader (Cat 14G)	1.0		87.75			1,755				
	Roller 12 ton (Cat CB 634C)	1.0		45.85			917				
	3/4 Ton Pickup Truck 4x4	1.0		12.00			240				
	5000 Gallon Watertanker	1.0		33.29			666				
B	Hydroseed	6.00	AC							9,000	9,000
										1,500.00	1,500.00
	Hydroseeding	6.0	AC	1,500.00						9,000	
002090	Restore Construction Staging/Laydown Areas	15,000.00	SY		180	11,285	7,424			7,500	26,209
					0.01	0.75	0.49			0.50	1.75
A	Scarify/Grade Laydown Areas	15,000.00	SY		180	11,285	7,424				18,709
					0.01	0.75	0.49				1.25
	Prod=500.00 SY/hour, 0.012MH/SY, 83.33 SY/MH, 30.00 hour										
	Scarify/Grade Crew	*1.00*	*EA*	*623.62*							18,709
	Grademan Roadwork	1.0		64.86		1,946					
	Equipment Foreman	1.0		69.32		2,080					
	Grader Operator	1.0		64.92		1,948					
	Dozer Operator	1.0		63.56		1,907					
	Roller Operator	1.0		55.43		1,663					
	Water Truck Driver	1.0		58.07		1,742					
	170 Hsp Bulldozer (Cat D6)	1.0		68.57			2,057				
	200 Hsp Grader (Cat 14G)	1.0		87.75			2,633				
	Roller 12 ton (Cat CB 634C)	1.0		45.85			1,376				
	3/4 Ton Pickup Truck 4x4	1.0		12.00			360				
	5000 Gallon Watertanker	1.0		33.29			999				

Currency: USD-United States-Dollar

Item	Description	Quantity	UOM	Rate	ManHrs	Labor	Equip	Job Mat	Perm Mat	Sub/Plug	Total Cost
B	Hydroseed	6.00	AC							7,500	7,500
										1,250.00	1,250.00
	Hydroseeding	5.0	AC	1,500.00						7,500	
003000	Demobilization & Cleanup	1.00	LS		1	48,563	10,000			10,000	68,563
					1.39	48,563.00	10,000.00			10,000.00	68,563.00
A	Final Punch List/Clean Up/Demobe	1.00	LS		1	48,563	10,000			10,000	68,563
					1.39	48,563.00	10,000.00			10,000.00	68,563.00
	Labor	1.0	EA	35,000.00		Prod=0.72 LS/hour, 1.39 hour					48,563
	Equipment Rental	1.0	EA	10,000.00		Prod=1.00 LS/hour, 1.00 hour					10,000
	Subontractors	1.0	LS	10,000.00						10,000	
004000	Dam Removal By Blasting	7,500.00	CY		28,934	99,766	93,481			1,825,000	2,018,247
					3.86	13.30	12.46			243.33	269.10
A	Excavation for Downstream Cofferdam Installation	5,000.00	CY		400	24,550	24,057				48,607
					0.08	4.91	4.81				9.72
	Prod=100.00 CY/hour, 0.080MH/CY, 12.50 CY/MH, 50.00 hour										
	Excavation Crew	*1.00*	*EA*	*972.14*							48,607
	Equipment Foreman	1.0		69.32		3,466					
	Grader Operator	1.0		64.92		3,246					
	Loader Operator	1.0		63.56		3,178					
	Dozer Operator	1.0		63.56		3,178					
	Roller Operator	1.0		55.43		2,772					
	Water Truck Driver	1.0		58.07		2,904					
	Articulated Truck Driver	2.0		58.07		5,807					
	170 Hsp Bulldozer (Cat D6)	1.0		68.57			3,429				
	4.5 CY Loader (Cat 966)	1.0		71.10			3,555				
	200 Hsp Grader (Cat 14G)	1.0		87.75			4,388				
	25 Ton Articulated Truck (Cat D250)	2.0		81.29			8,129				
	Roller 12 ton (Cat CB 634C)	1.0		45.85			2,293				
	3/4 Ton Pickup Truck 4x4	1.0		12.00			600				
	5000 Gallon Watertanker	1.0		33.29			1,665				

Currency: USD-United States-Dollar

Item	Description	Quantity	UOM	Rate	ManHrs	Labor	Equip	Job Mat	Perm Mat	Sub/Plug	Total Cost
B	Build Working Platform at Dam Face	1,500.00	CY		128	7,856	7,698				15,554
					0.09	5.24	5.13				10.37
	Prod=93.75 CY/hour, 0.085MH/CY, 11.72 CY/MH, 16.00 hour										
	Working Platform Crew	*1.00*	*EA*	*972.14*							15,554
	Equipment Foreman	1.0		69.32		1,109					
	Grader Operator	1.0		64.92		1,039					
	Loader Operator	1.0		63.56		1,017					
	Dozer Operator	1.0		63.56		1,017					
	Roller Operator	1.0		55.43		887					
	Water Truck Driver	1.0		58.07		929					
	Articulated Truck Driver	2.0		58.07		1,858					
	170 Hsp Bulldozer (Cat D6)	1.0		68.57			1,097				
	4.5 CY Loader (Cat 966)	1.0		71.10			1,138				
	200 Hsp Grader (Cat 14G)	1.0		87.75			1,404				
	25 Ton Articulated Truck (Cat D250)	2.0		81.29			2,601				
	Roller 12 ton (Cat CB 634C)	1.0		45.85			734				
	3/4 Ton Pickup Truck 4x4	1.0		12.00			192				
	5000 Gallon Watertanker	1.0		33.29			533				
C	Remove Dam Misc Metal Work	20,000.00	LB		27,750	27,750	20,000				47,750
					1.39	1.39	1.00				2.39
	Labor	1.0	EA	1.00		Prod=0.72 LB/hour, 27,750.00 hour					27,750
	Equipment Rental	1.0	EA	1.00		Prod=1.00 LB/hour, 20,000.00 hour					20,000
D	Drill/Shoot Dam Concrete	7,500.00	CY							1,125,000	1,125,000
										150.00	150.00
	Sub Shotcrete	7,500.0	cy	150.00						1,125,000	
E	Secondary Rubble Processing	3,500.00	CY							700,000	700,000
										200.00	200.00
	Secondary Rubble Processing	3,500.0	CY	200.00						700,000	

Currency: USD-United States-Dollar

Item	Description	Quantity	UOM	Rate	ManHrs	Labor	Equip	Job Mat	Perm Mat	Sub/Plug	Total Cost
F	Haul Concrete Rubble	7,500.00	CY		240	14,361	14,530				28,891
					0.03	1.91	1.94				3.85
	Prod=156.25 cy/hour, 0.032MH/cy, 31.25 cy/MH, 48.00 hour										
	Haul concrete rubble	*1.00*	*EA*	*601.89*							28,891
	General Labourer	1.0		61.41		2,948					
	Loader Operator	1.0		63.56		3,051					
	Truck Driver	3.0		58.07		8,362					
	3.5 CY Loader (Cat 950)	1.0		58.84			2,824				
	25 Ton Articulated Truck (Cat D250)	3.0		81.29			11,706				
I	Remove Trapped Solid	5,000.00	CY		192	11,608	12,294				23,902
					0.04	2.32	2.46				4.78
	Prod=156.25 cy/hour, 0.038MH/cy, 26.04 cy/MH, 32.00 hour										
	Remove trapped solid	*1.00*	*EA*	*746.93*							23,902
	General Labourer	1.0		61.41		1,965					
	Backhoe Operator	1.0		63.56		2,034					
	Loader Operator	1.0		63.56		2,034					
	Truck Driver	3.0		58.07		5,575					
	3.5 CY Loader (Cat 950)	1.0		58.84			1,883				
	2.3 CY Backhoe (Cat 235)	1.0		81.48			2,607				
	25 Ton Articulated Truck (Cat D250)	3.0		81.29			7,804				
J	Remove Temp Cofferdam	5,000.00	CY		224	13,642	14,901				28,543
					0.04	2.73	2.98				5.71
	Prod=156.25 cy/hour, 0.045MH/cy, 22.32 cy/MH, 32.00 hour										
	Remove temporary cofferdam	*1.00*	*EA*	*891.97*							28,543
	General Labourer	1.0		61.41		1,965					
	Backhoe Operator	2.0		63.56		4,068					
	Loader Operator	1.0		63.56		2,034					
	Truck Driver	3.0		58.07		5,575					
	3.5 CY Loader (Cat 950)	1.0		58.84			1,883				
	2.3 CY Backhoe (Cat 235)	2.0		81.48			5,215				
	25 Ton Articulated Truck (Cat D250)	3.0		81.29			7,804				

Currency: USD-United States-Dollar

Item	Description	Quantity	UOM	Rate	ManHrs	Labor	Equip	Job Mat	Perm Mat	Sub/Plug	Total Cost
004002	Dam Notching - OCRD	35.00	CY		24,281	24,281	35,000	3,500		17,500	80,281
					693.74	693.74	1,000.00	100.00		500.00	2,293.74
A	Sawcut/Remove Concrete	35.00	CY		24,281	24,281	35,000	3,500		17,500	80,281
					693.74	693.74	1,000.00	100.00		500.00	2,293.74
	Labor	1.0	EA	1.00		Prod=0.00 LS/hour, 24,281.00 hour					24,281
	Equipment Rental	1.0	EA	35,000.00		Prod=1.00 LS/hour, 1.00 hour					35,000
	Construction Materials	1.0	LS	3,500.00				3,500			
	Subontractors	1.0	ls	17,500.00						17,500	
004020	Ranney Intake System	1.00	LS		469,266	667,834	297,705	43,615	696,500	102,232	1,807,887
					469,266.00	667,834.49	297,705.31	43,615.00	696,500.00	102,232.00	1,807,886.80
A	Excavate for Pipes	8,500.00	CY		450	27,201	16,196				43,396
					0.05	3.20	1.91				5.11
	Prod=94.44 CY/hour, 0.053MH/CY, 18.89 CY/MH, 90.00 hour										
	Trench Excavation	*1.00*	*EA*	*482.18*							43,396
	Spotter	1.0		51.73		4,656					
	Equipment Foreman	1.0		69.32		6,239					
	Backhoe Operator	2.0		63.56		11,441					
	Oiler	1.0		54.06		4,865					
	2.3 CY Backhoe (Cat 235)	2.0		81.48			14,666				
	22" Smooth Drum Manual (Bomag 55)	1.0		5.65			509				
	3/4 Ton Crew Cab Truck	1.0		11.34			1,021				
B	Place RCP Well Segment	20.00	VLF		128	8,032	3,061		12,000		23,093
					6.40	401.60	153.06		600.00		1,154.66
	Prod=0.63 ft/hour, 6.400MH/ft, 0.16 ft/MH, 32.00 hour										
	Place RCP Well	*1.00*	*EA*	*346.66*							11,093
	General Labour Foreman	1.0		62.41		1,997					
	General Labourer	2.0		61.41		3,930					
	Auger Operator	1.0		65.77		2,105					
	Vertical Earth Drill (100 ft)	1.0		95.66			3,061				
	120" (3000 mm) Class V Concrete Sewer Pipe	20.0	ft	600.00					12,000		

Currency: USD-United States-Dollar

Item	Description	Quantity	UOM	Rate	ManHrs	Labor	Equip	Job Mat	Perm Mat	Sub/Plug	Total Cost
C	Install 12" Ranney Pipe	500.00	LF		2,142	133,598	58,172		200,000		391,770
					4.28	267.20	116.34		400.00		783.54
	Prod=3.27 ft/hour, 4.284MH/ft, 0.23 ft/MH, 153.00 hour										
	Install 12" Ranney Pipe	*1.00*	*EA*	*1253.4*							191,770
	General Labour Foreman	1.0		62.41		9,549					
	General Labourer	6.0		61.41		56,374					
	Equipment Foreman	1.0		69.32		10,606					
	Backhoe Operator	1.0		63.56		9,725					
	Sideboom Operator	3.0		65.77		30,188					
	Truck Driver	1.0		58.07		8,885					
	Oiler	1.0		54.06		8,271					
	1.7 CY Backhoe (JD 790)	1.0		68.92			10,545				
	4" Diesel Water Pump 30,000 gph	3.0		4.85			2,226				
	35 Ton Sideboom 230 hsp (Cat 572)	3.0		89.31			40,993				
	3/4 Ton Pickup Truck 2x2	1.0		11.14			1,704				
	5 Ton Flat Bed Truck	1.0		17.67			2,704				
	12" (300mm) Ranney Pipe	500.0	ft	400.00					200,000		
D	Install 18" Manifolds	100.00	LF		72	4,833	1,356		5,000		11,189
					0.72	48.33	13.56		50.00		111.89
	Prod=4.17 LF/hour, 0.720MH/LF, 1.39 LF/MH, 24.00 hour										
	Install manifolds	*1.00*	*EA*	*257.87*							6,189
	Pipefitter	1.0		68.11		1,635					
	Pipefitter Helper	1.0		67.50		1,620					
	Crane Operator Class A	1.0		65.77		1,578					
	20 Ton Hydraulic Crane (Grove58)	1.0		45.15			1,084				
	3/4 Ton Crew Cab Truck	1.0		11.34			272				
	Piping Materials	1.0	ls	5,000.00					5,000		
E	30" C200 AG Conveyance	3,500.00	LF		181,551	181,551	87,232	43,615	479,500	87,232	879,130
					51.87	51.87	24.92	12.46	137.00	24.92	251.18
	Labor	1.0	EA	1.00		Prod=0.00 LS/hour, 181,551.00 hour					181,551
	Equipment Rental	1.0	EA	87,232.00		Prod=1.00 LS/hour, 1.00 hour					87,232
	Construction Materials	1.0	LS	43,615.00				43,615			
	Piping Materials	3,500.0	lf	137.00					479,500		
	Subontractors	1.0	ls	87,232.00						87,232	
F	Connect to (E) Pipeline	1.00	LS							15,000	15,000
										15,000.00	15,000.00
	Subontractors	1.0	ls	15,000.00						15,000	

Currency: USD-United States-Dollar

Item	Description	Quantity	UOM	Rate	ManHrs	Labor	Equip	Job Mat	Perm Mat	Sub/Plug	Total Cost
G	Pipeline Concrete Foundation	325.00	EA		284,443	284,443	124,085				408,528
					875.21	875.21	381.80				1,257.01
	Labor	1.0	EA	1.00		Prod=0.00 LS/hour, 284,443.00 hour					284,443
	Equipment Rental	1.0	EA	124,085.00		Prod=1.00 LS/hour, 1.00 hour					124,085
I	Backfill	7,500.00	CY		480	28,177	7,604				35,780
					0.06	3.76	1.01				4.77
	Prod=125.00 cy/hour, 0.064MH/cy, 15.63 cy/MH, 60.00 hour										
	Backfill Trench	*1.00*	*EA*	*596.34*							35,780
	Spotter	1.0		51.73		3,104					
	General Labourer	2.0		61.41		7,369					
	Equipment Foreman	1.0		69.32		4,159					
	Backhoe Operator	1.0		63.56		3,814					
	Oiler	3.0		54.06		9,731					
	1.7 CY Backhoe (JD 790)	1.0		68.92			4,135				
	22" Smooth Drum Manual (Bomag 55)	2.0		5.65			678				
	10 Ton Compactor 120 hsp (Dyn CA25)	1.0		35.17			2,110				
	3/4 Ton Crew Cab Truck	1.0		11.34			680				
004500	Unidentified Items	1.00	LS		1	1,625,000	400,000			400,000	2,425,000
					1.00	1,625,000.00	400,000.00			400,000.00	2,425,000.00
A	Unscoped Items	1.00	LS		1	1,625,000	400,000			400,000	2,425,000
					1.00	1,625,000.00	400,000.00			400,000.00	2,425,000.00
	Labor	1.0	EA	1,625,000.00		Prod=1.00 LS/hour, 1.00 hour					1,625,000
	Equipment Rental	1.0	EA	400,000.00		Prod=1.00 LS/hour, 1.00 hour					400,000
	Subcontractor	1.0	LS	400,000.00						400,000	
005000	O&M Cost Allowance	1.00	LS		1	111,000	55,000		10,825		176,825
					1.00	111,000.00	55,000.00		10,825.00		176,825.00
B	Ranney System O&M	1.00	LS		1	111,000	55,000		10,825		176,825
					1.00	111,000.00	55,000.00		10,825.00		176,825.00
	Labor	1.0	EA	111,000.00		Prod=1.00 LS/hour, 1.00 hour					111,000
	Equipment Rental	1.0	EA	55,000.00		Prod=1.00 LS/hour, 1.00 hour					55,000
	Construction Materials	1.0	LS	10,825.00					10,825		

Material Quantity Summary

Estimate: - Carmel River Reroute and San Clemente Dam Removal Project

Currency: USD-United States-Dollar

Material Classification & Description

Code	Description	Quantity	UOM	Rate	Total Cost
100000	Indirect Items				
General	Construction Material	6,900.00	LF	10.00	69,000.00
General	Construction Material	2.00	LS	135,500.00	271,000.00
General	Construction Materials	500.00	cy	10.00	5,000.00
General	Construction Materials	4.00	LS	111,540.75	446,163.00
General	Permanent Materials	500.00	cy	135.00	67,500.00
	Sub-Total	7,906.00			858,663.00
2110000	Mechanical Pipe				
PE450	HDPE Pipe 18"	3,800.00	ft	36.00	136,800.00
PE900	HDPE Pipe 36"	5,000.00	ft	65.00	325,000.00
PE450	HDPE 90/45 deg 18"	10.00	ea	225.00	2,250.00
PE900	HDPE 45deg 36"	16.00	ea	600.00	9,600.00
PE900	HDPE 90 deg 36"	4.00	ea	900.00	3,600.00
	Sub-Total	8,830.00			477,250.00
3128000	Structural Backfill				
Backfill120	Pitrun Gravel	500.00	ton	20.00	10,000.00
	Sub-Total	500.00			10,000.00
3160000	Piling				
Pile4345	PZ 27 Sheetpile	8,500.00	sf	12.15	103,275.00
	Sub-Total	8,500.00			103,275.00
3211000	Aggregate Base				
Base1235	25mm (1") Aggregate Base	5,325.00	ton	22.00	117,150.00
	Sub-Total	5,325.00			117,150.00
3311300	Watermain Valves				
MAT	Piping Materials	3,500.00	lf	137.00	479,500.00
MAT	Piping Materials	1.00	ls	5,000.00	5,000.00
	Sub-Total	3,501.00			484,500.00
3342000	Culverts				
CSP450x2.8	450 mm (18") x 2.8 mm Corrugated Steel Pipe (68mm x 13m	435.00	lf	16.00	6,960.00
	Sub-Total	435.00			6,960.00
3344000	Concrete Pipe & Fittings				
CP3000V	120" (3000 mm) Class V Concrete Sewer Pipe	20.00	ft	600.00	12,000.00
	Sub-Total	20.00			12,000.00
3346000	Subdrains				
Ranney Pipe	12" (300mm) Ranney Pipe	500.00	ft	400.00	200,000.00
	Sub-Total	500.00			200,000.00
				Totals:	2,269,798.00

Labor Hour Summary

Estimate: - Carmel River Reroute and San Clemente Dam Removal Project

Currency: USD-United States-Dollar

Labor Classification & Description

Code	Description	Labor Hours	Rate	Total Cost
30000	Labourers			
General	Labor	528,854.90	7.84	4,147,189.00
General100	General Labour Foreman	2,779.68	62.41	173,480.09
General300	General Labourer	2,406.08	61.41	147,757.17
General420	Unskilled Labor	5,546.51	61.41	340,611.03
Road300	Grademan Roadwork	1,389.98	64.86	90,153.89
Road620	Spotter	150.00	51.73	7,759.50
	Sub-Total	541,127.15		4,906,950.68
210000	Pipefitters			
Pipefitter100	Pipefitter Foreman	0.00	0.00	0.00
Pipefitter200	Pipefitter	24.00	68.11	1,634.64
Pipefitter300	Pipefitter Helper	24.00	67.50	1,620.00
	Sub-Total	48.00		3,254.64
312300	Equipment Operators			
Operator010	Equipment Foreman	1,919.15	69.32	133,035.48
Operator200	Crane Operator Class A	1,311.33	37.07	48,617.52
Operator240	Auger Operator	32.00	65.77	2,104.64
Operator310	Backhoe Operator	658.25	63.56	41,838.37
Operator400	Grader Operator	2,911.23	64.92	188,996.84
Operator410	Loader Operator	847.25	63.56	53,851.21
Operator420	Dozer Operator	8,458.00	63.56	537,590.67
Operator440	Scraper Operator	2,790.00	63.56	177,332.40
Operator510	Sideboom Operator	459.00	65.77	30,188.43
Operator620	Roller Operator	6,688.38	55.43	370,736.91
	Sub-Total	26,074.59		1,584,292.46
312350	Truck Drivers			
Truck310	Articulated Truck Driver	1,098.00	58.07	63,760.86
Truck310	Truck Driver	1,989.00	58.07	115,501.23
Truck310	Water Truck Driver	2,930.23	58.07	170,158.27
	Sub-Total	6,017.23		349,420.36
316000	Pile Driver			
Pile500	Pile Driving Foreman	450.00	66.51	29,929.50
Pile510	Pile Driver	2,250.00	65.77	147,982.50
	Sub-Total	2,700.00		177,912.00
580000	Mechanics			
Mechanic520	Oiler	1,710.33	54.06	92,460.44
	Sub-Total	1,710.33		92,460.44
	Totals:	577,677.30		7,114,290.57

Equipment Hour Summary

Estimate: - Carmel River Reroute and San Clemente Dam Removal Project

Currency: USD-United States-Dollar

Equipment Classification & Description

Code	Description	Equip Hours	Average Rate	Total Cost
810000	Earthmoving Equipment			
14G	200 Hsp Grader (Cat 14G)	3,973.75	87.75	348,696.93
235	2.3 CY Backhoe (Cat 235)	276.00	81.48	22,488.48
330	2.0 CY Backhoe (Cat 330)	69.25	80.43	5,569.78
350	2.6 CY Backhoe (Cat 350)	100.00	98.70	9,870.00
627	18 CY Tandem Scraper (Cat 627)	2,790.00	180.37	503,232.30
790	1.7 CY Backhoe (JD 790)	213.00	68.92	14,679.96
950	3.5 CY Loader (Cat 950)	112.00	58.84	6,590.08
966	4.5 CY Loader (Cat 966)	613.25	71.10	43,602.08
Articulated250	25 Ton Articulated Truck (Cat D250)	1,434.00	81.29	116,569.86
ClamBucket	Clam Bucket	500.00	6.06	3,030.00
Compactor	Vibratory Compactor (CAT CS-533)	4,670.15	44.11	206,000.47
Compactor10Ton	10 Ton Compactor 120 hsp (Dyn CA25)	60.00	35.17	2,110.20
Compactor22Inch	22" Smooth Drum Manual (Bomag 55)	210.00	5.65	1,186.50
D10	570 Hsp Bulldozer (Cat D10)	867.82	238.55	207,018.94
D6	170 Hsp Bulldozer (Cat D6)	835.50	68.57	57,290.24
D7	220 Hsp Bulldozer (Cat D7)	500.00	93.22	46,610.00
D8	305 Hsp Bulldozer (Cat D8)	1,954.08	136.76	267,239.53
D9	405 Hsp Bulldozer (Cat D9)	4,300.60	181.39	780,086.60
Dragline1.75	2.0 CY Dragline	500.00	106.40	53,200.00
IT28	2.0 CY Loader (CAT IT28)	60.00	38.33	2,299.80
JumpJack20	Jumping Jack Handheld Packer	43.50	4.12	179.22
RipperD10	Ripper Attachment D10	1,043.53	13.35	13,931.09
TC	TC Device	21.00	500.00	10,500.00
	Sub-Total	25,147.44		2,721,982.04
820000	Paving Equipment			
Roller90	Roller 12 ton (Cat CB 634C)	2,018.23	45.85	92,535.69
	Sub-Total	2,018.23		92,535.69
850000	Utility Equipment			
FusionWelder20	Large Dia. Polyethylene Fusion Machine	30.00	1,100.00	33,000.00
Generator100kw	100 KW Diesel Generator Set	10,016.11	24.16	241,989.22
LightPlant2	Tower 4-Lights 12 Hsp	8,128.00	4.97	40,396.16
LightPlant4	Tower 8-Lights 20 Hsp	4,174.11	7.25	30,262.30
PumpDiesel4	4" Diesel Water Pump 30,000 gph	459.00	4.85	2,226.15
	Sub-Total	22,807.22		347,873.83
860000	Hoisting Equipment			
CrawlerCrane150T	150 Ton Crawler Crane (American 9260)	670.00	163.08	109,263.60
HydraulicCrane20T	20 Ton Hydraulic Crane (Grove58)	24.00	45.15	1,083.60
Sideboom16Ton	16 Ton Sideboom 120 hsp (Cat 561)	205.00	56.10	11,500.50
Sideboom35Ton	35 Ton Sideboom 230 hsp (Cat 572)	459.00	89.31	40,993.29
	Sub-Total	1,358.00		162,840.99
870000	Foundation & Marine Equipment			
Hammer50	225,000 Ft-Lb Pile Hammer (Delmag D100)	670.00	87.83	58,846.10
SoilAnchor10	Vertical Earth Drill (100 ft)	32.00	95.66	3,061.12
	Sub-Total	702.00		61,907.22
890000	Service & Maintenance Equipment			
Equip	Equipment Rental	27,810.00	56.00	1,557,493.00
Flatbed5	5 Ton Flat Bed Truck	153.00	17.67	2,703.51
Lowboy50	50 Ton Lowboy	1,500.00	52.09	78,135.00
Pickup40	1/2 Ton Pickup Truck 4x4	4,267.60	9.43	40,243.51
Pickup50	3/4 Ton Pickup Truck 2x2	153.00	11.14	1,704.42
Pickup60	3/4 Ton Pickup Truck 4x4	976.73	12.00	11,720.76
Pickup70	3/4 Ton Crew Cab Truck	174.00	11.34	1,973.16
Water30	5000 Gallon Watertanker	2,930.23	33.29	97,547.25
	Sub-Total	37,964.56		1,791,520.60
	Totals:	89,997.45		5,178,660.38

Subcontract Quantity Summary

Estimate: - Carmel River Reroute and San Clemente Dam Removal Project

Currency: USD-United States-Dollar

Subcontract Classification & Description

Code	Description	Quantity	UOM	Rate	Total Cost
13000	Site Facilities				
Dewater	Operate Dewater System	200.00	DA	200.00	40,000.00
General	Subcontract	500.00	cy	90.00	45,000.00
General	Subcontract	1.00	ls	120,000.00	120,000.00
General	Subcontractor	1.00	LS	400,000.00	400,000.00
General	Subontractors	400.00	CY	100.00	40,000.00
General	Subontractors	6,900.00	LF	20.00	138,000.00
General	Subontractors	6.00	ls	194,798.50	1,168,791.00
	Sub-Total				1,951,791.00
14000	Site Services				
General	Subcontractors	2.00	LS	95,000.00	190,000.00
	Sub-Total				190,000.00
16000	Quality Control				
Cement	Cement Stabilization	50,000.00	CY	75.00	3,750,000.00
Cement	Stabilization Extra	1.00	LS	200,000.00	200,000.00
	Sub-Total				3,950,000.00
33000	Concrete Placing				
Slurry	Slurry Wall	13,200.00	sf	12.50	165,000.00
	Sub-Total				165,000.00
313900	Rock Excavation				
DrillBlast180	Drill & Shoot	313,843.00	cy	10.00	3,138,430.00
DrillBlast180	Step Pools	38.00	cy	60,000.00	2,280,000.00
DrillBlast80	Pre-Split Drilling	2,500.00	VLF	15.00	37,500.00
	Sub-Total				5,455,930.00
314000	Shoring				
Shore10	Shotcrete	150.00	cy	300.00	45,000.00
Shore10	Soil Nails -10'	550.00	ea	100.00	55,000.00
Shotcrete10	Sub Shotcrete	7,500.00	cy	150.00	1,125,000.00
	Sub-Total				1,225,000.00
321100	Aggregate Base				
Crush20	Secondary Rubble Processing	3,500.00	CY	200.00	700,000.00
	Sub-Total				700,000.00
321200	Asphalt Paving				
Asphalt110	Double Chip Seal Road	213,250.00	SF	0.30	63,975.00
	Sub-Total				63,975.00
329000	Landscaping				
Land50	Cut Slope Stabilization	35,000.00	sf	4.00	140,000.00
Seed120	Hydroseeding	21.00	AC	1,500.00	31,500.00
	Sub-Total				171,500.00
				Total:	13,873,196.00

Plugged Cost Summary
Estimate: - Carmel River Reroute and San Clemente Dam Removal Project

Currency: USD-United States-Dollar

Line Description	Quantity	UOM	Unit Cost	Total Cost
River Bypass/Dam Removal	**1.00**	**LS**	**1,415,000.00**	**1,415,000.00**
I-002010-A-A Mobe/Demobe SP Equipment	1.00	LS	15,000.00	15,000.00
I-002050-A-E Stabilize Banks and Floodplain Ter	1.00	LS	1,400,000.00	1,400,000.00

AACE International CLASS 1 Cost Estimate -Class 1 estimates are generally prepared for discrete parts or sections of the total project rather than generating this level of detail for the entire project. The parts of the project estimated at this level of detail will typically be used by subcontractors for bids, or by owners for check estimates. The updated estimate is often referred to as the current control estimate and becomes the new baseline for cost/schedule control of the project. Class 1 estimates may be prepared for parts of the project to comprise a fair price estimate or bid check estimate to compare against a contractor's bid estimate, or to evaluate/dispute claims. Typically, engineering is from 50% to 100% complete, and would comprise virtually all engineering and design documentation of the project, and complete project execution and commissioning plans. (AACE International Recommended Practices and Standards).

AACE International CLASS 2 Cost Estimate - Class 2 estimates are generally prepared to form a detailed control baseline against which all project work is monitored in terms of cost and progress control. Typically, engineering is from 30% to 70% complete Class 2 estimates involve a high degree of deterministic estimating methods. Class 2 estimating efforts are characterized by significant line item detail. Typical accuracy ranges for Class 2 estimates are -5% to -15% on the low side, and +5 to +20% on the high side, depending on the technological complexity of the project. As little as 300 hrs or less to perhaps more than 3,000 hours may be spent preparing the estimate based on the project and estimating methodology. Bid estimates typically require more effort than estimates used for funding or control purposes (AACE International Recommended Practices and Standards).

AACE International CLASS 3 Cost Estimate - Class 3 estimates are generally prepared to form the basis for budget authorization, appropriation, and/or funding. Typically engineering is from 10% to 40% complete.They are typically prepared to support full project funding requests, and become the first of the project phase "control estimates" against which all actual costs and resources will be monitored for variation to budget. Most Class 3 estimates involve more deterministic estimating methods than stochastic methods. Typical accuracy ranges for Class 3 estimates are from +/- 10% to 30% (sometimes higher), depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. As little as 300 hrs or less to perhaps more than 2,000 hours may be spent preparing the estimate based on the project and estimating methodology (AACE International Recommended Practices and Standards).

AACE International CLASS 4 Cost Estimate - Class 4 estimates are generally prepared based on limited information and subsequently have fairly wide accuracy ranges. Typically, engineering is 10% to 40% complete. They are typically used for project screening, determination of feasibility, concept evaluation, and preliminary budget approval. Virtually all Class 4 estimates use stochastic estimating methods such as cost curves, capacity factors, and other parametric and modeling techniques. Expected accuracy ranges are from -15% to -30% on the low side and +20% to 50% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances. As little as 20 hours or less to perhaps more than 300 hours may be spend preparing the estimate depending on the project and estimating methodology (AACE International Recommended Practices and Standards).

AACE International CLASS 5 Cost Estimate - Class 5 estimates are generally prepared based on very limited information, and subsequently have wide accuracy ranges. As such, some companies and organizations have elected to determine that due to the inherent inaccuracies, such estimates cannot be classified in a conventional and systemic manner. Class 5 estimates, due to the requirements of end use, may be prepared within a very limited amount of time and with little effort expended— sometimes requiring less than an hour to prepare. Often, little more than proposed plant type, location, and capacity are known at the time of estimate preparation. (AACE International Recommended Practices and Standards).

Note/Assumptions;

1) **AACE Class 4 Cost Estimate (accuracy range = -20% to +35% of estimate point values)**
2) **Davis Bacon Wage Rates Included**
3) **Pricing includes escalation to MPC at 6%/year, Current Caltrans Price Index = 290**
4) **Pricing assumes competitive condition at time of tender (+3 bidders)**

Estimating Disclaimer - Engineer's Opinion of Probable Cost:

The estimate of costs shown and any resulting conclusions on the project financial, economic feasibility or funding requirements have been prepared from guidance in the project evaluation and implementation from the information available at the time the estimate was prepared. The final Costs of the project and resulting feasibility will depend on actual labor and material costs, competitive market conditions and other variable factors. Accordingly, the final project costs may vary from the estimate. Project feasibility, benefit/cost analysis, risk and funding must be reviewed prior to making specific funding decisions and establishment of the project budget.

ENTRIX ENVIRONMENTAL MITIGATION PLANNING/IMPLEMENTATION/MONITORING COST ESTIMATE

ENTRIX ESTIMATED BUDGET PLAN 2006-2008

LEAD	SAN CLEMENTE SEISMIC SAFETY PROG ENVIRONMENTAL/PERMITTING	Total	2007 January	February	March	April	May	June	July	August	September	October	November	December
	MITIGATION PLANNING / IMPLEMENTATION / MONITORING (2007 - 2008)	$ 3,500,000	$ 335,000	$ 135,000	$ 135,000	$ 135,000	$ 135,000	$ 135,000	$ 165,000	$ 135,000	$ 135,000	$ 135,000	$ 135,000	$ 135,000
Rick	Soils & Geology	$ 50,000	$ 50,000											
Jillian	Hydrology & Sediment	$ -												
Susan	Water Quality	$ 50,000	$ 50,000											
Tom	Fish & Aquatic Biology	$ 3,000,000	$ 125,000	$ 125,000	$ 125,000	$ 125,000	$ 125,000	$ 125,000	$ 125,000	$ 125,000	$ 125,000	$ 125,000	$ 125,000	$ 125,000
Gretchen	Terrestrial Biology (5 year monitoring)	$ 30,000							$ 15,000					
Gretchen	Wetlands (5 year monitoring)	$ 35,000	$ 5,000						$ 15,000					
Brad	Air Quality	$ 10,000	$ 10,000											
Brad	Noise	$ 5,000	$ 5,000											
Dan T	Traffic	$ 50,000	$ 50,000											
Kimberly	Cultural Resources	$ 250,000	$ 20,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000
Kimberly	Visual & Aesthetic Resources	$ 20,000	$ 20,000											

NOTES

Costs are estimated based on the Proposed Project (Dam Strengthening); this alternative

It is possible that Federal permits (404, 401, 106, ESA) may be required before the ROD

Field construction monitoring is based on a 17-week construction window (June 15 - Oct 1

ESA/CESA permitting estimates based on the assumption that new protocol surveys will n

Permits for the water system itself or dam are not included (e.g., DSOD dam safety; MPW

Engineering/earthmoving mitigation implementation activities are not costed by ENTRIX (a

Costs of additional public services (e.g., traffic enforcement), impact fees (e.g., for traffic),

Does not include cost of revegetation of disturbed areas, or any geotechnical work on road

ENTRIX ENVIRONMENTAL MITIGATION PLANNING/IMPLEMENTATION/MONITORING COST ESTIMATE

ENTRIX ESTIMATED BUDGET PLAN 2006-2008

	SAN CLEMENTE SEISMIC SAFETY PROG		**2008**											
LEAD	**ENVIRONMENTAL/PERMITTING**	Total	January	February	March	April	May	June	July	August	September	October	November	December
	MITIGATION PLANNING / IMPLEMENTATION / MONITORING (2007 - 2008)	$ 3,500,000	$ 135,000	$ 135,000	$ 135,000	$ 135,000	$ 135,000	$ 135,000	$ 165,000	$ 135,000	$ 135,000	$ 135,000	$ 135,000	$ 135,000
Rick	Soils & Geology	$ 50,000												
Jillian	Hydrology & Sediment	$ -												
Susan	Water Quality	$ 50,000												
Tom	Fish & Aquatic Biology	$ 3,000,000	$ 125,000	$ 125,000	$ 125,000	$ 125,000	$ 125,000	$ 125,000	$ 125,000	$ 125,000	$ 125,000	$ 125,000	$ 125,000	$ 125,000
Gretchen	Terrestrial Biology (5 year monitoring)	$ 30,000							$ 15,000					
Gretchen	Wetlands (5 year monitoring)	$ 35,000							$ 15,000					
Brad	Air Quality	$ 10,000												
Brad	Noise	$ 5,000												
Dan T	Traffic	$ 50,000												
Kimberly	Cultural Resources	$ 250,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000
Kimberly	Visual & Aesthetic Resources	$ 20,000												

NOTES

Costs are estimated based on the Proposed Project (Dam Strengthening); this alternative

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Field construction monitoring is based on a 17-week construction window (June 15 - Oct 1

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Costs of additional public services (e.g., traffic enforcement), impact fees (e.g., for traffic),

Does not include cost of revegetation of disturbed areas, or any geotechnical work on road

APPENDIX D

Carmel River Reroute and San Clemente Dam Removal Project
Draft Basis of Design Report
Review Comments 11/05/07; Reponses 1/2/08.

Commenters:

JA – Joyce Ambrosius - NOAA BC – Brian Cluer - NOAA TC – Trish Chapman - SCC MW – Marcin Whitman - CDFG FE – Frank Emerson - CRSA	LH – Larry Hampson - MPWMD TH – Tom Hepler - BUREC DH – Dennis Hanneman - BUREC NW – Noel Wong - URS	JC – John Carroll - Tetratech DL - Doug Lantz - Tetratech SV – Steve Verigin - GEI MB – Mike Burke – Inter-Fluve

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
1.	Global	Need page numbers throughout document.	JA. MB, TC	Added.
2.	Global	There is no mention of notching the Old Carmel River Dam. That is part of this project that needs to be included in this report.	JA	Added.
3.	Global	Engineering design criteria need to be researched and presented. Elements needing criteria are the dike and the geogrid. Both elements need design guidelines for flood risk and earthquake. Lack of design criteria is holding this process up.	BC	Amended. Dike and geogrid design criteria are added. Note that earthquake (seismic stability) critieria are covered within slope stability & liquefaction analysis criteria.
4.	Global	Document needs section unifying the discipline-specific aspects of each element – it is sometimes hard to track elements from one section to the next. What are the design functions of each element and how do they relate to each other? Can Section 1.2 be expanded to accomplish this? Alternatively, reformat of the document by major element may be an option, with subsections for geotech, civil, hydraulics, etc…	MB	The description of the major elements have been revised in section 1.3. The section has also been revised in response to other comments.
5.	Global	A general set of design criteria should be developed. This will be for seismic loading, hydrologic return period, etc. The owner and/or engineer may wish to make this risk based	SV	Added in section 1.3.

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
6.	List of Figures	Figures to add – 1) 1921 topo for project area; 2) end of project estimated topo (current figures show it for areas where sediment is added, but not areas where sediment will be removed); 3) Existing conditions with dam and associated structures that are referred to in section 3.1. Possibly add: Flood zone for 100 year flood	TC	1) Added; 2) End of project topography will be similar to 1921 topo & is indicated on new Figure 1-3 (showing another set of detailed topo of excavated contours on Figure 1-2 is not practical); 3) Figure 1-2 showing existing conditions and some proposed elements has been amended. This will be considered in next phase of design.
7.	Footer	Footer should read Draft Basis of Design Report…	TC	Changed.
8.	1.1 ¶1	Probable Maximum Flood – need to quantify it here and need to explain how it was calculated somewhere in the document. Clarify who calculated it.	TC	Reference added.
9.	**1.1 ¶2 S1** S = sentence	Add the word project after "(CRRDR)"	TC	Added.
10.	1.2, 10th bullet	Delete last part of sentence: …maintaining Cal-Am's water diversion rights on the Carmel River. From what I understand, Cal-Am will need to get a Change in Point of Diversion for the new Ranney collector, so this project will not maintain their diversion rights **NOTE FROM TRISH:** Rather than deleting last part of sentence, change "water diversion rights" to "water extraction rights."	JA	Changed.
11.	1.2	What were the assumptions (e.g public safety risks) that lead to the use of PMF (vs say 100 yr flood) in design of dam thickening option. Do these assumptions hold true and necessitate the same standard for the dam removal?	MW	Noted. The appropriateness for use of PMF or lower flood will be considered and justified in next phase of design.

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
12.	1.2 para 3	Assess the feasibility of transporting some of the San Clemente Arm sediment upstream of the diversion dike, rather than being stored in the Carmel River Arm of the Reservoir. This would allow gradual recruitment back into the Carmel River to restore cobble downstream of San Clemente Dam.	FE	Noted. Will be considered in next phase of design.
13.	Section 1.2, 1st Para.	The statement "The dam and fish ladder would be demolished and removed from the site." conflicts with the 9th bullet in the following paragraph, "... relocation of the demolished concrete debris in the abandoned Carmel River arm of the reservoir."	NW	Amended. Concrete from dam demolition will be re-used for construction.
14.	Section 1.2	Notching Old Carmel River Dam was left out.	MB	Added.s
15.	Page 2 Section 1.2	The report would benefit from a written sequence of construction (in addition to the schedule at the end).	DL	The project elements are essentially listed based on their relative significance to the project. May consider changing in next design phase.
16.	Pages 2 & 3 Section 1.2	Text reads: "The CRRDR Basis of Design will address the following major project elements: …Protection of resources through implementation of erosion and pollution control, species salvage and relocation and *species passage measures."* Comment – there is very little information regarding fish passage in the BOD Report. Fish passage criteria that are driving the design of the project should be clearly stated.	DL	Fish passage criteria were recently developed by PWA & THT (2007), and have been included in the revised BOD.
17.	1 or 2.1.1	In either section 1 or 2.1.1, include a discussion of the accumulated sediments. Including the following key elements: Volumes in each reach (San Clemente Creek; CR below div channel; CR above div channel); SCC sediments moved to CR below div channel; CR sediments below div dike will be cut off from river; CR sediments above div dike will remain in place.	TC	Summarized/added in section 1.2.
18.	Section 2.0	Provide Overview of Section 2	MB	Added.

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
19.	Section 2	Include discussion of excavation and slope stability aspects in San Clemente arm	MB	Sediment excavation is generally discussed in section 6. Section 2 has been revised to discuss San Clemente Creek slope stability.
20.	Section 2.1	Include reservoir profiles from MEI reports showing sample locations and mapped sediments?	MB	Noted. Sample (boring) locations are shown on the plan of Figure 2-1. A profile will be considered in next phase of design.
21.	Section 2.1, Paragraph 3	Suggest 'Sediment has accumulated through natural processes resulting in a downstream sloping deposit surface, which allows the volume of sediment to be larger than the original volume of water stored behind the dam, which was dictated by a level reservoir pool.'	MB	Agreed and changed.
22.	Page 4 Section 2.1.1	1st paragraph, last sentence states: "The dam and reservoir are owned by Cal-Am and the surrounding land is privately owned." Otherwise there appears to be no discussion of real estate acquisition or easements for construction and future O&M. Report should state clearly whether or not additional real estate is required.	DL	Amended.
23.	Page 4 Section 2.1.1	No reference provided for Dibblee, 1972. Other references are missing throughout the document. Please review and correct.	DL	Reference should be Kleinfelder (2002).
24.	Page 5 Section 2.1.2	First paragraph mentions organic layers in three test pits. Identify the pits by number as shown on figure 2-1.	DL	Information added.
25.	2.1.3 last paragraph	Explain "significant gas pockets were encountered in some borings" and any potential impacts to the project.	TH	Information added.
26.	2.2.1 ¶2 S2	"with dense to sparse vegetation." Not a clear statement.	TC	Changed to "varying density of vegetation".
27.	2.1.2	Need to clarify the location. From XX feet to XX feet above the dam.	TC	Amended.
28.	2.1.2, 2.1.3, 2.1.4	Include a figure that shows these distances. This could be added to figure 1-2 or 2-1 or a new figure could be provided.	TC	Boring/test pit locations in Figure 2-1 is used to indicate the relative locations/distances.
29.	2.1.4	How does the thickness of the alluvium compare to the 1921 topo contours in this reach?	TC	Amended (31-45 feet above pre-dam surface and 17.5 feet for MWH boring further upstream).

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
30.	Section 2.1.4	Note extents of SC arm that haven't been sampled, approximate correlation of pre-dam alluvium & bedrock to 1921 surface.	MB	Amended.
31.	2.2 ¶1 S1	Need a citation for Woodward Clyde's establishment of the MCE.	TC	Amended.
32.	2.2 ¶ S4	Delete "is" from main clause.	TC	Deleted.
33.	Table 2-1	What does "Characteristic Magnitude" mean? It seems like you mean the something akin to the MCE on these faults. Is this correct? Need to clarify.	TC	Characteristic magnitude is estimated using source scaling relations based on fault area or fault length. USGS reports estimate mean characteristic magnitude for faults based on commonly used magnitude-area scaling relationships for crustal faults. MCE is used in deterministic analysis and is considered the largest earthquake which can reasonably be considered to occur based on known seismological data.
34.	Section 2.2.1, Page 6	Recommend elaborating on the basis for selecting site seismicity	SV	Qualitative evaluation was presented in the report on the selection of the site seismicity. A number of different agency criteria exist; however, no criteria exist that are directly correlated and therefore attributable to this project. Pseudo-static analyses currently are based on USACE criteria for selection of pseudo-static loading. However, detailed analyses in the next phase of design will require some dynamic analysis (not pseudo-static) for evaluation of seismically induced deformations. Specific dynamic analysis criteria are not clearly defined by agencies, as mentioned above. As such, the next phase of design will consider a risk-based design approach, where cost-benefit relations will be used to select appropriate design criteria for seismic loading.

Comment No.	**Reference** (Section & Paragraph)	**Comment Description**	**Commenter**	**Response by MWH**
35.	Section 2.2.2, 1st Para.	How were "directivity effects" taken into account in the PSHA? Or can they?	NW	Directivity effects are taken into account in one attenuation relationship (by Abrahamson) that is included in the PSHA. However, the PSHA averages several attenuation relationships, reducing the effects of directivity. Because the averaging masks directivity effects, mention of directivity has been removed from the report. For more information on how directivity is included in Abrahamson's attenuation relationships see: Somerville, P.G., et al (1997). "Modification of Empirical Strong Ground Motion Attenuation Relations to Include the Amplitude and Duration Effects of Rupture Directivity,", Seismological Research Letters, Volume 68, Number 1, pp. 199.
36.	Section 2.2.2, 2nd Para.	Attenuation relationships used for the PSHA were old; consider using the NGA relationships.	NW	All of the 2007 attenuation relationships have not yet been released. The next phase of design will use the newest attenuation relationships available. In general, 2007 attenuation relationships predict lower ground motion than 1997 relationships.
37.	2.2.2 ¶2 S3	"Ground motion" should be singular What does the phrase "assuming rock site conditions" mean?	TC	Amended. Assuming rock site conditions is standard practice. Attenuation calculations are carried out assuming the ground motion occurs on rock and does not magnify through the soil column.
38.	Section 2.2.2, Figure 2-3	Please check – Figure 2-3 suggests that the local fault – Tularcitos does not contribute to total hazard for return period less than 1000 years. Consider providing recurrence relationship for each fault.	NW	Correct. The Tularcitos fault does not contribute significantly to the hazard for return periods less than 1,000 years. According to the USGS, the mean return period for the Tularcitos fault is on the order of 4,000-5,700 years.
39.	Section 2.2.2, Figure 2-3	Please check – Figure 2-3 suggests that the background source dominates the hazard for return period less than 1000 years. Consider comparing PSHA results with USGS maps.	NW	Correct. The hazard curve indicates that background sources dominate the hazard for periods less than 1,000 years. Results from EZ-FRISK match PGA on USGS hazard maps as the same data is used for both. This was verified by checking the hazard maps.

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
40.	2.2.3 ¶2 S2& 3	Sentences 2 and 3 are not clear. Does the hazard curve include all of the sources that are shown on the figure? What other sources does it include? Clarify.	TC	The total hazard curve includes all sources within 100km of the site. Only select sources contributing to the hazard were shown
41.	2.2.3 ¶3 S3	What was the "corresponding PGA"? Need to quantify this so it can be compared to what is being recommended.	TC	The pga of the MCE calculated by WCC in 1992 was 0.70g. If this MCE were calculated today, we would get a different value using updated attenuation relationships. Because we are not using the MCE in the design criteria, we do not recommend comparing the recommended pga with the previously determined MCE pga
42.	2.2.3 ¶3 S4	…slopes <u>is</u> considered… (for this and all other comments with this format, the underlined text should be added (and may replace other text)	TC	Amended.
43.	Section 2.2.3, Last paragraph on P.7	Clarify statement of recommended ground motion criteria. Qualitatively characterize how conservative the MCE is relative to the recommended criteria. Which design elements will this ground motion criteria be applied to?	MB	This will be applied to all components of the project. MCE's are generally developed using a 2475 year return period or greater whereas the current design criteria uses a 975 year return period.
44.	Page 7, Section 2.2.3	Statement is made regarding moderate risk to downstream property. Seismic loading probability may be low, but habitat and property values are presumably high.	SV	Agree. The next phase of design will require detailed quantification of downstream risks from failure under seismic loading vs. cost of improvements under specific levels of seismic loading. Currently, our qualitative assessment assumes that failures of the CRRDR project components that may occur would not travel far enough downstream to immediately impact property and only affect habitat in the short-term.
45.	2.2.3 last paragraph	How did you determine there is a "moderate risk" to downstream property and inhabitants? Selection of the design earthquake loading should consider the potential failure modes and downstream consequences, and consider capital costs. A return period of 975 years may be too conservative for stabilization of the toe of these sediments. What alternatives have been considered?	TH	Agree. See response to 44. above.

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
46.	2.2	Need to make it clear that the 975 year return period is being recommended for design of all project features.	TC	Amended.
47.	2.3 ¶2 s2	… will be designed to have…	TC	Changed.
48.	2.3	Will the analysis be redone with #'s from the geotech study? Or only if they vary by a certain amount or a certain direction?	TC	A preliminary analysis has been done and included in the preliminary geotechnical investigation report.
49.	2.3 p 4	What is the likely size and consequences of a slope failure in the diversion channel and what is the cost saving of increasing slope and risk of slope failure? (forthcoming report) How do the consequences of slope failure compare to natural landsides which are apparently common in the watershed ?	MW	Noted. This is essentially a risk-based design approach, which will be considered in next phase of design.
50.	2.3, **Diversion Channel**	Suggest adding information concerning potential for blockage by landslide, and possible impact scenarios, i.e. landslide created dam. Such information would be useful in determining minimum height of diversion dike.	JC	Noted and added. Will be further considered in next phase of design.
51.	2.3 first paragraph	Note that the diversion channel design is being revised for improved fish passage, which will change the gradient.	TH	Note added.
52.	2.3 second paragraph	What do you consider to be an "adequate factor of safety" for the excavated slopes under static and seismic loading conditions? The Basis of Design report should establish design loading conditions and safety factors to be used for final design.	TH	Amended. Recommended values of factor of safety to be achieved are provided.
53.	2.3 third paragraph	Again, consider the consequences of potential failure modes and capital costs for selection of design earthquake.	TH	Noted. This is essentially a risk-based design approach, which will be considered in next phase of design.
54.	Section 2.3, 3rd Para.	Need to check if indeed "the seismic coefficient of 0.37g [PGA] will be incorporated in a pseudo static slope stability analysis.	NW	Revised. 0.15g for pseudostatic slope stability analysis.
55.	Section 2.3, 3rd Para, 2nd & 3rd bullet	"Selected" strength parameters appear high, justification is needed.	NW	Revised. Actual values have been revised based on geotechnical investigation.

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
56.	Section 2.3	Recommend Section 2.3 be relabeled ‘Geotechnical Design of Project Elements’, then make current sections 2.3-2.6 subsections to this, e.g. Section 2.3.1-2.3.4	MB	Agreed and amended; however, numbering is different due to some changes to the report
57.	Section 2.3, Paragraph 1	Update geometry of bypass cut to be consistent with hydraulics section.	MB	Updated.
58.	Section 2.3, Paragraph 2	What are recommended factors of safety?	MB	Information was added.
59.	Page 8 Section 2.3	Provide citation for SWEDGE computer program.	DL	Added.
60.	Page 8 Section 2.3	A statement is made about ‘the seismic coefficient of 0.37g’. MWH said they will clarify this, and that it is not intended as a pseudo-static slope stability coefficient.	SV	Revised. 0.15g for pseudostatic slope stability analysis.
61.	2.4 first paragraph	Clarify one-foot rock size – can larger sizes be produced from existing bedrock? Large boulders will be needed for fish passage. Also, what is the basis for designing the diversion dike crest so high above the PMF level? Considers slumping during design earthquake?	TH	Larger size of rock can be produced and is addressed in geotechnical report. Dike height is based on super-elevation of water table at PMF, and to accommodate the volume of the excavated rock. Dike design and height will be revised during detailed geotechnical analyses in the next phase of design.
62.	2.4 first bullet	Should slopes be designed for stability during PMF or some lesser flood? (This may not make much difference to design.)	TH	Slope design is intended for PMF but the design criteria may be subject to review in next phase of design.
63.	2.4 second bullet	Again, consider the consequences of potential failure modes and capital costs for selection of design earthquake and for mitigation measures for potential liquefaction of diversion dike foundation. The upstream slope may slump into the river channel and cutoff wall may be damaged, but what other consequences would there be to warrant costs of treatment?	TH	Noted. This is essentially a risk-based design approach, which will be considered in next phase of design.
64.	2.4 third bullet	Similar comments as for second bullet. Possible improvement measures to mitigate excessive dike deformation must be warranted based on potential failure modes and consequences.	TH	Noted. This is essentially a risk-based design approach, which will be considered in next phase of design.

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
65.	Section 2.4, 2nd Para.	"... 40-foot-deep soil-cement cutoff wall will be constructed ..." conflicts with "soil-bentonite cutoff wall" shown in Figure 2-4. Soil-cement and soil-bentonite cutoff walls will have different levels of impermeabilities.	NW	Corrected to be cement-bentonite cutoff wall per geotechnical report recommendations.
66.	2.4, **Diversion Dike**	Is there a minimum height requirement for the diversion dike? This may be useful for determining how the cut/fill balance can be manipulated to create a more natural appearing biological setting.	JC	Dike height is based on super-elevation of water table at PMF, and to accommodate the volume of the excavated rock. The design of the diversion dike will be revised in the next phase of design.
67.	2.4	How will the diversion dike tie into the valley walls?	TC	"The valley walls within the footprint of the dike will have sufficient excavation so that the ends of the dike could be appropriately embedded and tied in" has been added. Details of valley wall excavation will be shown in the next phase of design.
68.	Figure 2-4	Need to show a cross valley cross section of the diversion dike to illustrate how it will tie into the valley walls.	TC	Noted, additional detail will be added in next phase of design.
69.	2.4 ¶1 s4	...50 <u>foot</u> crest…	TC	Changed.
70.	2.4 ¶1	Are one-foot rock pieces big enough to withstand PMF velocities? What are PMF velocities? What are 100 year velocities?	TC	Noted and amended. Will be further considered in next phase of design. Larger size of rock pieces or rock caged with wire mesh (gabions) may be provided. Also, large rock import may be required if adequately sized material cannot be extracted from the channel cut. Potential costs are discussed in Section 6.
71.	2.4 ¶1	This says that the dike geometry will contain approximately 319,000 cubic yards from the bypass cut. But section 2.3 says 234,000 yd3 will come from the bypass channel. Resolve the discrepancy.	TC	The 319k cy of rock assumes 36% of increase of in-place rock (234k cy).
72.	2.4 ¶2 s2	Delete sentence. It is a repeat from above.	TC	Deleted.

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
73.	2.4 p 1	What is basis for dike crest elevation? Is height of diversion dike dictated by height of fill material downstream (550 vs 605 crest elevation) or disposal of Blast material or required thickness of dike to prevent seepage? Blast material might also be used to 1) add boulder component to mobilized material or 2) toe stability for downstream face of fill in reservoir area	MW, TC	See #61. See #61. Agreed, text was amended.
74.	Page 8 Section 2.4	Text states that the height of diversion dike is 70 feet. Figure 2-1 shows diversion dike invert at 530 feet and crest at 605 feet, giving a total height of 75 feet.	DL	Changed to 75 feet.
75.	Page 8 Section 2.4	Text states that base width of diversion dike is 330 feet. Figure 2-4 shows sides slopes of 2.5:1 and 3:1 with 50-foot crest. Given the 75-foot height, the computed base width is 463 feet.	DL	Changed to 460 feet. Will be refined in next phase of design.
76.	Section 2.4	What are the factors of safety/design criteria for the diversion dike against liquefaction, bearing capacity & settlement, seepage? Which of the design aspects in Section 2.4 will be completed this fall?	MB	Design criteria/considerations are described in the text and have been amended. They will be refined in next phase of design.
77.	2.4 p 2	Cutoff wall is to prevent river flow seepage into fill area primarily for bulk flow. Seepage is being minimize to prevent piping. Will there be a pore pressure lag? Might a design that intends, accounts for and permits pore pressure equalization serve project goals.	MW	Noted, will be further considered in next phase of design.
78.	Page 8 Section 2.4	Second paragraph - Text states that cutoff wall is 200 feet wide. Scaling from figure 1-2 shows cutoff wall is about 170 feet wide. Scaling from figure 2-1 shows cutoff wall is about 150 feet wide. Check dimensions and/or scales in the figures.	DL	Changed to 160 feet wide and will be refined in next phase of design.
79.	2.4 first sentence of second paragraph. Also 2.5, first sentence of 4th paragraph.	These may be conflicting—using a cutoff wall to help prevent seepage into the sediment or maintaining a high water table in the sediment.	JA	Amended. Purpose of cutoff wall is described in revised text and geotechnical investigation report.

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
80.	Page 8 Section 2.4	Third paragraph (slope stability) - Text shows factor of safety of 1.2PMF. Does this refer to the peak discharge or the maximum water surface elevation?	DL	This refers to maximum water surface elevation. The text has been revised. Please refer to the summarized factors of safety.
81.	Page 8 Section 2.4	An erosion resistance analysis should be performed for the diversion dike and maximum riprap particle size selected on that basis	SV	Noted, will be further considered in next phase of design.
82.	Page 9 Section 2.4	Provide citations for Slope/W and Sigma/W computer programs.	DL	Provided.
83.	Page 9, section 2.4	Could not understand how the seepage analysis will be performed based on the draft BOD report description	SV	The seepage section has been revised.
84.	2.4 slope stability bullet	Will water velocity be an input to the calculation?	TC	Water velocity may be required to estimate the erosive force applied to the slope face, but not directly affect slope stability computations. Please refer to the revised text.
85.	2.4	What will the H:V slope of the diversion dike face be?	TC	2.5:1 for upstream face, and 3:1 for downstream face. See Figure 2-4.
86.	2.4 liquefaction bullet ¶1	…foundation will rest on 40-foot… …soils will be evaluated for liquefaction…. …will be investigated and may include…	TC, MW , DL	Changed.
87.	2.4 liquefaction bullet ¶2	1996 NCEER and 1998 NCEER/NSF protocols should be cited in the references.	TC	Cited.
88.	2.4 p 6	Is PMF right design parameter as mode, extent and consequences of failure are different than with dam failure as the diversion channel will act as a relief rather than cutting through sediment as with dam failure?	MW	Noted. This is essentially related to risk-based design approach, which will be considered in next phase of design. Lower flood level can be considered if the risk can be justified.
89.	2.4 bearing bullet ¶3	Include citation for Makdisi-Seed method.	TC	Added.
90.	2.4 seepage bullet ¶2 s3	Sentence says the design will consider a deeper cutoff wall – do you really mean deeper than bedrock?	TC	To the bedrock, which is about 40 feet deep. Note that the text has been revised and eliminated some descriptions. Many design considerations are addressed in the geotechnical investigation report.

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
91.	2.4 seepage bullet ¶3	Am I correct in assuming that none of these analyses have been completed yet?	TC	Preliminary analyses have been performed in the geotechnical investigation report.
92.	Page 9 Section 2.4	Seepage paragraph. Seepage also depends on hydraulic head and duration of wetting. Hydraulic parameters for the analysis should be cited. Section 5.2 states that diversion dike will be constructed of highly permeable material and conflicts with text in this section.	DL	Agreed, and amended. Hydraulic parameters will be added in next phase of design once they become available. Most of the material will be highly permeable (rock pieces), but a low permeability zone (core) may be included. Will be refined further in next phase of design. Note that the text has been revised and eliminated some descriptions. Many design considerations are addressed in the geotechnical investigation report.
93.	Section 2.4, 9th Para.	Selection of strength parameters for foundation granular materials and the compacted dike fill need to be justified. May be high.	NW	Revised. Actual values are based on geotechnical investigation data.
94.	2.4, 5th paragraph, Liquefaction	Excavation and replacement is another option to mitigate potentially liquefiable materials below the proposed diversion dam.	DH	Agreed, and added.
95.	2.4 and 2.5, Material poperties; and Liquefaction and lateral spreading	No mention is made of using undrained residual shear strengths for the liquefiable materials during stability analyses under earthquake loading.	DH	Discussed in geotechnical investigation report. Note that the text has been revised and eliminated some descriptions. Many design considerations are addressed in the geotechnical investigation report.
96.	Section 2.5, Table 2-3	"Abundant stones are available onsite (channel excavation)" but they may not be suitable for stone column construction without significant processing.	NW	Agreed, text amended.
97.	2.5 p 10	Design alternative: can waste concrete from dam be used as alternate material for stone columns?	MW	Noted.. Will be evaluated in next phase of design.
98.	Section 2.5, Page 10	Stabilization of the sediment slope is likely the key project component. Additional detail should be given on the analytical approach and the post-earthquake performance objectives should be stated.	SV	Agreed. The section for slope stability has been amended. Note that the text has been revised and eliminated some descriptions. Many design considerations are addressed in the geotechnical investigation report.

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
99.	2.5 ¶1	S5 says 360,000 yd3 will be taken from San Clemente Creek. Page 2 says it will be 235,000 yd3. Resolve discrepancy. How much sediment in the stockpile will come from the Carmel River downstream of the stockpile? That is, down closer to the dam? What will the H:V slope of the sediment stockpile face be? Need clearer language to differentiate between the sediment stockpile and associated slope, and the sediment slope stabilization feature.	TC	235k cy is in-place rock to be excavated from the diversion channel, not sediments. About 88 acre-feet (142k cy) based on the 4:1 slope cut. 2.75:1, see Figure 2-4. Amended.
100.	2.5 ¶2	How deep will the soil-cement columns be? How many of them will there be?	TC	Maximum 80 feet (to bedrock). The quantity will be obtained after a refined design.
101.	2.5 ¶2 s4	…slope would be <u>covered</u> with a layer…	TC	Changed.
102.	Figure 2-5	Plan View – what does the 200' at the top refer to, that is, what is the significance of breaking the top measure into 50' and 200' segments? Will plants be able to grow in the spaces between the soil cement columns? How will they get water? Have any calculations been done to confirm that there will be enough water given that the structure is supposed to be impermeable. How can the columns overlap if they are cement?	TC	200 ft is for the slope, and 50 ft is for the level portion (top of the slope). Figure amended. Noted. Will be considered in next phase of design. Columns are constructed when the soil-cement is in a slurry form, which takes 1/2 hr. to several hours to fully solidify. As such, columns are constructed in a continuous pattern, one after another, and are overlapped in order to provide a continuous subsurface wall.

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
103.	2.5 Bul2 ¶1	Include a description of the geogrid. What it is, what it's made out of, etc. At the meeting Vik said this would be removed after a few years. If this is correct, that information should be included. S2 Sentence says that the optimum slope will be determined based on cost versus slope stability. What will the minimum slope stability factor be?	TC	Included. See "Design considerations for the geogrid". Geogrid may not need to be removed after vegetative growth has established on the slope, since it will be covered by this growth. Geogrids are usually designed with the intent to be left in place. However, geogrid removal can be investigated in the next phase of design, Required factor of safety are provided in this section (see added tables).
104.	2.5 bul 4	Have any of the liquefaction calculations been done?	TC	Preliminary analyses have been performed in the geotechnical investigation report.
105.	2.5 Design Param	Section discusses three alternatives, not two. Bullet 2 – Last sentence says a soil-cement cutoff wall would be necessary with stone columns. What would this look like?	TC	Updated. Refer to the slope profile in Figure 2-5, where cutoff wall would be located within the 50 ft of flat portion (top of the slope), installed from the surface vertically down to bedrock.
106.	Section 2.5, Table 2-3	Retaining wall alternative not included	MB, TC	Amended. Note that the text has been revised and eliminated some descriptions. Many design considerations are addressed in the geotechnical investigation report.
107.	Table 2-3	Technical feasibility, stone column – what constitutes a "relatively gentle slope?"	TC	Slope Less than 20 degrees may be considered relatively gentle. Amended. Note that the text has been revised and eliminated some descriptions. Many design considerations are addressed in the geotechnical investigation report.

Comment No.	**Reference** (Section & Paragraph)	**Comment Description**	**Commenter**	**Response by MWH**
108.	2.5 Additional comments on sediment slope stabilization (soil cement columns) from Dennis Hanneman (Geotechnical Engineer) of this office.	Rather than designing the Stabilized Sediment Slope to prevent drainage of the sediments, the opposite approach of encouraging drainage of the sediments would increase the seismic stability over a long period of time (by lowering the ground water level). This assumes that wetland mitigation will be provided elsewhere. In addition, an option for a stability berm (consisting mostly of rock excavation) does not appear to have been considered as an alternative to soil-cement columns. The stability berm would be extended to bedrock, or below any liquefiable layers, and have a configuration sufficient to buttress the sediments. Advantages include well known material properties of the compacted fill, simplified analysis (as compared to the grid pattern of soil-cement columns), and possibly lower construction costs. Rather than overbuilding the diversion dike (apparently to waste the excess rock excavation), the excess could serve as a low cost material source for a stability berm/buttress. Additionally, concrete rubble from the dam demolition could be incorporated into the stability berm.	DH	Agreed. “Wet” condition (high GWT) for the sediment disposal area is currently considered and discussed. “Dry” condition (low GWT, no wetland) can be considered as well, and will generally be much favorable for design. This will be considered in the next phase of design. Agreed. Design alternatives amended. Note that the text has been revised and eliminated some descriptions. Many design considerations are addressed in the geotechnical investigation report. Agreed. A new design alternative of buttress has been added. Note that the text has been revised and eliminated some descriptions. Many design considerations are addressed in the geotechnical investigation report.
109.	2.5	Need to include any information available regarding the small side drainage (trib) to the sediment wedge. How was the runoff dealt with on the sediment wedge?	JA	Noted, will be mentioned in text and further considered in next phase of design. Hydraulics section addresses drainage area contributing to flow onto stabilized slope. The deposited wedge avoids the flows from the trib.
110.	Section 2.5	What is the basis for the footprint (eg avoids trib entering from NE) and height of the sediment stockpile? Will surface of the stockpile be contoured?	MB	The basis is to contain the volume of sediments from San Clemente Creek, minimizing height, and avoiding trib flows. The surface will be flat. See Figure 1-2. Text has been amended to state this criteria

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
111.	Section 2.5	What are the factors of safety/design criteria for the sediment slope stabilization against liquefaction and related to GW flow/retention? Which of the design aspects in Section 2.5 will be completed this fall?	MB	The section for slope stability has been amended to address liquefaction. GW was used to evaluate slope stability. Note that the text has been revised and eliminated some descriptions. Many design considerations are addressed in the geotechnical investigation report.
112.	Page 10 Section 2.5	First paragraph notes that tributary watershed draining to the sediment pile is 21 acres. The NFPP calcs in section 4.3.1 are based on a drainage area of 1.42 square miles (~910 acres) that apparently drains to the sediments just upstream of the dam (just below the sediment pile). The report should include a watershed map that clearly delineates the contributing drainage areas to sediment pile and the stabilized sediment area upstream of the dam.	DL	A watershed map has been provided in figure 4-10. Discrepancies have been revised. Note that overall the text has been revised and eliminated some descriptions. Many design considerations are addressed in the geotechnical investigation report.
113.	Page 10 Section 2.5	Second paragraph notes that surface of the 4H:1V slope will be treated with a layer of topsoil and geogrid. This implies that the geogrid will cover the entire slope. Clarify that geogrid is limited to a 50-foot-wide strip down the middle and is intended to convey runoff from upstream of the slope (as stated in section 6.5.3).	DL	Clarified. Text amended.
114.	Page 10 Section 2.5	Design Alternatives. Call out the depth of the soil columns, stone fill columns and soil cement cutoff wall in the first two alternatives.	DL	Additional information was added for each design alternative. Note that the text has been revised and eliminated some descriptions. Many design considerations are addressed in the geotechnical investigation report.
115.	Page 11 Section 2.5	This section includes design criteria that are based on the assumption of a high groundwater table in the stabilized sediment slope. Based on discussions during the 10/25/2007 conference call, the high water table apparently results from 1) residual water in the sediments after drawdown, and 2) maintaining a wetland for red legged frog habitat on the upper surface. There seems to be some disagreement about the need for a wetland and it sounds like a separate mitigation could be implemented at a different location for the lost frog habitat. Since the high groundwater table is a major driver in the geotechnical design, the assumptions regarding dewatering of sediments and inclusion of wetland habitat need to be clearly spelled out.	DL	Agreed. The assumption regarding the inclusion of wetland by maintaining a high GWT was added in the first paragraph of design alternative section. Drainage of the sediments will be considered in the next phase of design.

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
116.	Page 11, Section 2.5	Erosion resistance of the sediment mass should be addressed.	sv	Consideration of surface erosion of the sediment has been added.
117.	2.5 sixth paragraph	This states that "The design assumes a high water table since the upstream sediments will be restored as wetland." Is this still true? Comments during the review meeting suggested otherwise. Perhaps this area should be kept drained to minimize potential liquefaction or slope stability concerns. (High groundwater elevations in this area mentioned elsewhere as well.)	TH	Noted. Will be considered in next phase of design.
118.	Page 13 Section 2.6	First full paragraph. The sump apparently collects water that drains from the upstream sediment and would be pumped out after it is "cleared for turbidity". There should be some discussion of the downstream discharge requirements and the time or expense involved in meeting them. Drainage may be slow and if there are significant amounts of sediment, clay, or organic mater, the "clearing" could take a long time and seems like a potential risk for the schedule. The last sentence in the same paragraph mentions filtration or a desilting basin at the dewatering discharge point – but it seems like an afterthought. Recommend rewriting this section to better document the issue of turbidity and water quality in the dewatering process, the expected length of time this process will take, and possible treatment alternatives to speed the process.	DL	This section has been amended under new section 2.3.5.3. - Construction Dewatering. Basically, "large" particles would have settled before discharging the turbid water, thus reduce the delay to construction; small and fine particles would need to settle/be removed by filtration system or desilting basin (could be located downstream of the dam) to clear turbidity before the water is released to the downstream river. Further detailed study would be required in next phase of design.
119.	Page 13 Section 2.6	The temporary stream diversion and piping for San Clemente Creek (upstream of the bypass channel outlet) are not shown in any of the graphics.	DL	Agreed. Included in the existing Figure 1-2.
120.	2.6 ¶4 s1	Would the wells that are installed need to be pumped out?	TC	Yes.
121.	2.6 fifth paragraph	Probably should have the diversion facilities fleshed out a bit more for a basis of design report, including the design criteria. Also, what protection is envisioned for diversion piping located along the reservoir banks and within active channels?	TH	A separate section –for stream diversion has been provided. Note that the text has been revised and eliminated some descriptions. Many design considerations are addressed in the geotechnical investigation report.

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
122.	Page 15 Section 3.0	Civil design should include a discussion of access for construction and future O&M.	DL	Agreed. Discussion of construction access is described in section 6. However, discussion of O&M will be considered in next phase of design.
123.	3.1	Add figure showing dam and all the structures discussed in this section (except the filter plant)	TC	Figure 1-2 has been amended and will be further amended in next phase of design.
124.	3.1 <u>Spillway</u> <u>Outlet Structure</u>	Please provide existing spillway crest length under Spillway section. Please provide outlet dimensions under Outlet Structure. Discharge curves, or some discharge estimates, for these features would be helpful. Upstream diversions will need to get past the existing dam during the first two years of construction (until removal of the dam), and I am not sure what head will be required for design flow.	TH	Noted. Details, where available, will be added; however, discharge estimates, etc. will be added in next phase of design.
125.	Sections 3.1&3.2	How much rebar is in the existing structure, and implications for demo?	MB	Noted. Existing drawings show minimal rebar. Demolition will segregate concrete with steel from concrete to be used for erosion protection. In any case, exact amounts and location of rebar will be detailed in next phase of design.
126.	Section 3.2	What happens to plunge pool after project? How deep is the pool relative to downstream channel grades?	MB	Noted. Will be considered in next phase of design.
127.	3.2	Use subsection numbering (3.2.1, 3.2.2 etc) to make it easier for future reference.	TC	Changed.
128.	3.2 Diversion sill	Why is a diversion sill needed? At TRT Vik said it was in case the bedrock of the diversion channel were to erode. But if bedrock channel erodes and sill remains, it will create a fish barrier. Wouldn't it be better for bedrock channel to erode and create some upstream headcutting if necessary?	TC	Noted. Will be considered in next phase of design. Channel design by PWA suggests that the diversion sill could be eliminated. Text revised to reflect this.
129.	3.2 ranney intake	Does this mean that there will need to be 3 temporary diversion pipelines – one for the Carmel River, San Clemente Creek, and the Ranney intake? Is there anyway to combine the CR diversion and the Ranney intake diversion?	TC	Noted. Will be considered in next phase of design. Also see Stream Diversion section for discussion on the possibility of two pipelines.

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
130.	3.2 p 5	Has construction and maintenance of Rainey collect been compared to providing a pump and diversion at the Sleepy Hollow site? I believe this is so but have not seen the cost comparison. What is current max diversion rate – 10 cfs ?	MW	This comparison was made during the EIR/EIS process and was provided in the EIR/EIS appendices. Current maximum diversion from the Carmel River is not known, other than total annual acre-foot rights. Seasonally adjusted maximum diversion rates will be detailed in the next phase of design.
131.	3.2, subpar: **River Water Intake System**; and 6.5.1, **Stream Diversion**	The need for having a temporary diversion and then later building the permanent diversion is not well explained and should be a clearly described project criterion. Suggest adding this information for use during next stage of design. Significant cost savings could result from a decision to make the initial diversion a permanent installation.	JC	Noted. Will be considered in the next phase of design. Also see Stream Diversion section for discussion on the possibility of two pipelines. The next phase of design evaluation will balance cost savings of temporary pipeline (~$700,000) vs. schedule impacts of constructing permanent bypass line first. The latest construction schedule assumes some temporary bypass installation will occur in Phase I of construction. The latest permitting schedule shows that the CDF&G streambed alteration permits may not be complete in time to allow for permanent structure installation in 2009.
132.	Page 16 Section 3.2	Plunge Pool and Cofferdams. In relation to previous comments on turbidity, how much area is required to provide for adequate clearing/desilting in accordance with the schedule?	DL	Noted. Will be considered in the next phase of design.

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
133.	Page 16 Section 3.2	River Water intake System. There should be some discussion about the reliability of a river intake system versus the reliability of the existing reservoir. It seems that in dry years, the subsurface flows in the river may be variable and could potentially miss the well field. Recommend including documentation for all or some of the following items: 1) Seasonal flow duration curves. If it can be shown that the river will have a fully saturated subsurface throughout the year, then reliability of the intake system will not be an issue. 2) Full or partial cutoff just downstream of the intake to ensure a saturated field at the well screens. This condition maybe satisfied by the proposed cutoff feature under the diversion dike and the sill on the bypass channel. If so – then include documentation in the BOD report.	DL	Noted. Will be considered in the next phase of design.
134.	3.2 Demolition of the Dam, Spillway, and Outlet Structure	Do you plan to remove any reinforcing steel from the concrete? Do you have detailed drawings for all structures to assess structure dimensions and embedded items?	TH	Steel from demolished concrete will be removed. Detailed as-built drawings will be reviewed in the next phase of design.
135.	3.2 Diversion Grade Control Sill	Could this concrete sill represent a potential future barrier to upstream fish passage? Why specify 5,000 psi concrete at 90 days? Reclamation typically specifies 4,000 psi concrete at 28 days for structural applications. Are you concerned about potential abrasion damage from bedload materials?	TH	Noted. Design details of diversion sill will be considered in the next phase of design.
136.	3.2 River Water Intake System (Ranney Intake)	Consider locating the water supply pipe alignment along the Carmel arm beneath the sediments (alongside the diversion pipeline) instead of along the exposed San Clemente arm. Pipeline would be better protected against possible damage. Inspection wells could be provided if needed. Could also provide additional flood diversion capacity during construction.	TH	Agreed and amended. See Stream Diversion Section for discussion of the possibility of two pipe lines.
137.	Section 4	Provide overview of Section 4.	MB	Provided.

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
138.	Section 4	Include hydraulic aspects and design criteria for the diversion dike	MB	Agreed. Section 4 has been amended.
139.	Section 4 in General	There are a number of hydrologic/hydraulic criteria that are not addressed in the draft BOD. Missing items include: 1) Peak discharges for the 21 acre area affecting the sediment pile. 2) Annual runoff volumes that affect the sediment pile and the tributary area above the dam. These are necessary inputs to the discussion of wetlands and seepage. 3) Carmel River hydraulics (depth and duration of flow, flow velocity, shear, etc.) that affect the diversion dike. 4) Carmel River hydraulics that affect the toe of the sediment slope	DL	1. Peak discharges for relocated sediments will be developed in next phase of design 2. Volumes will be developed in next phase of design 3. A range of flows will have to be evaluated for the diversion dike design. Stating this amount of hydraulic data at this stage will not be useful. As channel design is developed in the next phase of design, hydraulic design data will be presented. 4. See 3.
140.	Page 22 Table 4.1	The Diversion Channel has a variable width. Identify the width that corresponds to the hydraulic parameters in the last 4 columns.	DL	Table 4.1 summarizes the reach-averaged hydraulic parameters for the reconstructed reach of San Clemente Creek and the Diversion Channel. The values for the Diversion Channel in the last four columns represent the average through the reach with overall bottom widths that transition from 215 feet at the upstream end to 150 feet at the downstream end.
141.	4.1.1 ¶1 s2	How steep is “relatively steep”?	TC	The Carmel River upstream from the backwater effects of the reservoir has a gradient of about 1.0 percent (S=0.010), significantly steeper than the reach in the reservoir.
142.	4.1.1 ¶5	670 ac-ft should be 674 ac-ft to be consistent with other sections.	TC	Changed.
143.	Section 4.2	Will need to update with channel design study for advance BOD.	MB	Noted.

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
144.	4.2 Hydraulic Routing	What roughness assumptions were used for the channel routing? Did you consider potential control shift to the existing dam spillway or outlet works during large floods? Not clear how these flows are passed through or over the dam. Spillway crest is at elevation 525, which matches the downstream end of the diversion channel invert.	TH	Noted. Will be considered in the next phase of design.
145.	Section 4.2.1 – 'Diversion Channel'	Double check gradient when sill set at Carmel River thalweg. Channel design team found this to be about 2.7% +/- based on grades in model.	MB	The gradient of the diversion channel with the sill set at the Carmel River thalweg is 2.7 percent (not 2.9 percent). The gradient with the sill set at 1 foot above the thalweg is 2.9 percent.
146.	Section 4.2.1 – 'Diversion Grade Control Sill', paragraphs 1 & 2	Per MEI 2005, it seemed the sill was not used in the sediment transport modeling.	MB	A sill was not explicitly included in the sediment transport model. The sill referred to in Paragraph 2 under "Diversion Grade Control Sill" is simply the assumed channel bottom in the cut at the head of the diversion channel with the thalweg at the same elevation as the Carmel River at this location. The sediment-transport model assumes that either: 1. A hardened (e.g., concrete) sill is constructed with this geometry or, 2. The excavation results in a natural bedrock sill at this location.
147.	Section 4.2.1 – 'Sediment Transport', paragraph 2	Clarify whether 'existing conditions' refers to 'with dam' scenario at the end of the sediment transport simulations.	MB	"Existing conditions" should be referred to as "baseline conditions", with the dam in-place and the approximately 150 ac-feet of available reservoir storage that existed at the time of the mapping at the beginning of the simulations.
148.	4.2.1 ¶1	Will the accumulated sediment on San Clemente Creek upstream of the div channel outlet be removed to the sediment stockpile area? If yes, this should be clarified somewhere. If not, what will keep it in place?	TC	The accumulated sediment on San Clemente Creek upstream of the diversion channel will be removed to match the pre-dam contours. The extent of removal is indicated on Figure 1-1 and described in the overview of Section 1.2.

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
149.	4.2 last paragraph, last sentence	Aren't there hot spots where the model predicts significantly higher increases? These should be identified and not lumped into a generalization.	TC	The following statements have been added to the last paragraph in Section 4.2: Specific locations where the CRRDR results in a significant increase in flooding over baseline conditions includes: a) The reach upstream from Rancho San Carlos Road (increase of about 2.5 feet for the wet start condition), b) Midway between Quail Lodge Bridge and Schulte Road (increase of about 0.6 feet for both wet and dry start conditions), c) Three locations in the vicinity of Stonepine Bridge (increase of between 0.5 and 0.7 feet for the wet start condition), d) Upstream from the Sleepy Hollow Filter Plant (increase of 0.7 feet for the wet start condition), and e) Near Old San Clemente Dam (increase of about 0.7 feet for both wet and dry start conditions).
150.	4.2.1 p 3	Diversion sizing:If channel width of 150 ft is similar to that downstream of the dam (and slope is substantially steeper) was backwater being caused by higher "n" than in channel upstream (or was it momentum or some other factor)? What n was assumed compared to studies now being done by PWA ?	MW	The backwater upstream from the diversion channel is caused by the contraction from the wider valley bottom into the narrower diversion channel (the valley bottom upstream from the diversion channel is > 250 feet wide). The reconstructed reach through the San Clemente Creek branch and the river upstream from the diversion were modeled with a main channel Manning's n-value of 0.035 and overbank n-values of 0.08. A Manning's n-value of 0.030 was used in the diversion channel to simulate the likely smoother bedrock surface that would be excavated through the ridge. PWA set floodplain and valley side n-values at 0.08 and 0.09, respectively, Also PWA's analysis had the high-flow channel's n-value is 0.05 and the riparian strip separating the high-flow and low-flow channel set at 0.12

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
151.	4.2.1 p5	Control sill: Is it possible to provide sill with flashboard (or simpler device – will discuss) so that there can be a sill shape for the initial release and then the sill can be easily reshaped for a long-term or second wave release ?	MW	Noted. Will be considered in next phase of design.
152.	Page 20 Section 4.2.1	The profile in Figure 4-5 is limited to the reaches immediately upstream and downstream of the dam. Recommend showing profiles for current conditions, pre-dam conditions, and the proposed project conditions that extends further downstream and further upstream of the dam. This will give the reader a better sense of how the proposed project compares to the historic stream profiles.	DL	Noted. Will be considered in next phase of design.
153.	Page 21 Section 4.2.1	The "San Clemente Creek Reach" section cites a low-flow channel design for flows up to the 10% exceedance level (200 cfs) based on a mean daily flow duration curve. The range of velocities and the implications for fish passage should be discussed as well.	DL	Noted. Will be considered in next phase of design.
154.	Page 21 Section 4.2.1	The "Diversion Channel" section discusses the need to transition the diversion channel from 215 feet at the upstream end to 150 feet at the downstream end. The graphics suggest a linear transition over the length of the reach, but the same effect could be obtained, with less rock excavation, with a localized transition near the upper end (i.e., an improved channel inlet). (Need an underline on the Diversion Channel heading.)	DL	Noted. Will be considered in next phase of design.
155.	Page 21 Section 4.2.1	The "Diversion Grade Control Sill" section discusses the widths for section of the channel. The numbers provided do not add up to 215 feet so something is missing. Recommend adding dimensions to the typical detail on Figure 4-8.	DL	Figure 4.8 has been amended by adding dimensions.
156.	Page 22 Section 4.2.1	The end of the paragraph at the top of the page notes that reach upstream of the sill will store approximately 16 to 19 percent of the sediment delivered to the head of reservoir with a corresponding 2.2 foot increase in bed elevation (on average) upstream of the sill, but it does not say why this desirable. There was some discussion during the 10/25 conference call regarding the need for the concrete sill. The report should state the sediment transport criteria that driving the design of the sill.	DL	The statement regarding additional accumulations in the reservoir upstream from the diversion channel is intended only to summarize the results of the modeling, and is not intended to address the desirability of aggradation. The sill elevation used in the modeling was set at the existing river thalweg to avoid exposure and entrainment of the reservoir sediment deposits that are present upstream from the diversion channel.

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
157.	Page 23 Section 4.2.1	First full paragraph notes increase sediment storage downstream of the dam and documents impacts on the Q1000 water surface profile. It should also at acknowledge impacts on fish passage and state whether or not they are significant.	DL	Noted. Will be considered in next phase of design.
158.	4.3 ¶1 s1	Sentence says the sediment stabilization slope will be cutoff from the Carmel River. What about during high flows? At what size flood would the river be expected to flow against this sediment face?	TC	Noted. This analysis is not being considered at this time. Future analysis will take into account flood-stage events.
159.	4.3.2 and Table 4-3	This section should be written in terms of the median rainfall and can include confidence intervals. Is the confidence on the median rainfall really +/- 10 inches? That seems awfully high. Is this table confusing annual variation in rainfall with uncertainty about a median? This section and table should be revised to be clearer. What are the hydraulic design criteria for the geogrid/stabilized sediment slope? What event would be conveyed, water depths, velocities, etc.	TC	Amended. Noted. Required velocities will be considered in next phase of design.
160.	4.3.2	I assume this is all for design of the channel through the spoils and not release over the downstream slope of any collected overland flow.	MW	Correct.
161.	Section 4.3	Discuss groundwater hydraulics, anticipated ponding within sediment stockpile	MB	Noted. Will be considered in next phase of design.
162.	Page 23 Section 4.3	First paragraph states “The stabilized sediment slope will be cutoff from Carmel River flow due to the construction of the diversion channel.” It should also reference the diversion berm. Also, this statement only applies to the upstream end of the stabilized slope. Section 6.5.3 notes that the downstream section of the stabilized slope needs armoring to prevent erosion from flows in the Carmel River.	DL	Amended
163.	Page 24 Table 4.2	Change label for “precipitation” to “mean annual precipitation”.	DL	Amended.

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
164.	Page 24 Table 4.3	Not quite sure what this table is intended to show. Changing the mean annual precipitation implies a climate shift. If the author is trying to show the uncertainty in the estimate, I believe the NFFP provides confidence intervals (or standard error of the estimate) for the regression equations.	DL	Table amended to show standard error of peak discharge.
165.	4.4 ¶1 last sent	How many cfs/year does 3,376 acre-feet average out to? Include this number as well so that it can be used to put the cfs values earlier in the paragraph in context.	TC	Amended.
166.	4.4, **Relocated Water Diversion**, and 4.5, **Temporary Bypass Pipeline**	Is there a minimum flow to be passed downstream required by a NMFS or other agency Biological Opinion? Is the water right description mentioned adequately researched and documented?	JC	Noted. Will be considered in next phase of design and after the project permitting process. 3,376 ac-ft. is a well documented water right.
167.	Page 25 Section 4.4	Head loss for the pipe extension is easily calculated. It should be included in the concept design and documented in this report.	DL	Agreed. Head loss is dependent on selected pipe diameter, pipe material, and flow rate. Head loss through the new 3500-foot extension is currently estimated to be up to 4-feet for the maximum diversion rate of 16 cfs. However, pipeline design & associated losses will be considered in the next phase of design. The finished elevation of the sediments (and approximate median stream flow elevation) upstream of the diversion dike are currently at El. 530, five feet above the required head elevation.
168.	Page 25 Section 4.4	Basic considerations - As noted previously, withdrawal from a river may not be as reliable as withdrawal from a reservoir. A small reservoir or impoundment at the intake might be useful in smoothing out fluctuations during dry periods.	DL	Noted. Will be considered in next phase of design.
169.	Page 25 Section 4.5	Temporary bypass pipeline. The peak discharges summarized in this section far exceed the capacity of a 30-inch pipe. A summary of daily flows, by month, will be more useful in evaluating the capacity of the pipe. The higher flows (e.g. the 2-year peak, etc.) are useful in evaluating the potential for overtopping of the temporary bypass.	DL	Noted. Will be considered in next phase of design.

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
170.	4.5 ¶1	How many temporary pipelines will there be – 2 or 3? What happens to Cal-Am's water diversion currently during the summer drawdown? This should be in the current operations sections.	TC	It is possible to have two pipelines for diversion, but this needs further study. See section on Stream Diversion.
171.	Section 4.5	Refine the discussion of the timing and size criteria for the temporary bypass pipeline	MB	Noted. General refinement will be made, but detailed criteria will be considered in next phase of design.
172.	4.5	My understanding is that the temporary diversion facilities will be designed for seasonal floods (May through October). The basis of design report should provide the design criteria for the temporary bypass pipeline. Most of the flow rates indicated here do not pertain to this temporary diversion feature. Also consider potential limitations of discharge capacity at existing dam.	TH	Noted. Applicable flow rates will be mentioned, but detailed design criteria will be considered in next phase of design.
173.	5.1 last sentence	Steelhead trout specific name spelled 'mykiss'	JA, FE, TC	Changed.
174.	Section 5	Provide overview of landscape design and environmental restoration.	MB	Provided.
175.	Section 5.1	Possible to quantify the amount of RLF habitat currently present at the site?	MB	Noted. Will be considered in next phase of design.
176.	5.2 ¶1	S1 – What about the reconstructed San Clemente Creek channel? Won't that be revegetated? S2 – sentence reads …due to *their* susceptibility to runoff… Whose susceptibility does this refer to?	TC	It will be revegetated. See section 5.3. Changed to "due to the susceptibility of the ground surface to runoff".
177.	5.2 ¶3 bul 1	S2 – Sentence refers to "smaller slopes". Smaller than what? What is the comparison? S3 -- … will be achieved by hydroseeding with native grasses.	TC	Changed to "relatively small slopes". Changed.
178.	5.2 ¶3 bul 2	Could the diversion dike be filled in with smaller material as it is created? The goal being to help with water retention and revegetation.	TC	Agreed. Amended.

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
179.	Page 26 Section 5.2	The first paragraph states: “Vegetation stabilizes the soils surface by the intertwining of its roots, minimizes seepage of runoff into the soils by intercepting rainfall, and retards runoff velocity.” Comment - Vegetative cover does not “minimize seepage”. It generally increases infiltration by reducing raindrop impacts, contributing organic matter to the soil, and supporting fauna (e.g. earthworms) that work the soil.	DL	The mechanism may be subject to further elaboration. However, a reference is added to support the statement.
180.	Page 26 Section 5.2	Last paragraph (Diversion Dike) notes that the diversion berm is highly permeable. This conflicts with statements in section 2.4.	DL	The dike section is amended.
181.	Sections 5.2 & 5.3	What are the anticipated landscape scale restoration elements for upland areas – e.g., what are the habitat types, typical vegetative communities, etc.	MB	PWA & THT (2007) provided preliminary descriptions, which has been included in the advance BOD Section 5.
182.	5.3 #1	Refers to San Clemente Creek as a “relatively wide river/creek valley”. This seems inaccurate since some of the cross sections are not big enough to hold the combined flow with a three stage channel.	TC	“relatively wide” has been removed.
183.	5.3 ¶3	Will irrigation be required? Has any thought gone into this yet?	TC	Noted. Will be considered in next phase of design.
184.	5.3 para 3	Would downed trees (LWD) and boulders be anchored to prevent a peak flow failure that might cause a boulder/log jam?	FE	Noted. Will be considered in next phase of design.
185.	5.3 para 4	Recommend willow cuttings to revegetate the channel banks quickly	FE	Agreed. Added.
186.	Section 5.4	The proposed deep soil-cement treatment of the sediment in the Carmel River arm and placement of demolished concrete debris have the potential of causing high pH levels for stormwater runoffs and groundwater seepage, and thereby significantly impacting the water quality downstream after construction, and potentially for an extended period of time. Such impact should be evaluated and mitigated as required.	NW	Noted. Will be considered in next phase of design.

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
187.	5.4.1	Recommend a Steelhead biologist with local knowledge of Central CA Coastal ESU be retained for hands on surveying, monitoring and management of rescuing/relocating steelhead	FE	Agreed. Added. Also, PWA & THT (2007) provided preliminary assessment of existing fish passage data which may be useful for reference for the local biologist.
188.	5.4.1	Recommend contingency plan for wild broodstock rearing of all life cycle and sizes of SH. In case of severe impacts to fish passage/fish ladder operation, or severe turbidity problems during construction	FE	Noted. Will be considered in next phase of design.
189.	Page 28 Section 5.4.1	Third bullet discusses trapping and netting of steel head, frogs, turtles, etc. It should also discuss relocations. Also consider designing the temporary pipe for downstream fish passage.	DL	Noted. Will be considered in next phase of design.
190.	5.4.1 third bullet	Some discussion during the review meeting suggested a potential desire to pass the fish through the pipe?	TH	Noted. Will be considered in next phase of design.
191.	Section 6	Provide overview for this section	MB	Provided.
192.	6.1	Monterey County will require land use approval, and a grading permit and an encroachment permit.	TC	Added.
193.	Section 6.1, 2nd Para.	The permitting schedule should also include RWQCB for Clean Water Act Section 401.	NW, TC, TH	Schedule amended.
194.	Section 6.1, 3rd Para.	While the Contractor is responsible for obtaining the General Construction Permit (NPDES), which includes the preparation of a SWPPP, because the extended time that will be required to complete and approve a SWPPP for this project, it is recommended that the Owner/Engineer works with the SWRCB to prepare a draft SWPPP that the Contractor can finalize and submit.	NW	Agreed. Section amended.
195.	6.2 bul 3	What level of service would be needed from PG&E? Is an upgrade required?	TC	Noted. Will be considered in next phase of design.
196.	6.2 4th bullet	Operation and maintenance of Cal Am's diversion should not be part of this project. Need to delete the last bullet.	JA, TC, TH	Noted. Removed.

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
197.	6.2, 6.6 p1	Schedule is constricted by construction window. Can this be expanded with additional mitigation measures? Would the extended window be worth that tradeoff? (appears that, for this report, a standard working window was chosen)	MW	Noted. Will be considered in next phase of design.
198.	6.3	Are there access issues common to both treatment alternatives (dam removal and dam thickening) that can therefore be expedited ?	MW	Noted. Will be considered in next phase of design.
199.	6.3	Access section is lacking a lot of information. The temporary bridge over Tularcitos Creek should be verified if for the Reroute project. I believe it was for the buttressing.	JA, TC	The section has been revised. The EIR/EIS suggests a bridge over Tularcitos Creek should be constructed similar to the buttressing project; however, it may not be necessary due to the limited equipment mobilizations along San Clemente Drive required for the dam removal portion of the CRRDR project. This should be addressed in the next phase of design.
200.	6.3	Need to include the full discussion of road work. S7 …left abutment of the dam will be …	TC	Amended. Changed.
201.	6.5.1 second paragraph	Temporary diversion pipe and cofferdam for San Clemente arm should be shown on drawings. What is proposed alignment, design criteria, and protection for this pipe?	TH	The drawing has been amended as shown in Figure 1-2. Design criteria will be provided in next phase of design. It should be noted that the San Clemente Creek is a seasonal stream that may not require diversion.
202.	6.5.2 seventh paragraph	Consider use of available sediments (sands, gravels, and cobbles) to provide a filter on upstream face of diversion dike before adding topsoil for vegetation. Avoid synthetic materials such as geotextiles for this application. Consider use of rockfill erosion protection up to the 2-year flood level (bank full conditions).	TH	Agreed and amended, and will be further considered in next phase of design.

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
203.	6.5.3	Is the geogrid overkill for such a small drainage? What was the design standard? How much topsoil will need to be trucked in? Which accessway will be used? How many truck loads will be required?	TC	Noted. Will be considered in next phase of design.
204.	6.5.3	Is it intended that no waste concrete from the dam, fish ladder, etc will need to be moved off site? (assumed but I did not see this explicitly stated)	MW	Waste concrete is intended to be re-used at the site.
205.	Page 34 Section 6.5.3	This is the first place in the report where it is documented that the 50-foot-wide strip of geogrid on the stabilized sediment slope is intended to convey runoff from the area upstream. This function should be noted in previous sections (e.g. section 2.5 Sediment Slope Stabilization). The hydraulic design parameters (peak discharge, flow depth, velocity), the cross section of the swale, and the suitability of the geogrid should be documented under Section 4 – Hydraulic/Hydrologic Design.	DL	Added in Section 2. Noted. Will be considered in next phase of design.
206.	Page 34 Section 6.5.3	It is noted that the stabilized sediment slope will be armored at the downstream end to prevent erosion from flows in the Carmel River. The flow depths and velocities that affect the slope should be documented under Section 4 – Hydraulic/Hydrologic Design.	DL	Noted. Will be considered in next phase of design.
207.	Page 34 Section 6.5.3	The last two sentences in the paragraph state: "Once stabilization has been completed, a 2-foot-thick layer of organic soil would be added, and the slope would be vegetated. Prior to topsoil placement on concrete debris, geotextiles or other methods will be used to prevent topsoil from migrating into the voids of the debris." Comment: It is not reasonable to expect a geotextile to support 2 feet of topsoil (plus accumulated water) over voids in concrete debris for the life of the project. The load may be excessive, thus tearing the fabric, and it will interrupt deep rooting by large trees or shrubs. Instead, the placement of the concrete debris should include filling the voids with earth prior to placing the topsoil layer. This will be more stable in the long term and will allow for deep rooting of plants.	DL	Agreed. Amended.

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
208.	Section 6.5	Discuss diversion dike construction, discuss channel construction, environmental protection/erosion control	MB	Discssion has been added.
209.	Page 32 Section 6.5.1	The temporary stream diversion and piping for San Clemente Creek (upstream of the bypass channel outlet) are not shown in any of the graphics.	DL	Amended as in Figure 1-2.
210.	Section 6.6	Recommend moving discussion of anticipated instream work window to Section 6.1, labor estimates to section 6.7.	MB	Agreed. Changed.
211.	Section 6.7	Update cost estimate with detail on LS items. 12%/annum escalation in cost table doesn't match Section 6.7	MB, TC, NW	Where possible, LS items will be factored against a quantity basis to derive item unit pricing. The stated escalation allowance will be recalculated to consider a longer construction program relative to shorter yearly construction seasons. Approximately 3 years will be added to the mid point of construction. 7.5% will remain the annual inflation rate.
212.	6.7	The assumption are the same (where relevant) that were used for the dam thickening alternative	MW	Agreed. No changes necessary.
213.	6.7 ¶1	Provide a copy of the Entrix 2004 with details on the cost estimate for permitting and steelhead and CRLF mitigation.	TC	MWH will provide the Entrix cost estimate in estimate details in Appendices.
214.	Section 6.7, 1st Para, 9th & 10th bullet	Given the short construction season, May 15 through October 15, and the uncertainties of the project at this stage, the construction schedule presented in Figure 6-2 is too aggressive.	NW	Agreed. The schedule is being updated to consider the shorter yearly construction seasons.
215.	Section 6.7, 2nd Para	Given the amount of unknowns and uncertainties at this stage of the project, "a contingency of 25 percent ..." for cost estimate is too low.	NW	Subjective. MWH has provided a fairly detailed contractor's style cost estimate approximating Class 4 estimating methodology as per AACE. MWH's cost estimate also includes a 10% unlisted items allowance for "known", but currently un-priced items. The 25% contingency factor is consistent with Class 3 AACE guidelines and is compatible with the project team's awareness of potential scope growth concerns.

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
216.	Section 6.8	Previously 2009 commencement has been assumed. Also, schedule included appears off (const. activities indicated mid-winter).	MB	Agreed. See comment 214.
217.	Section 6.8	Expand discussion of required sequencing of work items	MB	Section 6.7 expanded to include a discussion of sequencing.
218.	Section 6.8	The annual construction window, May-Oct, is very short. It may be difficult to complete the work as scheduled.	SV	Agreed. See comment 214.
219.	6.8	Schedule should be laid out for a 2009 construction start unless that is basically impossible. If it is, this should be explained in the document.	TC	See comment 214.
220.	Project Schedule (p. 67 of 68) and Section 4.5 – Temporary Diversion	I presume that work in the existing main stem river channel both in the Carmel branch reservoir sediments and in the area upstream of the San Clemente branch diversion is intended to be carried out during low flow season (May-December). But the schedule and description seem to imply that all river flows would be bypassed and construction work would be carried out through the highest flow months of winter (Jan-Mar). No work should be attempted in the river channel between the end of December and the beginning of May due to the potential for high flows to compromise the work.	LH	Agreed. No construction is planned for the Dec through May periods.
221.	Table 6-1	Need to include whatever break down costs there are available.	JA	Cost details are available and are attached to the report.

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
222.	Table 6-1	Need to provide details for quantities and unit costs. This table includes too many lump sums. Why do some categories differ from categories for the thickening alternative in MWH's 2006 cost estimate memo? Additional information is definitely required on the following line items: • Contractor indirects – use footnote to explain what this is • Improve dam access road vs Access to Dam Haul Road. Dam Haul Road is not referred to in this document. All costs for roads should be based on linear feet cost estimate.	TC	Agreed. See comment 221.
223.	Table 6-1, cont	• Site dewatering – should be broken up by at least each time that it is required, and preferably by more specific subsections (feet of pipeline to be constructed, amount of water pumped, etc.) • Sediment removal – breakout into subcategories and base cost on a cubic yard basis. • Cutoff walls – include line item for each cutoff wall. Give cost based on cubic yards or some other suitable quantity.	TC	Agreed. See comment 221.
224.	Table 6-1, cont	• Channel/ Dike construction. This should be broken into two categories: 1) Bypass channel – costed out by cubic yard of rock, and 2) diversion dike – also costed by CY • Sediment stabilization – This should be broken out into geogrid structure and soil-cement column structure. Break out into suitable quantity. • Stream/Reservoir Restoration – what does this include? Where does this number come from. Provide citation and lots more detail in a footnote. • Disposal site closure – what is meant by this? This concept is not discussed in the BOD. • Which road is the "haul" road? This is not referred to in the BOD. Cost should be based on linear feet.	TC	Agreed. See comment 221. Disposal site closure refers to site restoration required to reclaim the area to pre-existing conditions considering contouring and seeding activities.

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
225.	Table 6-1, cont	• Ranney intake System Pipeline should be costed based on linear feet. • Unidentified items – where does this number come from? Is it a percentage of some total? How is this different from the contingency? • What is operations and maintenance cost allowance? Explain in a footnote. 1. Land use easements unit should be acre not ton and the unit cost should be $5,000.	TC	Agreed. See comment 221. Unidentified items is an allowance for known, but yet un-priced items at approximately 10% of direct cost totals. O&M cost allowance refers to the yearly budget to clean the Ranney intake system.
226.	Section 6.9	Civil Series: channel restoration plan, profiles, sections and typical details will be required Temporary stream diversion sheets Erosion, sediment, and pollution control plan Demolition plans	MB	Agreed. Amended.
227.	Section 6.9	Likely other Division 2 specs will be required, for items such as channel construction	MB	The specs of 02200, 02210, 02266 and 02490, etc are applicable to channel construction, and should be sufficient. Additional drawings will be considered in next phase of design.
228.	7	Kleinfelder 2002 is repeated twice in list. Delete one.	TC	Deleted one.
229.	Figure 1-1	Label Carmel River downstream of dam.	DL	Amended.
230.	Figure 1-2	1. Call out existing intake structure 2. Show cofferdam and pipeline for San Clemente Creek Diversion 3. Label River Water Intake (Rainey Intake) as a "Proposed Feature" 4. The cofferdam is shown upstream of the Rainey intake and may impede the water supply intake for Cal-Am. 5. The figure shows a 20-foot high slope at the downstream end of the sediment disposal area. There seems to be little discussion of the stability or erosion treatment on this slope.	DL	Amended. Cofferdam will be temporary & should not impact Ranney intake.

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
231.	Figure 2-1	1. Show cofferdam and pipeline for San Clemente Creek Diversion 2. Label the permanent 30-inch diversion pipe. 3. Some of the borehole/test pit labels are illegible. One is off the right side of the page. 4. Check scale.	DL	Amended.
232.	Figure 2-4	1. Diversion channel typical section – show bottom width dimension. 2. Diversion channel typical profile section – extend it to show more of the existing river upstream and downstream. 3. Diversion Dike and Sediment Pile Typical Detail: ▪ Show rock armoring on diversion dike. ▪ Call out top elevation of sediment pile	DL	Amended.
233.	Figure 2-5	Organic soil layer should go over top of broken concrete layer (per section 6.5.3).	DL	Amended.
234.	Figure 2-5	1. Organic soil layer should cover the of broken concrete layer (per section 6.5.3). 2. Typical Trench for dewatering – does it include sheetpile on both sides? If not, should the side without sheetpile be vertical?	DL	Amended. Typical trench details with and without sheepile are shown.

Comment No.	Reference (Section & Paragraph)	Comment Description	Commenter	Response by MWH
235.	Figure 3-1	Figure shows invert of 2.5-foot conveyance pipe at 525 feet – the minimum head elevation required by the water utility. If the water surface in the well drops a little below 525 feet (say 524.9 feet), there will be no flow into the pipe and the head in the pipe will fall as water is delivered downstream. The invert of the pipe should be located below this critical elevation so that head is controlled entirely be the water surface in the well. Also – head loss for the additional pipe should be calculated and included in design of this structure for this report.	DL	Amended. Agree. Head loss should be accounted for in design. However, head loss calculation without a confirmed alignment, pipeline size, and type will not be accurate. Head loss through the new 3500 extension is currently estimated to be up to 4-feet for the maximum diversion rate of 16 cfs. However, pipeline design & associated losses will be considered in the next phase of design. The finished elevation of the sediments (and approximate median stream flow elevation) upstream of the diversion dike are currently at approximately El. 530, five feet above the required head elevation.
236.	Figure 4-5	Provide an extended profile that shows the existing invert for the Carmel River for some distance (1-2 miles) upstream and downstream of the project limits. It will be more useful in understanding how the proposed diversion fits within the historical profile. The graphic should also include historic invert for San Clemente Creek to a point 1 mile upstream of the dam.	DL	Noted. Will be considered in next phase of design.
237.	Figure 4-8	1. Call out elevation 529.7 (grade break in low-flow section). 2. Add horizontal dimensions for each subsection. 3. Include second cross section showing dimensions for the 150-foot wide section.	DL	Amended. See figure 4-7 for 150-foot wide section dimensions.

APPENDIX 3

San Clemente Dam Removal Project
Collaboration Statement

We, the undersigned, recognize:

- California American Water owns the San Clemente Dam ("the dam"), located on the Carmel River in Monterey County approximately 18 miles upstream from the mouth of the river in Monterey Bay.
- The Carmel River and the area surrounding the dam constitute valuable watershed area and habitat for many species of plants and animals.
- California American Water and the California Department of Water Resources (DWR) Division of the Safety of Dams (DSOD) have determined the dam is inadequate for seismic stability and flood safety. DSOD is requiring California American Water to alleviate the dam safety hazards.
- In December 2007, DWR completed the San Clemente Dam Seismic Safety Project Final Environmental Impact Report/Environmental Impact Statement ("EIR/EIS"), under the California Environmental Quality Act and the National Environmental Policy Act, analyzing alternatives for addressing the safety issues. Alternatives that meet DSOD safety requirements include Dam Strengthening (buttressing) and the Carmel River Reroute, which includes removal of San Clemente Dam. DWR certified the Final EIR on December 31, 2007.
- The California State Coastal Conservancy has recently funded several studies and has determined that the River Reroute and Dam Removal Project is a feasible alternative.
- The California State Coastal Conservancy, NOAA's National Marine Fisheries Service, the California Department of Fish and Game, and multiple non-governmental organizations believe that removing San Clemente Dam will result in multiple public environmental benefits, including improving access to 25 miles of spawning and rearing habitat for steelhead trout, restoring the ecological connectivity of the river and riparian corridor, and restoring river functions and sediment transport.
- The South-Central California Coast steelhead trout and the California red-legged frog are listed as threatened species under the Federal Endangered Species Act. The Carmel River has been designated critical habitat for both of these species.
- California American Water has determined that implementation of the Reroute and Dam Removal alternative would cost more than the Dam Strengthening alternative.
- California American Water is obligated to resolve the safety risk posed by the dam at the least cost possible to its ratepayers.
- California American Water is amenable to removal of the dam instead of buttressing it, provided the project will satisfy the safety concerns of DSOD in a timely manner and will not unduly burden California American Water's ratepayers and shareholders.
- The California State Coastal Conservancy, NOAA's National Marine Fisheries Service, and California American Water have been working collaboratively since 2007 along with other federal, state, and local organizations to develop a reasonable and prudent solution for San Clemente Dam that would meet the requirements and constraints of the undersigned.
- California American Water has implemented risk reduction measures for the dam's operation as requested by DSOD while California American Water and resource agencies develop a plan.

In recognition of these facts, we, the undersigned, are committed to:

Working collaboratively over the next year to develop a project plan by June 2010 for the Carmel River Reroute and San Clemente Dam Removal Project such that it can be compared to the project plan for the San Clemente Dam Strengthening Project with regard to costs and liabilities, and to making a good faith effort between now and November 2010 to find funding sources and a governmental or non-profit entity to take over the dam site before or after Dam Removal.

HON. SAM FARR

Sam Farr 1-11-'10

Representative Sam Farr Date
Member, House of Representatives,
California 17th District

HON. ABEL MALDONADO

1-8-10

Senator Abel Maldonado Date
California 15th District

HON. BILL MONNING

Bill 1-07-2010

Assemblymember Bill Monning Date
California 27th District

HON. DAVE POTTER

Dave Potter 1-19-2010

Supervisor Dave Potter Date
Monterey County Board of Supervisors

HON. REGINA DOYLE

1-19-2010

Chair Regina Doyle Date
Monterey Peninsula Water Management District

SECRETARY MICHAEL CHRISMAN

Mike Chrisman 1/11/10

Secretary Michael Chrisman Date
California Department of Natural Resources

COMMISSIONER JOHN BOHN

1/11/10

Commissioner John Bohn Date
California Public Utilities Commission

NOAA'S NATIONAL MARINE FISHERIES SERVICE

Rodney R McInnis 1-11-10

Rodney R. McInnis Date
Southwest Regional Administrator

CALIFORNIA DEPARTMENT OF FISH AND GAME

For 1-11-10

John McCammon Date
Director

CALIFORNIA STATE COASTAL CONSERVANCY

1/11/10

Samuel Schuchat Date
Executive Officer

MONTEREY COUNTY WATER RESOURCES AGENCY

1/11/10

Curtis Weeks Date
General Manager

CALIFORNIA AMERICAN WATER

1/11/10

Robert MacLean Date
President

CALIFORNIA
AMERICAN WATER

APPENDIX 4

SAN CLEMENTE DAM
ALTERNATIVE COST COMPARISON SUMMARY

Cost Breakdown	Dam Strengthening Alternative	River Bypass/Dam Removal Alternative
Construction Cost Items	$27,900,000	$49,300,000
25 percent Contingency	$6,600,000	$12,300,000
Subtotal - Construction Costs	$34,500,000	$61,600,000
Implementation Costs (*)	$14,300,000	$21,700,000
Total Construction Cost (in 2009 Dollars)	$49,000,000	$83,000,000
Post Construction Mitigation Costs	$3,300,000	$2,100,000
TOTAL PROJECT COSTS	$52,300,000	$85,100,000

Note: Total Dollars rounded to nearest Million Dollars

(*) Implementation Costs include:
1) Environmental Permitting
2) Engineering Design
3) Steelhead and CRLF Mitigation and Monitoring
4) Construction Management and Construction-Phase Engineering
5) Owner Administration and Legal

SAN CLEMENTE DAM
ALTERNATIVE COST COMPARISON SUMMARY

Cost Breakdown	Dam Strengthening Alternative	River Bypass/Dam Removal Alternative
Mobilization and Access Roadwork	$5,920,000	$5,650,000
Earthwork (Including Dewatering)	0	12,670,000
Sediment Management	0	10,540,000
Dam Preparation Work	3,230,000	0
Concrete Work on Dam	6,130,000	0
Fish Ladder	7,350,000	390,000
Stream/Reservoir Restoration	0	9,080,000
Dam Removal	0	3,340,000
Miscellaneous Work Items	1,770,000	3,360,000
Allowance for Unidentified Items	3,500,000	4,300,000
Subtotal	**$27,900,000**	**$49,300,000**
Contingency	**$6,600,000**	**$12,300,000**
Subtotal - Construction Costs	**$34,500,000**	**$61,600,000**
Environmental Permitting	$2,800,000	$2,800,000
Engineering Design	1,603,000	3,080,000
Steelhead and CRLF Mitigation/Monitoring	3,500,000	3,500,000
Construction Management/Engineering	3,205,000	6,170,000
Owner Administration and Legal	3,205,000	6,170,000
Subtotal - Implementation Costs	**$14,300,000**	**$21,700,000**
Total Cost (in 2009 Dollars)	**$49,000,000**	**$83,000,000**

Note: Total Dollars rounded to nearest Million Dollars

APPENDIX 5

STATE OF CALIFORNIA – CALIFORNIA NATURAL RESOURCES AGENCY **ARNOLD SCHWARZENEGGER**, *Governor*

DEPARTMENT OF WATER RESOURCES
1416 NINTH STREET, P.O. BOX 942836
SACRAMENTO, CA 94236-0001
(916) 653-5791

MAY 11 2010

Mr. F. Mark Schubert, Vice President, Engineering
California American Water
1033 B Avenue, Suite 200
Coronado, California 92118

San Clemente Dam, No. 642
Monterey County

Dear Mr. Schubert:

This is in reply to your May 5, 2010 transmittal of the Pre-Construction Work Plan for the removal of San Clemente Dam. Your removal application received on January 26, 2010 is now considered complete. The work includes sediment removal; reroute of the Carmel River; and demolition of the concrete dam, spillway, outlet structure, and appurtenances.

We have reviewed the Pre-Construction Work Plan for the removal of the San Clemente Dam and find it acceptable. If sufficient progress is not made to begin the construction required to remove the dam by 2013, the alternative of strengthening the dam for seismic and flood safety will need to be resurrected.

You requested that the alteration application filed on April 29, 2009 be withdrawn since the scope of work for the project has changed from a buttressing alternative to a dam removal. The alteration application is being returned to you. Your fees paid in the amount of $210,500 will be applied towards the filing fee required for the removal application.

Please review the enclosed "Information Regarding the Consideration of Applications for the Approval of Plans and Specifications for the Construction, Enlargement, Repair, or Alteration of Dams and Reservoirs."

We will inform you by June 10, 2010 as to our progress in reviewing your application or of additional information which may be required.

If you have any questions or need additional information, you may contact Design Engineer Richard Olebe at (916) 227-0533 or Project Engineer Dena Uding at (916) 227-4624.

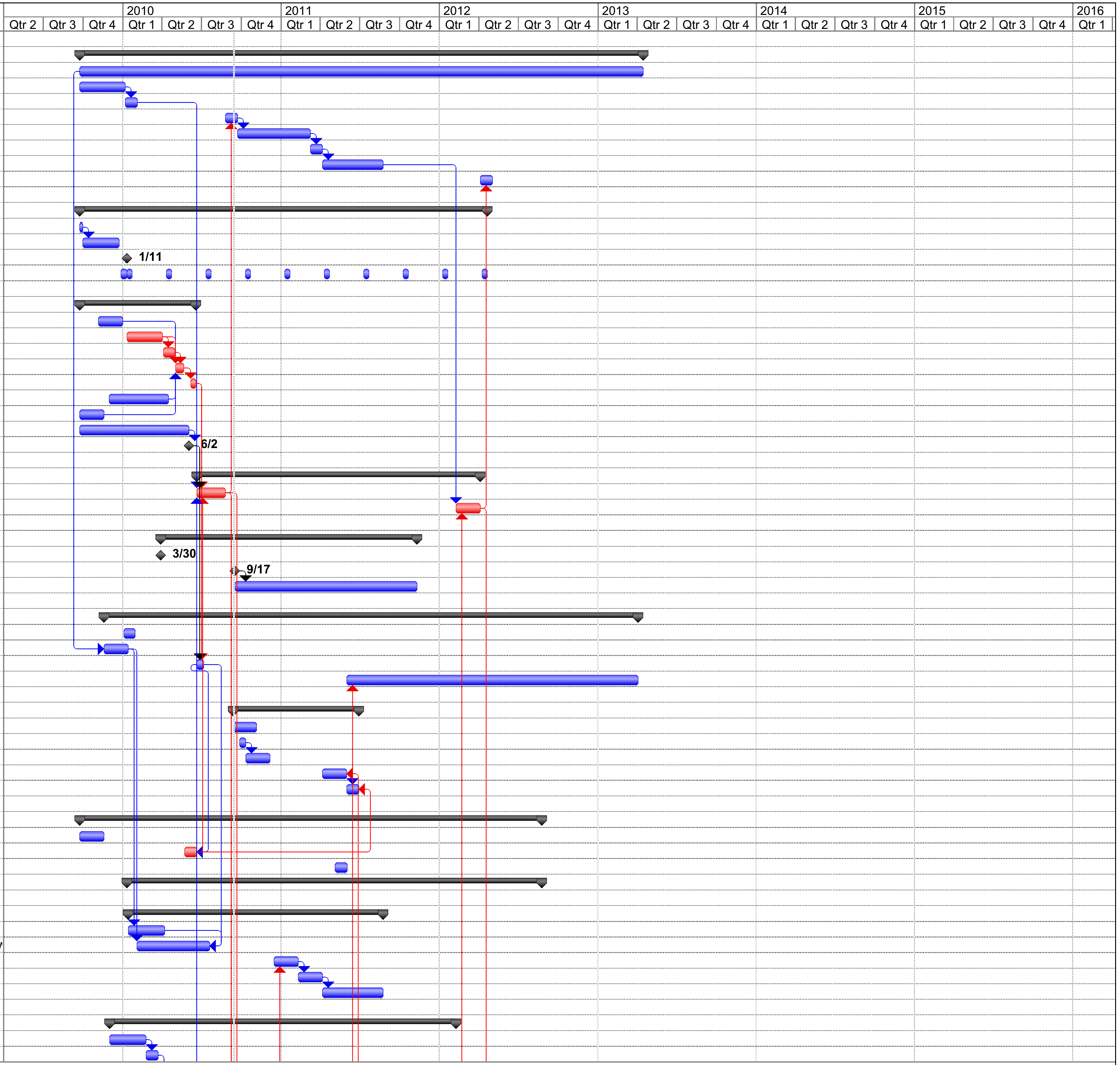
Sincerely,

David A. Gutierrez, Chief
Division of Safety of Dams

Enclosures

APPENDIX 6

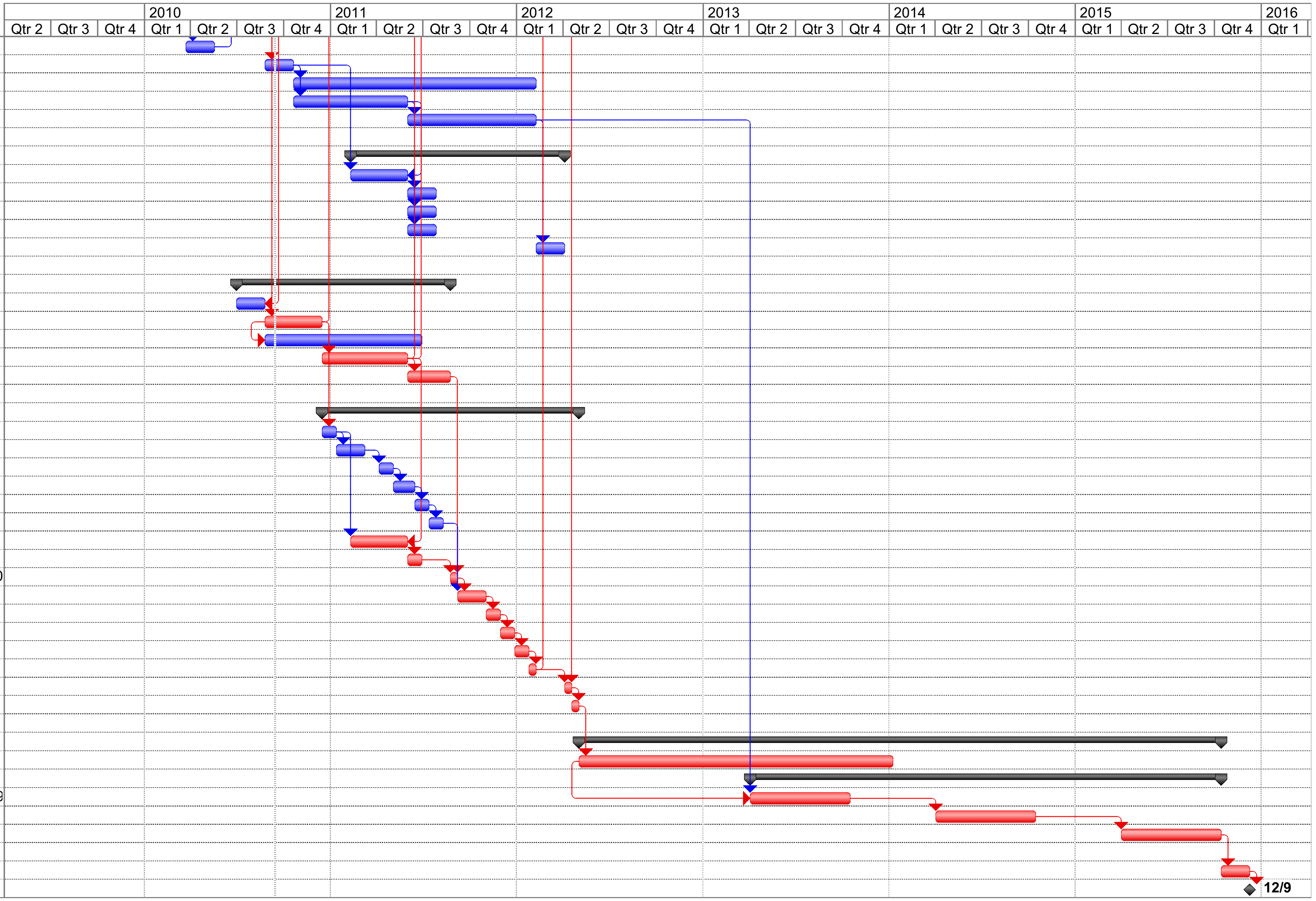
ID	ℹ	Task Name	Duration	Start	Finish	Predecessors
1						
2		**Project Management**	**928 days**	**Thu 9/24/09**	**Mon 4/15/13**	
3	▦	Planning Team Meetings	928 days	Thu 9/24/09	Mon 4/15/13	
4		Draft Pre-Construction Work Plan	15 wks	Thu 9/24/09	Wed 1/6/10	
5		Final Pre-construction Work Plan	1 mon	Thu 1/7/10	Wed 2/3/10	4
6		Implementation Workshop 1	1 mon	Thu 8/26/10	Wed 9/22/10	41
7		Preliminary Implementation Planning	6 mons	Thu 9/23/10	Wed 3/9/11	6
8		Implementation Workshop 2	1 mon	Thu 3/10/11	Wed 4/6/11	7
9		Finalize Implementation Agreement	5 mons	Thu 4/7/11	Wed 8/24/11	8
10		Execute Implementation Agreement	1 mon	Thu 4/5/12	Wed 5/2/12	42
11						
12		**Stakeholder Involvement**	**672 days**	**Thu 9/24/09**	**Fri 4/20/12**	
13		Draft Stakeholder Covenant	1 wk	Thu 9/24/09	Wed 9/30/09	
14		Final Stakeholder Covenant	3 mons	Thu 10/1/09	Wed 12/23/09	13
15	▦	Stakeholder Covenant Signing	0 mons	Mon 1/11/10	Mon 1/11/10	
16	⟳	**Quarterly Stakeholder Meetings**	**605 days**	**Mon 12/28/09**	**Fri 4/20/12**	
28						
29		**Risk Management and Allocation**	**192 days**	**Thu 9/24/09**	**Fri 6/18/10**	
30	▦	Risk Analysis - SCD Removal	2 mons	Fri 11/6/09	Thu 12/31/09	
31	▦	Risk Analysis - SCD Buttressing	3 mons	Mon 1/11/10	Fri 4/2/10	
32		Comparative Risk Analysis	1 mon	Mon 4/5/10	Fri 4/30/10	31
33		Risk Comparison and Allocation Workshop	3 wks	Mon 5/3/10	Fri 5/21/10	30,35,36,32,31
34		Final Risk Matrix	2 wks	Mon 6/7/10	Fri 6/18/10	33FS+2 wks
35	▦	Post Construction Long Term Management Plan	4.95 mons	Tue 12/1/09	Fri 4/16/10	
36		Preliminary Geotechnical Report	2 mons	Thu 9/24/09	Wed 11/18/09	
37		Landowner / Manager Screening Meetings	9 mons	Thu 9/24/09	Wed 6/2/10	
38		Landowner / Manager Selection	0 days	Wed 6/2/10	Wed 6/2/10	37
39						
40		**CAW Management Approval**	**468 days**	**Mon 6/21/10**	**Wed 4/4/12**	
41		Preliminary Approval	48 days	Mon 6/21/10	Wed 8/25/10	34,5,38,64,87
42		Implementation Approval	2 mons	Thu 2/9/12	Wed 4/4/12	9,121
43						
44		**CPUC Approval**	**423 days**	**Tue 3/30/10**	**Thu 11/10/11**	
45	▦	Submit Regulatory Filing Discusion Paper	0 mons	Tue 3/30/10	Tue 3/30/10	
46	▦	Submit Final Application to CPUC	0 wks	Fri 9/17/10	Fri 9/17/10	
47		CPUC approval	15 mons	Fri 9/17/10	Thu 11/10/11	46
48						
49		**DSOD Approval**	**880 days**	**Thu 11/19/09**	**Wed 4/3/13**	
50	▦	DSOD Approval of Pre-construction work plan	1 mon	Mon 1/4/10	Fri 1/29/10	
51		DSOD Application (Conditional)	2 mons	Thu 11/19/09	Wed 1/13/10	3SS+2 mons
52	▦	Feasibility Phase progress report	12 days	Mon 6/21/10	Tue 7/6/10	34,38
53		DSOD approval of construction documents	24 mons	Thu 6/2/11	Wed 4/3/13	104
54						
55		**Cost Analysis**	**208 days**	**Mon 9/13/10**	**Wed 6/29/11**	
56	▦	Bureau of Reclamation DEC review	2 mons	Mon 9/13/10	Fri 11/5/10	
57	▦	Cost Estimate and Cost Sharing Workshop	2 wks	Tue 9/28/10	Mon 10/11/10	
58		Engineering Phase Cost Sharing Plan	2 mons	Tue 10/12/10	Mon 12/6/10	57
59		Implementation Phase Cost Estimate	2 mons	Thu 4/7/11	Wed 6/1/11	104FF
60		Implementation Phase Cost Sharing Plan	1 mon	Thu 6/2/11	Wed 6/29/11	59,64FF
61						
62		**Funding**	**762 days**	**Thu 9/24/09**	**Fri 8/24/12**	
63		Draft Funding Plan	8 wks	Thu 9/24/09	Wed 11/18/09	
64		Update Funding Plan (Feasibility Phase)	1 mon	Mon 5/24/10	Mon 6/21/10	52SF
65	▦	Update Funding Plan (Engineering Phase)	1 mon	Fri 5/6/11	Thu 6/2/11	
66		**Apply for and secure funding**	**685 days**	**Mon 1/11/10**	**Fri 8/24/12**	
76						
77		**CEQA/NEPA Compliance**	**420 days**	**Thu 1/14/10**	**Wed 8/24/11**	
78		Community relations prior to NOD	3 mons	Thu 1/14/10	Wed 4/7/10	51
79		Notice of Determination	6 mons	Wed 2/3/10	Tue 7/20/10	51,78FF,52FF+2 v
80		Determine if additional environmetnal review is requir	2 mons	Thu 12/16/10	Wed 2/9/11	102
81		Scope and budget for additional review	2 mons	Thu 2/10/11	Wed 4/6/11	80
82		Complete additional CEQA/NEAP review	5 mons	Thu 4/7/11	Wed 8/24/11	81
83						
84		**Permitting**	**571 days**	**Wed 12/2/09**	**Wed 2/8/12**	
85	▦	Draft Permitting Plan	3 mons	Wed 12/2/09	Tue 2/23/10	
86		Permitting Workshop	4 wks	Wed 2/24/10	Tue 3/23/10	85



Project: 091208_SCD Project Schedul
Date: Mon 9/13/10

Task	▬	Milestone	◆	Rolled Up Critical Task	▬	Split	┈	Group By Summary	▬
Critical Task	▬	Summary	▬	Rolled Up Milestone	◇	External Tasks	▬	Deadline	⇩
Progress	▬	Rolled Up Task	▬	Rolled Up Progress	▬	Project Summary	▬		

ID	ℹ	Task Name	Duration	Start	Finish	Predecessors
87		Final Permitting Plan	2 mons	Wed 3/24/10	Tue 5/18/10	86
88		Select permitting consultant	2 mons	Thu 8/26/10	Wed 10/20/10	41
89		Coordination and communication with regulatory age	17 mons	Thu 10/21/10	Wed 2/8/12	88
90		Prepare permit applications	8 mons	Thu 10/21/10	Wed 6/1/11	88
91		Secure permits and approvals	9 mons	Thu 6/2/11	Wed 2/8/12	90
92						
93		**Complete Environmental Compliance Plan (ECP)**	**300 days**	**Thu 2/10/11**	**Wed 4/4/12**	
94		Prepare preliminary list of mitigation, monitoring, and	4 mons	Thu 2/10/11	Wed 6/1/11	88,90FF
95		Incorporate pre- and during-construction environment	2 mons	Thu 6/2/11	Wed 7/27/11	94
96		Develop strategy for implementation of post-construc	2 mons	Thu 6/2/11	Wed 7/27/11	94
97		Prepare draft ECP	2 mons	Thu 6/2/11	Wed 7/27/11	94
98		Finalize ECP	2 mons	Thu 2/9/12	Wed 4/4/12	91
99						
100		**Preliminary Engineering**	**300 days**	**Thu 7/1/10**	**Wed 8/24/11**	
101		Select engineering consultant	2 mons	Thu 7/1/10	Wed 8/25/10	41FF
102		Finalize Design Criteria / Concepts	4 mons	Thu 8/26/10	Wed 12/15/10	41
103		Technical Review Team review	11 mons	Thu 8/26/10	Wed 6/29/11	102SS
104		Draft 30% Design	6 mons	Thu 12/16/10	Wed 6/1/11	102
105		Final 30% Design	3 mons	Thu 6/2/11	Wed 8/24/11	104
106						
107		**Design-Build Procurement**	**360 days**	**Thu 12/16/10**	**Wed 5/2/12**	
108		D/B Procurement Workshop 1	1 mon	Thu 12/16/10	Wed 1/12/11	102
109		Draft D/B RFQ	2 mons	Thu 1/13/11	Wed 3/9/11	108
110		Final D/B RFQ	1 mon	Thu 4/7/11	Wed 5/4/11	109FS+1 mon
111		RFQ on street	6 wks	Thu 5/5/11	Wed 6/15/11	110
112		SOQ review	1 mon	Thu 6/16/11	Wed 7/13/11	111
113		D/B shortlist	1 mon	Thu 7/14/11	Wed 8/10/11	112
114		Draft D/B RFP, Contract	4 mons	Thu 2/10/11	Wed 6/1/11	104FF,108
115		D/B Procurement Workshop 2	1 mon	Thu 6/2/11	Wed 6/29/11	114
116		Final D/B RFP, Contract	2 wks	Thu 8/25/11	Wed 9/7/11	115FS+2 mons,10
117		RFP to shortlisted teams	2 mons	Thu 9/8/11	Wed 11/2/11	113,116
118		Proposal Review	1 mon	Thu 11/3/11	Wed 11/30/11	117
119		D/B Interviews	1 mon	Thu 12/1/11	Wed 12/28/11	118
120		D/B Negotiations	1 mon	Thu 12/29/11	Wed 1/25/12	119
121		Select D/B Team	2 wks	Thu 1/26/12	Wed 2/8/12	120
122		D/B Award	2 wks	Thu 4/5/12	Wed 4/18/12	42,121
123		D/B NTP	2 wks	Thu 4/19/12	Wed 5/2/12	122
124						
125		**Design-Build**	**900 days**	**Thu 5/3/12**	**Wed 10/14/15**	
126		Design	22 mons	Thu 5/3/12	Wed 1/8/14	123
127		**Construction**	**660 days**	**Thu 4/4/13**	**Wed 10/14/15**	
128		Phase 1 - Site Preparation	7 mons	Thu 4/4/13	Wed 10/16/13	126SS+12 mons,9
129		Phase 2 - Bypass and Stabilization	7 mons	Thu 4/3/14	Wed 10/15/14	128FS+6 mons
130		Phase 3 - River Restoration	7 mons	Thu 4/2/15	Wed 10/14/15	129FS+6 mons
131						
132		Transfer of ownership	2 mons	Thu 10/15/15	Wed 12/9/15	130
133		Construction Phase Complete	0 days	Wed 12/9/15	Wed 12/9/15	132



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Critical Task	🟥	Summary	▬	Rolled Up Milestone	◇	External Tasks	▬	Deadline	⇩
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