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GEI Consultants

Geotechnical
Water Resources
Environmental and
Ecological Services

Guadalupe Dam Seismic Retrofit Project

Planning Study Report

Submitted to:
Santa Clara Valley Water District
5750 Almaden Expressway
San Jose, CA 95118-3686

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October 2015
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GUADALUPE DAM SEISMIC RETROFIT PROJECT

PROJECT NO. 91084020

PLANNING STUDY REPORT

I have reviewed and concur with the alternatives analysis and recommendation presented in this Planning Study Report for the Guadalupe Dam Seismic Retrofit Project and recommend proceeding with design to implement the project as recommended.

Katherine Oven 12/23/15

Katherine Oven, P.E. Date
Deputy Operating Officer
Water Utility Capital Division

I have reviewed and approve the alternatives analysis and recommendations presented in this Planning Study Report for the Guadalupe Dam Seismic Retrofit Project and approve proceeding with design to implement the project as recommended.

for FM 12/23/15

Frank Maitski, P.E. Date
Deputy Operating Officer
Water Utility Technical Support Division

GUADALUPE DAM SEISMIC RETROFIT PROJECT

PROJECT NO. 91084020

PLANNING STUDY REPORT

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October 2015

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Acronyms and Abbreviations

AACE	American Association of Cost Engineers
ADAS	automated data acquisition system
AF	acre-feet
AQ	Almaden Quicksilver
cfs	cubic feet per second
CBA	Cost-Benefit Assessment
CDFW	California Department of Fish and Wildlife
CEO	Chief Executive Officer
CEQA	California Environmental Quality Act
GLFE	Guadalupe local fault event
CMP	corrugated metal pipe
CNDDB	California Natural Diversity Database
CNPS	California Native Plant Society
CRHR	California Register of Historical Resources
CRPR	California Rare Plant Rank
CSC	County of Santa Clara
GSFE	Guadalupe San Andreas fault event
CY	cubic yards
DSM	deep soil mixing
DSOD	California Division of Safety of Dams
DSP	Dam Safety Program
DTSC	Department of Toxic Substances Control
EIR	Environmental Impact Reports
ESA	Environmental Site Assessment
FE	Federally Endangered
FP	Fully Protected
FT	Federally Threatened
HCP	Habitat Conservation Plan
HMR	Hydrometeorological Report
LEDPA	Least Environmentally Damaging Project Alternative
MCE	Maximum Credible Earthquake
MMRP	Mitigation Monitoring and Reporting Plan
M_W	Moment Magnitude
NEPA	National Environmental Protection Act
NMFS	National Marine Fisheries Service
NAHC	Native American Heritage Commission
NAVD88	North American Vertical Datum of 1988
NGS	National Geodetic Survey
NGVD29	National Geodetic Vertical Datum of 1929
NRHR	National Register of Historic Places
NTP	Notice to Proceed
OPAU	Water Operations and Planning Unit

Acronyms and Abbreviations (continued)

PDR	Problem Definition Report
PFMA	Probable Failure Mode Analysis
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
Project	Calero and Guadalupe Dams Seismic Retrofits Project
PSR	Planning Study Report
QEMS	Quality and Environmental Management System
QMS	Quality Management System
RCP	Reinforced Concrete Pipe
ROV	Remotely Operated Vehicle
ROW	Right-of-way
RWQCB	Regional Water Quality Control Board
SCCPRD	Santa Clara County Parks and Recreation District
SCVWD (District)	Santa Clara Valley Water District
SFPUC	San Francisco Public Utilities Commission
SRA	Staff Recommended Alternative
SSC	Species of Special Concern
SSE	Seismic Stability Evaluation
SE	State Endangered
ST	State Threatened
STID	Supporting Technical Information Document
SVOC	semi volatile organic compound
TM	Technical Memorandum
TDR	Transition to Design Report
UT	Ultrasonic Thickness
USACE	United States Army Corp of Engineers
USFWS	United States Fish and Wildlife Service
VHP	Valley Habitat Plan
VWP	Vibrating Wire Piezometers

Executive Summary

The Guadalupe Dam facilities are located in Santa Clara County about 9.5 miles south of the City of San Jose. The facilities include Guadalupe Dam, an emergency spillway, and low-level outlet works. Guadalupe Dam is located less than 0.1 miles off Hicks Road and across Guadalupe Creek. Construction of the facilities occurred in the mid 1930's with completion in 1936. The location of Guadalupe Dam is shown on the vicinity map in **Figure 1-1** and on the site plan in **Figure 1-2**.

Guadalupe Dam is a 129-foot-high, 650-foot-long compacted earth embankment. The dam impounds Guadalupe Reservoir. Which, with a capacity of approximately 3,564 acre-feet at full storage (Elevation 619.3 feet NAVD88), is one of the District's smaller reservoirs. Additional pertinent data for Guadalupe Dam is provided in **Appendix A.**

A seismic stability evaluation of the Guadalupe Dam completed in 2012 (URS-AMEC, 2012a), indicated inadequate seismic stability of the dam from postulated design earthquake events. As a result, Guadalupe Reservoir is currently subject to operational restrictions imposed by the California Division of Safety of Dams (DSOD) due to seismic stability concerns. Guadalupe Reservoir is restricted to elevation 601.3 feet, approximately 18 feet below spillway level which limits storage to 2,335 acre-feet, or 66 percent of the normal 3,564 acre-foot storage capacity. Retrofit of the 80-year-old Guadalupe Dam and associated facilities is necessary to address seismic safety concerns and other identified dam issues; to meet current regulatory requirements; to satisfy District operational requirements; and to remove the reservoir operating restriction and restore normal water supply capacity.

The seismic safety concerns and potential embankment retrofit options were identified in prior Seismic Stability Evaluations (SSE1B) (URS-AMEC, 2012a, 2012c). These reports provided the initial basis for the planning study documented herein.

The planning study included additional investigations and analyses to further define the dam safety and operational deficiencies at Guadalupe Dam that were summarized in the Guadalupe Dam Problem Definition Report (GEI, 2014b). The investigations and analyses included flood studies (probable maximum precipitation/probable maximum flood; PMP/PMF), underwater outlet works inspections and condition assessments, and geotechnical and geologic explorations to further define the dam safety issues. The Guadalupe Dam Problem Definition Report provides documentation of the existing conditions; identifies the problems and issues affecting the dam and appurtenant facilities; identifies constraints and options for remediation of the issues; and documents the District's Project Requirements. The Project Requirements are also included in this report in **Appendix B.**

Based on the seismic stability evaluations documented in the SSE1B Report (URS, 2012a) and dam safety issues identified in the Problem Definition Report (GEI, 2014b), the following deficiencies have been identified at Guadalupe Dam:

1) Seismic stability: the dam embankment will experience excessive and unacceptable deformations under the maximum credible earthquake. Consequently, the California

Division of Safety of Dams (DSOD) accepted reservoir operating restrictions that limit the storage at Guadalupe to approximately 66% of its design capacity.

2) PMF passage: an updated PMP/PMF study identified that the PMF (HMR 59) exceeds the existing spillway capacity and will potentially overtop the dam during this maximum flood event. Also, the downstream stilling basin should be improved to protect downstream facilities from erosion damage.
3) Outlet works capacity and condition: while the outlet capacity is sufficient for emergency drawdown in accordance with DSOD guidelines, its current condition will not provide 50-years of service without modifications or replacement. In addition the intake needs to be replaced in a location not subject to seismic deformations of the upstream berm, and downstream release facilities need to be replaced in a location downstream of any dam modifications.
4) Upstream concrete panels: the top few rows of erosion protection panels show signs of deterioration and should be replaced.
5) Crest parapet wall: the existing concrete parapet wall (up to 2.5 feet high) would be removed and replaced with a corresponding raise of the dam embankment crest.

The planning process, including alternatives formulation, evaluation and screening was documented in the Guadalupe Dam Alternatives Report (GEI, 2015c). Ten (10) conceptual alternatives to remediate the dam and mitigate the identified dam safety deficiencies were developed and evaluated, and Cost-Benefit Assessment (CBA) methods were utilized to compare dam retrofit alternatives with potential dam removal alternatives. The Guadalupe Dam CBA is included in this report as **Appendix C**. Five feasible retrofit alternatives were selected for further refinement and evaluated to identify the Staff-Recommended Alternative.

The Staff-Recommended Alternative includes the following:

- Addition of a downstream buttress, with limited excavation of the downstream shell and foundation in preparation for buttress construction;
- Installing an internal filter and drain system;
- Lengthening the crest of the existing side channel spillway by approximately 100 feet to pass the updated probable maximum flood (PMF) with adequate freeboard;
- Adding scour protection/flood walls at the downstream spillway stilling pool to protect outlet works release facilities from erosion damage;
- Adding a new multi-level sloping intake on the left abutment;
- Adding a new tunneled outlet conduit below the left abutment that connects to new downstream release facilities to Guadalupe Creek;
- Abandoning the existing outlet works by backfilling/sealing the existing conduit;
- Replacing the concrete parapet wall with a slightly raised embankment crest and replacing the top three rows of concrete erosion protection panels;
- Improving dam access roads including a new bridge over the spillway from Hicks Road to the dam crest, and realignment of Hicks Road near the dam abutment.

The Staff-Recommended Alternative is presented in the drawings included in **Appendix D.**

In conjunction with the planning study, evaluations of borrow and spoil disposal requirements are being completed. The evaluation concluded that soil and rock for the buttress could be obtained from on-site sources through the development of a borrow site on the north-east side of the reservoir. Filter and drain material would be imported from off-site commercial sources.

The implementation of the Staff-Recommended Alternative would not only remove the DSOD storage restrictions allowing full operational use of the reservoir, but also improve reliability and extend the service life of the Guadalupe Dam facilities for another 50 to 100 years.

For planning purposes, it was concluded that Guadalupe Reservoir would be fully lowered (drained) to facilitate retrofit construction, with the reservoir lowered for approximately two years. The total estimated construction duration is approximately 2-1/2 to 3 years.

The estimated project cost is approximately $57 million in 2015 dollars. This cost estimate is an Association for Advancement of Cost Engineering (AACE) Classification Class 3 cost estimate, which is assumed to represent the actual total installed cost within the range of -20 percent to +30 percent of the cost indicated. The cost estimate does not include District administrative and legal costs, right of way costs, replacement water supply, planning/environmental studies and permitting, and habitat restoration and mitigation.

The estimated schedule for the project is as follows:

- Completion of design – March 2018
- Completion of California Environmental Quality Act (CEQA) studies – Dec 2017
- Acquisition of Permits – February 2019
- Start of Construction – March 2019
- End of Construction – October 2021

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1.0 Introduction and Project Background

1.1 Project Overview

A seismic stability evaluation of Guadalupe Dam completed in 2012 (URS-AMEC, 2012a), determined that significant deformation dam could occur from postulated design earthquake events. Deformations of the crest were estimated to be up to 6.5 feet horizontal in the downstream direction with up to 8 feet vertical under the anticipated Maximum Credible Earthquake (MCE) of M_W 6.9 on the local Stanford-Monte Vista fault (1.9 km away). Deformations of the crest were estimated to be up to 6.5 feet horizontal in the downstream direction with up to 7 feet vertical for a MCE of M_W 7.9 on the San Andreas fault (approximately 8.8 km away). Potential upstream slope deformations of up to 6 feet horizontally at the toe of the upstream berm were judged as tolerable from a dam embankment safety perspective but could damage the intake tower rendering it incapable of controlling reservoir releases through the outlet works.

Based on the findings, Guadalupe Reservoir was and remains restricted to a maximum elevation of 601.3 feet, approximately 18 feet below spillway level that limits storage to 2,335 acre-feet or 66 percent of the normal 3,564 acre-foot storage volume. The restriction was approved by the California Division of Safety of Dams (DSOD) (DSOD, 2012; URS-AMEC, 2012b). This interim risk reduction measure will remain in place until the seismic deficiencies are remediated.

Retrofit of the 80-year-old Guadalupe Dam and associated facilities is necessary to address seismic safety concerns and identified dam safety issues; to meet current DSOD regulatory requirements; to satisfy District operational requirements; and to remove the reservoir operating restriction. Implementation of the Staff-Recommended Alternative to address these problems would not only remove the DSOD storage restrictions allowing full operational use of the reservoir, but also improve reliability and extend the service life of the facilities for another 50 to 100 years.

1.2 Project Objectives

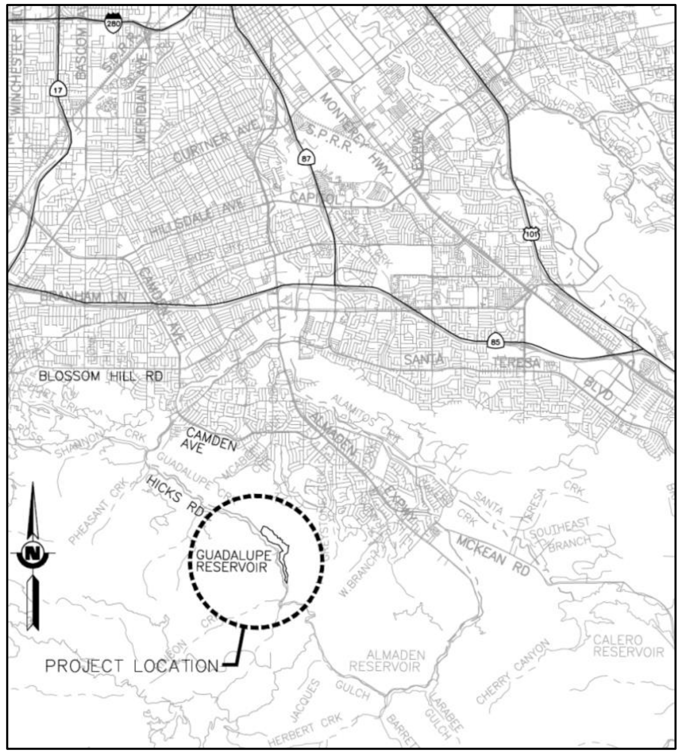
The District's objectives for the Project are to make improvements necessary to:

1) Stabilize the Guadalupe Dam embankment to withstand a Maximum Credible Earthquake (MCE).
2) Implement improvements as necessary for the Dam system to safely pass the Probable Maximum Flood (PMF)
3) Ensure that the outlet works and hydraulic control system meet the Division of Safety of Dams (DSOD) requirements.
4) Relocate the Guadalupe Dam intake structure out of the upstream berm in a timely manner.
5) Incorporate other measures to address seismic and other dam safety deficiencies that are identified through the Project delivery process

The District also developed project requirements for addressing issues associated with the planning and design of the Guadalupe Dam Retrofit. The project requirements are provided in **Appendix B** for reference.

1.3 Guadalupe Facilities Location and Overview

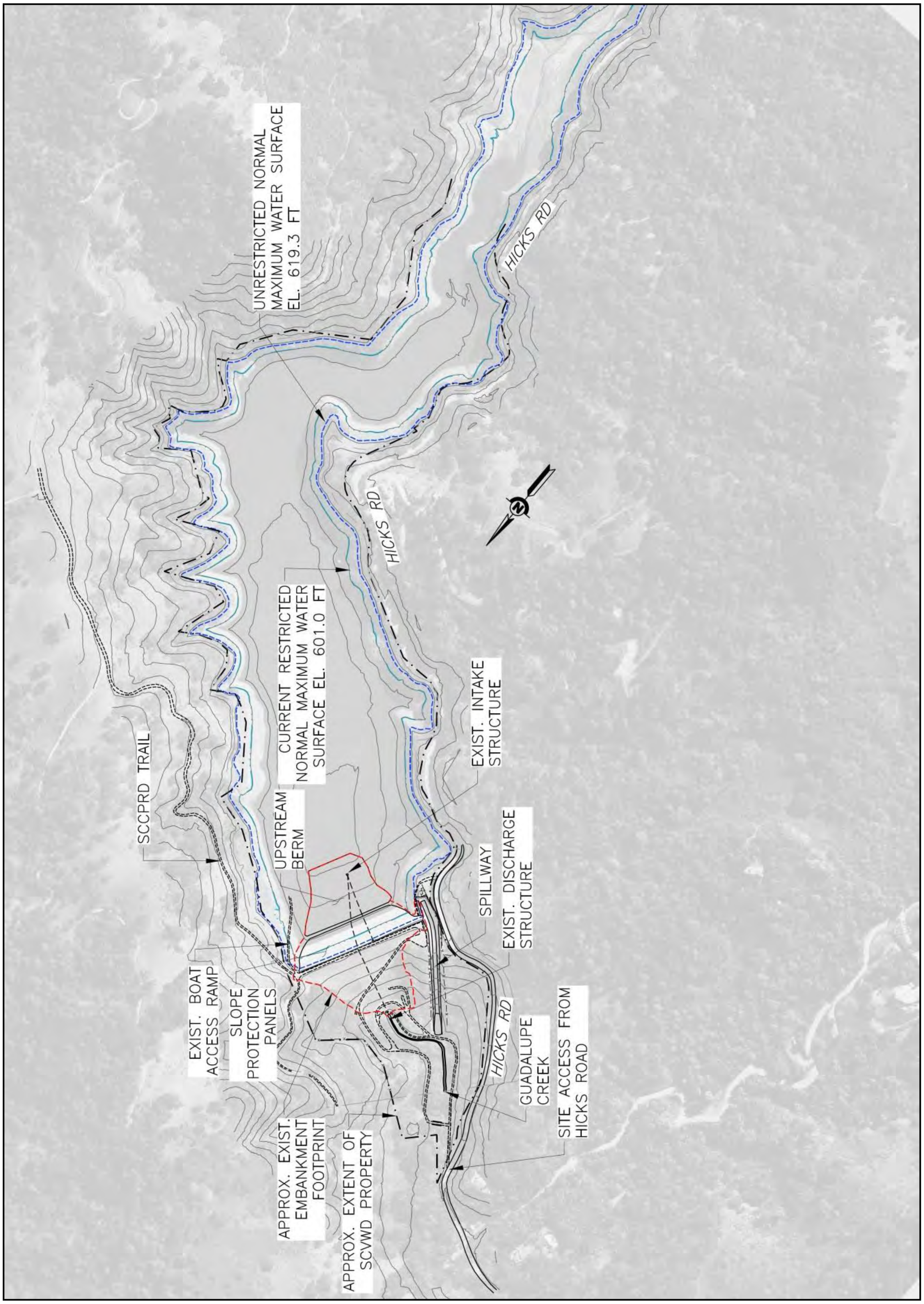
Figure 1-1: Project Vicinity Map



The Guadalupe Dam and Reservoir are located in south Santa Clara County, approximately 4 miles south of the District headquarters on Almaden Expressway, and approximately 7 miles southwest of the junction of Highway 85 and US 101 as shown in **Figure 1-1.** The District uses Guadalupe Reservoir to store natural watershed runoff, replenish downstream wells by ground water recharge, and provide recreation and environmental flows, and incidental flood control. Controlled releases from Guadalupe Reservoir provide water to recharge the groundwater basin. Typically, the reservoir is filled during the winter and early spring and drawn down from late spring to early fall.

Guadalupe Reservoir is impounded by the Guadalupe Dam embankment across Guadalupe Creek as shown in **Figure 1-2**. Access to Guadalupe Dam is from Hicks Road, a county road that skirts the western perimeter of Guadalupe Reservoir. A gravel single-lane road extends approximately 0.2 miles from a gated turnout on Hicks Road across Guadalupe Creek and to the downstream toe of the dam. There is also a small turnout off Hicks Road to a small parking area on the left dam abutment, adjacent to the spillway inlet. An oxygenation facility is located at this turnout, but the spillway prevents access to the dam crest from the turnout.

Figure 1-2: Guadalupe Site Plan



1.4 Guadalupe Facilities Description

1.4.1 Embankment

Guadalupe Dam is a 129-foot-high, 650-foot-long rolled earth embankment that impounds Guadalupe Reservoir with a capacity of 3,564 acre-feet at full storage (Elevation 619.3 feet NAVD88).

Construction of the Guadalupe facilities occurred in the mid 1930's with completion in 1936. The upstream slope was buttressed in 1972 with a compacted clay berm (known historically as the "Sherard Wright" berm), after evidence of potential instability was found (Sherard, 1972). Guadalupe Dam has a Total Class Weight of 32 and falls in the "High Consequence" category according to the DSOD Consequence-Hazard Matrix for seismic hazard analysis (DSOD, 2002). Additional pertinent data for Guadalupe Dam is provided in **Appendix A.**

1.4.2 Spillway

The Guadalupe Reservoir spillway is located in a rock cut on the left dam abutment, and consists of a concrete side-channel overflow weir and concrete-lined chute with downstream unlined plunge pool. The crest is an 80-foot-long broad-crested side weir with a crest at 619.3 feet NAVD88 (617 feet NGVD).

The concrete-lined spillway chute is 650 feet long, 20 feet wide, and has side slopes of 1H: 1V. The concrete-lined spillway chute directs spills north into an excavated/previously scoured, unlined area adjacent to Guadalupe Creek approximately 300 feet downstream from the toe of Guadalupe dam.

No floods have been passed through the spillway in recent years since reservoir restrictions were implemented in October 2006. The last reported spill was in April 2006.

1.4.3 Outlet Works

The original Guadalupe Dam outlet works, constructed in 1935, consisted of a concrete box intake structure and a 720-foot-long, 36-inch-diameter, concrete-encased steel pipe under the dam which discharged to a stilling basin at Guadalupe Creek, located at the downstream toe of the dam. The outlet conduit alignment has two low-angle horizontal bends. Flow control was provided at both the inlet structure (hydraulically actuated, 42-inch slide guard gate) with the hydraulic controls on the dam crest, and at the discharge structure (manually actuated 30-inch butterfly valve).

The STID construction history (Geosyntec 2012) indicates that in 1948 the inlet riser was raised 20 feet to prevent blockage by sediment, and in 1972, the inlet riser was raised another 17.5 feet to accommodate an upstream slope buttress. The modified intake structure is comprised of a reinforced concrete inlet with trash racks at the top of the riser, a 37.5 foot tall, 6-foot-diamter riser constructed of stacked concrete pipe segments down through the berm, and a concrete vault (original inlet structure) that houses the hydraulically actuated slide gate and connects to the outlet conduit. The 1972 improvements also included installation of a concrete block downstream control house and raising of the valve actuator. An electric actuator was installed in the downstream valve in 1987.

1.5 Project Studies

This Guadalupe Dam Planning Study Report builds upon numerous previous studies performed for the Guadalupe facilities including problem definition studies, alternatives evaluations, stability analyses, and borrow studies. Key studies are listed in Section 6, References.

1.6 Datum and Topographic Information

The District and future designers will prepare the design documents for the Project using elevations based on NAVD88. Unless noted, elevations listed in this report are shown as NAVD88 and as appropriate, the NGVD29 elevation in parenthesis. Many existing reports refer to elevations in NGVD29. DSOD correspondence and the District's ALERT system use NGVD29 elevations. The National Geodetic Survey (NGS) datum conversion indicates NAVD88 is 2.3 feet higher in elevation than NGVD29 at the location of Guadalupe Dam.

1.7 Report Organization

The Planning Study Report is organized into the following sections:

- **Section 1** provides an introduction to the purpose, scope, and organization of this Planning Study Report. It also provides an overview and location of the Guadalupe Facilities.
- **Section 2** provides a summary of the project's Problem Definition as the basis for the development and evaluation of project alternatives.
- **Section 3** describes the alternatives analysis planning process, including the Conceptual-level Alternatives Evaluation for 10 conceptual alternatives, Cost-Benefit Assessment (CBA) to compare dam retrofit and dam removal options, Feasibility-level Alternatives Evaluation for 5 feasible alternatives, and identifies the Staff-Recommended Alternative including modifications to reduce project implementation costs.
- **Section 4** introduces and describes the recommended project, including the preliminary design of embankment, outlet works, and spillway components. It also discusses real estate needs for the Project, environmental considerations, and issues to be considered for final design.
- **Section 5** presents preliminary construction cost estimates and schedule based on the preliminary design of the Staff-Recommended Alternative.
- **Section 6** lists references utilized in preparing this Planning Study Report.
- **Appendix A** is a table of pertinent data for Guadalupe Dam.
- **Appendix B** is a table of the District's project requirements for the Guadalupe Dam Seismic Retrofit Project.
- **Appendix C** is the Guadalupe Dam Cost-Benefit Assessment.
- **Appendix D** includes the set of drawings describing the Guadalupe Dam Staff-Recommended Alternative.

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2.0 Problem Definition

2.1 Overview

For the current planning study, existing data review, field investigations and analyses were performed to define the problems, identify dam safety issues, and develop feasible alternatives to remediate the seismic and other identified dam safety deficiencies. The results of the investigations and analyses were summarized in the Guadalupe Dam Problem Definition Report (GEI, 2014b). The following problems have been identified at Guadalupe Dam:

1. Seismic Stability – The dam embankment will experience excessive and unacceptable deformations under the MCE likely leading to cracking of the embankment. Additionally, the upstream berm will experience deformations which will likely damage the inlet riser. Consequently, DSOD accepted reservoir operating restrictions that limit the storage at Guadalupe to approximately 66% of its design capacity.
2. Spillway Capacity – An updated PMF study identified that the PMF (HMR 59) exceeds the existing spillway capacity and will potentially overtop the Dam during this maximum flood event.
3. Outlet Works Condition – While the existing low-level outlet works hydraulic capacity satisfies emergency release criteria for the current reservoir size, seismic deformation of the dam and upstream berm would likely damage or block the inlet riser. Additionally, the structural capacity of the conduit is not robust and it cannot accommodate additional seismic retrofit loads from a downstream buttress, nor provide 50 years of additional service. The horizontal bends in the existing alignment prevent slip-lining the existing conduit for increased structural capacity.
4. Upstream Concrete Face Panels – The existing panels show signs of distress and have required ongoing O&M repairs. While no panel replacements are considered necessary at this time for dam safety reasons, replacement of some panels as part of dam seismic retrofit efforts will reduce the need and cost for future O&M repairs.
5. Parapet Wall – The existing concrete parapet wall (up to 2.5 feet high) should be removed and replaced with a corresponding raise of the dam embankment to restore the crest to its original crest elevation.

A synopsis of the investigations and analyses leading to the identification of these deficiencies is provided below.

2.2 Embankments

The District completed a Seismic Stability Evaluation of the Guadalupe Dam in 2012 (SSE1B) (URS-AMEC, 2012a) following earlier DSOD studies that indicated seismic concerns for Guadalupe Dam. The analyses included seismic source evaluation, liquefaction evaluation of the embankment and underlying foundation materials (alluvium) and post-earthquake stability and deformation estimates of the embankment under potential seismic ground motions. Two events were identified as the controlling Maximum Credible Earthquakes (MCE); a local M_W 6.9 event on the Stanford-Monte Vista fault (designated as the Guadalupe Local Fault Event, (GLFE)) with a closest distance of 1.9 km, and a M_W 7.9 event on the San Andreas fault (designated as the Guadalupe San Andreas Fault Event, (GSFE)) with a closest distance of approximately 8.8 km. Potential ground motions from these MCE events were used for the seismic stability analyses.

The Guadalupe Dam seismic stability analyses indicated that the dam would likely experience excessive deformations during the controlling MCE events, but the materials in the embankment and foundation were determined not to be susceptible to liquefaction. The primary mode of displacement is in the downstream direction with corresponding settlement of the crest. Deformations of the crest were estimated to be up to 6.5 feet horizontally and 8 feet vertically under the GLFE. Deformations of the crest were estimated to be up to 6.5 feet horizontally and 7 feet vertically for the GSFE. Downstream toe displacements were estimated to be over 8.5 feet horizontally and 4 feet upward for both events. Such large deformations and the expected embankment cracking would compromise the integrity of the dam and are considered unacceptable for dam safety.

In addition to the primary downstream displacements, the SSE1B work estimated upstream toe displacements of up to 6 feet horizontally and 0.5 feet upward, with horizontal displacements near the intake tower estimated at about 4 feet for both events. The SSE1B work judged that if the downstream slope is stabilized, estimated deformations of the upstream slope under the controlling MCE event would be tolerable from an embankment dam safety perspective. However, such deformations could damage or block the intake riser through the berm preventing use of the outlet works to control the level of the reservoir, which is considered unacceptable for dam safety.

2.3 Spillway / PMF Passage

The standard hydraulic requirement for public safety on high-hazard potential dams is to provide spillway capacity capable of passing the probable maximum flood (PMF). When significant changes to the dam are proposed or made (such as a seismic retrofit project), DSOD requires confirmation of the PMF spillway capacity using updated methods. The previous PMF study for Guadalupe Dam was completed in 1982 using Hydrometeorological Report (HMR) 36 whereas current studies use HMR 59. The updated PMF inflow to Guadalupe Reservoir (Ford, 2014a) following the HMR 59 protocols produces a maximum still water surface elevation of 629.9 feet NAVD88 (627.1 feet NGVD29), which results in approximately 0.1 feet of potential overtopping over the entire length of the dam. DSOD requires passage of the PMF with no less than 1.5 feet of residual freeboard (DSOD, 2012). Under existing conditions, this requirement is not met.

2.4 Outlet Works

The original Guadalupe Dam outlet works, constructed in 1935, consisted of a concrete intake structure with hydraulically actuated slide gate, and a straight, 720-foot-long, 36-inch-diameter, concrete-encased steel pipe under the dam which discharged to a release structure/stilling basin at Guadalupe Creek, located at the downstream toe of the dam. The intake structure was later modified to include the vertical riser constructed of stacked reinforced concrete pipe (RCP) sections through the 1972 upstream “Sherard Wright” berm, and in the 1980’s the downstream outlet structure and butterfly release valve were modified to include a concrete block house and electric valve actuator. The vertical riser is considered susceptible to damage from the estimated seismic lateral displacements and must be moved from the dam footprint.

Additional key findings from the recent assessment of the Guadalupe outlet works are summarized below:

1. No conditions were observed during the inspections that would require immediate repair for continued operational service over the next few years while the seismic retrofit project is being planned and implemented.
2. The hydraulic capacity of the existing outlet is judged satisfactory to meet DSOD emergency release criteria.
3. Visual dive and ROV inspection and limited non-destructive (UT) testing of the conduit interior show the existing outlet conduit is unlined and has experienced moderate corrosion over the last 79 years that has reduced the computed hydraulic capacity and is causing some wall thinning of the steel outlet pipe and appurtenances. No out-of-round deformation or other visual structural distress was observed during the inspections; however, the structural capacity of the outlet conduit is not robust and will not provide 50 years of service, without significant rehabilitation or replacement. Horizontal bends in the alignment prevent rehabilitation by slip-lining the conduit for added structural capacity to accommodate increased embankment loads from seismic retrofit improvements.
4. Inlet and outlet control facilities, while currently serviceable, will require full replacement if the existing outlet conduit is rehabilitated or replaced. The new inlet needs to be relocated outside the zone of potential seismic deformation (upstream buttress), and the new outlet needs to be relocated beyond the embankment toe of any seismic retrofit improvements.

2.5 Upstream Concrete Panels

The concrete panels that protect the upstream face of Guadalupe Dam from erosion are nearly 80 years old, with distress of some lower panels observed starting in the 1960’s. Lower panels were removed in 1972 for construction of the “Sherard Wright” upstream berm, and the District has made occasional repairs over the years to replace limited areas of spalled or excessively cracked concrete, primarily at joints. Additional cracking and offset damage was observed following the Loma Prieta Earthquake in 1989, although no sliding or other major damage required wholesale replacement of damaged panels. Based on a recent assessment of the panels, no large-scale panel replacement efforts are necessary at this time for dam safety reasons; however, replacement of the upper two to three rows of panels as part of dam seismic retrofit efforts would reduce the need for and cost of future O&M repairs.

2.6 Potential Changes to Project Objectives and Requirements

New investigations as documented in the Problem Definition Report (GEI, 2014a) confirmed the adequacy of project objectives. No changes to the project objectives were recommended in the report.

However, during subsequent refinement and cost evaluation of the Staff Recommended Alternative (GEI, 2015c) the District determined there were several clarifications/modifications to previously established project requirements (included in **Appendix B)** as noted below:

1) Technical Outlet Works Requirement No. 7 indicated that if a new outlet is planned, it is preferred by the District to be a carrier pipe in an oversized tunnel to facilitate inspection and maintenance. During refinement of the Staff-Recommended Alternative, it was determined that the O&M benefits of having access for personnel along the exterior of the outlet conduit was not worth the additional cost for an accessible carrier tunnel; therefore the Staff-Recommended Alternative could include the new conduits in a fully grouted tunnel with the conduits oversized to facilitate inspection and future maintenance. Technical OW Requirements No. 8-11 related to drainage, ventilation, lighting and paging in the carrier tunnel are no longer applicable.
2) Discussions with DSOD and District staff have indicated the need for an access bridge over the spillway from Hicks Road to provide alternate access to the dam crest in the event spillway operation prevents use of the main access road to the toe of the dam, and an improved low-water crossing of Guadalupe Creek below the dam due to weight limitations on the existing access bridge preventing use by heavy maintenance or construction vehicles. This improved access would be an additional General Project Requirement.

3.0 Alternatives Analysis

3.1 Overview

Based on the issues identified and documented in the Problem Definition Report, and District and DSOD requirements, the seismic retrofit of Guadalupe Dam included development and evaluation of alternatives for the following three primary project components:

1) Embankment seismic stabilization;
2) Safe passage of the PMF, and;
3) Outlet works replacement.

Each of these three primary components could be achieved with multiple options which in turn are influenced by the water level in the reservoir during construction. In addition to these primary components, the District also requested consideration of spillway notching with a permanent reduction in reservoir storage, and possible dam removal with elimination of reservoir storage and change in site use to an un-regulated streamflow regime. These would avoid costs for seismic retrofit, but require use of Cost Benefit Assessment (CBA) to evaluate changes in future benefits as well as costs.

Additional discussion of the technical considerations for formulation of the components and alternatives is presented in the Alternatives Report (GEI, 2015c).

3.2 Conceptual Alternatives Formulation

3.2.1 Primary Project Component Options

The options for the embankment seismic stabilization component were combined with required PMF passage and outlet works replacement components into overall project conceptual alternatives for conceptual-level screening. The following options (for each component) were considered in the initial formulation of alternatives.

Embankment stabilization – As identified in the SSE1B report (URS-AMEC 2012c) the options for seismic stabilization of the dam included the following:

1) Remove and replace downstream foundation and embankment.
2) Add downstream buttress with limited removal of the downstream foundation and embankment.
3) Insitu embankment and foundation treatment with Deep Soil Mixing (DSM).
4) Accept permanent storage restriction with no embankment modifications by lowering (notching) the spillway.

Two conceptual options for dam removal were identified in the Alternatives Report (GEI, 2015c) that would have distinct costs/benefits depending on whether post dam removal stream restoration accommodated fish passage, and on how much sediment removal/stabilization might be required:

5) Partial dam removal, leaving the lower portion of the dam and some reservoir sediments in-place but requiring a streamflow drop structure down the face of the remaining dam that would not allow upstream fish passage.
6) Full dam removal, restoring the original stream channel with full removal of reservoir sediments thus allowing upstream fish passage.

Conceptual options for dam removal include consideration of potential costs related to onsite stabilization or offsite disposal of reservoir sediment containing elevated levels of mercury from historic mining activities in the tributary basin upstream of Guadalupe Reservoir.

Safe PMF passage of the PMF with adequate freeboard – The options included the following:

1) Raising the dam embankment up to 4.3 feet above the top of the existing parapet wall to provide adequate containment and sufficient freeboard without modifying the spillway crest.
2) Lengthening the spillway crest up to 104 feet (130% over existing 80 foot width) to provide sufficient freeboard without raising the dam crest.
3) Lowering the spillway crest up to 4.3 feet to provide adequate flood containment, and install an operable spillway crest gate that would be seasonally operated to maintain existing storage.

For the seismic retrofit option consisting of spillway notching for a permanent reduction in storage but no dam modifications, the SSE1B study (URS-AMEC 2012c) assumed the spillway crest would be lowered 29 feet to provide 39 feet of total freeboard to safely accommodate crest settlement and cracking caused by an MCE. Such spillway crest lowering could be accomplished by an open cut or possibly a tunneled intake, plus deepening of the upper spillway chute.

Outlet works modifications – Based on the outlet works condition assessment and the need to modify Guadalupe Dam for seismic stability, the outlet works improvement alternatives judged most practical for dam seismic retrofit included a new replacement outlet works and abandonment of the existing outlet works. The replacement outlet works were configured to accommodate the planned seismic retrofit and current District operational and maintenance requirements. The new replacement outlet works facilities should be located outside the footprint of the modified dam embankment, and incorporate appropriate air venting, man-ways and other operational improvements (e.g. multi-level intake, alternate actuators) deemed necessary by the District for improved reliability, operations and maintenance. For the seismic retrofit consisting of spillway notching, the inlet and release structures would be replaced, but the existing outlet conduit could be rehabilitated with new lining and also extended to connect to the new inlet and outlet structures. For dam removal options, the existing outlet would be abandoned in-place or totally removed.

The options included two outlet works locations and alignments including:

1) A new tunneled outlet through the left abutment.
2) A new tunneled outlet through the right abutment.

The two intake structure types including:

1) A sloping intake situated on the reservoir slope.
2) A vertical shaft situated on the rim of the reservoir with horizontal micro-tunneled intakes allowing construction into an active reservoir (i.e. wet-tap).

3.2.2 Reservoir Drawdown and Stream Diversion Considerations

The SSE1B studies (URS-AMEC 2012c) considered different reservoir drawdown levels for construction of the embankment retrofit options, as follows:

1) Limited Drawdown for the Spillway Notching and Deep Soil Mixing (DSM) Options – Temporary construction water level maintained 10 to 15 feet below the current DSOD restricted elevation (601.3 feet NAVD88), for a construction water depth of approximately 60 feet above the intake (elevation 532 feet NAVD88). This would preserve about 1,600 acre-feet of water storage during construction (~45% of capacity).
2) Major Drawdown for the Embankment Buttress Option – Temporary construction water level maintained near elevation576 feet NAVD88, for a construction water depth of approximately 45 feet above the intake invert. This provides up to approximately 1,200 acre-feet of water storage. (~35% of capacity).
3) Full Drawdown for Removal/Replacement of the Downstream Slope or Dam Removal Options – Full lowering of the reservoir to the intake riser sill elevation of 532 feet NAVD88, with no water storage during construction.

However, the required new intake and conduit replacement/rehabilitation would involve construction at the upstream toe below the elevation of the existing intake. This would require either: 1) full reservoir lowering, 2) a very tall cofferdam, or 3) use of a microtunneled lake tap. The very tall cofferdam is not deemed cost-effective given the small reservoir storage volume that would be preserved for use, and it also is not advisable given the increased construction risk from overtopping and failure of a tall cofferdam during a winter flood. A microtunneled lake tap was assessed during the prior studies at Calero Dam (GEI, 2014d), and it was determined that the microtunneled lake tap would limit District O&M access and not satisfy the District's project requirements. Due to the challenges and issues with either a tall cofferdam or microtunneled lake tap, it was determined that the reservoir would need to be fully lowered for construction of all retrofit alternatives. Even with a fully drained reservoir, a small cofferdam (e.g. earth or braced sheet pile) would still be needed around the intake construction area.

Construction of required retrofit improvements is estimated to require at least 3 summer construction seasons with limited/no work during the two intervening winter rainy seasons. Preliminary evaluation of construction flood hydrology (Ford, 2014b) indicates that with the reservoir fully lowered for construction, a 100-year storm could temporarily raise the water surface 90 feet and cause the reservoir to spill even with the outlet works fully open for stream diversion; even a 10-year storm could temporarily raise the water surface 50-60 feet. All retrofit alternatives, therefore, need to incorporate measures to mitigate construction flood risks, including the following:

1) Shutdown of the intake work area during the winter rainy season;

2) Provision for controlled flooding of the intake work area at the start of winter;
3) Temporary bulkhead to prevent flooding of a partially completed outlet tunnel;
4) Geotechnical instrumentation to monitor performance of the partially removed dam; and
5) Rainy season limitations on open downstream dam excavation/backfill.

3.2.3 Site Constraints

The dam and reservoir site is situated in the narrow valley of Guadalupe Creek and is characterized by steep slopes, potential landslide areas and areas of dense vegetation and woods. Hicks Road is immediately adjacent to the left abutment of the dam and left side of the reservoir and the road is steep and narrow impeding traffic for large construction equipment. Site access via Hicks Road is limited to one direction with a small weight-limited bridge over Guadalupe Creek that could be washed out in larger flood events. Potential borrow areas are all located on the right side of the reservoir and the constrained site lacks large, flat or open areas desirable for construction staging, stockpiling and onsite disposal. These site constraints affect the feasibility, constructability, environmental, permitting and O&M of the various retrofit options, and were considered in the configuration and evaluation of alternatives. In addition, it is expected that dam retrofit options would require access improvements including new access roads and bridges, and possible improvements along Hicks Road.

3.2.4 Other Required Components

In addition to the main project components, the alternatives also included components identified in the PDR as follows:

1) Parapet Wall – Removal of the existing concrete parapet wall and replacement with a small downstream raise of the dam embankment;
2) Upstream Concrete Panels – Replacement of the top three rows of concrete slope protection panels on the upstream face of the dam to reduce future O&M requirements;
3) Oxygenation Equipment – Removal/replacement of the existing reservoir oxygenation equipment on the left abutment in a new location to allow intake and spillway construction; and
4) Geotechnical Instrumentation – Existing instruments on the dam need to be removed to allow retrofit construction and replaced with new instruments under a new instrumentation plan acceptable to DSOD.

3.2.5 Conceptual Alternatives Considered

The initial formulation of alternatives resulted in over 50 possible pre-conceptual component combinations that could be considered. To focus on a realistic subset of conceptual alternatives (approximately 10), pre-conceptual screening was completed through consideration of the component feasibility given expected project needs and constraints, and also the compatibility/feasibility of one component with another component, or with the assumed amount of temporary reservoir drawdown during construction.

Key conclusions from the pre-conceptual screening included:

1) The original SSE1B embankment retrofit options that did not include full reservoir drawdown are not feasible given the need to fully lower the reservoir for intake replacement work. Assuming full drawdown, conceptual alternatives could include all four SSE1b options.
2) Conceptual retrofit alternatives should include both abutments for the replacement outlet works to better differentiate cost, access and other tradeoffs.
3) Conceptual retrofit alternatives should consider all three spillway options to better differentiate cost, operations and other tradeoffs.
4) The conceptual screening tool can be used to evaluate tradeoffs between retrofit options that restore reservoir operations with the same future benefits, however Cost-Benefit Assessement is needed to compare retrofit options with dam removal options since they will have different future benefits and operational costs.

Based on the prescreening, 10 conceptual alternatives were identified for evaluation and are listed in **Table 3-1** below.

Table 3-1: Guadalupe Dam Conceptual Alternatives

No.	Embankment Retrofit	PMF Passage[1]	Outlet Location and Type	Future Storage[2]
1-1	Downstream Removal/Replacement	Dam Crest Raise	Right Abutment Sloping Intake & New Conduit	3,564
1-2	Downstream Removal/Replacement	Crest Gate Spillway	Left Abutment Sloping Intake and New Conduit	3,564
2a-1	Add Downstream Buttress	Dam Crest Raise	Right Abutment Sloping Intake and New Conduit	3,564
3a-1	Insitu Treatment with DSM	Dam Crest Raise	Right Abutment Sloping Intake and New Conduit	3,564
3a-2	Insitu Treatment with DSM	Crest Gate Spillway	Left Abutment Sloping Intake and New Conduit	3,564
3a-3	Insitu Treatment with DSM	Widen Spillway	Left Abutment Sloping Intake and New Conduit	3,564
4a-1	Permanent Storage Reduction with No Embankment Modifications	Lower (Notch) Spillway with Short Tunnel/Culvert	Right Abutment Intake Rehabilitate Conduit	1,735
4a-2	Permanent Storage Reduction with No Embankment Modifications	Lower (Notch) Spillway with Open Cut	Left Abutment Sloping Intake Rehabilitate Conduit	1,735
5	Partial Dam Removal & Drop Structure Leave Most Sediment In-Place	N/A	Abandon	0
6	Complete Dam Removal with Sediment Removal/Stream Restoration	N/A	Remove	0

1) PMF Passage: Dam crest raise – 4.3-foot raise of main dam; Spillway Widening – lengthen weir crest by 130%; Crest Gate Spillway – for 4.3- foot seasonal lowering of storage level under new rule curve; Notch Spillway – lower spillway crest to El 590 under permanent storage restriction.
2) Future reservoir storage capacity in acre-feet after retrofit completion

All 10 conceptual alternatives assume full drawdown of the reservoir during construction. All retrofit alternatives also assume the existing outlet works is abandoned by grouting. Spillway notching options with permanent storage restriction include rehabilitation of the existing outlet conduit in conjunction with a new sloping intake.

3.3 Evaluation and Scoring Criteria

The screening framework for evaluation of conceptual alternatives was formulated as a simple decision tree matrix with four major goals and with each goal having two to four key objectives. Relative weights were assigned to each goal and to each objective. The individual goal weights sum to 100%. The four major goals (with relative weights) for the Guadalupe Dam alternatives included:

- Minimize Adverse Environmental Impacts (20%)
- Maximize Operational Effectiveness (20%)
- Minimize Overall Project Costs (30%)
- Maximize Project Implementability (30%)

Within each goal are a number of identified objectives that would be attained to varying degrees, depending on the configuration and performance of each alternative. Within each goal, the assigned objective weights must also sum to 100%. District staff were consulted and provided input to the relative weights for both the goals and objectives. The decision matrix with goals and objectives, and relative weighting percentages is shown in Table 3-2. The goals and objectives were measured based on the specific considerations noted.

Table 3-2: Guadalupe Dam Screening Framework

GOALS	Goal WT %	OBJECTIVES	Objective WT%	CONSIDERATIONS
Minimize Adverse Environmental Impacts	**20%**	Minimize Adverse Impacts to Sensitive Biological Resources	35%	Habitat Sensitivity (HCP)
				Work Windows - Migratory Species
				Other T&E Species
		Minimize Adverse Water Resource Impacts	30%	Instream Flows
				Water Quality
		Minimize Community Impacts	35%	Construction Traffic
				Fugitive Dust
				Noise Impacts
				Visual Impacts
				Recreation
				Cultural and Archaeological Resources
Maximize Operational Effectiveness	**20%**	Safety & Security	40%	Operational Reliability/Dam Safety
				Security
		Water System Operations	35%	Water Supply Reliability
				Ease of Operations
				Flexibility for Enlargement
		Sustainability	25%	Long Service Life
				Ease of Maintenance
				Other Beneficial Uses
Minimize Overall Project Costs	**30%**	Implementation Costs	70%	Construction Cost
				Indirect Costs
		Life Cycle (O&M) Costs	30%	O&M & Replacement Costs

GOALS	Goal WT %	OBJECTIVES	Objective WT%	CONSIDERATIONS
				Lost Benefits
Maximize Project Implementability	**30%**	Regulatory Approvals	30%	DSOD Approvals
				Environmental Permits
				Land Acquisition
		Risk Management/Claims Potential	20%	Environmental Risks
				Delay Potential
				Supply Interruption Risks
				Construction Claims Potential
		Completion Schedule	20%	Construction Duration
				Completion Date
		Constructability	30%	Borrow, Staging and Spoil Areas
				Construction QA Verification
				Temporary Facility Requirements
				Difficulty of Construction

3.4 Conceptual Alternatives Evaluation and Scoring Results

Each of the 10 conceptual alternatives were evaluated by assessing the key components and features, key assumptions needed for project implementation, design and construction feasibility considerations, and the advantages and disadvantages of the alternative. Drawings were developed at a conceptual level to identify key work items and quantities and identify approximate project footprint. Expected construction duration was estimated to the nearest 6-months based on a conceptual-level understanding of the work required, key construction constraints, and using professional judgment from similar projects. Construction costs (AACE Class 5) were estimated based on the conceptual-level layouts of key features and estimated quantities for major work items where there were differences among alternatives (earthwork, tunnel/pipe lengths, etc.), with unit prices and lump sum allowances based on similar projects and judgment.

The conceptual alternatives were then screened and comparatively evaluated in a workshop using a discussion/consensus process, with the workshop participants comprised of District and consultant subject-matter experts with appropriate perspectives to cover the relevant goals and objectives. Key conclusions from conceptual-level screening of retrofit alternatives are summarized in the following points:

1) Embankment Retrofit should focus on Alternative 2 (add downstream buttress) and Alternative 3(DSM), and should eliminate Alternative 1 (downstream removal/replacement). Alternative 4 (spillway notching) also appeared as a favorable alternative if the District can accept the loss in benefits from reduced storage. Alternative 1 (downstream removal/replacement) was eliminated due to a combination of implementability, cost and environmental issues largely related to greater earthwork and associated project footprint impacts.
2) Outlet Works Replacement should further consider both left and right abutments for the outlet tunnel and sloping intake. The left abutment has more potential conflicts with spillway and dam crest raise work than the right abutment location, but also provides a shorter tunnel alignment, improved operational access and avoids the borrow/haul route interference of the right abutment location. Both options should be

carried forward, with the preferred location and alignment subject to confirmation by future geologic and subsurface investigations to be performed during design.

3) Spillway Capacity Enlargement should consider both a dam crest raise and a lengthened spillway crest. It appears the lengthened spillway crest may be preferable to the dam crest raise due to the reduced earthwork/environmental footprint and improved possibility of a left abutment location for the replacement outlet works. The spillway crest gate results in lower scores than both these options due to concerns with DSOD acceptance and operational reliability of the crest gate.
4) Spillway Notching appears viable if the District is willing to forgo approximately 1,800 acre-feet of storage, and should be carried forward for cost-benefit assessment. Use of an open cut for spillway notching is preferable to using a short tunnel.
5) The Top-Ranked Full Retrofit and Spillway Notching Alternatives (3a-2 and 4a-2, respectively) should be used for comparison with Dam Removal Alternatives (5 and 6) in a separate Cost-Benefit Assessment. These alternatives, as the apparent preferred conceptual alternatives for retrofit with restored and reduced storage, respectively, provide the baseline for CBA comparisons of construction and operational costs and benefits.

3.5 Cost-Benefit Assessment

Due to the relatively small storage capacity of Guadalupe Reservoir, at District request the planning study process included a Cost-Benefit Assessment to compare dam retrofit and dam removal alternatives to determine if dam retrofit costs are justified by realized benefits. Or, stated differently, might dam removal be more cost-effective than dam retrofit? Evaluating this question required consideration of 1) the full range of construction and operational costs and benefits provided by the alternatives, and 2) the impact of different schedules for those costs and benefits.

3.5.1 Summary of CBA Approach

The CBA was performed by a resource economist in collaboration with Consultant and District staff. Consultant staff provided definition of construction costs, while District staff provided input on operational costs and benefits. The approach and findings from the Guadalupe Dam CBA are summarized below and fully documented in a separate memorandum (URS, 2015) included in this report as **Appendix C**.

Concurrent with development and screening of conceptual alternatives, an initial workshop was held with the District to review a proposed CBA approach, including identifying the cost and benefit categories, and obtaining initial input on parameters to be used in the analysis. After conceptual screening of retrofit alternatives, the top ranked dam retrofit and spillway notching alternatives were then compared on the basis of costs and benefits over time to the partial and full dam removal alternatives. The alternatives and cost and benefit categories and assumptions used in the analysis are summarized below:

<u>Conceptual Alternatives</u>:

- Dam retrofit with full operational storage – the top-ranked conceptual alternative is 3a-2.

- Spillway notching with operational storage reduced by 1,800 acre-feet – the top ranked conceptual alternative is 4a-2.
- Partial dam removal with limited sediment removal and no storage – allowing habitat restoration but no fish passage.
- Full dam removal with full sediment removal and no storage – allowing full stream restoration with fish passage.

Cost Categories:

- Construction and other initial costs (e.g. replacement water supply).
- Future O&M Costs (e.g. dam operations, water and sediment monitoring, vegetation maintenance).

Benefit Categories:

- Water supply.
- Downstream minimum stream flows.
- Downstream flood management.
- Water quality.
- Habitat and other environmental benefits.
- Recreation.

Net Present Value (NPV):

- For CBA comparison using NPV, costs and benefits over time were evaluated based on a 50-year life and a 3 percent discount rate.
- Benefits were computed relative to a "base case" (the dam embankment retrofit alternative) which by definition had a benefit of $0.

A second workshop was held with the District and Consultant team to review the conceptual screening of retrofit alternatives, discuss preliminary CBA findings and review comments on a draft CBA memorandum, and identify feasible alternatives to be carried forward. The CBA memorandum was finalized based on workshop feedback and further input from the District regarding flood management benefits.

3.5.2 Summary of CBA Findings

The total project costs and benefits from the CBA are summarized in Table 12 of the Guadalupe Dam CBA (URS, 2015), included in this report as **Appendix C**, with key findings as follows:

Costs:

- The construction costs for alternatives range from $39 million for the lower spillway alternative to $93 million for full dam removal. The retrofit and partial dam removal alternatives have comparable construction costs of $58 million and $56 million respectively.

- The future O&M costs for the alternatives are comparable and range from $143,000 to $310,000 per year. It is assumed that there would be no water quality monitoring requirements for the dam removal alternatives.
- The present value of the total project costs (50 years and 3 percent discount rate) range from $47 million for the lowered spillway alternative to $99 million for full dam removal. The present value cost for the retrofit base case is $66 million.

Benefits:

- The dam retrofit alternative is the base case and by definition has a $0 total benefit for CBA benefit comparison purposes. Present value of its projected 2,500 af/yr water supply yield is $66.0 million and approximately equivalent to a $1,015/af annual benefit value.
- Lowered spillway is $27.7 million (present value) - all from its 500 af/yr reduced water yield.
- Dam removal alternatives are projected to result in major benefit losses of $79.5 to $83.3 million (present value).
- Water supply benefit loss estimated to be $80.2 million (present value)
- Only minor habitat benefits could be identified for dam removal ($5.7 million to $9.3 million total present value). Gains nearly offset by potential impairment to the Guadalupe Creek Restoration Project (up to $8.9 million cost).
- Negligible benefit changes for recreation and water quality.

Overall

- Dam retrofit results in the greatest total benefits.
- Lowered spillway would result in a comparative net benefit loss of $8.7 million in present value terms over the 50 year study period. Benefit loss is attributable to the cost premium for alternative replacement water sources.
- Dam removal alternatives would result in comparable net benefit losses of $83.3 to $79.8 million. This would be expected to result in significant additional annual water supply costs for SCVWD.

3.6 Feasible Alternatives Evaluation

3.6.1 Alternatives Carried Forward

The Guadalupe Dam recommended feasible alternatives are summarized in **Table 3-3**. These five alternatives include the top three dam retrofit and top spillway notching alternative from the conceptual screening, plus one additional retrofit alternative (2a-2) identified by the District that would allow further consideration of spillway widening paired with an added downstream buttress. The alternatives provide flexibility for two embankment retrofit approaches (buttress and DSM) paired with two options for increased spillway capacity and different locations for the outlet works, plus one alternative for notching the spillway to avoid the costs of dam retrofit in exchange for some loss of storage capacity. All alternatives provide accessible sloping intake structure and improved downstream release capability that fully meets District operational requirements. All of the alternatives require full reservoir lowering for construction and a small temporary cofferdam to protect the in-reservoir work areas during the construction season, with expected controlled flooding of the cofferdam and in-reservoir work areas during the winter rainy season.

Table 3-3: Guadalupe Dam Recommended Feasible Alternatives

No.	Embankment Retrofit	PMF Passage	Outlet Location and Type	Future Storage
2a-1	Add Downstream Buttress	Dam Crest Raise	Right Abutment Sloping Intake & New Conduit	3,564 ac-ft
2a-2	Add Downstream Buttress	Widen Spillway	Left Abutment Sloping Intake & New Conduit	3,564 ac-ft
3a-1	Insitu Treatment with DSM	Dam Crest Raise	Right Abutment Sloping Intake & New Conduit	3,564 ac-ft
3a-2	Insitu Treatment with DSM	Widen Spillway	Left Abutment Sloping Intake & New Conduit	3,564 ac-ft
4a-2	Permanent Storage Reduction with No Embankment Modifications	Lower (Notch) Spillway with Open Cut	Left Abutment Sloping Intake & Rehabilitated Conduit	1,735 ac-ft

3.6.2 Design Refinements, Baseline Cost and Schedule Estimates

The five feasible alternatives were further developed from the conceptual level to an approximate 10-percent level of project definition to better define project configuration and footprint, construction considerations including sequence and schedule, and further refine costs. The key feasibility level design refinements are summarized below:

1) Sloping Intake – Better defined the layout and required excavation for placement of the intake structure and connection with the new tunneled outlet conduit, as well as preliminary layout for the temporary construction cofferdam.

2) Tunnel Alignment and Profile – Refined the preliminary tunnel alignment to include straight tangents with small bends rather than long bends, and identified tunnel portal location and excavation requirements.

3) Downstream Valve House for Stream Release – Refined the location and preliminary configuration for the downstream valve house for releases to Guadalupe Creek.

4) Dam Crest Raise – Refined the footprint and section for raising the crest of the dam for alternatives that include a dam crest raise to contain the PMF. Identified the likely need for a small flood wall or raising of Hicks Road to contain the PMF water surface on the left abutment.

5) Spillway Modifications – More accurately defined the configuration and estimated quantities for either lengthening of the existing side channel weir or installation of a new crest gate. Also developed preliminary layouts for the spillway lowering (notching) alternative using an open cut.

6) Configuration for Embankment Modifications – Developed more refined cross sections and layout of embankment modifications to understand required limits, quantities and construction sequence for foundation excavation/dam removal,

construction of filter drains, embankment placement, Deep Soil Mixing (DSM) and extension/restoration of concrete panels at the upstream face of the dam.

7) Borrow, Stockpile and Disposal – Incorporated initial findings of the Borrow Screening study in layout of potential borrow and disposal sites, and nature and volume of borrow materials available for embankment construction.

8) Haul Routes and Staging – Identified potential haul routes and staging areas for construction considering location and layout of key facility construction areas, reservoir drawdown, and borrow/stockpile/disposal locations.

9) Quantities – Refined the expected quantities for construction based on the refined facility layouts, and made conservative estimates of the "use percentage" of identified borrow/stockpile/disposal areas to estimate the likely environmental impact footprint for construction.

10) Construction Sequence, Schedule and Other Considerations – Developed a potential sequence and preliminary schedule for construction and identified special considerations that could increase construction risk, constrain acceptance or extend the schedule. Also identified the benefits of temporarily extending the existing outlet conduit through the dam foundation work area for stream diversion during construction to shorten the construction schedule.

11) Construction Cost Estimate – Refined the cost estimates to AACE Cost Class 4 to reflect an approximate 10% level of project definition based on the updated configuration and quantities of each alternative. It is noted that these cost opinions are for alternative comparison and not for project budgeting or approval as they do not include all project implementation costs.

3.6.3 Feasible Alternatives Evaluation

The five feasible alternatives were re-screened using the same screening framework and workshop scoring process used in prior conceptual-level screening (see Section 3.2), however during the evaluation workshop with the District, conceptual weighting of the project goals was revised to equal weighting for feasibility screening as follows:

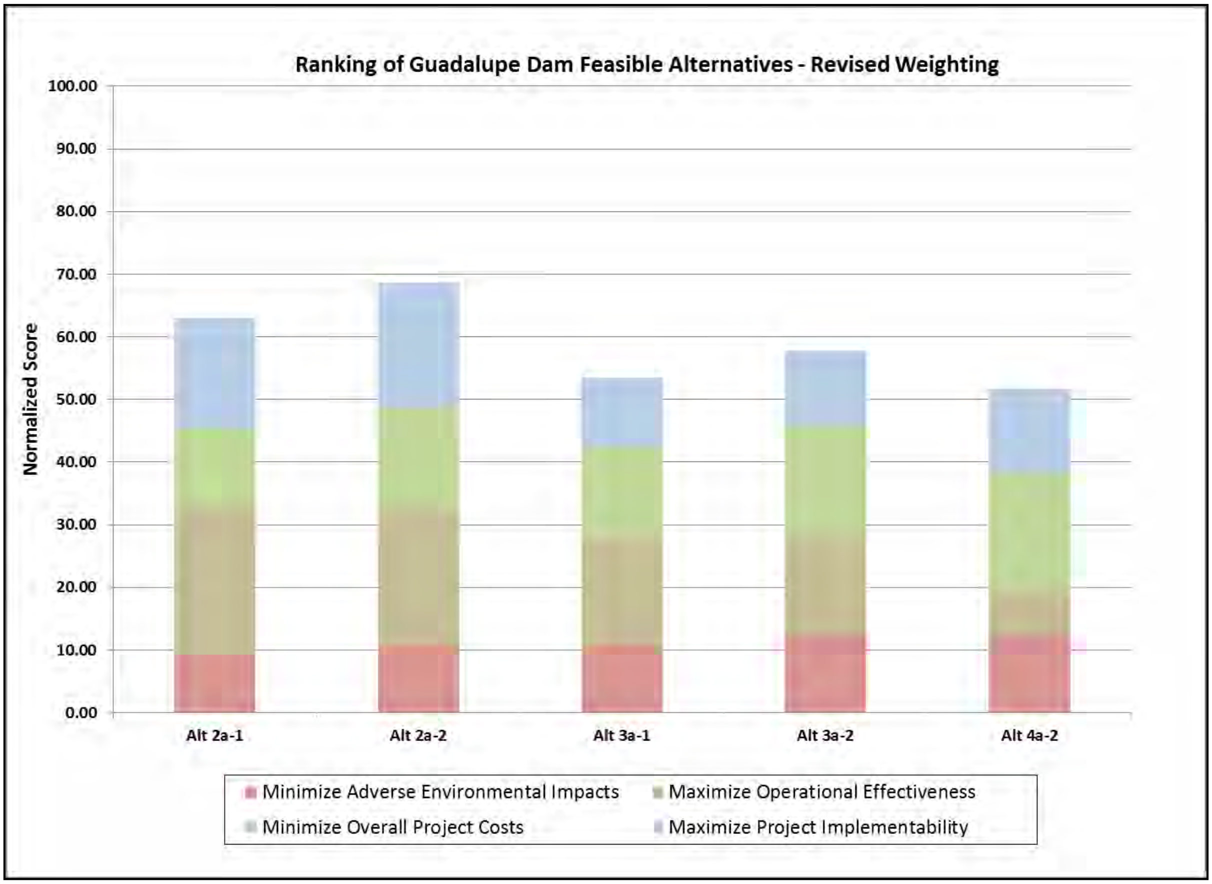
- Minimize Adverse Environmental Impacts (25%)
- Maximize Operational Effectiveness (25%)
- Minimize Overall Project Costs (25%)
- Maximize Project Implementability (25%)

Table 3-4 presents a summary of the scores for each alternative for the revised weighting, with results shown graphically in **Figure 3-1**. It is noted that these scores are relative, and for comparison purposes only.

Table 3-4: Summary Relative Scores for Guadalupe Dam Feasible Alternatives

NORMALIZED SCORES	Alt 2a-1	Alt 2a-2	Alt 3a-1	Alt 3a-2	Alt 4a-2
Minimize Adverse Environmental Impacts	9.50	11.00	11.00	12.50	12.50
Maximize Operational Effectiveness	23.00	21.25	16.50	14.75	6.75
Minimize Overall Project Costs	13.00	16.50	15.00	18.50	19.00
Maximize Project Implementability	17.50	20.00	11.00	12.00	13.50
Total	63.00	68.75	53.50	57.75	51.75

Figure 3-1: Graphical Relative Scoring of Guadalupe Dam Feasible Alternatives



Key conclusions from feasibility-level screening are summarized as follows:

1) Alternatives 2a-1 and 2a-2 are the top-ranked alternatives. Both involve a Downstream Buttress with Limited Downstream Foundation/Embankment Removal. This embankment retrofit option is preferred over DSM (Alternatives 31-1 and 3a-2) or the spillway lowering (notching) (Alternative 4a-2).

2) The difference between the top two alternatives is how the spillway capacity is increased and the location of the outlet works, with Alternative 2a-1 utilizing a Dam Crest Raise and Right Abutment Outlet Works, and Alternative 2a-2 utilizing Lengthened Spillway Crest and Left Abutment Outlet Works. The ranking indicates

that Lengthened Spillway Crest and Left Abutment Outlet Works are preferred with a slightly reduced operational effectiveness score being outweighed by reduced environmental footprint, lower costs and better implementability from the shorter tunnel alignment and reduced earthwork.

3) Alternative 2a-2 is the preferred alternative to carry forward. However, in the event the geotechnical feasibility of the left abutment outlet works is not confirmed by future site investigations, then an alternate location on the right abutment should be considered.

Based on the feasibility-level screening, Alternative 2a-2 was selected as the Staff-Recommended Alternative. Subsequently, the District hosted a workshop on July 2, 2015 to discuss and evaluate design refinements for Alternative 2a-2 that could provide potential cost savings. The outcome of the workshop was a Staff-Recommended Alternative that includes the following:

1) The outlet tunnel concept was changed from an accessible tunnel housing exposed outlet pipes to an outlet tunnel with a 48 inch diameter outlet pipe, and second low flow conduit fully grouted in the tunnel, with no manned access.
2) A spillway terminal structure with erosion protection that would be designed to be “performance based” to protect critical project features at the toe of the spillway.
3) An accessible intake structure with multiport intakes and electric actuators for valves (no hydraulic lines in contact with the reservoir).
4) Access improvements including a new bridge from Hicks Road, across the spillway to the crest of Guadalupe Dam and realignment of Hicks Road.

This alternative is discussed in further detail in Section 4.

4.0 Recommended Project

4.1 Staff-Recommended Alternative Description Overview

The Staff-Recommended Alternative 2a-2 includes the following elements:

- Addition of downstream buttress, with limited excavation of the downstream shell and foundation in preparation for buttress construction;
- A new internal filter and drain system beneath the downstream buttress;
- Lengthening the crest of the existing side channel spillway by up to 104 feet (130%) to contain and pass the updated probable maximum flood (PMF) through the spillway and meet DSOD freeboard requirements;
- New scour protection/flood walls at the spillway stilling pool to protect the outlet works release facilities from erosion damage
- A new sloping, multi-level intake on the left abutment;
- A new tunneled outlet works with new downstream release facilities on the left abutment ;
- Abandonment of the existing outlet works by backfilling/sealing with grout;
- Replacement of the top three rows of concrete slope protection panels on the upstream slope of the dam;
- Removal of the concrete parapet wall on the dam crest with a slight raise of the dam embankment, and;
- A new access bridge over across the spillway from Hicks Road with realignment of Hicks Road to improve access to the dam crest, and replacement of the existing low-water crossing over Guadalupe Creek to improve access to the toe of the dam.

Figure 4-1 presents an overview of the Guadalupe facilities that would be modified by construction of Alternative 2a-2, including callouts of key project features. Preliminary design drawings for the Staff-Recommended Alternative are included for reference in **Appendix D**. A more detailed description of the preliminary design considerations for Alternative 2a-2 is provided in the following sections.

4.2 Staff-Recommended Alternative Refinements

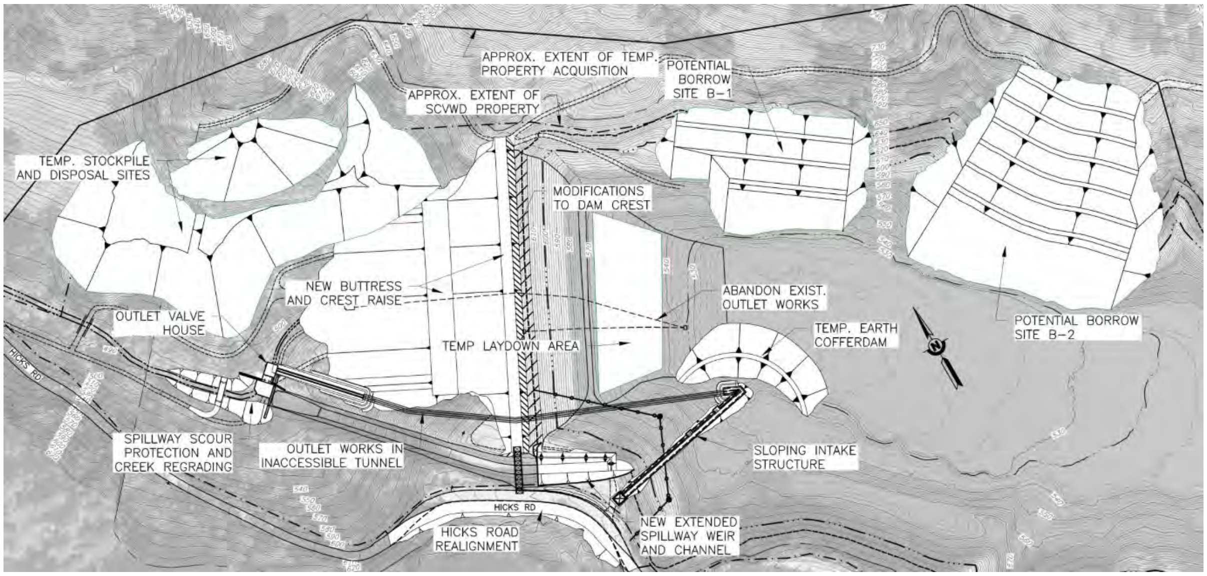
Further development of the Staff-Recommended Alternative includes:

1) Borrow Material – Results from recent subsurface explorations and lab testing were considered in refinement of borrow quality and processing requirements, and associated quantity and cost estimates. A summary of the borrow studies is included in Section 4.7.
2) Construction Flood Hydrology and Stream Diversion – The 2-yr, 10-yr and 100-yr floods were evaluated to support evaluation of diversion, cofferdam, and temporary dam stability risks during construction, and to support refinement of the construction

schedule. A temporary extension of the existing outlet conduit for use in stream diversion during construction was included to allow downstream embankment work to start before completion of the replacement outlet works.

3) Downstream Embankment Stability – The stability of the partially excavated embankment was analyzed to confirm temporary construction stability for the critical section of the partially excavated embankment.
4) Embankment Details – Additional cross sections and details of the embankment retrofit were developed, including filter and drain and seepage improvements, replacement of the top 3 rows of concrete panels, and elimination of parapet wall.
5) Spillway Improvements – More detailed layouts were developed for the spillway crest extension and erosion protection at the spillway stilling pool.
6) Tunneled Outlet Conduit – The accessible carrier tunnel enclosing the new outlet conduit was eliminated to reduce construction costs; however, the conduit size was increased from 36 inches to 48 inches to improve inspection access and allow for a future rehabilitation by slip-lining.
7) Outlet Works Downstream Release Structure – More detailed layouts were developed for the downstream release structure and modifications to the adjacent spillway stilling pool.
8) Outlet Works Intake Structure – More detailed layouts were also developed for the control building and other operational features at the intake given the tight working space on the left abutment.
9) Access Improvements – Conceptual layout of access improvements to the dam, including an access bridge over the spillway to the dam crest from Hicks Road, and realignment of Hicks Road.
10) Preliminary ROW Requirements – Preliminary delineations were made for approximate limits for proposed land acquisition (either in fee or by permanent easement) needed for construction of the retrofit facilities including borrow/disposal areas, temporary staging areas and haul routes, and Hicks Road realignment.

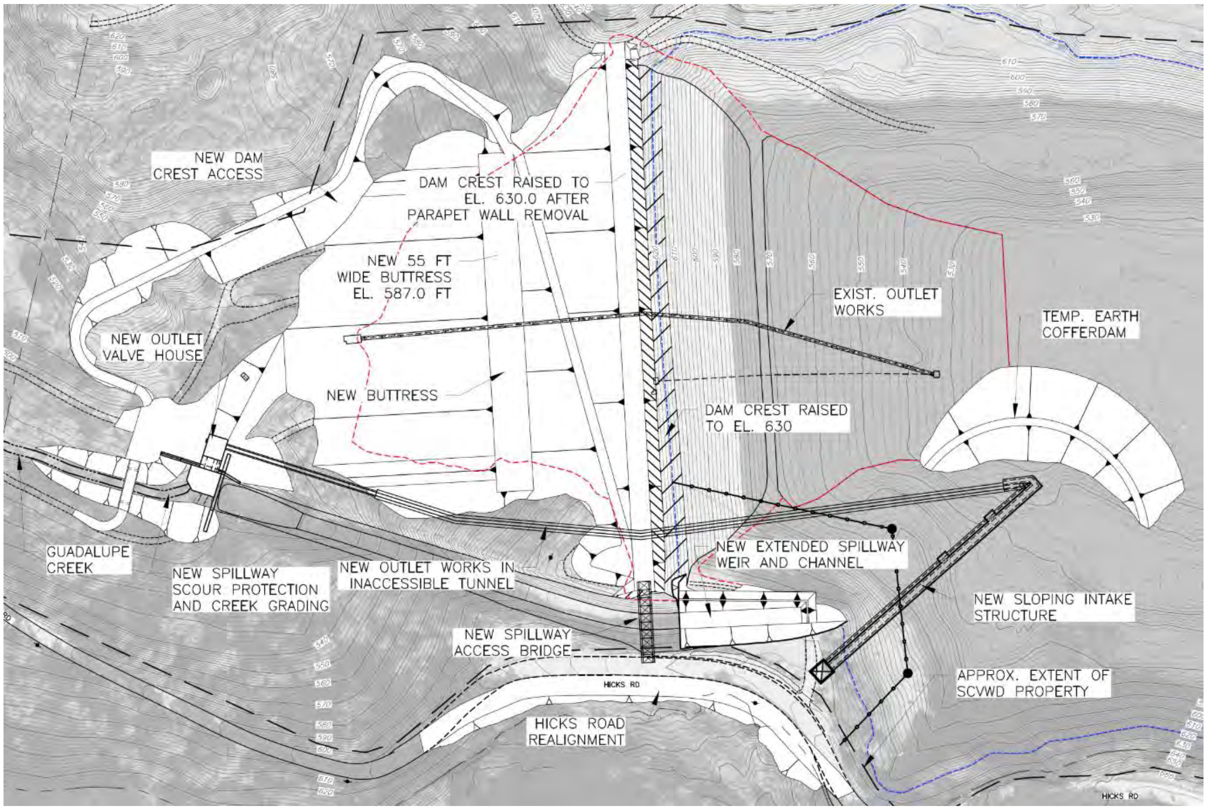
Figure 4-1: Overview of Guadalupe Facilities with Alternative 2a-2 Modifications



4.3 Embankment Design

Alternative 2a-2 requires limited removal and replacement of existing downstream embankment and foundation materials in preparation for the new buttress; the construction of a chimney and blanket drain; the removal of the existing concrete parapet wall and reconstruction of the dam crest with a slightly raised and widened crest; and the construction of an earth fill buttress to approximately two-thirds of the height of the dam, as shown in plan view in **Figure 4-2** and schematically in **Figure 4-3**. The intent of Alternative 2a-2 is to improve embankment stability and reduce downstream deformations during a large earthquake that could otherwise cause crest deformations and cracking, threatening the integrity of the dam. In addition, as part of outlet works replacement discussed further below, the reservoir intake structure would be relocated outside the upstream dam berm to prevent potential upstream slope deformations from damaging the outlet works during a large seismic event.

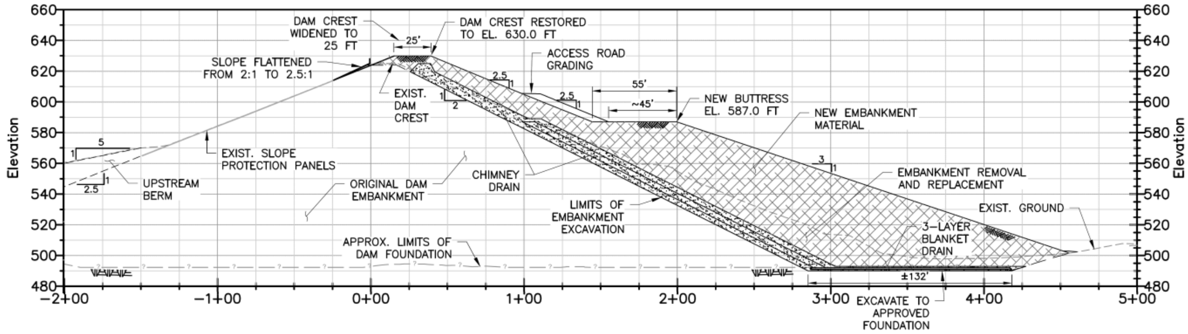
Figure 4-2: Plan View of Guadalupe Dam Improvements



The downstream slope of the dam would be excavated to bedrock for about 50 feet upstream from the current toe, with the excavation of surficial soils extending downstream about 80 feet beyond the existing toe in the valley bottom. The inclination of the excavation would be about 2.0H:1.0V through the existing embankment, starting at about elevation 625 feet on the downstream face. The widened and raised dam and buttress would be constructed with well-compacted earth fill and would have an upper slope of 2.5H:1.0V (similar to the existing slope), an intermediate bench approximately 55 feet wide at about elevation 587, and a lower slope of 3.0H:1.0V below the bench. The new buttress would extend about 100 feet beyond the existing downstream toe.

The Staff-Recommended Alternative also includes the construction of a chimney drain for controlling the phreatic surface within the embankment and providing a seepage drainage path for reducing the potential for through-seepage. The chimney drain would be located between the existing embankment and new embankment/buttress material; above the top of the buttress, the chimney would consist of a single layer of filter sand for drainage and as a crack-stopper; below the top of the buttress, the chimney would consist of a three-layer filter sand/drain gravel sandwich for added drainage capacity. A similar three-layer blanket drain would be placed on the foundation below the buttress (see **Figure 4-3**). The blanket drain would extend up the abutments beneath the footprint of the new buttress zone to collect seepage. Seepage from the chimney and blanket drains would be collected at a toe drain for conveyance to a seepage measurement vault; downstream of the vault, temporary diversion piping would be repurposed to convey seepage flows back to Guadalupe Creek.

Figure 4-3: Typical Cross Section of Alternative 2a-2 (Maximum Section)



The reservoir would be fully dewatered during construction to approximate elevation 532. Excavation of the downstream foundation soils may require temporary lowering of the groundwater table through localized dewatering measures. The earth fill material would be sourced from the existing embankment excavation and augmented by on-site borrow areas. The filter and drain materials would need to be imported from offsite sources.

The Borrow and Spoil Siting Suitability Screening Study (GEI, 2014a) indicated that suitable material for construction of the new buttress can be found in adequate quantities on-site along the northeast rim of the reservoir in the vicinity of previous borrow areas for the original dam construction (see **Figure 1-2**).

In addition to the embankment work, the existing concrete parapet wall would be demolished and replaced with a small dam embankment raise. The top three rows of concrete erosion panels would be demolished and new concrete panels constructed up to the top of the restored dam embankment crest.

Access to the dam crest would be provided by a new ramp from the top of the berm as well as a new bridge from Hicks Road across the dam crest. New geotechnical instrumentation would be installed in the dam to monitor dam safety embankment performance.

4.4 Preliminary Design for Containment and Passage of the PMF

For the Staff-Recommended Alternative, passage of PMF would be accomplished by means of lengthening the existing side-channel spillway crest 104 feet from 80 feet to 184 feet (approximately 130%). The spillway crest modifications are shown in **Figures 4-4** and **4-5**. The 104-foot lengthening is based on conservative assumptions of a minimum 1.5 feet of freeboard required by DSOD plus 2.6 feet for wind-wave setup and run-up for a total of 4.1 feet of freeboard above the PMF level. The total amount of freeboard above the spillway crest would be approximately 10 feet. The freeboard requirement would have to be approved by DSOD prior to final design.

Figure 4-4: Plan and Profile of Spillway Crest Lengthening

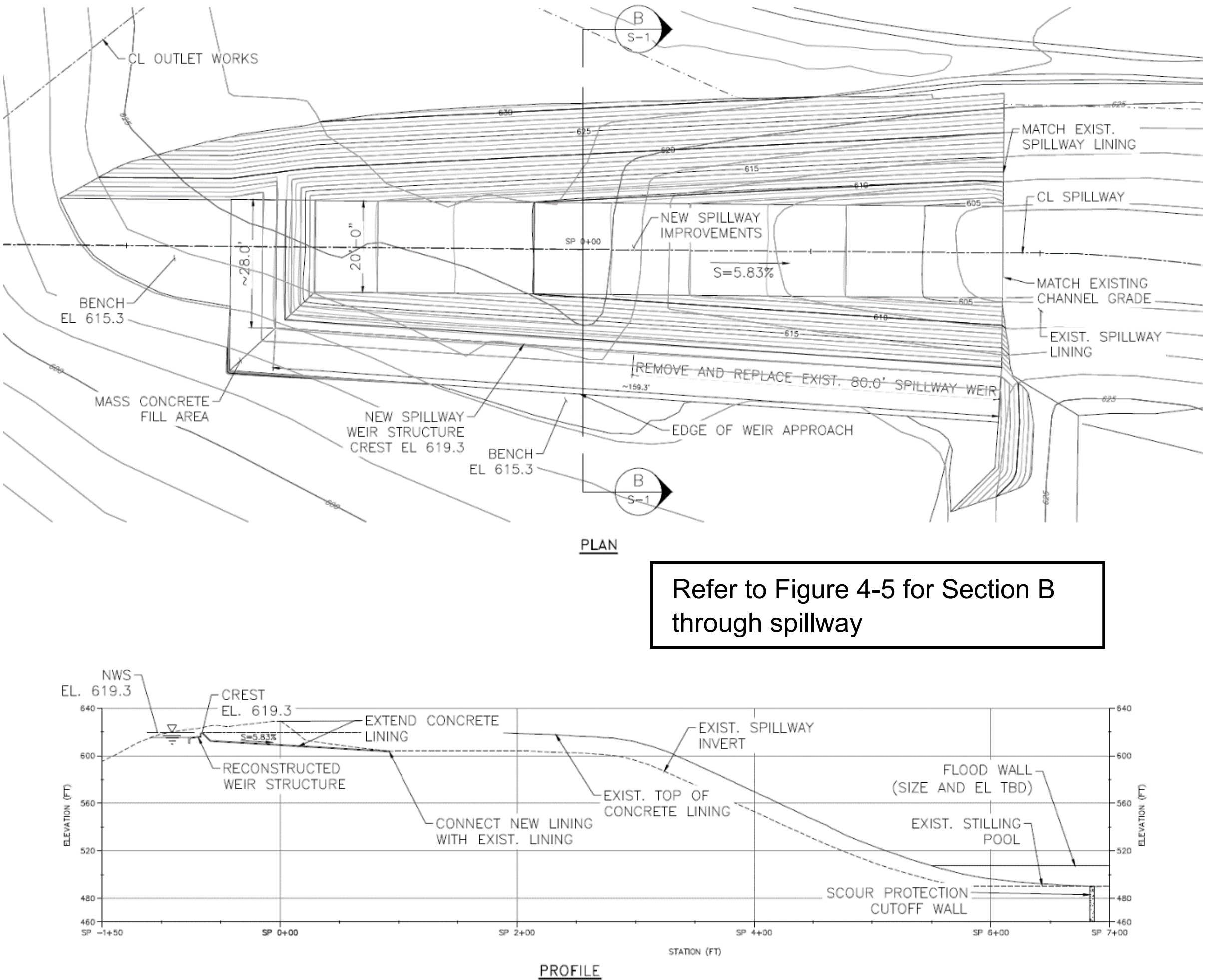
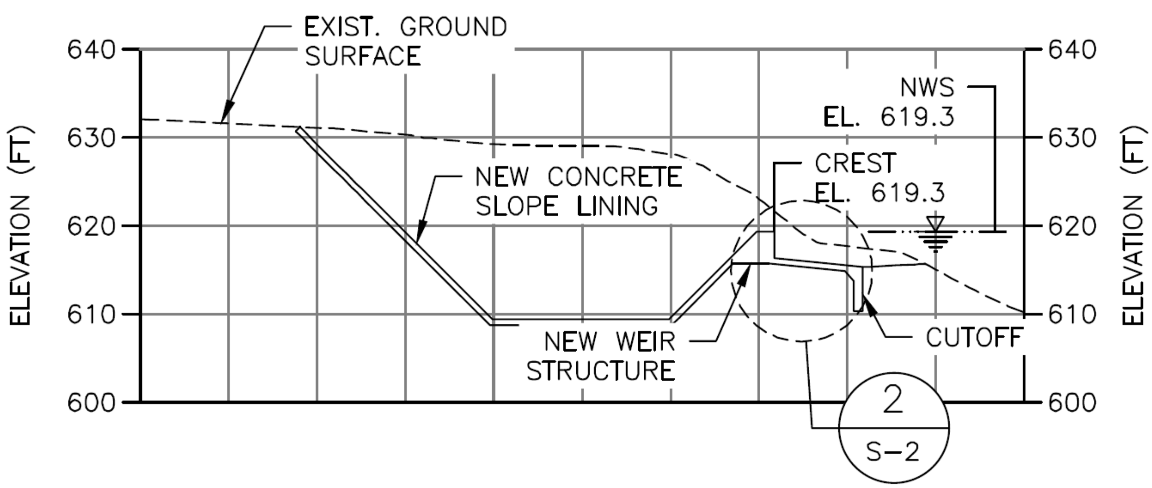


Figure 4-5: Cross Section through Lengthened Spillway Crest



As shown on **Figure 4-2**, a new crest access bridge would be constructed over the upper spillway chute to provide access to the dam crest from Hicks Road. As currently envisioned, this bridge would be a single-span, fabricated bridge that is HS-20 load rated for truck use, with the bridge abutments supported on drilled shafts on either side of the spillway. Security fencing and a gate would be necessary.

At the stilling pool located at the downstream end of the spillway chute, additional scour protection measures would be constructed to protect the downstream valve house and spillway chute from potential erosion damage from larger spillway discharges (see **Figures 4-6 and 4-7**). The improvements would include below-grade reinforced-concrete cutoff walls approximately 50 feet deep that would be installed using diaphragm construction methods, and an overlying flood wall to separate the spillway from the adjacent outlet release facilities. Drilled shaft foundations would be installed below the outlet release facilities for added scour protection.

Without a conventional stilling basin to provide full energy dissipation in a large concrete-lined basin, large spillway flows may erode soils and weathered bedrock in the stilling pool area; however, the added scour protection improvements would prevent lateral scour progression and potential undermining damage to the outlet works discharge facilities and the spillway chute.

Figure 4-6: Plan of Scour Protection Improvements at Spillway Stilling Basin

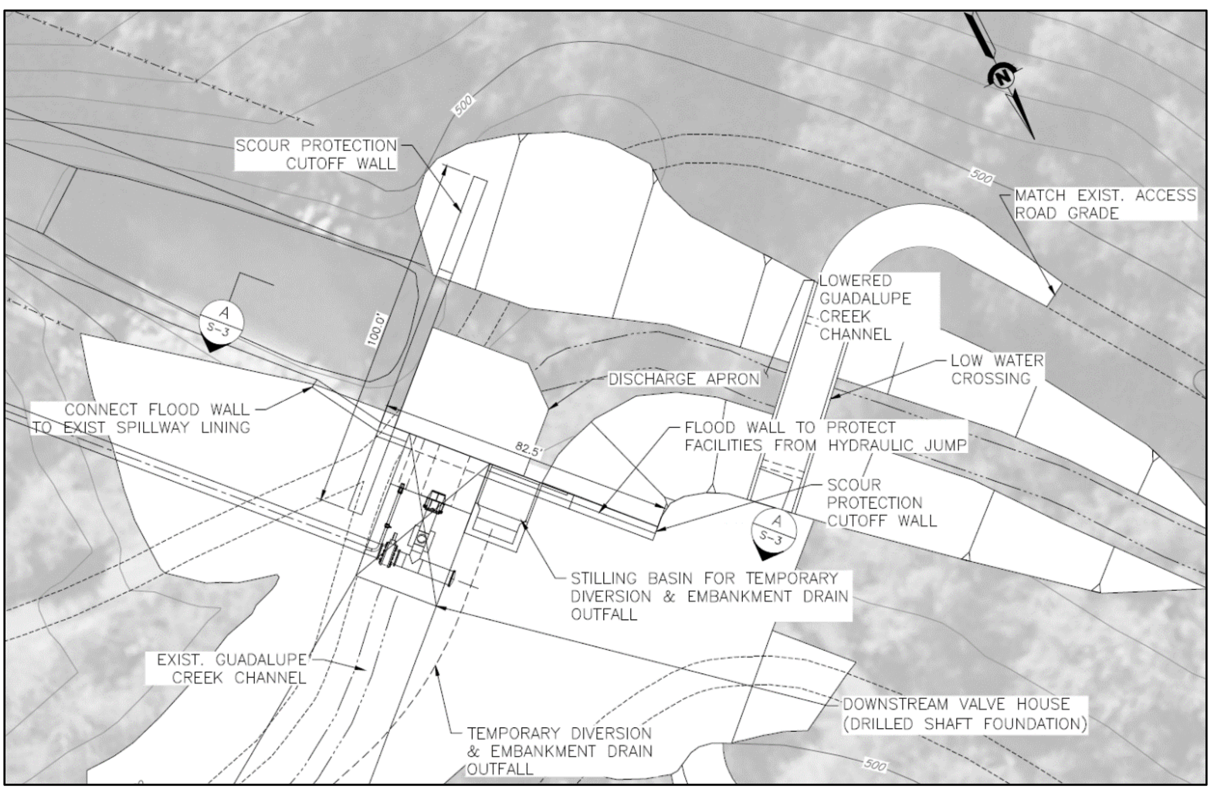
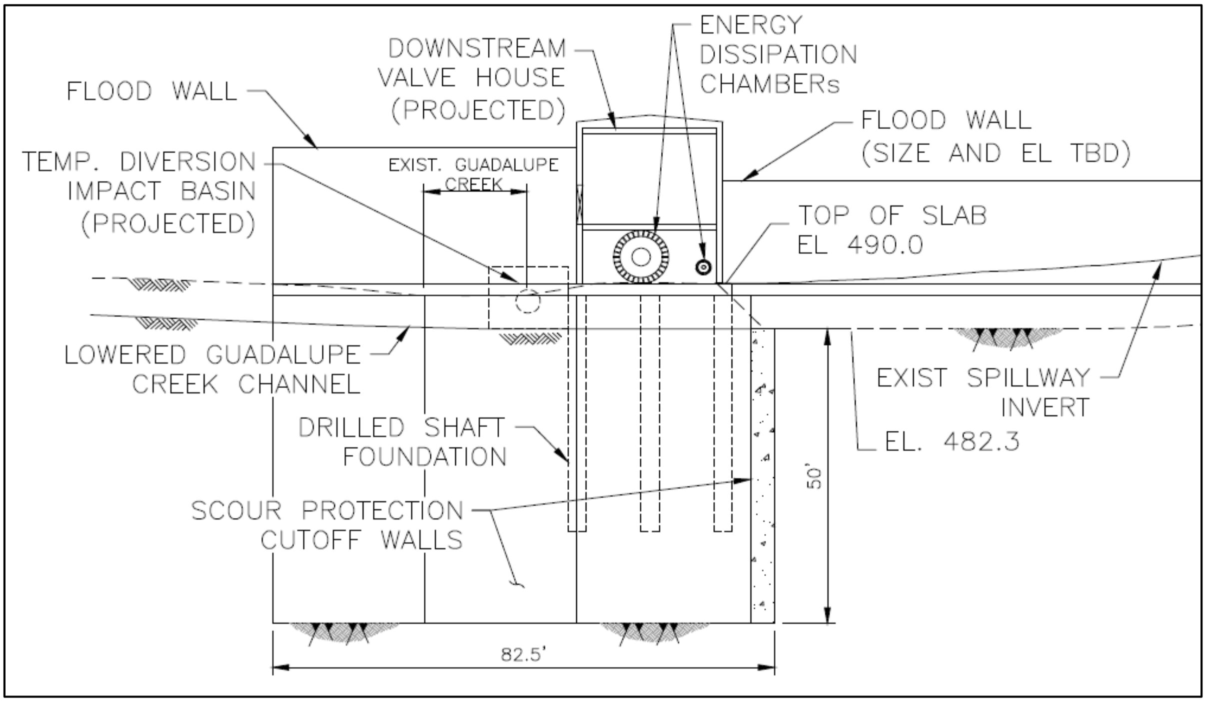


Figure 4-7 Section of Scour Protection Improvements at Spillway Stilling Basin

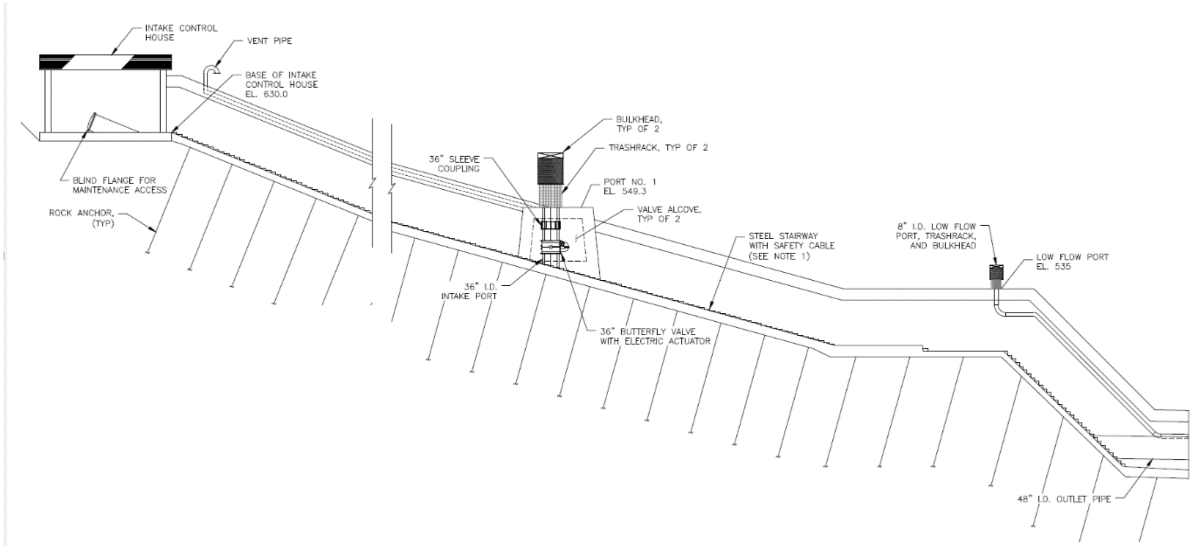


4.5 Outlet Works Design for Operations and Emergency Drawdown

The Staff-Recommended Alternative includes a new outlet works constructed through the left abutment consisting of a sloping intake structure, new main and low-flow outlet conduits constructed in a tunnel, and a downstream valve house for control and energy dissipation of releases to Guadalupe Creek at the spillway stilling pool. The reservoir intake structure would be relocated outside the upstream dam berm to prevent potential upstream slope deformations from damaging the outlet works during a large seismic event. **Figure 4-8** shows a profile view along the new sloping intake along the left abutment. **Figure 4-9** shows a cross-section view of the new tunneled outlet conduits, including the 8-inch low flow conduit and 48-inch discharge pipe.

Geotechnical investigations during final design would be necessary to confirm the location and alignment of the new outlet works access tunnel. In addition, the hillside stability in the vicinity of the sloping intake structure must also be confirmed during final design.

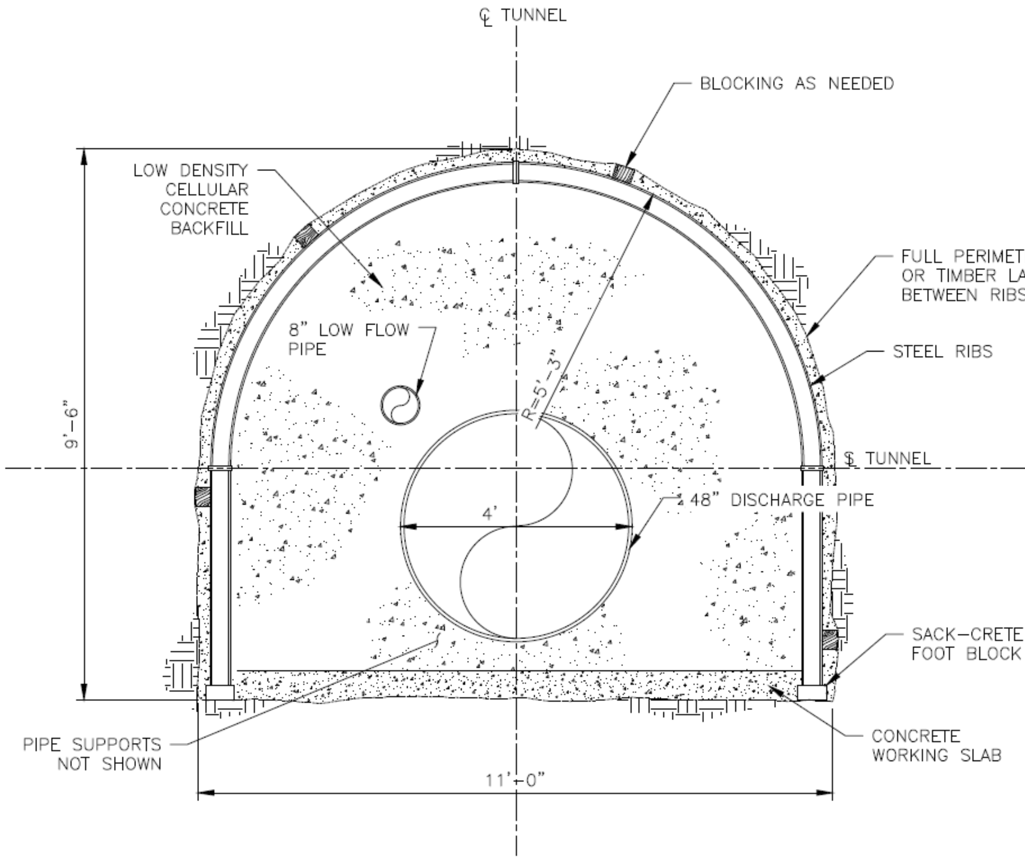
Figure 4-8: Profile of Sloping Intake Structure



An earthen cofferdam would be required to isolate the construction area for the sloping intake and left abutment tunnel. For planning purposes, it has been assumed that the cofferdam would be an earthfill structure with a sheet pile cutoff wall and crest elevation at El. 542 feet. It should be noted that this configuration assumes full reservoir drawdown with the existing outlet kept in a full-open condition for stream diversion. Even with full drawdown, winter storms could fill the reservoir above any reasonably sized cofferdam, so the cofferdam should have a gated pipe to allow controlled flooding of the cofferdam and intake work area prior to a major storm. A temporary bulkhead would also be installed in the upstream end of the new outlet tunnel prior to winter to prevent flooding of a partially completed outlet conduit. The preliminary construction schedule assumes that the site would be winterized each year due to potential expected inflows exceeding the capacity of any reasonably sized cofferdam and diversion system.

With the reservoir fully drained for construction, and the diversion system passing natural streamflow, there would be no way to maintain minimum stream flow releases downstream of the dam if upstream Guadalupe Creek dries up in the summer or fall. Because of this, it is expected that there would be an unavoidable environmental impact during construction from potential dry-season loss of minimum streamflow releases. Environmental studies and permitting must address permitting and mitigation requirements associated with this unavoidable environmental impact.

Figure 4-9: Tunneled Outlet Conduit Cross Section



4.6 Access Improvements

Existing access to the dam from Hicks Road via the downstream access road is difficult, relying either on a limited-capacity bridge over Guadalupe Creek, or a low-water crossing below the spillway for larger equipment. Both access routes would be unusable in significant spillway discharges. In addition, access to the dam crest is via a very steep (>15% grade) ramp up the downstream face of the dam that may not be trafficable during storm events. Access to the dam would be improved as part of the retrofit project as shown on **Figure 4-1**, and described below:

- A fabricated steel bridge would be installed over the spillway to provide all-weather access to the dam crest from Hicks Road, even during spillway discharges.
- Approximately 600 lineal-feet of Hicks Road would be realigned approximately 20-25 feet into the hillside opposite the left abutment of the dam. This is needed to facilitate construction and use of the crest access bridge, but it would also provide staging and parking area for dam construction work as well as future dam operations and maintenance.
- The limited-downstream capacity bridge would need to be replaced/supplemented with a higher-capacity culvert bridge or low-water crossing for construction and future operational use.

- A new wider, flatter graveled access road would be provided to the downstream release facilities, bench and dam crest, and additional parking would be available at the downstream release facilities and bench.

4.7 Earthwork and On-Site Borrow Evaluation

The Staff-Recommended Alternative would result in a retrofitted embankment volume of approximately 215,000 cubic yards (CY). Earthwork quantities associated with this alternative would include approximately 85,000 CY of material from the excavation of the existing embankment and foundation, 62,000 CY of imported filter and drain material, 76,000 CY of material reused from the embankment and foundation excavation, and approximately 77,000 CY of material from on-site borrow sources. The assumption is that about 85 to 90% of the embankment and foundation excavation would be reused as embankment fill (i.e. unsuitable material is about 10 to 15% of the excavation volume).

There are no on-site sources of suitable filter and drain materials available from on-site borrow areas; this material would need to be imported. Approximately 23,000 CY of spoil material would be generated from embankment foundation excavation and outlet tunneling operations that would require disposal in approved spoil areas.

A screening study of preferred borrow, spoils disposal, and stockpile sites (areas) was conducted during the planning study. The following is a summary of the studies and selected sites.

- Based on field and laboratory data, Borrow Areas B-2 and B-1 (shown in Figure 4-1) appear to have suitable buttress materials for the Staff-Recommended Alternative. The Franciscan rock materials in Borrow Area B-2 (mélange with block and matrix materials, and silicified mudstone) could be ripped and processed and would meet the strength requirements for buttress fill. However, there is a large degree of variability in block sizes, strength, and hardness in the Franciscan materials that would require further field investigation and evaluation during final design.
- Borrow Area B-2 meets the volumetric yield requirements for embankment fill that would be required for the Staff-Recommended Alternative buttress configuration. Borrow Area B-1 could provide supplemental material if needed.
- Borrow Areas B-2 and B-1 are along the margins of Guadalupe Reservoir and within close proximity to the dam site, allowing for development of reasonable ingress and egress haul routes over the top of the dam and to the downstream placement area.
- Borrow Area B-1, however, could not be used if the outlet works needs to be constructed on the right dam abutment as it would interfere with the location of the replacement intake structure.
- Because of the constrained site, there are limited sites for spoil disposal and temporary stockpiling of materials. Temporary Stockpile Site SS-2 and Spoil Disposal Site SD-1, both located on the right side of the valley downstream of the dam, would be fully utilized for construction. Material disposal in excess of the capacity of SD-1 would need to be disposed of in reservoir bottom or borrow areas below the elevation of the intake, or hauled offsite.

- Temporary Stockpile Site SS-1, located on the upstream berm, could be used for staging or limited temporary stockpiling of small quantities of materials; large stockpiles would have to be avoided to prevent destabilizing the upstream berm.

4.8 Right of Way Needs

Construction work is anticipated to extend outside District property limits in some areas. **Figure 4-1** illustrates the areas identified for temporary and/or permanent land acquisition to complete the Staff-Recommended Alternative. Also delineated are areas identified for borrow, temporary stockpile and staging, as well as permanent spoils disposal sites, potential haul routes, and key temporary facilities such as an earth cofferdam.

For planning purposes, it has been estimated that approximately 17 acres of permanent land acquisition would be required to complete the retrofit project. This estimate includes approximately 0.5 acre of permanent land acquisition for the realignment of Hicks Road on the left abutment, with the remaining 16.5 acres consisting of acquisition on the right side of the reservoir and valley below the left abutment for borrow, stockpile and disposal areas and associated haul routes. There should be early discussions between the District and Santa Clara County Parks to determine preference for permanent acquisition versus temporary easement. Right of way acquisition costs were excluded from the project cost estimates for the Staff-Recommended Alternative but would need to be included in the final design.

4.9 Environmental Impacts

Environmental impacts will be assessed in future studies and covered under the California Environmental Quality Act (CEQA). The District would serve as lead agency for CEQA compliance and the project would be evaluated in an Environmental Impact Report (EIR). The EIR would address the environmental impact of the Staff-Recommended-Alternative. A key feature of the CEQA process is the opportunity for the public to review and provide input on the project.

Environmental studies and permitting to support the CEQA process will take place concurrently with final design. Key environmental impacts to be considered during the process include, but are not limited to, protection of cultural resources, protection of biological resources, mitigation of hazardous materials, and protection of recreational usage. The CEQA process would also incorporate proactive community outreach to manage public expectations regarding changes in recreational uses as well as temporary impacts such as traffic, dust, and noise during the dam retrofit project construction.

4.10 Environmental Mitigation

Compliance with the Federal and State Endangered Species Acts would be conducted through the 2013 Santa Clara Valley Habitat Plan (VHP) process. The United States Fish and Wildlife Service and California Department of Fish and Wildlife have ceded regulatory authority under these laws to the VHP Implementing Agency in the expectation that the VHP will both simplify and shorten the regulatory process and provide for improved resource protection. The VHP covers the “take” of 18 federal and state listed species, and imposes a fee menu for mitigation of impacts to those species and to sensitive natural communities. The VHP provides coverage for special-status wildlife and plants impacted by dam seismic retrofit projects, including the Calero and Guadalupe Dams Seismic Retrofits Project. The VHP also provides coverage for borrow sites and reservoir dewatering associated with project construction.

4.11 Public Outreach

The results of the planning study will be disseminated into the community through the Calero and Guadalupe Dams Seismic Retrofits Project Community Engagement Action Plan. This living document has been created and maintained by the District, and included plans to inform the community through various media including a web-page, public meetings, mailers, and display materials at community venues. Efforts to inform the public are ongoing and expected to continue through project completion.

4.12 Design and Permitting Issues

In preparation of the Planning Study Report, the configuration, schedule, and cost estimate for the Staff-Recommended Alternative have been refined to approximately the 15-20% level of design development. The Staff-Recommended Alternative is provided in the Preliminary Design Drawings included in **Appendix D**.

During the alternatives evaluation, several project components have been identified as either: a) areas for future design refinement, or b) additional project improvements that may be included as part of the project, but are not covered in the currently defined project requirements:

1) Borrow Material – The engineering properties and compaction requirements for borrow from the identified site(s) must be confirmed during final design with additional geotechnical investigation and laboratory testing. The extent of borrow development, quantities necessary to complete the retrofit, and construction considerations (i.e. rippability, material processing requirements, etc.) of selected borrow sources must also be further developed and confirmed during final design and permitting.
2) Freeboard & Spillway Crest Length Refinement – The spillway crest extension of 104 feet may be able to be decreased by approximately 50 feet by reducing the residual flood freeboard of 4.1 feet (2.6 feet waves plus 1.5 feet DSOD minimum) to 2.6 feet assuming the 10 feet of total freeboard is maintained above the spillway crest elevation and spillway hydraulics are acceptable to DSOD. Based on recent feedback in a meeting on May 14, 2015, DSOD indicated they would be receptive to such refinement provided the total freeboard over the spillway crest was at least 10 feet, and the side-channel hydraulics were acceptable.
3) Spillway Hydraulics – Final design should include detailed hydraulic analysis of the lengthened side channel spillway crest and downstream chute/stilling basin to confirm acceptable performance.
4) Slope Deformations Analysis – Final design should include seismic deformation analysis of the remediated embankment section (with downstream buttress and parapet replacement) to confirm that embankment deformations do not exceed an acceptable amount. This includes both downstream deformations, and deformation

of the upstream slope and upstream berm. If the District decides to include mitigation of upstream deformations as an additional project requirement, such mitigation would also need to be evaluated.

5) Confirmation of Outlet Tunnel Location on Left Abutment – Final design geotechnical investigations are needed to confirm the feasibility/alignment of a tunneled outlet on the left abutment. If infeasible, then the outlet works would be moved to the right abutment with the preliminary right abutment alignment, considered in the several feasible alternatives, also subject to confirmation based on further geotechnical investigations.

6) Left Abutment Access – Early in final design, the District should coordinate with County Roads to confirm of requirements/layout for relocation of Hicks Road at the left abutment to provide improved access to the left abutment intake structure and a bridge over the spillway to the dam crest. Final design should also include refined layout of access road improvements to the downstream release structure adjacent to the spillway stilling basin, including replacement of the existing access bridge over Guadalupe Creek.

7) Permitting/Mitigation Requirements for Unavoidable Temporary Downstream Impacts – Final design and environmental studies should develop a reservoir dewatering plan and stream diversion plan, estimation of likely native stream flows with the reservoir temporarily out of service, and coordination with agencies to confirm permitting and mitigation requirements for the unavoidable potential dry-season loss of minimum stream flow.

5.0 Construction Costs and Schedule

5.1 Preliminary Construction Cost Estimates

A comparative (construction) cost for the Staff-Recommended Alternative has been estimated at approximately $56.7 million in 2015 dollars (2nd quarter 2015). The comparative cost estimate was generated in accordance with guidelines established by the Association for Advancement of Cost Engineering (AACE) as a Class 3 estimate which is assumed to include the actual installed cost within the range of -20 to +30 percent. Assumptions made in developing the construction costs included a 15% cost for unlisted items and a 20% Class 3 contingency. **Table 5-1** summarizes the estimated construction costs.

Table 5-1: Estimated Guadalupe Seismic Retrofit Construction Costs

Project Element	Amount
Main Dam Seismic Retrofit	$11,100,000
Spillway Improvements for PMF	$2,900,000
Outlet Works Replacement and Abandonment of Existing Outlet Conduit	$9,500,000
Other Site Work	$5,200,000
Miscellaneous Uncosted Items @ 15%	$4,300,000
General Conditions, Bonds & Insurance	$4,900,000
Direct Construction Subtotal (DCS)	**$37,800,000**
Class 3 Contingency (20%)	$7,600,000
Estimated Construction Cost	**$45,400,000**
Design Engineering and CM Allowance (25% of DCS + Contingency)	$11,300,000
Total Estimate (2015 dollars)	**$56,700,000**

It should be recognized that this is not the overall estimated project cost. Costs for right of way acquisition, replacement water supply, District administration and legal fees, planning and environmental studies and permitting, and habitat restoration/mitigation costs, are not included in the $56,700,000 estimate.

Assuming the midpoint of construction would be in 2020, estimated escalation from 2015 would be $5,500,000 yielding a projected project construction cost of $62,200,000 in 2020 dollars.

5.2 Construction Schedule

Based on preliminary schedule estimates, and assuming the reservoir is fully drained for construction, the seismic and other retrofit improvements at Guadalupe Dam could be constructed over approximately 32 to 36 months. Assuming construction begins in March 2019 as forecast by the District, construction would be completed by late 2021.

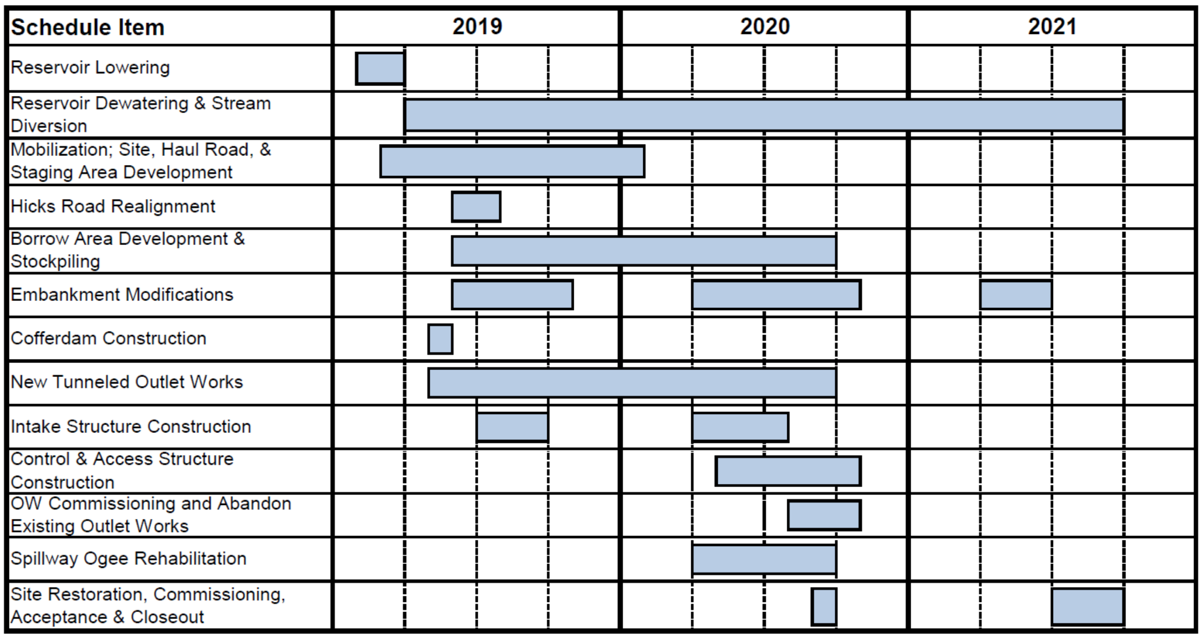
In general, construction of the Staff-Recommended Alternative would span at least two full construction seasons, with some work over the intervening winters, plus most of a third construction season. Key sequence assumptions made in preparing the construction schedule for the Staff-Recommended Alternative are as follows:

- As indicated by the District, the construction contract notice to proceed (NTP) would be issued by March 1, 2019 to allow a full construction season starting in April 2019.
- Reservoir lowering by the District would occur in March-April 2019, allowing access for the temporary cofferdam for sloping intake construction to occur by the end of May 2019.
- Hicks Road would be realigned from May through July 2019 to facilitate construction staging and access for work on the spillway and outlet works.
- The existing outlet would be converted to a temporary diversion conduit early in 2019 by partially demolishing the existing downstream valve house and extending the existing outlet conduit to a downstream stilling basin; this system would be used to pass Guadalupe Creek flows until the new outlet works is substantially complete in September 2020.
- Dam retrofit work would occur over three construction seasons from May 2019 through July 2021, and with a shutdown of major earthwork during the two intervening rainy seasons. Dam demolition and earthwork preparations would occur from May through October 2019, major dam/foundation excavation and buttress construction would be performed from April through October 2020, with concrete panel and crest finishing and geotechnical instrumentation deferred to the 2021 construction season.
- The new outlet works would be constructed continuously from May 2019 through September 2020, allowing partial refill of the reservoir and restoration of minimum downstream flows with work occurring over the intervening winter, and completion required before abandoning the existing outlet works.
- The existing outlet works would be abandoned in October 2020 after the new outlet works is substantially complete, and could be used for stream diversion the second winter rainy season.
- The spillway improvements would be constructed from April through September 2020.
- Final dam construction finishing, geotechnical instrumentation and other site restoration work would occur in summer 2021 after substantial project completion.

This schedule would allow refilling of Guadalupe Reservoir beginning in September 2021 after substantial completion of the overall project. It may, however, be possible to begin a partial refilling in late 2020 after completion of the outlet works and major dam earthwork, subject to the approval of DSOD.

The generalized schedule discussed above is also presented graphically in **Figure 5-1**.

Figure 5-1: Preliminary Construction Schedule for the Staff-Recommended Alternative



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Appendix A

Table A-1: Guadalupe Dam Pertinent Data (Modified from Guadalupe Dam Supporting Technical Information Document (STID), Appendix D, Pertinent Data Table; Geosyntec, 2012b)

A. General	
Location	Santa Clara County, 9.5 miles south of downtown San Jose
Dam No.	CA 72-005, National ID. No. CA00290
Latitude/Longitude	37°11'57.01"N, 121°52'45.43"W
Stream/River	Guadalupe Creek
Project Function	Storage for conservation, groundwater recharge, flood control, environmental flows, and recreation.
Datum	District has converted to NAVD 1988 which is 2.28 feet higher than NGVD 1929 at this location.
Drainage Area	5.9 sq. miles
Reservoir Capacity	3,415 ac-ft (note 1)
Reservoir Area	79 acres at NHWL El. 618.3 ft (El. 616 ft NGVD29)
Dam Type	Compacted earthfill with concrete face and upstream berm
Height	129 ft [142 ft DSOD bulletin 17] (note 2)
Dam Crest Length/Width	650 ft long, 20 ft wide
Dam Crest Elev.	Design El. 629.3 ft (El. 627 ft NGVD29) top of parapet (note 3)
Spillway Crest Elev.	El. 619.3 (El. 617 NGVD29)
Reservoir Elev.	El. 618.3 (El. 616 NGVD29) (NHWL DSOD certificate); Restricted to El. 612.1 ft (El. 609.8 NGVD29), 4/1 to 2/15; El. 609.8 ft (El. 607.5 ft NGVD29) 2/16 through 3/31. As of October 13, 2011, restriction was changed to El. 601 ft (El. 598.7 NGVD29)
Outlet Type/Capacity	Low-level outlet: • Capacity 235 cfs (SCVWD 2005) • 72-inch RCP inlet riser and 36-inch diameter welded steel pipe encased in concrete; 720 ft long conduit • 42-inch diameter hydraulically actuated upstream slide gate; 30-inch downstream butterfly valve

Table 2-1. Guadalupe Dam Pertinent Data (continued)

Slopes	Upstream: • 2.5 H:1 V crest to El. 572.3 ft (El. 570 ft NGVD29) • 5 H:1 V below El. 572.3 ft (El 570 ft NGVD29) Downstream: • 2.5 H:1 V
Hazard Classification	DSOD Total Class Weight 32
Original Construction	Completed in 1936
Modifications	1948: Intake/Outlet modifications 1972: Stabilizing berm constructed on the upstream face below El. 572.3 ft (El. 570 ft NGVD29); slope of 5 H:1 V 1972: Parapet wall constructed 1972: Outlet modifications 1977: Outlet modifications 1987: Outlet modifications 2006/07: 23 vibrating wire piezometers and 2 inclinometers installed 2010: 4 vibrating wire piezometers installed

Notes:
1) From SCVWD website.
2) From SCVWD 2005. DSOD Bulletin 17 lists the dam height as 142 ft.
3) From DSOD Bulletin 17, DSOD 1982, and as-built drawings. In 1972, a parapet was constructed to restore about 2.5 ft of freeboard lost to "normal embankment settlement".

Appendix B

Guadalupe Dam Seismic Retrofit Project Requirements

PROJECT # 91084020 - CALERO AND GUADALUPE DAMS SEISMIC RETROFIT PROJECT - GUADALUPE DAM

District Project Manager: Bal Ganjoo

Planning Consultant: GEI Inc.

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			Planning	Design					
GENERAL PROJECT REQUIREMENTS									
1	All facilities associated with the Project, outlet works, spillway, and their appurtenances shall have a useful life of at least 50 years without requiring major repairs.	Project Requirements Workshop (Internal) on 9/11/13	X	X	A specific life line standard is not referenced. However, it is common engineering and planning practice to assume major infrastructure will remain in service 100-years or more. Specific materials and designs of specific major components (ie outlet pipes) should be designed to remain in service for at least 50 - years without major rehabilitation or replacement. Pertinent USACE design manuals and other industry standards are recommended for estimating major feature service life. Refer to USACE ER 1110-2-8159 for typical major infrastructure design life requirements.				
2	Comply with all DSOD safety requirements/guidelines, and use engineering judgment consistent with the state-of-the-practice.	Project Requirements Workshop (Internal) on 9/11/13	X	X					
3	Construction of the Project shall be substantially complete by June 2019.	Project Requirements Workshop (Internal) on 9/11/13	X	X	DSOD letter dated 3/23/2012				
4	Seismic Performance. The project shall be designed such that after MCE loading, the project will not suffer catastrophic failure (such as breach of the dam) and all features necessary to ensure dam safety will remain operational (such as the ability to quickly lower the reservoir).	Project Requirements Workshop (Internal) on 9/11/13	X	X	Seismic performance for ancillary facilities, access roads, and instrumentation and controls systems will be addressed as part of design. Consideration will be given to distinguishing performance for both an operating basis earthquake (OBE) and the MCE.				
5	The District has the following post-MCE service level requirements that shall be incorporated to the extent practical within the retrofit project area (a) Ancillary structures housing valves or other mechanical/electrical equipment shall not fail during the Maximum Credible Earthquake (MCE) and any resulting structural damage shall not prohibit access for inspection and/or operation of mechanical and electrical systems, (b) Access roads to the dam embankment and appurtenances shall remain accessible by standard passenger vehicles for inspection and readily repairable by dozer or grader to facilitate repairs following the MCE, (c) instrumentation and surveillance monitoring equipment for the dam embankment and appurtenances shall remain operational immediately following the MCE, including communication links to District headquarters, and (d) Power and SCADA controls required to operate the intake, outlet works, spillway gates (if applicable), and other appurtenances shall not be disrupted following the maximum credible earthquake.	Project Requirements Discussion February 18, 2014	X	X	There are portions of this requirement they may not be possible to guarantee. The planners and designers should identify specific issues, as they are encountered to agree upon a path forward.				

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6	An independent source of back-up power should be incorporated into the Project, such as propane generators, UPS or other suitable.	Project Requirements Workshop (Internal) on 9/11/13		X	Provisions for back-up power to be addressed by the design consultant.				
7	For planning include cost estimates for replacement of all blockhouses. Design should include the evaluation and design of replacement blockhouses, as necessary.	Project Requirements Workshop (Internal) on 9/11/13	X	X					
8	Storage of boring log (geotechnical investigation) sample for geotechnical investigation; obtain District's warehouse's confirmation for approximately one year storage after construction is complete.	Project Requirements Workshop (Internal) on 9/11/13	X	X	Storage of samples from final design investigation only.				
TECHNICAL - EMBANKMENT									
1A	The embankment requirements for the project will require discussion and agreement with DSOD. Requirements noted below may require modification as the project continues.	Project Requirements discussion 2/18/14	X	X					
1	The dam embankment shall have sufficient freeboard to safely pass the PMF without overtopping, and to meet DSOD freeboard requirements.	PMC - per PC comments on previous revisions	X	X	It is not anticipated that parapet walls for freeboard will be accepted by DSOD				
2	Embankment shall have adequate stability, and any deformation post MCE shall not pose a dam safety risk and shall be readily repairable.	PMC - per PC comments on Revision 2	X	X					
3	Embankment seepage shall be safely controlled using filters, drains, cutoffs and/or other methods. USBR and/or other industry standards should be used in design.	PMC - per PC comments on Revision 2	X	X					
4	If borrow is required by the project alternative, designs should make use of on-site borrow sources, if possible and practical.	PMC - per PC comments on Revision 2	X	X					
TECHNICAL - OUTLET WORKS									

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1A	The outlet works requirements for the project will require discussion and agreement with DSOD. Requirements noted below may require modification as the project continues.	Project Requirements discussion 2.18.14	X	X					
1	The new outlet works shall meet the DSOD emergency drawdown criteria or 50% of the reservoir capacity in 7 days and full contents within 20 days.	Project Requirements Workshop (Internal) on 9/11/13	X	X					
2	The outlet works shall remain fully operable and accessible following the Maximum Credible Earthquake (MCE). For the outlet works damage to the existing conduit is acceptable only to the point where it does not compromise flow carrying capacity of the system commensurate with DSOD emergency drawdown criteria or normal operations that provide for flows to Guadalupe Creek. Further, the outlet works must remain accessible for repairs that allow the system to remain fully operational.	Project Requirements Workshop (Internal) on 9/11/13	X	X					
3	Any modifications to the intake structure shall consider sedimentation, and operations and maintenance, and temperature in selection of the intake port elevation(s). The FAHCE draft agreement proposes temperature requirements for stream releases. A multi port intake similar to Stevens creek should be reviewed for suitability at this project for providing temperature goal operating flexibility	Project Requirements Workshop (Internal) on 9/11/13	X	X	Verify with Jae Abel in regards to reservoir temperature requirements, if any. Design consultant will be responsible for refining intake elevations based on sedimentation, temperature, or other factors.				
4	If necessary, the existing outlet conduit, intake, and the outlet structures should be abandoned as per DSOD requirements	Project Requirements Workshop (Internal) on 9/11/13	X	X					
5	Evaluate the replacement of the hydraulic lines, such that they are not in contact with water.	Project Requirements Workshop (Internal) on 9/11/13		X					
6	Perform inspection of outlet pipe. This will assist in determining to construct a new outlet or to continue to use existing outlet and connect to new intake.	Project Requirements Workshop (Internal) on 9/11/13	X						
7	If a new outlet is planned, it is preferred by the district to be a carrier pipe in an oversized tunnel, to facilitate inspection and maintenance	Project Requirements Discussion 2/18/14	X	X					

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8	If new outlet tunnel option is selected, it shall be constructed in such a way as to minimize leakage into tunnel.	Project Requirements Workshop (Internal) on 9/11/13	X	X					
9	If new outlet tunnel option is selected, all lighting and emergency lighting should be water tight design and installed according to manufacturer specifications in order to ensure effective and long lasting performance.	Project Requirements Workshop (Internal) on 9/11/13		X					
10	If new outlet tunnel option is selected, it shall accommodate trench grates to efficiently eliminate any water that collects in the tunnel in order to avoid any slip hazards.	Project Requirements Workshop (Internal) on 9/11/13		X					
11	If new outlet tunnel option is selected, a paging system (such as Gaitronics or similar) shall be installed with necessary receivers/transmitters to effectively communicate.	Project Requirements Workshop (Internal) on 9/11/13		X					
12	NOT USED	M. DeVore, Internal Kickoff Meeting, 9/11/13	X	X	Combined with other requirements				
13	New intakes will require inspection gallery. Required by Dam Safety Unit.	M. Mooers, Internal Kickoff Meeting, 9/11/13	X	X					
14	Inlet must be removed from berm per DSOD.	B. Ganjoo, Internal Kickoff Meeting, 9/11/13	X	X					
15	If a new outlet works is selected, provide a separate low level system to maintain environmental flows in creek at all times.	PMC added based on H. Desai comments		X					
TECHNICAL - SPILLWAY									
1	The spillway shall be capable of safely routing past the downstream toe of the dam, storm flows in accordance with HMR 58/59 with adequate freeboard.	DSOD	X	X					
2	The spillway for the Project shall remain fully operable and accessible following the MCE.	Project Requirements Workshop (Internal) on 9/11/13	X	X					
3	Install screening at weep holes in spillway to keep amphibians and other animals from nesting there.	T. Neudorf, Internal Kickoff Meeting, 9/11/13		X					

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4	Spillway modifications are required at spillway plunge pool. Access Road modifications, outlet to stream, and other modifications are likely to be required	M. Mooers, Internal Kickoff Meeting, 9/11/13	X	X					
5	If other items, such as vegetation overgrowth or materials from road washout affect stilling basin, these will need to be resolved during spillway modifications.	M. Mooers, Internal Kickoff Meeting, 9/11/13	X	X					
6	NOT USED								
7	Spillway modifications need to consider environmental and wetlands impacts	PMC added based on PC comments on revision 2	X	X					
8	Safety harness attachment points should be installed along the spillway walls	H. Desai, Comments on Rev 2		X					
MAINTENANCE									
1	Guard valves shall be provided upstream of the main control valves to facilitate ease of maintenance and inspection of the outlet pipe(s).	Project Requirements Workshop (Internal) on 9/11/13	X	X					
2	Outlet works shall be configured such that the intake and outlet pipe(s) can be inspected without lowering or dewatering the reservoir.	Project Requirements Workshop (Internal) on 9/11/13	X	X	The District maintains it's requirement that to the extent practical the intake and outlet conduits required for stream releases, emergency drawdown, and distribution of water be "housed" such that they can be visually inspected and maintained by District staff. The Planning Consultant is advised to refer to the intake and outlet works at Austrian Dam (Lake Elsman) or San Antonio Reservoir for examples of where man access has been provided for inspection and maintenance.				
3	NOT USED								
4	Main control valves and structure should be easy to access, inspect, and maintain. Meaning special equipment or training should not be needed for maintenance of valves.	Project Requirements Workshop (Internal) on 9/11/13	X	X					

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			Planning	Design					
5	Use of low maintenance valves such as stainless steel cone valves.	Project Requirements Workshop (Internal) on 9/11/13		X					
6	Intake structure sloped (as opposed to vertical)so that it can be inspected by walking through it.	Project Requirements Workshop (Internal) on 9/11/13	X	X	If sloping intake is difficult due to topography and or geology the consultant should discuss with district on suitable approach.				
7	Use of standard off the shelf (available/reliable) parts to the extent possible. Parts should be relatively common, such that special manufacturing and long lead ordering would not be required for replacement parts.	Project Requirements Workshop (Internal) on 9/11/13		X	Do not use butterfly valves, too many issues with capitation, vibration, noise, and requires long dissipation. Prefer using smaller sized valves.				
8	Ability to replace oil during preventative maintenance without lowering the reservoir (if oil is used).	Project Requirements Workshop (Internal) on 9/11/13		X					
9	Horizontal cylinders or lockout valves on underwater gates and valves.	Project Requirements Workshop (Internal) on 9/11/13		X					
10	Use of non-hazardous hydraulic fluid (no oil) for hydraulic systems for the upstream valves and gates.	Project Requirements Workshop (Internal) on 9/11/13		X					
11	Ability to isolate hydraulic pumps and connect backups. Hydraulic piping should have a minimum of connections.	Project Requirements Workshop (Internal) on 9/11/13		X					
12	Stainless steel shall be used to prevent corrosion of metallic parts. Metal parts are likely to include valves, hydraulic lines, and other associated parts..	Project Requirements Workshop (Internal) on 9/11/13		X	Trash racks and other large metallic parts are not part of this requirement				
13	Metallic components shall have adequate corrosion protections. Cathodic protection should be utilized as required.	Project Requirements Workshop (Internal) on 9/11/13		X					

OPERATIONS

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			Planning	Design					
1	All upstream valves and gates should have position, as well as full-range indicators.	Project Requirements Workshop (Internal) on 9/11/13		X					
2	Valves associated with the outlet works shall be sized specific to their function (do not want one size fits all). Need to be able to control releases to within 20% or so many cfs. 1. Dam, Low Flow: 0 - 5 cfs 2. Dam, Mid Flow: 0 - 200 cfs. If higher releases are required for DSOD emergency release a full port valve may be acceptable	J. Sparkman, Project Requirements Workshop (Internal) on 9/11/13	X	X	Design Consultant to clarify requirement based on discussion with valve expert.				
3	Valve / Gate Operations - Communication: Telephone communication (for communication w/ RWTP and for Dam Safety) - All valves should have a position indicator locally and remote (SCADA, etc.)	Project Requirements Workshop (Internal) on 9/11/13		X					
4	Security & Monitoring -Dam vaults/control structures will secured with District provided security locks. -PTZ w/ infrared CC cameras to monitor dam infrastructure.	Project Requirements Workshop (Internal) on 9/11/13		X					
5	Any large valves/gates that will not be automated will require manual operation shall incorporate means of attaching a portable electric motorized device for operation.	Project Requirements Workshop (Internal) on 9/11/13		X					
6	Valves to be electrically operated, and suitable for continuous operation. Motors to be rated for continuous duty.	E-mail received from Jerry Alexander (Control Systems) 9/11/13.		X					
7	The discharge valves should match the existing valve timing or at least have not less than 15 minutes for full stroke operation. For larger flow potential situations a full stroke duration should be 30 minutes.	E-mail received from Jerry Alexander (Control Systems) 9/11/13.		X					
8	Valves to have the following remote control interface signals: Position status, Position indication, and OPEN / CLOSE command signals (see Jerry Alexander's 9/11/13 e-mail for further circuit details).	E-mail received from Jerry Alexander (Control Systems) 9/11/13.		X					
9	Local manual operators and lights (to be used if remote controls are not available or not functioning properly)	E-mail received from Jerry Alexander (Control Systems) 9/11/13.		X					

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10	Unit 545 electrical, I&C and SCADA personnel should review the valve and actuator submittals prior to installation.	E-mail received from Jerry Alexander (Control Systems) 9/11/13.		X					
CONSTRUCTION									
1	Reservoir levels during construction shall not exceed operating restrictions based on agreement with the DSOD. Other construction considerations are likely to further restrict levels	Project Requirements Workshop (Internal) on 9/11/13	X	X	Storage during construction will be required to meet flow requirements to creek.				
2	The spillway and existing outlet works shall remain operable and serviceable such that winter flows can be passed in any given year that construction requires these systems to be taken off-line. Further, construction shall be scheduled such that the spillway and outlet works are off-line for no more than one construction season.	Project Requirements Workshop (Internal) on 9/11/13	X	X					
3	If the reservoir is lowered to facilitate construction, this work shall be carefully coordinated with District Operations. Further, a Plan should be developed that, to the maximum extent possible, beneficially uses stored reservoir water that needs to be discharged to facilitate lowering of the water surface elevation, including diversions for water supply or water storage.	Project Requirements Workshop (Internal) on 9/11/13	X	X	Any release requirements will need to be met with onsite storage. Dewatering level assumptions should plan for meeting minimum releases during the construction period.				
4	During a reservoir drawdown the downstream well needs shall be considered in maintain downstream flows. 1 cfs will be required.	J. Sparkman / T. Neudorf, Project Requirements Workshop (Internal) on 9/11/13	X	X	The reservoir is not operated for temperature per discussion with J. Sparkman. Terry indicated matching temperatures is goal, but may not be possible during construction and associated impacts would require evaluation.				

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5	Evaluate power requirements as part of the planned 2 year design period and procure appropriate upgrades to power at site prior to award of a construction contract.	Project Requirements Workshop (Internal) on 9/11/13		X					
6	If the reservoir is lowered to facilitate construction, the drawdown plan must meet requirements of HCP. Maximum summer releases are 10 cfs (dry season, May 1 - Oct 31) and 235 cfs (wet season, Nov. 1- April 31). A minimum of 1 cfs is required at all times. Dewatering coordination between all 3 (Almaden/Calero/Guadalupe) projects will need to take place.	T. Neudorf, Project Requirements Workshop (Internal) on 9/11/13	X	X	Planning Consultant instructed to base evaluations on requirements for flow released indicated in the SCVHCP.				
7	If the reservoir is lowered to facilitate construction, the reservoir dewatering plan shall be included as part of the project CEQA review.	Project Requirements Workshop (Internal) on 9/11/13	X	X					
8	Mercury Diffuser System will need to be protected during construction.	Project Requirements Workshop (Internal) on 9/11/13		X					
9	Access to control points to be maintained throughout construction	M. Devore, Project Requirements Workshop (Internal) on 9/11/13	X	X	This requirement is intended to indicate that access to all dam operating controls should be maintained during construction.				
10	Need to evaluate power needs and ensure adequate power is installed to dam and valve yard.	M. Devore, Project Requirements Workshop (Internal) on 9/11/13	X	X					

INSTRUMENTATION

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1	Install new/improved instrumentation at dam. Planning shall consider conceptual instrumentation plans in cost estimating and transitioning to design phase of project.	James Nelson, Project Requirements Workshop (Internal) on 9/11/13	X	X					
2	Instrumentation shall be designed and installed at the dam to measure seepage flows, seepage turbidtity,embankment pore pressures, foundation pore pressures, settlement, tunnel deformations and ground movement, and outlet flows and temperatures, and any other information needed to understand the dam performance and determine safety. Instruments should be compatible with District automation systems	PMC		X					
3	Turbidity meters will need to be installed at the seepage weir and as appropriate. Turbidity meter will need to be automated.	J. Nelson, Project Requirements Workshop (Internal) on 9/11/13		X	Design Consultant to clarify requirement based on discussion with turbidity meter expert. Jim Nelson to supply turbidity meter product data.				
4	Flow measuring devices shall be incorporated into the outlet works for the full range of flows.	Project Requirements Workshop (Internal) on 9/11/13		X					
5	Seepage collection system shall have automated weir data connection to ADAS.	J. Nelson, Project Requirements Workshop (Internal) on 9/11/13		X					
6	Critical instruments impacted during construction will need to be replaced or relocated and connected to ADAS and SCADA.	J. Nelson, Project Requirements Workshop (Internal) on 9/11/13		X					
7	Instrumentation shall include remote sensing and observation of the dam, such as robotic survey equipment and cameras.	Project Requirements Discussion 2.18.14		X					
8	Critical survey monuments and benchmarks impacted during construction will need to be replaced or relocated .	J. Nelson, Project Requirements Workshop (Internal) on 9/11/13		X					

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ENVIRONMENTAL									
1	If the reservoir is lowered to facilitate construction, flow measurements shall be taken within 100-feet of reservoir drawdown discharge point.	T. Neudorf, Project Requirements Workshop (Internal) on 9/11/13		X					
2	Determine baseline turbidity prior to construction and implementation of Turbidity Monitoring Plan, during construction.	Project Requirements Workshop (Internal) on 9/11/13		X					
3	Implement the Conservation Strategies outlined within the SCVHCP/NCCP as it relates to the California tiger salamander	SCVHCP		X					
4	Implement the Conservation Strategies outlined within the SCVHCP/NCCP as it relates to the California red-legged frog	SCVHCP		X					
5	Impact assessment and implement mitigations to reduce impacts to Steelhead downstream of the reservoir.	Project Requirements Workshop (Internal) on 9/11/13		X					
6	Pre-construction Surveys & Mitigation Strategies developed for various species not covered by the Santa Clara Valley HCP/NCCP: - San Francisco dusky footed wood rat - Migratory birds - Raptor Nests - Special status vegetation	T. Neudorf, Project Requirements Workshop (Internal) on 9/11/13		X					
8	Evaluate need for Archaeological & Paleontological Monitoring during Construction.	Project Requirements Workshop (Internal) on 9/11/13		X					

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9	Geotechnical explorations will require proper environmental clearance which may indicate work is categorically exempt from CEQA or may require mitigation to support a negative declaration. Seasonal restrictions of work may apply, depending on the environmental concerns associated with specific exploration locations.	T. Neudorf, Project Requirements Workshop (Internal) on 9/11/13	X	X					
10	The discharge piping shall have a port, to allow future injection of muscle eradication/containment chemicals.	Per discussion with Mike Devore 2/20/14		X					
Permit Condition									
1	Obtain Categorical Exemption for Design Phase geotechnical investigations (Seepage/Outlet Works/Spillway)	Project Requirements Workshop (Internal) on 9/11/13		X	Design Consultant to prepare.				
2	Provide notice & obtain permits if necessary from California Department of Fish and Wildlife, USACE & RWQCB for Design Phase geotechnical investigations within the reservoir.	Project Requirements Workshop (Internal) on 9/11/13		X	Design Consultant to prepare.				
3	Obtain mitigated neg-dec for design phase geotechnical investigations as needed	Project Requirements Workshop (Internal) on 9/11/13		X	Design Consultant to prepare.				
4	Obtain USACE Verified Wetland Delineation	Project Requirements Workshop (Internal) on 9/11/13		X	Planning Consultant to prepare.				
5	Biological Assessment for Project including dewatering if proposed	Project Requirements Workshop (Internal) on 9/11/13		X	Planning Consultant to prepare.				
6	Obtain USACE Individual Permit for Construction (Section 404 of the Clean Water Act)	Project Requirements Workshop (Internal) on 9/11/13		X	Planning Consultant to prepare.				
7	Obtain/Demonstrate USACE National Historic Preservation Act Section 106 Compliance	Project Requirements Workshop (Internal) on 9/11/13		X	Planning Consultant to prepare.				

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8	Obtain USFWS ESA Coverage via SCVHCP	Project Requirements Workshop (Internal) on 9/11/13		X	Planning Consultant to prepare.				
9	Obtain NMFS ESA Section 7 Permit, will require Biological Opinion for Central California Coast Steelhead and critical Habitat	Project Requirements Workshop (Internal) on 9/11/13		X	Planning Consultant to prepare.				
10	Obtain RWQCB 401 Water Quality Certification for project	Project Requirements Workshop (Internal) on 9/11/13		X	Planning Consultant to prepare.				
11	Obtain California Department of Fish & Wildlife 1602 Permit	Project Requirements Workshop (Internal) on 9/11/13		X	Planning Consultant to prepare.				
12	Obtain DSOD Permit & Approvals (pre-construction approval of plans & specifications)	Project Requirements Workshop (Internal) on 9/11/13		X	Design/District to Prepare				
13	State of California Dept. of Industrial Relations - Divisions of Occupational Safety and Health - Mining and Tunneling Unit Permit required; Underground Classification with respect to the quantities of flammable gas or vapors.	Project Requirements Workshop (Internal) on 9/11/13		X	Design/District to Prepare				
14	Santa Clara County Grading Permit	Project Requirements Workshop (Internal) on 9/11/13		X	Designers/District				
15	Santa Clara County Tree Removal Permit	Project Requirements Workshop (Internal) on 9/11/13		X	Planning Consultant to prepare.				
16	Santa Clara County Design Review for visual impacts	Project Requirements Workshop (Internal) on 9/11/13		X	Design/District to Prepare				
17	Obtain Encroachment Permits	Project Requirements Workshop (Internal) on 9/11/13		X	Design/District to prepare				
18	Obtain Bay Area Air Quality Management District Permits/Approvals for: - Generators larger than 50hp; - Compliance with Asbestos ATCM (CA Code Title 17, Sec. 93105)	Project Requirements Workshop (Internal) on 9/11/13		X	Planning Consultant to prepare.				
19	Obtain peizometer well permits	J. Nelson, Project Requirements Workshop (Internal) on 9/11/13		X	Design/District to Prepare				

Appendix C

Guadalupe Dam Cost-Benefit Assessment

URS

Date: February 17, 2015

To: Bal Ganjoo, SCVWD

CC: Bill Martin, URS; Bill Rettberg, GEI; Joe Green-Heffern, GEI

From: Nik Carlson, URS

Subject: ***Guadalupe Dam Cost-Benefit Assessment***

1.0 INTRODUCTION

Guadalupe Reservoir is one of the smaller capacity reservoirs in the SCVWD system. The District seeks to determine if the anticipated expenditure for a seismic retrofit would potentially be worth the realized benefits. Alternatives for analysis include the seismic retrofit, modification of the spillway and partial or full dam removal alternatives. This memorandum provides a preliminary Cost-Benefit Assessment (CBA) of the proposed Guadalupe Dam alternatives to assist SCWVD in its planning and decision-making retrofit or possible removal of the Dam.

The CBA findings are intended to provide the District with a systematic estimate and comparison of the various alternatives' costs and various benefits. The CBA estimates the expected Net Present Value and its Cost Benefit Ratio (CBR) for those parameters that can be quantified for each alternative.

This memorandum is organized as follows:

1. Introduction
2. Guadalupe Dam CBA Overview
3. Alternatives
   - 3.1 Retrofit Dam to Full Storage
   - 3.2 Lower Spillway
   - 3.3 Partial Dam Removal
   - 3.4 Full Dam Removal
4. Cost Benefit Assessment
   - 4.1 Selection of Base Case
   - 4.2 Cost Estimates
   - 4.3 Projected Future Benefits
   - 4.4 Net Present Value Calculation
5. Summary
6. References

Attachments:

- Figures
- Appendix A – Table A-1 Description of Alternatives Key Features
- Appendix B – Supplemental CBA Analysis including Flood Protection Benefits

2.0 GUADALUPE DAM CBA OVERVIEW

CBA is a well-established and widely used economic tool for project evaluation and selection. CBA estimates and aggregates the expected future benefits and costs for a proposed project or set of project alternatives. The central component of CBA is to identify and represent all cost and benefit parameters into a single common and equivalent monetary unit whenever possible. This facilitates comparisons between the different cost and benefit trade-offs of different project alternatives. CBA is a particularly helpful tool for evaluating alternatives that have differing schedules in their future costs or benefits over their future operational lifecycle.

For Guadalupe Dam, a high-level review of the major modification alternatives' expected costs and performance outcomes (e.g. water supply, water quality, flood control etc.) has been performed. This has been conducted for three dam modification alternatives (not including the base case alternative). The costs and benefits of each project alternative are assessed so that fair comparisons can be made. In some cases, particularly with respect to benefits, there was insufficient information for quantitative analysis. When benefits could not be quantified and monetized, comparative qualitative analysis was conducted.

To obtain guidance from the District on CBA input parameters, a joint work session with the District was conducted on October 16, 2014. This joint work session with District staff and the consultant team was an integral part of the CBA development process. At this session a proposed CBA approach was presented and SCVWD staff discussed the costs and benefits that they believed were important to address. The team discussed District data that might be available, and agreed on the qualitative parameters could be used in cases where quantification is not possible. The scope and goals of this session were:

- Identify/involve key District stakeholders
- Develop common understanding of what is to be done
- Understand Guadalupe Dam alternatives and identify the base case to be used
- Understand applicable costs & benefit categories, significance/scale, and uncertainties
- Identify simplified CBA framework (commensurate with goals and budgets)
- Identify information required, how it can be obtained and what can be ignored

The following sections and tables presents the CBA approach, information sources, analysis and findings.

3.0 ALTERNATIVES

The CBA considers the four alternatives described below. Table A-1 provides a preliminary description of the major features of each dam alternative. The accompanying Figure 1 provides a general site layout showing the existing dam facilities, and Figures 2 through 4 illustrate the key concepts related to the alternatives.

As shown on Figure 1, it is expected that the reservoir would need to be fully lowered for construction of any of the alternatives, and stream diversion would need to be handled by the existing outlet and/or a pump-over until the rehabilitated outlet or restored stream channel is available to handle flows.

3.1 RETROFIT DAM TO FULL STORAGE

This alternative would follow through with the seismic retrofit currently in the planning phase and would entail the following key components:

- **Embankment Stabilization Component** – stabilize the downstream slope of the dam embankment to protect against liquefaction of alluvial soils and embankment deformation during the Maximum Credible Earthquake. Options identified during the previous SSE1B study and evaluated included the following:

    1. Remove/replace downstream foundation and embankment.
    2. Add downstream buttress
    3. In-situ treatment of embankment and foundation with Deep Soil Mixing (DSM)
    4. Permanent reservoir level restriction with no embankment modifications but lowered spillway.

- **Spillway Component** – enlarge the capacity of the existing spillway to safely pass the recently updated, larger PMF flood with 4.1 feet of freeboard (1.5 feet DSOD minimum plus 2.6 feet for waves). Options identified during the PMF study and evaluated include the following:

    1. Raise dam crest by 4.3 feet.
    2. Lengthen spillway crest by 104 feet (114% increase from existing 80 foot length).
    3. Install a mechanical crest gate to seasonally lower the spillway crest by 4.3 feet.

- **Outlet Works Replacement Component** - replace the existing intake structure with a new multi-level intake structure located away from the existing upstream slope buttress. Based on the findings of the recent condition assessment, for any full retrofit options, the existing outlet conduit would also be replaced with a new tunneled outlet conduit and downstream release structure, and the existing outlet abandoned. If there are interference issues with other dam retrofit components, the new outlet works may need to be constructed on the right abutment rather than the left abutment.

The preferred combination of these components will be determined during the course of the conceptual and feasibility-level screening based on consideration of cost and non-cost factors. Full retrofit concepts are illustrated by Alternatives 1 through 3 on Figure 2, with outlet options and approximate dam footprints (assuming dam crest raise) shown on Figure 4.

The retrofit alternatives evaluation work is being performed under a separate ongoing task led by GEI with environmental input from URS. Conceptual-level alternative development and a November 24, 2014 screening workshop identified the top-ranked conceptual alternative as follows:

- 3a-2 – In-situ Treatment with Deep Soil Mixing (DSM), lengthen spillway crest, new tunneled outlet with sloping intake on left abutment, and abandon existing outlet.

This conceptual alternative has been used for development of full retrofit costs in the cost-benefit assessment.

3.2 LOWER SPILLWAY

This alternative would avoid major modifications to the dam embankment by lowering the spillway to make permanent the existing DSOD storage restriction. This is option 4 identified in the SSE1B study noted above and would entail a permanent storage capacity loss of approximately 1,500 acre feet. Key components include the following:

- **Embankment Stabilization Component** – no major work; accept deformation in an earthquake.
- **Spillway Component** – permanently lower the spillway crest by approximately 20 feet.
- **Outlet Works Rehabilitation Component** - replace the existing intake structure with a new multi-level intake structure located away from the existing upstream slope buttress. Based on the findings of the recent condition assessment, rehabilitate the existing outlet conduit by re-lining and installing a new downstream release structure and control valves.

The existing embankment section with the revised water surface is shown as Alternative 4 on Figure 2.

During conceptual development and screening of dam retrofit alternatives, a concept and construction costs for spillway crest lowering was developed; these costs have been used in the cost-benefit assessment.

3.3 PARTIAL DAM REMOVAL

This alternative would involve removing the dam down to approximate elevation 525 and leaving most of the existing reservoir sediment in place. The facility would no longer function as a dam and reservoir but would be operated as part of the watershed/floodway, with the reservoir area restored as some combination of wetland/riparian habitat. If not hauled offsite, it may be possible to place removed embankment materials as landscaping materials in the reservoir area. A drop structure would need to be constructed down the face of the dam precluding upstream fish passage. The existing outlet and spillway would be abandoned. This alternative would entail a permanent storage capacity loss of approximately 3,500 acre feet, with no future ability to regulate stream-flow for water supply, environmental or flood management purposes.

The partial dam removal concept is illustrated by Alternative 5 on Figure 2.

During conceptual development and screening of dam retrofit alternatives, a concept and construction costs for partial dam removal has been developed. This concept assumes excavation and offsite disposal of approximately 80,000 cy of sediment to establish an erosion protected stream channel across the remaining reservoir sediments, and restoration of approximately 45 acres in a mixture of wetland, riparian and upland habitat. Excavated dam materials would be placed to partially cap remaining reservoir sediments and for landscaping. The costs for this concept has been used in the cost-benefit assessment; however it should be noted that there is high degree of uncertainty associated with the required sediment removal quantity and disposal costs as well as habitat restoration.

3.4 FULL DAM REMOVAL

This alternative would involve entirely removing the dam and excavation/disposal of the existing reservoir sediment (or stabilizing in-place). The facility would no longer be a dam and reservoir but would be operated as part of the watershed/floodway, with restoration of the stream channel through the reservoir providing riparian and upland habitat and allowing potential fish passage upstream. Accumulated sediment in the reservoir, which has elevated mercury concentrations, would be hauled off site. It may be possible to place removed dam embankment materials as landscaping materials or for capping sediments with elevated mercury in the reservoir area. The existing outlet and spillway would be abandoned. This alternative would entail a permanent storage capacity loss of approximately 3,500 acre feet with no future ability to regulate stream-flow for water supply, environmental or flood management purposes.

The full dam removal concept is illustrated by Alternative 6 on Figures 2 and 3.

During conceptual development and screening of dam retrofit alternatives, a concept and construction costs for full dam removal has been developed. This concept assumes excavation and offsite disposal of all reservoir sediments (estimated at approximately 250,000 cy), establishment of a fish-passable stream channel at the approximate original stream grade, and restoration of approximately 45 acres in a mixture of riparian and upland habitat. Excavated dam materials would be placed in the reservoir area as landscaping berms. The costs for this concept has been used in the cost-benefit assessment; however it should be noted that there is high degree of uncertainty associated with the required sediment removal quantity and disposal costs as well as habitat restoration.

The actual configuration and costs for partial and full dam removal could vary significantly from that assumed for this preliminary CBA, partly due to site uncertainties related to actual sediment quantities and characteristics, and partly due to currently unknown objectives and requirements for habitat restoration and sediment handling/disposal. The preliminary concepts are suitable for initial cost-benefit comparison; however detailed site investigations, feasibility studies and discussions with regulatory agencies and stakeholders would be required to evaluate dam removal options in more detail.

4.0 COST BENEFIT ASSESSMENT

The assessment approach, described below, consisted of the following steps:

- Agreement with SCVWD that the Guadalupe Dam seismic retrofit would be used as the base case for the impact comparisons and assessment;
- Developed rough cost estimates;
- Selected benefit parameters used for CBA and collected available information. Agreement with SCVWD on the parameters (water quality, recreation, habitat, e.g.) that are qualitatively analyzed or not included in the CBA:
- Calculate Net Present Values and Cost Benefit ratios (when applicable).

4.1 SELECTION OF A BASE CASE

The baseline alternative for the CBA was determined to be the future full retrofit of Guadalupe Dam (restore reservoir) in consultation with the District staff during the October 16th joint work session. The other dam alternatives are evaluated through comparisons with this base case alternative.

Table A-1 provides a preliminary description of the major features of the base case and each dam alternative. These project features are used to identify the projected future costs and benefits for each project alternative being analyzed.

4.2 COST ESTIMATES

Preliminary construction and net lifecycle cost estimates for each alternative have been developed. The cost analysis projected the expected annual operating and maintenance (O&M) costs for the facility's future operation. In addition to labor, utility and equipment repair costs, the future O&M costs may also include environmental costs (e.g. increased and long-term vegetation management or habitat restoration requirements). Future decreased or increased downstream monitoring requirements were also considered.

Tables 1 and 2 show the estimated total construction and O&M costs for each alternative with the estimated present value of the project's total lifecycle costs over the 50 year study period and a 3 percent discount rate in 2014 dollar terms. Construction costs were developed by GEI consultants during development and evaluation of conceptual alternatives that will be included in a separate Guadalupe Dam Alternatives Report currently in preparation. Annual O&M costs have been estimated with input from SCVWD staff.

Table 1: Total Project Costs by Alternative – Present Value (3%, 2014$)

Cost Item	Retrofit (Base Case)	Lower Spillway	Dam Removal	
			Partial	Full
Estimated Water Supply Yield (af/yr)	2,500	2,000	490	490
Total Construction	$58,000,000	$39,000,000	$56,000,000	$93,000,000
Total O&M - Annual	$310,000	$310,000	$143,079	$231,279
Total O&M - PV (3%)	$7,976,227	$7,976,227	$3,681,378	$5,950,743
Total Cost - PV (3%)	**$65,976,227**	**$46,976,227**	**$59,681,378**	**$98,950,743**

Source: GEI and URS 2014.

Table 2: Operating and Maintenance Costs by Alternative – Annual (2014$)

Cost Item	Retrofit (Base Case)	Lower Spillway	Dam Removal	
			Partial	Full
Reservoir O&M and Dam Safety ($/yr)	$160,000	$160,000	$0	$0
Water Quality Monitoring	$150,000	$150,000	$0	$0
Habitat Maintenance	$0	$0	$143,079	$231,279
Total O&M	**$310,000**	**$310,000**	**$143,079**	**$231,279**

Source: GEI, URS and SCVWD 2014.

4.3 PROJECTED FUTURE BENEFITS

Reconstruction or modification of Guadalupe Dam may result in future water quality, flood protection, recreation and habitat benefits or adverse impacts. The CBA identifies, and when possible, quantifies each alternative's major operational benefits.

4.3.1 Water Supply

Guadalupe Dam's primary purpose is a future water storage facility providing water supply for groundwater recharge at the Los Capitancillos and Alamitos percolation ponds downstream of the dam. As a result, the facility's projected annual water supply yield is a primary benefit of the seismic retrofit, and lower spillway alternatives and a major focus of the benefit analysis.

Analysis

The value of the dam's future water supply deliveries will depend on the average quantity of supplied water and its unit value.

SCVWD performed water-modeling analysis to estimate the dam's average expected yield based on the watershed's topography, expected precipitation patterns and typical dam operations. Guadalupe Reservoir is generally operated as an annual fill and drain facility with limited carry-over water supplies maintained between water years. Consequently, the reservoir's water supply is typically released gradually between late Spring and early Autumn to maintain water deliveries to its downstream groundwater recharge facilities. The dam's release schedule also results in increased downstream water flows.

Table 3 shows SCWD's water modeling analysis yield results for each of the Guadalupe Dam alternatives.

Table 3: Guadalupe Reservoir Water Supply Yields by Alternative

Item	Dam Retrofit	Lower Spillway	Dam Removal
	Base Case		(Partial and Full)
Water Storage Capacity	3,500 af	1,500 af	0 af
Average Water Yield	2,500 af/yr	2,000 af/yr	490 af/yr

Source: SCVWD 2014.

Dam Retrofit Baseline Water Supply Benefits

SCVWD management is strongly committed to making full use of its in-District water sources to reduce its long-term reliance on imported water supplies. The District's current Ensure Sustainability water supply strategy has three key elements: (1) secure existing supplies and facilities; (2) optimize the use of existing supplies and facilities; and (3) expand water use efficiency efforts. The dam retrofit alternative directly aligns with its secure existing supplies and facilities.

Consequently, the annualized water supply cost of the retrofit alternative is used to represent the benefit value of the project's future water supply yield. In the absence of any other benefits or non-water supply related costs, the annualized water supply benefit will exactly equate with its corresponding construction and operating costs. Simply stated, the benefit value of its water supply yield should at a minimum be equal to its supply cost. Typically, many users obtain greater use benefits (e.g. have a higher willingness to pay) than the price they pay to meet their water needs. In such cases water users will obtain additional consumer surplus benefits from the delivered water that are not reflected in the benefit evaluation for the CBA.

Note that the valuation in this assessment assumes that there are no other alternative lower cost water supply options that could otherwise be used or developed to meet the project's specific water supply delivery requirements. Subject to supply availability and market price fluctuation, in the short term imported water supplies could be purchased at a lower cost. However, additional water delivery facilities and conveyance costs would nonetheless also be necessary for direct water supply benefit comparison with the proposed project.

Imported water supplies also have the major disadvantage that they are generally more susceptible to uncertainty and fluctuation in availability, pricing and delivery costs. Increased future SCVWD reliance on imported water supplies is also contrary to District management principles stated in its "Ensure Sustainability" strategy stated in its 2012 Water Supply and Infrastructure Master Plan (SCVWD 2012a). District staff expect major price increases in future imported water costs for the District from greater competing demand (from future population growth), increased delivery costs (from aging infrastructure) and likely reduced water supplies (from possible climate change effects) (SCVWD 2014a). Given their projected future construction costs, successful future development of the Bay Delta Conservation Plan and other proposed water supply projects are not expected to be able to prevent major imported water price increases over the long term. Finally, imported water supplies will not have the reliability of in-District sources and as such could result in water shortages during periods of drought or other water shortage conditions when the marginal value of water supplies are at their highest.

Table 4 shows a preliminary estimate of the annual water supply benefit for a 50 year repayment period and a 3% real interest rate. On an annualized basis, the retrofit alternative's estimated total water benefit value for its projected average 2,500 acre foot yield is approximately $2.539 million per year and roughly equivalent to $1,015 acre foot. Note that under higher interest assumptions, annual capital repayment costs would be greater and result in higher annual water supply costs and imputed water supply benefits.

Table 4: Estimated Costs for Guadalupe Dam Retrofit Water Supply Alternatives (2014$)

Cost Item	Est. Cost
Total Construction Cost	$58,000,000
Annual Capital Repayment Cost (50yrs, 3%)	$2,188,542
Annual Water Supply O&M	$350,000
Annual Water Supply Total Cost ($/yr)	$2,538,542
Est. Water Benefit Cost/Value ($/AF)	$1,015

Source: GEI and URS 2014.

Lower Spillway and Dam Removal Water Supply Benefits

As the baseline condition, the full dam retrofit alternative's estimated average water supply yield of 2,500 acre feet represents the expected future water supply benefit conditions against which the other alternatives are evaluated. Consequently both the lower spillway and dam removal alternatives will result in negative water supply outcomes since they will result in reduced future average water supply deliveries. As such they will result in negative benefits (i.e. net cost increases) compared to the seismic retrofit alternatives.

Under the lower spillway alternative, future reservoir yields are projected to average approximately 2,000 acre feet annually, resulting in a net loss of 500 acre feet in annual water deliveries to Guadalupe Creek's downstream percolation system for groundwater recharge.

The two dam removal alternatives would reduce the future water yields for groundwater recharge to an estimated 490 acre feet resulting in a net loss of 2,010 acre feet in annual future water supplies.

The direct benefit loss for both these alternatives can be computed by the corresponding reduction in annual water deliveries at the seismic retrofit alternatives' unit water benefit value of approximately $1,000 / acre foot (at a 3% real interest rate).

However, the full value of the lost supply capacity needs to recognize the full cost for SCVWD to make it "whole" by recognizing the net additional cost it would incur to obtain future long-term replacement water supplies from its next best suitable alternate water source.

The District's other water supply source options will be expected to have a higher unit water cost. Unit values for Guadalupe Reservoir's future water yield have been estimated based on SCVWD's alternative least cost sourcing options for acquiring replacement water supplies to Guadalupe Creek.

SCVWD identified two potable reuse alternatives as possible replacement water supplies for any permanent future water supply decrease from Guadalupe Dam. In both cases, reclaimed water would be collected for either: (1) Groundwater recharge in Ford Road Ponds with the use of a satellite water treatment facility; or (2) Injection west of the Los Gatos Ponds (Westside injection alternatives) with use of a centralized water treatment facility.

Existing detailed cost estimates for each facility were used by the District to determine applicable pro-rated costs based on the corresponding replacement water supply needs for both the reduced capacity and dam removal alternatives. Table 5 provides capital and annual operating and maintenance cost estimates for both the Ford Road Ponds and Westside Injection alternatives.

Table 5: Estimated Costs for Guadalupe Dam Replacement Water Supply Alternatives (2014$)

	Lower Spillway		Dam Removal (Partial and Full)	
Cost Factor	**Recharge at Ford Road Ponds**	**Westside Injection**	**Recharge at Ford Road Ponds**	**Westside Injection**
Original Capacity Estimates				
Capacity (AFY)	480		2,422	
Capital Costs	$14.6 million	$35.6 million	$36 million	$72.0 million
Annual O&M	$0.5 million/yr	$0.4 million/yr	$2.3 million/yr	$2.1 million/yr
Revised Capacity Estimates				
Capacity (AFY)	500		2,010	
Capital Costs	$14.8 million	$35.6 million	$31.3 million	$64.2 million
Annual O&M	$0.5 million/yr	$0.4 million/yr	$1.9 million/yr	$1.8 million/yr
Net Present Value (3%)	**$27.7 million**	**$45.9 million**	**$80.2 million**	**$110.5 million**

Source: SCVWD 2014a and URS.

The Ford Road Ponds replacement supply option is cheaper under both the lower spillway and dam removal alternatives. Consequently, the Ford Road Ponds option is used to determine the value of the water supply capacity lost under both the lower spillway and dam removal alternatives.

Table 6 shows the estimated annual cost for the replacing the lost Guadalupe water supply capacity using the Ford Road Ponds facility. Overall, it is estimated that it will cost SCVWD approximately $1.6 million annually to replace the 500 acre feet of water that would be lost under the Lower Spillway Alternative. If the dam is removed, SCVWD would need to spend $3.08 million per year to replace the 2,010 acre feet of lost water supply.

Table 6: Annual Water Supply Cost Replacement Water Supply – Ford Ponds Facility (2014$)

Cost Factor	Lower Spillway	Dam Removal (Partial and Full)
Lost Water Supply Capacity (acre feet /yr)	500 af/yr	2,010 af/yr
Construction Cost	$14,800,000	$31,300,000
Est. Annual Construction Cost (50yr, 3%)	$558,456	$1,181,058
O&M Replacement Supply - Annual ($/yr)	$500,000	$1,900,000
Annual Replacement Water Supply Cost ($/yr)	$1,058,456	$3,081,058
Est. Price of Water/ Value ($/AF)	$2,117	$1,533

Source: SCVWD 2014a and URS.

Note that the lower spillway alternative has a higher unit price (supply cost) and consequently a higher imputed value for its lost supply capacity. The higher marginal cost is a result of the fixed costs for the replacement water supply.

It is important to recognize that the total benefit loss for the lower spillway and dam removal alternatives includes both: (1) the value of lost water deliveries from Guadalupe Reservoir; and (2) the extra cost premium for SCVWD to obtain replacement water from more expensive alternate water sources.

Table 7 shows the estimated value of the lost water deliveries from the Guadalupe Reservoir. The value of the lost deliveries resulting from the Lower Spillway alternatives reduced annual yield is $508,000. The value of the annual water delivery lost under the dam removal alternatives is projected to be $2.04 million.

Table 7: Replacement Water Supply Annual Net Cost – Ford Ponds Facility (2014$)

Cost/Benefit Values	Dam Retrofit Base Case	Lower Spillway	Dam Removal (Partial and Full)
Guadalupe Reservoir Water Deliveries Value	$2,538,542	$2,030,834	$497,554
Net Value of Lost Deliveries	*$0*	*$507,708*	*$2,040,988*
Replacement Water Supply Cost	$0	$1,058,456	$3,081,058
Net Cost to Replace Capacity Loss	*$0*	*$550,747*	*$1,040,070*
Total Cost for Full Water Deliveries/Capacity	**$2,538,542**	**$3,089,290**	**$3,578,613**

Source: URS 2014.

It also shows the additional annual net replacement cost (i.e. benefit reduction) to replace the lost supply capacity. The calculation determines the extra cost premium for SCVWD of using a more expensive replacement water supply source.

The net cost to replace the capacity loss is the annual extra cost for SCVWD if it has to use another more expensive replacement water source. Under the lower spillway option it will cost SCVWD an additional $551,000 to obtain 500 acre feet of extra water from the Fords Pond Facility. For the dam removal alternatives the cost premium for the capacity loss is $1,040,000 per year.

Other Water Supply Considerations

SCVWD currently has 3,500 AF of water rights for Guadalupe Dam. While these water rights are only a small proportion of the Districts total system-wide water rights, the water rights for Guadalupe Dam account for approximately 18% of the Guadalupe River watershed's total water rights. Transfer of SCVWD's current water rights would likely be highly problematic and unlikely to be successful (SCVWD 2014b). Consequently, capacity reduction or removal of the Guadalupe Dam would be expected to result in a similar permanent reduction or loss of the District's current water rights for Guadalupe Dam. In the absence of any open market for water right transfer sales, it is very difficult and potentially speculative to quantify the monetary value of the District's water rights separate from its associated water supply. Nonetheless, possession of such water rights generally ensures greater supply reliability and represents an additional value premium over other water sources. Consideration of the water rights represents an additional benefit (incorporated in its estimated water supply benefit valuation) to the water use benefits that would be associated with use of imported water supply source that would offer no guarantee of future water availability to SCVWD.

Conclusions

As the baseline condition, the dam retrofit alternative's estimated average water supply yield of 2,500 acre feet per year represents the expected future water supply benefit conditions against which the other alternatives are evaluated. Since the lower spillway and dam removal alternatives will reduce future water supply yields, they will result in negative water supply outcomes (i.e. benefit losses compared to the baseline conditions).

Under the lower spillway alternative, future reservoir yields are projected to average approximately 2,000 acre feet annually resulting in a net loss of 500 acre feet in annual water deliveries to Guadalupe Creek's downstream percolation system for groundwater recharge. Both dam removal alternatives would reduce the future water yields for groundwater recharge to an estimated 490 acre feet resulting in a net loss of 2,010 acre feet in annual future water supplies.

The total water supply benefit loss for the lower spillway is estimated to be $1,058,000 per year. The value of the 500 acre feet in lost reservoir water deliveries represents approximately $507,000 of the total loss in water supply benefits. SCVWD also faces $551,000 per year in additional water supply costs to replace that lost water from more expensive alternate water sources.

The total water supply benefit loss for the dam removal alternatives is estimated to be $3,081,000 per year. The value of the 2,010 acre feet in lost reservoir water deliveries represents approximately $2,041,000 of the total loss in water supply benefits. SCVWD would face an additional $1,040,000 per year in higher water supply cost to obtain suitable replacement supplies from more expensive alternate water sources.

4.3.2 Downstream Minimum Stream Flows

Dam removal would result in loss of controlled downstream releases and all minimum stream flow benefits. Current Guadalupe Dam operations result in water releases are generally maintained throughout the summer, providing downstream flows to Guadalupe Creek through the dry season. Lowering of the spillway could potentially result in reduced post-spring releases on Guadalupe Creek, similar to current conditions. Dam removal would be expected to result in dry creek conditions during the summer in most water years.

This benefits category considers both the land-use impacts and regulatory issues associated with the Guadalupe Reservoir's current and future downstream flow conditions. Other physical effects of future changes to the Reservoir's downstream flow conditions are considered under the Habitat and Other Environmental benefits categories.

Analysis

While SCVWD currently operates Guadalupe Reservoir primarily to meet its water supply needs for ground recharge, when possible the District also manages its water releases to maintain the Creek water conditions and its habitat resources. Typically, the Reservoir operations maintain approximately 6 cfs downstream flow conditions (SCVWD 2014c). Under high water storage conditions in the Reservoir (e.g. 2,200 to 2,500 acre feet of storage from November to May) then the release rate may increase from 9 cfs to 11 cfs (SCVWD 2006).

Although SCVWD has not finalized its FAHCE agreement, the District has draft agreements with other stakeholders to maintain downstream minimum stream flow conditions within Guadalupe Creek. Under the dam removal alternatives SCVWD would no longer have the capability to fulfill its current agreements and consequently would need to renegotiate terms with the other watershed stakeholders. The likely outcome of any resulting renegotiations is currently speculative so their impacts cannot be projected. Any such renegotiations would require commitment of additional agency staff time and resources to resolve.

As discussed above, future impacts on fish and wildlife habitat conditions from the dam alternatives are analyzed under the Habitat and Other Environmental benefits categories. However, discussions with SCVWD staff identified a potential land use impact to the existing Guadalupe Creek Restoration Project that would be associated with the dam removal alternatives.

In 2002 SCVWD completed construction of a major restoration project on the creek between Masson Dam and the Almaden Expressway Bridge. This creek restoration project was constructed as mitigation for the Downtown Guadalupe River Flood Protection project and was completed in 2004. Restoration actions included construction of a fish ladder at Masson Dam, streambed modifications and establishment of new vegetation to improve aquatic habitat in Guadalupe Creek. The estimated construction cost for the project was $6.6 million in 2001 dollars – equivalent to $8.8 million in 2014 dollars.

According to SCVWD staff, the Restoration Project could be impaired if downstream flow conditions were reduced under the dam removal alternatives (SCVWD 2014d). Consequently, the project would represent an adverse land-use impact associated with the dam removal alternatives and additional mitigation may be required to meet the mitigation requirements agreed to for the flood protection project. It is conservatively assumed that $8.8 million would likely represent a maximum cost for mitigation to address any adverse impacts to the restoration project from future reduced downstream flow impacts under the dam removal alternatives.

Conclusions

Due the uncertain nature of any future revised agreements, no future District costs have been estimated for regulatory and stakeholder engagement activities that would be necessary due to changes in downstream flows from the dam removal alternatives.

The primary future land use impact anticipated from the proposed dam removal alternatives would be future degradation of SCVWD's Guadalupe Creek Restoration Project which could represent up to $8.8 million one-time land use damage cost.

4.3.3 Downstream Flood Management

While SCVWD operates the reservoir for groundwater recharge purposes, the facility also currently results in incidental flood control benefits. The magnitude of the potential flood control benefits not only depends on the nature/likelihood of the future flood events but also on SCVWD's ability during heavy rainfall conditions to modify the reservoir operations to reduce its downstream releases sufficiently to decrease the severity of flood events in Guadalupe Creek and also further downstream in the Guadalupe River. The property values of the affected residences and businesses will also affect the flood protection benefit estimates.

SCVWD is currently developing a future flood protection project for Guadalupe River to prevent such future inundation events occurring. Once completed, the Guadalupe River Flood Protection Project (GRFPP) would make levee and other channel improvements to ensure that no future flood damages occur with the River irrespective whether Guadalupe Dam is retrofitted or removed.

Analysis

SCVWD has assessed the ability of all the creeks within the Guadalupe Creek watershed and made modifications to ensure their water conveyance abilities. Downstream of the dam, Guadalupe Creek has 100-year flood capacity, while the Guadalupe River does not (SCVWD 2006). As a result, Guadalupe Reservoir's flood protection benefits result from its indirect effects on the flood conditions along the Guadalupe River. Due to the dam's relatively small capacity, its flood reduction benefits are realized more for smaller recurrence events.

As discussed above, GRFPP's completion would improve future Guadalupe River flood protection independent of whether Guadalupe Dam is retrofitted or removed. Consequently there would be no future flood protection benefits for the seismic retrofit alternative. Although full project funding has not yet been secured, the CBA analysis conservatively assumes that GRFPP funding and completion could occur before major construction of the Guadalupe Dam alternatives would be underway. In which case, no future flood protection benefits would be associated with the Guadalupe Dam seismic retrofit alternatives.

Conclusions

For the purposes of the CBA it is conservatively assumed that the proposed GRFPP would be completed before major construction has begun for the proposed Guadalupe Dam alternatives. As such, no future flood protection benefits would result from the Guadalupe Dam retrofit alternatives. However, the major funding requirement for the GRFPP's future construction could possibly delay its completion until after the Guadalupe Dam retrofit/removal project is built. In which case, there would be potential future Guadalupe Dam-related flood protection benefits. Analysis of this alternate scenario is provided in Appendix B.

4.3.4 Water Quality

Water quality impacts can result from changes in the water's temperature, turbidity and composition of dissolved or suspended materials. Water quality effects may also be related to the quantity and timing of the future dam releases. Avoided or reduced water treatment costs can be used to approximate the benefits or costs of project related water quality impacts for water supply use (water quality effects on fish habitat are analyzed separately as environmental impacts).

Analysis:

The existing reservoir impounds sediment that has elevated mercury concentrations resulting from historic mining in the Guadalupe watershed. As a result, adverse water quality effects could occur from the dam removal alternatives if sediment were to be transported downstream.

It is not anticipated that any water treatment processing would be viable for addressing any resulting water quality degradation from downstream sediment transport. Consequently, it is assumed that for the dam removal alternatives, sediment would be removed and transported off-site for disposal, or capped and stabilized if any were left on-site. The costs for sediment removal and disposal or stabilization necessary to ensure no downstream water quality impacts are included as cost components of the dam removal alternatives.

The seismic retrofit and spillway modification alternatives would maintain the benefit of cold water releases below the dam that are part of the current operations. The partial or full dam removal alternatives would return Guadalupe creek below the dam to ephemeral flow conditions, potentially causing water temperatures to become elevated during the dry season and reducing dissolved oxygen levels and potentially impairing some of the current beneficial uses of Guadalupe Creek below the dam.

Identification and quantification of such effects would require facility operations and watershed specific hydrological data to predict the future water flow conditions. Currently, no suitable baseline data is available and extensive hydrological analysis would be necessary to develop any water quality projections for the alternative's future water releases.

Current flow rates for the Dam are low – typically averaging 6 cfs or lower. Under the dam removal alternatives, future flows are expected to be very low (averaging less than 1cfs) or zero. Under these flow conditions temperatures in the downstream reaches may increase. Under these conditions it will be difficult to identify any substantial water quality differences. Furthermore, the use of the water supply for groundwater recharge will ensure that any non-chemical water quality effects would likely have negligible effects on its groundwater recharge use.

Conclusions

The cost estimate for the dam removal alternative includes costs for sediment removal and disposal necessary to ensure no downstream water quality impacts. As a result, no long-term turbidity or mercury related water quality differences are expected between the project alternatives. Under the dam partial and full dam removal alternatives, water temperatures may increase in downstream reaches, potentially impairing current cold water beneficial uses.

4.3.5 Habitat and Other Environmental Benefits

Both wildlife and river habitat conditions will depend on water availability. Lack of an adequate supply of water will reduce and/or alter vegetation growth and can affect the wildlife and fish populations that can be supported. Reduced creek water flows can result in higher water temperatures, lower dissolved oxygen levels and reduced habitat suitability for fish.

The alternatives' potential natural resource value benefits were assessed to determine if the Dam's future effects on downstream flows and/or expected opportunities for upstream fish passage enhancement can be adequately determined.

Enhancement values from other comparable projects can be used to quantify or qualitatively assess the project alternatives' future environmental benefits. In some cases, the development/restoration costs for other comparable projects can potentially also be used to approximate the benefit value for the project alternatives' expected amount and quality of habitat change. Comparable projects can also be used as a qualitative measure to assess the type and quality of habitat changes that might be expected to result under each of the project alternatives.

Analysis

Site specific data on the area's existing habitat condition is necessary for quantifying the type, quality and extent of its future habitat enhancement potential.

Upstream Habitat Potential

Guadalupe dam would continue to limit fish passage to the downstream creek areas under the seismic retrofit, lowered spillway, or partial dam removal alternatives. Unimpeded fish passage to the creek areas upstream of the reservoir would only be possible under the full dam removal alternative, which would include restoration of habitat currently inundated by the reservoir. Consequently, only the full dam removal alternative would have the potential to result in new upstream habitat benefits.

There is very little reported data on current habitat conditions of areas upstream of Guadalupe Dam. Above the reservoir, North Los Capitancillos Creek contributes water mainly during flooding events. Rincon Creek, although it may have some flows during the dry season due to being spring fed, is also considered to be "flashy" with water levels rising and falling rapidly due to storm events. The hydrology of the subwatersheds upstream of Guadalupe Reservoir suggests that both Rincon and Los Capitancillos run dry most years and consequently they may be expected to have limited habitat potential for steelhead, in which case, the future potential habitat value for these areas would be limited to their vegetation and other wildlife benefits.

As noted in the Guadalupe Watershed Stewardship Plan (SCVWD 2006) steelhead/rainbow trout and native sculpin species have been captured in Guadalupe Creek above Guadalupe Reservoir. Other than this, very little is known about fish productivity or specific amounts of potentially suitable habitat, particularly for listed species such as steelhead. The drainage area upstream of the reservoir is approximately 6 miles (SCVWD 2006), although of this drainage area, only approximately 3 miles may be suitable habitat[1] for fish (SCVWD 2014d).

Removal of the dam and restoration of fish passage to upstream areas might be used in negotiations with regulators such as the National Marine Fisheries Service regarding potential fisheries impacts of other District dams, however, that would require a system-wide assessment of effects and how removal of Guadalupe Dam might mitigate those effects and is beyond the scope of this assessment.

Due to the limited available information, it is not possible to fully evaluate the suitability of the upstream habitat and thereby determine the value of enhanced fish passage or riparian habitat restoration for those areas. For purposes of this assessment, restoration cost information from the Carmel River Reroute and San Clemente Dam Removal project can be used to provide bookend values of upstream habitat re-establishment at Guadalupe.

The California Department of Water Resources (CDWR) Division of the Safety of Dams issued a safety order for the San Clemente Dam structure in the early 1990s. A number of seismic safety options were evaluated, including dam strengthening (the owner, California American Water's preferred approach), as well as dam removal. Recently, public agency and non-profit stakeholders contributed at least $29.4 million towards the project so that the dam removal alternative could be

[1] based on limited reconnaissance level observations

undertaken. This funding ensured that Cal-Am did not rebuild the dam but instead removed the dam structure and accumulated sediment in San Clemente Creek to enable fish unimpeded access to approximately 25 miles of known and high quality upstream steelhead spawning and rearing habitat. Approximately $4.7 million of the restoration cost is specifically allocated for fish habitat enhancement actions in the former reservoir area.

These funding contributions suggest maximum benefit values for habitat of up to $1.176 million per mile of upstream habitat (if all the net dam removal cost is solely attributable to future fishery benefits). The minimum habitat value for San Clemente's upstream fisheries is estimated to be $188,000 per mile (i.e. if only the $4.7 million in restoration costs and none of the other net dam removal cost is attributable to the fishery benefits).

The imputed benefit value for the full dam removal alternative's potential 3 miles increase in future fish habitat would be at most $3.528 million (based on the San Clemente's $1.176 million per mile maximum fishery benefit value). It should be noted that any future any creek enhancement costs that might necessary for the fishery establishment would reduce this maximum benefit.

However, using the more conservative minimum San Clemente benefit value estimate of $188,000 per mile, future full dam removal would be expected to result in only $546,000 of potential upstream fishery benefits.

Unlike San Clemente Dam, the suitability and viability of Guadalupe Creek's upstream area as future fish habitat is currently unknown and uncertain. If the upstream areas that are open to fish passage result in little increase in productivity, then the actual fish benefits would be small.

Reservoir Area Habitat Potential

Guadalupe Reservoir currently has an average surface area of 79 acres. Guadalupe dam would continue to inundate this existing reservoir area under both the seismic retrofit and lowered spillway alternatives. Reclamation and future restoration of the reservoir area would only be possible under the partial and full dam removal alternatives. Consequently, only the partial and full dam removal alternatives would have the potential to result in any new habitat benefits for the reservoir area.

There is no historical data on the original land and habitat conditions of the habitat currently inundated by the reservoir, but it is reasonable to expect that it was similar to that of the surrounding areas and region. For purposes of this assessment, it is assumed that for spillway lowering, habitat around the lowered pool would be restored to that of the surrounding area. For the partial or full dam removal, it is assumed that the Guadalupe Creek channel would be restored to riparian habitat. However, as discussed above, past sedimentation has resulted in the accumulation of large quantities of mercury bearing sediment that would need to be removed and/or suitably capped to prevent their future erosion and downstream migration.

Under the dam removal alternatives it is conservatively estimated that 45 acres of new vegetation habitat could be created on areas formerly inundated by the reservoir. This habitat is expected to primarily consist of riparian woodland habitat. Using an average habitat value of $123,000 per acre consistent with the recent Santa Clara Valley Habitat Plan, the potential future benefit value of the added habitat acreage is projected to be approximately $5.535 million (SCVWD, 2012b).

Downstream Guadalupe Creek Habitat Potential

Historically, Guadalupe Creek was an ephemeral creek. Several small ephemeral creeks are also located along the Guadalupe Creek below the reservoir. These include Shannon Creek, Pheasant Creek and Cherry Springs (Hicks) Creek.

Development of the Guadalupe Reservoir has added summer flows to the creek from its operations supplying its captured water to the downstream percolation ponds. This has resulted in Guadalupe Creek downstream of the dam becoming a perennial stream that supports riparian habitat, with fish and other wildlife species. The seismic retrofit and spillway lowering alternatives could maintain this current flow regime. However, partial or full dam removal would reduce dry season flows downstream of the dam and return Guadalupe Creek to its historically ephemeral nature. This may impair certain current beneficial uses of the reach downstream of the dam, such as cold water habitat.

As discussed previously the downstream minimum flows analysis (Section 4.3.2), reduced flows could potentially adversely affect the Guadalupe Creek Restoration Mitigation project. The potential value of the resulting benefits loss is estimated to be up to $8.8 million in 2014 dollars and is recognized by the CBA as a downstream minimum flow related impact and not as a habit impact.

Conclusions

Future habitat and environmental benefits would only result under the dam removal alternative. Potential upstream habitat benefits would only occur under the full dam removal alternative which could result in up to 3 miles of new fishery habitat. The potential value for this added fishery habitat could be up to $3.528 million.

Both the dam removal alternatives could result in 45 acres of new riparian woodland habitat on reclaimed areas currently inundated by the reservoir. The potential future benefit value of the added habitat acreage is projected to be approximately $5.535 million.

No downstream habitat benefits could be identified for any of the alternatives. Potential reduced flows could potentially adversely affect the habitat conditions for Guadalupe Creek Restoration Mitigation project. However this impact is included in the CBA in as downstream impacts and therefore not attributed as a habit impact.

4.3.6 Recreation

Changes in current or future visitor use of the facility for recreational purposes could result in positive or adverse future project-related impacts. The magnitude of the potential impacts would depend on the magnitude and type of the change in future recreational use associated with Guadalupe Dam. However, in the absence of current or future recreational use then no recreational impacts would occur.

Analysis

Guadalupe Reservoir (and approximately a 1.25 mile downstream section of Guadalupe Creek) is located within the northwestern portion of Almaden Quicksilver County Park which is operated by the Santa Clara County. The eastern side of the watershed is also located within the County Park. The western side of the watershed (which includes the Upper Guadalupe Creek watershed) is located in the Sierra Azul Open Space Preserve operated by the Mid-peninsula Open Space District.

Visitor access and recreation at Guadalupe Reservoir and its tributaries is very limited. County park access and visitor use is predominantly concentrated in its southern half. Parking in the area is limited to informal sites along Hicks Road for at most 6 to 8 vehicles. No reservoir access or use is permitted. While fishing at the Reservoir is permitted, catch and release is recommended due to potentially high mercury levels in the fish. No bathrooms or other visitor facilities are located at the Reservoir or along Guadalupe Creek except for a picnic area Guadalupe Trail about 0.8 miles below the Dam. Park staff report typical use of only one or two daily Guadalupe Reservoir visitors as well as some hikers/dog walkers in in the mornings (SCCP 2014). There are also no visitor facilities within the neighboring Sierra Azul Open Space Preserve.

Given the Reservoir's current minimal recreational use and the proximity of several alternative recreation destinations, the Reservoir currently provides negligible recreation use benefits. Future recreation use limits would be expected to continue to be imposed for either rebuilt or reduced capacity alternatives. The dam removal alternative could possible result in general open space areas and would remove the need for access restrictions. However future habitat restoration efforts may be expected to limited the area's future recreational use potential especially in the absence of any new visitor parking and other facility development occurring.

Consequently, the potential recreational use impacts for all alternatives are expected to be negligible.

Conclusions

No recreation use benefits are included in the CBA.

4.4 NET PRESENT VALUE (NPV) CALCULATION

For each project alternative, the specific cost and benefit value estimates results from the previous analysis have been used to determine the net present value (NPV) to SCVWD of developing that alternative. The corresponding Cost Benefit Ratios (CBR) for each alternative is also estimated and any costs or benefits that could not be adequately quantified for the CBA's NPV calculation are also noted.

A 50 year future lifecycle period was used for the proposed project. The future schedule of costs and benefits over the time period was determined in discussion with SCVWD. All future monetary values are reported in current (2014) dollar term values and a standard public agency discount rate of 3 percent is used to discount future benefits/expenditures into corresponding present value terms.

Table 9 shows the projected annual benefits by alternative. Only recurring annual benefits are shown in the table. One-time benefit events (e.g. habitat gains or losses) are reported in the subsequent Present Value Benefit calculation. As shown below in Table 9 (and discussed in detail in Sections 4.3.4 and 4.3.6) no future project-related water quality or recreation benefits are identified and quantified for the CBA.

The annual total benefit loss for the proposed lower spillway alternative is projected to be approximately $1.06 million. The benefit loss results from the combined effects of future decrease in delivered water ($0.51 million loss in supply benefits) and an additional $0.55 million cost premium for SCVWD to replace that lost water using more expensive alternative water sources.

The annual total benefit loss for the both dam removal alternative is projected to be approximately $3.08 million annually. The value of the 2,010 acre feet in lost water deliveries is projected to be $2.04 million per year and there is expected to be an additional $1.04 million cost premium for SCVWD to replace that lost water using more expensive alternative water sources.

Table 10 shows each alternative's projected benefits and benefit losses in present value terms using a 3 percent discount rate. It also includes the one-time benefit events (e.g. habitat gains or losses). Over the future 50 year study period, the present value of lower spillway alternative's total lost benefit value is estimated to be approximately $27.7 million in 2014 dollar terms. Reduced water supply effects account for all the projected benefit losses as no other resource effects are expected.

Table 9: Projected Guadalupe Dam Alternatives Benefits – Annual (2014$/yr)

Benefit Categories	Retrofit (Base Case)	Lower Spillway	Dam Removal Partial and Full
Water Supply Deliveries (Guadalupe)	*$0*	*-$507,708*	*-$2,040,988*
Replacement Supply Net Cost Increase	-	*-$550,747*	*-$1,040,070*
Net Water Supply	$0	-$1,058,456	-$3,081,058
Downstream Minimum Flows	-	-	(a)
Flood Management (b)	$0	$0	$0
Water Quality (c)	-	-	-
Habitat and Other Environmental			(d)
Recreation	-	-	-
Total Benefits - Annual	$0	-$1,058,456	-$3,081,058

Source: URS 2014.
(a) A potential one-time damage loss to the Guadalupe Creek Restoration Project is identified in the NPV Benefit Table.
(b) No benefits expected assuming completion of the Guadalupe River Protection Project before major project construction begins.
(c) No water quality impacts from full dam removal due to proposed sediment removal and off-site disposal.
(d) Full dam removal may result in net gain of up to 3 miles of upstream fish and 45 acres of reclaimed vegetation habitat.
The one-time gain is identified in the NPV Benefit Table.

Table 10: Comparison of Projected Guadalupe Dam Alternatives Benefits – Present Value (3% Discount Rate; 2014$)

Benefit Categories	Retrofit (Base Case)	Lower Spillway	Dam Removal	
			Partial	Full
Water Supply	$0	-$27,664,882	-$80,186,552	-$80,186,552
Downstream Minimum Stream Flows	$0	$0	-$8,879,000	-$8,879,000
Flood Benefits	$0	$0	$0	$0
Habitat and Other Environmental	$0	$0	$5,723,143	$9,251,143
Total Benefits - PV (3%)	**$0**	**-$27,664,882**	**-$83,342,409**	**-$79,814,409**

Source: URS 2014.

For the partial dam removal alternative, the present value of future total lost benefit value is estimated to be approximately $83.3 million in 2014 dollar terms. Under the full dam removal alternative, the total lost benefit value is projected to be $79.8 million as a result of up to $3.5 million in potential positive upstream fishery habitat benefit gains.

Under both dam removal alternatives the lost water supply benefits are estimated to total approximately $80.2 million and account for the largest share (approximately 90 percent) of these alternatives' total benefit losses.

Both dam removal alternatives are projected to generate up to nearly $5.7 million in new habitat benefits from 45 acres of reclaimed riparian woodland habitat that would be located on the formerly inundated reservoir area. In addition, the full dam removal alternative could potentially create 3 miles of new upstream fishery habitat. However, the current Guadalupe Creek Restoration Project may be adversely affected by the reduced downstream minimum water flow releases that would occur if the Reservoir is removed. It is estimated that the future damages to Guadalupe Creek Restoration Project could result in up to an $8.9 million benefit loss.

As discussed in Section 4.1, at a minimum the water supply benefit value for seismic retrofit alternative would be expected to be equivalent to its total development cost. This would correspond to a projected benefit cost ratio of 1.0 and indicate that it would in effect operate as a break even enterprise. In actuality, SCVWD water users undoubtedly obtain further additional benefits from future use of the delivered water but any such consumer surplus benefits are not estimated by the CBA.

Applying a $66.0 million water value for the retrofit base case water to the Table 10 benefit comparison results enable the total project net benefit estimates shown in Table 11 for each of the dam alternatives. Table 11 shows the total estimate cost in present value terms for the four Guadalupe Alternatives assuming a 3% discount rate and a 50 year future study period.

Table 11: Total Project Costs and Benefits by Alternative – Net Present Value (3% Discount Rate; 2014$)

Cost Factors	Retrofit (Base Case)	Lower Spillway	Dam Removal	
			Partial	Full
Water Supply Yield (af/yr)	2,500	2,000	490	490
Total Construction	$58,000,000	$39,000,000	$56,000,000	$93,000,000
Total O&M - Annual	$310,000	$310,000	$143,079	$231,279
Total O&M - PV (3%)	$7,976,227	$7,976,227	$3,681,378	$5,950,743
Total Cost - PV (3%)	$65,976,227	$46,976,227	$59,681,378	$98,950,743
Total Benefits – PV (3%)	$65,976,227	$38,311,345	-$17,366,182	-$13,838,182
Net Benefits - PV (3%)	**$0**	**-$8,664,882**	**-$77,047,560**	**-$112,788,925**

Source: GEI and URS 2014.

Overall, the results show that there is a relatively minor benefit loss associated with the lower spillway alternative, which over the 50 year period would result in approximately net economic cost of $8.7 million. Given its estimated total lifecycle cost of approximately $47.0 million the lower spillway alternative would have a cost benefit ratio of less than 0.82. These results indicate that generally speaking the lower spillway alternative would not be a recommended use of future SCVWD funding.

Both the dam removal alternatives are projected to result in major net benefit losses of between $77.0 million (partial dam removal) and $112.8 million (full dam removal). These alternatives would have negative cost benefit ratios of -1.29 for the partial dam removal and -1.14 for the full dam removal alternative. The magnitude of the net benefit loss and the negative cost benefit ratios indicate that the dam removal alternatives would be an extremely expensive undertaking for the SCVWD both in terms of its initial construction cost and from the long term increase in annual water supply costs.

5.0 SUMMARY

Table 12 provides the CBA's summary findings. The following key findings can identified from the analysis.

Costs:

- The construction costs for alternatives range from $39 million for the lower spillway alternative to $93 million for full dam removal. The retrofit and partial dam removal alternatives have comparable construction costs of $58 million and $56 million respectively.
- The future O&M costs for the alternatives are comparable and range from $143,000 to $310,000 per year. It is assumed that there would be no water quality monitoring requirements for the dam removal alternatives.
- The present value of the total project costs (50 years and 3 percent discount rate) range from $47 million for the lower spillway alternative to $99 million for full dam removal. The present value cost for the retrofit base case is $66 million.

Benefits:

- Retrofit alternative is the base case and by definition has a $0 total benefit for CBA benefit comparison purposes. Present value of its projected 2,500 af/yr water supply yield is $66.0 million and approximately equivalent to a $1,015/af benefit value.
- Lower spillway is $27.7 million (present value) - all from its 500 af/yr reduced water yield.
- Dam alternatives projected to result in major benefit losses of $79.5 to $83.3 million (present value).
    - Water supply benefit loss estimated to be $80.2 million (present value)
    - Only very minor habitat benefits could be identified for dam removal ($5.7 million to $9.3 million total present value). Gains nearly offset by potential impairment to the Guadalupe Creek Restoration Project (up to $8.9 million cost).
- Negligible benefit changes for recreation and water quality.

Overall

- Retrofit results in the greatest total benefits.
- Lower spillway would result in a comparative net benefit loss of $8.7 million in present value terms over the 50 year study period. Benefit loss is attributable to the cost premium for alternative replacement water sources.

Dam removal alternatives would result in comparable net benefit losses of $83.3 to $79.8 million. This would be expected to result in major additional annual water supply costs for SCVWD.

Table 12: Cost-Benefit Evaluation of Guadalupe Dam Removal Options Versus Dam Retrofit

Parameter	Comparative Costs & Benefits				Comments
	Dam Retrofit (Base case)	Lower Spillway	Partial Dam Removal	Full Dam Removal	
Construction Costs					
Dam Modifications	$9,200,000	$3,000,000	$8,200,000	$9,800,000	
Spillway Modifications	$1,500,000	$3,400,000	$0	$1,000,000	
Outlet Modifications	$13,300,000	$9,700,000	$1,100,000	$1,000,000	
Reservoir/Stream Habitat Construction	$0	$0	$14,900,000	$31,000,000	High degree of uncertainty on quantity of sediment removal and offsite disposal requirements. Moderate uncertainty on habitat restoration objectives and requirements for.
Miscellaneous Items	$11,800,000	$8,100,000	$10,300,000	$14,500,000	
Allowances	$22,400,000	$15,200,000	$21,500,000	$35,800,000	
Total Construction Costs	**$58,000,000**	**$39,000,000**	**$56,000,000**	**$93,000,000**	
Annual Operating & Maintenance Costs (in 2014 dollars)					
Reservoir O&M and Dam Safety	$160,000	$160,000	$0	$0	
Water Quality Monitoring	$150,000	$150,000	$0	$0	
Habitat Maintenance	$0	$0	$143,079	$143,079	
Total Annual O&M Costs	**$310,000**	**$310,000**	**$143,079**	**$231,279**	
Total Costs (in 2014 dollars) – Net Present Value (3% discount rate, 50 year period)					
Total Construction Costs	$58,000,000	$39,000,000	$56,000,000	$93,000,000	
Total Annual O&M Costs	$7,976,227	$7,976,227	$3,681,378	$5,950,743	
Total Costs	**$65,976,227**	**$46,976,227**	**$59,681,378**	**$98,950,743**	

Table 12: Cost-Benefit Evaluation of Guadalupe Dam Removal Options Versus Dam Retrofit

Parameter	Comparative Costs & Benefits				Comments
	Dam Retrofit (Base case)	Lower Spillway	Partial Dam Removal	Full Dam Removal	
Total Benefits (in 2014 dollars) – Net Present Value (3% discount rate, 50 year period)					
Water Supply	$0	-$27,664,882	-$80,156,552	-$80,156,552	Water supply benefits compared to retrofit base case 2,500 af/yr yield
Downstream Minimum Stream Flows	$0	$0	-$8,879,000	-$8,879,000	Potential impairment to Guadalupe Creek Restoration Project.
Flood Management	-	-	-	-	Assumes Guadalupe River Flood Protection Project built before project construction starts.
Habitat and Other Environmental	-	-	$5,723,143	$9,251,143	Dam removal may add 45 acres of reclaimed vegetation habitat. Full dam removal may add up to 3 miles of new fish habitat.
Water Quality	-	-	-	-	Sediment removal and off-site disposal required for Full dam removal Alternative.
Recreation	-	-	-	-	Negligible current/future use.
Total Benefits	**$0**	**-$27,664,882**	**-$83,342,409**	**-$79,814,409**	Total benefits compared to retrofit base case.
Net Benefits (in 2014 dollars) – Net Present Value (3% discount rate, 50 year period)					
Total Costs	$65,976,227	$46,976,227	$59,681,378	$98,950,743	
Total Benefits	$65,976,227	$38,311,345	-$17,366,182	-$13,838,182	Includes retrofit base case water supply value of $65.9 million
Total Project Net Benefits	**$0**	**-$8,664,882**	**-$77,047,560**	**-$112,788,925**	

6.0 REFERENCES

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FIGURES

Figure 1

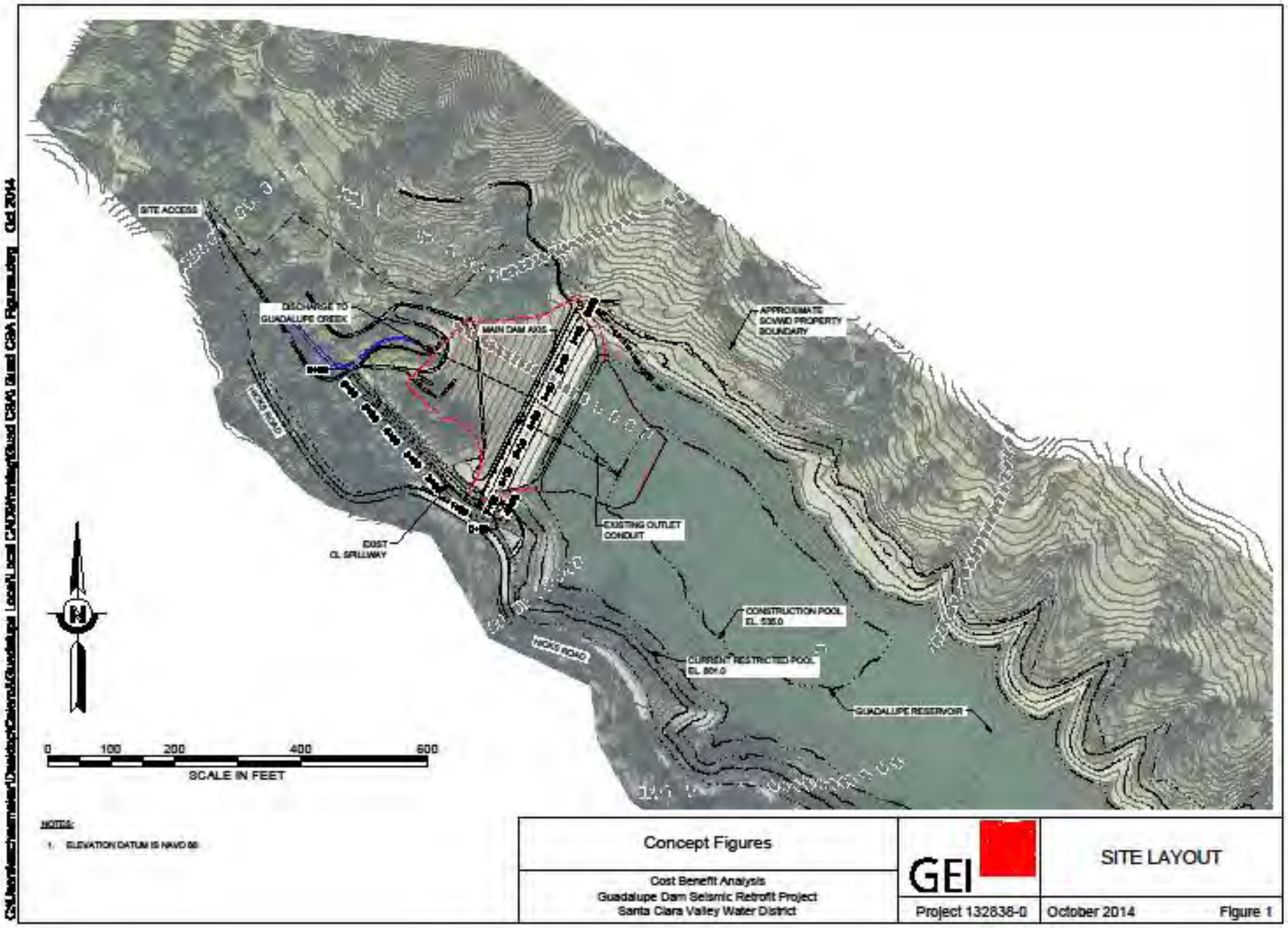

SITE ACCESS
DISCHARGE TO GUADALUPE CREEK
MAIN DAM AXIS
APPROXIMATE SCVWD PROPERTY BOUNDARY
EXIST CL SPILLWAY
EXISTING OUTLET CONDUIT
CONSTRUCTION POOL EL. 535.0
CURRENT RESTRICTED POOL EL. 501.0
GUADALUPE RESERVOIR
HICKS ROAD
0 100 200 400 600
SCALE IN FEET
NOTES:
1. ELEVATION DATUM IS NAVD 88
Concept Figures
Cost Benefit Analysis
Guadalupe Dam Seismic Retrofit Project
Santa Clara Valley Water District
GEI
SITE LAYOUT
Project 132838-0
October 2014
Figure 1

Figure 2

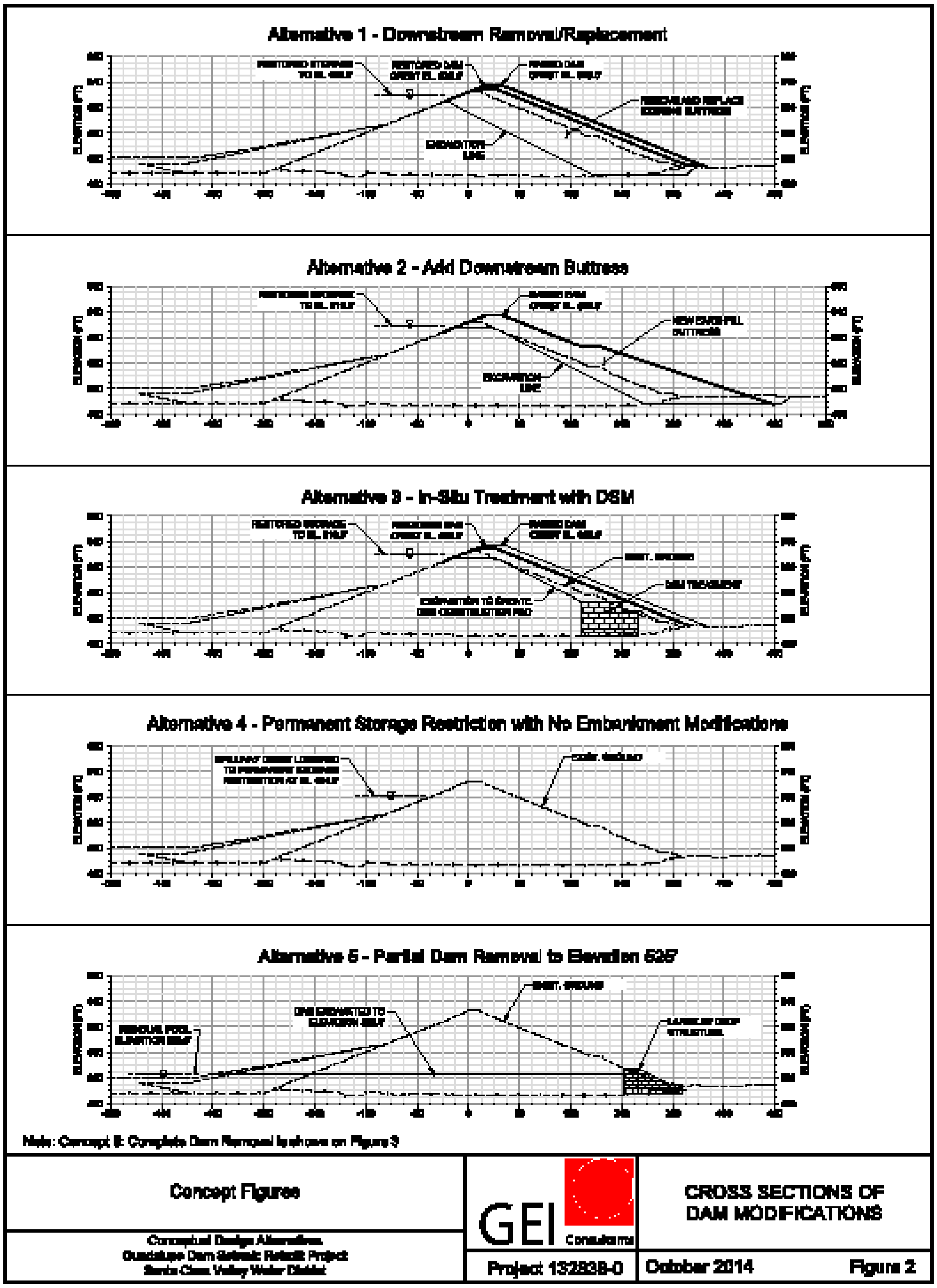

Alternative 1 - Downstream Removal/Replacement
Alternative 2 - Add Downstream Buttress
Alternative 3 - In-Situ Treatment with DSM
Alternative 4 - Permanent Storage Restriction with No Embankment Modifications
Concept Figures
CROSS SECTIONS OF DAM MODIFICATIONS
GEI Consultants
October 2014
Figure 2

Figure 3

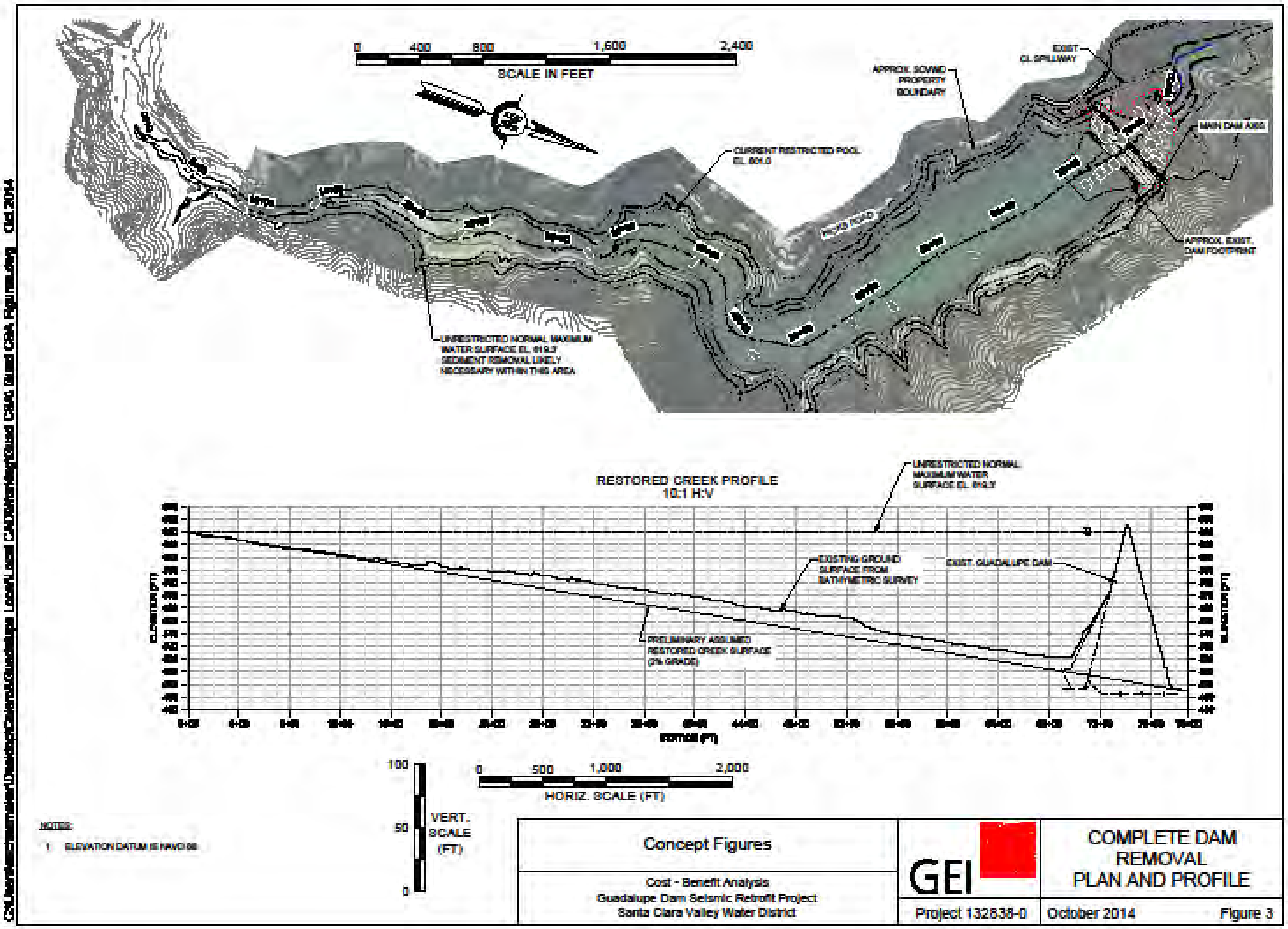
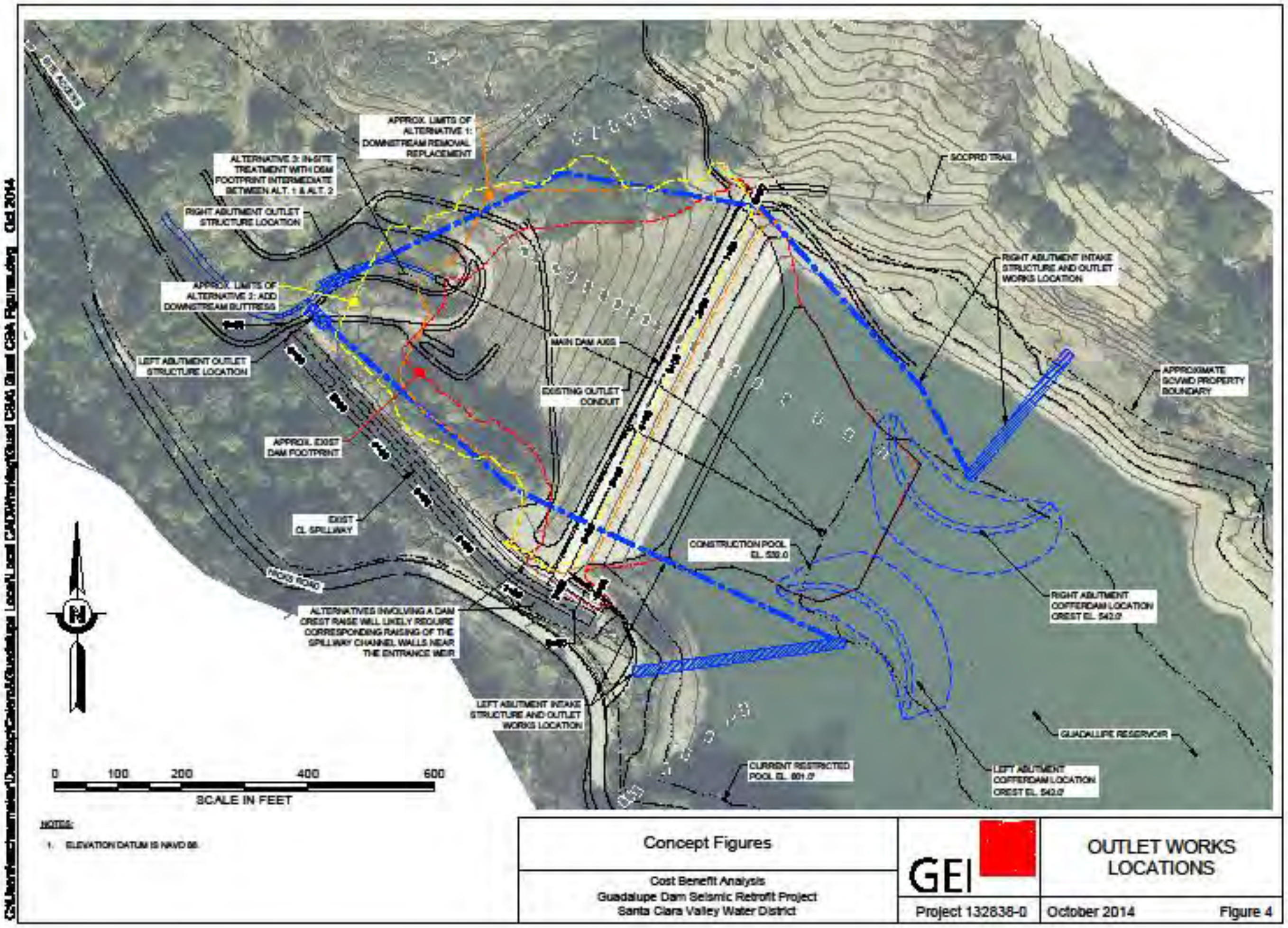

SCALE IN FEET
0
400
800
1,600
2,400
APPROX. SCVWD PROPERTY BOUNDARY
EXIST. CL SPILLWAY
MAIN DAM AXIS
CURRENT RESTRICTED POOL
APPROX. EXIST. DAM FOOTPRINT
UNRESTRICTED NORMAL MAXIMUM WATER SURFACE EL. 619.3'
SEDIMENT REMOVAL LIKELY NECESSARY WITHIN THIS AREA
RESTORED CREEK PROFILE
10:1 H:V
UNRESTRICTED NORMAL MAXIMUM WATER SURFACE EL. 619.3'
EXISTING GROUND SURFACE FROM BATHYMETRIC SURVEY
EXIST. GUADALUPE DAM
PRELIMINARY ASSUMED RESTORED CREEK SURFACE (2% GRADE)
ELEVATION (FT)
STATION (FT)
VERT. SCALE (FT)
100
50
0
HORIZ. SCALE (FT)
0
500
1,000
2,000
NOTES:
1 ELEVATION DATUM IS NAVD 88
Concept Figures
Cost - Benefit Analysis
Guadalupe Dam Seismic Retrofit Project
Santa Clara Valley Water District
GEI
COMPLETE DAM REMOVAL PLAN AND PROFILE
Project 132838-0
October 2014
Figure 3

Figure 4


APPROX. LIMITS OF ALTERNATIVE 1: DOWNSTREAM REMOVAL REPLACEMENT
ALTERNATIVE 3: IN-SITE TREATMENT WITH DAM FOOTPRINT INTERMEDIATE BETWEEN ALT. 1 & ALT. 2
RIGHT ABUTMENT OUTLET STRUCTURE LOCATION
APPROX. LIMITS OF ALTERNATIVE 2: ADD DOWNSTREAM BUTTRESS
LEFT ABUTMENT OUTLET STRUCTURE LOCATION
APPROX. EXIST DAM FOOTPRINT
EXIST CL SPILLWAY
MAIN DAM AXIS
EXISTING OUTLET CONDUIT
ALTERNATIVES INVOLVING A DAM CREST RAISE WILL LIKELY REQUIRE CORRESPONDING RAISING OF THE SPILLWAY CHANNEL WALLS NEAR THE ENTRANCE WEIR
CONSTRUCTION POOL EL. 530.0
LEFT ABUTMENT INTAKE STRUCTURE AND OUTLET WORKS LOCATION
CURRENT RESTRICTED POOL EL. 601.0'
SCCPRD TRAIL
RIGHT ABUTMENT INTAKE STRUCTURE AND OUTLET WORKS LOCATION
APPROXIMATE SCVWD PROPERTY BOUNDARY
RIGHT ABUTMENT COFFERDAM LOCATION CREST EL. 542.0'
GUADALUPE RESERVOIR
LEFT ABUTMENT COFFERDAM LOCATION CREST EL. 542.0'
N
0
100
200
400
600
SCALE IN FEET
NOTES:
1. ELEVATION DATUM IS NAVD 88.
Concept Figures
Cost Benefit Analysis
Guadalupe Dam Seismic Retrofit Project
Santa Clara Valley Water District
GEI
Project 132838-0
OUTLET WORKS LOCATIONS
October 2014
Figure 4

APPENDIX A

Table A-1 – Description of Alternatives Key Features

Retrofit Features	Seismic Retrofit Alternatives: Retrofit Dam to Restore Full Storage	Lower Spillway – Leave Dam In Place	Partial Dam Removal	Full Dam Removal
Key Retrofit Components	• Dam Embankment Modified • Abandon Existing Outlet Works • Add New Outlet Works • Raise Dam Crest or Enlarge Spillway Note: Multiple design alternatives	• Dam Embankment Unchanged • Rehabilitate Outlet Works (new intake and outlet structures, line conduit) • Notch Spillway (permanent lowering of crest resulting in reduced maximum operating pool) Note: DSOD confirmation of dam safety adequacy may be required.	• Remove Dam Down to Level of Reservoir Sediments (leave reservoir sediments in-place) • New Overflow Structure Down Face of Dam • Abandon Existing Outlet Works • Abandon or Remove Spillway • Vegetate Reservoir and Establish Upstream Channel Across Sediments Note: DSOD / stakeholders support may be required.	• Full dam removal • Excavate Reservoir Sediments and • Remove Existing Outlet Works • Abandon or Remove Spillway • Channel Restoration Note: DSOD / stakeholders support may be required.
Loss of Reservoir Storage full capacity (3,564 ac-ft)	None	Partial (approx. 1,500 ac-ft)	Full (3,564 ac-ft)	Full (3,564 ac-ft)
Operational Uses/Features	• Water Supply (recharge) • Minimum Streamflow • Flood Management (secondary) • Recreation (secondary)	• Reduced Water Supply (recharge) • Minimum Streamflow • Flood Management (secondary) • Recreation (secondary)	• Natural Streamflow • No Water Supply (recharge) • No minimum stream flow • No Flood Management • Change in reservoir habitat/recreation from lake to wetland/riparian/upland	• Natural Streamflow • No Water Supply (recharge) • No minimum stream flow • No Flood Management • Change in reservoir habitat/recreation from lake to riparian/upland • Fish passage to upstream watershed

Table A-1 – Description of Alternatives Key Features

Retrofit Features	Seismic Retrofit Alternatives			
	Retrofit Dam to Restore Full Storage	**Lower Spillway – Leave Dam In Place**	**Partial Dam Removal**	**Full Dam Removal**
Operational & Maintenance Requirements	• Ongoing water supply operations, facility maintenance, and dam safety instrumentation and monitoring • Continued DSOD oversight of dam	• Ongoing water supply operations, facility maintenance, and dam safety instrumentation and monitoring • Continued DSOD oversight of dam	• Change from dam/water supply to stream maintenance operations • Possible continued DSOD oversight for remaining embankment and overflow structure • Vegetation restoration, maintenance and monitoring for establishment (10 yr) • Reduced vegetation maintenance and monitoring after establishment • Division ownership and maintenance/monitoring responsibility TBD	• Change from dam/water supply to stream maintenance operations • Vegetation restoration, maintenance, and monitoring for establishment (10 yr) • Reduced vegetation maintenance/monitoring after establishment • Need for fish passage maintenance and monitoring TBD • Division ownership and maintenance/monitoring responsibility TBD

APPENDIX B

SUPPLEMENTAL CBA INCLUDING FLOOD PROTECTION BENEFITS

Current Guadalupe Dam operations result in incidental flood control benefits for the Guadalupe River. As discussed previously in Section 4.3.3, SCVWD is planning to develop the Guadalupe River Flood Protection Project (GRFPP). Once the proposed levee and other channel improvements are completed, the currently vulnerable residences and businesses located near the Guadalupe River will be better protected from future downstream flood damages and consequently Guadalupe Dam would no longer result in any incidental downstream flood protection benefits.

The initial CBA has assumed that the GRFPP would be completed before major construction work for the Guadalupe Dam retrofit or removal project would begin. Accordingly, no future flood protection costs were attributed to either of the project's two dam removal alternatives.

Congressional authorization for the GRFPP was originally obtained in 1999 and subsequently re-authorized in 2007. However, while preliminary planning and design is underway, the necessary non-federal project funding has not yet been secured. The GRFPP is a major infrastructure project with an estimated construction cost of $277.0 million in 2012 dollars (USACE 2012). Based on the most current Producer Price Index for construction industry inputs, the project cost in 2014 dollars would be unchanged (BLS 2014).

Given the flood protection project's major funding requirement it is possible that future funding and construction of the GRFPP could be majorly delayed until after the Guadalupe Dam retrofit/removal project has been completed. In which case, the dam removal alternatives would result in flood protection costs compared to the dam retrofit alternatives' flood protection benefits.

The supplemental CBA estimates the Guadalupe Dam alternatives' potential short-term flood protection costs and incorporates them into modified CBA results.

Analysis

The magnitude of the potential flood control benefits will depend on several factors. The nature/likelihood of the future flood events will be a key factor, but more specifically for the CBA will be SCVWD's ability during heavy rainfall conditions to modify reservoir operations to reduce its downstream releases sufficiently to decrease the severity of flood events in Guadalupe Creek and further downstream in the Guadalupe River. The property values of the affected residences and businesses will also affect the flood protection benefit estimates.

Impact Duration

As a conservative assumption, it is assumed that future Guadalupe Dam removal could begin as soon as 2020 from which point it is assumed that the facility would no longer provide incidental flood protection to the Guadalupe River.

While future funding may be delayed, it is assumed that funding would occur and GRFPP would be in operation by 2030. Consequently, the flood benefit costs associated with the Guadalupe Dam removal alternatives would be limited to the ten-year period between 2020 and 2030.

Description of Flood Protection Effects

Downstream of the dam, Guadalupe Creek has 100-year flood capacity, while the Guadalupe River does not (SCVWD 2006). As a result, Guadalupe Reservoir's flood protection benefits result from its indirect effects on the flood conditions along the Guadalupe River. Due to the dam's relatively small capacity, its flood reduction benefits are realized more for smaller recurrence events.

A majority of the flood damages that occur are along the tributaries that empty into the Guadalupe River. When the Guadalupe River is in high stage, a backwater condition exists where the tributaries cannot convey the flood waters and end up overbanking and spilling into the urban areas. SCVWD flood analysis determined that during a 100-year flood event up to 5 feet of flooding could occur to a large number of houses and businesses located within a 2,400 foot corridor of the Guadalupe River. Figures A-1 to A-4 show the projected flood impacts if Guadalupe dam is removed under 10-year, 25-year, 50-year and 100-year flood conditions.

These figure show that flood damage is particularly predicted to occur: (1) near the river between Capitol Expressway and Curtner Avenue; (2) between Willow Street and Willow Glen Way; (3) on Ross Creek tributary between Jarvis Avenue and Cherry Avenue; and (4) on Canoas Creek tributary near Nightingale Avenue. In addition, under the extent of the flood damages increase under the more infrequent and larger 50-year and 100-year flood events.

The US Army Corps of Engineers recently completed an updated economic impact study of the proposed GRFPP (USACE 2012). The economic analysis determined the project's net benefits for a wide variety of flood related impacts. While the inundation reduction is the primary project benefit, USACE's economic analysis also considers the emergency response, displacement and traffic related avoided cost savings, as well as reduced flood insurance, infrastructure and other project benefits.

The GRFPP would protect up to 9,590 structures (under a 500-year flood event) of which 8,250 would be damaged under a 100-year flood event. A 20-year flood event is projected to result in flood damages to approximately 3,230 structures within the Guadalupe River flood plain. While residential homes account for the majority of affected buildings, up to 540 businesses (both commercial and industrial) and 29 public buildings would be protected from major flood damage.

Estimated Flood Protection Benefits/Costs

The expected flood damages values were estimated by SCVWD using the recent USACE analysis and FEMA HAZUS modeling information. HAZUS is a nationally applicable standardized methodology that contains models for estimating potential losses from floods and other natural disaster events. HAZUS uses Geographic Information Systems (GIS) technology to estimate physical, economic and social impacts of disasters. The analysis of the avoided flood damage benefits incorporated local property data with standard Content Structure Value Ratio values with future flood incidence projections to develop Expected Annual Damage (EAD) outcomes for both with and without Guadalupe Reservoir conditions. Table A-1 provides estimates of the average annualized damages expected for the seismic retrofit, spillway modification and dam removal alternatives.

Figure A-1: 10-year Flood Conditions

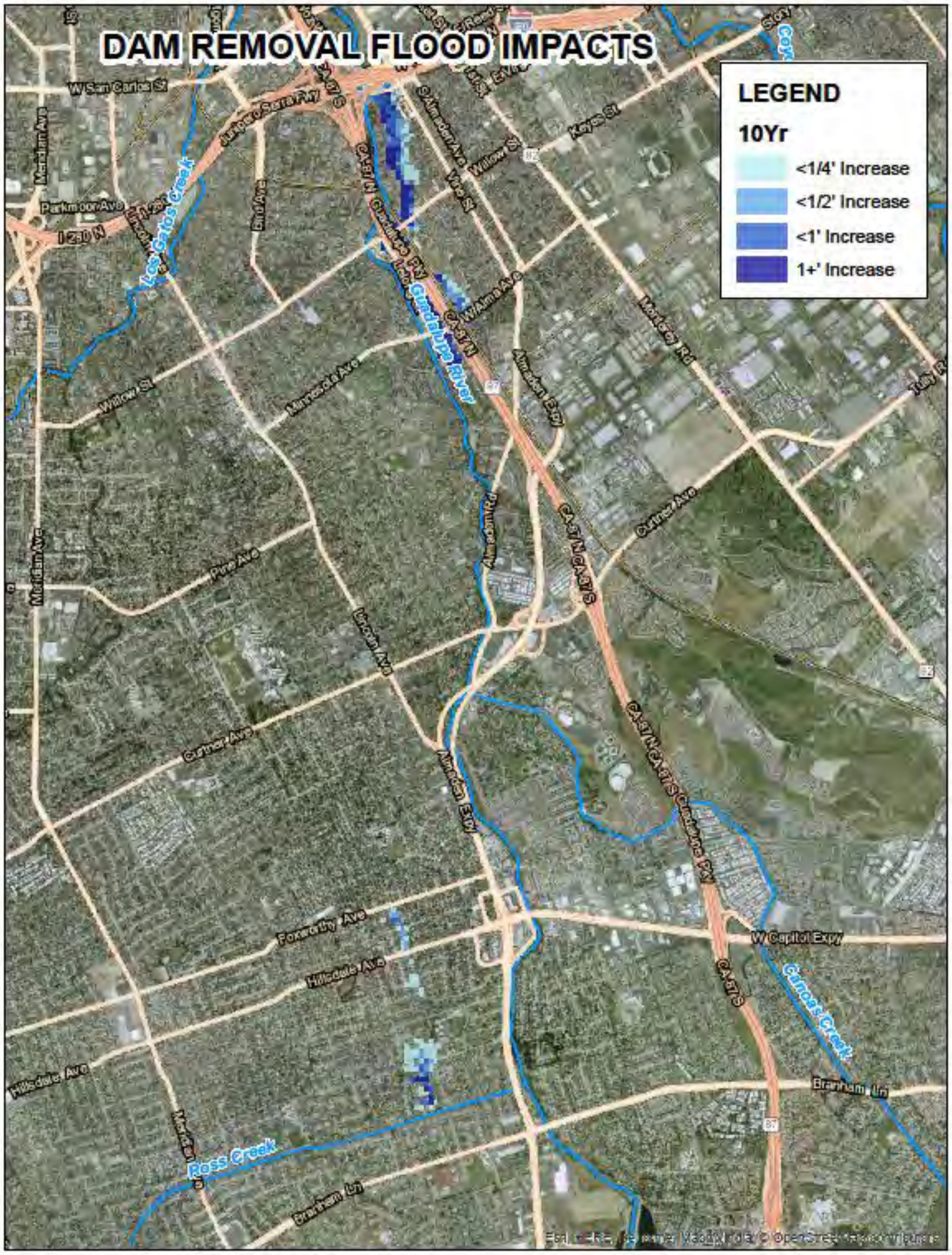


Figure A-2: 25-year Flood Conditions

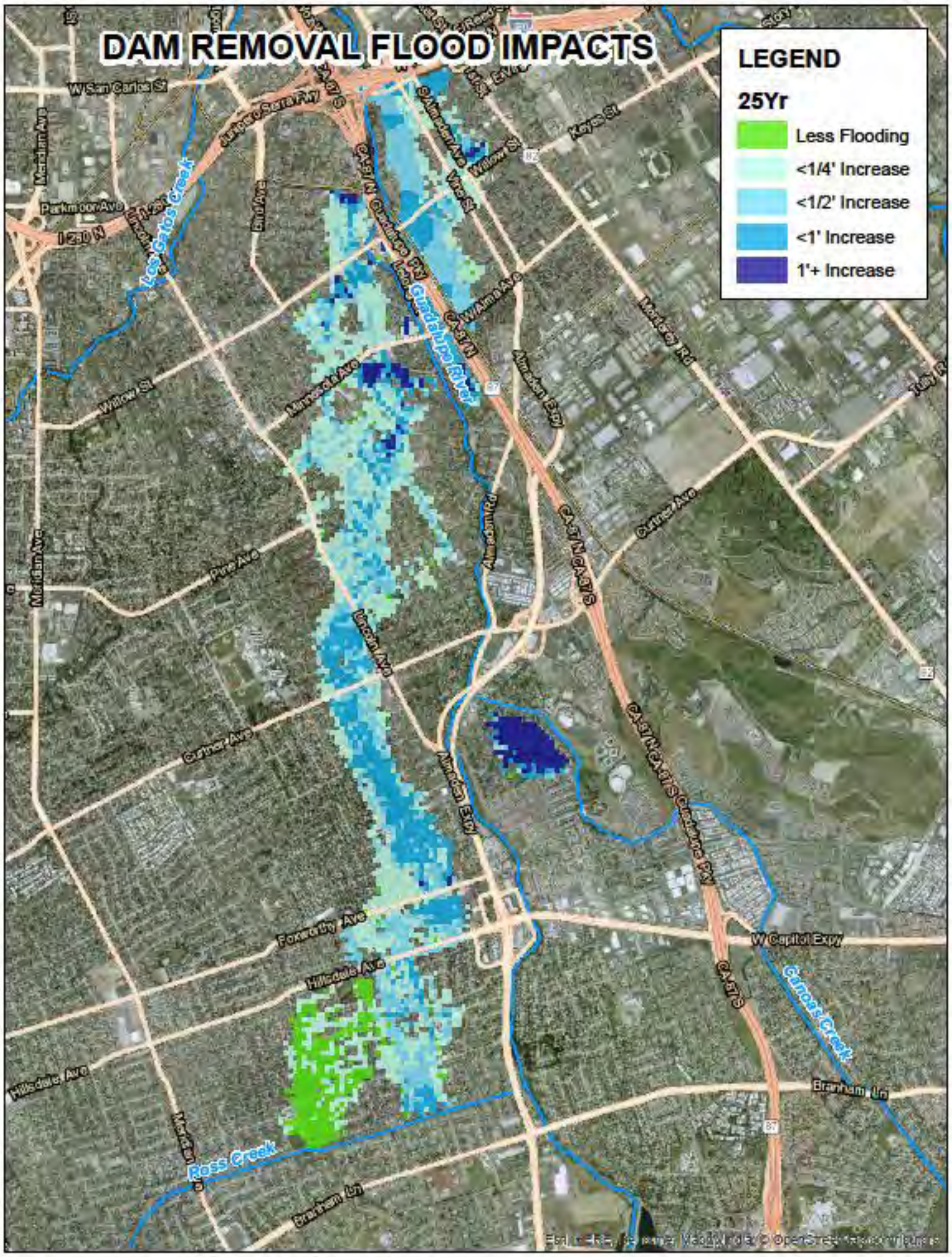


Figure A-3: 50-year Flood Conditions

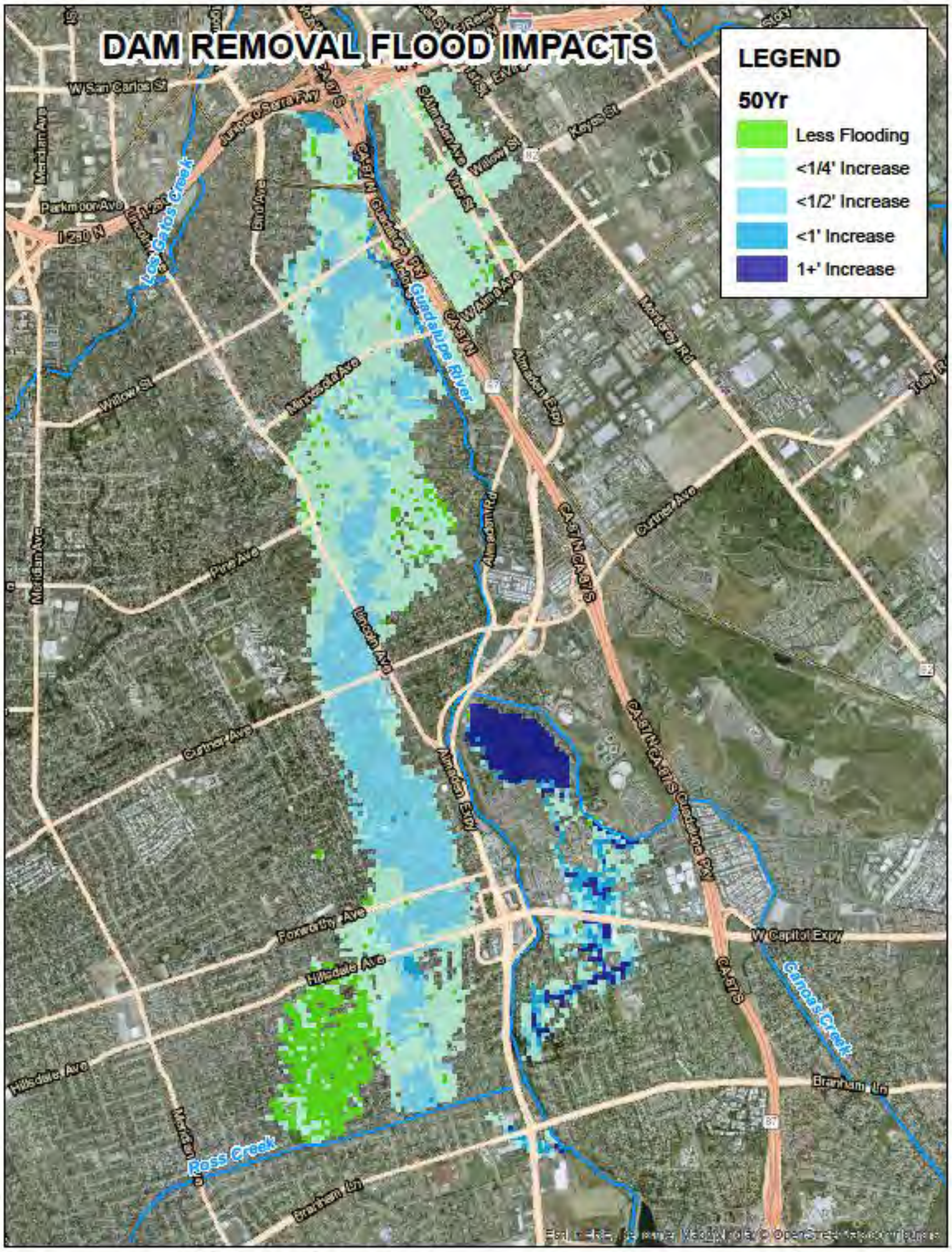


Figure A-4: 100-year Flood Conditions

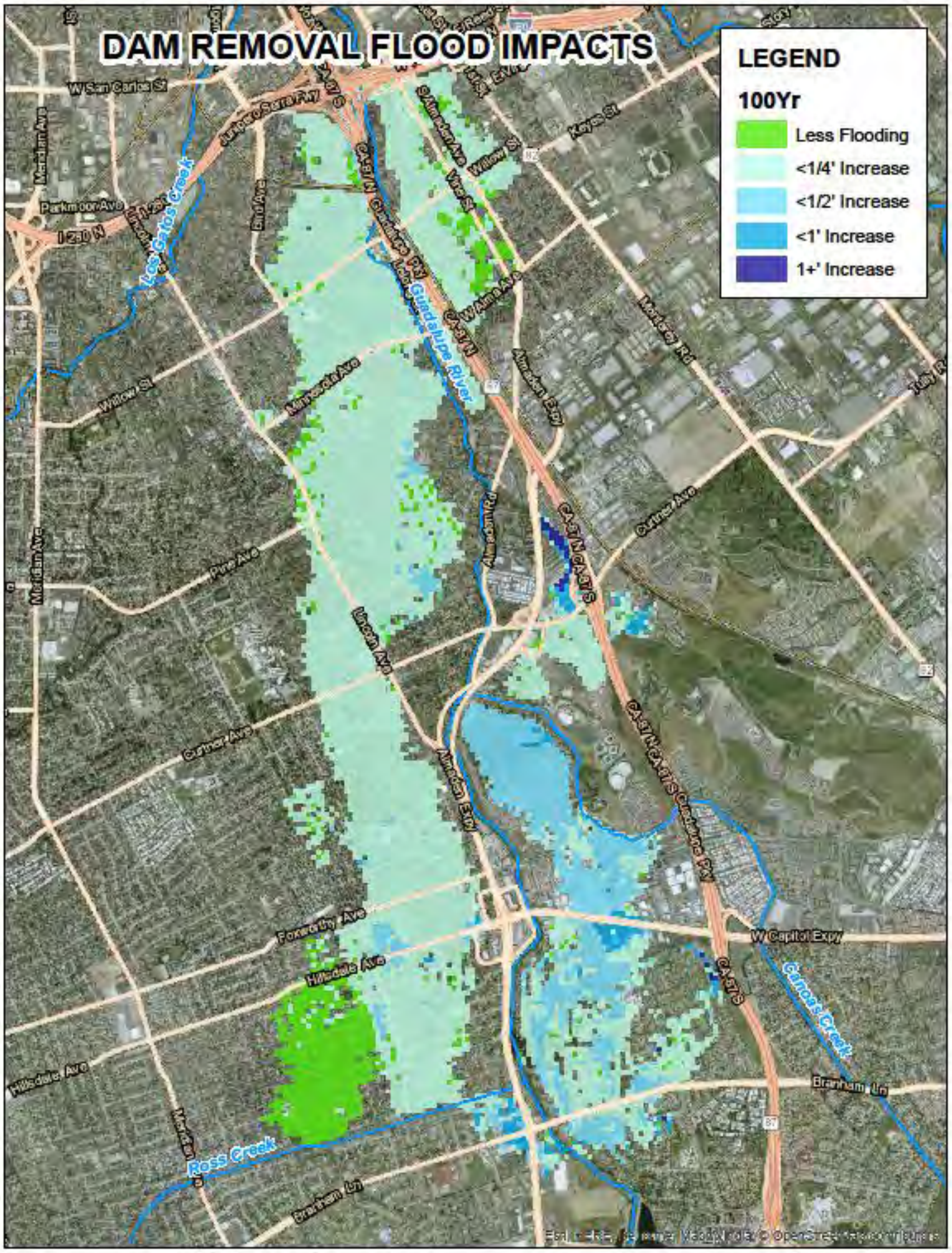


Table A-1: Future Flood Damages

Flood Impacts	Retrofit (base case) and Lower Spillway	Dam Removal	Net Change
Projected Flood Conditions at Almaden Rd.			
100 Year Flood Event	14,579 cfs	15,372 cfs	- 793 cfs
10 Year Flood Event	6,417 cfs	7,889 cfs	-1,472 cfs
Average Annualized Damages	**$28.6 million**	**$45.0 million**	**- $16.4 million**

Source: SCVWD 2014e.

SCVWD projects that seismic retrofit of Guadalupe Dam and restoration of full reservoir capacity would enable a 793 cfs reduction to the flood conditions for a 100-year flood and 1,472 cfs for a 10-year flood event. Annualizing the cost and likelihood of such flood events, retrofit or the lower spillway alternatives are estimated to result in a benefit of $16.4 million in avoided future flood damages annually.

Conclusions

The dam retrofit alternatives are estimated to result in $16.4 million in annual flood protection benefits for the region until the Guadalupe River Flood Protection Project is operational. For the purposes of the CBA it is conservatively assumed that the proposed Guadalupe River Flood Protection Project would be completed by 2030. These flood benefits would be lost if the dam removal alternatives are implemented. It is conservatively assumed the dam removal alternative could result in reduced flood protection as soon as 2020. As a result, the potential flood protection benefits of the retrofit and lower spillway alternatives would potential extend between the 2020 to 2030 time period.

CBA Findings including Guadalupe Dam Potential Flood Benefits

Table A-2 shows each alternative's projected annual benefits and benefit losses. The annual total benefit loss for both dam removal alternatives including their potential flood benefits is projected to be approximately $19.5 million. The lost benefits in downstream flood protection are projected to account for the majority (84.2 percent) of the annual benefit loss. However, this flood protection benefit reduction is expected to be limited to the 2020 to 2030 time period.

Table A-3 shows each alternative's projected benefits and benefit losses in present value terms using a 3 percent discount rate. It also includes the one-time benefit events (e.g. habitat gains or losses). Over the future 50 year study period, the present value of lower spillway alternative's total lost benefit value is estimated to be approximately $27.7 million in 2014 dollar terms. Reduced water supply effects account for all the projected benefit losses as no differences in its flood protection performance or other resource effects are expected.

Table A-2: Projected Guadalupe Dam Alternatives Benefits – Annual (2014$/yr)

Benefit Categories	Retrofit (Base Case)	Lower Spillway	Dam Removal Partial and Full
Water Supply Deliveries (Guadalupe)	*$0*	*-$507,708*	*-$2,040,988*
Replacement Supply Net Cost Increase	-	*-$550,747*	*-$1,040,070*
Net Water Supply	$0	-$1,058,456	-$3,081,058
Downstream Minimum Flows	-	-	(a)
Flood Management (b)	$0	$0	-$16,400,000
Water Quality (c)	-	-	-
Habitat and Other Environmental			(d)
Recreation	-	-	-
Total Benefits - Annual	$0	-$1,058,456	-$19,481,058

Source: URS 2014.
(a) A potential one-time damage loss to the Guadalupe Creek Restoration Project is identified in the NPV Benefit Table.
(b) Benefits expected until completion of the Guadalupe River Protection Project Completion in 2030 (projected).
(c) No water quality impacts from full dam removal due to proposed sediment removal and off-site disposal.
(d) Full dam removal may result in net gain of up to 3 miles of upstream fish and 45 acres of reclaimed vegetation habitat.
The one-time gain is identified in the NPV Benefit Table.

Table A-3: Comparison of Projected Guadalupe Dam Alternatives Benefits – Present Value (3% Discount Rate; 2014$)

Benefit Categories	Retrofit (Base Case)	Lower Spillway	Dam Removal	
			Partial	Full
Water Supply	$0	-$27,664,882	-$80,186,552	-$80,186,552
Downstream Minimum Stream Flows	$0	$0	-$8,879,000	-$8,879,000
Flood Benefits	$0	$0	-$120,674,938	-$120,674,938
Habitat and Other Environmental	$0	$0	$5,723,143	$9,251,143
Total Benefits - PV (3%)	**$0**	**-$27,664,882**	**-$204,017,347**	**-$200,489,347**

Source: URS 2014.

For the partial dam removal alternative, the present value of future total lost benefit value is estimated to be approximately $204.0 million in 2014 dollar terms. Under the full dam removal alternative, the total lost benefit value is projected to be $200.5 million as a result of up to $3.5 million in potential positive upstream fishery habitat benefit gains.

Under both dam removal alternatives the lost water supply benefits are estimated to total approximately $80.2 million. The largest share (approximately 60 percent) of these alternatives’ total benefit losses are associated with their estimated $120.7 million in reduced future flood protection between 2020 and until 2030 (when the planned Guadalupe River Protection Project is assumed to be completed).

As discussed in Section 4.1, at a minimum the water supply benefit value for seismic retrofit alternative would be expected to be equivalent to its total development cost. This would correspond to a projected benefit cost ratio of 1.0 and indicate that it would in effect operate as a break even enterprise. In actuality, SCVWD water users undoubtedly obtain further additional benefits from future use of the delivered water but any such consumer surplus benefits are not estimated by the CBA.

Applying a $66.0 million water value for the retrofit base case water to the Table A-3 benefit comparison results enable the total project net benefit estimates shown in Table A-4 for each of the dam alternatives. Table A-4 shows the total estimate cost in present value terms for the four Guadalupe Alternatives assuming a 3% discount rate and a 50-year future study period.

Table A-4: Total Project Costs and Benefits by Alternative – Net Present Value (3% Discount Rate; 2014$)

Cost Factors	Retrofit (Base Case)	Lower Spillway	Dam Removal	
			Partial	**Full**
Water Supply Yield (af/yr)	2,500	2,000	490	490
Total Construction	$58,000,000	$39,000,000	$56,000,000	$93,000,000
Total O&M - Annual	$310,000	$310,000	$143,079	$231,279
Total O&M - PV (3%)	$7,976,227	$7,976,227	$3,681,378	$5,950,743
Total Cost - PV (3%)	$65,976,227	$46,976,227	$59,681,378	$98,950,743
Total Benefits – PV (3%)	$65,976,227	$38,311,345	-$138,041,120	-$134,513,120
Net Benefits - PV (3%)	**$0**	**-$8,664,882**	**-$197,722,498**	**-$233,463,863**

Source: GEI and URS 2014.

Overall, the results show that there is a relatively minor benefit loss associated with the lower spillway alternative which over the 50 year period would result in a net economic cost of approximately $8.7 million. Given its estimated total lifecycle cost of approximately $47.0 million the lower spillway alternative would have a cost benefit ratio less than 0.82. These results indicate that generally speaking the lower spillway alternative would not be a recommended use of future SCVWD funding.

Both the dam removal alternatives are projected to result in major net benefit losses of between $197.7 million (partial dam removal) and $233.5 million (full dam removal). This is largely due to the approximately $120.7 million net lost in flood protection benefits if the dam is removed.

Inclusion of the Guadalupe Reservoir's potential flood protection benefits further increases the net societal cost of the dam removal alternatives compared to the retrofit and lower spillway alternatives which have the additional comparative benefit of providing future water supplies for SCVWD groundwater recharge system.

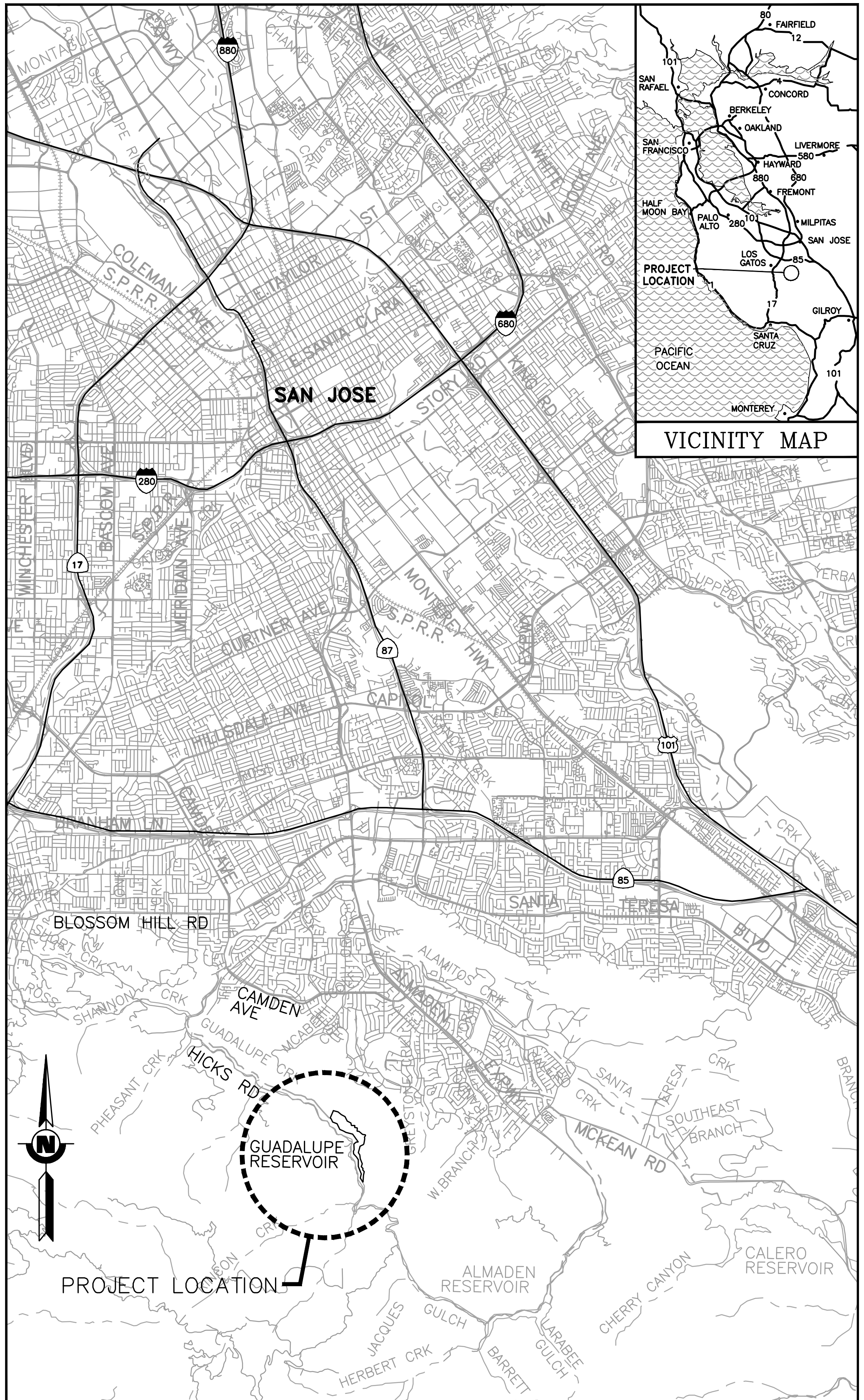
References

United States Army Corps of Engineers (USACE), *Upper Guadalupe River Flood Risk Management Project – Level 3 Economic Update Final,* June 2013.

Appendix D

Guadalupe Dam Staff Recommended Alternative Drawings

Sheet No.	Drawing No.	Drawing Title
General Drawings		
1	G-1	Vicinity / Project Area Map and List of Drawings
2	G-2	Abbreviations and Notes
3	G-3	Overall Site Map
4	G-4	Existing Facilities
5	G-5	General Plan of New Facilities and Access
6	G-6	Borrow, Stockpile and Miscellaneous Details
7	G-7	Material Handling Details
Embankment Drawings		
8	E-1	Dam Crest and Buttress Plan
9	E-2	Dam Excavation & Drainage Plans
10	E-3	Dam Profiles
11	E-4	Dam Cross Sections
12	E-5	Embankment Details
Outlet Works Drawings		
13	O-1	Outlet Works Plan & Profile
14	O-2	Intake Structure Plan and Sections
15	O-3	Intake Control House General Arrangement
16	O-4	Intake Structure and Outlet Works Cross Sections
17	O-5	Outlet Valve House General Arrangement
18	O-6	Temporary Diversion Plan & Profile
Spillway Drawings		
19	S-1	Spillway Plan, Profile and Sections
20	S-2	Spillway Crest Details
21	S-3	Spillway Discharge Area General Arrangement



VERIFY SCALES

0 1"

BAR IS ONE INCH ON ORIGINAL DRAWING IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

LOCATION MAP
SCALE: 1"=5,000'

PRELIMINARY DESIGN DRAWINGS
FOR
STAFF–RECOMMENDED ALTERNATIVE
FOR
GUADALUPE DAM AND RESERVOIR

SEISMIC RETROFIT PROJECT
SAN JOSE, CALIFORNIA

Santa Clara Valley Water District[SM]

PREPARED BY:

GEI Consultants

FINAL
10-30-15

NAME ______________________ DATE
PRINCIPAL ENGINEER

LIST OF DRAWINGS

SHEET NO	SHEET CODE	TITLE
1	G-1	VICINITY / PROJECT AREA MAP AND LIST OF DRAWINGS
2	G-2	ABBREVIATIONS & NOTES
3	G-3	OVERALL SITE MAP
4	G-4	EXISTING FACILITIES AT GUADALUPE DAM
5	G-5	GENERAL PLAN OF NEW FACILITIES & ACCESS
6	G-6	SITE USE PLAN
7	G-7	MATERIAL HANDLING DETAILS
8	E-1	DAM CREST RAISE & BUTTRESS PLAN
9	E-2	DAM EXCAVATION & DRAINAGE PLAN
10	E-3	DAM PROFILES
11	E-4	DAM CROSS SECTIONS
12	E-5	EMBANKMENT DETAILS
13	O-1	OUTLET WORKS PLAN & PROFILE
14	O-2	INTAKE STRUCTURE PLAN & SECTIONS
15	O-3	INTAKE CONTROL HOUSE GENERAL ARRANGEMENT
16	O-4	INTAKE STRUCTURE & OUTLET WORKS CROSS SECTIONS
17	O-5	OUTLET VALVE HOUSE GENERAL ARRANGEMENT
18	O-6	TEMPORARY DIVERSION PLAN & PROFILE
19	S-1	SPILLWAY PLAN, PROFILE & SECTIONS
20	S-2	SPILLWAY CREST DETAILS
21	S-3	SPILLWAY DISCHARGE AREA GENERAL ARRANGEMENT

PROJECT NUMBER
132838–0

SHEET CODE
G–1

SHEET NUMBER:
1 OF 21

DOCUMENT NUMBER: Guad_01_G-1-Cover

ABBREVIATIONS

ALIGN – ALIGNMENT
APPROX – APPROXIMATE

CL – CLEARANCE
CLR – CLEAR
CONC – CONCRETE

DIA – DIAMETER
DISTRICT – SCVWD
DSOD – CA DIVISION OF SAFETY OF DAMS
D/S – DOWNSTREAM

EL – ELEVATION
EXIST – EXISTING

FT – FEET

GEI – GEI CONSULTANTS, INC.

HORIZ – HORIZONTAL
HJW – HJW GEOSPATIAL, INC.

ID – INSIDE DIAMETER
INV – INVERT

MIN – MINIMUM

NMWS – NORMAL MAXIMUM WATER SURFACE
N/A – NOT APPLICABLE

NO – NUMBER
NTS – NOT TO SCALE

OD – OUTSIDE DIAMETER
OW,O/W – OUTLET WORKS

REINF – REINFORCED
REQ'D – REQUIRED

S – SLOPE
SCCPRD – SANTA CLARA COUNTY PARKS AND RECREATION DEPARTMENT
SCVWD – SANTA CLARA VALLEY WATER DISTRICT
SHT – SHEET
SPECS – SPECIFICATIONS
SRA – STAFF–RECOMMENDED ALTERNATIVE
STD – STANDARD
STL – STEEL

TYP – TYPICAL

URS – URS CORPORATION
U/S – UPSTREAM

VERT – VERTICAL

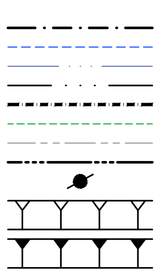
WS – WATER SURFACE
W/ – WITH

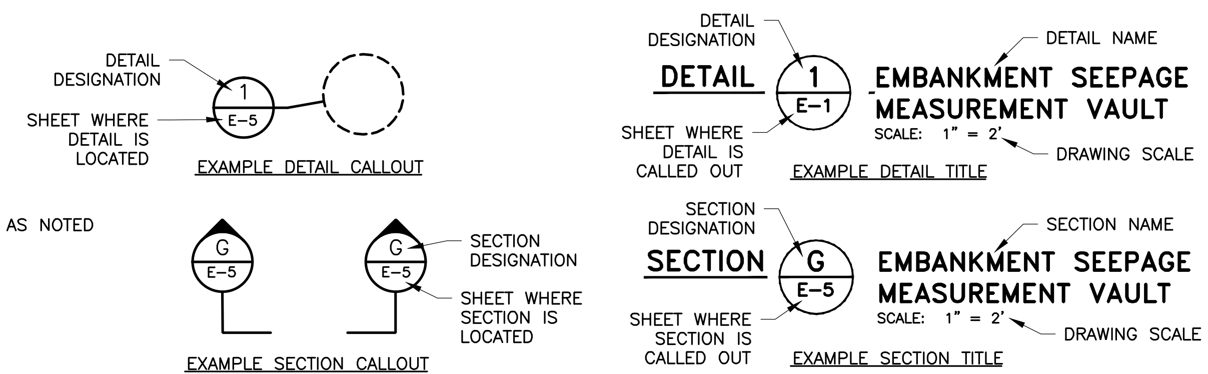
& – AND
@ – AT
℄ – CENTERLINE
Ø – DIAMETER
℘ – PROPERTY LINE

GENERAL NOTES

1. THESE DRAWINGS REPRESENT THE CONFIGURATION AND KEY FEATURES OF THE DISTRICT'S STAFF–RECOMMENDED ALTERNATIVE (SRA) CONSISTENT WITH AN APPROXIMATE 20% LEVEL OF DESIGN CONCEPT DEVELOPMENT. AS SUCH, ADDITIONAL INVESTIGATIONS, ANALYSES AND FINAL DESIGNS WILL BE REQUIRED TO FURTHER DEVELOP THE 30%, 60%, 90% AND 100% DESIGN DRAWINGS, SPECIFICATIONS AND SUPPORTING INFORMATION NEEDED FOR DISTRICT REVIEW, DSOD REVIEW, AND OTHER APPROVALS PRIOR TO BIDDING AND CONSTRUCTION.
2. THE SRA IS BASED UPON EXISTING INFORMATION PROVIDED BY THE DISTRICT INCLUDING THE FINAL REPORT SSE1B – SEISMIC STABILITY EVALUATION OF GUADALUPE DAM, BY AMEC GEOMATRIX, INC AND URS CORPORATION, MAY 2012; AS WELL AS PLANNING LEVEL EVALUATIONS BY GEI CONSULTANTS AS SUMMARIZED IN THE GUADALUPE DAM PROBLEM DEFINITION REPORT, DATED SEPTEMBER 2014 AND THE GUADALUPE DAM ALTERNATIVES REPORT, DATED JUNE 2015. THE FINAL DESIGN CONSULTANT WILL NEED TO FURTHER CONFIRM AND VERIFY THE INFORMATION TO FORM THE BASIS FOR FINAL DESIGN.
3. THE VERTICAL DATUM IS NAVD88 FEET (AT THIS SITE NAVD88 IS APPROXIMATELY EQUAL TO NGVD29+2.3 FT).
4. THE HORIZONTAL COORDINATE SYSTEM IS BASED ON CA ZONE III, NAD 83.
5. TOPOGRAPHY WITHIN THE LIMITS SHOWN IS FROM 2012 PHOTOGRAMMETRY AND BATHYMETRY COMPILED AT 1 FT CONTOUR INTERVALS BY PHOTO SCIENCE INC. TOPOGRAPHY OUTSIDE THESE LIMITS IS FROM USGS LIDAR DATA.
6. TUNNEL PORTALS AND ALIGNMENT, AND INTAKE STRUCTURE LOCATION ARE PRELIMINARY AND WILL REQUIRE ADDITIONAL GEOTECHNICAL INVESTIGATIONS TO CONFIRM FINAL LOCATION AND CONFIGURATION.
7. DISTRICT WILL FULLY LOWER THE RESERVOIR PRIOR TO CONSTRUCTION. AFTER INITIAL RESERVOIR LOWERING BY THE DISTRICT, THE CONTRACTOR SHALL BE RESPONSIBLE FOR TEMPORARY DIVERSION OF NATURAL RESERVOIR INFLOW THROUGH THE WORKSITE AND MAY USE THE EXISTING OUTLET WORKS FOR SUCH PURPOSES. CONTRACTOR SHALL CONTINUOUSLY MAINTAIN, PROTECT AND OPERATE THE EXISTING OUTLET WORKS IN A FULLY SERVICEABLE CONDITION, INCLUDING POTENTIAL EMERGENCY USE, UNTIL THE NEW OUTLET WORKS IS SUBSTANTIALLY COMPLETE AND ACCEPTED FOR USE BY THE DISTRICT, FINAL DESIGN CONSULTANT, AND DSOD.
8. CONTRACTOR SHALL INSTALL AND OPERATE TEMPORARY PUMPOVERS TO PASS NATURAL STREAMFLOW DURING PERIODS WHEN THE EXISTING OUTLET CANNOT PASS STREAMFLOW BY GRAVITY. SUCH PUMPOVERS SHALL BE SCHEDULED OUTSIDE THE WINTER RAINY SEASON SUBJECT TO PERMIT REQUIREMENTS.
9. THE SRA DESIGN CONCEPT IS BASED ON THE REMOVAL OF A PORTION OF THE DAM EMBANKMENT, AND REMOVAL OF THE FOUNDATION SOIL BELOW THE REMOVED EMBANKMENT AND NEW BUTTRESS (ALLUVIAL AND COLLUVIAL SOILS) TO EXPOSE UNDISTURBED ROCK. THE EMBANKMENT BUTTRESS MATERIAL WILL BE PLACED ON APPROVED FOUNDATION MATERIALS. THE DAM FOUNDATION OBJECTIVE AND PREPARATION REQUIREMENTS WILL BE REFINED DURING FINAL DESIGN BY THE FINAL DESIGN CONSULTANT, AND SUBJECT TO CONFIRMATION BY DSOD.

LEGEND





REV	DESCRIPTION	DATE	APPR.	REFERENCE INFORMATION AND NOTES

GEI Consultants

DATE 10-30-15
DESIGN N.K.S.
DRAWN N.K.S.
CHECKED J.G.H.

ENGINEERING CERTIFICATION
PROJECT ENGINEER DATE

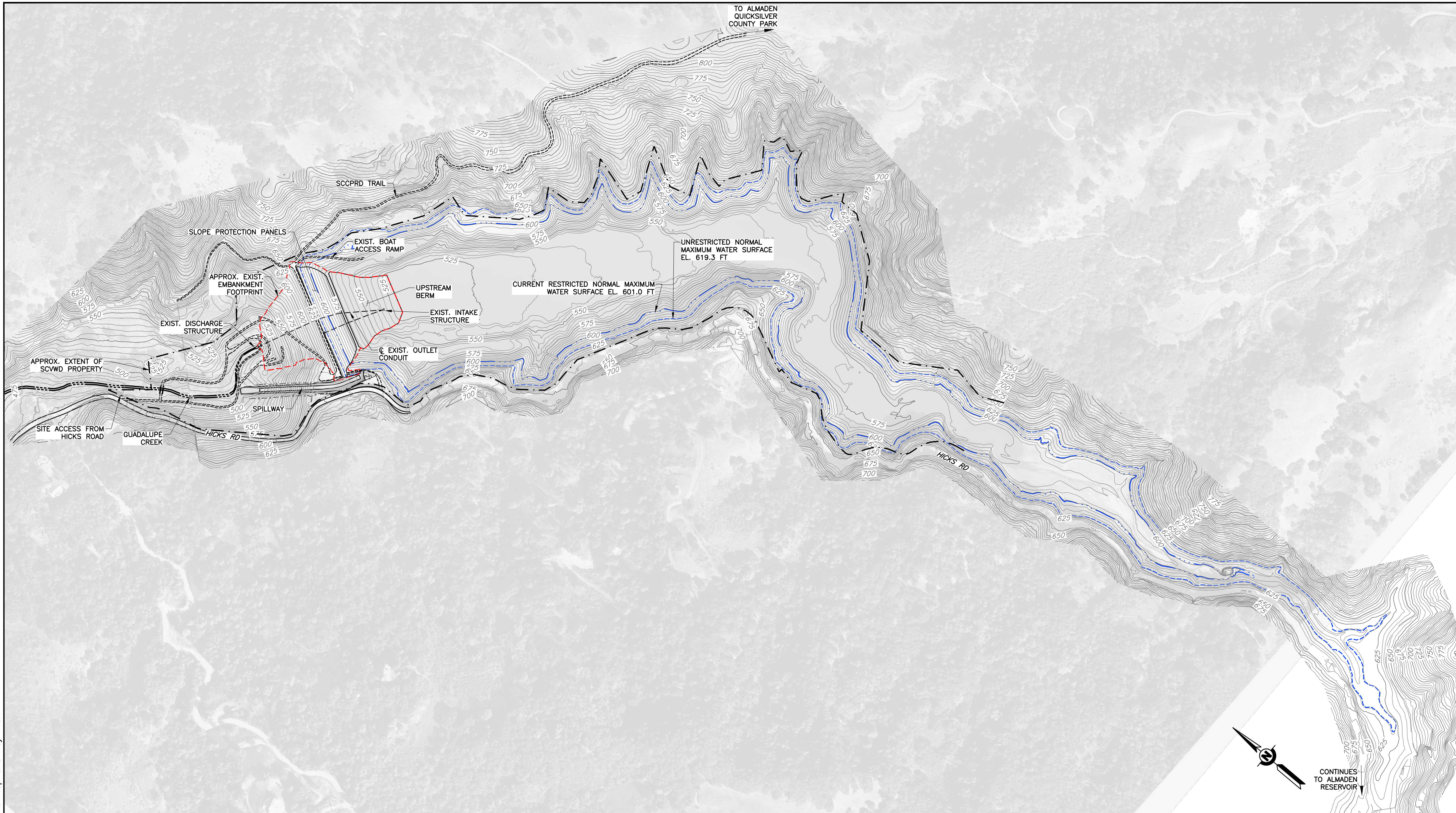
Santa Clara Valley Water District
ACCEPTED BY DISTRICT
PROJECT ENGINEER DATE

PROJECT NAME AND SHEET DESCRIPTION:
GUADALUPE DAM SEISMIC RETROFIT PROJECT
STAFF-RECOMMENDED ALTERNATIVE
ABBREVIATIONS & NOTES

SCALE: AS NOTED
VERIFY SCALES
0 1"
BAR IS ONE INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

PROJECT NUMBER: 1328380
SHEET CODE: G-2
SHEET NUMBER: 2 OF 21

Guad_02_G-2-Abbreviations and Notes



PLAN

SCALE: 1"=250'

REV	DESCRIPTION	DATE	APPR.	REFERENCE INFORMATION AND NOTES

GEI Consultants

DATE 08-14-15
DESIGN N.K.S.
DRAWN N.K.S.
CHECKED J.G.H.

ENGINEERING CERTIFICATION
PROJECT ENGINEER DATE

Santa Clara Valley Water District

ACCEPTED BY DISTRICT
PROJECT ENGINEER DATE

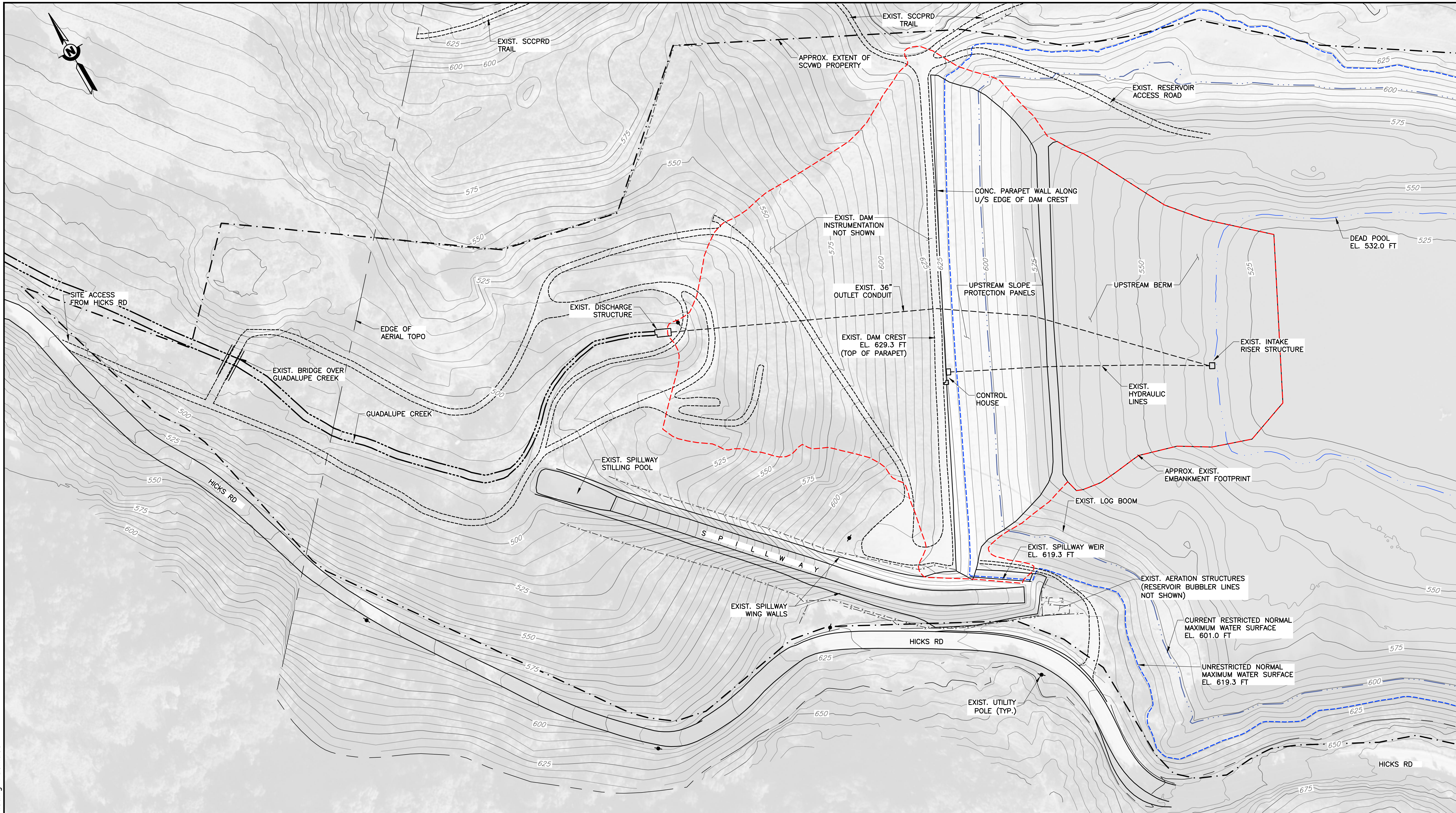
PROJECT NAME AND SHEET DESCRIPTION:

GUADALUPE DAM SEISMIC RETROFIT PROJECT
STAFF-RECOMMENDED ALTERNATIVE
OVERALL SITE MAP

SCALE
AS NOTED
VERIFY SCALES
0 1"
BAR IS ONE INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

PROJECT NUMBER
1328380
SHEET CODE:
G-3
SHEET NUMBER:
3 OF 21

Guad_03_G-3-Overall Site Map and Key Plan



PLAN

SCALE: 1"=60'

Guad_04_G-4-Existing Facilities

REV	DESCRIPTION	DATE	APPR.	REFERENCE INFORMATION AND NOTES

GEI Consultants

DATE 08-14-15
DESIGN N.K.S.
DRAWN N.K.S.
CHECKED J.G.H.

ENGINEERING CERTIFICATION
PROJECT ENGINEER DATE

Santa Clara Valley Water District
ACCEPTED BY DISTRICT
PROJECT ENGINEER DATE

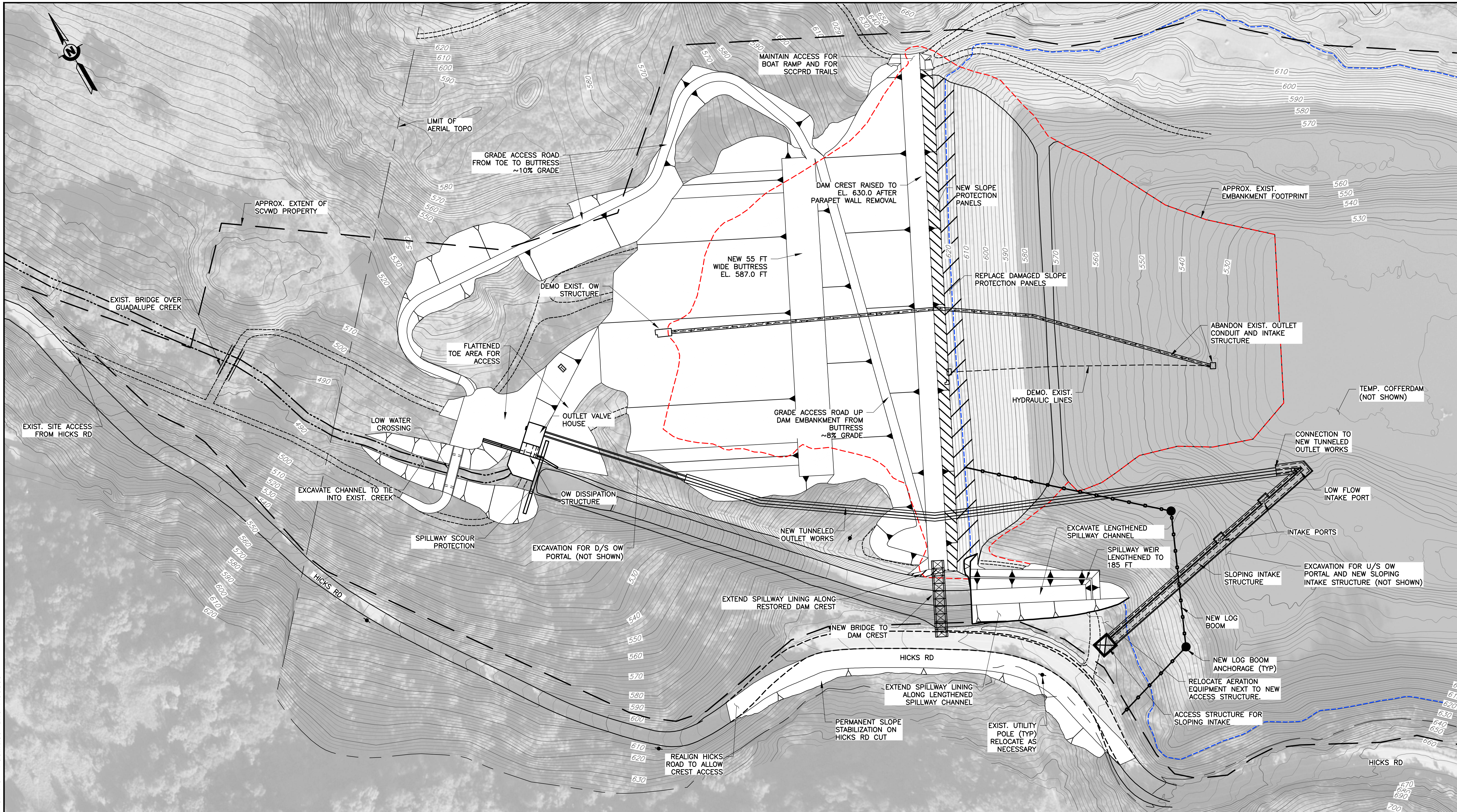
PROJECT NAME AND SHEET DESCRIPTION:

GUADALUPE DAM SEISMIC RETROFIT PROJECT
STAFF-RECOMMENDED ALTERNATIVE

EXISTING FACILITIES AT GUADALUPE DAM

SCALE: AS NOTED
VERIFY SCALES
0 1"
BAR IS ONE INCH ON ORIGINAL DRAWING IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

PROJECT NUMBER 1328380
SHEET CODE: G-4
SHEET NUMBER: 4 OF 21



PLAN

SCALE: 1"=60'

REV	DESCRIPTION	DATE	APPR.	REFERENCE INFORMATION AND NOTES

GEI Consultants

DATE 10-30-15
DESIGN N.K.S.
DRAWN N.K.S.
CHECKED J.G.H.

ENGINEERING CERTIFICATION

PROJECT ENGINEER DATE

Santa Clara Valley Water District

ACCEPTED BY DISTRICT

PROJECT ENGINEER DATE

PROJECT NAME AND SHEET DESCRIPTION:

GUADALUPE DAM SEISMIC RETROFIT PROJECT
STAFF-RECOMMENDED ALTERNATIVE

GENERAL PLAN OF NEW FACILITIES & ACCESS

SCALE: AS NOTED

VERIFY SCALES

0 1"

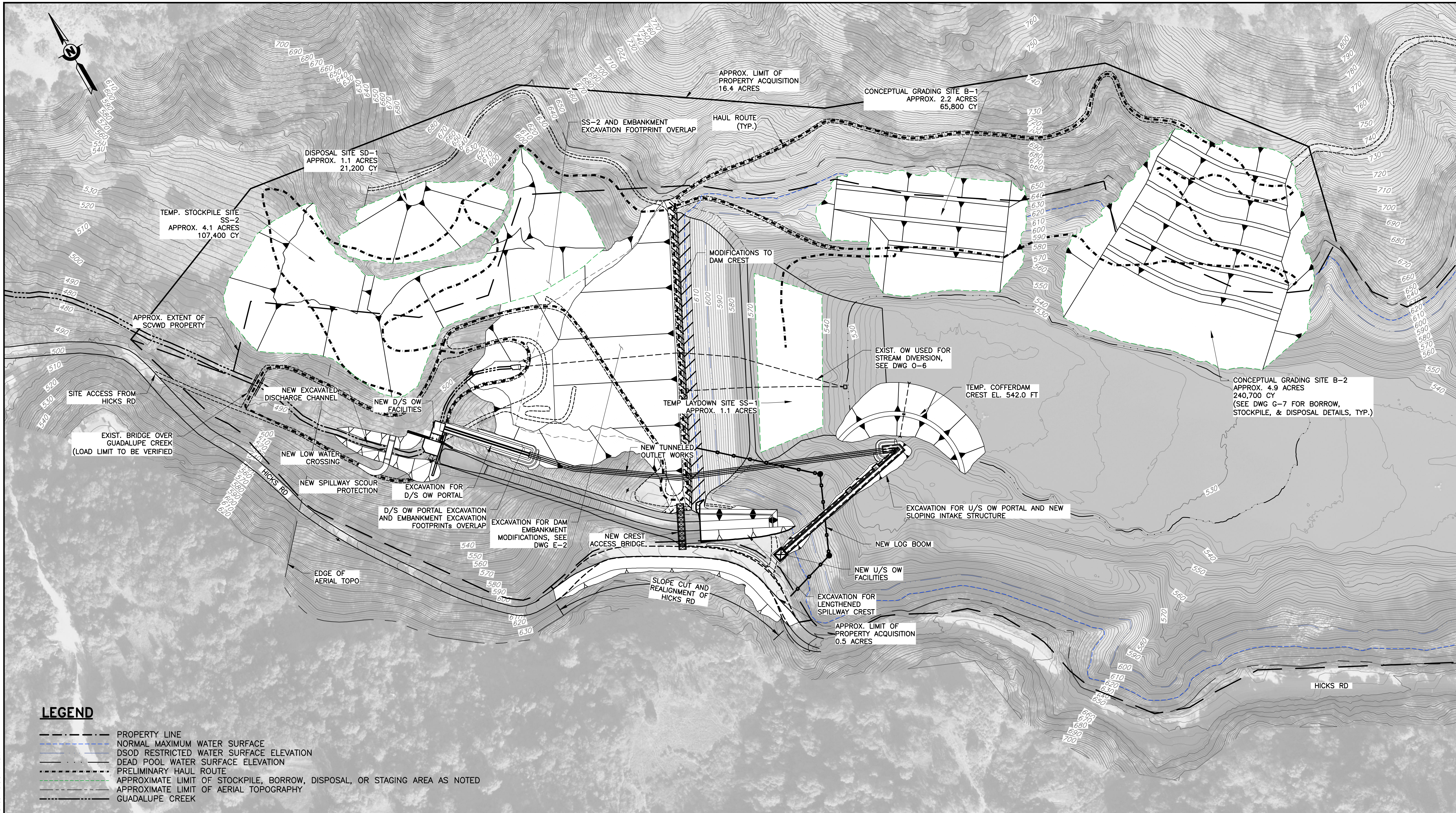
BAR IS ONE INCH ON ORIGINAL DRAWING IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

PROJECT NUMBER 1328380

SHEET CODE: G-5

SHEET NUMBER: 5 OF 21

Guad_05_G-5-General Plan of New Facilities and Access



PLAN

SCALE: 1"=100'

Guad_06_G-6-Site Use Plan

REV	DESCRIPTION	DATE	APPR.	REFERENCE INFORMATION AND NOTES

GEI Consultants

DATE 10-30-15
DESIGN N.K.S.
DRAWN N.K.S.
CHECKED J.G.H.

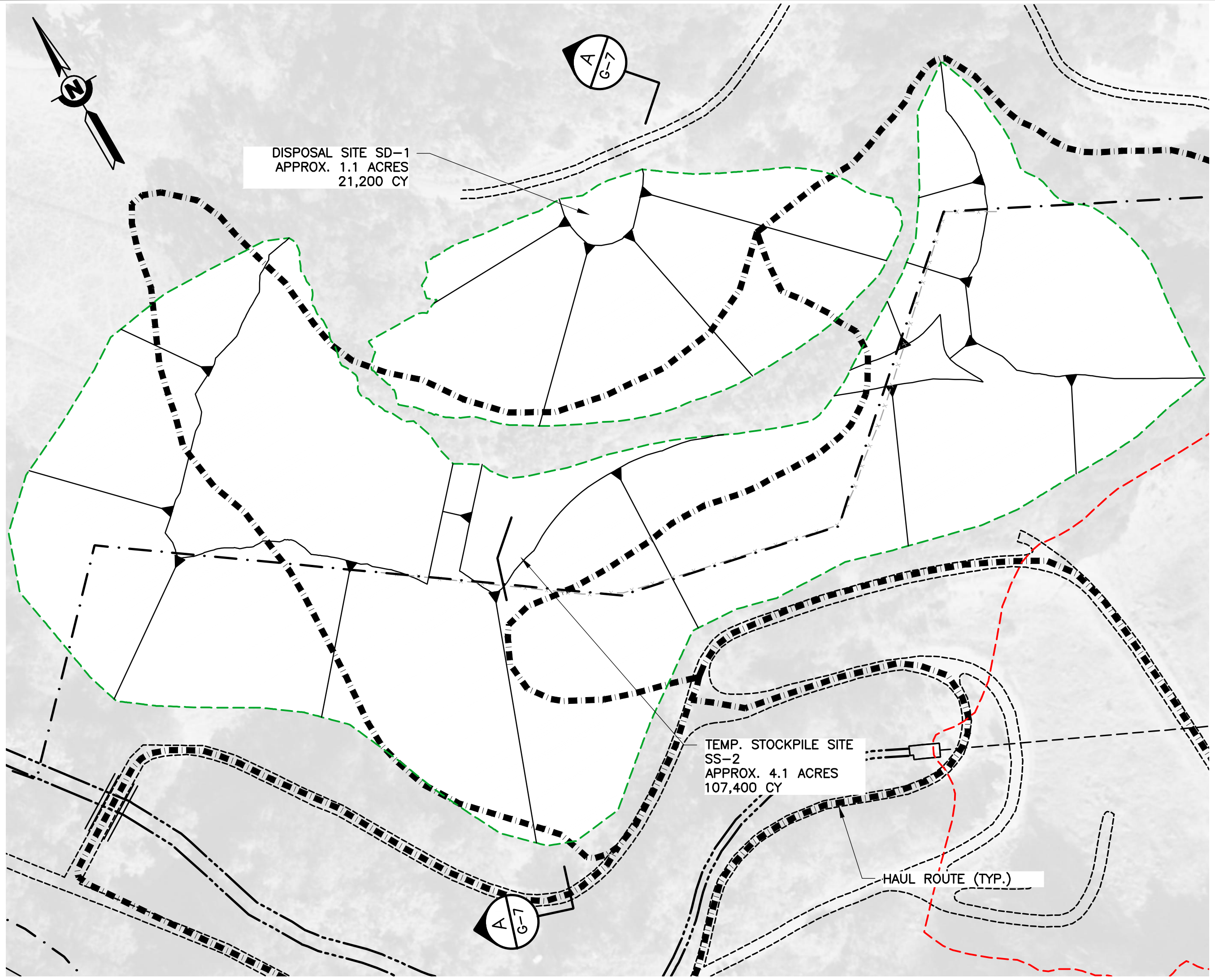
ENGINEERING CERTIFICATION
PROJECT ENGINEER DATE

Santa Clara Valley Water District
ACCEPTED BY DISTRICT
PROJECT ENGINEER DATE

PROJECT NAME AND SHEET DESCRIPTION:
GUADALUPE DAM SEISMIC RETROFIT PROJECT
STAFF-RECOMMENDED ALTERNATIVE
SITE USE PLAN

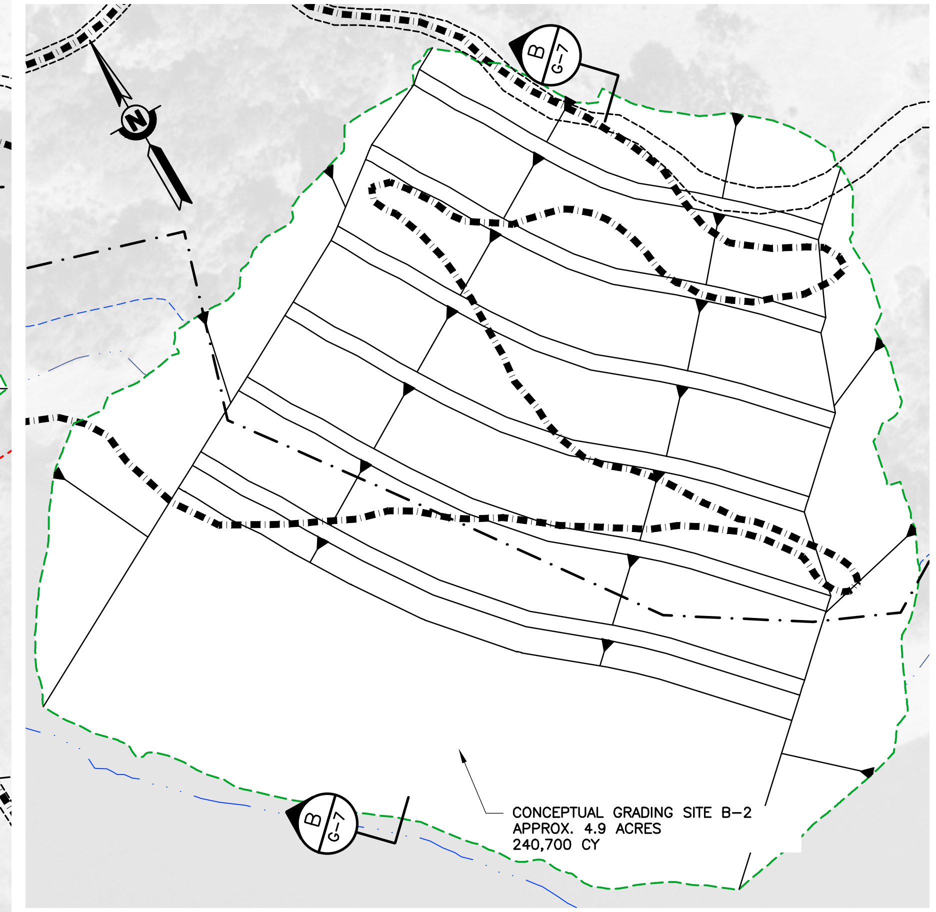
SCALE: AS NOTED
VERIFY SCALES
0 1"
BAR IS ONE INCH ON ORIGINAL DRAWING IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

PROJECT NUMBER: 1328380
SHEET CODE: G-6
SHEET NUMBER: 6 OF 21



PLAN – SD-1 & SS-2

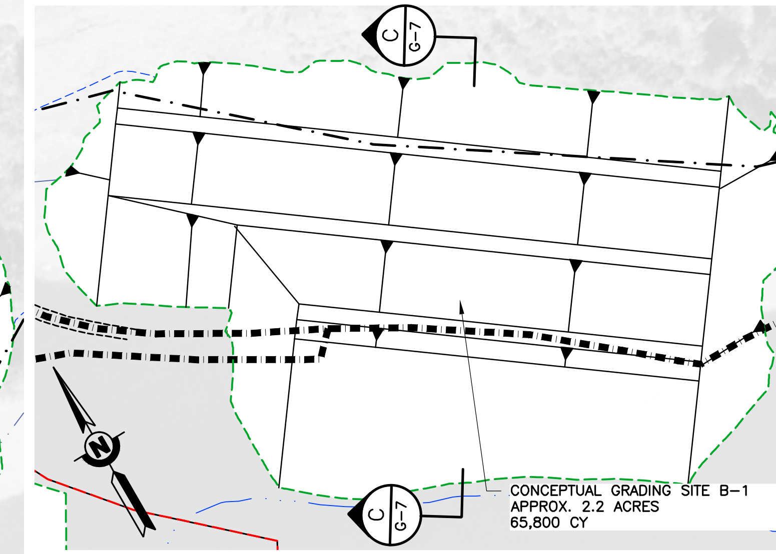
SCALE: 1"= 60'



PLAN – B-2

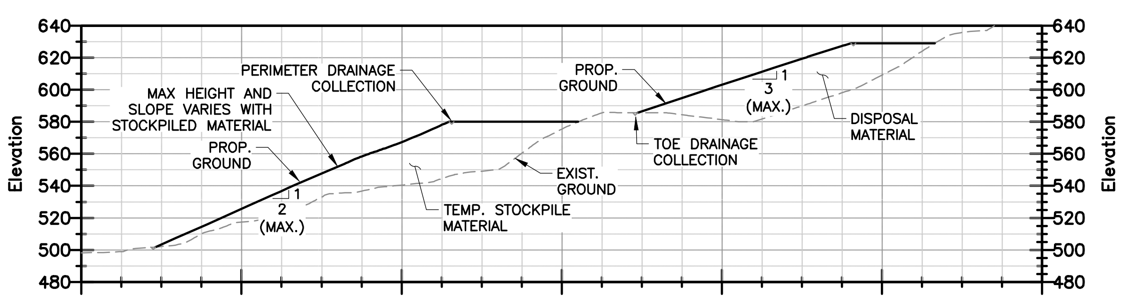
SCALE: 1"= 60'

NOTE:
1. HAUL ROUTES SHOWN ARE PRELIMINARY AND WILL VARY FOR CONSTRUCTION.



PLAN – B-1

SCALE: 1"=60'

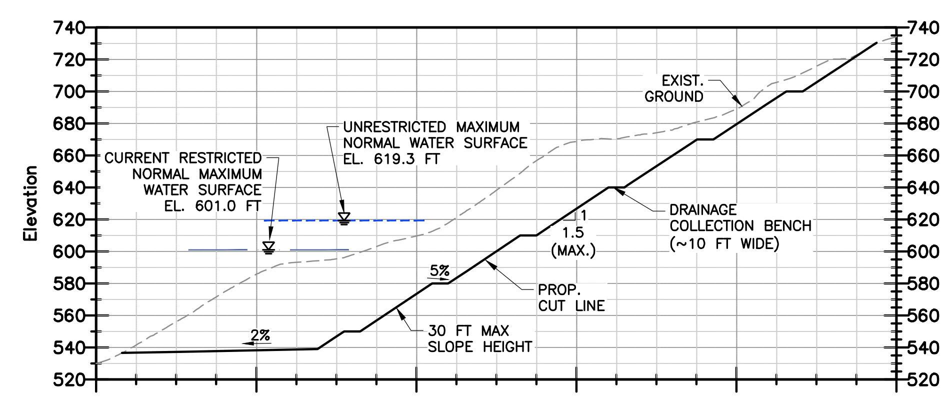


SECTION A G-7 TYP. HILLSIDE STOCKPILE & DISPOSAL SITE SD-1 & SS-2

SCALE: 1" = 60'

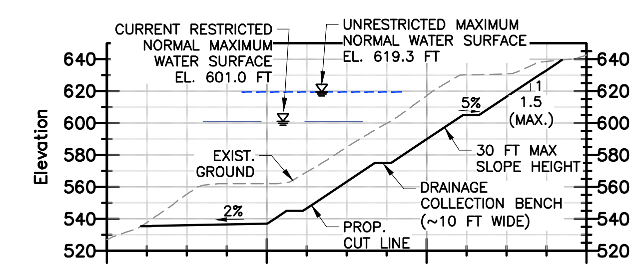
LEGEND

- PROPERTY LINE
- NORMAL MAXIMUM WATER SURFACE
- DSOD RESTRICTED WATER SURFACE ELEVATION
- DEAD POOL WATER SURFACE ELEVATION
- PRELIMINARY HAUL ROUTE
- APPROXIMATE LIMIT OF STOCKPILE, BORROW, DISPOSAL, OR STAGING AREA AS NOTED
- APPROXIMATE LIMIT OF AERIAL TOPOGRAPHY
- EXISTING EMBANKMENT FOOTPRINT



SECTION B G-7 TYP. HILLSIDE BORROW CUT SITE B-2

SCALE: 1" = 60'



SECTION C G-7 TYP. HILLSIDE BORROW CUT SITE B-1

SCALE: 1" = 60'

REV	DESCRIPTION	DATE	APPR.	REFERENCE INFORMATION AND NOTES

GEI Consultants

DATE	08-14-15
DESIGN	N.K.S.
DRAWN	N.K.S.
CHECKED	J.G.H.

ENGINEERING CERTIFICATION

PROJECT ENGINEER DATE

Santa Clara Valley Water District

ACCEPTED BY DISTRICT

PROJECT ENGINEER DATE

PROJECT NAME AND SHEET DESCRIPTION:

GUADALUPE DAM SEISMIC RETROFIT PROJECT
STAFF-RECOMMENDED ALTERNATIVE
MATERIAL HANDLING DETAILS

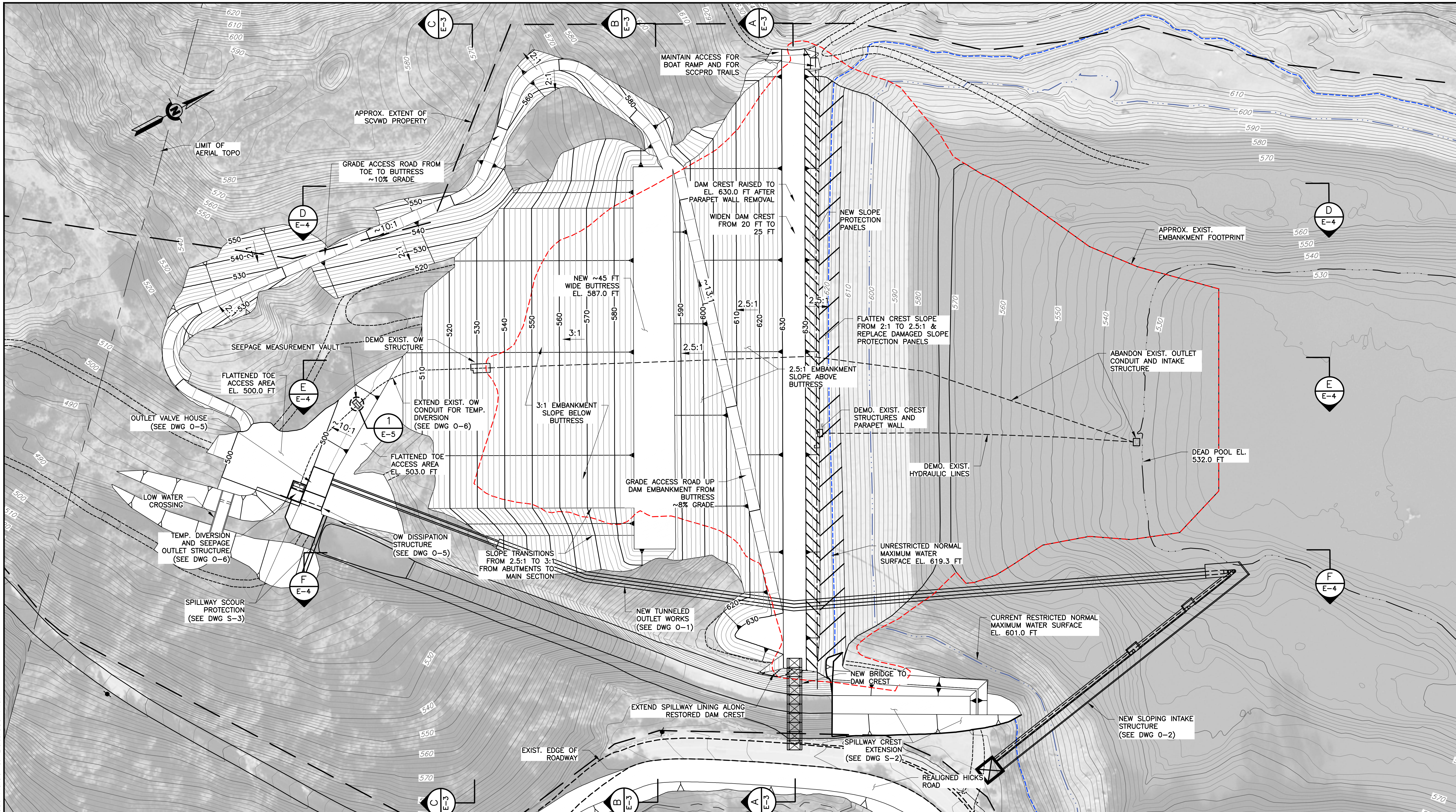
SCALE: AS NOTED

VERIFY SCALES
0 1"
BAR IS ONE INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

PROJECT NUMBER: 1328380

SHEET CODE: G-7

SHEET NUMBER: 7 OF 21



PLAN

SCALE: 1"=40'

Guad_08_E-1-Dam Crest Raise & Buttress Plan

REV	DESCRIPTION	DATE	APPR.	REFERENCE INFORMATION AND NOTES

GEI Consultants

DATE 10-30-15
DESIGN N.K.S.
DRAWN N.K.S.
CHECKED J.G.H.

ENGINEERING CERTIFICATION

PROJECT ENGINEER DATE

Santa Clara Valley Water District

ACCEPTED BY DISTRICT

PROJECT ENGINEER DATE

PROJECT NAME AND SHEET DESCRIPTION:

GUADALUPE DAM SEISMIC RETROFIT PROJECT

STAFF-RECOMMENDED ALTERNATIVE

DAM CREST RAISE & BUTTRESS PLAN

SCALE: AS NOTED

VERIFY SCALES

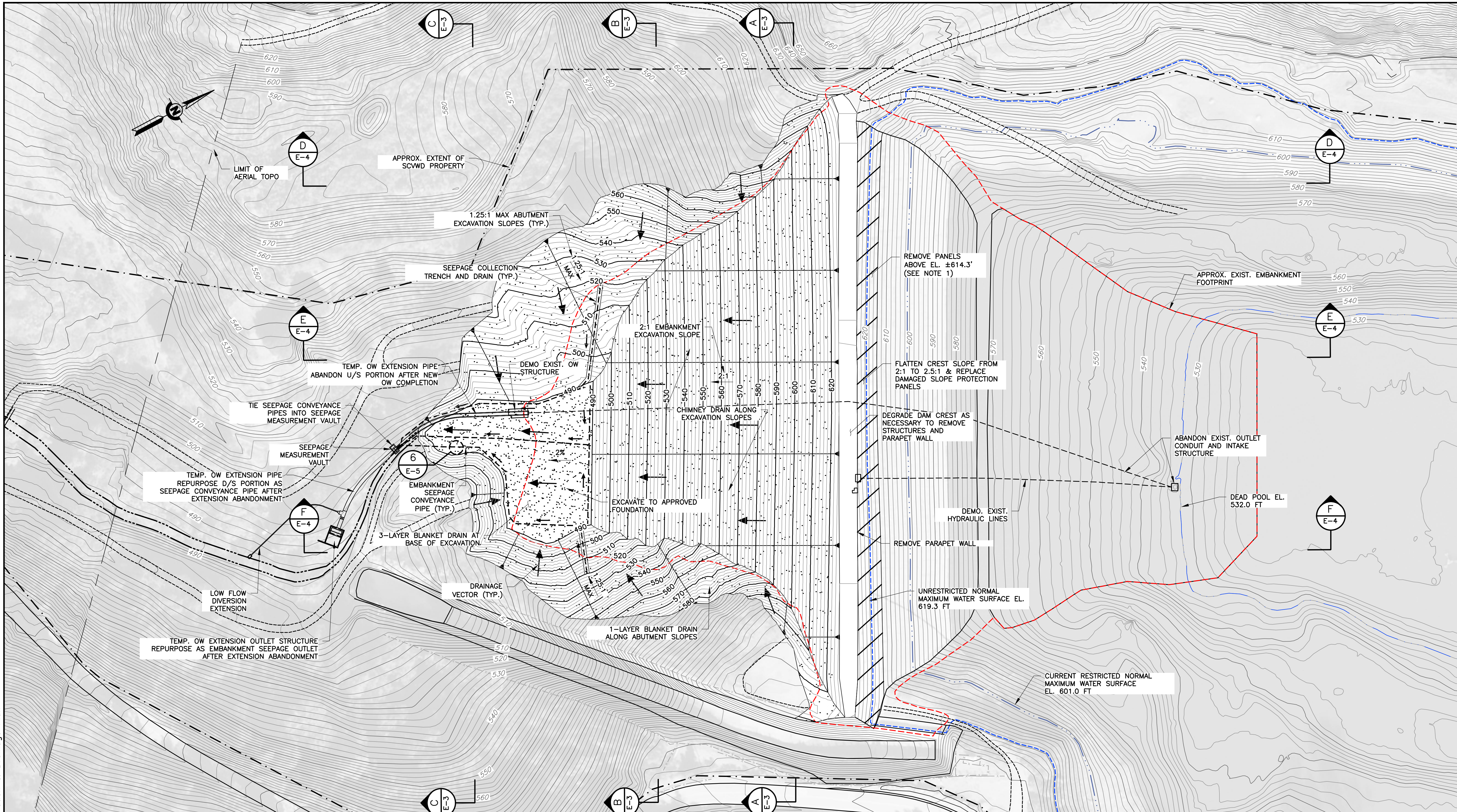
0 1"

BAR IS ONE INCH ON ORIGINAL DRAWING IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

PROJECT NUMBER: 1328380

SHEET CODE: E-1

SHEET NUMBER: 8 OF 21



NOTE:
1. REMOVE OTHER DAMAGED PANELS BELOW EL. ±614.3 AS NECESSARY

PLAN

SCALE: 1"=50'

REV	DESCRIPTION	DATE	APPR.	REFERENCE INFORMATION AND NOTES

GEI Consultants

DATE	08-14-15
DESIGN	N.K.S.
DRAWN	N.K.S.
CHECKED	J.G.H.

ENGINEERING CERTIFICATION

PROJECT ENGINEER DATE

Santa Clara Valley Water District

ACCEPTED BY DISTRICT

PROJECT ENGINEER DATE

PROJECT NAME AND SHEET DESCRIPTION:

GUADALUPE DAM SEISMIC RETROFIT PROJECT
STAFF-RECOMMENDED ALTERNATIVE

DAM EXCAVATION & DRAINAGE PLAN

SCALE: AS NOTED

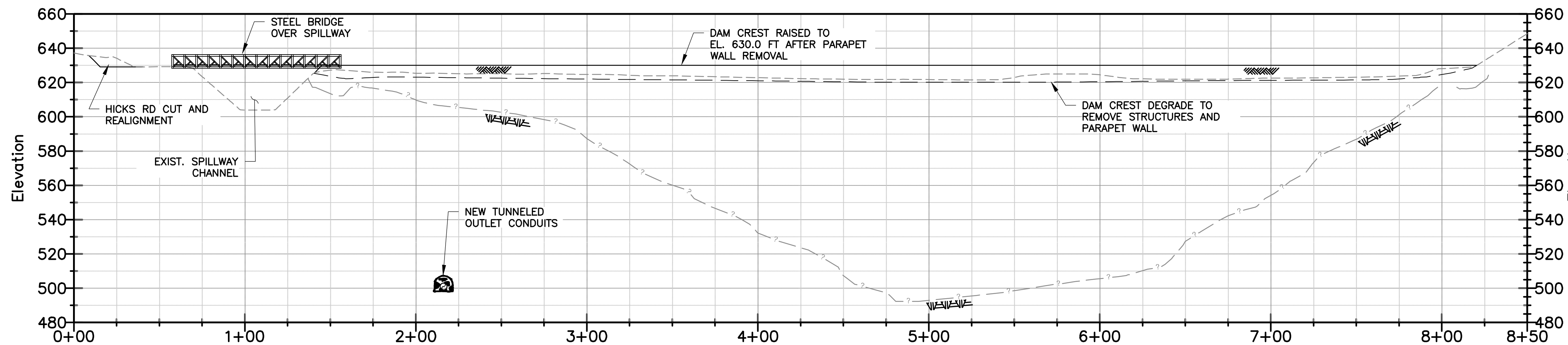
VERIFY SCALES: 0 1" BAR IS ONE INCH ON ORIGINAL DRAWING IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

PROJECT NUMBER: 1328380

SHEET CODE: E-2

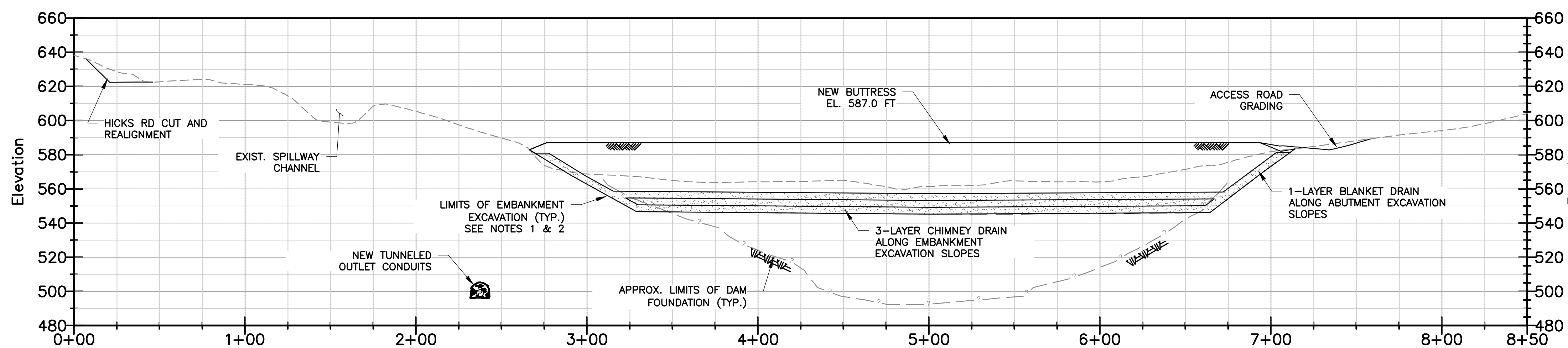
SHEET NUMBER: 9 OF 21

Guad_09_E-2-Dam Excavation & Drainage Plan



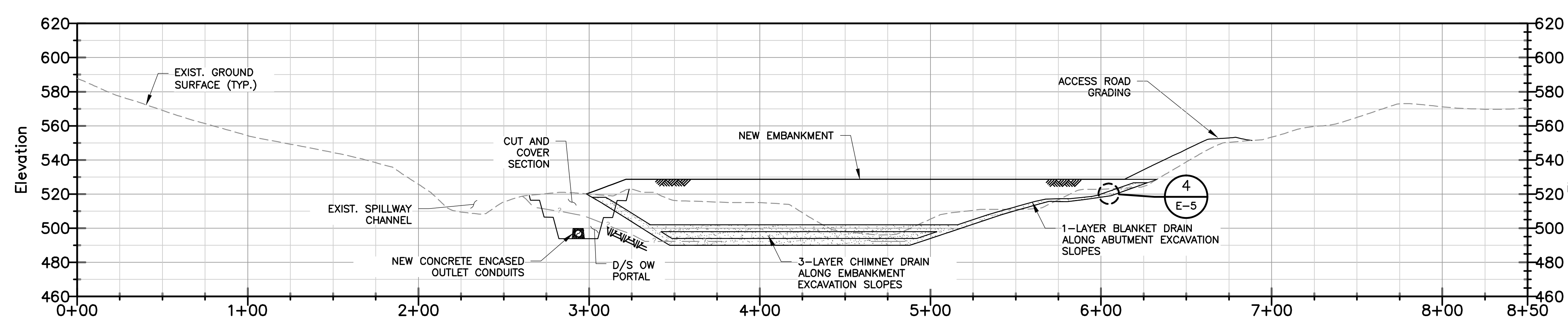
SECTION A (E-1,2) DAM PROFILE

SCALE: 1" = 40'



SECTION B (E-1,2) DAM PROFILE

SCALE: 1" = 40'



SECTION C (E-1,2) DAM PROFILE

SCALE: 1" = 40'

NOTE:
1. LIMITS OF EXCAVATION AND CONSTRUCTION OF FILTER BLANKET TO BE CONFIRMED DURING FINAL DESIGN, AND ADJUSTED IN FIELD BASED ON CONDITIONS ENCOUNTERED IN THE FIELD.
2. FINAL BEDROCK EXCAVATION LINE WILL BE SUBJECT TO MEETING THE FOUNDATION OBJECTIVE AND FIELD APPROVAL BY DSOD.

Guad_10_E-3-Dam Crest Raise & Buttress Plan

REV	DESCRIPTION	DATE	APPR.	REFERENCE INFORMATION AND NOTES

GEI Consultants

DATE 08-14-15
DESIGN N.K.S.
DRAWN N.K.S.
CHECKED J.G.H.

ENGINEERING CERTIFICATION

PROJECT ENGINEER DATE

Santa Clara Valley Water District

ACCEPTED BY DISTRICT

PROJECT ENGINEER DATE

PROJECT NAME AND SHEET DESCRIPTION:

GUADALUPE DAM SEISMIC RETROFIT PROJECT
STAFF-RECOMMENDED ALTERNATIVE
DAM PROFILES

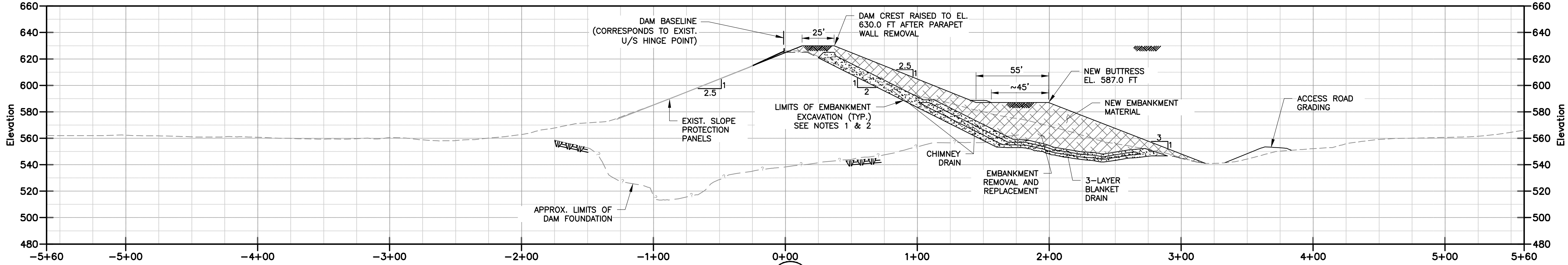
SCALE: AS NOTED

VERIFY SCALES
0 1"
BAR IS ONE INCH ON ORIGINAL DRAWING IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

PROJECT NUMBER 1328380

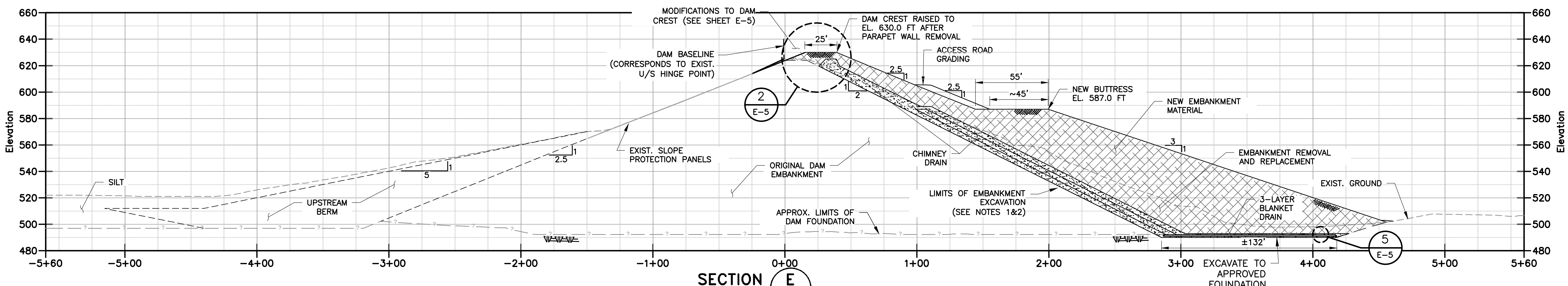
SHEET CODE: E-3

SHEET NUMBER: 10 OF 21



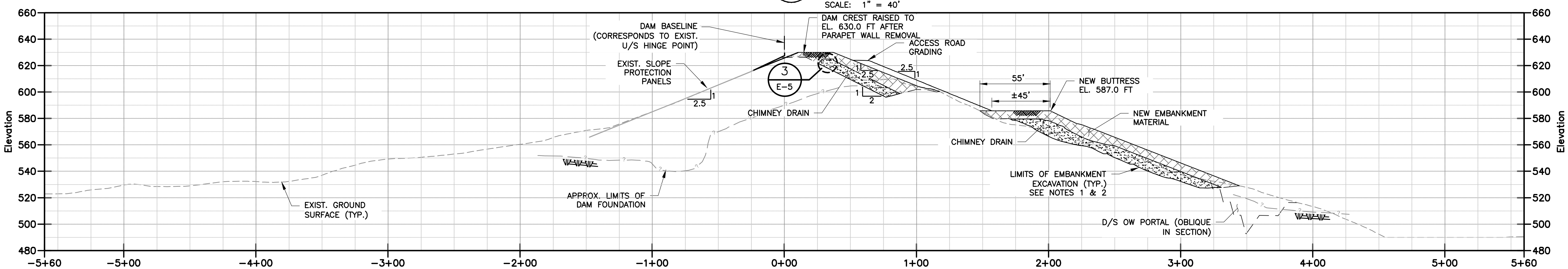
SECTION D
E–1,2

SCALE: 1" = 40'



SECTION E
E–1,2

SCALE: 1" = 40'



SECTION F
E–1,2

SCALE: 1" = 40'

NOTE:
1. LIMITS OF EXCAVATION AND CONSTRUCTION OF FILTER BLANKET TO BE CONFIRMED DURING FINAL DESIGN, AND ADJUSTED IN FIELD BASED ON CONDITIONS ENCOUNTERED IN THE FIELD.
2. FINAL BEDROCK EXCAVATION LINE WILL BE SUBJECT TO MEETING THE FOUNDATION OBJECTIVE AND FIELD APPROVAL BY DSOD.

Guad_11_E-4-Dam Sections

REV	DESCRIPTION	DATE	APPR.	REFERENCE INFORMATION AND NOTES

GEI Consultants

DATE 08–14–15
DESIGN N.K.S.
DRAWN N.K.S.
CHECKED J.G.H.

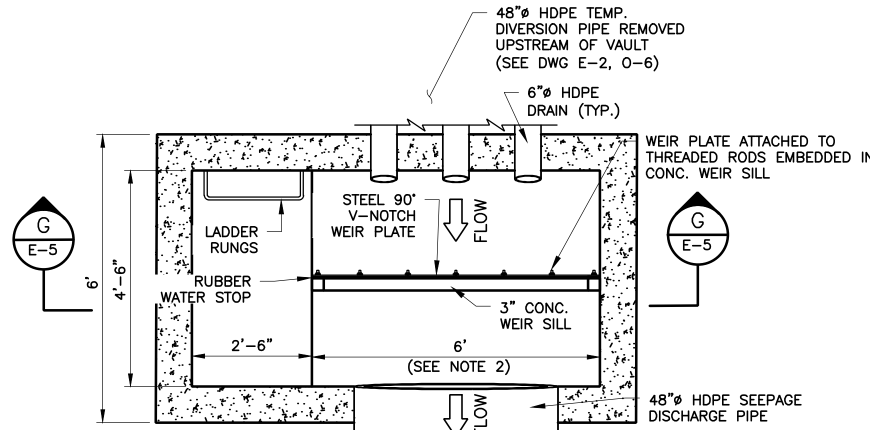
ENGINEERING CERTIFICATION
PROJECT ENGINEER DATE

Santa Clara Valley Water District
ACCEPTED BY DISTRICT
PROJECT ENGINEER DATE

PROJECT NAME AND SHEET DESCRIPTION:
GUADALUPE DAM SEISMIC RETROFIT PROJECT
STAFF–RECOMMENDED ALTERNATIVE
DAM CROSS SECTIONS

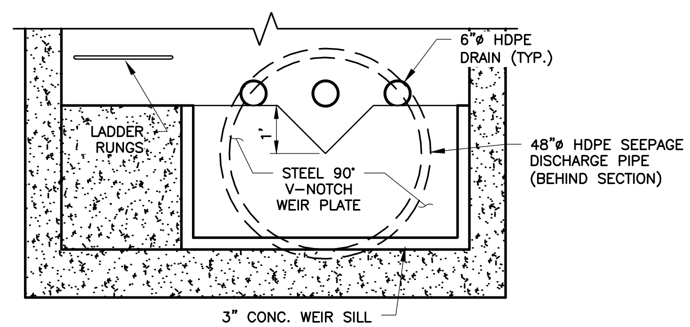
SCALE: AS NOTED
VERIFY SCALES
0 1"
BAR IS ONE INCH ON ORIGINAL DRAWING IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

PROJECT NUMBER: 1328380
SHEET CODE: E–4
SHEET NUMBER: 11 OF 21



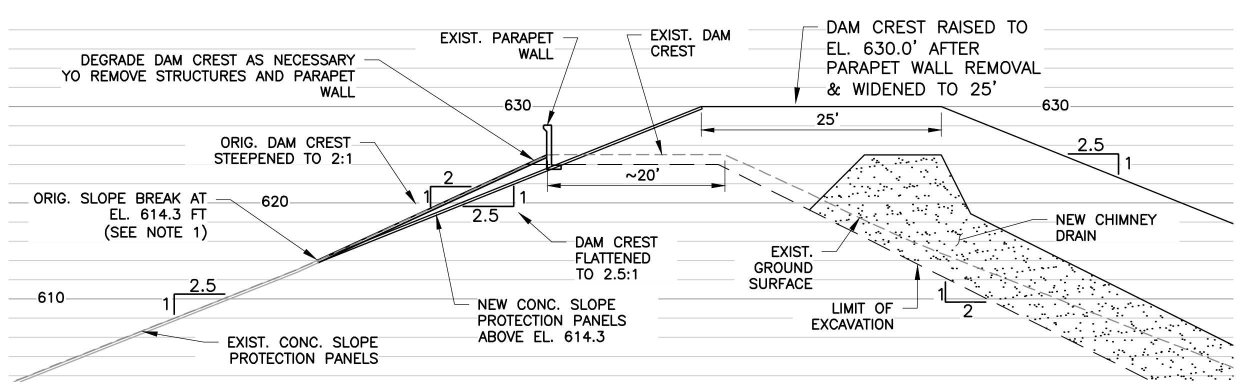
DETAIL 1 (E-1) EMBANKMENT SEEPAGE MEASUREMENT VAULT

SCALE: 1" = 2'



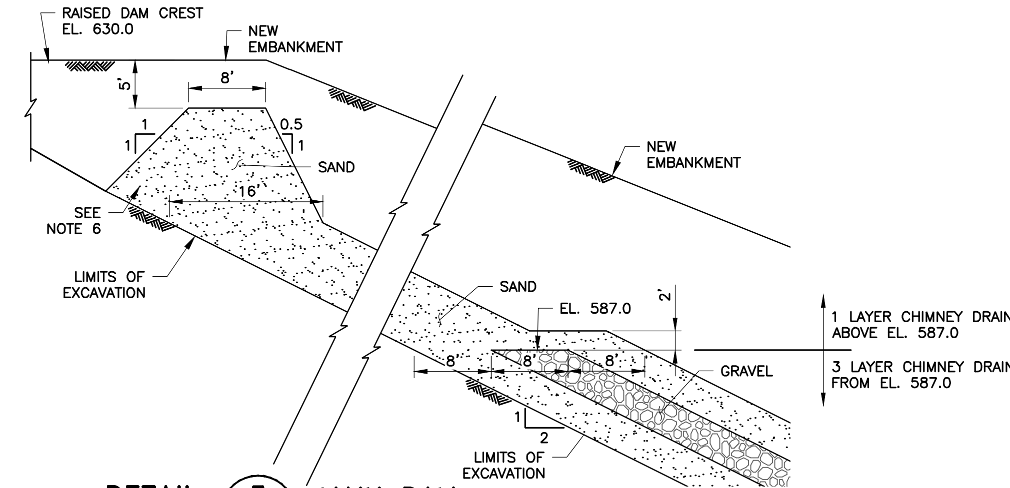
SECTION G (E-5) EMBANKMENT SEEPAGE MEASUREMENT VAULT

SCALE: 1" = 2'



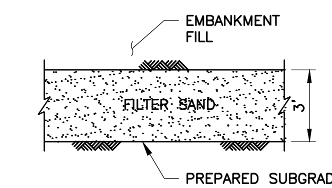
DETAIL 2 (E-4) CREST MODIFICATIONS

SCALE: 1" = 10'



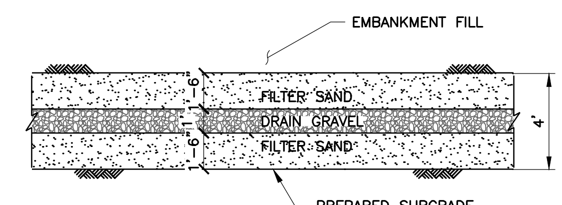
DETAIL 3 (E-4) MAIN DAM CHIMNEY DRAIN

SCALE: 1" = 10'



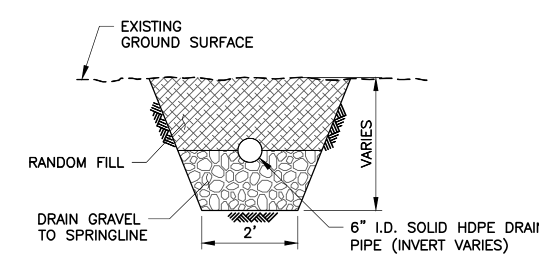
DETAIL 4 (E-4) MAIN DAM 1 LAYER BLANKET DRAIN

SCALE: 1" = 4'



DETAIL 5 (E-4) MAIN DAM 3 LAYER BLANKET DRAIN

SCALE: 1" = 4'



DETAIL 6 (E-2) MAIN DAM OUTLET DRAIN

SCALE: 1" = 2'

NOTES:

1. RECORD DRAWINGS INDICATE CONSTRUCTION OF A GRADE BREAK NEAR THE CREST FROM 2.5:1 TO 2:1 AT EL. 614.3 NAVD (612.0 NGVD). SETTLEMENT OF DAM MAY HAVE CAUSED GRADE BRAKE ELEVATION TO CHANGE.
2. REQUIRED WEIR PLATE AND VAULT DIMENSIONS DEPEND ON EXPECTED FLOW RATES. THE WEIR AND VAULT SHOWN CAN MEASURE UP TO 2.5 CFS.
3. CHIMNEY DRAIN LAYER SHOWN AS 8' WIDE FOR CONTRACTIBILITY; MINIMUM HORIZONTAL WIDTH IS 5' PER LAYER.

Guad_12_E-5-Embankment Details

REV	DESCRIPTION	DATE	APPR.	REFERENCE INFORMATION AND NOTES

GEI Consultants

DATE: 10-30-15
DESIGN: N.K.S.
DRAWN: N.K.S.
CHECKED: J.G.H.

ENGINEERING CERTIFICATION

PROJECT ENGINEER DATE

Santa Clara Valley Water District

ACCEPTED BY DISTRICT

PROJECT ENGINEER DATE

PROJECT NAME AND SHEET DESCRIPTION:

GUADALUPE DAM SEISMIC RETROFIT PROJECT
STAFF-RECOMMENDED ALTERNATIVE
EMBANKMENT DETAILS

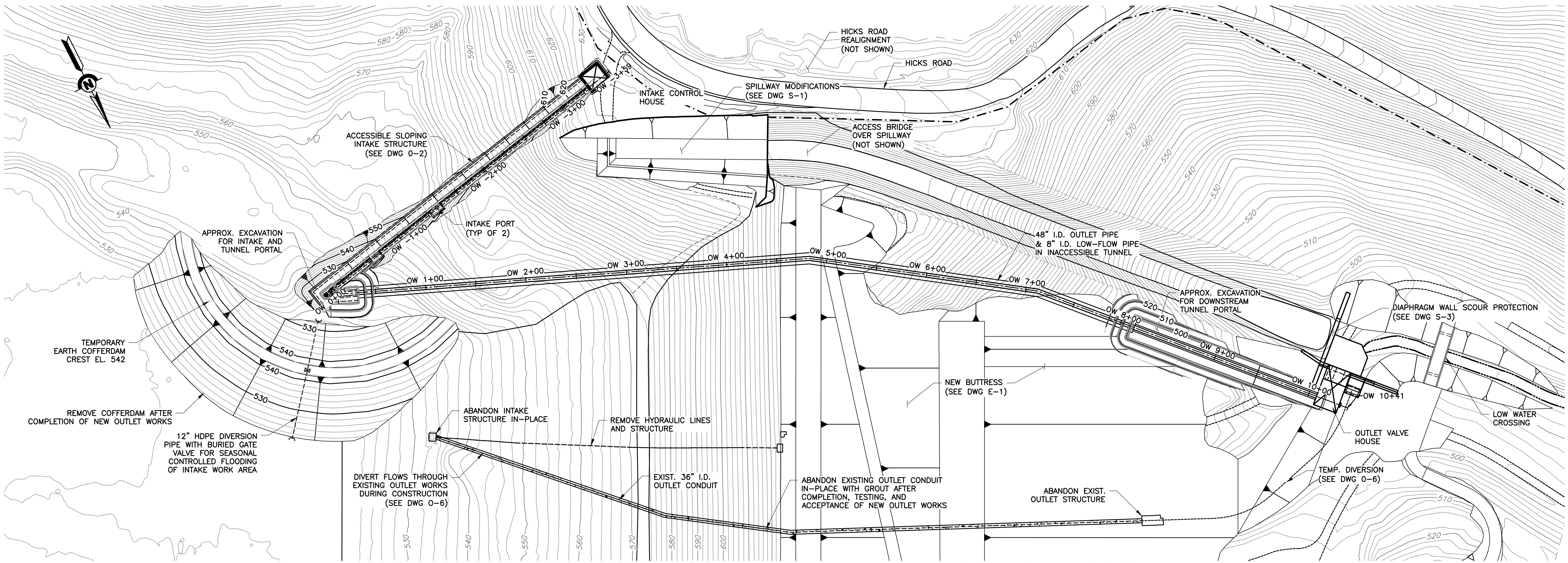
SCALE: AS NOTED

VERIFY SCALES: 0 1" — BAR IS ONE INCH ON ORIGINAL DRAWING. IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

PROJECT NUMBER: 1328380

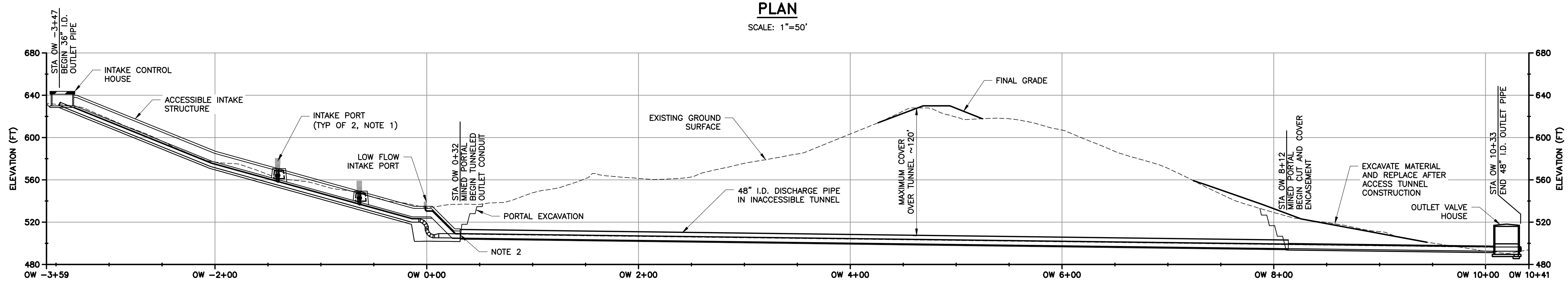
SHEET CODE: E-5

SHEET NUMBER: 12 OF 21



PLAN

SCALE: 1"=50'



PROFILE

SCALE: 1"=50'

NOTES:

1. FINAL NUMBER AND ELEVATION OF INTAKE PORTS TO BE DETERMINED DURING FINAL DESIGN.
2. INSTALL TEMPORARY TUNNEL BULKHEAD AT UPSTREAM TUNNEL PORTAL TO PREVENT DOWNSTREAM FLOODING DURING WINTER RAINY SEASON.

Cal_12_O-1-OW Plan and Profile

REV	DESCRIPTION	DATE	APPR.	REFERENCE INFORMATION AND NOTES

GEI Consultants

DATE 08-14-15
DESIGN P.J.E.
DRAWN P.J.E.
CHECKED J.G.H.

ENGINEERING CERTIFICATION

PROJECT ENGINEER DATE

Santa Clara Valley Water District

ACCEPTED BY DISTRICT

PROJECT ENGINEER DATE

PROJECT NAME AND SHEET DESCRIPTION:

GUADALUPE DAM SEISMIC RETROFIT PROJECT
STAFF-RECOMMENDED ALTERNATIVE

OUTLET WORKS
PLAN & PROFILE

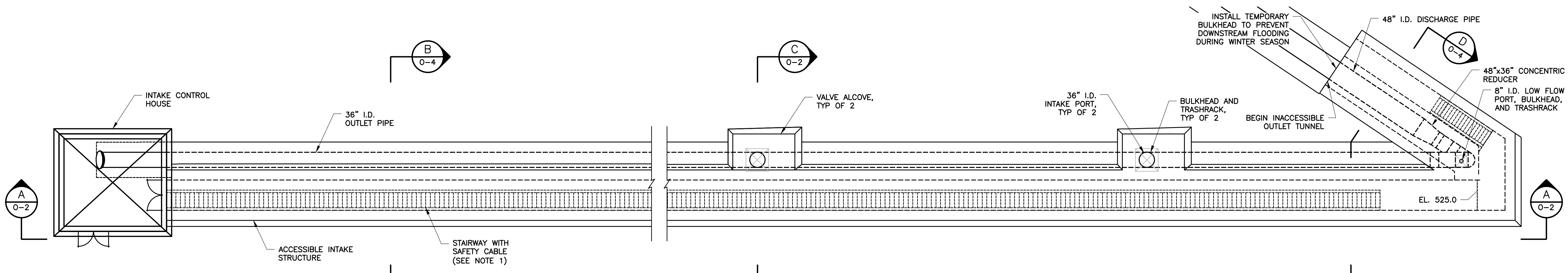
SCALE: AS NOTED

VERIFY SCALES
0 1"
BAR IS ONE INCH ON ORIGINAL DRAWING IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

PROJECT NUMBER 1328380

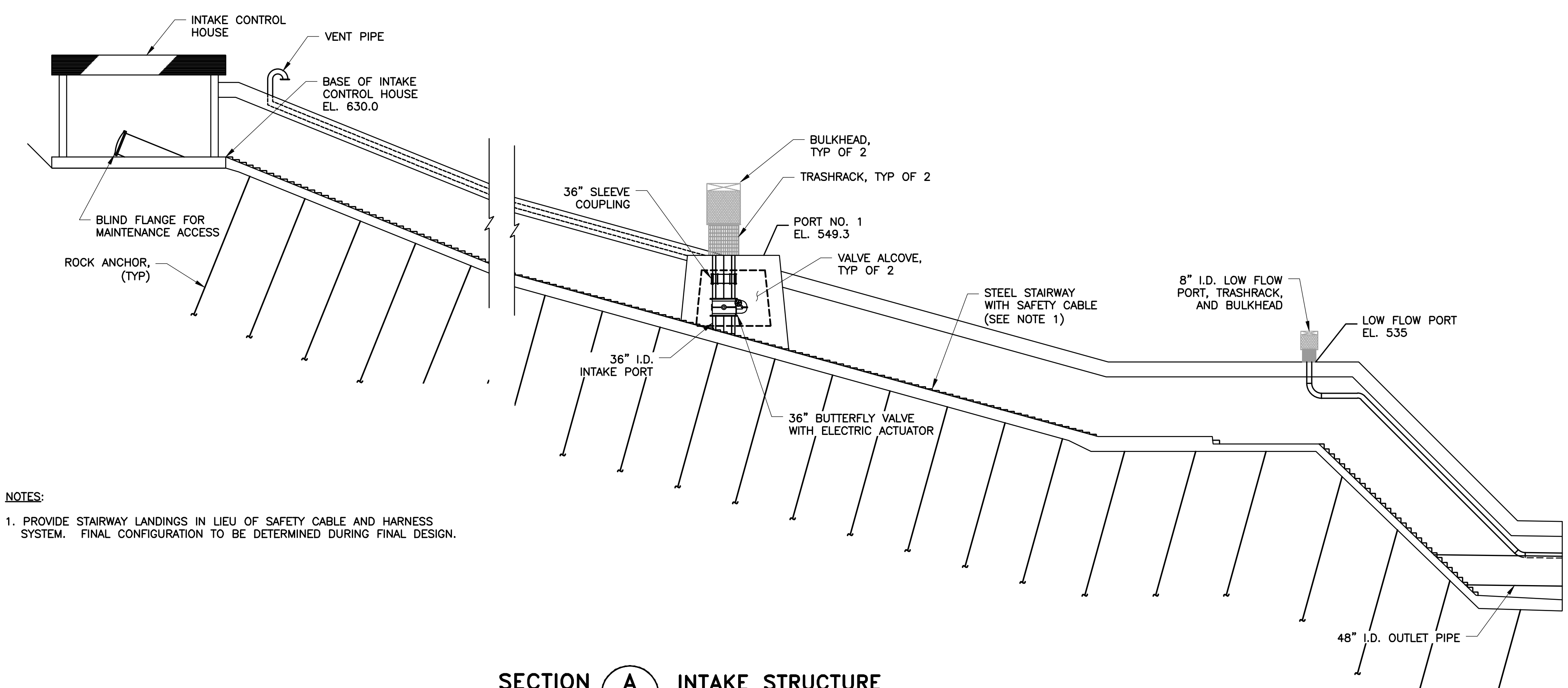
SHEET CODE: O-1

SHEET NUMBER: 13 OF 21



PLAN

SCALE: 1"=10'

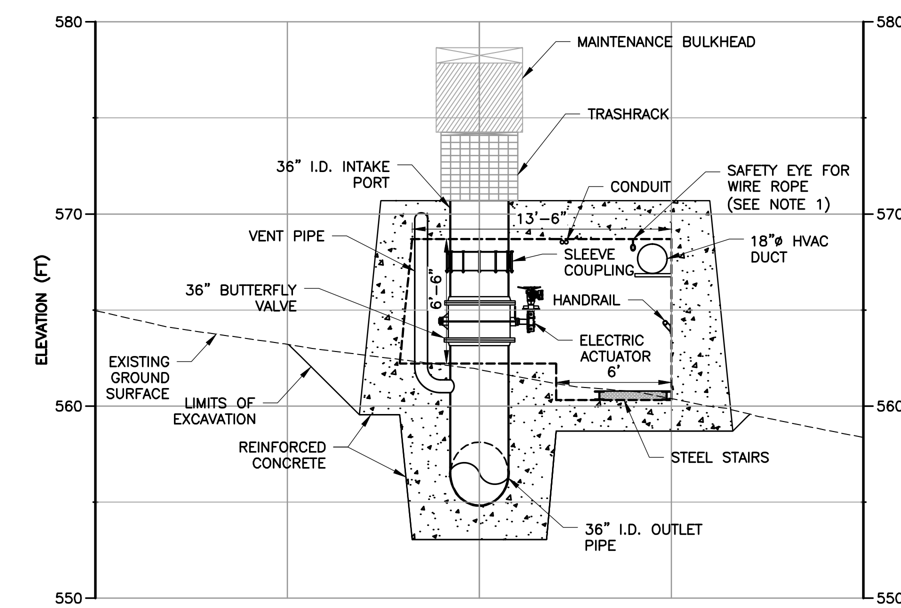


NOTES:

1. PROVIDE STAIRWAY LANDINGS IN LIEU OF SAFETY CABLE AND HARNESS SYSTEM. FINAL CONFIGURATION TO BE DETERMINED DURING FINAL DESIGN.

SECTION A (0-2) INTAKE STRUCTURE

SCALE: 1" = 10'



SECTION C (0-2) VALVE ALCOVE

SCALE: 1" = 5'

Guad_14_0-2-Intake Plan and Section

REV	DESCRIPTION	DATE	APPR.	REFERENCE INFORMATION AND NOTES

GEI Consultants

DATE 08-14-15
DESIGN P.J.E.
DRAWN P.J.E.
CHECKED J.G.H.

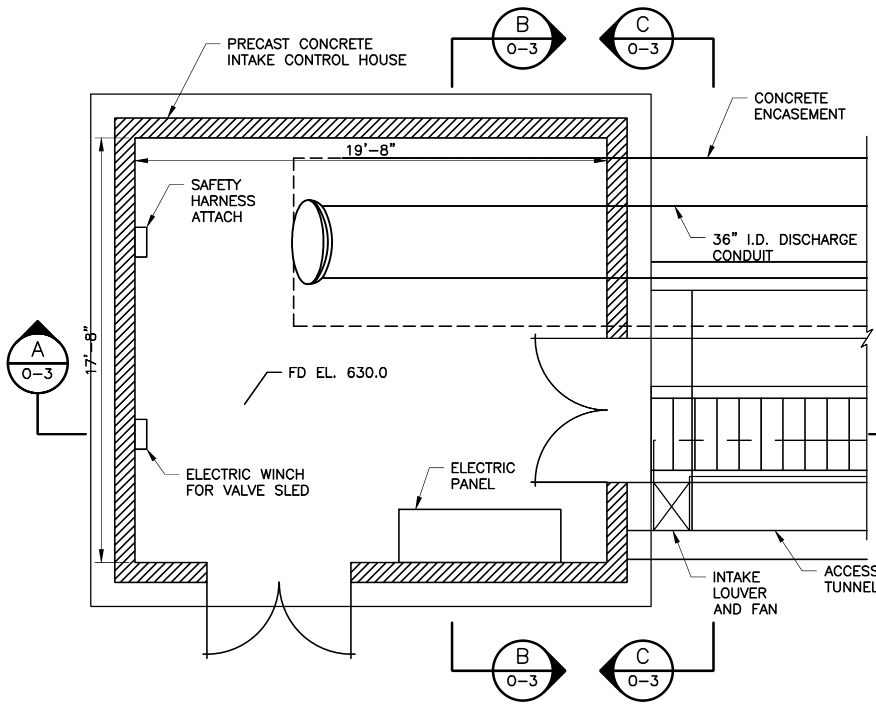
ENGINEERING CERTIFICATION
PROJECT ENGINEER DATE

Santa Clara Valley Water District
ACCEPTED BY DISTRICT
PROJECT ENGINEER DATE

PROJECT NAME AND SHEET DESCRIPTION:
GUADALUPE DAM SEISMIC RETROFIT PROJECT
STAFF-RECOMMENDED ALTERNATIVE
INTAKE STRUCTURE
PLAN & SECTIONS

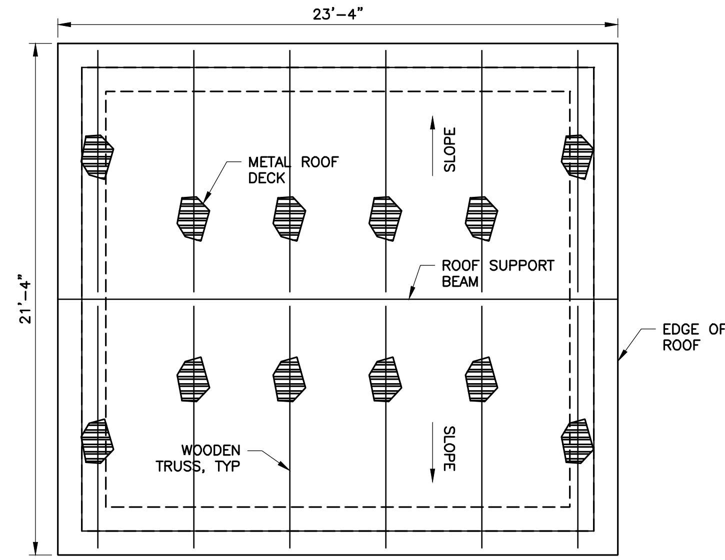
SCALE: AS NOTED
VERIFY SCALES
0 1"
BAR IS ONE INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

PROJECT NUMBER: 1328380
SHEET CODE: 0-2
SHEET NUMBER: 13 OF 21



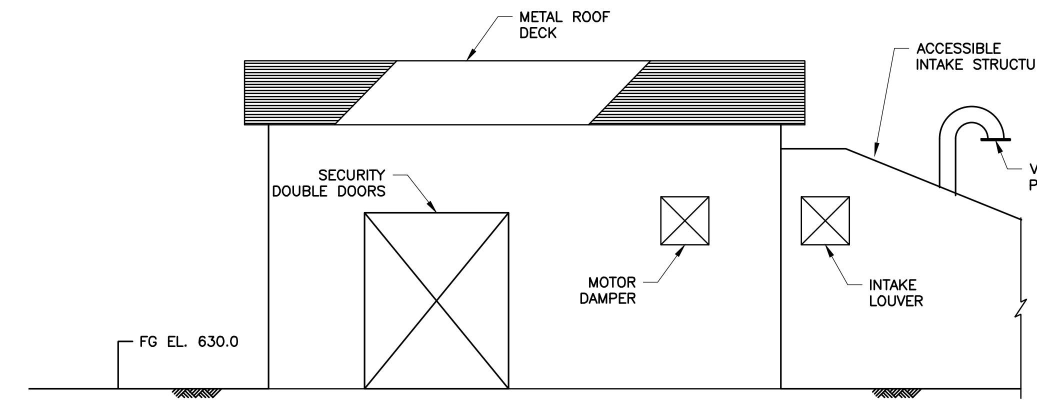
FLOOR PLAN

SCALE: 1/4" = 1'



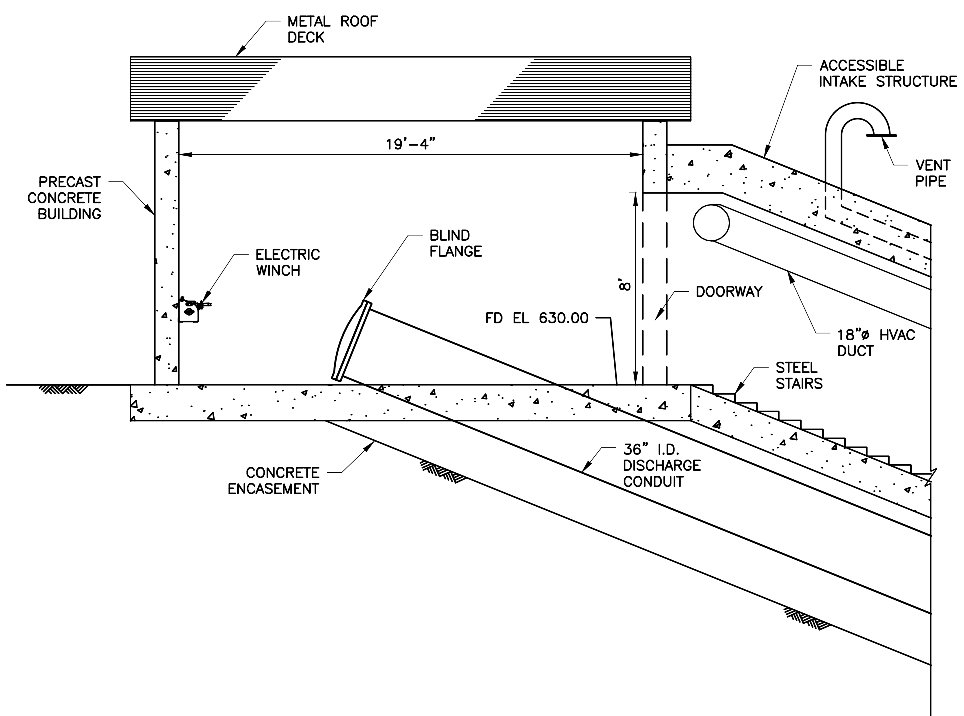
ROOF PLAN

SCALE: 1/4" = 1'



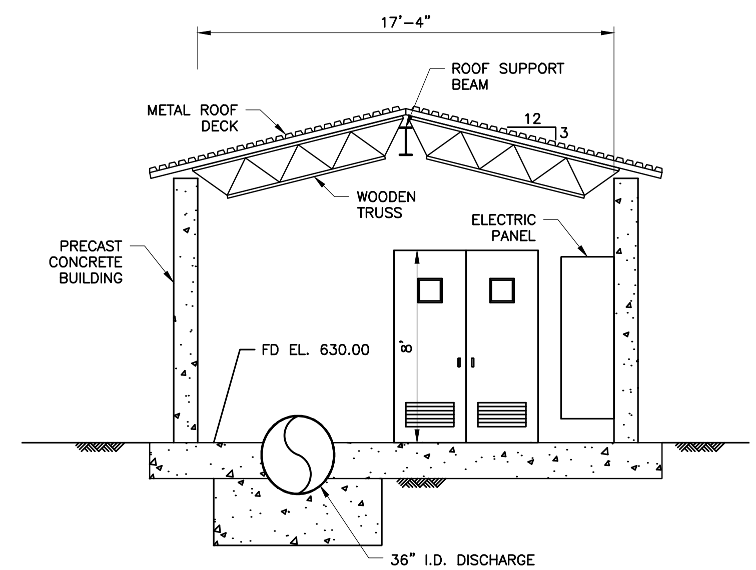
NORTH ELEVATION

SCALE: 1/4" = 1'



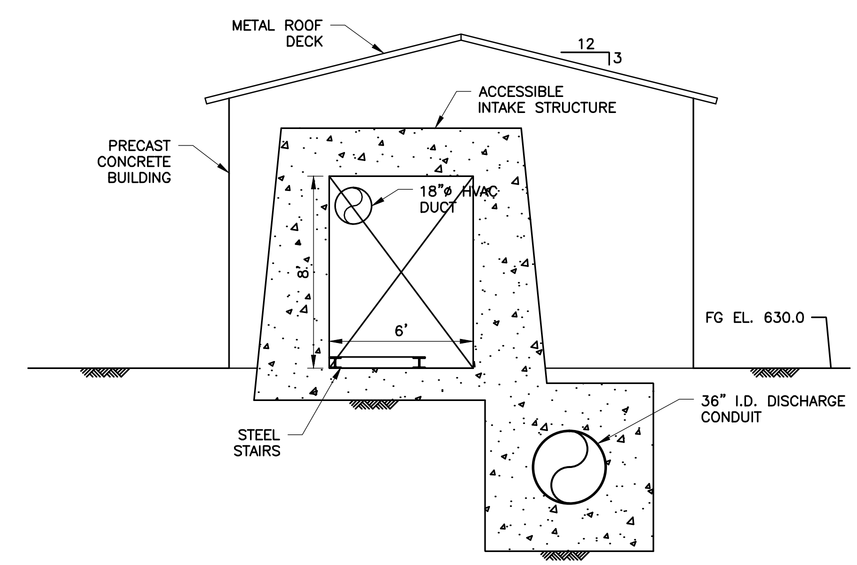
SECTION A 0-3

SCALE: 1/4" = 1'



SECTION B 0-3

SCALE: 1/4" = 1'



SECTION C 0-3

SCALE: 1/4" = 1'

REV	DESCRIPTION	DATE	APPR.	REFERENCE INFORMATION AND NOTES

GEI Consultants

DATE	08-14-15
DESIGN	P.J.E.
DRAWN	P.J.E.
CHECKED	J.G.H.

ENGINEERING CERTIFICATION

PROJECT ENGINEER DATE

Santa Clara Valley Water District

ACCEPTED BY DISTRICT

PROJECT ENGINEER DATE

PROJECT NAME AND SHEET DESCRIPTION:

GUADALUPE DAM SEISMIC RETROFIT PROJECT
STAFF-RECOMMENDED ALTERNATIVE
INTAKE CONTROL HOUSE GENERAL ARRANGEMENT

SCALE: AS NOTED

VERIFY SCALES

0 1"

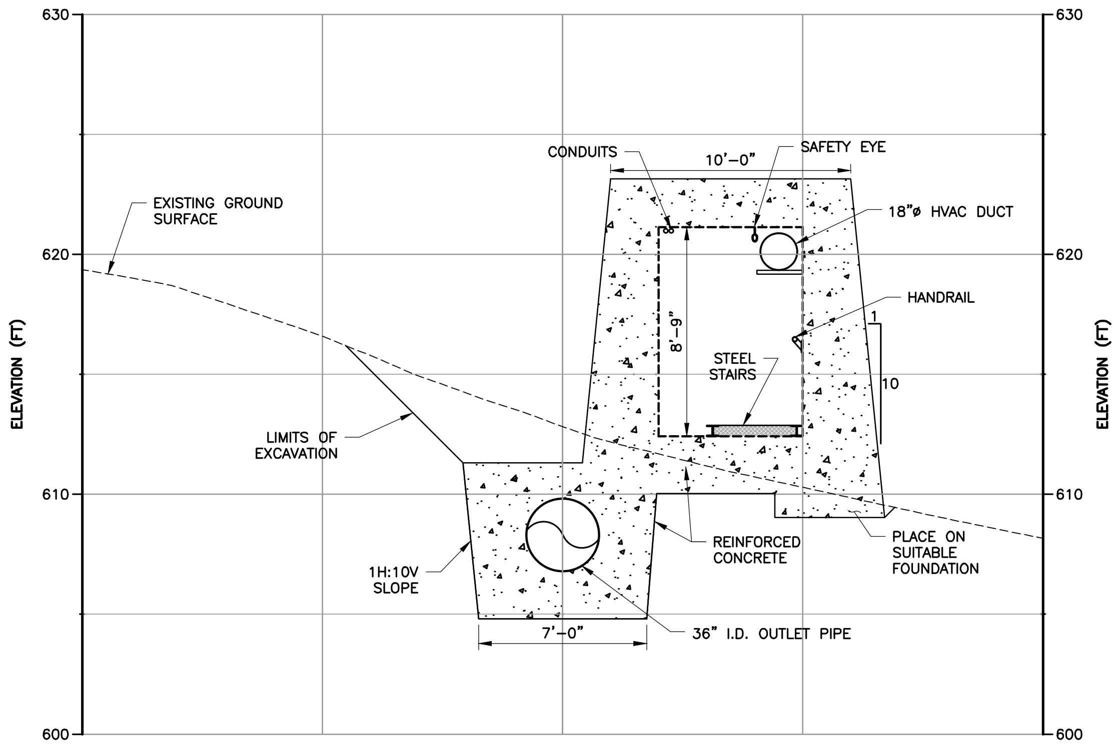
BAR IS ONE INCH ON ORIGINAL DRAWING IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

PROJECT NUMBER: 1328380

SHEET CODE: 0-3

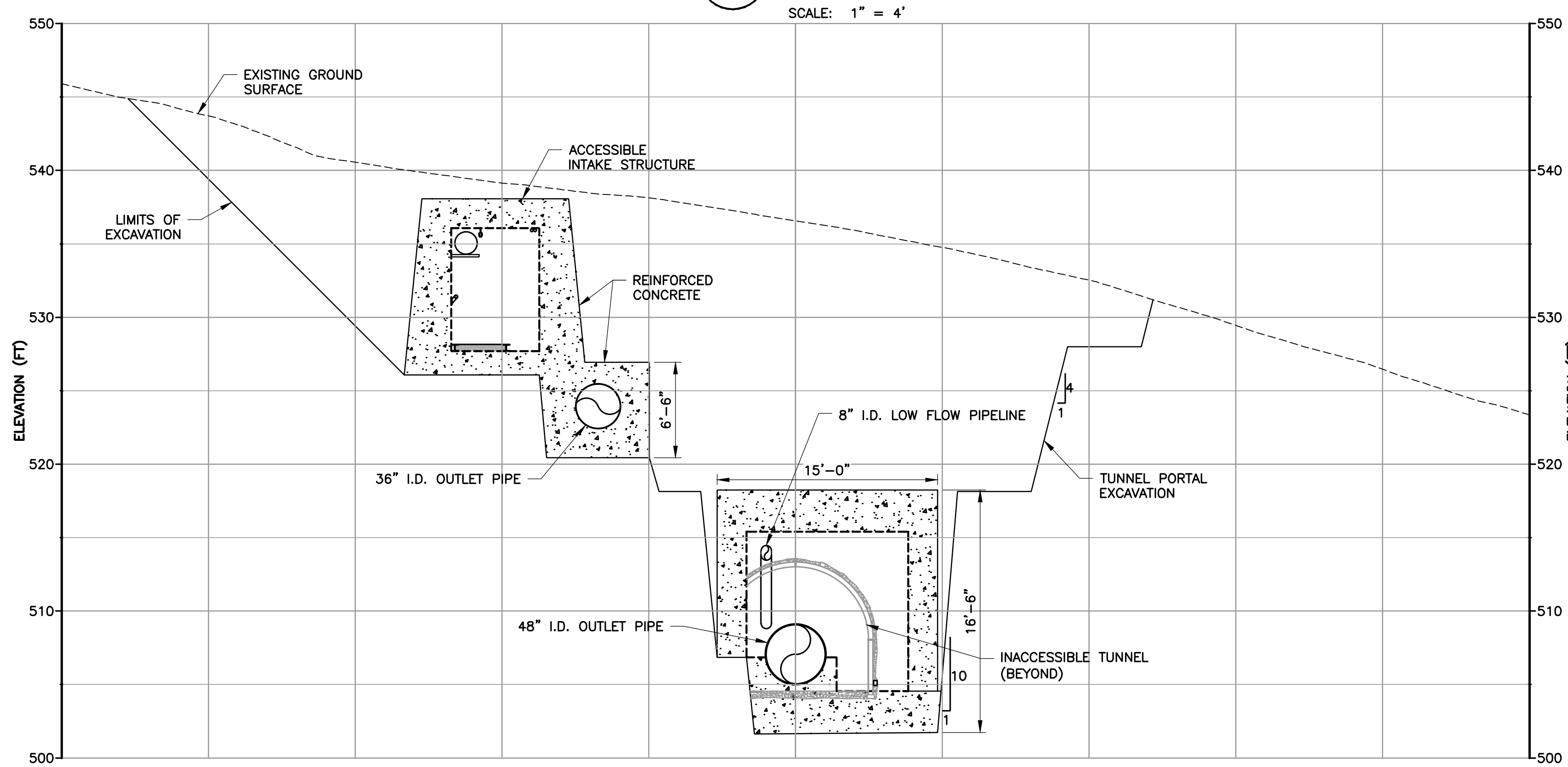
SHEET NUMBER: 15 OF 21

Guad_15_0-3-Intake Control House



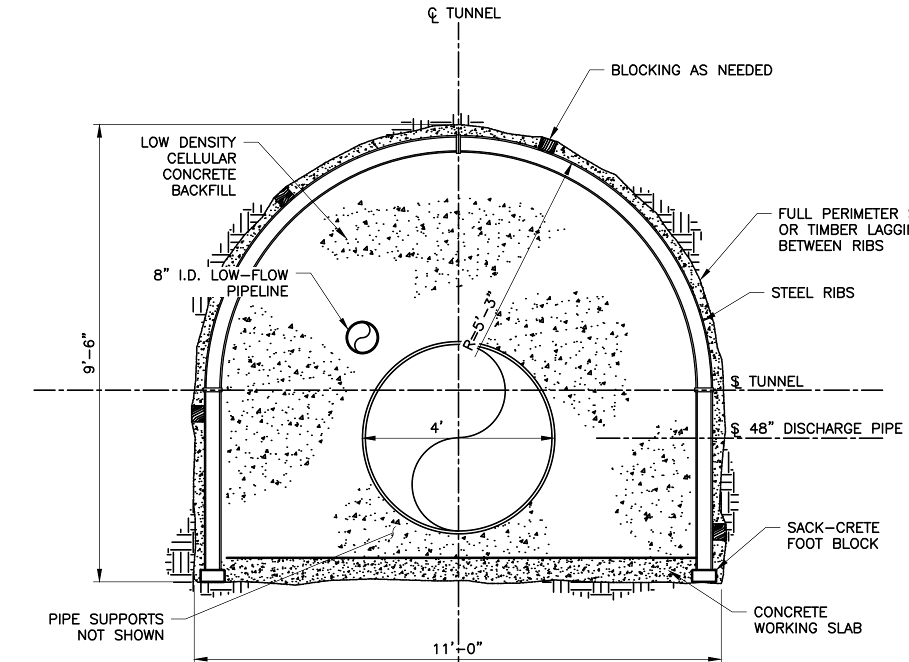
SECTION B (0-2) INTAKE STRUCTURE

SCALE: 1" = 4'



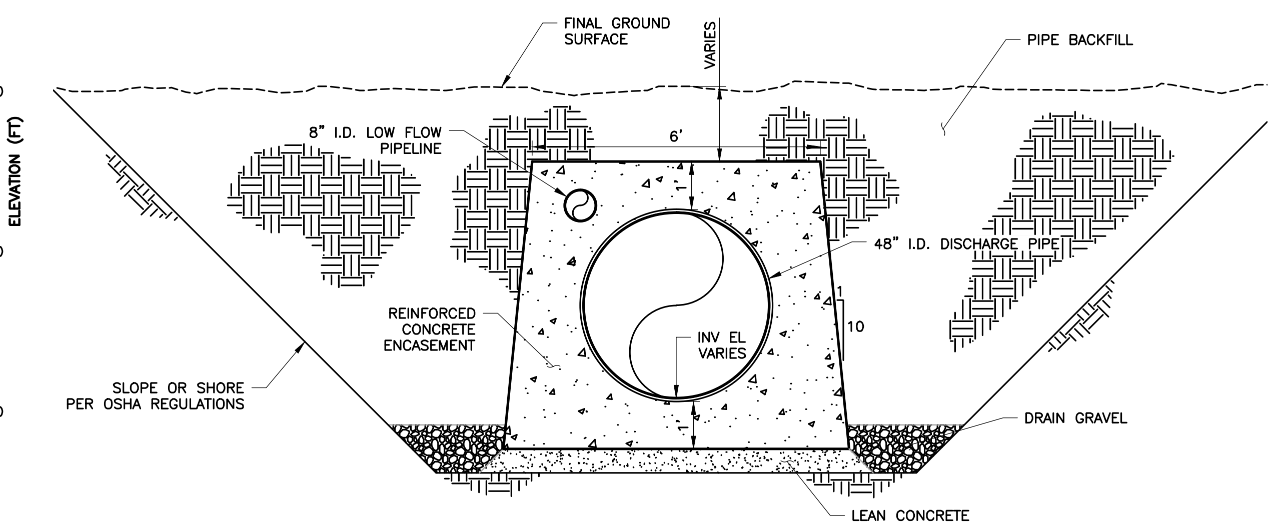
SECTION D (0-2) INTAKE STRUCTURE

SCALE: 1" = 6'



TYPICAL SECTION (A) INACCESSIBLE TUNNEL STA OW 0+32 TO OW 8+25

SCALE: 1/2" = 1'



TYPICAL SECTION (B) CONCRETE ENCASEMENT STA OW 8+25 TO OW 10+22

SCALE: 1/2" = 1'

Guad_16_0-4-Tunnel and Pipeline Details

REV	DESCRIPTION	DATE	APPR.	REFERENCE INFORMATION AND NOTES

GEI Consultants

DATE	08-14-15
DESIGN	P.J.E.
DRAWN	P.J.E.
CHECKED	J.G.H.

ENGINEERING CERTIFICATION

PROJECT ENGINEER DATE

Santa Clara Valley Water District

ACCEPTED BY DISTRICT

PROJECT ENGINEER DATE

PROJECT NAME AND SHEET DESCRIPTION:

GUADALUPE DAM SEISMIC RETROFIT PROJECT
STAFF-RECOMMENDED ALTERNATIVE

INTAKE STRUCTURE & OUTLET WORKS CROSS SECTIONS

SCALE: AS NOTED

VERIFY SCALES

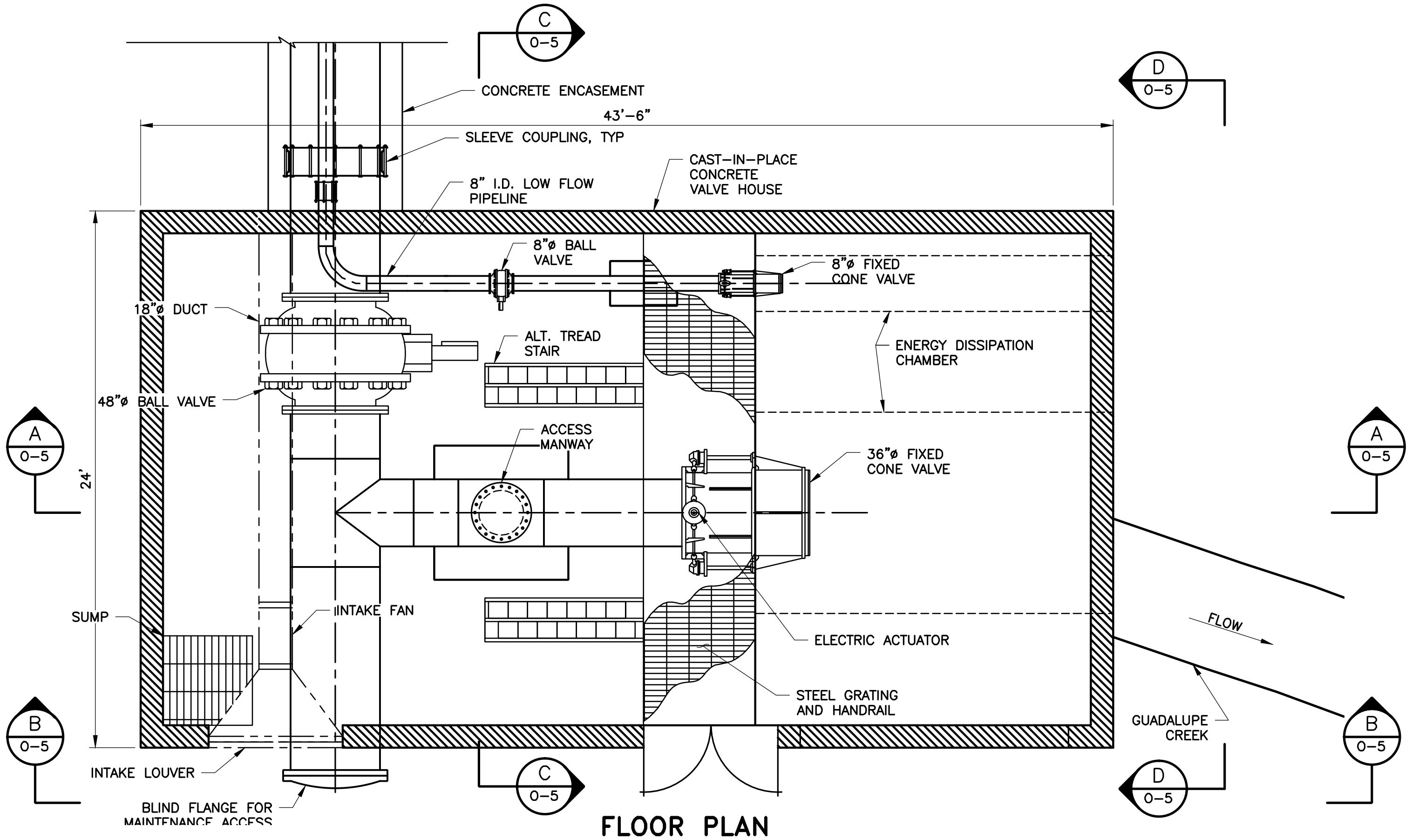
0 1"

BAR IS ONE INCH ON ORIGINAL DRAWING IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

PROJECT NUMBER: 1328380

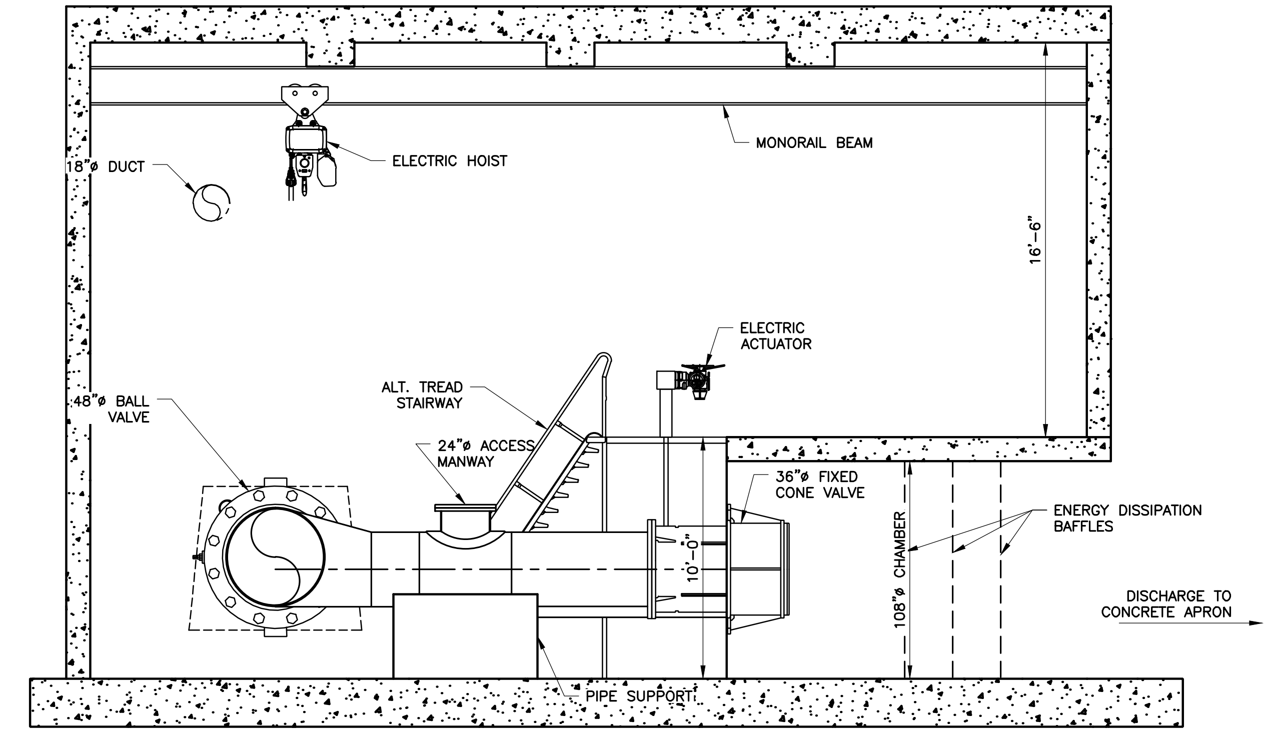
SHEET CODE: 0-4

SHEET NUMBER: 16 OF 21



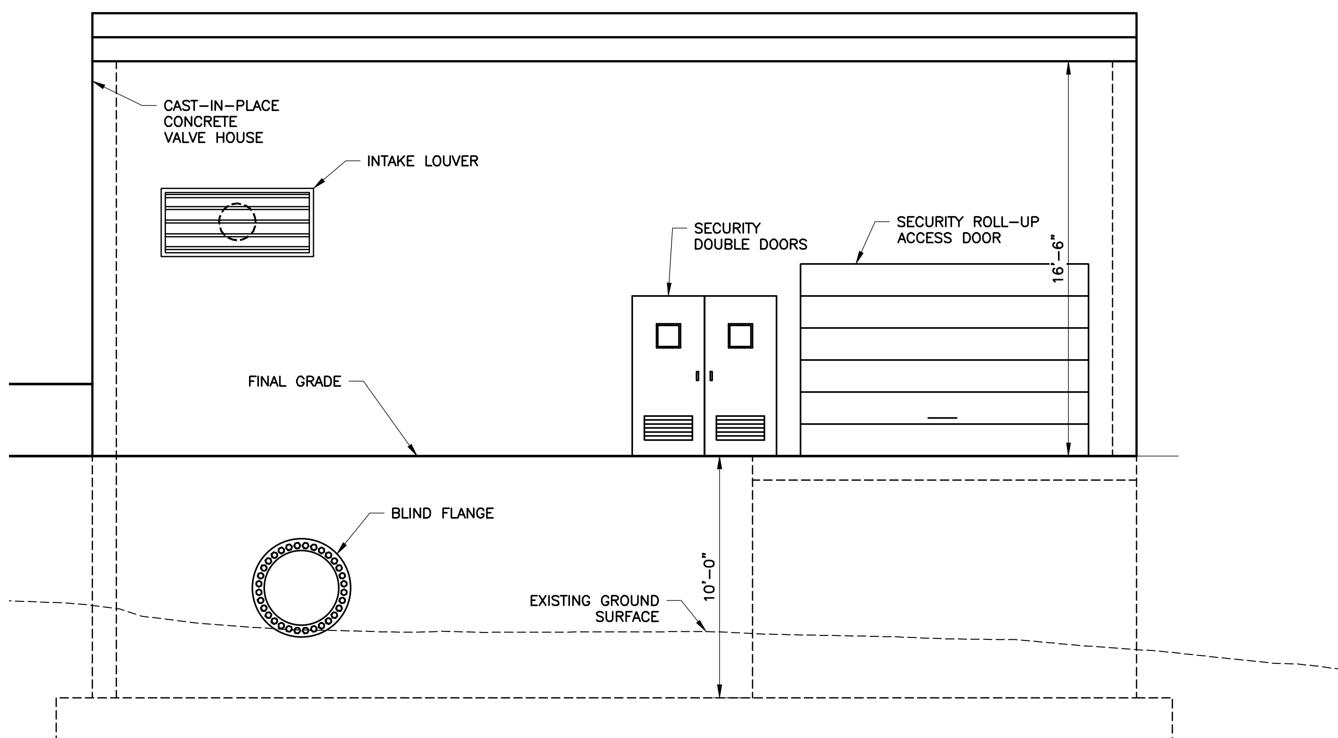
FLOOR PLAN

SCALE: 1/4"=1'



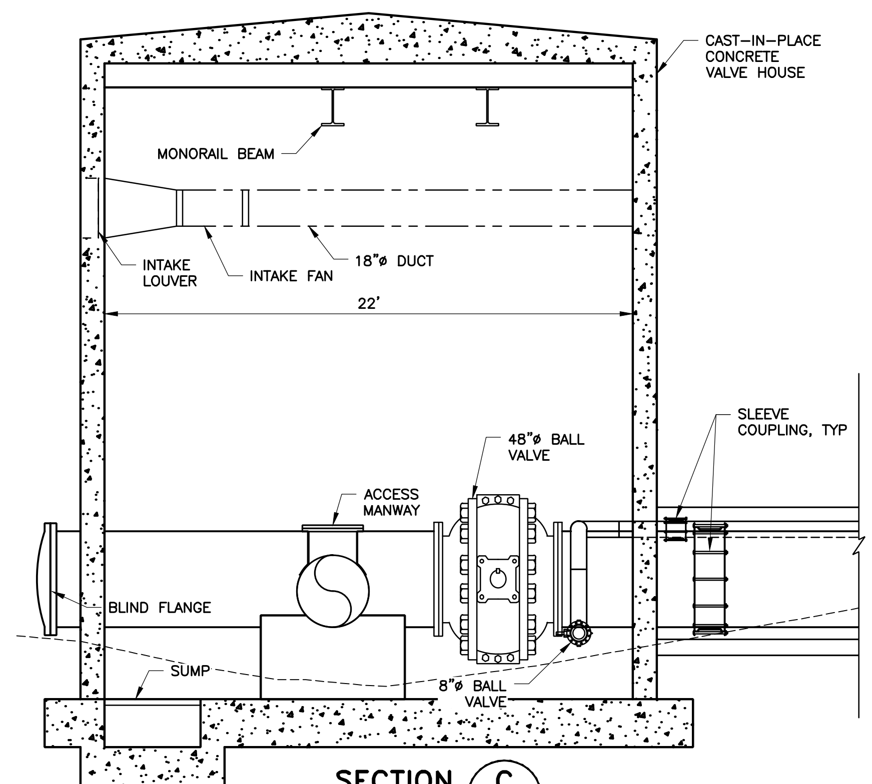
SECTION A 0-5

SCALE: 1/4" = 1'



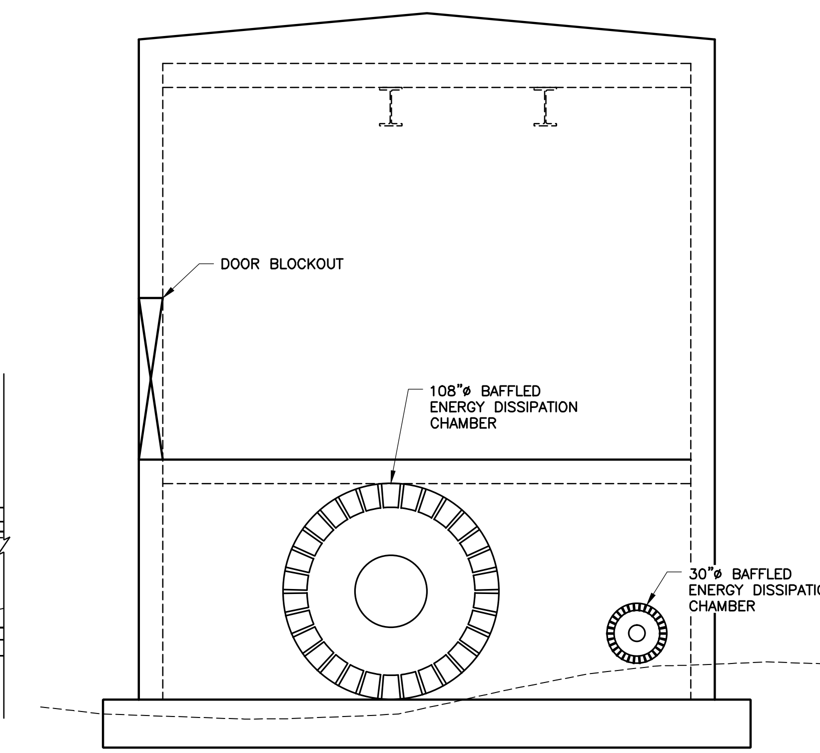
SECTION B 0-5

SCALE: 1/4" = 1'



SECTION C 0-5

SCALE: 1/4" = 1'

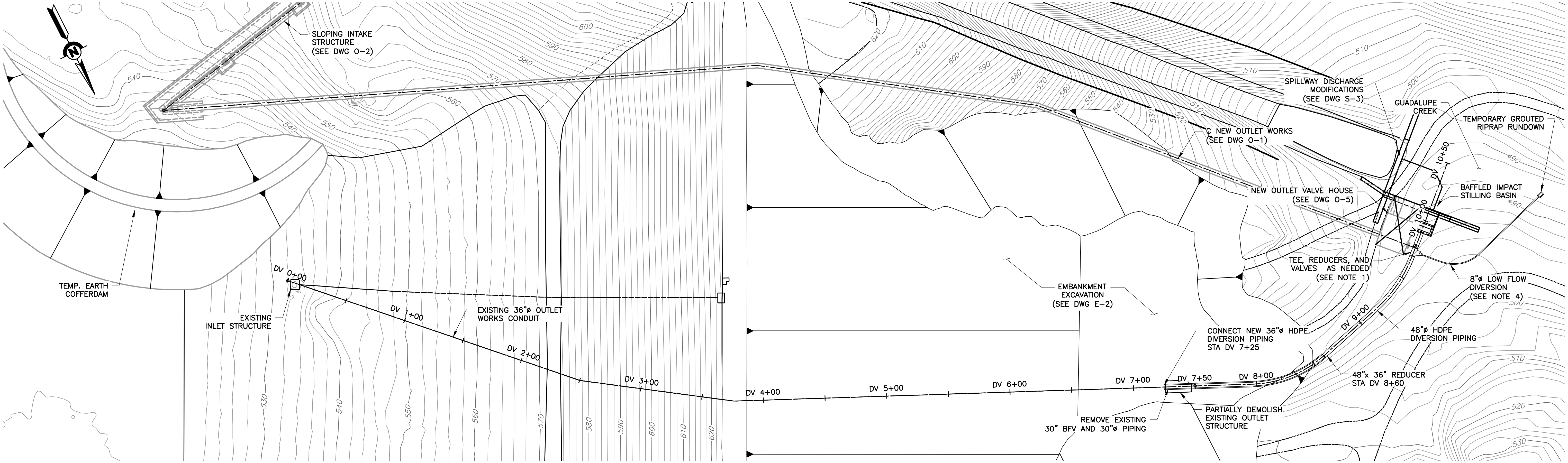


SECTION D 0-5

SCALE: 1/4" = 1'

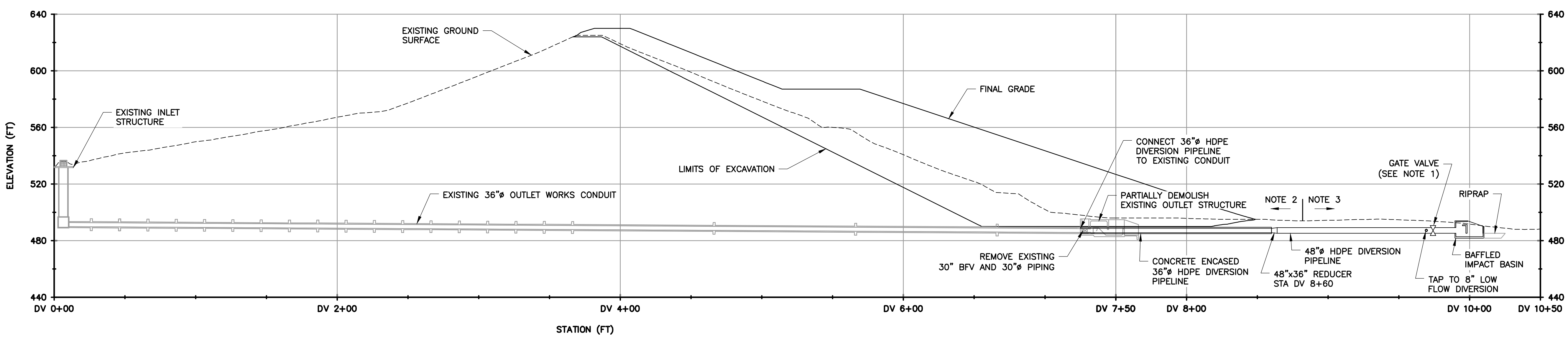
Guad_17_0-5-Downstream Valve House

REV	DESCRIPTION	DATE	APPR.	REFERENCE INFORMATION AND NOTES		DATE	ENGINEERING CERTIFICATION		PROJECT NAME AND SHEET DESCRIPTION:	SCALE	PROJECT NUMBER
					GEI Consultants	08-14-15 DESIGN P.J.E. DRAWN P.J.E. CHECKED J.G.H	PROJECT ENGINEER DATE	Santa Clara Valley Water District ACCEPTED BY DISTRICT PROJECT ENGINEER DATE	GUADALUPE DAM SEISMIC RETROFIT PROJECT STAFF-RECOMMENDED ALTERNATIVE OUTLET VALVE HOUSE GENERAL ARRANGEMENT	AS NOTED VERIFY SCALES 0 1" BAR IS ONE INCH ON ORIGINAL DRAWING IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY	1328380 SHEET CODE: 0-5 SHEET NUMBER: 17 OF 21



PLAN

SCALE: 1"=40'



PROFILE

SCALE: 1"=40'

NOTES:

1. MAINTAIN OPEN VALVE DURING WINTER RAINY SEASON FOR STORM ROUTING THROUGH MAIN DIVERSION CONDUIT. GATE VALVE MAY BE CLOSED DURING SUMMER DRY SEASON TO BYPASS MINUMUM STREAMFLOW BELOW DOWNSTREAM CONSTRUCTION AREAS USING LOW FLOW DIVERSION PIPE.
2. BACKFILL DIVERSION CONDUIT UPSTREAM OF APPROX. STA. 8+80 WITH CONCRETE AFTER NEW OW IS ACCEPTED AND IN SERVICE.
3. REPURPOSE DIVERSION CONDUIT DOWNSTREAM OF APPROX. 8+80 AS DRAIN OUTFALL FOR EMBANKMENT TO DRAIN.
4. REMOVE LOW FLOW DIVERSION PIPE AND RUNDOWN AFTER NEW OW IS IN SERVICE.
5. PROVIDE TEMPORARY PUMPOVER OF MINIMUM STREAMFLOW DURING ANY SHORT TERM OUTAGE OF GRAVITY DIVERSION SCHEDULE ONLY DURING SUMMER DRY SEASON THROUGH THE OW.

Guad_18_O-6-Temp Diversion Plan and Profile

REV	DESCRIPTION	DATE	APPR.	REFERENCE INFORMATION AND NOTES

GEI Consultants

DATE 08-14-15
DESIGN P.J.E.
DRAWN P.J.E.
CHECKED J.G.H.

ENGINEERING CERTIFICATION

PROJECT ENGINEER DATE

Santa Clara Valley Water District

ACCEPTED BY DISTRICT

PROJECT ENGINEER DATE

PROJECT NAME AND SHEET DESCRIPTION:

GUADALUPE DAM SEISMIC RETROFIT PROJECT
STAFF-RECOMMENDED ALTERNATIVE

TEMPORARY DIVERSION PLAN & PROFILE

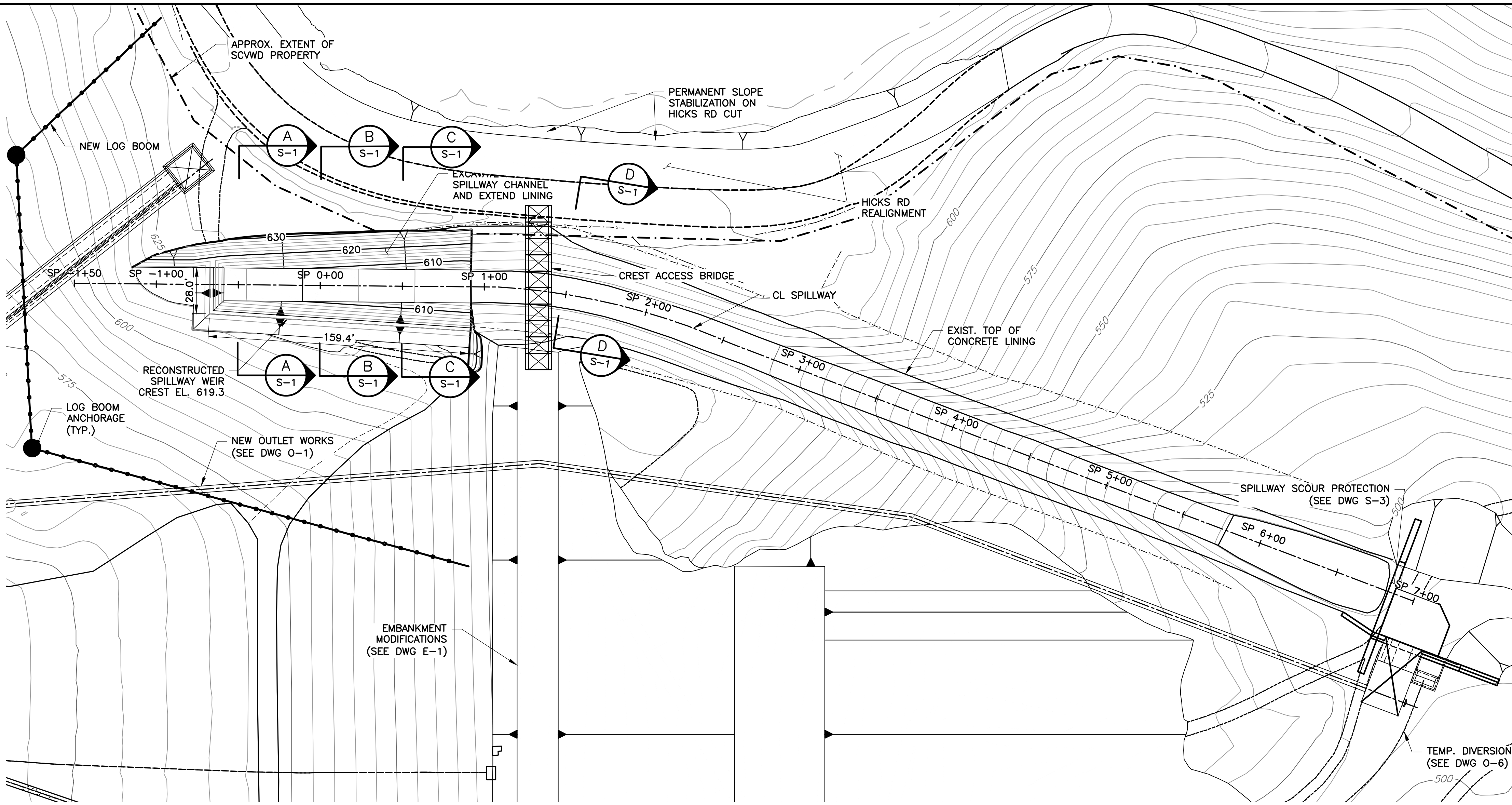
SCALE: AS NOTED

VERIFY SCALES
0 1"
BAR IS ONE INCH ON ORIGINAL DRAWING IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

PROJECT NUMBER: 1328380

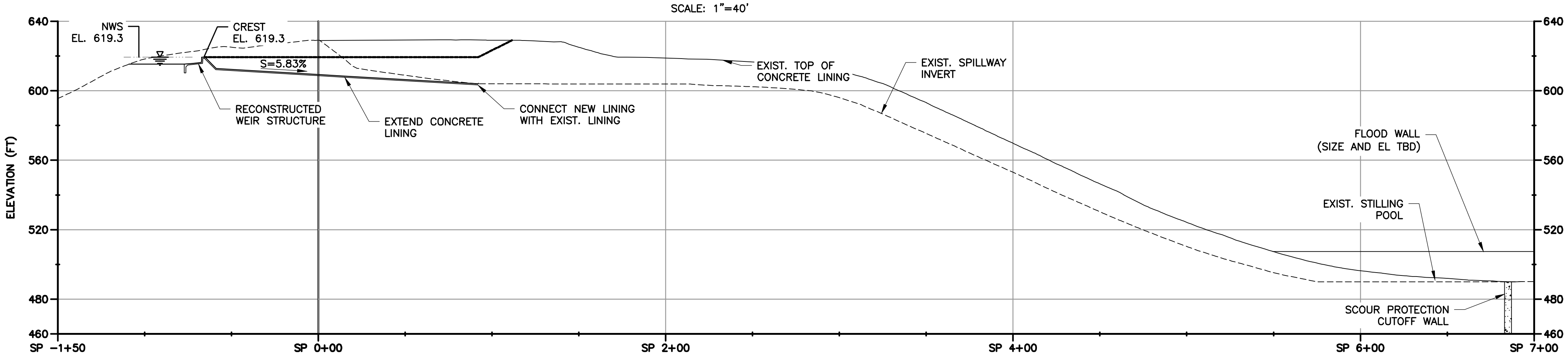
SHEET CODE: O-6

SHEET NUMBER: 18 OF 21



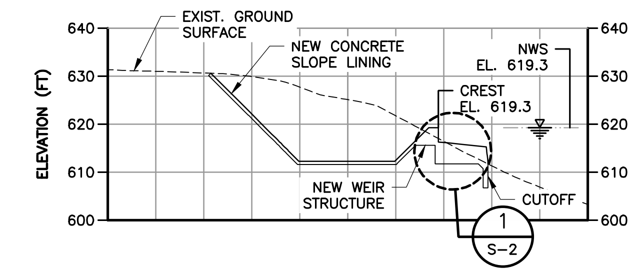
PLAN

SCALE: 1"=40'



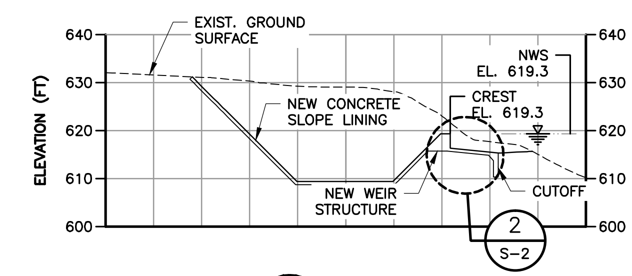
PROFILE

SCALE: 1"=40'



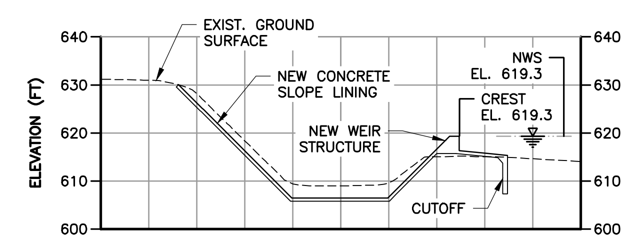
SECTION A S-1 SPILLWAY

SCALE: 1" = 20'



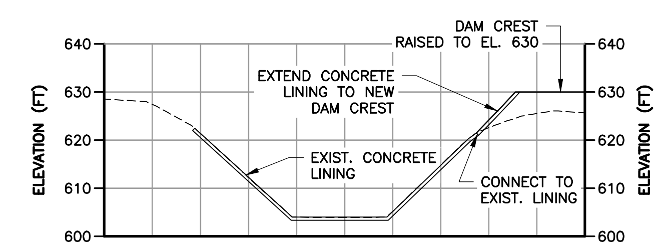
SECTION B S-1 SPILLWAY

SCALE: 1" = 20'



SECTION C S-1 SPILLWAY

SCALE: 1" = 20'



SECTION D S-1 SPILLWAY

SCALE: 1" = 20'

Guad_19_S-1-Spillway Plan and Profile

REV	DESCRIPTION	DATE	APPR.	REFERENCE INFORMATION AND NOTES

GEI Consultants

DATE 10-30-15
DESIGN P.J.E.
DRAWN P.J.E.
CHECKED J.G.H.

ENGINEERING CERTIFICATION

PROJECT ENGINEER DATE

Santa Clara Valley Water District

ACCEPTED BY DISTRICT

PROJECT ENGINEER DATE

PROJECT NAME AND SHEET DESCRIPTION:

GUADALUPE DAM SEISMIC RETROFIT PROJECT
STAFF-RECOMMENDED ALTERNATIVE

SPILLWAY
PLAN, PROFILE, & SECTIONS

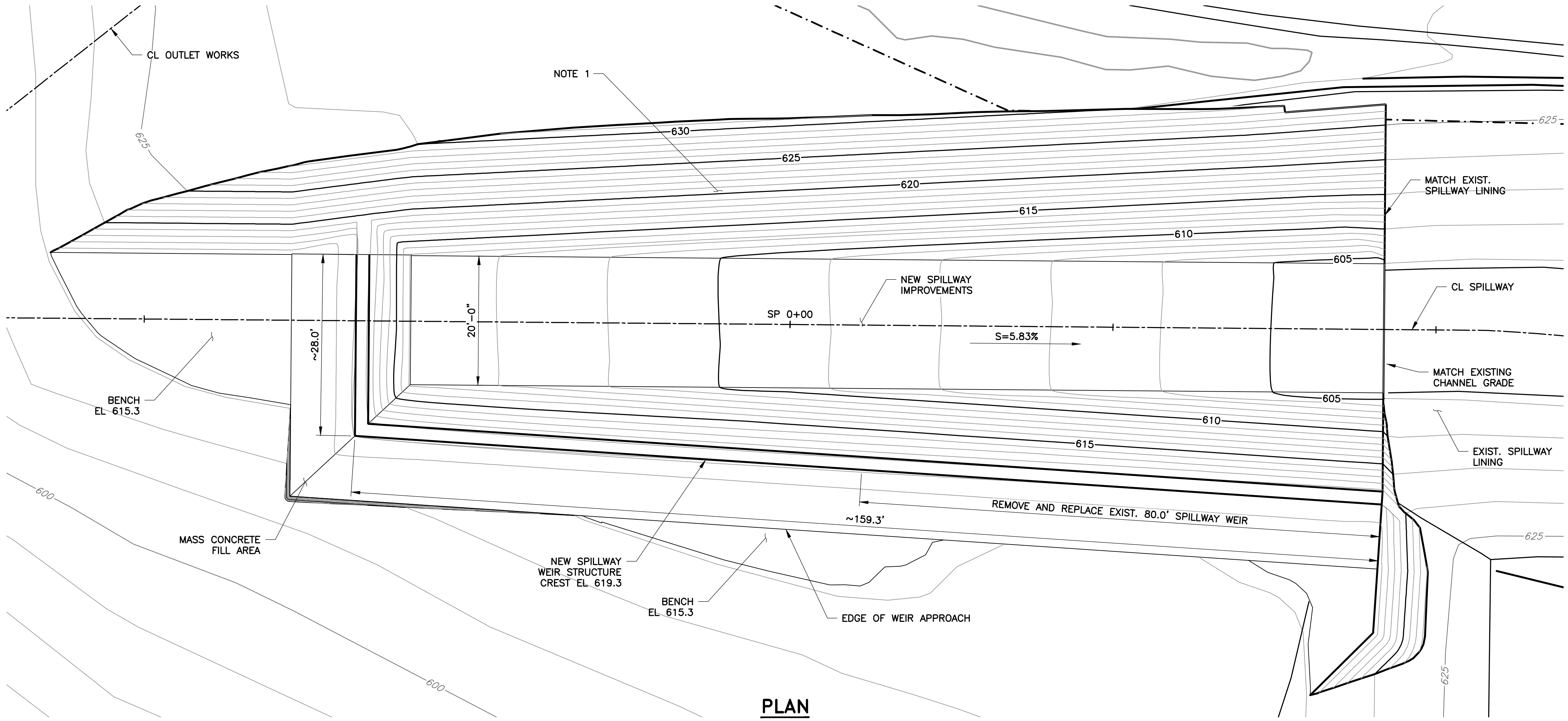
SCALE: AS NOTED

VERIFY SCALES
0 1"
BAR IS ONE INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

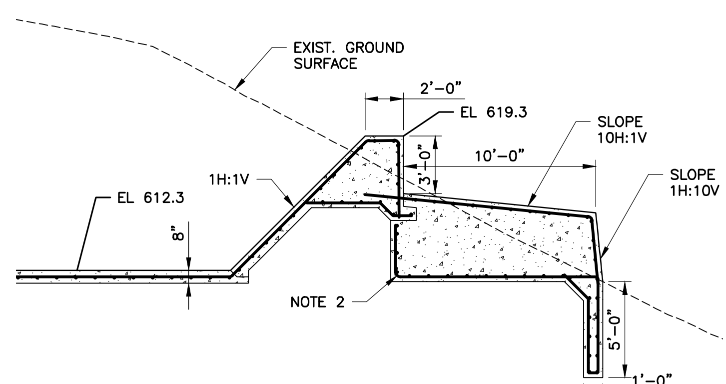
PROJECT NUMBER 1328380

SHEET CODE: S-1

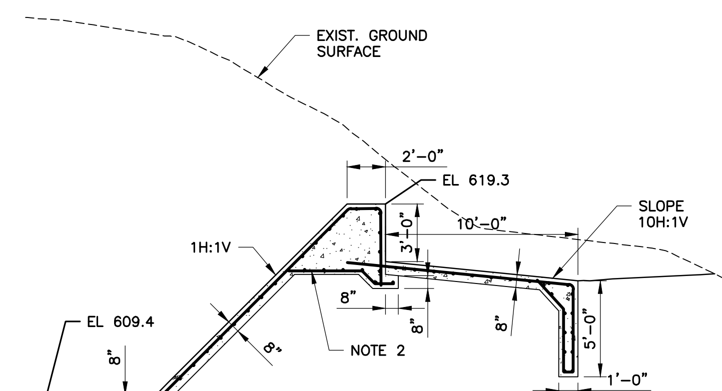
SHEET NUMBER: 19 OF 21



PLAN
SCALE: 1"=10'



DETAIL 1 / S-1 — STA SP -0+50 SPILLWAY WEIR
SCALE: 1" = 5'



DETAIL 2 / S-1 — STA SP 0+00 SPILLWAY WEIR
SCALE: 1" = 5'

NOTES:

1. REMOVE AND RELOCATE EXISTING AERATION EQUIPMENT OUTSIDE OF NEW SPILLWAY IMPROVEMENTS FOOTPRINT.
2. REINFORCING SHOWN IS FOR GENERAL LAYOUT, NOT FINAL DESIGN.

Guad_20_S-2-Spillway Crest Details.dwg

REV	DESCRIPTION	DATE	APPR.	REFERENCE INFORMATION AND NOTES

GEI Consultants

DATE 08-14-15
DESIGN P.J.E.
DRAWN P.J.E.
CHECKED J.G.H.

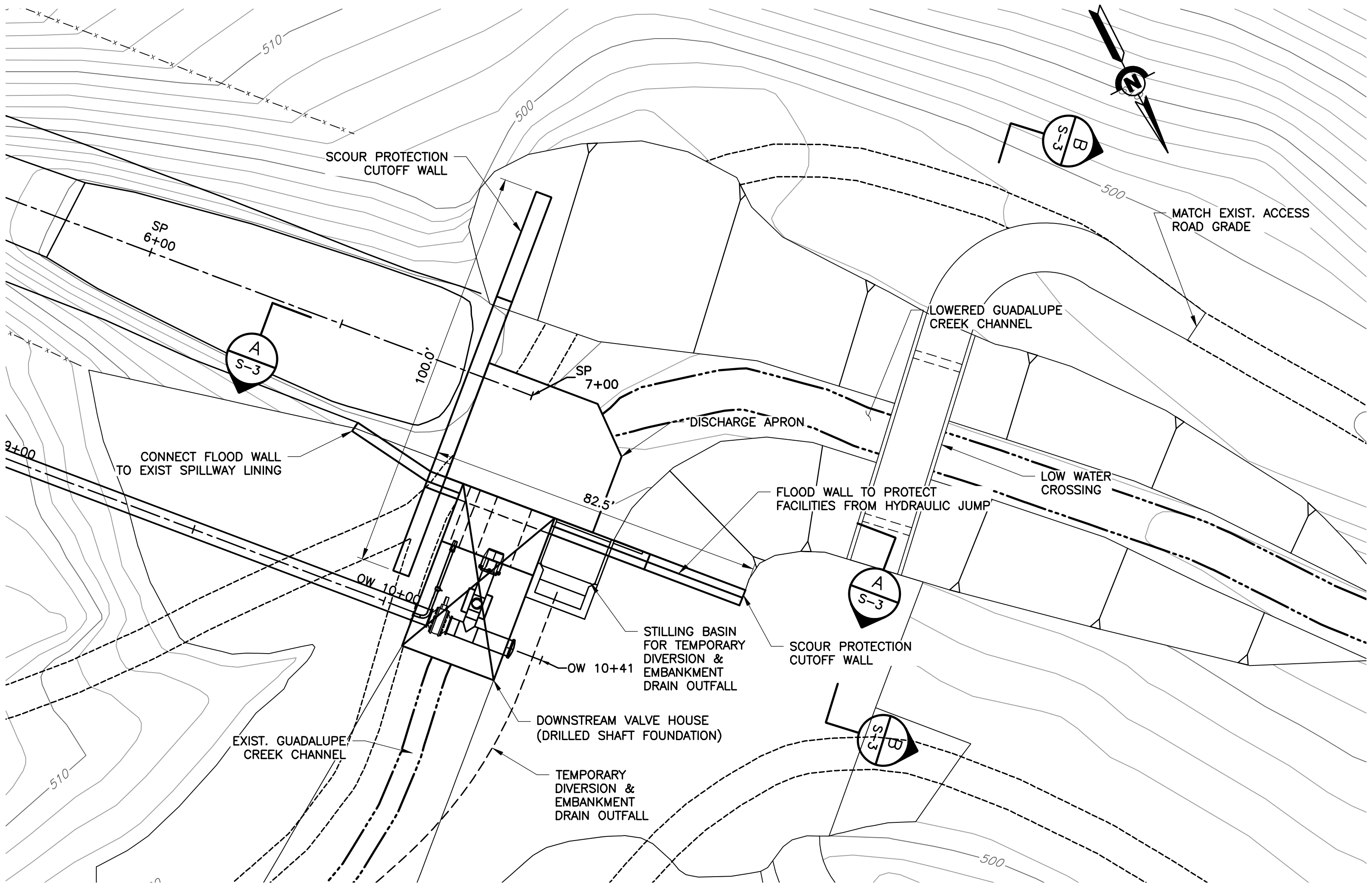
ENGINEERING CERTIFICATION
PROJECT ENGINEER DATE

Santa Clara Valley Water District
ACCEPTED BY DISTRICT
PROJECT ENGINEER DATE

PROJECT NAME AND SHEET DESCRIPTION:
GUADALUPE DAM SEISMIC RETROFIT PROJECT
STAFF-RECOMMENDED ALTERNATIVE
SPILLWAY CREST DETAILS

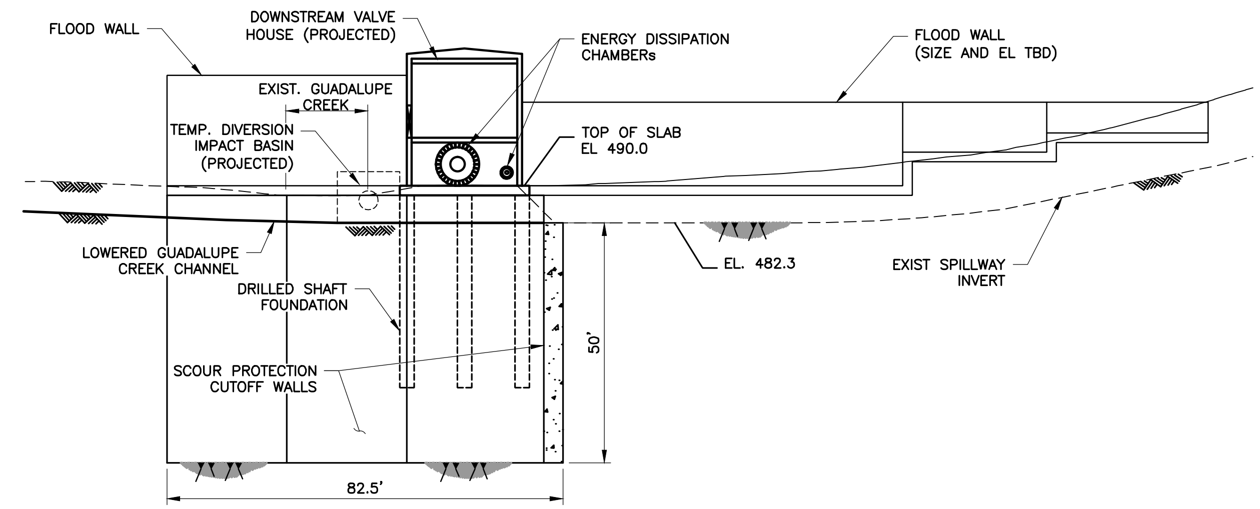
SCALE: AS NOTED
VERIFY SCALES
0 1"
BAR IS ONE INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

PROJECT NUMBER 1328380
SHEET CODE: S-2
SHEET NUMBER: 20 OF 21



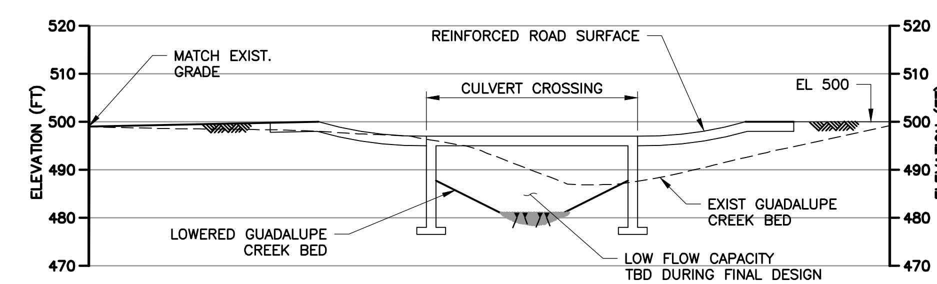
PLAN

SCALE: 1"=20'



SECTION A S-3 **SCOUR PROTECTION FEATURES GENERAL ARRANGEMENT**

SCALE: 1" = 20'



SECTION B S-3 **PROFILE ALONG LOW WATER CROSSING**

SCALE: 1" = 20'

Guad_22_S-3A-Alt Spillway Energy Dissipation

REV	DESCRIPTION	DATE	APPR.	REFERENCE INFORMATION AND NOTES

GEI Consultants

DATE 08-14-15
DESIGN P.J.E.
DRAWN P.J.E.
CHECKED J.G.H.

ENGINEERING CERTIFICATION

PROJECT ENGINEER DATE

Santa Clara Valley Water District

ACCEPTED BY DISTRICT

PROJECT ENGINEER DATE

PROJECT NAME AND SHEET DESCRIPTION:

GUADALUPE DAM SEISMIC RETROFIT PROJECT
STAFF-RECOMMENDED ALTERNATIVE
SPILLWAY DISCHARGE AREA GENERAL ARRANGEMENT

SCALE: AS NOTED

VERIFY SCALES
0 1"
BAR IS ONE INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

PROJECT NUMBER: 1328380

SHEET CODE: S-3

SHEET NUMBER: 21 OF 21