FINAL

SAN VICENTE PUMPED STORAGE PROJECT

Technical Memorandum – Additional Studies

B&V PROJECT NO. 181868

PREPARED FOR

San Diego County Water Authority / City of San Diego

20 JANUARY 2016

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ACRONYMS AND ABBREVIATIONS

AC	Alternating Current
A-F	Acre-Feet
AC-FT	Acre-Feet
AVG	Average
B&V	Black & Veatch
CFS	Cubic feet per second
City	City of San Diego
CY	Cubic yards
DAH	Day Ahead
DSOD	Department of Safety of Dams
EAIL	Existing Aqueduct Inlet Location
El	Elevation
Evaluation	Technical Evaluation
FERC	Federal Energy Regulatory Commission
FPS	Feet per second
FT	Feet
FY	Fiscal Year
GPM	Gallons per minute
GWh	Gigawatt hours
Hrs	Hours
kV	kiloVolt
kW	kilowatt
LBS	Pounds
L/H	Length over Height
LV	Low Voltage
M	Meters
MG	Motor Generator
MW	Megawatts
MW-hrs	Megawatts per hour
MHh	Megawatts per hour
MSL	Mean Sea Level
NPSH	Net Positive Suction Head
NPV	Net Project Value
PG&E	Pacific Gas & Electric
PPA	Power Purchase Agreement
PT	Pump Turbine
Project	San Vicente Pumped Storage Project
Program	Pure Water Program
RCC	Roller Compacted Concrete
Reservoir	San Vicente Reservoir
ROW	Right-of-Way
RPM	Revolutions per minute
SDG&E	San Diego Gas & Electric

SF	Square feet
SONGS	San Onofre Nuclear Generation Station
Study	San Vicente Pumped Storage Project Economic and Financial Study
Sycamore	Sycamore Canyon Substation
T	Ton
TM	Technical Memorandum
TS	Technical Summary
Water Authority	San Diego County Water Authority
WACC	Weighted Average Cost of Capital
WQS	Water Quality Solutions
XFMR	Transformer
¼ DIL	½ Design Inlet Location
½ DIL	¼ Design Inlet Location

Technical Summary

PURPOSE

The purpose of this San Vicente Pumped Storage Project (Project) Additional Studies Technical Memorandum (TM) is to provide the San Diego County Water Authority (Water Authority) and the City of San Diego (City) with additional technical information needed to determine the impacts of the proposed Project to the City's planned Pure Water Program (Program) at the San Vicente Reservoir. Under this TM, additional technical aspects of the Project will be performed to determine the effects of the proposed facilities on the Program including: 1) evaluating proposed inlet/outlet locations for the various sites and impacts to water quality, 2) utilizing an expanded range of operation within the lower reservoir, and 3) revising powerhouse sizing by the use of multiple units with variable frequency drives. Based on the findings of these evaluations, the overall project costs and financial statements will be updated. The TM will provide the basis to present a recommendation to the Water Authority/City and Board of Directors/City Council regarding the viability to continue to develop a pumped storage project at the San Vicente Reservoir site in conjunction with the City's planned Pure Water Program.

PROJECT CONFIGURATION

As previously developed in the San Vicente Pumped Storage Project Economic and Financial Feasibility Study (Black & Veatch, April 2014), the proposed San Vicente Pumped Storage Project (Project) was initially configured for a nominal 500 Megawatts (MW) pumped storage project using the existing San Vicente Reservoir as the lower reservoir. The original Project configuration was based on the following:

- Four alternative upper reservoir sites adjacent to the existing lower reservoir (see Figure TS-1)
- Lower reservoir level operation from elevation 764 to 750
- Intertie connection at the Sycamore Substation owned by SDG&E, 5 miles west of the Project Area

As part of the work performed under this Additional Studies the following key assumptions where developed:

- As originally configured, only Alternatives A1, B3 and C3 can meet the 500 MW capacity of generation with 8 hours of storage requirements. Site D (Alternatives D1 and D2) only provides 5.7 hours of storage at 500 MW or 8 hours of storage at 350 MW, respectively. However, Site D will continue to be evaluated under this TM to determine the value of this alternative and its viability to be expanded to the full 500 MW capacity of generation with 8 hours of storage requirement for comparison with Alternatives A1, B3 and C3. This new alternative will be designated D3 for purposes of this TM.
- Each site will consist of an upper reservoir, conveyance tunnels/shafts to transport the water to and from a new powerhouse, access facilities including roads, electrical transmission lines and substations to transport the energy to the existing transmission grid
- The originally proposed Intertie connection at Sycamore Substation would continue to be utilized

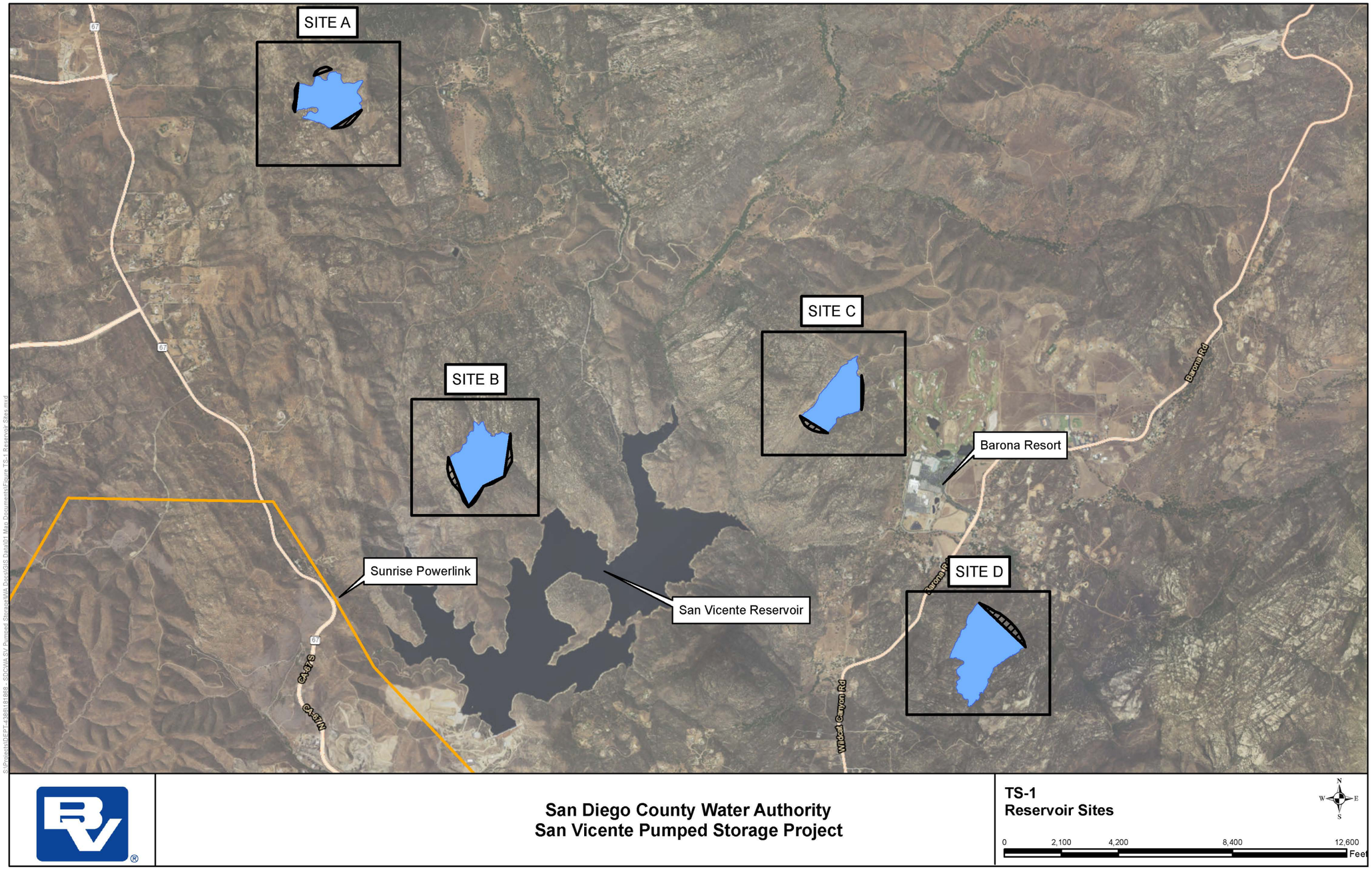


Figure TS-1 Reservoir Sites

In addition the following components of the project where established to determine the evaluation approach:

- As with the previous Study, the Pump Storage project must be complementary to the City of San Diego's Pure Water Program water quality parameters
- Identify inlet/outlet locations at the lower reservoir that work with the City's Pure Water Program
- Provide a high level review of potential water quality modeling to understand the impacts of the City's Pure Water Program
- Provide operational flexibility with varying Reservoir levels which would be attractive to potential energy partners
- Provide additional operational flexibility with the use of multiple pump-turbine units that operate with the use of variable frequency drives
- All options must also allow for continued use of the reservoir for water storage and recreational needs

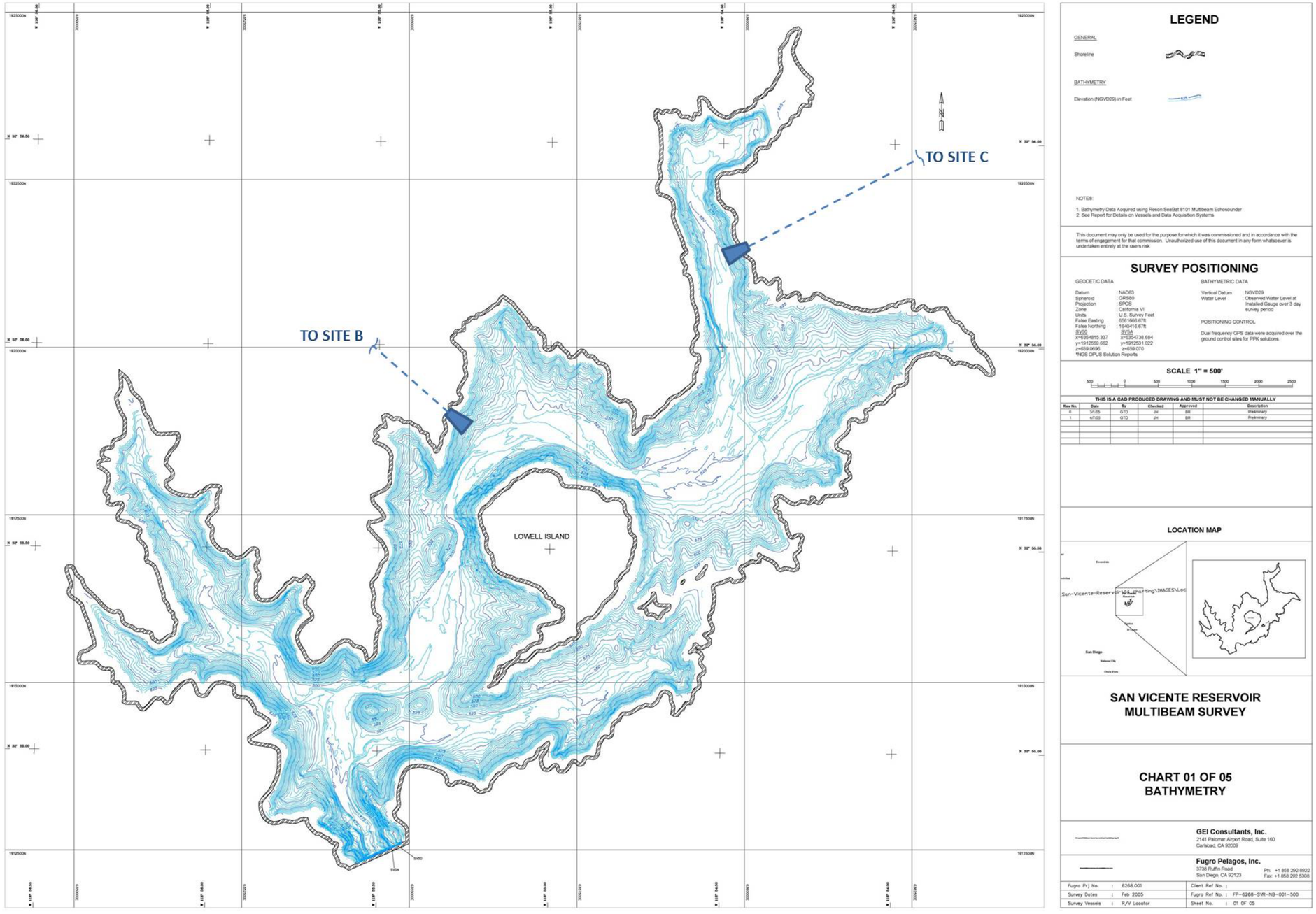
LOWER RESERVOIR INLET/OUTLET SITING EVALUATION

As part of this task Black & Veatch reviewed the existing Reservoir bathymetry to determine feasible locations for the new inlet/outlet structures associated with each site. Meetings with Water Authority and City staff were held to discuss the proposed inlet/outlet locations as well to establish the potential operating range of the lower reservoir. By maximizing this range the Water Authority and City can bring additional financial value to the Project since the reservoir would be able to operate over a wider band. The proposed Pure Water Program inlet locations where discussed at these meetings. Based on the work performed under this section, it was determined that the reservoir water surface elevation could be reduced to elevation 618 feet during the pumped storage operation, which would allow for a minimum remaining storage of 58,000 acre-feet within the reservoir. This minimum storage represents storage for drought or other emergencies.

As shown in Figure TS-2, two locations, for the inlet/outlet structure were identified by the team and considered for water quality and limnology modeling by the City's modeling consultant, Water Quality Solutions (WQS). Site B was recommended to be modeled first, followed by Site C. Site C would only be modeled if Site B was found not to work with the City's Pure Water Program parameters. Results of the modeling are presented in the next section.

WATER QUALITY MODELING

Black & Veatch worked with the City and WQS to establish the modeling parameters associated with the inlet/out structure. Initial efforts utilized a FLUENT model to determine how the inlet/outlet structure could be emulated by use of downward acting draft tubes and bubblers to represent the impacts of the Pumped Storage project within the reservoir. The results of the FLUENT model where incorporated into another model, the ELCOM model, to determine the impacts of the Pumped Storage project on the reservoir water quality when combined with purified water (PW) entering the reservoir as part of the City's Pure Water Program. Initial results from the model indicate that the Pump Storage Project should be able to co-exist with the Pure Water Program. Detailed results of this modeling work are presented in a stand-alone report developed by WQS titled *Limnology and Detention Study for San Vicente Reservoir: Effects of Pump Storage.*



LEGEND

GENERAL

Shoreline

BATHYMETRY

Elevation (NGVD29) in Feet

NOTES:

1. Bathymetry Data Acquired using Reson SeaBat 8101 Multibeam Echosounder
2. See Report for Details on Vessels and Data Acquisition Systems

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SURVEY POSITIONING

GEODETIC DATA

Datum	: NAD83
Spheroid	: GRS80
Projection	: SPCS
Zone	: California VI
Units	: U.S. Survey Feet
False Easting	: 6561666.67ft
False Northing	: 1640416.67ft
SVS5	: SVS6
x=6534815.337	x=6554738.684
y=1912569.662	y=1912531.022
z=659.0696	z=659.070

*NGS CPUS Solution Reports

BATHYMETRIC DATA

Vertical Datum	: NGVD29
Water Level	: Observed Water Level at Installed Gauge over 3 day survey period

POSITIONING CONTROL

Dual frequency GPS data were acquired over the ground control sites for PPK solutions.

SCALE 1" = 500'

500 0 500 1000 1500 2000 2500

THIS IS A CAD PRODUCED DRAWING AND MUST NOT BE CHANGED MANUALLY

Rev No.	Date	By	Checked	Approved	Description
0	3/1/05	GTD	JH	BR	Preliminary
1	4/7/05	GTD	JH	BR	Preliminary

LOCATION MAP

SAN VICENTE RESERVOIR
MULTIBEAM SURVEY

CHART 01 OF 05
BATHYMETRY

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San Diego, CA 92123
Ph: +1 858 292 8922
Fax: +1 858 292 5308

Fugro Prj No.	: 6268.001	Client Ref No.	:
Survey Dates	: Feb 2005	Fugro Ref No.	: FP-6268-SVR-NB-001-500
Survey Vessels	: R/V Locator	Sheet No.	: 01 OF 05

Figure TS-2 Proposed Inlet/Outlet Locations – Site B and C

As a result of the modeling efforts, it was determined that the Site B inlet/outlet location was feasible and no addition site modeling was necessary under this TM. Potential inlet/outlet locations where identified for all four upper reservoir options and are shown on Figure TS-3.

UPDATED SITE CONFIGURATIONS

The following steps were then performed to further evaluate the site alternatives:

Revised Site Evaluation – The four sites that were previously identified within the Feasibility Study were updated to meet the requirements set forth within this TM, specifically meeting the 500 MW of capacity and 4,000 MW-hrs of storage. In addition, the powerhouse configurations where modified to utilize 4-125MW units with variable frequency drives while meeting the revised low water surface elevation operating range (elevation 618 feet) within the lower reservoir. Updates to each site facility included: 1) lower reservoir (i.e. reservoir levels and an inlet/outlet structure), 2) upper reservoir, 3) powerhouse with variable pump-turbine capacity, 4) water conductor features, 5) access tunnels, 6) mechanical systems, and 7) electrical systems. As part of this evaluation, the inlet/outlet structure was modified to provide an optimized, more economical alternative than the original outlet structure

Substation and Transmission – The original substation and transmission corridors that were presented in the previous Study was utilized for this TM.

Access Roadways Costs – Roadway costs where further developed under this TM. Roads costs were based on $25/lf for new roadways and $15/lf for improvements to existing roadways with a width of 20 feet. Roadway costs varied from $945,000 for Site A to $369,000 for Site D.

Land Acquisition Cost Evaluation – Land acquisition costs where further evaluated under this scope of work. Land costs where based on $50,000/acre for lands to be purchases, with the assumption that 120 acres would be required for each site. Easement costs where based on $3,500/acre. Easements for access roads and tunnels varied by site from 46.3 acres for Site A to 15.3 acres for Site D. In total land and easement costs will range from $6,000,000 to $6,200,000, depending on which site is developed.

Project Development and Cost Evaluation – Results of the evaluations noted above provided the necessary information to determine development costs for the Project. The costs presented are based on the parametric model and conceptual engineering described herein that include the following:

- Project construction and procurement cost
- Land acquisition costs as described above
- Allowance for engineering at 5% of direct cost
- Allowance for Construction Management/Resident engineering of 5% of direct cost
- Allowance of $8,000,000 for licensing and permitting
- Allowance of $5,000,000 for power marketing

To the sum of the above cost, a 20% allowance for contingency was added.

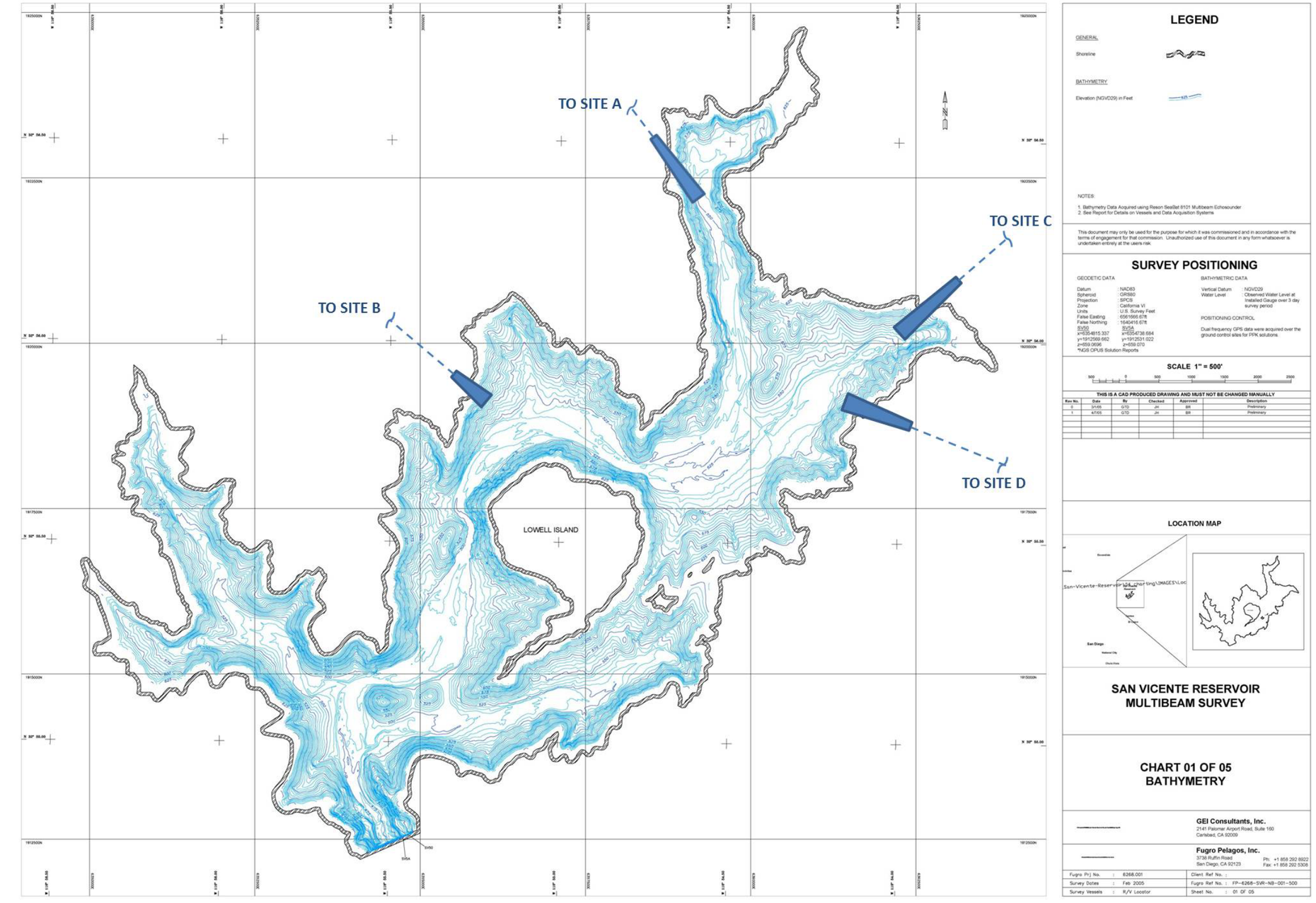


Figure TS-3 Revised Inlet/Outlet Locations

The following are not included in the cost estimate and will be added in the economic analysis.

- Allowance for Funds Used During Construction
- Permanent financing
- Escalation
- Development fees

Table TS-1 summarizes the Project Development Cost for each alternative.

Table TS-1 Project Development Cost

ALTERNATIVE NUMBER	PROJECT COST (2014 DOLLARS)
A1	$1,297,000,000
B3	$1,324,000,000
C3	$1,255,000,000
D3	$1,396,000,000

From a purely technical point of view, all four alternatives are feasible and can satisfy the 500 MW and 4,000-hr storage requirements. From an economic point of view, the costs of the four alternatives are within approximately 10 percent of each other. For comparison purposes, the associated sizing and cost tables for the two unit configuration are presented in Appendix B. The four unit pump-turbine configurations are slightly more costly than the two unit configurations primarily due to the equipment and underground powerhouse costs for the different unit configurations.

Cost and sizing results of the initial site conceptual designs are summarized in Table TS-2. Figure TS-2 shows the site configurations, transmission interconnect location, and preliminary transmission route.

Table TS-2 Conceptual Site Sizing and Costs

ALTERNATIVE =======>	A1	B3	C3	D3
COMMENT ========>	500 MW - Daily Cycle 8 hrs Storage	500 MW - Daily Cycle 8hrs Storage - Larger Upper Reservoir	500 MW - Daily Cycle 8 hrs Storage - Larger Upper Reservoir	500 MW - Daily Cycle 8 hrs Storage - Larger Upper Reservoir
TECHNICAL PARAMETERS				
GROSS CAPACITY	540	540	540	540
NET CAPACITY	500	500	500	500
NUMBER OF UNITS	4	4	4	4
UNIT CAPACITY	125	125	125	125
GENERATING HOURS AT RATED	8.00	8.00	8.00	8.00
PUMPING HOURS AT RATED	9.61	9.61	9.61	9.61
DAILY GENERATION (MW-HRS)	4000	4000	4000	4000
ANNUAL GENERATION (70% CF)	1,022,000	1,022,000	1,022,000	1,022,000
DIRECT CONSTRUCTION COST				
POWERHOUSE STRUCTURE	$ 64,000,000	$ 75,700,000	$ 80,800,000	$ 69,700,000
UPPER RESERVOIR	$ 170,000,000	$ 235,000,000	$ 152,000,000	$ 271,000,000
INLET / OUTLET STRUCTURES (2)	$ 49,300,000	$ 76,800,000	$ 67,100,000	$ 72,400,000
POWER TUNNEL /SHAFT	$ 174,400,000	$ 27,900,000	$ 33,100,000	$ 76,100,000
TAILRACE TUNNEL	$ 17,600,000	$ 14,700,000	$ 16,700,000	$ 24,000,000
ACCESS TUNNEL	$ 17,220,000	$ 15,540,000	$ 15,160,000	$ 15,990,000
CABLE TUNNEL	$ 3,950,000	$ 3,560,000	$ 3,470,000	$ 3,660,000
PUMP TURBINE / MOTOR GENERATORS	$ 390,000,000	$ 458,000,000	$ 486,000,000	$ 429,000,000
BALANCE OF PLANT - MECHANICAL	$ 15,100,000	$ 15,100,000	$ 15,100,000	$ 15,100,000
BALANCE OF PLANT - ELECTRICAL	$ 38,500,000	$ 38,500,000	$ 38,500,000	$ 38,500,000
SUBSTATION - PLANT	$ 7,433,000	$ 7,433,000	$ 7,433,000	$ 7,433,000
TRANSMISSION	$ 11,350,000	$ 11,350,000	$ 11,350,000	$ 11,350,000
ROADS AND SITEWORK	$ 6,000,000	$ 6,000,000	6,000,000	$ 6,000,000
TOTAL DIRECT CONSTRUCTION COST	$ 964,853,000	$ 985,583,000	932,713,000	$ 1,040,233,000
INDIRECTS				
ENGINEERING % OF TDC	5%	5%	5%	5%
ENGINEERING COST	$ 48,242,650	$ 49,279,150	46,635,650	$ 52,011,650
CM/RESIDENT ENGINEERING % OF TDC	5%	5%	5%	5%
CM/RESIDENT ENGINEERING COST	$ 48,242,650	$ 49,279,150	46,635,650	$ 52,011,650
PERMITTING AND LICENSING	$ 8,000,000	$ 8,000,000	8,000,000	$ 8,000,000
OWNER ADMIN / MARKETING COSTS	$ 5,000,000	$ 5,000,000	5,000,000	$ 5,000,000
LAND / EASEMENT COSTS	$ 6,035,000	$ 6,035,000	6,035,000	$ 6,035,000
TOTAL INDIRECT COSTS	$ 115,520,300	$ 117,593,300	112,306,300	$ 123,058,300
TOTAL PROJECT DIRECT COST	$ 1,080,373,300	$ 1,103,176,300	1,045,019,300	$ 1,163,291,300
CONTINGENCY ALLOWANCE (%)	20%	20%	20%	20%
CONTINGENCY ALLOWANCE	$ 216,074,660	$ 220,635,260	209,003,860	$ 232,658,260
PARAMETRIC COST ESTIMATE	$ 1,297,000,000	$ 1,324,000,000	$ 1,255,000,000	$ 1,396,000,000
COST PER kW	$ 2,594	$ 2,648	2,510	$ 2,792

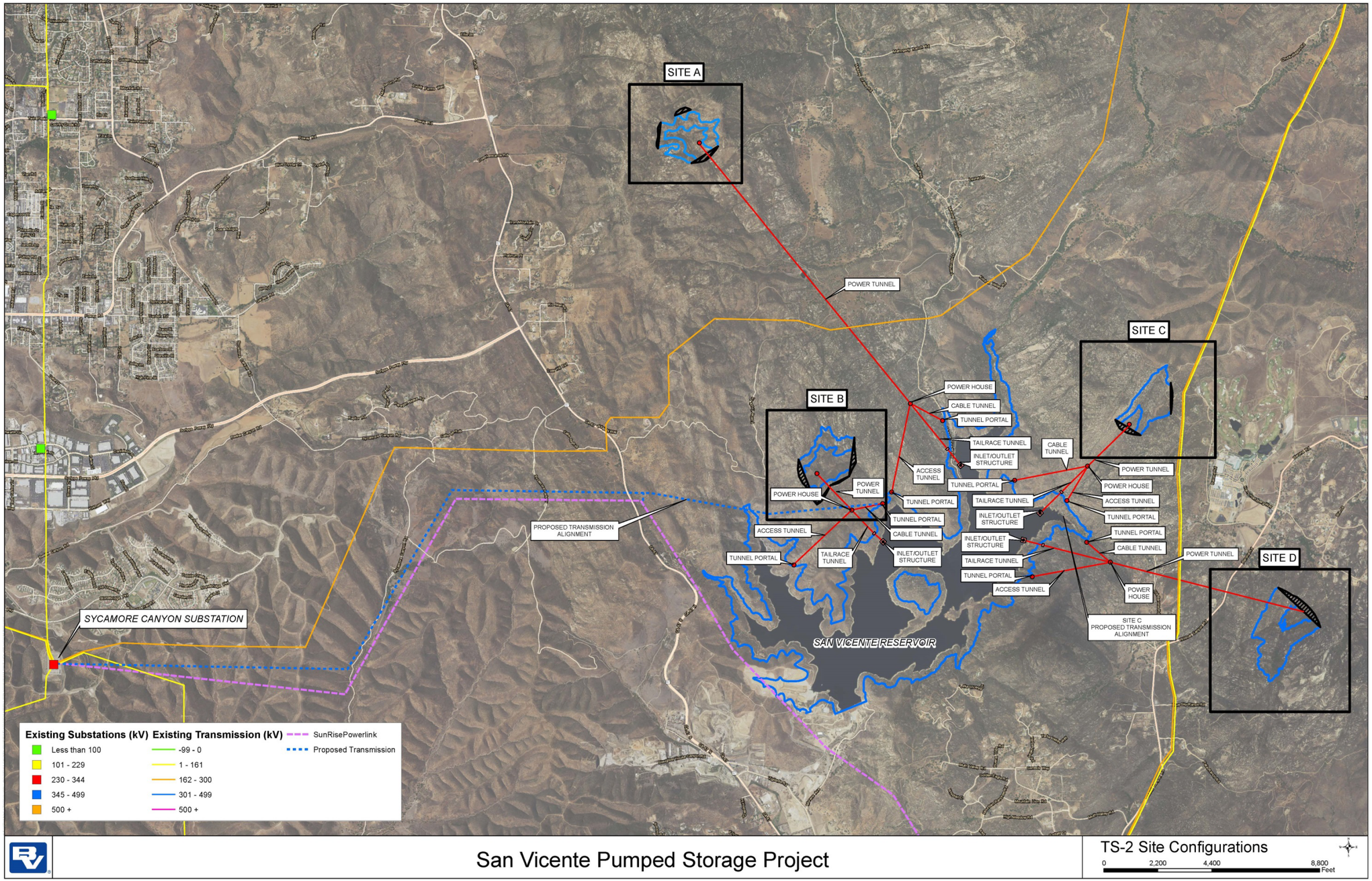


Figure TS- 4 Site Configuration and Interconnect Location

UPDATED FINANCIAL STATEMENT

Based on the original projected economic performance as performed under the original Feasibility Study and based on the updated projected construction cost estimates developed for this TM, Black & Veatch revised the original set of high level pro forma financial forecasts. As previously noted in the original Feasibility Study, Black & Veatch's market projections cover the 2014 through 2038 period, so in the pro forma analysis, the study period was extended through 2050 by assuming that the year 2038 results repeat each year between 2039 and 2050. This will provide a more conservative approach since energy prices will likely continue to raise during these additional years.

As originally performed under the previous Feasibility Study, Black & Veatch assumed three different financing scenarios, along with three different projections for operating revenue and performance. These scenarios were developed to provide a range of potential project values. The three scenarios examined are described generally in Table TS-3.

Table TS-3 Economic Performance Scenario Assumptions

VARIABLE	LOW VALUE CASE	MID VALUE CASE	HIGH VALUE CASE
San Vicente Construction Cost ($Million)	$1,400	$1,324	$1,324
Debt Ratio (% of Total Financing)	50%	75%	100%
Capacity Revenue Level	Low	Mid	High
Ancillary Services Revenue Level (% of Maximum Potential)	30%	60%	90%
Long-Term Interest Rate on Debt Financing	5.5% Nominal (3.0% Real)	6.0% Nominal (3.5% Real)	6.5% Nominal (4.0% Real)
Required Return on Equity Investment	12% Nominal (9.4% Real)	12% Nominal (9.4% Real)	N/A

As shown in Table TS-3, the scenarios include different financing assumptions. The scenarios also include two different estimates of construction costs for the facilities, and low, mid and high range estimates of value for the project from provision of capacity and ancillary services in California power markets. For a project like this to realize the likely economic value it can bring to market participants, it will be necessary for capacity and ancillary services market opportunities in the state to expand from current levels. The scenario definitions are meant to reflect uncertainty surrounding potential value for this Project.

Table TS-4 summarizes results from the economic analysis for each of the three scenarios. Detailed financial projections from each scenario are presented in Section 4 of this report. In Table TS-4, common investment analysis measures are presented. As shown, both the mid vale and high value scenarios, suggest sufficient value to produce positive Net Present Value for the project. The Net Project Value (NPV) measures presented are estimates of value from the Project in excess of its projected operating and capital investment costs. The low value case suggests that the payback period would not occur over a reasonable time period.

Results from both the mid and high value scenarios suggested that the Project has potential to be an economically viable project. Under the economic projections, the project brings value to California electricity markets that exceed the underlying cost to develop, build and operate the facility. Under the Low Value case, projected cash flow and project value is marginally higher than the underlying cost of the project, including investment carrying costs. In the Mid Value and High Value cases, projected cash flow and project value is substantially higher than the underlying cost of the facility. From the Owner's perspective, these results suggest that the project has sufficient potential value to be shared through a Power Purchase Agreement (PPA) or partnership agreement with a California utility company or energy market participant.

Table TS-4 San Vicente Scenario Profitability Measures (2014$)

	LOW VALUE CASE ($000)	MID VALUE CASE ($000)	HIGH VALUE CASE ($000)
Investment Requirements:			
Equity Investment	$756,155	$362,786	$147
Debt Investment	$756,155	$1,088,357	$1,473,621
Debt Ratio (Percent of Total Capital)	50%	75%	100%
Profitability Measures:			
NPV @ Real 2.54% discount rate	$415,397	$529,581	$843,553
NPV @ 3.19% After Tax WACC	$428,159	$498,799	$529,269
NPV @ Real 9.38% equity cost of capital	$256,368	$309,790	$427,768
Payback Period @ Real 2.54% discount rate	N/A	12[(1)] , 15[(2)] years	1[(1)] , 12[(2)] years
Payback Period @ 3.19% After Tax WACC	N/A	13[(1)] , 15[(2)] years	1[(1)] , 12[(2)] years
Payback Period @ Real 9.38% equity cost of capital	N/A	N/A	1[(1)] , 12[(2)] years

[(1)] Payback Period is the amount of time to generate enough revenue to recover your equity investment.

[(2)] Payback Period is the number of years required for the project to produce operating profit (earnings before interest and taxes) that are sufficient to recover the initial total investment.

1 Introduction

1.1 PURPOSE

The purpose of this San Vicente Pumped Storage Project (Project) Additional Studies Technical Memorandum (TM) is to provide the San Diego County Water Authority (Water Authority) and the City of San Diego (City) with additional technical information needed to determine the impacts of the proposed Project to the City's planned Pure Water Program (Program) (also referred to as the Pure Water Program) at the San Vicente Reservoir (Reservoir). Under the Program, highly treated recycled water from the City's North City Water Reclamation Plant would be pumped to the Reservoir to be mixed with raw water prior to being sent to the City's Alvarado Water Treatment Plant for potable water treatment. In addition, this TM will further develop the technical aspects of the proposed inlet/outlet locations utilizing an expanded range of operation within the Reservoir, revise the powerhouse sizing to utilize multiple units with variable frequency drives, and update Project costs. The TM will provide the basis to present a recommendation to the Water Authority/City and Board of Directors/City Council regarding the viability of developing a pumped storage project at the San Vicente Reservoir site in conjunction with the City's planned Pure Water Program.

1.2 BACKGROUND

The San Vicente Reservoir site is located approximately 13 miles northeast of the Water Authority's Kearny Mesa office as shown on Figure 1-1.

The San Vicente Reservoir has recently gone through a major expansion that raised the existing dam 117 feet, increasing the reservoir storage by approximately 152,000 acre-feet. The reservoir and much of the surrounding land is owned by the City. The City also operates and maintains the reservoir and related facilities. The Water Authority and the City have an agreement in place which allows the Water Authority to store up to 152,000 acre-feet of water within the reservoir.

The Water Authority, in conjunction with the City, have recently developed studies related to the feasibility of the San Vicente Pumped Storage Project with the most recent study titled the "San Vicente Pumped Storage Project Economic and Financial Feasibility Study (Study)" dated May 2014 as developed by Black & Veatch. The purpose of this Study was to perform a high level technical and economical evaluation to determine the financial feasibility of the project. Results of the Study showed the Project to be feasible both technically and financially.

Currently, the Water Authority and the City have applied for a new preliminary permit from the Federal Energy Regulatory Commission (FERC) for the proposed San Vicente Pumped Storage Project (No. P-12747-000). This permit would allow the Water Authority and the City first rights to develop a pumped storage project at the Reservoir with the potential to produce power in the range of 480 to 570 megawatts (MW) and generation up to 1,000 gigawatt-hours (GWH). In addition, with the recent construction of the San Diego Gas & Electric (SDG&E) Sunrise Powerlink, which travels adjacent to the Reservoir along the south end, connection to the existing electrical grid network may be more feasible than in past years. The retirement of the San Onofre Nuclear Generation Station (SONGS) Units 2 and 3 in June of 2013 also increases the attractiveness of projects like the San Vicente Pumped Storage Project due to the energy void left in the grid, based upon conversations with SDG&E.

Figure 1-1 Vicinity Map

The previous Study related to the viability of power storage at San Vicente identified four potential alternative sites for the new upper reservoir. These potential sites are shown below on Figure 1-2.

Locations of the four upper sites are described below:

- Alterative Site A is located near Iron Mountain, approximately three miles northwest of the San Vicente Reservoir site
- Alternative Site B is located near Foster Canyon, approximately 0.5 miles northwest of the San Vicente Reservoir
- Alternative Site C is located approximately 0.8 miles northeast of the San Vicente Reservoir
- Alternative Site D is located approximately 1.8 miles east of the San Vicente Reservoir

1.3 KEY PROJECT ASSUMPTIONS

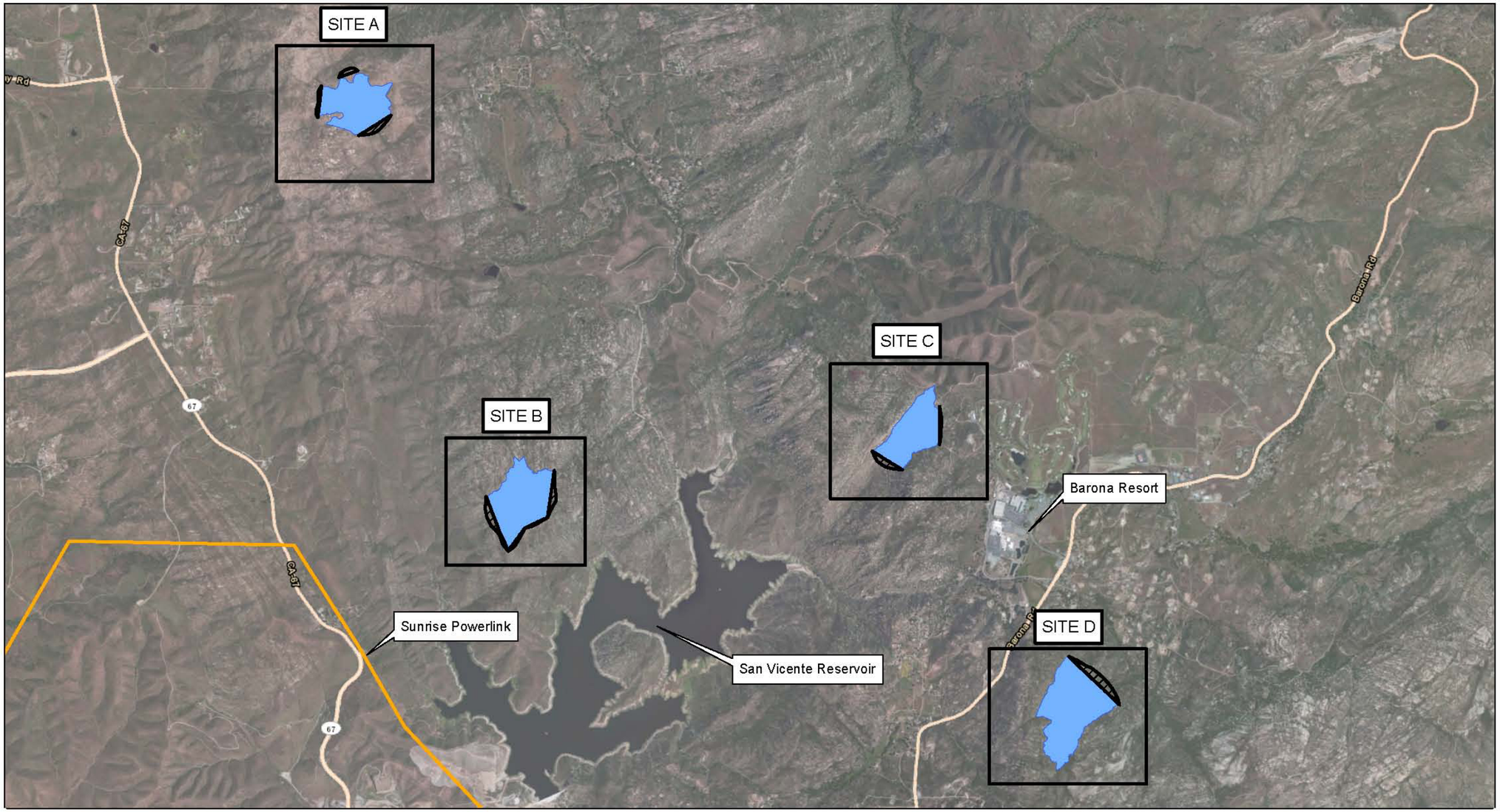
As described throughout subsequent sections of this TM, there are several assumptions that have been made to help develop the overall evaluation of this TM. A summary of these items is presented below to help frame the overall context of the evaluation and to clarify the relationship between the various topics and technical issues considered in this TM.

- As evaluated under the previous Report, only Alternatives A1, B3 and C3 can meet the 500 MW capacity of generation with 8 hours of storage requirements. Site D (Alternatives D1 and D2) only provides 5.7 hours of storage at 500 MW or 8 hours of storage at 350 MW, respectively. However, Site D will continue to be evaluated under this TM to determine the value of this alternative and its viability to be expanded to the full 500 MW capacity of generation with 8 hours of storage requirement for comparison with Alternatives A1, B3 and C3. This new alternative will be designated D3 for purposes of this TM.
- Each site will consist of an upper reservoir, conveyance tunnels/shafts to transport the water to and from a new powerhouse, access facilities including roads, electrical transmission lines and substations to transport the energy to the existing transmission grid
- Each site will utilize the existing San Vicente Reservoir as the lower reservoir

1.4 EVALUATION APPROACH

In order for this Project to be feasible under the provisions of this TM, components of the project were evaluated for the following conditions:

- The Pumped Storage project can have no detrimental effect on the City of San Diego's Pure Water Program water quality parameters
- Provide operational flexibility with varying Reservoir levels which would be attractive to energy generators
- Provide additional operational flexibility with the use of multiple units that operate with the use of variable frequency drives
- All options must also allow for continued use of the reservoir for water storage and recreational needs



San Diego County Water Authority
San Vicente Pumped Storage Project

Figure 1-2
Reservoir Sites

0 0.4 0.8 1.6 2.4 Miles

Figure 1-2 Reservoir Sites

1.5 TECHNICAL MEMORANDUM ORGANIZATION

The TM is organized as follows:

- Section 1.0 – provides an introduction to the TM and establishes the overall strategy of the TM
- Section 2.0 – discusses the lower reservoir inlet/outlet siting evaluation
- Section 3.0 – provides a brief summary of the water quality modeling performed to better understand the impacts of the Project with the City's Pure Water Program
- Section 4.0 – presents the updated site configurations and costs based on the results obtained from Sections 2 and 3
- Section 5.0 - provides an updated financial statement based on the revised project costs
- Section 6.0 – provides a brief summary of the TM findings

2 Lower Reservoir Inlet/Outlet Siting Evaluation

2.1 REVIEW SAN VICENTE BATHYMETRY

As the first task in preforming this additional work, Black & Veatch reviewed the existing Reservoir bathymetry as provided by the Water Authority to determine feasible locations for the new inlet/outlet structures associated with each site. The bathymetry titled "San Vicente Reservoir Multi-beam Survey Bathymetry" was originally conducted by Fugro Pelagos, Inc. in February 2005.

The bathymetry survey file was compared against the site inlet/outlet locations as identified in the previous Study. The bathymetry contours were then utilized to determine locations where the large inlet/outlet structure could be reasonably constructed. Due to the large volume of flow being moved through the inlet/outlet structure, its size is large in order to reduce inlet/outlet velocities to less than 1 foot per second.

2.2 REVIEW SAN VICENTE OPERATING PROCEDURES

Following an initial review of the bathymetry survey file, a meeting was held with the Water Authority and City of San Diego staff to discuss the Reservoir's current operating plan. Understanding this plan is important as it helps determine the potential varying water surface levels that the Reservoir will likely operate under during seasonal and long term conditions. Setting the parameters in which a minimum water surface must always be maintained will help to establish the potential operating range for the Project. By maximizing this range, the Water Authority and the City can bring additional financial value to the Project, since it would be able to operate over a wider band of water surface elevations.

2.2.1 Pure Water Inlet Locations

The first item discussed in the meeting was the locations of the proposed Pure Water Program inlets as shown on Figure 2-1. These locations represent where the highly treated recycled water would enter into the Reservoir for blending.

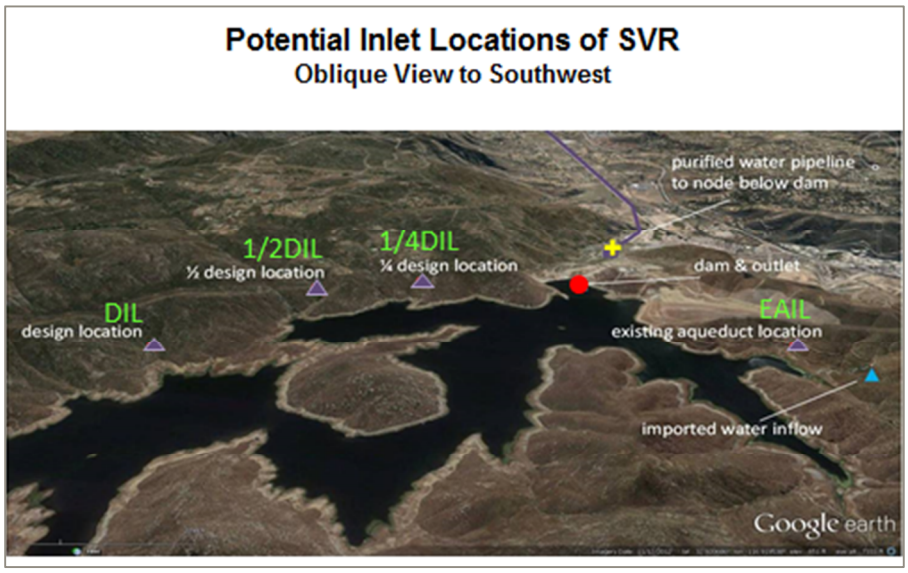


Figure 2-1 Pure Water Inlet Locations

To date, four different locations (EAIL, DIL, 1/2DIL and the 1/4DIL) have been modeled by the City to determine the impacts of dilution to the highly treated water through the reservoir as well as the duration of time it takes for the water to reach the new San Vicente outlet tower. Initial regulatory approval for the Pure Water Program is based on a minimum dilution of 100:1 before the water reaches the new outlet tower. It was noted by the City's water modeling consultant, Water Quality Solutions, that a minimum reservoir volume of 100,000 acre-feet or its corresponding water surface elevation of 660 feet was utilized as the starting elevation for all the Pure Water Program model runs performed to date.

2.2.2 Reservoir Operation

Next, a detailed discussion was held to review the current Reservoir operation and storage parameters. Figure 2-2 provides a summary as to the different water volumes dedicated to each owning agency within the Reservoir during winter and summer months.

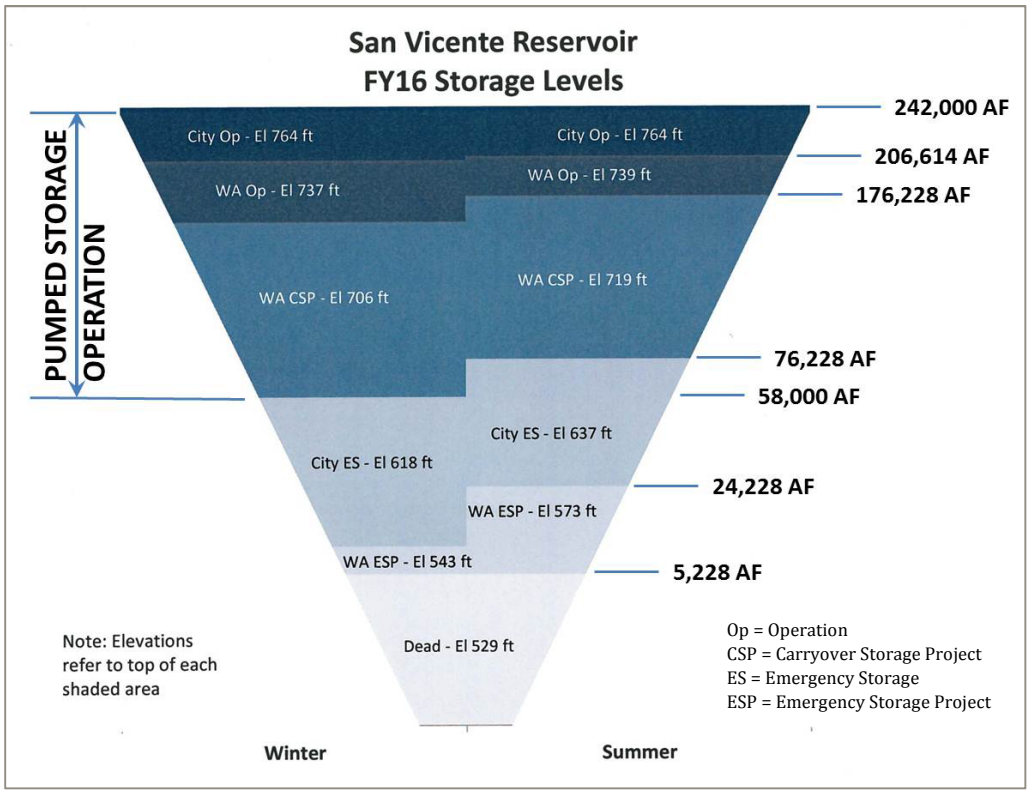


Figure 2-2 San Vicente Reservoir Storage Levels by Agency

Based on the discussion held with the Water Authority and City staff, it was determined that a minimum storage or 58,000 acre-feet (water surface elevation 618 feet) must be maintained within the Reservoir to provide emergency storage for water supply emergencies. Therefore, the team decided to move forward with evaluating the potential for the Project to operate with water surface elevations ranging from 764 feet to 618 feet (146 feet difference). It was also discussed in the meeting that due to the large size of the inlet/outlet structure a minimum invert elevation of 563 would be utilized to ensure proper submergence during pumping. Finally, it was noted that no environmental constraints currently existed with the proposed 618 foot elevation.

2.3 INLET/OUTLET SITE SELECTION AND EVALUATION

The structure for each alternative was sized based on the pumping flow requirements for a 500 MW system with 8 hours of storage and its respective head condition. As noted above, the new inlet/outlet structure will be required to move large amounts of water. In order to protect sensitive fish habitats within the reservoir during operation of the Project, it was decided by the team that the structure should limit approach velocities in the pumping mode to less than 1 foot per second to mitigate fish impingement on the intake's trashracks. As an example, the following parameters resulted for Alternative B3. The parameters for the other alternatives are provided in the respective tables included in Section 4.

- Generating mode discharge = 8,748 cfs
- Discharge velocity in generating mode = 1.17 fps
- Pumping mode intake = 7,280 cfs
- Approach velocity in pumping mode = 0.97 fps
- Minimum submergence in pumping mode = 55 feet above intake invert
- Approximate inlet/outlet mouth dimensions = 50 ft (height) x 150 ft (width)

Figure 2-3 provide a preliminary plan and section of the proposed horizontal-type, inlet/outlet structure to be utilized for this Project. Other features of the inlet/outlet structure include the following:

- Full operation of the inlet/outlet structure at the proposed low reservoir operating elevation of 618 feet
- Gate shaft and gate room to allow for isolation of the tailrace tunnel and powerhouse for maintenance
- Trashrack to limit debris from entering during pumping mode
- Cast-in-place concrete construction

Based upon the reservoir operating meeting noted above, it was also decided by the team that only two locations for the inlet/outlet structure should be located at this time. Sites B and C where chosen as they were the two most feasible sites identified from the previous Study. It was also decided that the City's modeling consultant would only move forward with utilizing the Site B location for the initial modeling. Based on the findings of the modeling, Site C would only be evaluated within the model if Site B was found to impact the Pure Water Program in a detrimental way.

In utilizing the bathymetry survey, Black & Veatch further evaluated locations for the inlet/outlet structure. Locations were chosen where existing contour aided in the construction or operation of the inlet/outlet structure. Figure 2-4 provides a preliminary plan showing the proposed locations of the inlet/outlet structure for Sites B and C based on review of the Reservoir bathymetry. This information was passed along to the modeling consultant so that he could set up the pumped storage components within the existing Pure Water Program model.

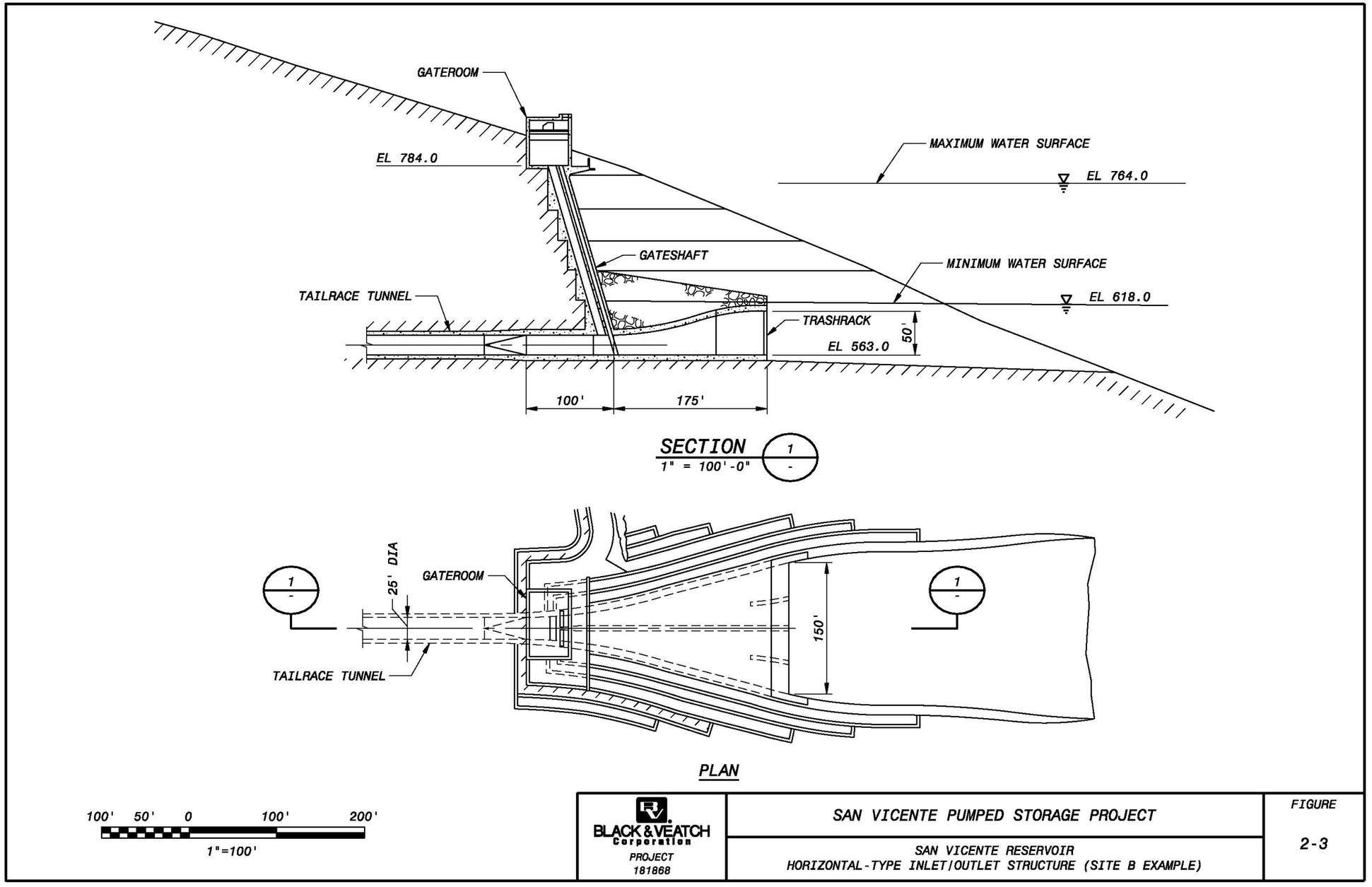


Figure 2-3 Proposed Inlet/Outlet Structure

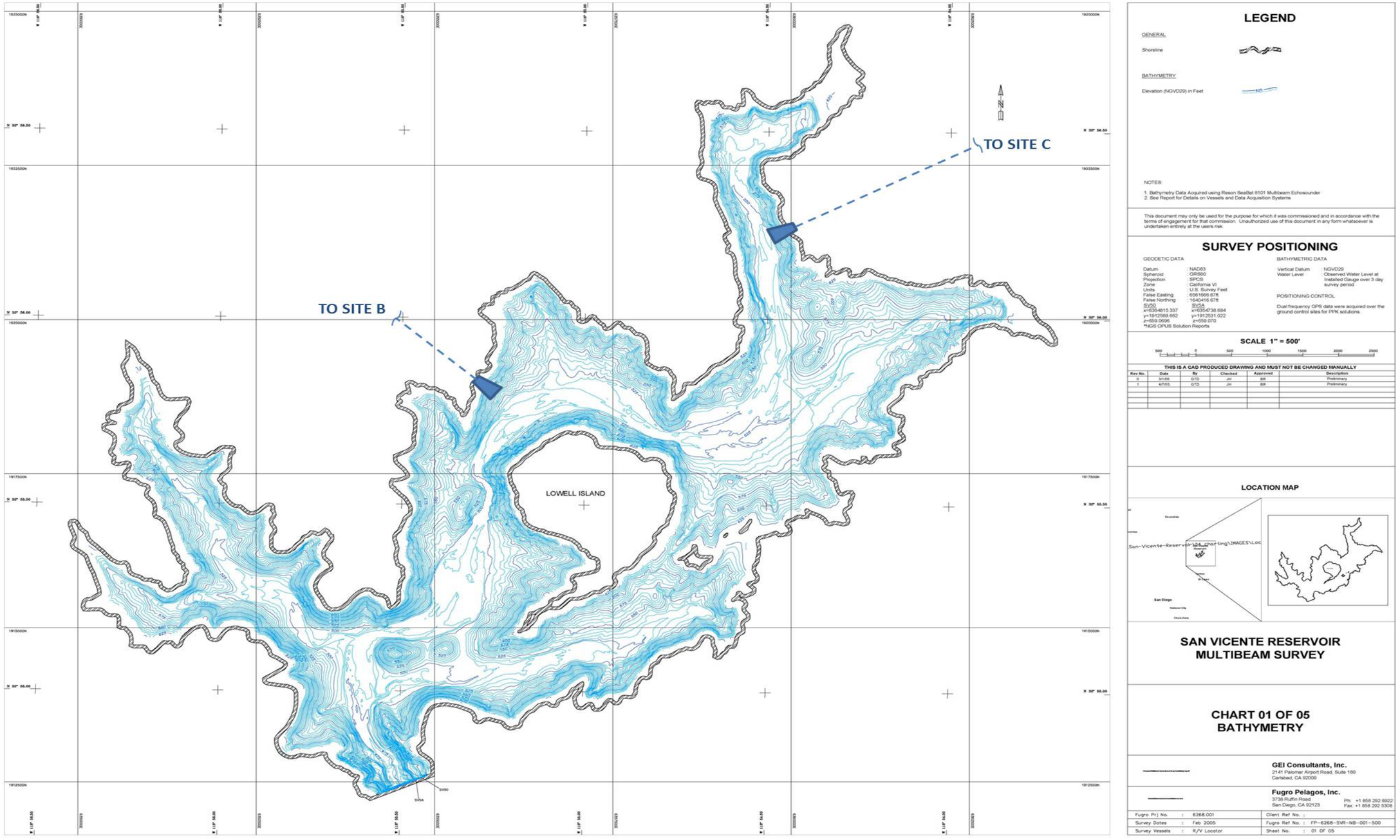


Figure 2-4 Proposed Inlet/Outlet Locations – Sites B and C

3 Water Quality Modeling

3.1 COORDINATION WITH MODELING CONSULTANT

This section of the TM briefly described the process in which project staff members (Water Authority, City, Black & Veatch and Water Quality Solutions) met and discussed efforts/results associated with the modeling of the Project within the City's existing Pure Water Program models. This section only provides a brief summary of the steps and initial model results that occurred. A more detailed memorandum of the actual model assumptions, process and results has been developed by Water Quality Solutions (WQS) as a stand-alone report following the final model results. The information below is only provided to assist the reader in understanding the steps and process performed to determine the impacts of pumped storage on the Pure Water Program.

3.2 INITIAL MODELING EFFORTS

After the location of the inlet/outlet structure for Site B was agreed upon by all parties (see Section 2), Water Quality Solutions began to incorporate the pump storage project elements into the existing Pure Water Program model. Computational boundaries where develop by WQS to define the limits of impacts related to the inlet/outlet flows within the Reservoir. Utilizing the City's FLUENT model, various model runs where performed and determined that downward acting draft tubes and bubblers could be utilized to represent the impacts of pumped storage within the three-dimensional reservoir ELCOM model.

Next, the ELCOM model was utilized to analyze the effects of pumped storage on the original Pure Water Program modeling results and compare many factors, including water temperatures, mixing dilutions and travel time on tracer inputs from the various PW Design Inlet Locations to the exit dam outlet tower. Model runs were also performed at different water surface elevations for various times of year and different Pure Water Program flow rates. The model also took into account seasonal parameters, including wind strength and direction, and whether the Project was in generating or pumping mode during different times of the day.

Initial results of the modeling to date have indicated that the Project should be able to co-exist with the Pure Water Program. These results still need to be discussed with regulatory agencies to confirm their agreement with the initial findings. Additional benefits found from the modeling efforts indicate that reduced evaporation from the Reservoir would also likely occur with the use of the Project.

As previously noted, the information provided in this section of the TM is only a small portion of the modeling assumptions and results performed to date. A detailed stand-alone memorandum has recently been developed by WQS to present the findings of the modeling effort.

3.3 UPDATED INLET/OUTLET LOCATIONS

Based on the initial modeling results, the proposed Site B location for the inlet/outlet structure appears to co-exist with the City's Pure Water Program at the Reservoir. Therefore, it was determined by the project team not to perform any additional modeling for the other inlet/outlet locations at this time.

As part of the development of this TM, the Black & Veatch team did decide to slightly move and angle the orientation of the inlet/outlet structures for Sites A, B, C and D. This was done to minimize the tailrace tunnel lengths and to locate and direct the flows in a more favorable direction. For example with the original Site B location (Figure 2-4), the modeling results showed the generation flows from the Project would impact Lowell Island, causing an upward circular movement of water along the bank. The revised location for Site B, shown in Figure 3-1, moves the flow stream east to minimize impact on the island. It should be noted that these slight revisions where not updated in the model.

Similarly, the location for Site C was moved back to its original location designated in the original Study due to concerns with discharge flows impacting the shoreline on the opposite side of the lake finger. Figure 3-1 shows the revised inlet/outlet structure locations which will be utilized for updating the site configurations and costs under Section 4. It should also be noted that Site D utilized the same inlet/outlet configuration and sizing (i.e. 500 MW with 8 hours of storage) as presented in Section 2 of the TM, which is further discussed in Section 4.

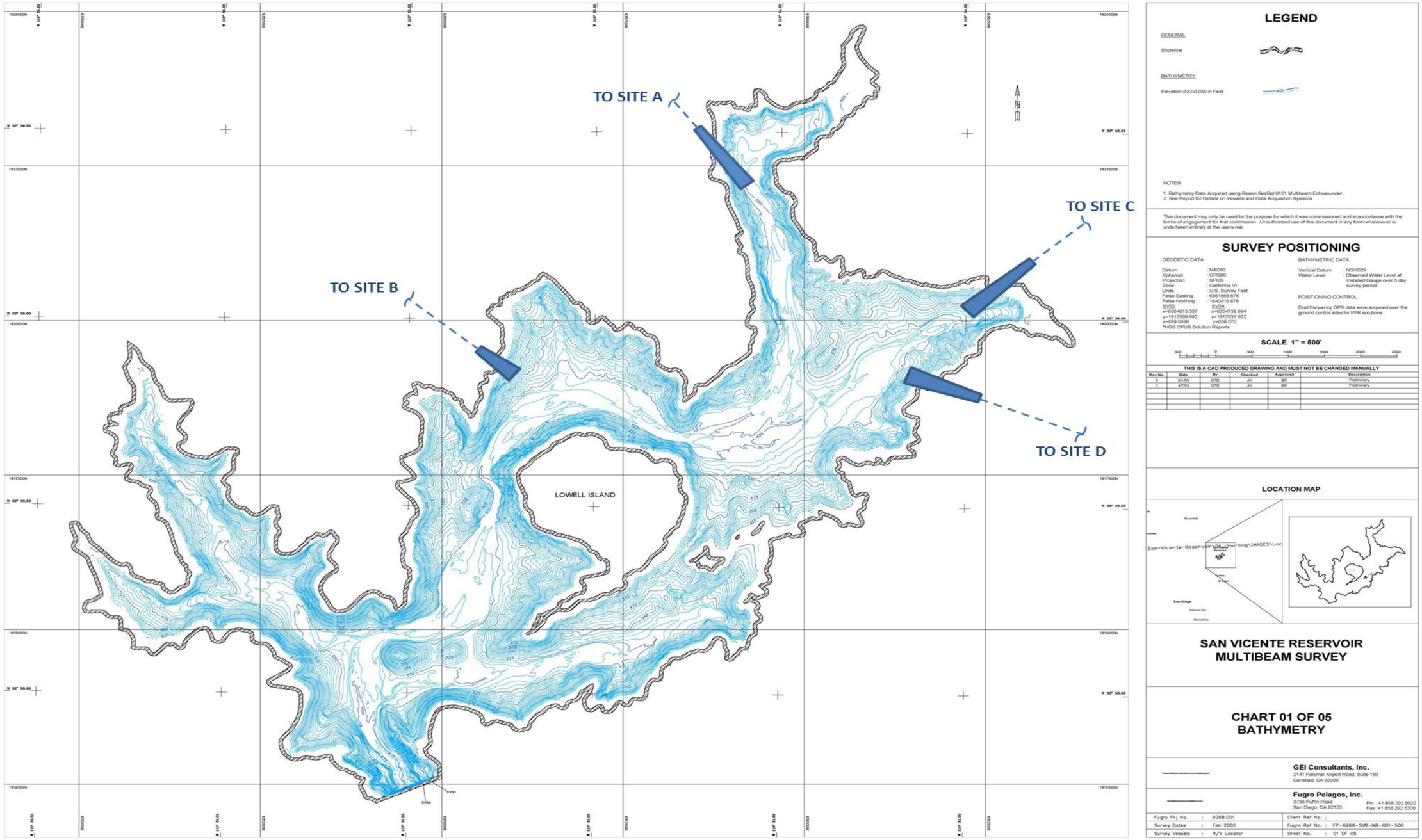


Figure 3-1 Revised Inlet/Outlet Locations

4 Updated Site Configurations

4.1 GENERAL

The proposed Project is initially configured for a nominal 500 MW pumped storage project using the existing San Vicente Reservoir as the lower reservoir.

The purposes of this Technical Evaluation (Evaluation) for this TM, as presented within this section, are as follows:

- Evaluate the pumped storage potential for four alternative upper reservoir sites adjacent to the existing lower reservoir (i.e. Alternatives A1, B3, C3 and D3)
- Provide Project operating capability for a low reservoir elevation of 618 feet in San Vicente Reservoir
- Include provisions and costs for variable speed pump-turbine/motor-generator units, including a four unit powerhouse (4x125 MW units) for this TM versus a two unit powerhouse (2x250 MW units) evaluated in the original Study
- Prepare an updated conceptual level development cost estimate of the four alternative sites
- Prepare a data set that describes the key pumped storage operating and design parameters for each alternative site

As with the Study, this Evaluation utilized B&V's proprietary parametric pumped storage conceptual design and cost model.

As part of the Study effort, the Water Authority and B&V consulted with San Diego Gas & Electric (SDG&E) with regard to their suggestions as to Project capacity (MW), energy storage (MW-hrs), and substation intertie. SDG&E was very cooperative and forthcoming with their suggestions as follows:

- They suggested intertie at the Sycamore Canyon Substation (Sycamore) 5 miles west of the Project area
- They indicated that 500 MW will be a reasonable starting point for defining the Project capacity
- They indicated that the likely scenario is a daily Project operation with energy storage of eight hours or 4,000 MW-hrs. They indicated that Project operation will be tied to fluctuating renewable energy supply characteristics and hourly power demand.

It was acknowledged that there may be other options for capacity, storage and intertie identified in the future as the Project is marketed, but this evaluation still presents a reasonable representation of the likely Project configuration and will continue to be used as a baseline for this evaluation.

4.2 INITIAL SITE CONFIGURATIONS

As described previously in the Study, the Water Authority identified four potential upper reservoir sites (Sites A through D) as shown on Figure 1-2. The first task of the Study was to identify the available upper reservoir storage at each site using simple saddle type dams to form the reservoir, perform Project sizing calculations, and compare the results to the capacity and energy baselines.

The results of the Study's first task indicated the following:

- Site A can support both the 500 MW capacity and 4,000 MW-hr storage requirements
- Site B cannot support both the 500MW capacity and 4,000 MW-hr storage requirements. (Without a larger upper reservoir, Site B's energy storage of 2,750 MW-hrs can either support 5.5 hours of generation at 500 MW or about 340 MW for 8 hrs.)
- Site C cannot support both the 500MW capacity and 4,000 MW-hr storage requirements. (Without a larger upper reservoir, Site C's energy storage of 2,500 MW-hrs can either support 5.0 hours of generation at 500 MW or about 310 MW for 8 hrs.)
- Site D cannot support both the 500MW capacity and 4,000 MW-hr storage requirements. (Without a larger upper reservoir, Site D's energy storage of 2,850 MW-hrs can either support 5.7 hours of generation at 500 MW or 350 MW for 8 hrs.)

Based on the initial sizing effort, it was apparent that the four sites could support a minimum capacity and energy storage of 310 MW/2,500 MW-hrs. No site option was eliminated at that point based on site technical limitations, and all were carried over for further detailed evaluation in the Study. Additional options to upgrade the Sites B and C upper reservoirs to 500 MW/4,000 MW-hrs were added to the evaluation mix (i.e. Alternatives B3 and C3). An expanded upper reservoir for Site D was not pursued at that time unless it is determined later that the site will be cost competitive with the others after the initial cost evaluation.

Based on the outcome of the Study, Alternatives A1, B3 and C3 were carried forward for further evaluation in this TM because of their ability to provide the desired 500 MW and 4,000 MW-hrs storage requirements. In addition, Alternative D3 was developed to the full 500 MW and 4,000 MW-hr storage requirements for cost comparison purposes and included as part of this Evaluation.

The key parameters associated with conceptual sizing of each alternative (i.e. Alternatives A1, B3, C3 and D3) for this Evaluation were calculated and are provided in Table 4-1. These parameters will be refined later during the preliminary engineering phase and after the best project alternative is selected. These parameters are also used in the model to size the features of the Project. It should be noted that the values of the key parameters for Alternatives A1, B3 and C3 are slightly different than those provided in the Study. This difference is primarily due to the different operating conditions associated with the larger operating range of San Vicente Reservoir assumed for this Evaluation.

Site arrangement and profile figures of the four alternatives are provided in Appendix A.

Table 4-1 Site Conceptual Sizing

ALTERNATIVE ======>	A1	B3	C3	D3
COMMENT ========>	Daily Cycle 8 hrs Storage	Daily Cycle 8 hrs Storage	Daily Cycle 8 hrs Storage	Daily Cycle 8 hrs Storage
GENERAL SIZING ASSUMPTIONS				
COMPOSITION OF CYCLE EFFICIENCY - GENERATING				
WATER CONDUCTORS	97.40%	97.40%	97.40%	97.40%
TURBINE	92.00%	92.00%	92.00%	92.00%
GENERATOR	98.00%	98.00%	98.00%	98.00%
TRANSFORMER	99.50%	99.50%	99.50%	99.50%
SUBTOTAL GENERATING	87.38%	87.38%	87.38%	87.38%
COMPOSITION OF CYCLE EFFICIENCY- PUMPING				
WATER CONDUCTORS	97.60%	97.60%	97.60%	97.60%
PUMP	92.00%	92.00%	92.00%	92.00%
MOTOR	98.70%	98.70%	98.70%	98.70%
TRANSFORMER	99.50%	99.50%	99.50%	99.50%
SUBTOTAL PUMPING	88.18%	88.18%	88.18%	88.18%
TOTAL CYCLE EFFICIENCY	77.05%	77.05%	77.05%	77.05%
OPERATING CYCLE	Daily	Daily	Daily	Daily
PROJECT CAPACITY (GROSS MW)	540	540	540	540
PLANT GENERATING CAPACITY (NET MW)	500	500	500	500
NUMBER OF UNITS	4	4	4	4
UNIT GENERATING CAPACITY (MW)	125	125	125	125
CHARGE / DISCHARGE RATIO	1.08	1.08	1.08	1.08
AVG PUMPING LOAD OVER CYCLE CAPACITY (MW)	540	540	540	540
GENERATING HOURS	8.00	8.00	8.00	8.00
GENERATING ENERGY (MW-HRS)	4,000	4,000	4,000	4,000
PUMPING HOURS	9.6	9.6	9.6	9.6
PUMPING ENERGY (MW-HRS)	5,191	5,191	5,191	5,191
MAX GROSS HEAD (FT)	1,488	892	982	1,105
MIN GROSS HEAD (FT)	1,244	653	693	771
AVG GROSS HEAD (FT)	1,366	773	838	938
PLANT FLOW - GENERATING CYCLE (CFS)	4,947	8,748	8,069	7,205
UNIT FLOW - GENERATING CYCLE (CFS)	1,237	2,187	2,017	1,801
PLANT FLOW PUMPING CYCLE (CFS)	4,117	7,280	6,715	5,995
UNIT FLOW PUMPING CYCLE (CFS)	1,029	1,820	1,679	1,499

Table 4-1 Site Conceptual Sizing (Continued)

ALTERNATIVE ======>	A1	B3	C3	D3
COMMENT ========>	Daily Cycle 8 hrs Storage	Daily Cycle 8 hrs Storage	Daily Cycle 8 hrs Storage	Daily Cycle 8 hrs Storage
UPPER RESERVOIR OPERATION				
UPPER RESERVOIR MAX OP LEVEL - ACTIVE (FT MSL)	2,106	1,510	1,600	1,723
UPPER RESERVOIR MIN OP LEVEL - ACTIVE (FT MSL)	2,008	1,417	1,457	1,535
UPPER RESERVOIR FLOOR EL (FT MSL)	1,998	1,407	1,447	1,525
UPPER RESERVOIR SURCHARGE EL (FT MSL)	2,115	1,520	1,620	1,733
UPPER RESERVOIR ACTIVE DEPTH (FT)	98	93	143	188
UPPER RESERVOIR DEAD DEPTH (FT)	10	10	10	10
UPPER RESERVOIR SURCHARGE DEPTH (FT)	9	10	20	10
TOTAL RESERVOIR DEPTH (FT)	117	113	173	208
UPPER RESERVOIR AREA AT SURCHARGE (ACRES)	110	89	69	90
UPPER RESERVOIR AREA AT FLOOR (ACRES)	29	50	9	8
UPPER RESERVOIR AREA AT MAX OP (ACRES)	72	89	69	90
UPPER RESERVOIR AREA AT MIN OP (ACRES)	35	53	18	11
SURCHARGE VOLUME (ACRE-FT)	667	175	1,380	900
OPERATING VOLUME (ACRE-FT)	5,116	6,603	6,221	9,164
DEAD VOLUME	320	1,064	90	225
TOTAL STORAGE	6,103	7,842	7,691	10,289
UPPER RES GEN VOLUME REQ (A-F)	3,271	5,784	5,335	4,763
UPPER RES PUMP VOLUME REQ (A-F)	3,271	5,784	5,335	4,763
RATIO ACTUAL / REQ STORAGE	1.56	1.14	1.17	1.92
LOWER RESERVOIR OPERATION				
LOWER RESERVOIR MAX OP LEVEL	764.00	764.00	764.00	764.00
LOWER RESERVOIR MIN OP LEVEL	618.00	618.00	618.00	618.00
LOWER RESERVOIR OPERATING RANGE (FT) (ITERATION REQUIRED)	2.20	3.90	3.60	2.95
LOWER RESERVOIR AREA AT MAX OP (ACRES)	1,664	1,664	1,664	1,664
LOWER RESERVOIR AREA AT MIN OP (ACRES) -- ASSUME - TO MAX OP	1,583	1,583	1,583	1,583
OPERATING VOLUME REQUIRED (ACRE FT)	3,271	5,784	5,335	4,763
CALCULATED VOLUME (ACRE FT) (ITERATION)	3,572	6,332	5,845	4,789
ACTUAL RESERVOIR MIN LEVEL	761.80	760.10	760.40	761.05
PUMPED STORAGE METRICS				
DISTANCE FROM UPPER TO LOWER RESERVOIR (FT)	16,810	3,960	5,020	11,620
L/H RATIO (GROSS HEAD BASIS)	12.3	5.1	6.0	12.4

4.3 UPDATED PROJECT FEATURES

4.3.1 Upper Reservoir and Inlet/Outlet Structures

As described in the Study, the upper reservoir will need to be constructed on an undeveloped site. At that time, Black & Veatch performed an initial topographic review of the four previously identified sites by the Water Authority, which are shown on Figure 1-2.

For this Evaluation, the reservoirs for each alternative were sized to store the required water volume from the sizing calculations, the dams were conceptually laid out and sized, and the key construction quantities estimated on a conceptual basis. This was done using the parametric model in a similar fashion as was done for the Study. The model was based on finding sound foundation rock close to the surface and constructing roller compacted concrete (RCC) dams, as was done for the San Vicente Reservoir dams (the main dam raise and the saddle dam).

The updated input data, sizing, and cost data for the upper reservoirs can be found in Table 4-2. The reservoirs for Alternatives A1, B3, C3, and D3 can accommodate the 500 MW and 4,000 MW-hrs requirements.

The Project design for the upper reservoir, as well as the lower reservoir, will include an "inlet/outlet" structure. In general, this structure will be of the horizontal type similar to the configuration as depicted in Figure 2-3. However, after initial sizing and costing, it became apparent that a horizontal type inlet/outlet structure in the lower reservoir (San Vicente Reservoir) would require significant excavation and material handling, have complex design and constructability issues, and result in high costs due to the reservoir's bathymetry, structure's preferred location, and Reservoir's large water level operating range. Therefore, for this Evaluation, it was decided to utilize a vertical type inlet/outlet structure as shown in Figure 4-1 in the lower reservoir. For this type of inlet/outlet structure, the length of the tailrace tunnel will be somewhat longer than for the horizontal type of structure, and a gate shaft will be required; however, the excavation and material handling for its construction in the Reservoir will be much less resulting in an overall lower cost. Table 4-3 provides the inlet/outlet input data, sizing, and cost data for the upper and lower reservoirs for each alternative.

Table 4-2 Upper Reservoir Sizing and Cost

RESERVOIR SITE	A1	B3	C3	D3
UPPER RESERVOIR TYPE				
ALIGNMENT	LINEAR	LINEAR	LINEAR	LINEAR
TYPE OF DAM	GRAVITY	GRAVITY	GRAVITY	GRAVITY
CONSTRUCTION MATERIAL	RCC	RCC	RCC	RCC
CREST ELEVATION (FT MSL) (A)	2,115	1,520	1,620	1,733
GRADING AND SITE PREPARATION				
UPPER RESERVOIR AREA (SURCHARGE+20%) (ACRES)	132	107	83	108
UPPER RESERVOIR AREA (SURCHARGE+20%) (SF)	5,749,920	4,652,208	3,606,768	4,704,480
UPPER RESERVOIR GRADING UNIT PRICE ($/SF)	$ 5.00	$ 5.00	$ 5.00	$ 5.00
UPPER RESERVOIR GRADING COST ($)	$ 28,749,600	$ 23,261,040	$ 18,033,840	$ 23,522,400
DAM 1 CREST LENGTH (FT) (D)	1,425	1,760	1,173	2,323
DAM 1 FLOOR ELEV (FT MSL) (B)	1,880	1,360	1,360	1,440
HEIGHT MAX (H)	235.0	160.0	260.0	293.0
ABUTMENT HORIZ DISTANCE (E)	470	320	520	586
FOUNDATION BASE LENGTH (FT)	485	1,120	133	1,151
AVERAGE LENGTH (FT)	948	1,040	847	1,455
CREST WIDTH (FT)	20	20	20	20
BASE WIDTH (FT)	98.3	73.3	106.7	117.7
AVG WIDTH (FT)	59.2	46.7	63.3	68.8
CROSS SECTION AREA (SF)	13,904	7,467	16,467	20,168
DAM VOLUME (CY)	487,933	287,605	516,260	1,086,467
FOUNDATION PLAN AREA (SF)	93,171	76,267	90,293	171,146
EXCAVATION DEPTH (FT)	10	10	10	10
EXCAVATION VOLUME (CY)	34,508	28,247	33,442	63,387
RCC UNIT PRICE ($/CY)	$ 200	$ 200	$ 200	$ 200
EXCAVATION UNIT PRICE ($/CY)	$ 60	$ 60	$ 60	$ 60
ALLOWANCE FOR GROUTING, ETC	10%	10%	10%	10%
RCC COST	$ 97,586,651	$ 57,520,988	$ 103,252,099	$ 217,293,322
EXCAVATION COST	$ 2,070,463	$ 1,694,815	$ 2,006,519	$ 3,803,248
SUBTOTAL	$ 99,657,114	$ 59,215,802	$ 105,258,617	$ 221,096,570
ALLOWANCE	$ 9,965,711	$ 5,921,580	$ 10,525,862	$ 22,109,657
TOTAL COST DAM 1	$ 109,622,826	$ 65,137,383	$ 115,784,479	$ 243,206,227
DAM 2 CREST LENGTH (FT) (D)	1,340	838	1,508	-
DAM 2 FLOOR ELEV (FT MSL) (B)	2,040	1,440	1,600	-
HEIGHT MAX (H)	75.0	80.0	20.0	-
ABUTMENT HORIZ DISTANCE (E)	150	160	40	-
FOUNDATION WIDTH "C" FT	1,040	518	1,428	-
AVERAGE LENGTH (FT)	745	499	774	-
CREST WIDTH (FT)	20	20	20	-
BASE WIDTH (FT)	45.0	46.7	26.7	-
AVG WIDTH (FT)	32.5	33.3	23.3	-
CROSS SECTION AREA (SF)	2,438	2,667	467	-
DAM VOLUME (CY)	67,257	49,284	13,378	-
FOUNDATION PLAN AREA (SF)	33,525	23,287	20,640	-
EXCAVATION DEPTH (FT)	10	10	10	-
EXCAVATION VOLUME (CY)	12,417	8,625	7,644	-
RCC UNIT PRICE ($/CY)	$ 200	$ 200	$ 200	-
EXCAVATION UNIT PRICE ($/CY)	$ 60	$ 60	$ 60	-
ALLOWANCE FOR GROUTING, ETC	10%	10%	10%	-
RCC COST	$ 13,451,389	$ 9,856,790	$ 2,675,556	$ -
EXCAVATION COST	$ 745,000	$ 517,481	$ 458,667	$ -
SUBTOTAL	$ 14,196,389	$ 10,374,272	$ 3,134,222	$ -
ALLOWANCE	$ 1,419,639	$ 1,037,427	$ 313,422	-
TOTAL COST DAM 2	$ 15,616,028	$ 11,411,699	$ 3,447,644	-

Table 4-2 Upper Reservoir Size and Cost (Continued)

RESERVOIR SITE	A1	B3	C3	D3
DAM 3 CREST LENGTH (FT) (D)	838	838	1,500	-
DAM 3 FLOOR ELEV (FT MSL) (B)	2,100	1,440	1,600	-
HEIGHT MAX (H)	15.0	80.0	20.0	-
ABUTMENT HORIZ DISTANCE (E)	30	160	40	-
FOUNDATION WIDTH "C" FT	778	518	1,420	-
AVERAGE LENGTH (FT)	434	499	770	-
CREST WIDTH (FT)	20	20	20	-
BASE WIDTH (FT)	25.0	46.7	26.7	-
AVG WIDTH (FT)	22.5	33.3	23.3	-
CROSS SECTION AREA (SF)	338	2,667	467	-
DAM VOLUME (CY)	5,425	49,284	13,309	-
FOUNDATION PLAN AREA (SF)	10,850	23,287	20,533	-
EXCAVATION DEPTH (FT)	10	10	10	-
EXCAVATION VOLUME (CY)	4,019	8,625	7,605	-
RCC UNIT PRICE ($/CY)	$ 200	$ 200	$ 200	-
EXCAVATION UNIT PRICE ($/CY)	$ 60	$ 60	$ 60	-
ALLOWANCE FOR GROUTING, ETC	10%	10%	10%	-
RCC COST	$ 1,085,000	$ 9,856,790	$ 2,661,728	-
EXCAVATION COST	$ 241,111	$ 517,481	$ 456,296	-
SUBTOTAL	$ 1,326,111	$ 10,374,272	$ 3,118,025	-
ALLOWANCE	$ 132,611	$ 1,037,427	$ 311,802	-
TOTAL COST DAM 3	$ 1,458,722	$ 11,411,699	$ 3,429,827	-
DAM 4 CREST LENGTH (FT) (D)	-	1,006	2,700	-
DAM 4 FLOOR ELEV (FT MSL) (B)	-	1,280	1,600	-
HEIGHT MAX (H)	-	240.0	20.0	-
ABUTMENT HORIZ DISTANCE (E)	-	480	40	-
FOUNDATION WIDTH "C" FT	-	46	2,620	-
AVERAGE LENGTH (FT)	-	743	1,370	-
CREST WIDTH (FT)	-	20	20	-
BASE WIDTH (FT)	-	100.0	26.7	-
AVG WIDTH (FT)	-	60.0	23.3	-
CROSS SECTION AREA (SF)	-	14,400	467	-
DAM VOLUME (CY)	-	396,267	23,679	-
FOUNDATION PLAN AREA (SF)	-	74,300	36,533	-
EXCAVATION DEPTH (FT)	-	10	10	-
EXCVATION VOLUME (CY)	-	27,519	13,531	-
RCC UNIT PRICE ($/CY)	-	$ 200	$ 200	-
EXCAVATION UNIT PRICE ($/CY)	-	$ 60	$ 60	-
ALLOWANCE FOR GROUTING, ETC	-	10%	10%	-
RCC COST	-	$ 79,253,333	$ 4,735,802	$ -
EXCAVATION COST	-	$ 1,651,111	$ 811,852	$ -
SUBTOTAL	-	$ 80,904,444	$ 5,547,654	-
ALLOWANCE	-	$ 8,090,444	$ 554,765	$ -
TOTAL COST DAM 4	-	$ 88,994,889	$ 6,102,420	$ -

Table 4-2 Upper Reservoir Size and Cost (Continued)

RESERVOIR SITE	A1	B3	C3	D3
DAM 5 CREST LENGTH (FT) (D)		3,100		
DAM 5 FLOOR ELEV (FT MSL) (B)		1,490		
HEIGHT MAX (H)		30.0		
ABUTMENT HORIZ DISTANCE (E)		60		
FOUNDATION WIDTH "C" FT		2,980		
AVERAGE LENGTH (FT)		1,580		
CREST WIDTH (FT)		20		
BASE WIDTH (FT)		30.0		
AVG WIDTH (FT)		25.0		
CROSS SECTION AREA (SF)		750		
DAM VOLUME (CY)		43,889		
FOUNDATION PLAN AREA (SF)		47,400		
EXCAVATION DEPTH (FT)		10		
EXCVATION VOLUME (CY)		17,556		
RCC UNIT PRICE ($/CY)		$ 200		
EXCAVATION UNIT PRICE ($/CY)		$ 60		
ALLOWANCE FOR GROUTING, ETC		10%		
RCC COST		$ 8,777,778		
EXCAVATION COST		$ 1,053,333		
SUBTOTAL		$ 9,831,111		
ALLOWANCE		$ 983,111		
TOTAL COST DAM 5		$ 10,814,222		
TOTAL UPPER RESERVOIR DAM COST	$ 155,447,176	$ 211,030,931	$ 146,798,210	$ 266,728,627
UPPER RESERVOIR FLOOR AREA (SF)	1,283,046	2,088,570	398,320	329,324
TOTAL SURFACE AREA OF RESERVOIR (SY)	142,561	232,063	44,258	36,592
ASPHALT LINER WITH DRAIN SYSTEM ($/SY)	$ 100.00	$ 100.00	$ 100.00	$ 100.00
LINER COST	$ 14,256,067	$ 23,206,333	$ 4,425,778	$ 3,659,156
TOTAL UPPER RESERVOIR COST	$ 170,000,000	$ 235,000,000	$ 152,000,000	$ 271,000,000
UPPER RESERVOIR COST PER A-F	$ 47,600	$ 37,200	$ 26,100	$ 73,600

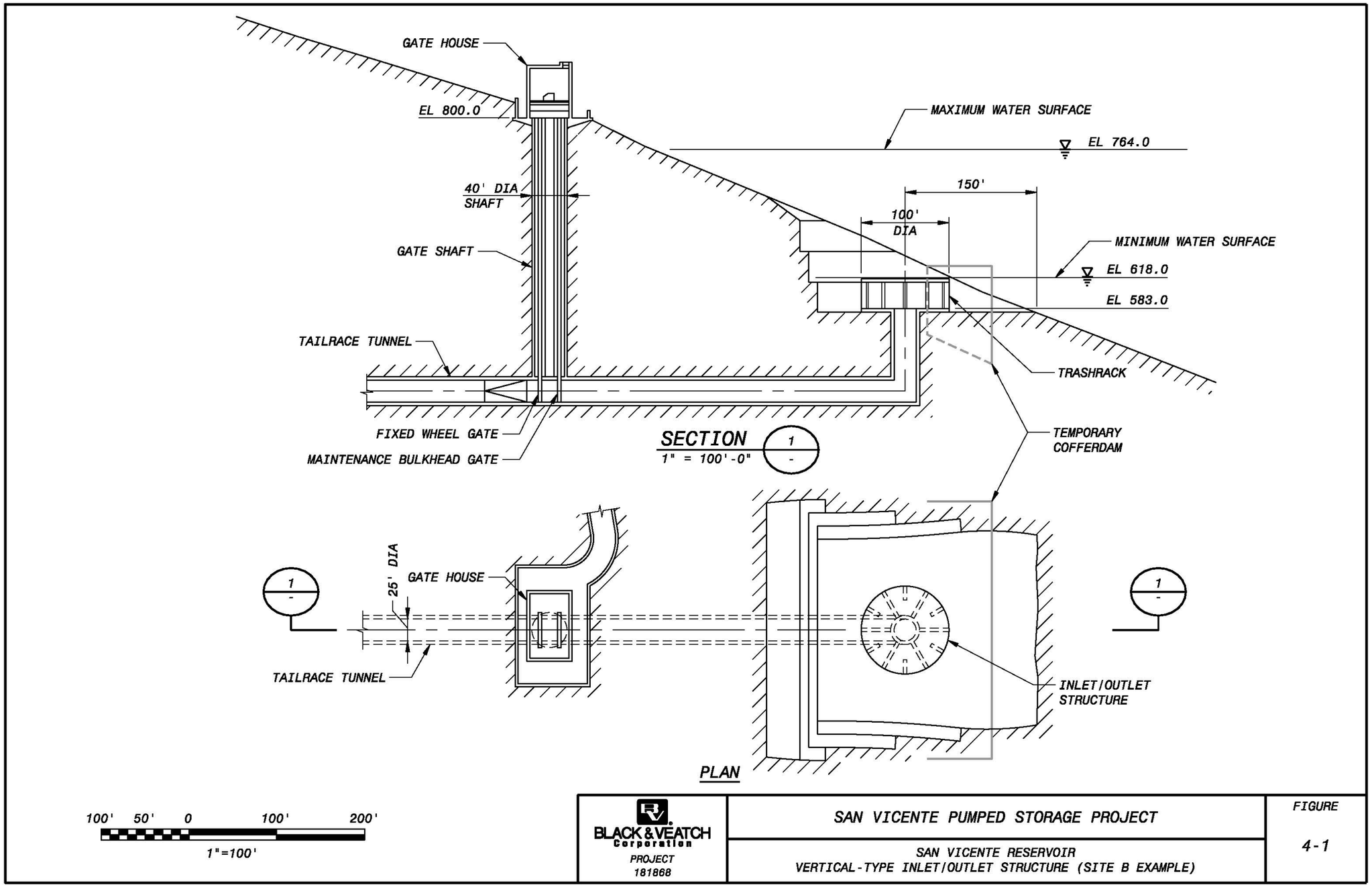


Figure 4-1 Vertical-Type Inlet/Outlet Structure

Table 4-3 Inlet/Outlet Structure Sizing and Costs

OPTION	A1	B3	C3	D3
UPPER RESERVOIR I/O				
HORIZONTAL TYPE				
PUMPING FLOW - MAX CFS	4117	7280	6715	5995
APPROACH VELOCITY (FPS)	1.00	1.00	1.00	1.00
GATE ROOM ELEV	2,126.0	1,530.0	1,620.0	1,743.0
GATE ROOM AREA (SF)	675.6	1,194.7	1,102.0	983.9
I/O STRUCTURE INVERT (EL)	1,963.0	1,372.0	1,412.0	1,490.0
GATE SHAFT HEIGHT (FT)	147.1	136.9	187.7	233.8
GATE SHAFT LENGTH (FT)	16.0	16.0	16.0	16.0
GATE SHAFT WIDTH (FT)	15.9	21.1	20.3	19.2
GATE SHAFT SLOT AREA (SF)	127.0	168.9	162.2	153.3
INLET AREA REQUIRED (SF)	4,117	7,280	6,715	5,995
INLET HEIGHT(FT)	40.0	40.0	40.0	40.0
INLET WIDTH (FT)	102.9	182.0	167.9	149.9
PENSTOCK OUTSIDE DIAMETER (FT)	15.9	21.1	20.3	19.2
TRIANGLE BASE SLICE WIDTH (FT)	43.5	80.4	73.8	65.4
TRUMPET RATIO	3.0	3.0	3.0	3.0
LENGTH OF TRUMPET (FT)	130.6	241.3	221.4	196.1
GATE SHAFT CONCRETE VOLUME (CY)	692	856	1,128	1,328
THICKNESS OF WALL, SLAB AND ROOF	4.0	4.0	4.0	4.0
BASE SLAB CONCRETE VOLUME (CY)	1,149.0	3,630.8	3,085.5	2,455.4
WALL CONCRETE VOLUME (CY)	1,631.1	3,014.8	2,765.8	2,449.7
ROOF SLAB CONCRETE (CY)	1,149.0	3,630.8	3,085.5	2,455.4
NUMBER OF PIERS	4.0	8.0	7.0	5.0
LENGTH OF PIER (FT)	32.6	60.3	55.3	49.0
WIDTH OF PIER (FT)	6.0	6.0	6.0	6.0
PIER CONCRETE VOLUME (CY)	1,160.6	4,290.2	3,443.9	2,178.7
TOTAL CONCRETE VOLUME	5,089.7	14,566.6	12,380.7	9,539.2
CONCRETE UNIT PRICE ($/CY)	$ 500.00	$ 500.00	$ 500.00	$ 500.00
CONCRETE COST	$ 2,544,871	$ 7,283,283	$ 6,190,331	$ 4,769,587
TRASHRACK WEIGHT (LB/SF)	130.0	130.0	130.0	130.0
STEEL UNIT COST ($/LB)	$ 2.00	$ 2.00	$ 2.00	$ 2.00
TRASHRACK ALLOWANCE	$ 1,070,395	$ 1,892,764	$ 1,745,863	$ 1,558,806
$125/SF	$ 84,452	$ 149,335	$ 137,745	$ 122,986
GATE ROOM EQUIPMENT COST	$ 779,189	$ 1,166,550	$ 1,097,355	$ 1,009,246
TOTAL GATE ROOM COST	$ 863,641	$ 1,315,885	$ 1,235,100	$ 1,132,232
EXCAVATION HEIGHT	163.0	158.0	208.0	253.0
EXCAVATION LENGTH	-	350.0	-	650
EXCAVATION WIDTH AT GATE ROOM	31.8	42.2	40.6	38.3
EXCAVATION WIDTH IN RESERVOIR	10.7	185.5	39.3	291.5
EXCAVATION VOLUME (CY)	0	116,587	0	502,138
EXCAVATION UNIT PRICE ($/CY)	$ 60.00	$ 60.00	$ 60.00	$ 60.00
EXCAVATON COST	$ -	$ 6,995,248	$ -	$ 30,128,267

Table 4-3 Inlet/Outlet Structure Sizing and Cost (Continued)

OPTION	A1	B3	C3	D3
EXCAVATION VOLUME -EQUAL CONCRETE VOLUME X1.2	6,107.7	-	14,856.8	-
EXCAVATION UNIT PRICE ($/CY)	$ 60.00	$ 60.00	$ 60.00	$ 50.00
EXCAVATION COST	$ 366,461	$ -	$ 891,408	$ -
TOTAL UPPER I/O COST	$ 4,900,000	$ 17,500,000	$ 10,100,000	$ 17,600,000
LOWER RESERVOIR I/O				
VERTICAL TYPE				
PUMPING FLOW - MAX CFS	4117	7280	6715	5995
APPROACH VELOCITY (FPS)	1.00	1.00	1.00	1.00
GATE HOUSE ELEV	800.0	800.0	800.0	800.0
GATE HOUSE AREA (SF)	42.9	42.9	42.9	42.9
I/O STRUCTURE INVERT (EL)	583.0	583.0	583.0	583.0
GATE SHAFT HEIGHT (FT)	235.7	241.9	240.9	239.6
GATE SHAFT DIAMETER (FT)	40.0	40.0	40.0	40.0
SHAFT ALLOWANCE FOR LINING (FT)	5.0	5.0	5.0	5.0
SHAFT EXCAVATION DIA. (FT)	45.0	45.0	45.0	45.0
SHAFT EXCAVATION VOLUME (CY)	13,877	14,240	14,182	14,104
EXCAVATION UNIT PRICE ($/CY)	60.00	60.00	60.00	60.00
GATE SHAFT EXCAVATION COST	$ 832,605	$ 854,387	$ 850,909	$ 846,262
ALLOWANCE FOR TEMP SUPPORTS OF EXCAVATION	15%	15%	15%	15%
GATE HOUSE SHAFT TEMP SUPPORTS COST ($)	$ 124,891	$ 128,158	$ 127,636	$ 126,939
BULKING FACTOR	1.25	1.25	1.25	1.25
HAULING AND DISPOSAL VOL (CY)	17,346	17,800	17,727	17,630
HAUL AND DISPOSE UNIT PRICE ($/CY)	$ 30.00	$ 30.00	$ 30.00	$ 30.00
HAUL AND DISPOSE COST ($)	$ 520,378	$ 533,992	$ 531,818	$ 528,914
SHAFT CONCRETE LINING VOL. (CY)	2,912	2,989	2,976	2,960
SHAFT DIVIDER CONC. WALL VOL. (CY)	1,397	1,433	1,427	1,420
TOTAL GATE SHAFT CONCRETE (CY)	4,309	4,422	4,404	4,380
CONCRETE UNIT PRICE ($/CY)	$ 600	$ 600	$ 600	$ 600
GATE SHAFT CONC LINING COST ($)	$ 2,585,481	$ 2,653,120	$ 2,642,322	$ 2,627,891
GATE HOUSE BLDG COST @ $125/SF	$ 5,360	$ 5,360	$ 5,360	$ 5,360
GATE HOUSE EQUIPMENT COST ($)	$ 307,000	$ 307,000	$ 307,000	$ 307,000
TOTAL GATE HOUSE COST ($)	$ 312,360	$ 312,360	$ 312,360	$ 312,360
DISTANCE FROM GATE HOUSE TO RESERVOIR (FT)	920.0	660.0	1,270.0	875.0
TUNNEL ADD. LENGTH (FT)	770.0	510.0	1,120.0	725.0
I/O SHAFT DIAMETER (FT) = TUNNEL ID	18.7	24.9	23.9	22.6
I/O SHAFT LENGTH (FT)	74.8	99.5	95.5	90.3
(FT)	5.0	5.0	5.0	5.0
I/O SHAFT EXCAVATION DIAMETER (FT)	23.7	29.9	28.9	27.6
I/O SHAFT EXCAVATION VOL (CY)	1,221	2,579	2,316	1,994
EXCAVATION UNIT PRICE ($/CY)	$ 60.00	$ 60.00	$ 60.00	$ 60.00
I/O SHAFT EXCAVATION COST ($)	$ 73,276	$ 154,743	$ 138,981	$ 119,633

Table 4-3 Inlet/Outlet Structure Sizing and Cost (Continued)

OPTION	A1	B3	C3	D3
ALLOWANCE FOR TEMP SUPPORTS OF EXCAVATION COST	15%	15%	15%	15%
I/O TEMP SUPPORTS COST ($)	$ 10,991	$ 23,211	$ 20,847	$ 17,945
BULKING FACTOR	1.25	1.25	1.25	1.25
HAULING AND DISPOSAL VOL (CY)	1,527	3,224	2,895	2,492
HAUL AND DISPOSE UNIT PRICE ($/CY)	$ 30.00	$ 30.00	$ 30.00	$ 30.00
($)	$ 45,797	$ 96,714	$ 86,863	$ 74,771
I/O SHAFT CONCRETE LINING VOL. (CY)	461	791	733	658
CONCRETE UNIT PRICE ($/CY)	$ 600	$ 600	$ 600	$ 600
I/O SHAFT CONCRETE LINING COST ($)	$ 276,583	$ 474,774	$ 439,575	$ 394,646
TRASHRACK AREA REQUIRED (SF)	4,117	7,280	6,715	5,995
TRASHRACK HEIGHT (FT)	30.0	30.0	30.0	30.0
TRASHRACK LENGTH (FT)	137.2	242.7	223.8	199.8
NUMBER OF PIERS	12.0	12.0	12.0	12.0
PIER WIDTH (FT)	4.0	4.0	4.0	4.0
TOTAL I/O CIRCUMFERENCE (FT)	185.2	290.7	271.8	247.8
I/O DIAMETER (FT)	59.0	92.6	86.6	78.9
4 X I/O SHAFT DIAMETER (FT)	74.8	99.5	95.5	90.3
I/O DIAMETER (FT) (FINAL)	75.0	100.0	95.0	90.0
I/O ROOF AND SLAB THICKNESS (FT)	4.0	4.0	4.0	4.0
I/O ROOF SLAB CONCRETE VOL. (CY)	654.2	1,163.0	1,049.6	942.0
I/O BASE SLAB CONCRETE VOL. (CY)	613.5	1,091.1	983.3	882.8
I/O PIER CONCRETE VOL. (CY)	125.1	167.0	158.0	149.9
TOTAL I/O CONCRETE VOL. (CY)	1,392.8	2,421.0	2,190.9	1,974.6
I/O CONCRETE UNIT COST ($)	$ 600	$ 600	$ 600	$ 600
I/O CONCRETE COST ($)	$ 835,672	$ 1,452,596	$ 1,314,524	$ 1,184,785
TRASHRACK WEIGHT (LB/SF)	130.0	130.0	130.0	$ 130
STEEL UNIT COST ($/LB)	$ 2.00	$ 2.00	$ 2.00	$ 2.00
TRASHRACK COST ($)	$ 1,462,500	$ 2,074,800	$ 1,952,340	$ 1,829,880
I/O EXCAVATION HEIGHT (FT)	90.0	100.0	98.0	96.0
I/O EXCAVATION LENGTH (FT)	225.0	250.0	245.0	240.0
I/O EXCAVATION WIDTH (FT)	187.5	250.0	237.5	225.0
I/O EXCAVATION VOLUME (CY)	70,313	115,741	105,600	96,000
EXCAVATION UNIT PRICE ($/CY)	$ 60.00	$ 60.00	$ 60.00	$ 60.00
I/O EXCAVATON COST ($)	$ 4,218,750	$ 6,944,444	$ 6,335,972	$ 5,760,000
BULKING FACTOR	1.25	1.25	1.25	1.25
HAULING AND DISPOSAL VOL (CY)	87,891	144,676	131,999	120,000
HAUL AND DISPOSE UNIT PRICE ($/CY)	$ 30.00	$ 30.00	$ 30.00	$ 30.00
I/O EXCVATION HAUL AND DISPOSE COST ($)	$ 2,636,719	$ 4,340,278	$ 3,959,983	$ 3,600,000
COFFERDAM HEIGHT (FT)	45.0	45.0	45.0	45.0
COFFERDAM DIA. (FT)	54.0	54.0	54.0	54.0
COFFERDAM LENGTH (FT)	392	508	496	483
COFFERDAM UNIT COST ($/FT)	$ 75,000	$ 75,000	$ 75,000	$ 75,000
COFFERDAM COST ($)	$ 29,362,500	$ 38,100,000	$ 37,162,500	$ 36,225,000
LOWER RESERVOIR COFFERDAM ALLOWANCE (MISC.)	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000
TOTAL LOWER I/O COST	$ 44,400,000	$ 59,300,000	$ 57,000,000	$ 54,800,000

4.3.2 Powerhouse Cavern

As noted in Section 1.4, this Evaluation considers the additional operating flexibility provided by multiple units. For purposes of this Evaluation, the powerhouse cavern will be sized to accommodate four reversible pump/turbine units (4x125 MW units) directly coupled to motor/generators versus the two unit (2x250 units) assumption used in the Study. Table 4-4 provides the parametric data on the sizes of the cavern for each alternative. The cavern size ranges, depending on alternative, are as follows:

- Cavern length will vary from 344 feet to 366 feet
- Cavern width will vary from 81 feet to 84 feet
- Cavern height will vary from 107 feet to 123 feet

As described in the Study, the cavern will be completely underground and excavated from bedrock.

The roof of the cavern will be stabilized with rock bolts. Rock reinforcement for the roofs of the cavern and other underground chambers will be designed to ensure the existence of a reinforced rock arch capable of withstanding the stresses and potential seepage pressures which may develop. The substructure and superstructure construction will include exposed rock surfaces and cast-in-place reinforced concrete. The pump/turbine spiral cases will be permanently embedded in second-stage concrete. Floors will be supported by concrete walls and columns. Walls will also serve to partition areas. Substructure and superstructure configurations will be dictated by final mechanical and electrical equipment arrangements.

The main machine hall will be equipped with a bridge crane to handle heavy turbine-generator components and other equipment. Floor hatches in the machine hall will be sized for moving equipment between floors and to the maintenance and access bays.

Other areas of the cavern will house the following equipment: upstream and downstream butterfly valves for unit isolation, pump/turbines, and maintenance bays with access to the pump/turbine pit, drainage pumps, cooling water strainers and pumps, compressor room and compressed air storage tanks, an oil treatment plant, a drainage gallery and sumps, access to the motor/generators, and auxiliary transformers.

Equipment access to the cavern will be provided by an access tunnel described later in this Evaluation. A separate power cable/emergency exit tunnel will exit the powerhouse to the surface.

The costs of the underground cavern are directly related and proportional to the size and number of generating units with the higher head units requiring a smaller cavern.

Table 4-4 Powerhouse Structure Sizing and Costs

OPTION	A	B3	C3	D3
POWERHOUSE STRUCTURE				
NUMBER OF UNITS	4	4	4	4
RUNNER DIAMETER (FT)	11.09	13.02	13.82	12.19
LENGTH CALCULATION				
ACCESS BAY WIDTH (FT)	35	35	35	35
SERVICE BAY LENGTH (FT)	60	60	60	60
UNIT BAY LENGTH (FT) (20 FT MIN)	22.2	26.0	27.6	24.4
TOTAL UNIT BAY LENGTHS (FT)	88.7	104.2	110.5	97.6
BAY LENGTH BETWEEN UNITS	30.0	30.0	30.0	30.0
TOTAL BAY LENGTHS BETWEEN UNITS (FT)	90.0	90.0	90.0	90.0
ELECTRICAL BAY WIDTH PER UNIT	40.0	40.0	40.0	40.0
TOTAL ELECTRICAL BAY LENGTH	160.0	160.0	160.0	160.0
TOTAL POWERHOUSE LENGTH (FT)	343.7	359.2	365.5	352.6
WIDTH CALCULATION				
VALVE / MECH AUX BAY WIDTH (FT)	30.0	30.0	30.0	30.0
UNIT BAY WIDTH (FT)	21.1	23.0	23.8	22.2
CONTROL ROOM / OFFICE / SHOPS BAY WIDTH (FT)	30.0	30.0	30.0	30.0
TOTAL POWERHOUSE WIDTH (FT)	81.1	83.0	83.8	82.2
POWERHOUSE HEIGHT				
CL RUNNER ELEV (FT MSL)	457.0	480.0	484.0	475.0
CROWN HEIGHT (FT)	20.3	20.8	21.0	20.5
AVG HEIGHT OF CROWN FOR AREA CALC (FT)	10.1	10.4	10.5	10.3
HEIGHT OP FLOOR TO CROWN (FT)	30.0	30.0	30.0	30.0
HEIGHT OP FLOOR TO CL RUNNER (FT)	38.8	45.6	48.4	42.7
OPERATING FLOOR ELEV (FT MSL)	495.8	525.6	532.4	517.7
HEIGHT CL RUNNER TO BOTTOM OF POWERHOUSE (FT)	27.7	32.5	34.5	30.5
TOTAL POWERHOUSE HEIGHT MAX (FT)	116.8	128.9	133.9	123.7
POWERHOUSE HEIGHT FOR VOLUME CALC (FT)	106.7	118.5	123.4	113.4
POWERHOUSE EXCAVATION VOL (CF)	2,974,273	3,533,108	3,780,030	3,287,301
POWERHOUSE EXCAVATION VOL (CY)	110,158	130,856	140,001	121,752
POWERHOUSE EXCAVATION UNIT PRICE ($/CY)	$ 100.00	$ 100.00	$ 100.00	$ 100.00
POWERHOUSE EXCAVATION COST	$ 11,015,827	$ 13,085,586	$ 14,000,110	$ 12,175,190
ROCK BULKING FACTOR	1.25	1.25	1.25	1.25
ROCK VOL -- HAUL AND DISPOSE (CY)	137,697.84	163,569.82	175,001.37	152,189.87
UNIT PRICE -HAUL AND DISPOSE ($/CY)	$ 60.00	$ 60.00	$ 60.00	$ 60.00
HAUL AND DISPOSE COST	$ 8,261,870	$ 9,814,189	$ 10,500,082	$ 9,131,392

Table 4-4 Powerhouse Structure Size and Cost (Continued)

OPTION	A	B3	C3	D3
EXCAVATION WALL SURFACE AREA (SF)	90,659	104,790	110,880	79,988
ROOF ROCK SURFACE (SF)	27,876	29,817	30,638	28,978
ROCK BOLT PATTERN AREA -WALL (SF)	50	50	50	50
ROCK BOLT PATTERN AREA -ROOF (SF)	25	25	25	25
NUMBER OF ROCKBOLTS - WALL	1,813	2,096	2,218	1,600
NUMBER OF ROCK BOLTS ROOF	1,115	1,193	1,226	1,159
TOTAL ROCK BOLTS	2,928	3,288	3,443	2,759
AVG ROCK BOLT LENGTH (FT)	50	50	50	50
TOTAL ROCK BOLT LENGTH (FT)	146,411	164,423	172,155	137,945
UNIT COST FOR ROCKBOLTS ($/FT)	$ 20.00	$ 20.00	$ 20.00	$ 20.00
ROCK BOLT COST	$ 2,928,212	$ 3,288,470	$ 3,443,109	$ 2,758,892
SHOTCRETE % OF WALL SURFACE	50%	50%	50%	50%
SURFACE AREA OF SHOTCRETE (SF)	59,267	67,303	70,759	54,483
UNIT COST FOR SHOTCRETE ($/SF)	$ 50.00	$ 50.00	$ 50.00	$ 50.00
SHOTCRETE	$ 2,963,372	$ 3,365,166	$ 3,537,939	$ 2,724,163
TOTAL EXCAVATION COST	$ 25,169,281	$ 29,553,410	$ 31,481,241	$ 26,789,637
POWERHOUSE STRUCTURE COST				
RATIO OF CONCRETE TO EXCAVATED VOLUME	40%	40%	40%	40%
CONCRETE VOLUME	44,063	52,342	56,000	48,701
UNIT COST FOR CONCRETE ($/CY AVG)	$ 800.00	$ 800.00	$ 800.00	$ 800.00
POWERHOUSE CONCRETE COST	$ 35,250,647	$ 41,873,874	$ 44,800,352	$ 38,960,607
ARCHITECTURAL ALLOWANCE	10%	10%	10%	10%
ARCHITECTURAL COST	$ 3,525,065	$ 4,187,387	$ 4,480,035	$ 3,896,061
TOTAL POWERHOUSE STRUCTURE	$ 64,000,000	$ 75,700,000	$ 80,800,000	$ 69,700,000

4.3.3 Access and Cable Tunnels

As described in the Study, the Project will include two auxiliary purpose tunnels as shown on the site figures presented within Appendix A. The tunnels consist of:

- An access tunnel from the Project access road to the powerhouse cavern. The tunnel will generally slope at an 8% grade and will be a 23 feet wide by 20 feet tall horseshoe tunnel. The invert (road) will be concrete paved. The wall and roof will be exposed rock shotcrete and rock bolted as required for stability. Lighting and floor drainage will be provided.
- An escape/cable tunnel will be provided to carry the main power feed (bus duct) from the powerhouse to the surface substation, a tunnel will be provided. The tunnel will also serve as an emergency escape in the event the access tunnel is unsafe. The tunnel will slope up as required not to exceed 20%. The tunnel will be approximately 15 feet wide by 15 feet high. It will be designed as described for the access tunnel.

Tables 4-5 and 4-6 provide the quantity and cost estimate for these tunnels as sized for each alternative.

Table 4-5 Access Tunnel Sizing and Costs

OPTION	A1	B3	C3	D3
ACCESS TUNNEL				
ACCESS TUNNEL PORTAL ELEVATION (FT MSL)	800	800	800	800
ACCESS TUNNEL GRADE (%)	8%	8%	8%	8%
ACCESS TUNEL LENGTH (INCLINED FT)	3,802	3,430	3,346	3,529
ACCESS TUNNEL HEIGHT (FT)	20.00	20.00	20.00	20.00
ACCESS TUNNEL FLOOR WIDTH	23.00	23.00	23.00	23.00
TUNNEL CONFIGURATION	HORSESHOE	HORSESHOE	HORSESHOE	HORSESHOE
WALL HEIGHT -STRAIGHT (FT)	10.00	10.00	10.00	10.00
ROOF RADIUS (FT)	11.50	11.50	11.50	11.50
CROSS SECTION AREA (SF)	438	438	438	438
TUNNEL VOLUME (CF)	1,663,949	1,501,255	1,464,107	1,544,402
TUNNEL VOLUME (CY)	61,628	55,602	54,226	57,200
EXCAVATION UNIT PRICE ($/CY)	$ 80.00	$ 80.00	$ 80.00	$ 80.00
EXCAVATION COST ($)	$ 4,930,218	$ 4,448,164	$ 4,338,094	$ 4,576,007
BULKING FACTOR	1.25	1.25	1.25	1.25
HAULING AND DISPOSAL VOL (CY)	77,035	69,503	67,783	71,500
HAUL AND DISPOSE UNIT PRICE ($/CY)	$ 30.00	$ 30.00	$ 30.00	$ 30.00
HAUL AND DISPOSE COST ($)	$ 2,311,040	$ 2,085,077	$ 2,033,482	$ 2,145,003
FLOOR PAVING THICKNESS (FT)	1.00	1.00	1.00	1.00
FLOOR PAVING VOLUME (CY)	3,239	2,922	2,850	3,006
FLOOR PAVING UNIT PRICE ($/CY)	$ 400	$ 400	$ 400	$ 400
FLOOR PAVING COST ($)	$ 1,295,551	$ 1,168,878	$ 1,139,954	$ 1,202,472
WALL ROCK PROTECTION TYPE	SHOTCRETE	SHOTCRETE	SHOTCRETE	SHOTCRETE
WALL PROTECTION AREA (SF)	144,691	130,544	127,314	134,296
WALL PROTECTION UNIT PRICE ($/SF)	$ 50	$ 50	$ 50	$ 50
WALL PROTECTION COST	$ 7,234,559	$ 6,527,197	$ 6,365,682	$ 6,714,793
ALLOWANCE FOR LIGHTS AND DRAINS (%)	20%	20%	20%	20%
LIGHTS AND DRAINS COST	$ 1,446,912	$ 1,305,439	$ 1,273,136	$ 1,342,959
TOTAL ACCESS TUNNEL COST	$ 17,220,000	$ 15,540,000	$ 15,160,000	$ 15,990,000

Table 4-6 Cable Tunnel Sizing and Costs

OPTION	A1	B3	C3	D3
TUNNEL PORTAL ELEVATION (FT MSL)	800	800	800	800
TUNNEL LENGTH (INCLINED FT)	1,521	1,372	1,338	1,412
ACCESS TUNNEL HEIGHT (FT)	15.00	15.00	15.00	15.00
ACCESS TUNNEL FLOOR WIDTH	15.00	15.00	15.00	15.00
TUNNEL CONFIGURATION	HORSESHOE	HORSESHOE	HORSESHOE	HORSESHOE
WALL HEIGHT -STRAIGHT (FT)	7.50	7.50	7.50	7.50
ROOF RADIUS (FT)	7.50	7.50	7.50	7.50
CROSS SECTION AREA (SF)	201	201	201	201
TUNNEL VOLUME (CF)	305,408	275,547	268,729	283,466
TUNNEL VOLUME (CY)	11,311	10,205	9,953	10,499
EXCAVATION UNIT PRICE ($/CY)	$ 80.00	$ 80.00	$ 80.00	$ 80.00
EXCAVATION COST ($)	$ 904,914	$ 816,436	$ 796,233	$ 839,900
BULKING FACTOR	1.25	1.25	1.25	1.25
HAULING AND DISPOSAL VOL (CY)	14,139	12,757	12,441	13,123
HAUL AND DISPOSE UNIT PRICE ($/CY)	$ 30.00	$ 30.00	$ 30.00	$ 30.00
HAUL AND DISPOSE COST ($)	$ 424,178	$ 382,704	$ 373,234	$ 393,703
FLOOR PAVING THICKNESS (FT)	0.50	0.50	0.50	0.50
FLOOR PAVING VOLUME (CY)	422	381	372	392
FLOOR PAVING UNIT PRICE ($/CY)	$ 400	$ 400	$ 400	$ 400
FLOOR PAVING COST ($)	$ 168,985	$ 152,462	$ 148,690	$ 156,844
WALL ROCK PROTECTION TYPE	SHOTCRETE	SHOTCRETE	SHOTCRETE	SHOTCRETE
WALL PROTECTION AREA (SF)	40,721	36,740	35,830	37,796
WALL PROTECTION UNIT PRICE ($/SF)	$ 50	$ 50	$ 50	$ 50
WALL PROTECTION COST	$ 2,036,057	$ 1,836,980	$ 1,791,524	$ 1,889,776
ALLOWANCE FOR LIGHTS AND DRAINS (%)	20%	20%	20%	20%
LIGHTS AND DRAINS COST	$ 407,211	$ 367,396	$ 358,305	$ 377,955
TOTAL CABLE TUNNEL COST	$ 3,950,000	$ 3,560,000	$ 3,470,000	$ 3,660,000

4.3.4 Pump Turbine / Motor Generation Units

For additional operating flexibility, four vertical, variable speeds, single-stage, Francis reversible pump/turbine-motor/generator units will be provided for pumping and generation versus the two unit configuration used in the Study. The turbines will each be rated for approximately 125 MW. Table 4-7 presents the conceptual calculation of the following key parameters:

- **Pump Turbine runner diameter.** This is used to size the powerhouse cavern.
- **Pump Turbine setting.** This is the distance below the minimum lower reservoir water level and represents the depth required to safely and efficiently operate in the pumping mode.
- **Unit speed.** This determines the size of the motor generator.
- **Water conductor headloss.** This determines the diameter of the water conductors.

Table 4-7 Pump Turbine / Motor Generator Unit Sizing and Costs

OPTION	A1	B3	C3	D3
PT/MG COST				
UNIT CAPACITY	125.00	125.00	125.00	125.00
NUMBER OF UNITS	4	4	4	4
RUNNER DIAMETER	1.0	1.0	1.0	1.0
AVERAGE COST PT/MG PER MW($)	780,000	780,000	780,000	780,000
BASE PT/MG COST PER UNIT	$ 97,500,000	$ 97,500,000	$ 97,500,000	$ 97,500,000
COST ADJUSTMENT FOR RUNNER DIAMETER	1.00	1.17	1.25	1.10
ADJUSTED COST PER UNIT	$ 97,500,000	$ 114,426,565	$ 121,434,629	$ 107,176,103
PT/MG TOTAL COST	$ 390,000,000	$ 458,000,000	$ 486,000,000	$ 429,000,000
Pump Discharge (cfs)	1029	1820	1679	1499
Specific Speed (gpm)	1625.00	2100.00	2000.00	2000.00
Rotational Speed (rpm)	537.23	340.47	358.72	413.31
Adjusted Rotational Speed (rpm)	500.00	340.00	340.00	400.00
Adjusted Specific Speed (gpm)	1512.39	2097.07	1895.64	1935.59
Peripheral Velocity	0.98	1.04	1.06	1.04
Runner Diameter (ft)	11.09	13.02	13.82	12.19
Runner Diameter (m)	3.38	3.97	4.21	3.72
Runner Ratio	1.00	1.17	1.25	1.10
Thoma sigma	0.14	0.22	0.20	0.17
NPSH (ft)	191.24	169.95	167.50	162.91
Atmospheric Pressure Head (ft)	31.42	31.42	31.42	31.42
Setting (ft)	160	136	134	130
Lower Reservoir Min Operating Level (ft)	618.00	618.00	618.00	618.00
Setting Elevation (ft)	458.00	482.00	484.00	488.00
Adjusted Setting (ft)	161.0	138.0	134.0	143.0
Adjusted Runner Elevation (ft)	457.0	480.0	484.0	475.0
Tailrace Horiz (ft)	3170	1910	2270	3500
Tailrace Slope (%)	5.08%	7.23%	5.90%	4.09%
Tailrace Length (ft)	3174	1915	2274	3503
Iterated headloss calculations				
Site	*A1*	*B3*	*C3*	*D3*
Rated Flow (cfs)	1029	1820	1679	1499
P.S. Diameter (ft)	12.00	18.00	17.00	15.00
Distance from Upper to Lower Reservoir (ft)	16040.00	3450.00	3900.00	11620.00
Elevation Difference (ft) (Avg Gross Hd)	1366.00	772.50	837.50	938.00
Tailrace Horiz. Distance (ft)	3170.00	1910.00	2270.00	3500.00
Tailrace Tunnel Length (ft)	2925.00	1667.00	2024.00	3253.00
Headloss (ft) (from calcs)	6.60	4.19	2.10	4.42
Setting Input (ft)	178.12	163.67	134.82	144.94
Setting Output (ft)	153.62	134.74	134.39	127.47

The above parameters are dependent on each other so an iterative calculation process is used to arrive at a reasonable conceptual solution.

Each pump/turbine will be directly coupled to a vertical shaft, three-phase, 60 hertz, ac synchronous motor/generator. Each motor/generator will be rated at the gross MW for each alternative and a 0.90 power factor.

For purposes of conceptual cost estimate, a unit price based on $/kw of net generating output was used for furnishing and installing the 2x250 MW, variable speed units of the Study. For furnishing and installing the 4x125 MW, variable speed units for this Evaluation, a 50 percent unit price increase was assumed for the two additional units. This estimate will be improved by budgetary quotes during the preliminary engineering phase.

Annual generation for the 125 MW units will average 1,022 GWh, assuming the daily energy storage of 4,000 MW-hrs and a 0.70 plant capacity factor. The estimated annual generation will be improved during the preliminary engineering phase based on final operating conditions and requirements for the power grid system.

4.3.5 Water Conductors

The water conductors consist of the pressure tunnel, tailrace tunnel and their associated bifurcations to the unit spiral cases and draft tubes, respectively.

As presented in the Study, the pressure tunnel, consisting of both shaft and tunnel segments, will extend between the upper inlet/outlet structure and the pump/turbine inlet valves. Table 4-8 presents the parametric conceptual pressure tunnel design and cost estimate for each alternative. The pressure tunnels and their bifurcations will be steel lined.

The pressure tunnel for Alternative A has a very high cost due to its high head and long length. This was to be expected with an L/H ratio of 12.3. The least cost pressure tunnel is Alternative B3, which would be expected since its L/H ratio of 5.1 is the smallest of the four alternatives.

The tailrace tunnel will extend between the lower inlet/outlet structure and the pump/turbine draft tubes. Table 4-9 presents the parametric conceptual tailrace tunnel design and cost estimate for each alternative. The tailrace tunnels will be concrete lined.

Seepage control methods will likely be required along the tunnels to ensure that water will not follow the tunnels and create water pressures that could cause tunnel collapse. Seepage control methods may include, but are not limited to, the following:

- Excavation techniques which minimize disturbance of the unexcavated rock, including blind drilling and raise boring for shafts and controlled blasting techniques for caverns and interconnecting tunnels
- Contact grouting concrete and steel tunnel linings, including steel/concrete and concrete/rock contacts

Table 4-8 Pressure Tunnel Sizing and Costs

OPTION	A1	B3	C3	D3
POWER TUNNEL				
UPPER RESERVOIR FLOOR (FT MSL)	1,998.0	1,407.0	1,447.0	1,525.0
UNIT CENTERLINE (FT MSL)	457.0	480.0	484.0	475.0
SHAFT LENGTH (FT)	995.4	845.0	853.0	725.2
TUNNEL LENGTH (FT)	13,640.00	2,050.00	2,750.00	8,120.00
GENERATION FLOW (CFS)	4,947	8,748	8,069	7,205
SELECTED VELOCITY (FPS)	25	25	25	25
REQUIRED AREA (SF)	197.89	349.93	322.77	288.19
REQUIRED RADIUS (FT)	7.94	10.56	10.14	9.58
REQUIRED DIAMETER (FT)	15.88	21.11	20.28	19.16
REQUIRED CIRCUM. (FT)	49.86	66.30	63.67	60.16
LINER EXCAVATION DIA ALLOW (FT)	2.00	2.00	2.00	2.00
EXCVATION DIAMETER (FT)	17.88	23.11	22.28	21.16
EXCAVATION AREA PER FOOT (SF)	250.89	419.37	389.59	351.50
EXCVATION VOLUME (CY)	135,995	44,966	51,988	115,150
EXCAVATION UNIT PRICE ($/CY)	$ 80.00	$ 80.00	$ 80.00	$ 80.00
EXCAVATION COST ($)	$ 10,879,614	$ 3,597,258	$ 4,159,045	$ 9,211,988
ALLOWANCE FOR TEMP SUPPORTS OF EXCAVATION COST	15%	15%	15%	15%
TEMP SUPPORTS	$ 1,631,942	$ 539,589	$ 623,857	$ 1,381,798
BULKING FACTOR	1.25	1.25	1.25	1.25
HAULING AND DISPOSAL VOL (CY)	169,994	56,207	64,985	143,937
HAUL AND DISPOSE UNIT PRICE ($/CY)	$ 30.00	$ 30.00	$ 30.00	$ 30.00
HAUL AND DISPOSE COST ($)	$ 5,099,819	$ 1,686,215	$ 1,949,552	$ 4,318,120
STEEL LINER THICKNESS (AVG) (IN)	0.75	0.50	0.50	0.50
STEEL LINER UNIT WEIGHT (LBS/SF) W/ ALLOWANCE FOR STIFFENERS	50.0	25.0	25.0	25.0
STEEL LINER UNIT COST ($/LB)	$ 4.00	$ 4.00	$ 4.00	$ 4.00
STEEL LINER AREA (SF)	729,652	191,927	229,408	532,161
STEEL LINER WEIGHT (LBS)	36,482,622	4,798,175	5,735,201	13,304,025
STEEL LINER COST	$ 145,930,489	$ 19,192,702	$ 22,940,805	$ 53,216,099
BACK-GROUTING THICKNESS (FT)	1.0	1.0	1.0	1.0
BACK GROUTING AREA (SF/FT)	49.9	66.3	63.7	60.2
BACK GROUTING VOLUME (CY)	27,024	7,108	8,497	19,710
BACK GROUTING UNIT COST ($/CY)	$400.00	$400.00	$400.00	$400.00
BACK GROUTING COST	$ 10,809,666	$ 2,843,363	$ 3,398,638	$ 7,883,866
TOTAL POWER TUNNEL COST	$ 174,400,000	$ 27,900,000	$ 33,100,000	$ 76,100,000

Table 4-9 Tailrace Tunnel Sizing and Costs

OPTION	A1	B3	C3	D3
TUNNEL LENGTH (FT)	3,172.5	1,912.8	2,272.2	3,501.7
PUMPING FLOW (CFS)	4,116.9	7,279.9	6,714.9	5,995.4
PUMPING VELOCITY (FPS)	15.0	15.0	15.0	15.0
TUNNEL AREA REQUIRED (SF)	274.46	485.32	447.66	399.69
TUNNEL RADIUS REQUIRED (FT)	9.3	12.4	11.9	11.3
TUNNEL DIAMETER REQUIRED (FT)	18.7	24.9	23.9	22.6
TUNNEL DIA ALLOWANCE FOR LINER	5.00	5.00	5.00	5.00
EXCAVATION DIAMETER (FT)	23.70	29.86	28.88	27.56
EXCAVATION AREA PER FOOT (SF)	440.87	700.14	654.74	596.45
EXCVATION VOLUME (CY)	51,802	49,600	55,099	77,355
EXCAVATION UNIT PRICE ($/CY)	$ 65.00	$ 65.00	$ 65.00	$ 65.00
EXCAVATION COST ($)	$ 3,367,132	$ 3,224,006	$ 3,581,443	$ 5,028,048
ALLOWANCE FOR TEMP SUPPORTS OF EXCAVATION COST	15%	15%	15%	15%
TEMP SUPPORTS	$ 505,070	$ 483,601	$ 537,216	$ 754,207
BULKING FACTOR	1.25	1.25	1.25	1.25
HAULING AND DISPOSAL VOL (CY)	64,753	62,000	68,874	96,693
HAUL AND DISPOSE UNIT PRICE ($/CY)	$ 30.00	$ 30.00	$ 30.00	$ 30.00
HAUL AND DISPOSE COST ($)	$ 1,942,576	$ 1,860,004	$ 2,066,217	$ 2,900,797
CONCRETE LINER AREA (SF/FT)	166.41	214.81	207.08	196.76
CONCRETE VOLUME (CY)	19,553	15,218	17,427	25,518
CONCRETE LINER UNIT COST ($/CY)	$ 600.00	$ 600.00	$ 600.00	$ 600.00
CONCRETE LINER COST	$ 11,731,748	$ 9,130,821	$ 10,456,195	$ 15,310,654
TOTAL TAILRACE TUNNEL COST	$ 17,600,000	$ 14,700,000	$ 16,700,000	$ 24,000,000

4.3.6 Balance of Plant Mechanical and Electrical Equipment

Tables 4-10 and 4-11 present the conceptual listing and cost of balance of plant mechanical and electrical systems and equipment. The balance of plant mechanical and electrical systems and equipment for this Evaluation was sized accordingly to accommodate the four unit arrangement versus the two unit arrangement assumed for the Study. In some cases, the systems are common to all units or may be strictly dedicated equipment per unit. The following is included in the cost estimate:

1. Mechanical systems and equipment
    a. Generator cooling system pumps and system auxiliaries
    b. Drains and dewatering pumps and system auxiliaries
    c. Service water pumps and system auxiliaries
    d. Potable water system
    e. Sanitary system
    f. Fire protection systems

   g. Oil conditions and storage systems
   h. Piping, valves and instrumentation
   i. Bridge crane
   j. HVAC systems

2. Electrical systems and equipment
   a. Unit step-up transformers
   b. Isophase bus duct systems
   c. Neutral grounding and line cubicle equipment
   d. Variable frequency drive systems
   e. Medium voltage switchgear
   f. Motor control centers and low voltage power systems
   g. DC and UPS systems
   h. Unit and plant control and protection systems
   i. SCADA and communication systems
   j. Emergency generator system
   k. Lighting
   l. Grounding
   m. Raceway and cable installation
   n. Security

Table 4-10 Mechanical Balance of Plant Sizing and Costs

OPTION	A1	B3	C3	D3
PT/MG COST				
UNIT CAPACITY	125.00	125.00	125.00	125.00
NUMBER OF UNITS	4	4	4	4
RUNNER DIAMETER	1.0	1.0	1.0	1.0
AVERAGE COST PT/MG PER MW($)	780,000	780,000	780,000	780,000
BASE PT/MG COST PER UNIT	$ 97,500,000	$ 97,500,000	$ 97,500,000	$ 97,500,000
COST ADJUSTMENT FOR RUNNER DIAMETER	1.00	1.17	1.25	1.10
ADJUSTED COST PER UNIT	$ 97,500,000	$ 114,426,565	$ 121,434,629	$ 107,176,103
PT/MG TOTAL COST	$ 390,000,000	$ 458,000,000	$ 486,000,000	$ 429,000,000
BALANCE OF PLANT				
GENERATOR COOLING PUMPS	$ 450,000	$ 450,000	$ 450,000	$ 450,000
BRIDGE CRANE (300t)	$ 3,000,000	$ 3,000,000	$ 3,000,000	$ 3,000,000
DRAIN AND DEWATERING PUMPS	$ 200,000	$ 200,000	$ 200,000	$ 200,000
HVAC	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000
SERVICE WATER PUMPS	$ 100,000	$ 100,000	$ 100,000	$ 100,000
POTABLE WATER SKID	$ 50,000	$ 50,000	$ 50,000	$ 50,000
FIRE PROTECTION SYSTEM	$ 2,000,000	$ 2,000,000	$ 2,000,000	$ 2,000,000
OIL STORAGE TANKS	$ 60,000	$ 60,000	$ 60,000	$ 60,000
SUBTOTAL EQUIPMENT	$ 6,860,000	$ 6,860,000	$ 6,860,000	$ 6,860,000
ALLOWANCE FOR VALVES	35%	35%	35%	35%
ALLOWANCE FOR INSTRUMENTS	25%	25%	25%	25%
ALLOWANCE FOR PIPING/ACCESSORIES	60%	60%	60%	60%
COST FOR VALVES	$ 2,401,000	$ 2,401,000	$ 2,401,000	$ 2,401,000
COST FOR INSTRUMENTS	$ 1,715,000	$ 1,715,000	$ 1,715,000	$ 1,715,000
COST FOR PIPING/ACCESSORIES	$ 4,116,000	$ 4,116,000	$ 4,116,000	$ 4,116,000
ALLOWANCE TOTAL	$ 8,232,001	$ 8,232,001	$ 8,232,001	$ 8,232,001
BOP MECHANICAL TOTAL	$ 15,100,000	$ 15,100,000	$ 15,100,000	$ 15,100,000
TOTAL MECHANICAL	$ 406,000,000	$ 474,000,000	$ 502,000,000	$ 445,000,000

Table 4-11 Electrical Sizing and Costs

OPTION	A1	B3	C3	D3
PT/MG COST				
UNIT CAPACITY	125.00	125.00	125.00	125.00
NUMBER OF UNITS	4	4	4	4
	1.0	1.0	1.0	1.0
BOP ELECTRICAL				
BALANCE OF PLANT COSTS (1)				
EMERGENCY GENERATOR (1)	$ 200,000	$ 200,000	$ 200,000	$ 200,000
STEP-UP TRANSFORMER UNIT COST	$ 1,500,000	$ 1,500,000	$ 1,500,000	$ 1,500,000
STEP-UP TRANSFORMER COST	$ 6,000,000	$ 6,000,000	$ 6,000,000	$ 6,000,000
BUS FROM XFMR TO SURFACE	$ 2,000,000	$ 2,000,000	$ 2,000,000	$ 2,000,000
ISOPHASE BUS - GEN TO TRANSFORMERS PER UNIT	$ 500,000	$ 500,000	$ 500,000	$ 500,000
ISOPHASE BUS DUCT $	$ 2,000,000	$ 2,000,000	$ 2,000,000	$ 2,000,000
SWITCHGEAR PER UNIT (16 kV)	$ 600,000	$ 600,000	$ 600,000	$ 600,000
SWITCHGEAR $	$ 2,400,000	$ 2,400,000	$ 2,400,000	$ 2,400,000
STATION SERVICE XFMR (1)	$ 200,000	$ 200,000	$ 200,000	$ 200,000
MOTOR CONTROL CENTER PER UNIT	$ 200,000	$ 200,000	$ 200,000	$ 200,000
MOTOR CONTROL CENTER COST	$ 800,000	$ 800,000	$ 800,000	$ 800,000
LV PANELS	$ 50,000	$ 50,000	$ 50,000	$ 50,000
NG AND LINE CUBICLES PER UNIT	$ 125,000	$ 125,000	$ 125,000	$ 125,000
NG AND LINE CUBICLES $	$ 500,000	$ 500,000	$ 500,000	$ 500,000
UPS EQUIPMENT	$ 250,000	$ 250,000	$ 250,000	$ 250,000
BATTERY AND CHARGER	$ 300,000	$ 300,000	$ 300,000	$ 300,000
SFC EQUIPMENT (PER UNIT)	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000
SFC EQUIPMENT COST $	$ 4,000,000	$ 4,000,000	$ 4,000,000	$ 4,000,000
CONTROL / PROT SYSTEM EQUIPMENT	$ 2,200,000	$ 2,200,000	$ 2,200,000	$ 2,200,000
TOTAL ELECT EQUIPMENT COST	$ 20,850,000	$ 20,850,000	$ 20,850,000	$ 20,850,000
ALLOWANCE FOR GROUNDING	$ 2,000,000	$ 2,000,000	$ 2,000,000	$ 2,000,000
ALLOWANCE FOR LIGHTING	$ 1,500,000	$ 1,500,000	$ 1,500,000	$ 1,500,000
ALLOWANCE FOR RACEWAY	25%	25%	25%	25%
ALLOWANCE FOR CABLE	40%	40%	40%	40%
RACEWAY COST $	$ 5,212,500	$ 5,212,500	$ 5,212,500	$ 5,212,500
CABLE COST $	$ 8,340,000	$ 8,340,000	$ 8,340,000	$ 8,340,000
TOTAL ELECTRICAL $	$ 38,500,000	$ 38,500,000	$ 38,500,000	$ 38,500,000

4.3.7 Access Roads

Access to the various sites was further defined under this TM. As shown on the detailed Site figures within Appendix A, roadways were identified to provide access for construction and long term operation of the facilities. Access would be required to the upper reservoir, access and cable tunnels, and the inlet/outlet structures. The figures show where existing roadways would be utilized versus where new roadways would have to be constructed. The criteria for the roadway locations and costing were based on the following parameters:

- Utilize existing roadways to the extent possible
- New roadways would be limited to a maximum grade of 20%
- Roadways would be obtained as easements
- Costs for new roadways was based on a $25 per linear foot
- Costs for existing roadways was based on $15 per linear foot as improvements to the existing roadways would likely be needed to handle the large construction equipment
- Roadways were assumed to be 20 feet wide

Table 4-12 presents the approximate length of roadway needed for each site and it's corresponding construction cost. It should be noted that these costs are rolled up into the road and sitework costs presented within the conceptual sizing and cost table (TS-2) within the technical summary section.

Table 4-12 Roadway Costs

SITE	NEW ROADWAY (FT)	EXISTING ROADWAY (FT)	COST
A	20,300	25,600	$892,000
B	25,200	8,900	$764,000
C	10,500	18,100	$534,000
D	9,100	9,300	$367,000

4.4 LAND ACQUISITION COST EVALUATION

Land cost fall into two categories – land and easement. Land purchase costs are assumed to be roughly $50,000/Acre. While each site alternative has slightly different land requirements, they are similar and a standard size of 120 acres was used uniformly for all sites. The total land cost for purchased land is approximately $6,000,000.

Easement purchase costs are assumed to be approximately $3,500/Acre based on recent easement acquisitions in similar areas by the Water Authority. Since easements will be needed for access roads to the upper reservoir, access and cable tunnels and inlet/outlet structure, as well as easements for all tunnel alignments, the total acreages for easements will vary for each site. The total easement acreage and cost determined for each Site is shown in Table 4-13. Roadway and tunnel easement widths are based upon a 30 foot width.

Table 4-13 Roadway and Tunnel Easement Costs

SITE	EASEMENT ACREAGE	COSTS
A	46.3	$162,000
B	29.2	$103,000
C	24.6	$87,000
D	15.3	$54,000

For the purposes of this TM, the land and easement acquisition is based on the assumption that all the land is owned by entities besides the City of San Diego, and thus, land and easements are required. This is a more conservative approach which is in line with this high level evaluation. As the project is further developed, land ownership should be better defined to determine which facilities fall within City owned land and costs adjusted accordingly.

4.5 PROJECT DEVELOPMENT COST EVALUATION

The following presents the estimated project development costs that were used to evaluate the alternative Project configurations and were used in the economic analysis for the Project as described later in this TM.

The costs presented are based on the parametric model and conceptual engineering described herein that include the following:

- Project construction and procurement cost
- Land acquisition costs as described in Section 4.4, above
- Allowance for engineering at 5% of direct cost
- Allowance for CM/Resident engineering of 5% of direct cost
- Allowance of $8,000,000 for licensing and permitting
- Allowance of $5,000,000 for power marketing

To the sum of the above cost, a 20% allowance for contingency was added.

The following are not included in the cost estimate and will be added in the economic analysis.

- Allowance for Funds Used During Construction
- Permanent financing
- Escalation
- Development fees

It should also be noted that no changes to the costs of the substation and electrical transmission system where identified under this work and the numbers presented within the previous Report were utilized. Table 4-14 summarizes the Direct Development Cost costs for each alternative.

Table 4-14 Project Development Costs

ALTERNATIVE NUMBER	PROJECT COST (2014 DOLLARS)
A1	$1,297,000,000
B3	$1,324,000,000
C3	$1,255,000,000
D3	$1,396,000,000

Based on the results of this Evaluation, all four alternatives are feasible from a purely technical point of view and can satisfy the 500 MW and 4,000 MW-hr storage requirements. From an economical point of view, the cost of the four alternatives is within approximately 10 percent of each other, which could be considered within the realm of the cost estimating accuracy for this Evaluation.

For comparison purposes, the associated sizing and cost tables for the two unit configuration for the four alternatives are provided in Appendix D. The costs for the two unit configuration are slightly less than the four unit configuration primarily due to the equipment and underground powerhouse costs for the different unit configurations.

5 Financial Statement

Based on the updated project configurations and associated costs presented above, Black & Veatch updated the high level pro forma financial projections from the original Study. Only capital and operations and maintenance costs were updated. All other assumptions from the original Study remain the same. As before, separate sets of financial projections were developed for the Low Value, Mid Value and High Value scenarios. Black & Veatch's EMP market projections cover the 2014 through 2038 period, so in the pro forma analysis, the study period was extended through 2050 by assuming that the year 2038 results repeat each year between 2039 and 2050.

As described in the original Study, the financial projections are stated from the perspective of an entity owning and operating the San Vicente Project. As such, the revenue projections underlying the financial projections are meant to reflect potential value that the project can bring to California power markets through the combined provision of capacity, ancillary services and energy market sales/arbitrage. Consistent with the revenue results shown in Table 5-1, the financial projections suggest that San Vicente has potential to bring significant value to California power markets, for the mid value and high value cases, in excess of the project's underlying capital and operating costs. Similar to the previous Report costs only associated with Alternative B3 where utilized for this updated financial evaluation.

Table 5-1 San Vicente Scenario Profitability Measures (2014$)

	LOW VALUE CASE ($000)	MID VALUE CASE ($000)	HIGH VALUE CASE ($000)
San Vicente Construction Cost ($Millions)	**$1,400**	**$1,324**	**$1,324**
Investment Requirements:			
Equity Investment	$756,155	$362,786	$147
Debt Investment	$756,155	$1,088,357	$1,473,621
Debt Ratio (Percent of Total Capital)	50%	75%	100%
Profitability Measures:			
NPV @ Real 2.54% discount rate	$415,397	$529,581	$843,553
NPV @ 3.19% After Tax WACC	$428,159	$498,799	$529,269
NPV @ Real 9.38% equity cost of capital	$256,368	$309,790	$427,768
Payback Period @ Real 2.54% discount rate	N/A	12[(1)] , 15[(2)] years	1[(1)] , 12[(2)] years
Payback Period @ 3.19% After Tax WACC	N/A	13[(1)] , 15[(2)] years	1[(1)] , 12[(2)] years
Payback Period @ Real 9.38% equity cost of capital	N/A	N/A	1[(1)] , 12[(2)] years

[(1)] Payback Period is the amount of time to generate enough revenue to recover your equity investment.

[(2)] Payback Period is the number of years required for the project to produce operating profit (earnings before interest and taxes) that are sufficient to recover the initial total investment.

From the Owner's perspectives, the financial statements and economic projections developed in the original Study and updated in this TM, suggest that the Project has potential to be a viable project in California's energy markets. There are uncertainties surrounding the demand for ancillary services and amount of revenue that can be captured by providing capacity services. There are also regulatory challenges that the Water Authority and City would face if it wanted to own and operate the Project themselves. As such, the most viable deal structure would likely include developing an investment partnership, or selling the offtake and operating rights of the project to a third-party energy company through a structured Power Purchase Agreement. Under such an arrangement, specific terms would be subject to negotiation. The Water Authority and City would have potential to recover its development and investment costs for the Project, plus some share of anticipated project value in excess of the underlying costs.

Results from the pro forma statements for the three scenarios are listed in Tables 5-2 through 5-4. In those tables, results are shown for every 5th year. More detailed results for each study year are available in Appendix B.

Table 5-2 San Vicente Pro Forma Financial Statement – Low Value Case

San Vicente Pro Forma Financial Projections - Initial and Every 5th Year

Low Value Case (2014$000)

	2022	2025	2030	2035	2040	2045	2050
Operating Revenues:							
Electric Sales Value	$13,752	$14,398	$14,421	$14,813	$15,385	$13,664	$12,137
Capacity Value	$69,438	$69,434	$69,438	$69,438	$66,221	$58,816	$52,239
Ancillary Services Value	$12,565	$13,066	$14,540	$15,811	$16,535	$14,686	$13,044
Other Revenue/Value	$0	$0	$0	$0	$0	$0	$0
Total Operating Revenue/Value	**$95,755**	**$96,898**	**$98,398**	**$100,062**	**$98,140**	**$87,166**	**$77,419**
Operating Expenses:							
Energy Pumping Cost	$7,962	$12,352	$20,403	$30,321	$34,442	$30,591	$27,170
Fixed O&M	$15,360	$15,360	$15,360	$15,360	$14,648	$13,010	$11,556
Variable O&M	$0	$0	$0	$0	$0	$0	$0
Total Operating Expenses	**$23,322**	**$27,712**	**$35,763**	**$45,681**	**$49,091**	**$43,601**	**$38,726**
Cash Available for Debt Service	$72,433	$69,185	$62,636	$54,381	$49,050	$43,565	$38,693
Senior Debt Service:							
Interest Payment for Tranche A	$34,286	$30,528	$24,529	$18,774	$13,166	$7,607	$1,994
Principal Payment for Tranche A	$8,522	$9,340	$10,881	$12,676	$14,767	$17,203	$20,041
Total Senior Debt Service	$42,808	$39,868	$35,410	$31,450	$27,933	$24,810	$22,035
Cash Available for Subordinate Debt Service	$29,625	$29,318	$27,226	$22,931	$21,116	$18,755	$16,658
Subordinate Debt Service:							
Interest Payment for Tranche C	$0	$0	$0	$0	$0	$0	$0
Principal Payment for Tranche C	$0	$0	$0	$0	$0	$0	$0
Other Fees for Tranche C	$0	$0	$0	$0	$0	$0	$0
Total Subordinate Debt Service	$0	$0	$0	$0	$0	$0	$0
Cash Flow Net Total Debt Service	**$29,625**	**$29,318**	**$27,226**	**$22,931**	**$21,116**	**$18,755**	**$16,658**
Income Taxes	-$9,492	-$7,565	-$5,183	-$3,887	-$1,718	$14,642	$14,944
After-Tax Operating Cash Flow	$39,117	$36,883	$32,409	$26,817	$22,834	$4,113	$1,714
After Tax Interest Income	$823	$852	$819	$803	$771	$685	$608
Net Reserve Fund Transfers	-$3,420	-$308	-$358	-$591	$0	$0	$0
After Tax Cash Flow / Funds	**$36,520**	**$37,426**	**$32,871**	**$27,029**	**$23,606**	**$4,798**	**$2,322**
Annual Debt Service Coverage Ratios:							
Senior Debt	2.99	2.93	2.93	2.85	2.89	2.89	2.89
Subordinate Debt	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total Annual Debt Service Coverage Ratio	**2.99**	**2.93**	**2.93**	**2.85**	**2.89**	**2.89**	**2.89**
After Tax Cash Flow Distribution:							
Equity Investor 1	$36,520	$37,426	$32,871	$27,029	$23,606	$4,798	$2,322
Cumulative After Tax Cash Flow	**$36,520**	**$150,726**	**$323,336**	**$471,366**	**$596,890**	**$641,773**	**$658,344**

Equity Investment	**$756,155**
Debt Investment	**$756,155**
Debt Ratio (Percent of Total Capital)	**50%**
Profitability Measures:	
NPV @ Real 2.54% discount rate	$415,397
NPV @ 2.18% After Tax WACC	$428,159
NPV @ Real 9.38% equity cost of capital	$256,368
Payback Period @ Real 2.54% discount rate	#N/A
Payback Period @ 2.18% After Tax WACC	#N/A
Payback Period @ Real 9.38% equity cost of capital	#N/A
Payback Period (Recovery of Initial Investment)	28
IRR	-1.0%
Real Discount Rate	2.5%
Real Equity Cost Rate	9.4%
Fixed Charge Rate	

San Vicente Revenue/Operations Assumptions	
Case	Low Value
Capacity Revenue Basis	F Class GT
Percent of Potential Ancillary Services Sales Volume	30%
San Vicente Construction Cost (Million)	$1,400

Table 5-3 San Vicente Pro Forma Financial Statement – Mid Value Case

San Vicente Pro Forma Financial Projections - Initial and Every 5th Year

Mid Value Case (2014$000)

	2022	2025	2030	2035	2040	2045	2050
Operating Revenues:							
Electric Sales Value	$13,752	$14,398	$14,421	$14,813	$15,385	$13,664	$12,137
Capacity Value	$89,173	$88,498	$90,246	$90,669	$87,135	$77,392	$68,737
Ancillary Services Value	$25,130	$26,132	$29,079	$31,622	$33,070	$29,372	$26,087
Other Revenue/Value	$0	$0	$0	$0	$0	$0	$0
Total Operating Revenue/Value	**$128,055**	**$129,028**	**$133,746**	**$137,104**	**$135,590**	**$120,428**	**$106,961**
Operating Expenses:							
Energy Pumping Cost	$7,962	$12,352	$20,403	$30,321	$34,442	$30,591	$27,170
Fixed O&M	$15,360	$15,360	$15,360	$15,360	$14,648	$13,010	$11,556
Variable O&M	$0	$0	$0	$0	$0	$0	$0
Total Operating Expenses	**$23,322**	**$27,712**	**$35,763**	**$45,681**	**$49,091**	**$43,601**	**$38,726**
Cash Available for Debt Service	$104,734	$101,316	$97,983	$91,423	$86,499	$76,826	$68,236
Senior Debt Service:							
Interest Payment for Tranche A	$53,850	$48,126	$38,938	$30,039	$21,256	$12,404	$3,288
Principal Payment for Tranche A	$11,208	$12,464	$14,878	$17,758	$21,197	$25,302	$30,201
Total Senior Debt Service	$65,059	$60,591	$53,815	$47,798	$42,453	$37,706	$33,489
Cash Available for Subordinate Debt Service	$39,675	$40,725	$44,168	$43,625	$44,046	$39,121	$34,746
Subordinate Debt Service:							
Interest Payment for Tranche C	$0	$0	$0	$0	$0	$0	$0
Principal Payment for Tranche C	$0	$0	$0	$0	$0	$0	$0
Other Fees for Tranche C	$0	$0	$0	$0	$0	$0	$0
Total Subordinate Debt Service	$0	$0	$0	$0	$0	$0	$0
Cash Flow Net Total Debt Service	**$39,675**	**$40,725**	**$44,168**	**$43,625**	**$44,046**	**$39,121**	**$34,746**
Income Taxes	-$3,049	-$477	$4,382	$7,533	$11,057	$26,233	$26,447
After-Tax Operating Cash Flow	$42,724	$41,203	$39,785	$36,092	$32,989	$12,888	$8,300
After Tax Interest Income	$1,213	$1,214	$1,141	$1,089	$1,025	$911	$809
Net Reserve Fund Transfers	-$3,420	-$308	-$358	-$591	$0	$0	$0
After Tax Cash Flow / Funds	**$40,517**	**$42,109**	**$40,569**	**$36,590**	**$34,014**	**$13,799**	**$9,109**
Annual Debt Service Coverage Ratios:							
Senior Debt	2.99	2.93	2.93	2.85	2.89	2.89	2.89
Subordinate Debt	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total Annual Debt Service Coverage Ratio	**2.99**	**2.93**	**2.93**	**2.85**	**2.89**	**2.89**	**2.89**
After Tax Cash Flow Distribution:							
Equity Investor 1	$40,517	$42,109	$40,569	$36,590	$34,014	$13,799	$9,109
Cumulative After Tax Cash Flow	**$40,517**	**$168,275**	**$373,858**	**$566,623**	**$745,725**	**$839,251**	**$894,187**

Equity Investment	**$362,786**
Debt Investment	**$1,088,357**
Debt Ratio (Percent of Total Capital)	**75%**
Profitability Measures:	
NPV @ Real 2.54% discount rate	$529,581
NPV @ 3.19% After Tax WACC	$498,799
NPV @ Real 9.38% equity cost of capital	$309,790
Payback Period @ Real 2.54% discount rate	12
Payback Period @ 3.19% After Tax WACC	13
Payback Period @ Real 9.38% equity cost of capital	#N/A
Payback Period (Recovery of Initial Investment)	15
IRR	10.0%
Real Discount Rate	2.5%
Real Equity Cost Rate	9.4%
Fixed Charge Rate	

San Vicente Revenue/Operations Assumptions	
Case	Mid Value
Capacity Revenue Basis	Mid-Point of High and Low Value
Percent of Potential Ancillary Services Sales Volume	60%
San Vicente Construction Cost ($Million)	$1,324

Table 5-4 San Vicente Pro Forma Financial Statement – High Value Case

San Vicente Pro Forma Financial Projections - Initial and Every 5th Year

High Value Case (2014$)

	2022	2025	2030	2035	2040	2045	2050
Operating Revenues:							
Electric Sales Value	$13,752	$14,398	$14,421	$14,813	$15,385	$13,664	$14,672
Capacity Value	$108,909	$107,563	$111,054	$111,900	$108,049	$95,967	$103,044
Ancillary Services Value	$37,695	$39,198	$43,619	$47,433	$49,604	$44,058	$47,306
Other Revenue/Value	$0	$0	$0	$0	$0	$0	$0
Total Operating Revenue/Value	**$160,356**	**$161,159**	**$169,094**	**$174,145**	**$173,039**	**$153,689**	**$165,023**
Operating Expenses:							
Energy Pumping Cost	$7,962	$12,352	$20,403	$30,321	$34,442	$30,591	$32,847
Fixed O&M	$15,360	$15,360	$15,360	$15,360	$14,648	$13,010	$13,970
Variable O&M	$0	$0	$0	$0	$0	$0	$0
Total Operating Expenses	**$23,322**	**$27,712**	**$35,763**	**$45,681**	**$49,091**	**$43,601**	**$46,817**
Cash Available for Debt Service	$137,034	$133,447	$133,331	$128,465	$123,948	$110,088	$118,206
Senior Debt Service:							
Interest Payment for Tranche A	$79,010	$70,856	$57,701	$44,852	$32,013	$18,866	$26,811
Principal Payment for Tranche A	$13,849	$15,627	$19,110	$23,370	$28,580	$34,952	$30,976
Total Senior Debt Service	$92,859	$86,482	$76,812	$68,222	$60,594	$53,818	$57,787
Cash Available for Subordinate Debt Service	$44,175	$46,964	$56,519	$60,242	$63,354	$56,270	$60,419
Subordinate Debt Service:							
Interest Payment for Tranche C	$0	$0	$0	$0	$0	$0	$0
Principal Payment for Tranche C	$0	$0	$0	$0	$0	$0	$0
Other Fees for Tranche C	$0	$0	$0	$0	$0	$0	$0
Total Subordinate Debt Service	$0	$0	$0	$0	$0	$0	$0
Cash Flow Net Total Debt Service	**$44,175**	**$46,964**	**$56,519**	**$60,242**	**$63,354**	**$56,270**	**$60,419**
Income Taxes	$0	$0	$0	$0	$0	$0	$0
After-Tax Operating Cash Flow	$44,175	$46,964	$56,519	$60,242	$63,354	$56,270	$60,419
After Tax Interest Income	$1,699	$1,667	$1,544	$1,446	$1,343	$1,193	$1,281
Net Reserve Fund Transfers	-$3,420	-$308	-$358	-$591	$0	$0	$0
After Tax Cash Flow / Funds	**$42,454**	**$48,324**	**$57,705**	**$61,097**	**$64,697**	**$57,463**	**$61,700**
Annual Debt Service Coverage Ratios:							
Senior Debt	2.99	2.93	2.93	2.85	2.89	2.89	2.89
Subordinate Debt	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total Annual Debt Service Coverage Ratio	**2.99**	**2.93**	**2.93**	**2.85**	**2.89**	**2.89**	**2.89**
After Tax Cash Flow Distribution:							
Equity Investor 1	$42,454	$48,324	$57,705	$61,097	$64,697	$57,463	$61,700
Cumulative After Tax Cash Flow	**$42,454**	**$184,881**	**$455,144**	**$758,013**	**$1,086,413**	**$1,387,852**	**$1,211,293**

Equity Investment	**$147**
Debt Investment	**$1,473,621**
Debt Ratio (Percent of Total Capital)	**100%**
Profitability Measures:	
NPV @ Real 2.54% discount rate	$843,553
NPV @ 6.93% After Tax WACC	$529,269
NPV @ Real 9.38% equity cost of capital	$427,768
Payback Period @ Real 2.54% discount rate	1
Payback Period @ 6.93% After Tax WACC	1
Payback Period @ Real 9.38% equity cost of capital	1
Payback Period (Recovery of Initial Investment)	12
IRR	28817.0%
Real Discount Rate	2.5%
Real Equity Cost Rate	9.4%
Fixed Charge Rate	

San Vicente Revenue/Operations Assumptions	
Case	High Value
Capacity Revenue Basis	LMS 100
Percent of Potential Ancillary Services Sales Volume	90%
San Vicente Construction Cost (Million)	$1,324

6 Summary

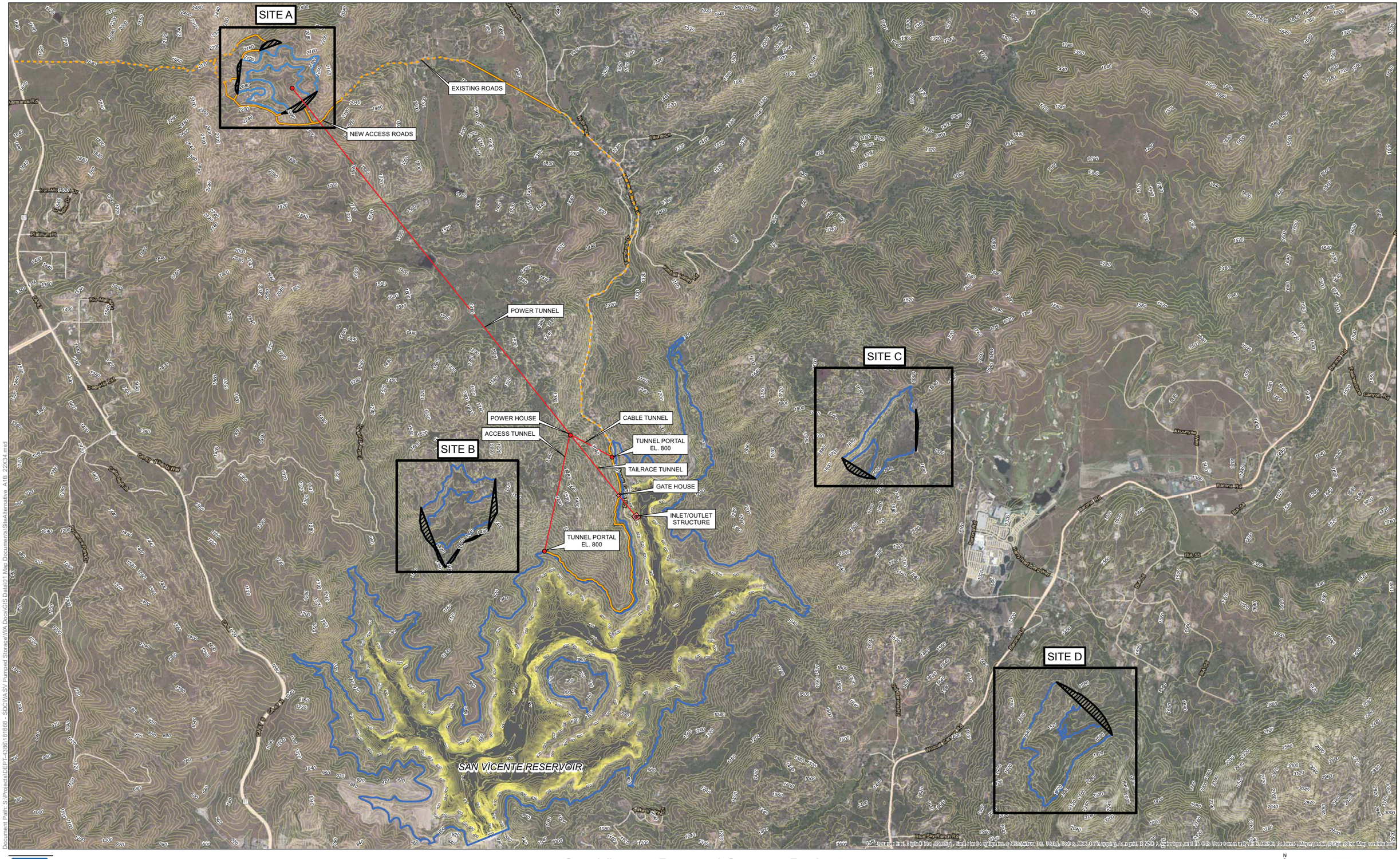
Based upon the findings presented within this TM, the Project appears to meet the primary objectives as summarized below:

- The Project appears to be able to co-exist with the City's planned Pure Water Program at San Vicente Reservoir
- The Project can be operated over a wide range of water reservoir levels within the Reservoir
- Utilizing multiple turbine units with varying capacity would be a viable option to provide greater value to the Project in terms of operating flexibility
- Updated costs associated with the revisions noted in this TM indicate the Project is still a very viable project within the California energy market

Based on discussion with the Water Authority and City staff, the next steps for the Project, based upon the information presented within this TM, include the following:

- Present the modeling results to the Pure Water Program Independent Advisory Panel to discuss thoughts/concerns regarding regulatory approval for the Pure Water Program if the San Vicente Pumped Storage Project is developed and utilized at the Reservoir.
- Present the findings of the modeling and the addition technical evaluations of this TM to the Water Authority's Board and City of San Diego's City Council
- Perform additional work on the Project to aid the Water Authority and City in obtaining the renewed FERC Preliminary Permit (permit obtained in May 2015)

APPENDIX A – SITE FIGURES



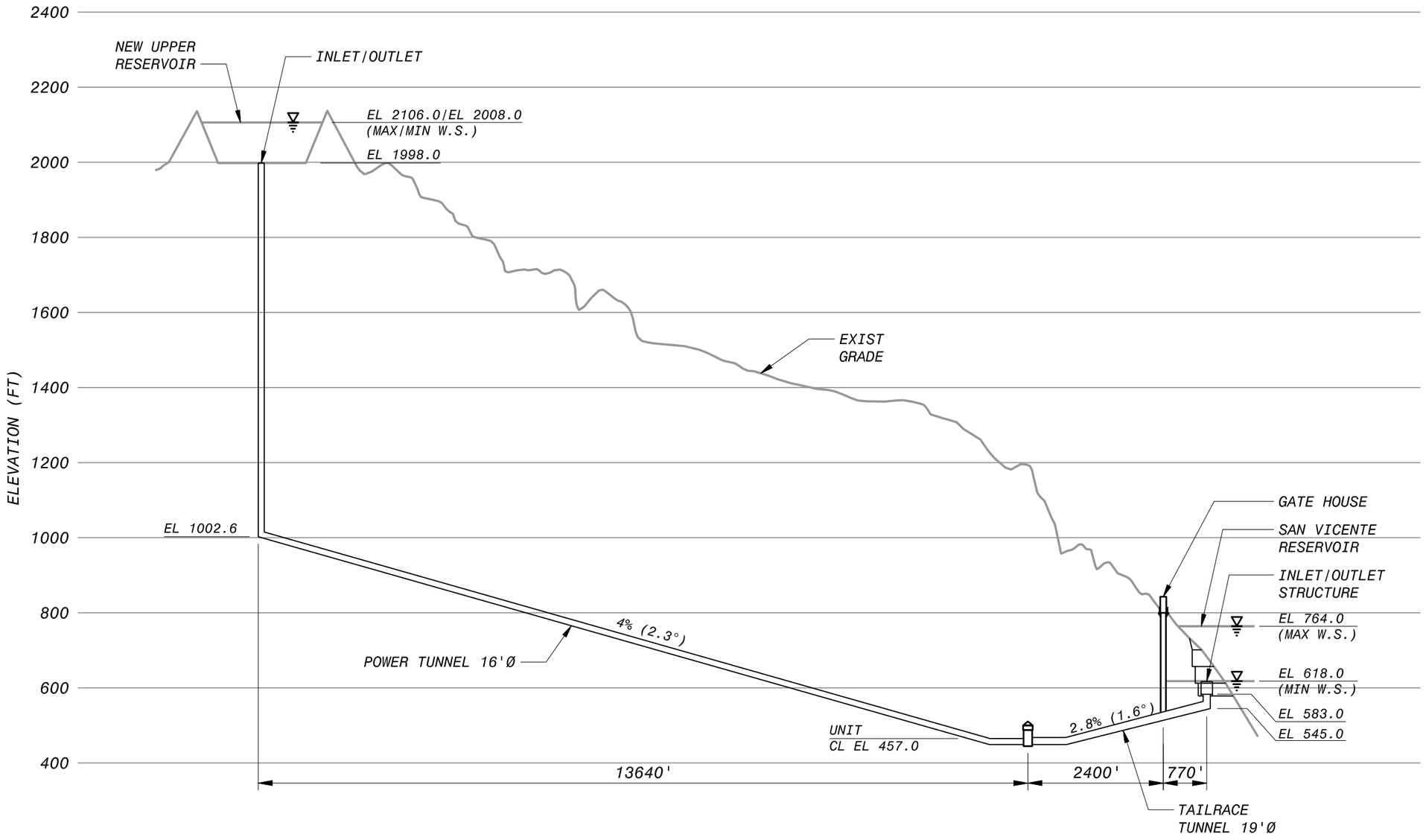
Document Path: S:\Projects\DEPT-438\181868 - SDCWA SV Pumped Storage\WA Docs\GIS Data\01 Map Documents\SiteAlternative_A1B_22X34.mxd

San Vicente Pumped Storage Project
Site Alternative A-1B

N

1 inch = 1,333 feet

0 1,650 3,300 6,600 Feet



300' 100' 0 300' 600'

200'

VERT: 1"=300'

2000' 1000' 0 2000' 4000'

HORIZ: 1"=2000'

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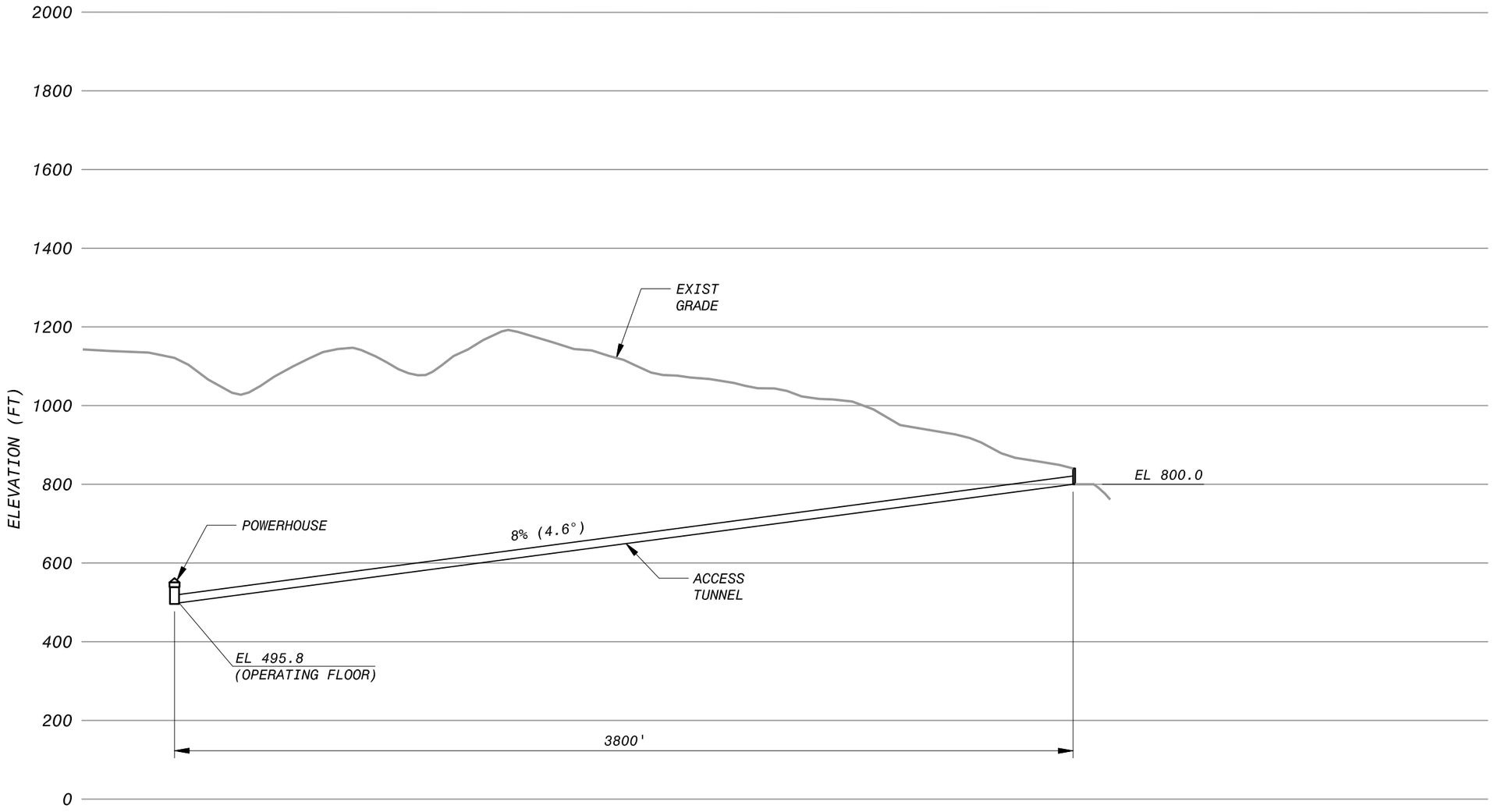
PROJECT 181868

SAN VICENTE PUMPED STORAGE PROJECT

SITE A
PROFILE - WATER CONVEYANCE SYSTEM

FIGURE

A-1B



300' 100' 0 300' 600'

200'

VERT: 1"=300'

500' 250' 0 500' 1000'

HORIZ: 1"=500'

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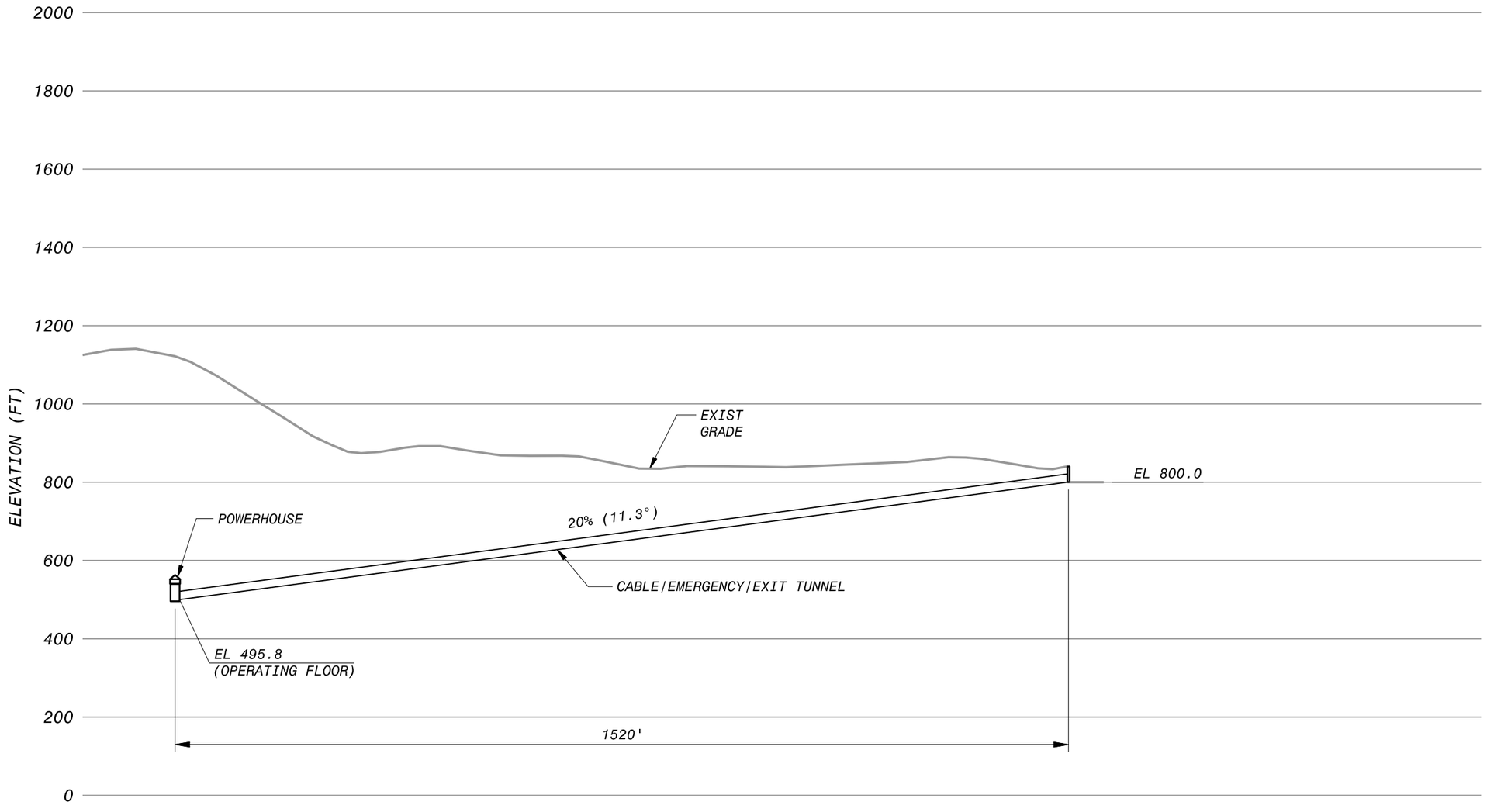
PROJECT
181868

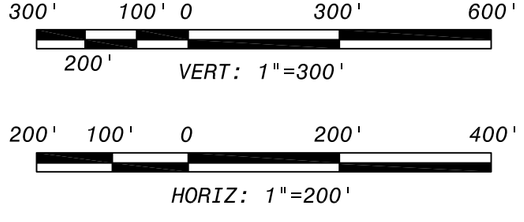
SAN VICENTE PUMPED STORAGE PROJECT

SITE A
PROFILE - ACCESS TUNNEL

FIGURE

A-2





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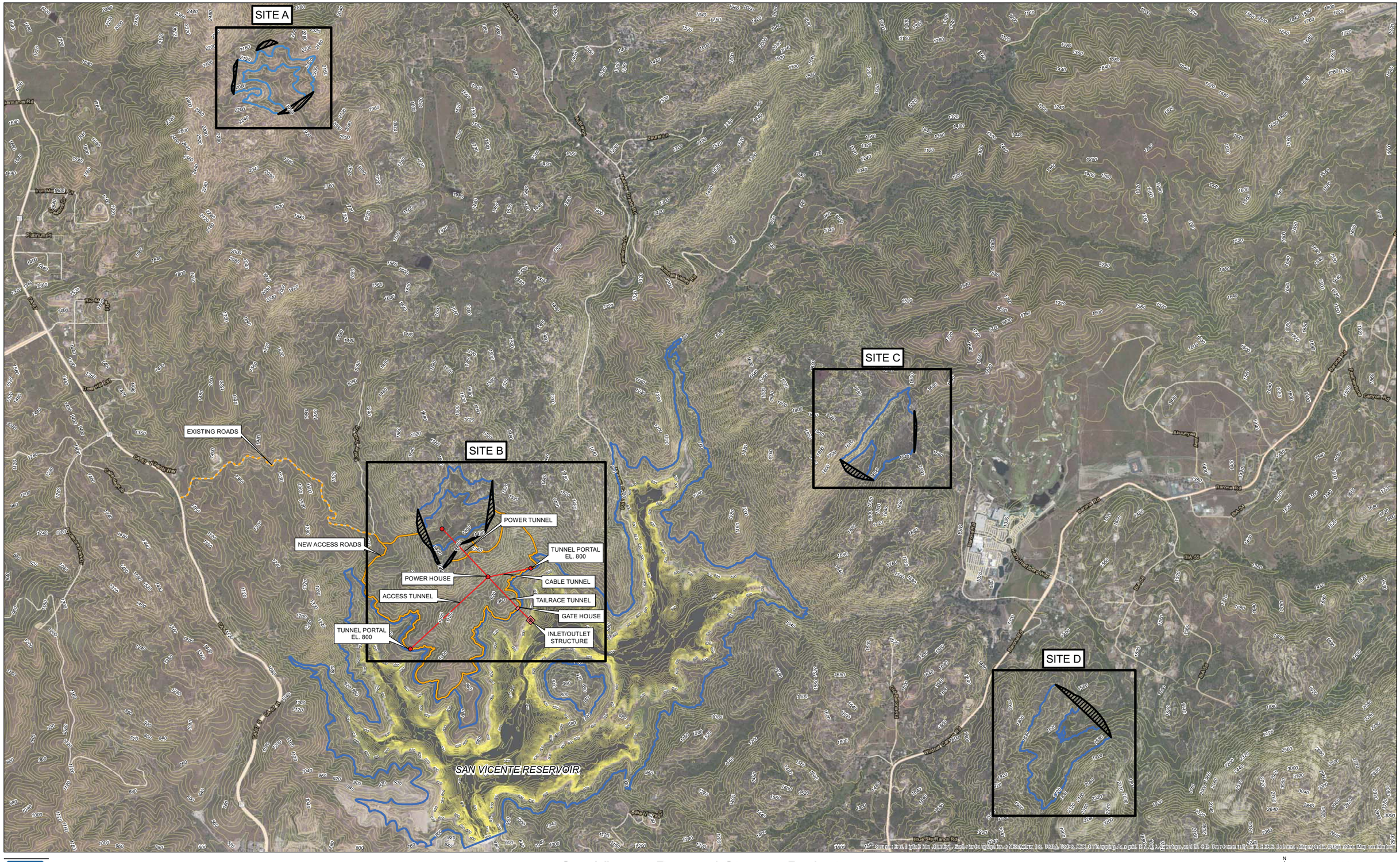
PROJECT
181868

SAN VICENTE PUMPED STORAGE PROJECT

SITE A
PROFILE - CABLE/EMERGENCY/EXIT TUNNEL

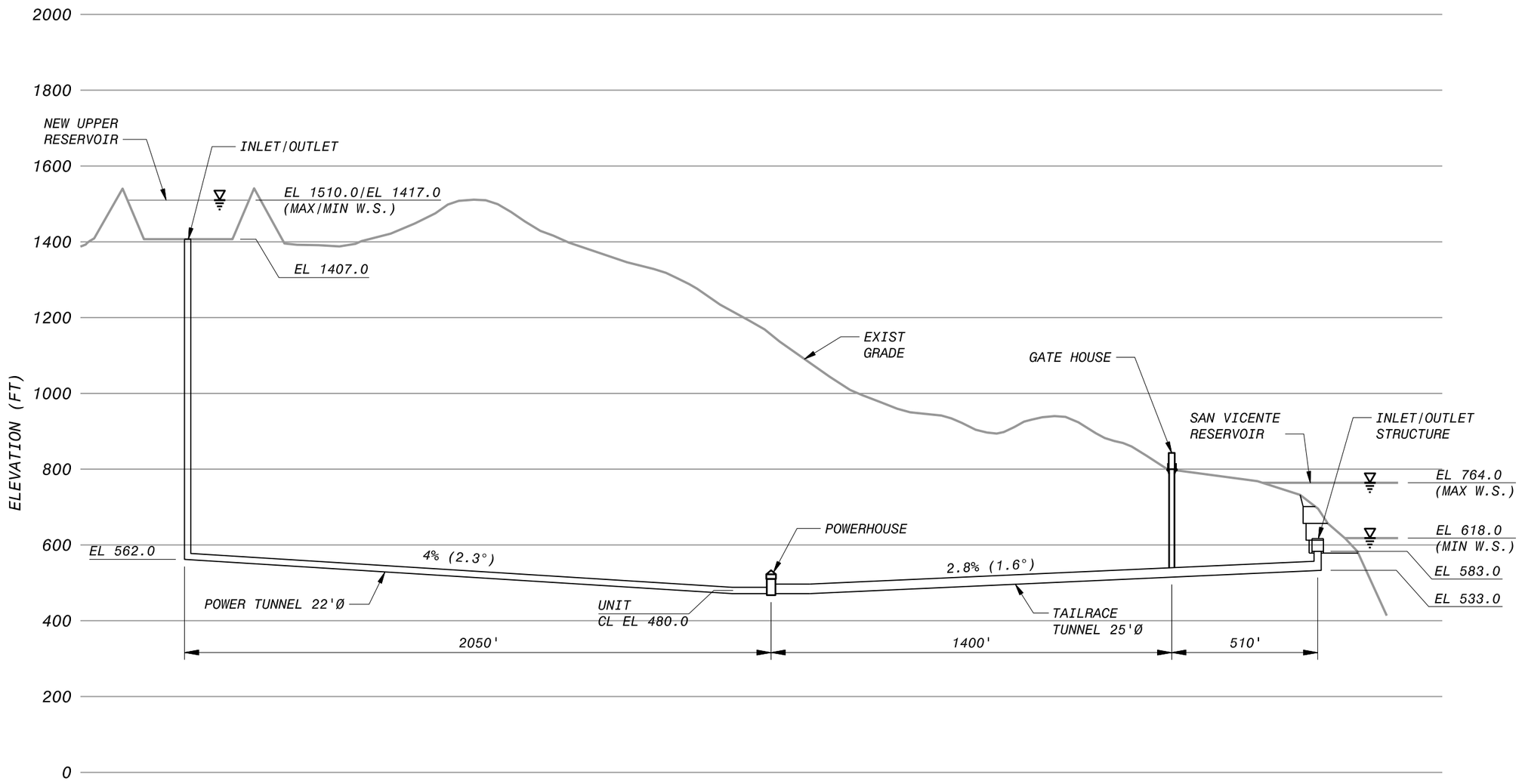
FIGURE
A-3



San Vicente Pumped Storage Project
Site Alternative B-3B

1 inch = 1,333 feet

0 1,650 3,300 6,600 Feet



300' 100' 0 300' 600'

200'

VERT: 1"=300'

400' 200' 0 400' 800'

HORIZ: 1"=400'

BLACK & VEATCH Corporation

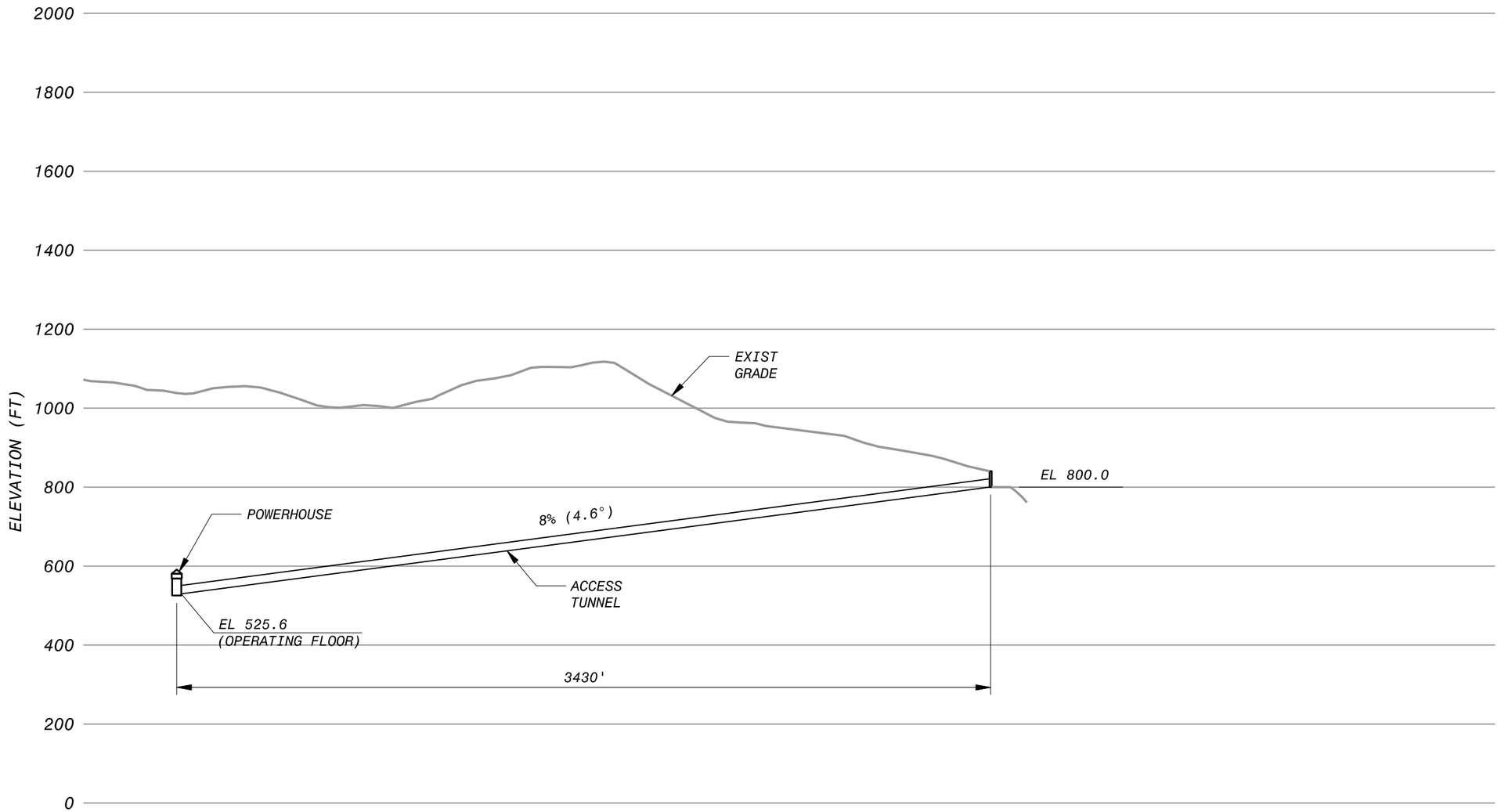
PROJECT 181868

SAN VICENTE PUMPED STORAGE PROJECT

SITE B3
PROFILE - WATER CONVEYANCE SYSTEM

FIGURE

B3-1B



300' 100' 0 300' 600'

200'

VERT: 1"=300'

500' 250' 0 500' 1000'

HORIZ: 1"=500'

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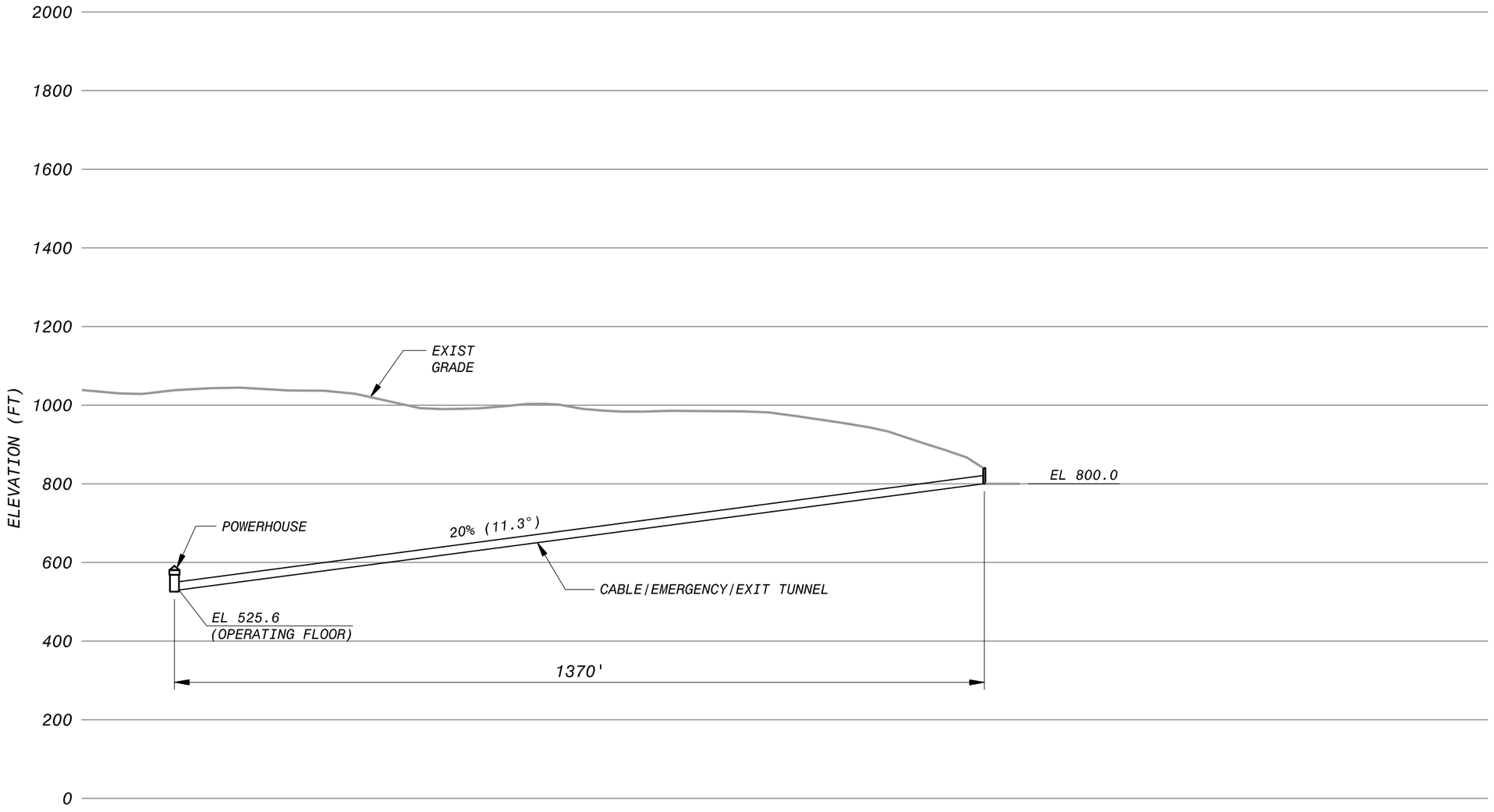
PROJECT
181868

SAN VICENTE PUMPED STORAGE PROJECT

STIE B3
PROFILE - ACCESS TUNNEL

FIGURE

B3-2



300' 100' 0 300' 600'

200'

VERT: 1"=300'

200' 100' 0 200' 400'

HORIZ: 1"=200'

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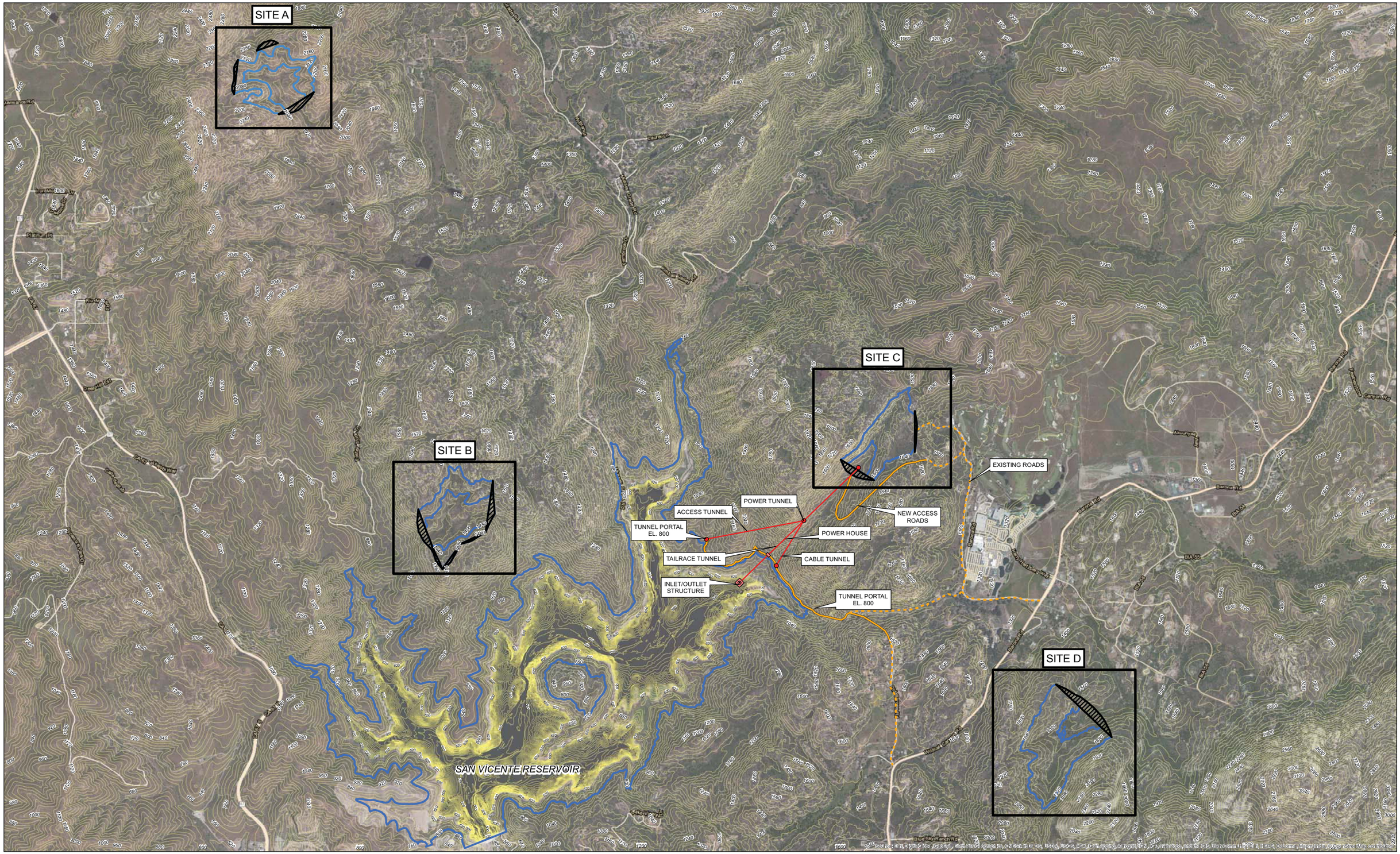
PROJECT
181868

SAN VICENTE PUMPED STORAGE PROJECT

SITE B3
PROFILE - CABLE/EMERGENCY/EXIT TUNNEL

FIGURE

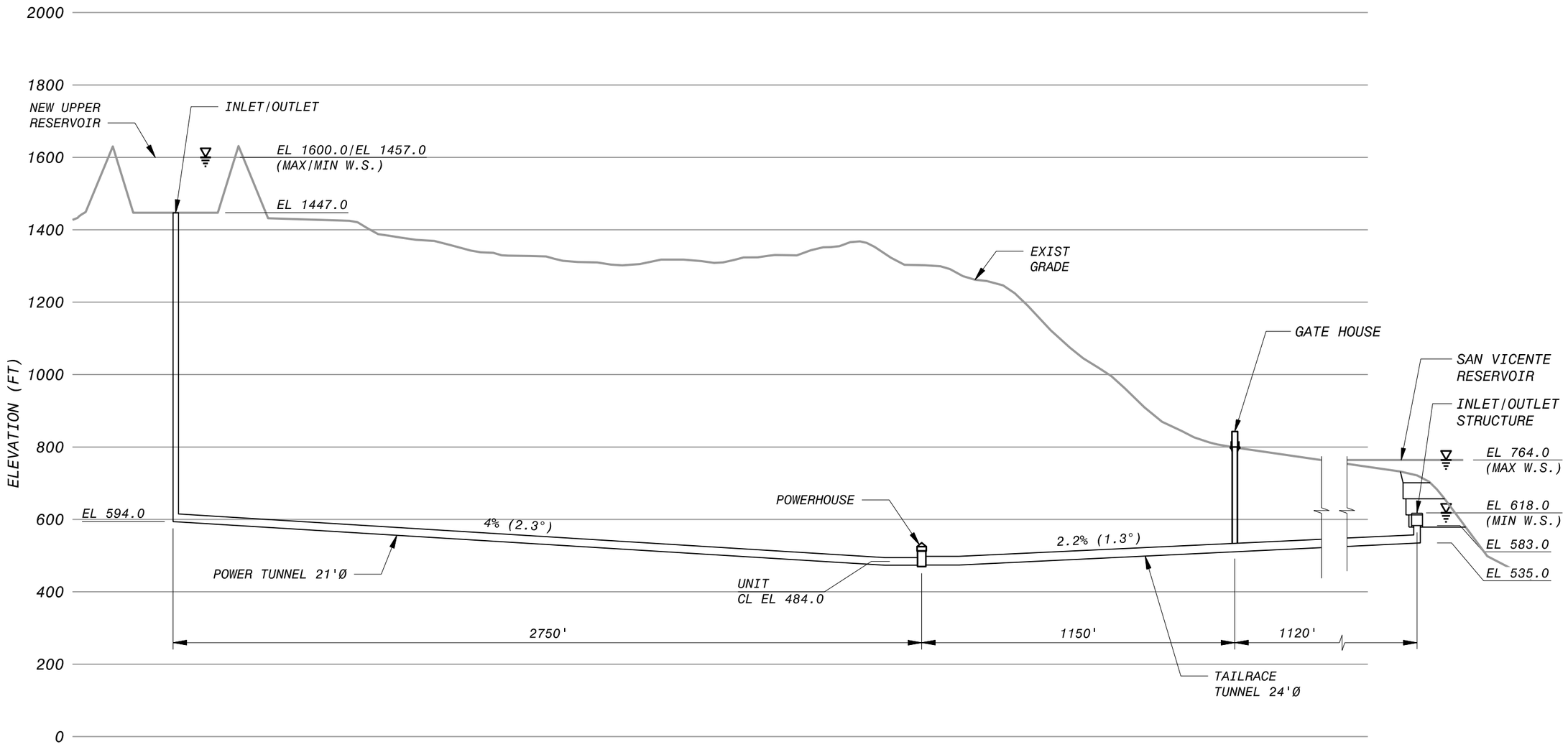
B3-3



San Vicente Pumped Storage Project
Site Alternative C3-B

1 inch = 1,333 feet

0 1,650 3,300 6,600 Feet



300' 100' 0 300' 600'

200'

VERT: 1"=300'

400' 200' 0 400' 800'

HORIZ: 1"=400'

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PROJECT 181868

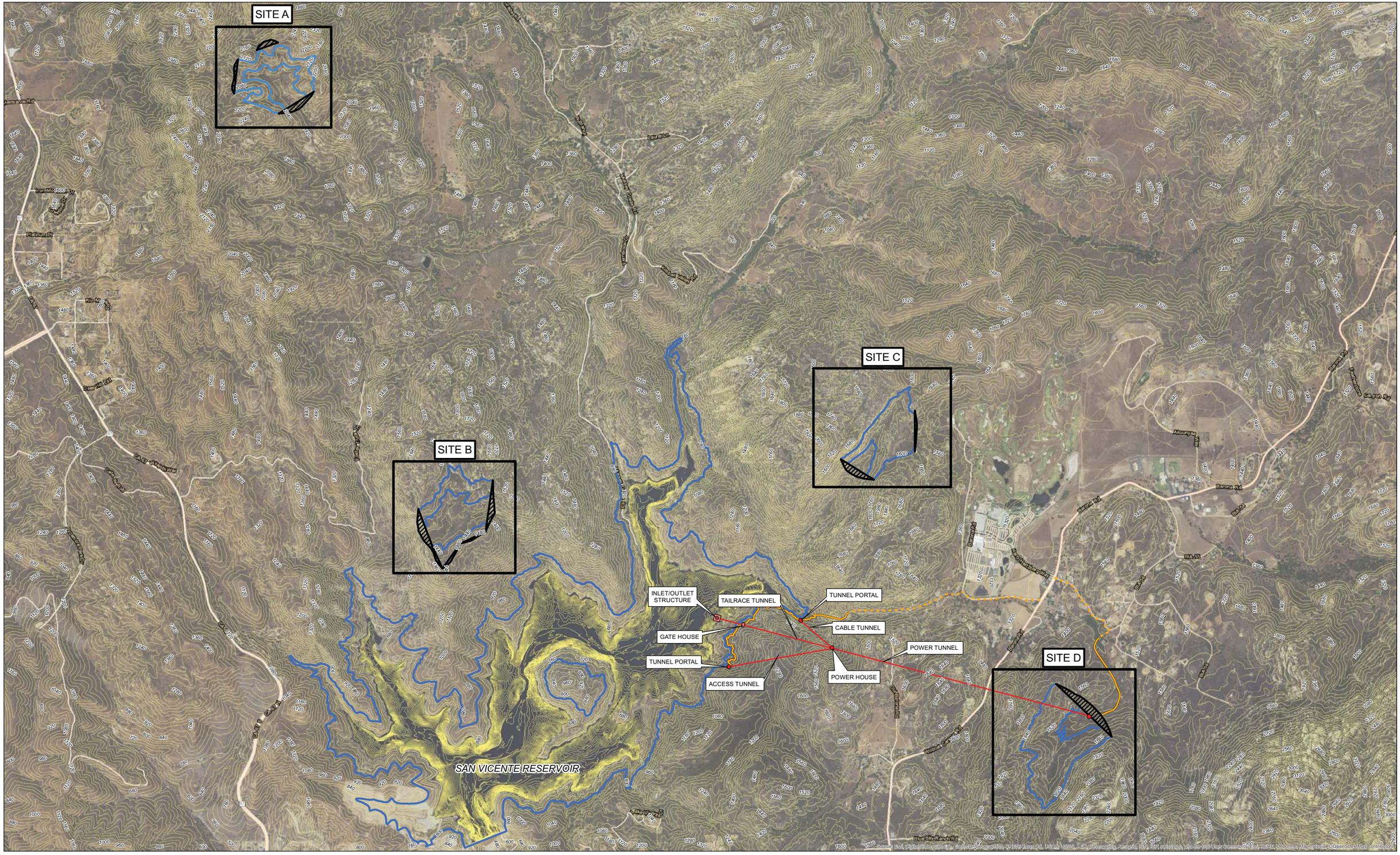
SAN VICENTE PUMPED STORAGE PROJECT

SITE C3

PROFILE - WATER CONVEYANCE SYSTEM

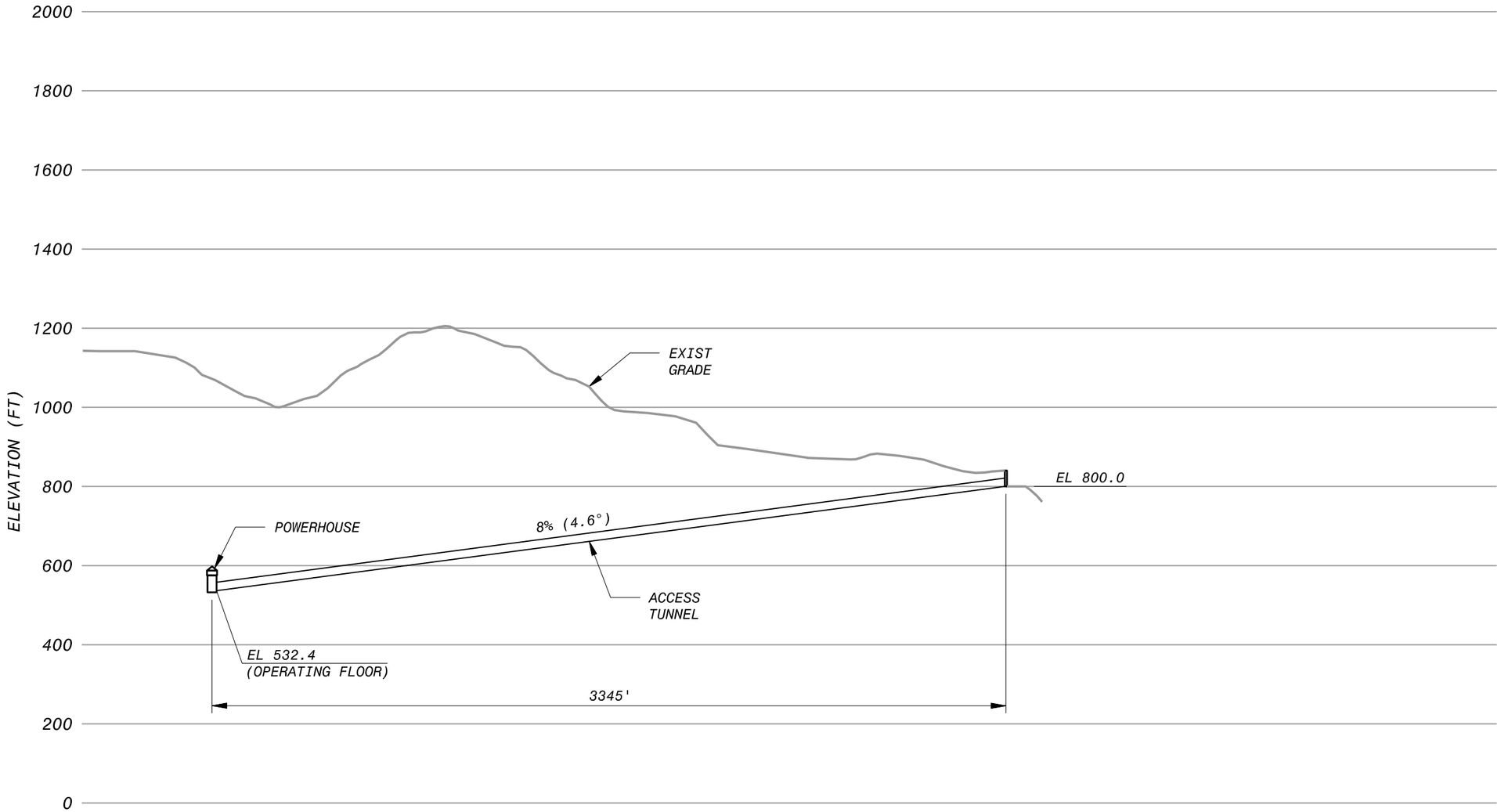
FIGURE

C3-1B



San Vicente Pumped Storage Project
Site Alternative D-3B

0 1,650 3,300 6,600 Feet



300' 100' 0 300' 600'

200'

VERT: 1"=300'

500' 250' 0 500' 1000'

1"=500'

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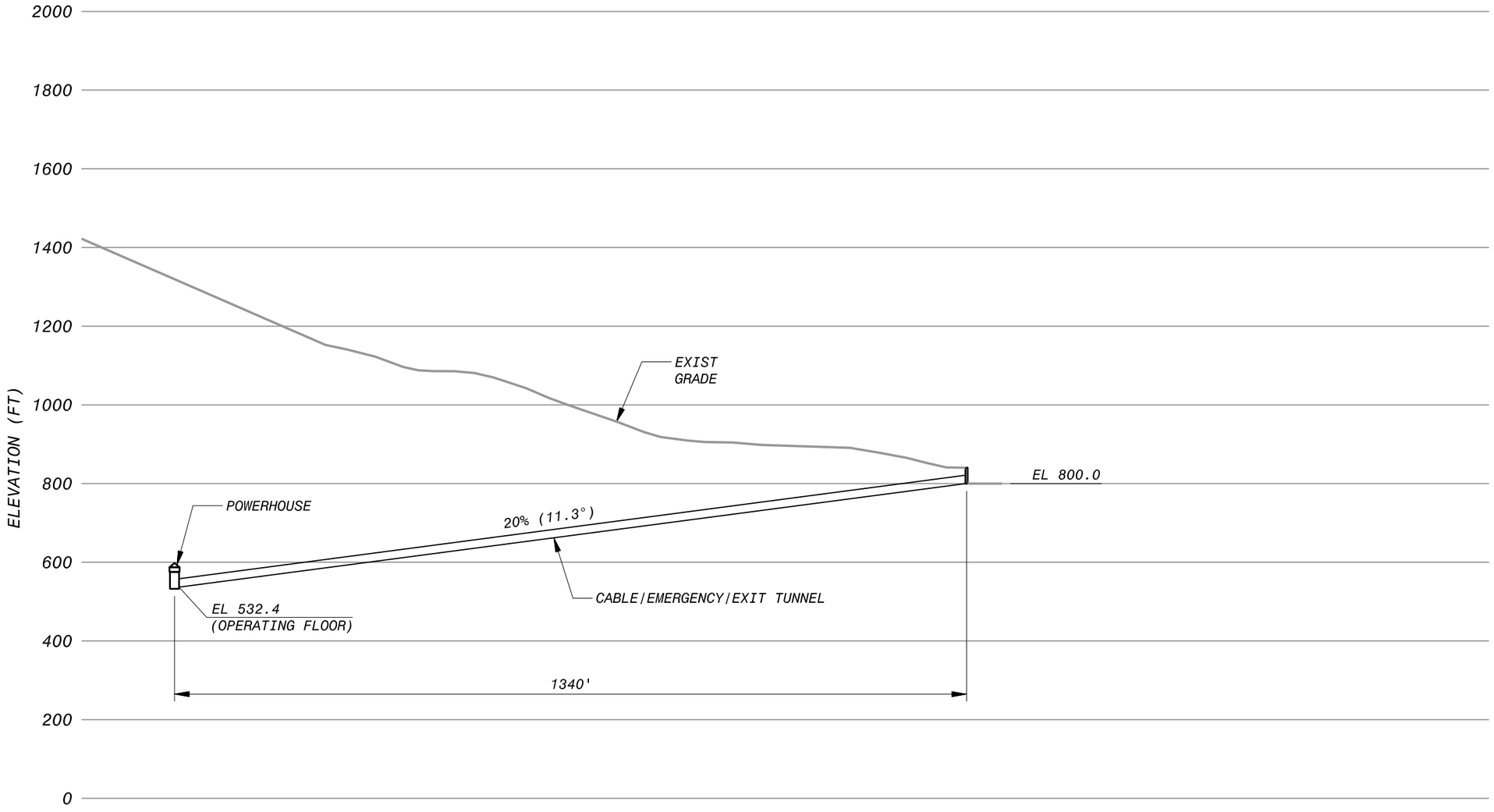
PROJECT
181868

SAN VICENTE PUMPED STORAGE PROJECT

SITE C3
PROFILE - ACCESS TUNNEL

FIGURE

C3-2



300' 100' 0 300' 600'

200'

VERT: 1"=300'

200' 100' 0 200' 400'

HORIZ: 1"=200'

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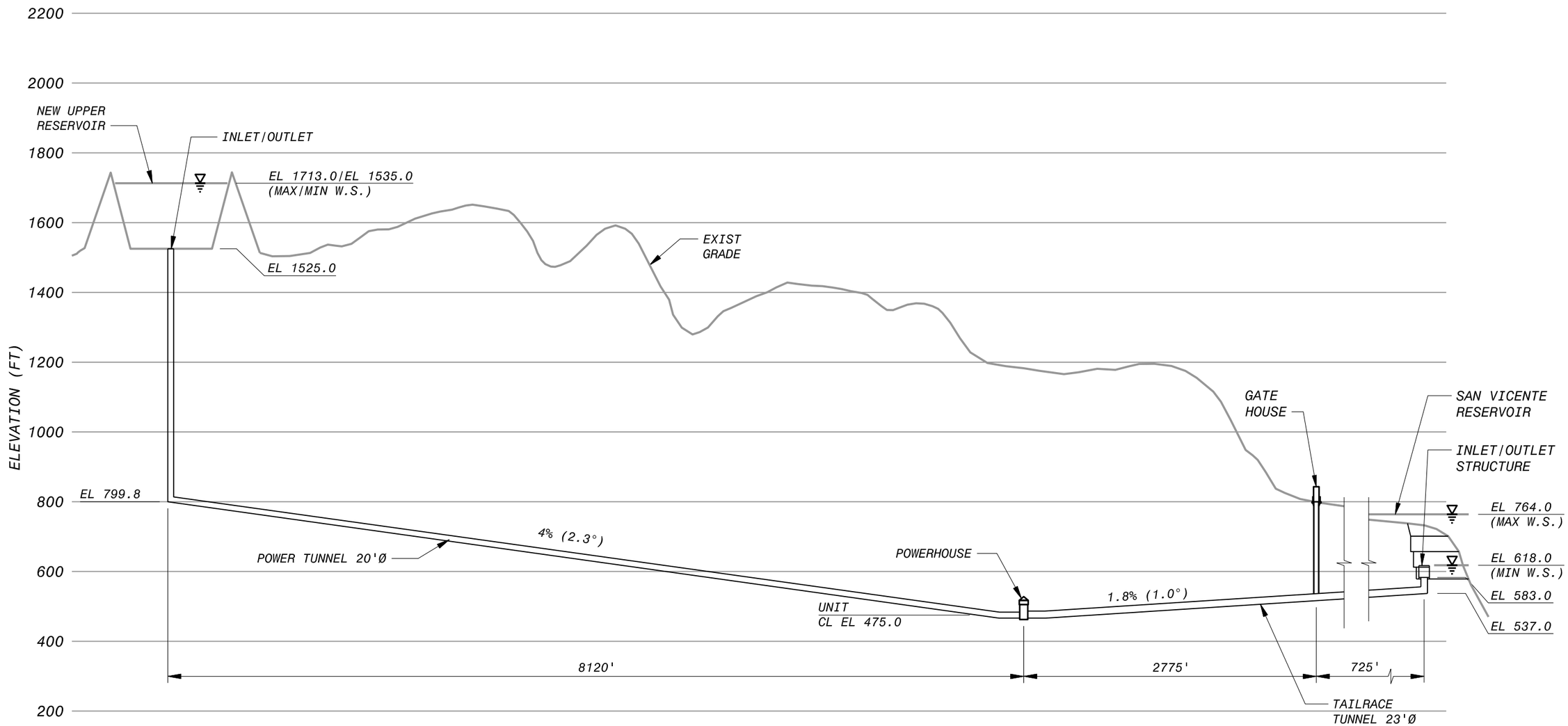
PROJECT
181868

SAN VICENTE PUMPED STORAGE PROJECT

SITE C3
PROFILE - CABLE/EMERGENCY/EXIT TUNNEL

FIGURE
C3-3



300' 100' 0 300' 600'

200'

VERT: 1"=300'

1000' 500' 0 1000' 2000'

HORIZ: 1"=1000'

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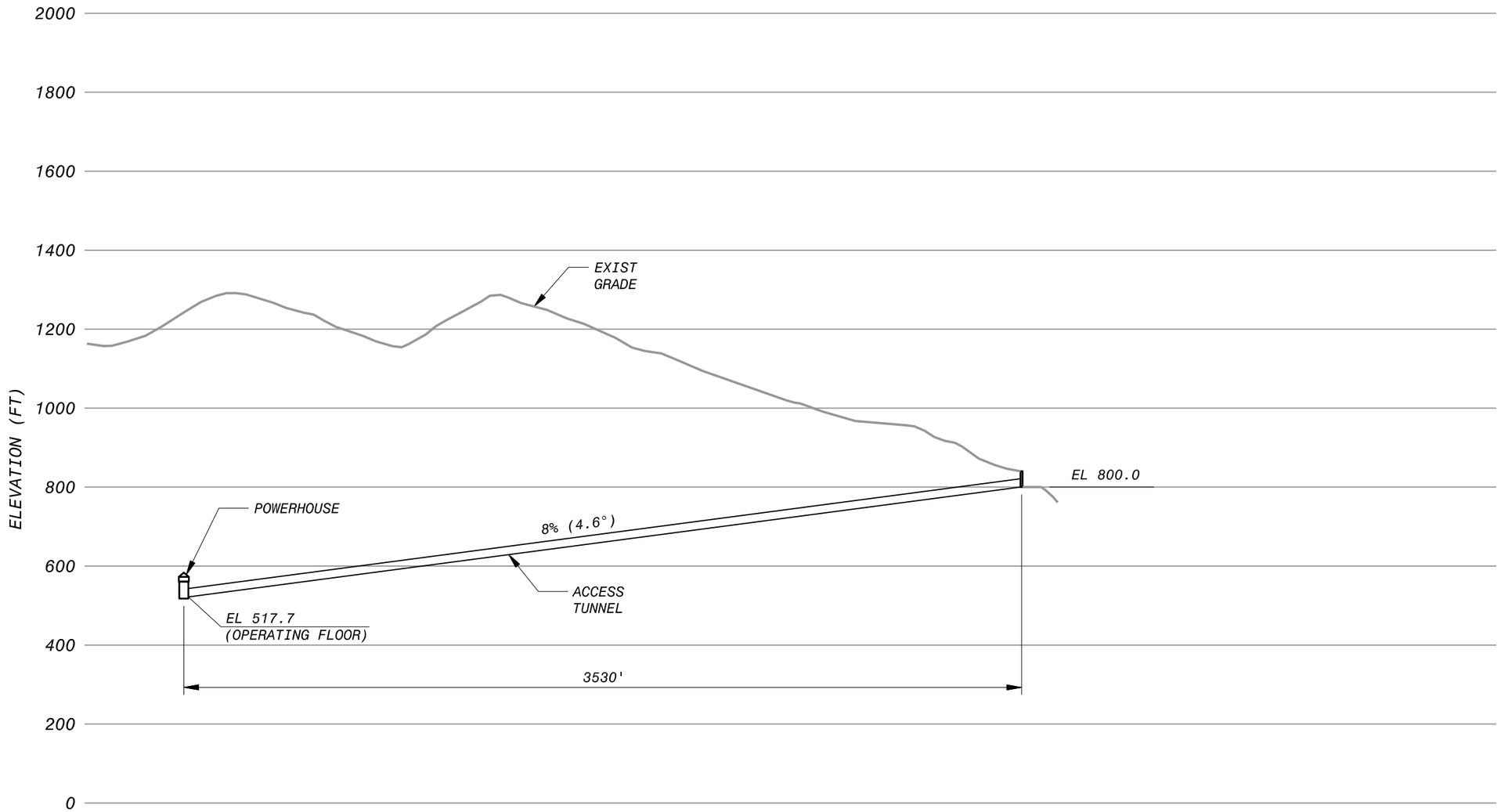
PROJECT 181868

SAN VICENTE PUMPED STORAGE PROJECT

SITE D3
PROFILE - WATER CONVEYANCE SYSTEM

FIGURE D3-1B



300' 100' 0 300' 600'

200'

VERT: 1"=300'

500' 250' 0 500' 1000'

HORIZ: 1"=500'

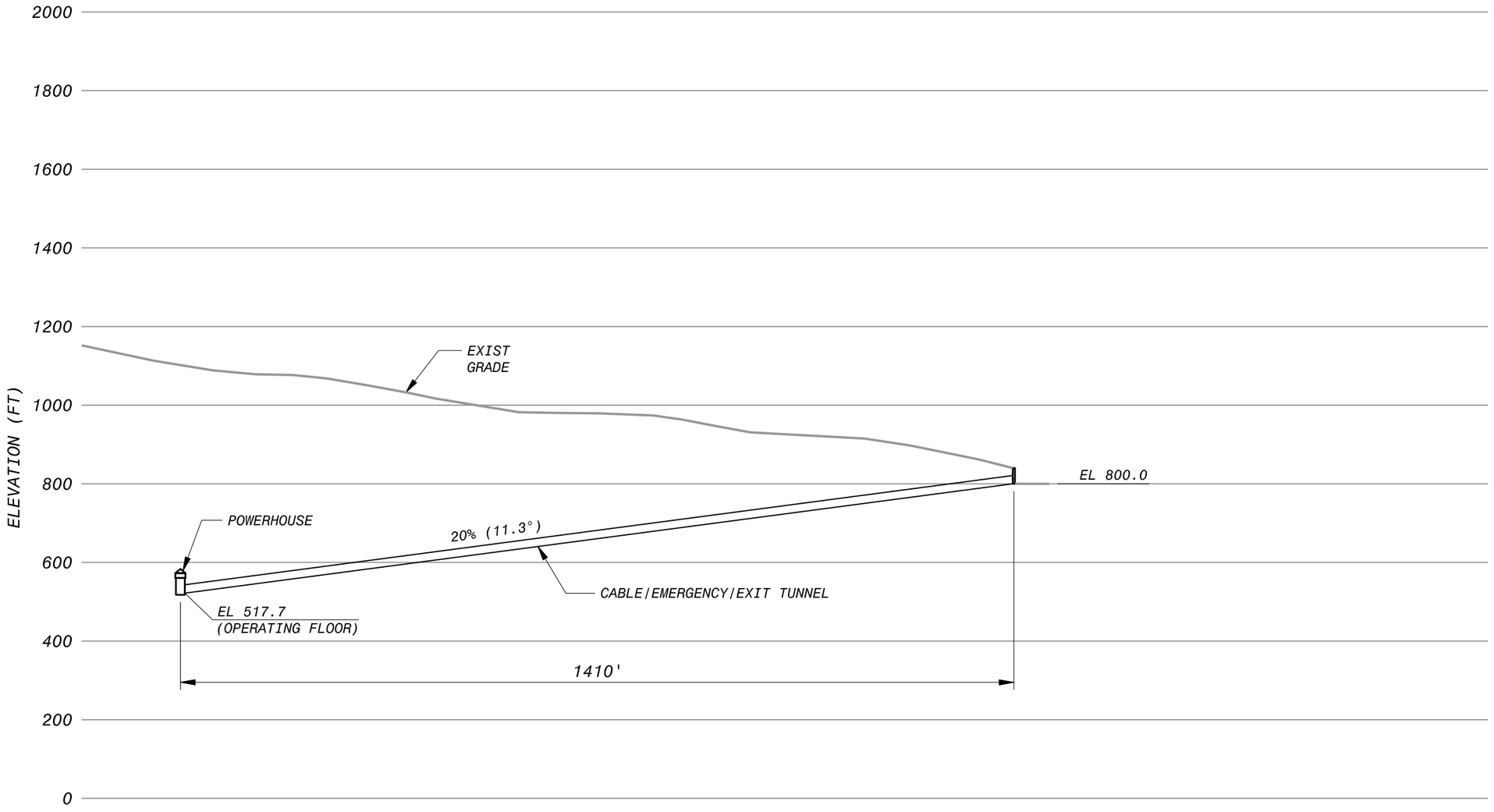
BLACK & VEATCH Corporation

PROJECT
181868

SAN VICENTE PUMPED STORAGE PROJECT

SITE D3
PROFILE - ACCESS TUNNEL

FIGURE
D3-2



300' 100' 0 300' 600'

200'

VERT: 1"=300'

200' 100' 0 200' 400'

HORIZ: 1"=200'

BLACK & VEATCH Corporation

PROJECT
181868

SAN VICENTE PUMPED STORAGE PROJECT

SITE D3
PROFILE - CABLE/EMERGENCY/EXIT TUNNEL

FIGURE
D3-3

APPENDIX B – FINANCIAL PROFORMA SPREADSHEETS

San Vicente Pro Forma Financial Projections

Low Value Case (2014$000)

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Operating Revenues:																													
Electric Sales Value	$13,752	$14,268	$13,965	$14,398	$14,700	$14,215	$13,761	$14,333	$14,421	$14,209	$14,723	$14,607	$14,738	$14,813	$15,095	$15,943	$16,132	$15,754	$15,385	$15,024	$14,672	$14,328	$13,992	$13,664	$13,344	$13,031	$12,726	$12,428	$12,137
Capacity Value	$69,438	$69,438	$69,438	$69,434	$69,438	$69,438	$69,438	$69,438	$69,438	$69,438	$69,438	$69,438	$69,438	$69,438	$69,438	$69,438	$69,438	$67,810	$66,221	$64,669	$63,153	$61,673	$60,227	$58,816	$57,437	$56,091	$54,777	$53,493	$52,239
Ancillary Services Value	$12,565	$12,825	$12,487	$13,066	$13,212	$13,507	$13,702	$14,149	$14,540	$14,873	$15,011	$15,389	$15,635	$15,811	$16,209	$17,035	$17,338	$16,932	$16,535	$16,147	$15,769	$15,399	$15,038	$14,686	$14,342	$14,006	$13,677	$13,357	$13,044
Other Revenue/Value	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Operating Revenue/Value	**$95,755**	**$96,530**	**$95,890**	**$96,898**	**$97,350**	**$97,160**	**$96,900**	**$97,919**	**$98,398**	**$98,520**	**$99,171**	**$99,434**	**$99,810**	**$100,062**	**$100,741**	**$102,415**	**$102,908**	**$100,496**	**$98,140**	**$95,840**	**$93,594**	**$91,400**	**$89,258**	**$87,166**	**$85,123**	**$83,128**	**$81,180**	**$79,277**	**$77,419**
Operating Expenses:																													
Energy Pumping Cost	$7,962	$9,416	$11,097	$12,352	$13,870	$15,431	$17,021	$19,033	$20,403	$22,156	$23,954	$25,819	$27,733	$30,321	$31,833	$33,931	$36,115	$35,269	$34,442	$33,635	$32,847	$32,077	$31,325	$30,591	$29,874	$29,174	$28,490	$27,822	$27,170
Fixed O&M	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,000	$14,648	$14,305	$13,970	$13,642	$13,323	$13,010	$12,705	$12,408	$12,117	$11,833	$11,556
Variable O&M	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Operating Expenses	**$23,322**	**$24,776**	**$26,457**	**$27,712**	**$29,230**	**$30,791**	**$32,381**	**$34,393**	**$35,763**	**$37,516**	**$39,314**	**$41,179**	**$43,093**	**$45,681**	**$47,193**	**$49,291**	**$51,475**	**$50,269**	**$49,091**	**$47,940**	**$46,817**	**$45,719**	**$44,648**	**$43,601**	**$42,579**	**$41,581**	**$40,607**	**$39,655**	**$38,726**
Cash Available for Debt Service	$72,433	$71,754	$69,433	$69,185	$68,119	$66,368	$64,519	$63,526	$62,636	$61,003	$59,858	$58,254	$56,717	$54,381	$53,549	$53,124	$51,432	$50,227	$49,050	$47,900	$46,778	$45,681	$44,611	$43,565	$42,544	$41,547	$40,573	$39,622	$38,693
Senior Debt Service:																													
Interest Payment for Tranche A	$36,137	$34,801	$33,481	$32,176	$30,886	$29,610	$28,346	$27,094	$25,853	$24,623	$23,402	$22,190	$20,985	$19,788	$18,597	$17,411	$16,230	$15,052	$13,877	$12,705	$11,533	$10,362	$9,190	$8,017	$6,842	$5,664	$4,482	$3,295	$2,102
Principal Payment for Tranche A	$8,982	$9,261	$9,548	$9,844	$10,149	$10,464	$10,788	$11,123	$11,468	$11,824	$12,190	$12,568	$12,958	$13,360	$13,774	$14,201	$14,642	$15,096	$15,564	$16,047	$16,544	$17,058	$17,587	$18,132	$18,694	$19,274	$19,872	$20,488	$21,123
Total Senior Debt Service	$45,119	$44,061	$43,029	$42,020	$41,035	$40,074	$39,134	$38,217	$37,321	$36,447	$35,592	$34,758	$33,944	$33,148	$32,371	$31,612	$30,872	$30,148	$29,441	$28,751	$28,077	$27,419	$26,777	$26,149	$25,536	$24,938	$24,353	$23,783	$23,225
	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Cash Available for Subordinate Debt Service	$27,314	$27,693	$26,404	$27,165	$27,084	$26,295	$25,384	$25,309	$25,314	$24,557	$24,265	$23,496	$22,773	$21,233	$21,177	$21,511	$20,561	$20,079	$19,608	$19,149	$18,700	$18,262	$17,834	$17,416	$17,008	$16,609	$16,220	$15,840	$15,468
Subordinate Debt Service:																													
Interest Payment for Tranche C	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Principal Payment for Tranche C	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Other Fees for Tranche C	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Subordinate Debt Service	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Cash Flow Net Total Debt Service	**$27,314**	**$27,693**	**$26,404**	**$27,165**	**$27,084**	**$26,295**	**$25,384**	**$25,309**	**$25,314**	**$24,557**	**$24,265**	**$23,496**	**$22,773**	**$21,233**	**$21,177**	**$21,511**	**$20,561**	**$20,079**	**$19,608**	**$19,149**	**$18,700**	**$18,262**	**$17,834**	**$17,416**	**$17,008**	**$16,609**	**$16,220**	**$15,840**	**$15,468**
Income Taxes	-$11,597	-$10,711	-$10,515	-$9,495	-$8,828	-$8,459	-$8,149	-$7,507	-$6,841	-$6,493	-$5,963	-$5,634	-$5,294	-$5,292	-$4,692	-$3,939	-$3,713	-$3,301	-$2,889	-$2,477	$14,352	$14,382	$14,423	$14,475	$14,538	$14,612	$14,696	$14,793	$14,900
After-Tax Operating Cash Flow	$38,911	$38,404	$36,919	$36,660	$35,912	$34,754	$33,533	$32,816	$32,155	$31,050	$30,228	$29,131	$28,067	$26,525	$25,869	$25,450	$24,274	$23,380	$22,498	$21,625	$4,348	$3,880	$3,411	$2,941	$2,470	$1,997	$1,523	$1,047	$568
After Tax Interest Income	$864	$908	$899	$889	$880	$872	$865	$859	$853	$846	$841	$837	$834	$833	$831	$828	$827	$817	$798	$779	$761	$743	$725	$708	$692	$676	$660	$644	$629
Net Reserve Fund Transfers	-$3,420	-$329	-$372	-$308	-$356	-$369	-$380	-$455	-$358	-$426	-$440	-$458	-$473	-$591	-$425	-$527	-$549	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
After Tax Cash Flow / Funds	**$36,355**	**$38,983**	**$37,446**	**$37,242**	**$36,436**	**$35,257**	**$34,017**	**$33,219**	**$32,650**	**$31,470**	**$30,630**	**$29,510**	**$28,427**	**$26,766**	**$26,275**	**$25,751**	**$24,552**	**$24,197**	**$23,295**	**$22,404**	**$5,109**	**$4,623**	**$4,136**	**$3,649**	**$3,162**	**$2,673**	**$2,183**	**$1,691**	**$1,197**
Annual Debt Service Coverage Ratios:																													
Senior Debt	2.99	2.98	2.94	2.93	2.95	2.93	2.93	2.92	2.93	2.93	2.92	2.91	2.88	2.85	2.87	2.89	2.89	2.89	2.89	2.89	2.89	2.89	2.89	2.89	2.89	2.89	2.89	2.89	2.89
Subordinate Debt	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total Annual Debt Service Coverage Ratio	**2.99**	**2.98**	**2.94**	**2.93**	**2.95**	**2.93**	**2.93**	**2.92**	**2.93**	**2.93**	**2.92**	**2.91**	**2.88**	**2.85**	**2.87**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**
After Tax Cash Flow Distribution:																													
Equity Investor 1	$36,355	$38,983	$37,446	$37,242	$36,436	$35,257	$34,017	$33,219	$32,650	$31,470	$30,630	$29,510	$28,427	$26,766	$26,275	$25,751	$24,552	$24,197	$23,295	$22,404	$5,109	$4,623	$4,136	$3,649	$3,162	$2,673	$2,183	$1,691	$1,197
Cumulative After Tax Cash Flow	**$36,355**	**$75,338**	**$112,784**	**$150,025**	**$186,461**	**$221,718**	**$255,735**	**$288,955**	**$321,604**	**$353,074**	**$383,704**	**$413,214**	**$441,641**	**$468,407**	**$494,683**	**$520,434**	**$544,985**	**$569,183**	**$592,478**	**$614,882**	**$619,992**	**$624,614**	**$628,750**	**$632,400**	**$635,561**	**$638,234**	**$640,417**	**$642,109**	**$643,306**

Equity Investment	**$796,979**
Debt Investment	**$796,979**
Debt Ratio (Percent of Total Capital)	**50%**
Profitability Measures:	
NPV @ Real 2.54% discount rate	$409,536
NPV @ 2.18% After Tax WACC	$421,917
NPV @ Real 9.38% equity cost of capital	$254,172
Payback Period @ Real 2.54% discount rate	#N/A
Payback Period @ 2.18% After Tax WACC	#N/A
Payback Period @ Real 9.38% equity cost of capita	#N/A
IRR	-2.0%
Real Discount Rate	2.5%
Real Equity Cost Rate	9.4%

San Vicente Revenue/Operations Assumptions	
Case	Low Value
Capacity Revenue Basis	F Class GT
Percent of Potential Ancillary Services Sales Volume	30%
San Vicente Construction Cost (Million)	$1,476

San Vicente Pro Forma Financial Projections

Mid Value Case (2014$000)

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Operating Revenues:																													
Electric Sales Value	$13,752	$14,268	$13,965	$14,398	$14,700	$14,215	$13,761	$14,333	$14,421	$14,209	$14,723	$14,607	$14,738	$14,813	$15,095	$15,943	$16,132	$15,754	$15,385	$15,024	$14,672	$14,328	$13,992	$13,664	$13,344	$13,031	$12,726	$12,428	$12,137
Capacity Value	$89,173	$88,829	$89,454	$88,498	$89,399	$89,437	$90,189	$89,808	$90,246	$90,526	$90,649	$90,760	$90,624	$90,669	$91,303	$90,975	$91,368	$89,226	$87,135	$85,093	$83,098	$81,151	$79,249	$77,392	$75,578	$73,806	$72,076	$70,387	$68,737
Ancillary Services Value	$25,130	$25,649	$24,974	$26,132	$26,424	$27,014	$27,404	$28,298	$29,079	$29,746	$30,021	$30,778	$31,269	$31,622	$32,417	$34,070	$34,676	$33,863	$33,070	$32,295	$31,538	$30,798	$30,077	$29,372	$28,683	$28,011	$27,355	$26,713	$26,087
Other Revenue/Value	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Operating Revenue/Value	**$128,055**	**$128,746**	**$128,393**	**$129,028**	**$130,523**	**$130,666**	**$131,354**	**$132,439**	**$133,746**	**$134,481**	**$135,393**	**$136,145**	**$136,631**	**$137,104**	**$138,815**	**$140,987**	**$142,176**	**$138,844**	**$135,590**	**$132,412**	**$129,308**	**$126,278**	**$123,318**	**$120,428**	**$117,605**	**$114,849**	**$112,157**	**$109,528**	**$106,961**
Operating Expenses:																													
Energy Pumping Cost	$7,962	$9,416	$11,097	$12,352	$13,870	$15,431	$17,021	$19,033	$20,403	$22,156	$23,954	$25,819	$27,733	$30,321	$31,833	$33,931	$36,115	$35,269	$34,442	$33,635	$32,847	$32,077	$31,325	$30,591	$29,874	$29,174	$28,490	$27,822	$27,170
Fixed O&M	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,000	$14,648	$14,305	$13,970	$13,642	$13,323	$13,010	$12,705	$12,408	$12,117	$11,833	$11,556
Variable O&M	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Operating Expenses	**$23,322**	**$24,776**	**$26,457**	**$27,712**	**$29,230**	**$30,791**	**$32,381**	**$34,393**	**$35,763**	**$37,516**	**$39,314**	**$41,179**	**$43,093**	**$45,681**	**$47,193**	**$49,291**	**$51,475**	**$50,269**	**$49,091**	**$47,940**	**$46,817**	**$45,719**	**$44,648**	**$43,601**	**$42,579**	**$41,581**	**$40,607**	**$39,655**	**$38,726**
Cash Available for Debt Service	$104,734	$103,970	$101,936	$101,316	$101,292	$99,875	$98,972	$98,046	$97,983	$96,965	$96,080	$94,966	$93,538	$91,423	$91,623	$91,696	$90,701	$88,575	$86,499	$84,472	$82,492	$80,558	$78,670	$76,826	$75,026	$73,267	$71,550	$69,873	$68,236
Senior Debt Service:																													
Interest Payment for Tranche A	$53,850	$51,922	$50,014	$48,126	$46,257	$44,405	$42,569	$40,747	$38,938	$37,140	$35,353	$33,575	$31,804	$30,039	$28,279	$26,522	$24,767	$23,012	$21,256	$19,497	$17,734	$15,965	$14,189	$12,404	$10,608	$8,801	$6,979	$5,142	$3,288
Principal Payment for Tranche A	$11,208	$11,612	$12,031	$12,464	$12,913	$13,379	$13,861	$14,360	$14,878	$15,414	$15,969	$16,545	$17,141	$17,758	$18,398	$19,061	$19,748	$20,460	$21,197	$21,961	$22,752	$23,572	$24,422	$25,302	$26,214	$27,158	$28,137	$29,151	$30,201
Total Senior Debt Service	$65,059	$63,534	$62,045	$60,591	$59,171	$57,784	$56,429	$55,107	$53,815	$52,554	$51,322	$50,119	$48,945	$47,798	$46,677	$45,583	$44,515	$43,472	$42,453	$41,458	$40,486	$39,537	$38,611	$37,706	$36,822	$35,959	$35,116	$34,293	$33,489
	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Cash Available for Subordinate Debt Service	$39,675	$40,436	$39,891	$40,725	$42,122	$42,091	$42,543	$42,939	$44,168	$44,411	$44,758	$44,846	$44,593	$43,625	$44,945	$46,113	$46,186	$45,103	$44,046	$43,014	$42,006	$41,021	$40,060	$39,121	$38,204	$37,309	$36,434	$35,580	$34,746
Subordinate Debt Service:																													
Interest Payment for Tranche C	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Principal Payment for Tranche C	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Other Fees for Tranche C	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Subordinate Debt Service	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Cash Flow Net Total Debt Service	**$39,675**	**$40,436**	**$39,891**	**$40,725**	**$42,122**	**$42,091**	**$42,543**	**$42,939**	**$44,168**	**$44,411**	**$44,758**	**$44,846**	**$44,593**	**$43,625**	**$44,945**	**$46,113**	**$46,186**	**$45,103**	**$44,046**	**$43,014**	**$42,006**	**$41,021**	**$40,060**	**$39,121**	**$38,204**	**$37,309**	**$36,434**	**$35,580**	**$34,746**
Income Taxes	-$3,049	-$2,018	-$1,525	-$477	$793	$1,477	$2,352	$3,200	$4,382	$5,161	$5,978	$6,688	$7,257	$7,533	$8,741	$9,885	$10,585	$10,815	$11,057	$11,312	$26,369	$26,302	$26,257	$26,233	$26,231	$26,251	$26,293	$26,358	$26,447
After-Tax Operating Cash Flow	$42,724	$42,453	$41,416	$41,203	$41,329	$40,615	$40,191	$39,740	$39,785	$39,250	$38,780	$38,159	$37,337	$36,092	$36,205	$36,227	$35,600	$34,288	$32,989	$31,702	$15,636	$14,719	$13,803	$12,888	$11,973	$11,058	$10,141	$9,222	$8,300
After Tax Interest Income	$1,213	$1,249	$1,231	$1,214	$1,197	$1,182	$1,167	$1,154	$1,141	$1,128	$1,117	$1,106	$1,096	$1,089	$1,081	$1,072	$1,066	$1,050	$1,025	$1,001	$978	$955	$933	$911	$889	$869	$848	$828	$809
Net Reserve Fund Transfers	-$3,420	-$329	-$372	-$308	-$356	-$369	-$380	-$455	-$358	-$426	-$440	-$458	-$473	-$591	-$425	-$527	-$549	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
After Tax Cash Flow / Funds	**$40,517**	**$43,373**	**$42,276**	**$42,109**	**$42,170**	**$41,427**	**$40,978**	**$40,439**	**$40,569**	**$39,952**	**$39,456**	**$38,806**	**$37,959**	**$36,590**	**$36,861**	**$36,772**	**$36,117**	**$35,338**	**$34,014**	**$32,704**	**$16,614**	**$15,674**	**$14,735**	**$13,799**	**$12,862**	**$11,926**	**$10,989**	**$10,050**	**$9,109**
Annual Debt Service Coverage Ratios:																													
Senior Debt	2.99	2.98	2.94	2.93	2.95	2.93	2.93	2.92	2.93	2.93	2.92	2.91	2.88	2.85	2.87	2.89	2.89	2.89	2.89	2.89	2.89	2.89	2.89	2.89	2.89	2.89	2.89	2.89	2.89
Subordinate Debt	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total Annual Debt Service Coverage Ratio	**2.99**	**2.98**	**2.94**	**2.93**	**2.95**	**2.93**	**2.93**	**2.92**	**2.93**	**2.93**	**2.92**	**2.91**	**2.88**	**2.85**	**2.87**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**
After Tax Cash Flow Distribution:																													
Equity Investor 1	$40,517	$43,373	$42,276	$42,109	$42,170	$41,427	$40,978	$40,439	$40,569	$39,952	$39,456	$38,806	$37,959	$36,590	$36,861	$36,772	$36,117	$35,338	$34,014	$32,704	$16,614	$15,674	$14,735	$13,799	$12,862	$11,926	$10,989	$10,050	$9,109
Cumulative After Tax Cash Flow	**$40,517**	**$83,890**	**$126,166**	**$168,275**	**$210,445**	**$251,872**	**$292,850**	**$333,289**	**$373,858**	**$413,811**	**$453,267**	**$492,073**	**$530,033**	**$566,623**	**$603,484**	**$640,256**	**$676,373**	**$711,711**	**$745,725**	**$778,429**	**$795,043**	**$810,717**	**$825,452**	**$839,251**	**$852,113**	**$864,039**	**$875,028**	**$885,078**	**$894,187**
Equity Investor 1	$40,517	$43,373	$42,276	$42,109	$42,170	$41,427	$40,978	$40,439	$40,569	$39,952	$39,456	$38,806	$37,959	$36,590	$36,861	$36,772	$36,117	$35,338	$34,014	$32,704	$16,614	$15,674	$14,735	$13,799	$12,862	$11,926	$10,989	$10,050	$9,109
Cumulative After Tax Cash Flow	**$40,517**	**$83,890**	**$126,166**	**$168,275**	**$210,445**	**$251,872**	**$292,850**	**$333,289**	**$373,858**	**$413,811**	**$453,267**	**$492,073**	**$530,033**	**$566,623**	**$603,484**	**$640,256**	**$676,373**	**$711,711**	**$745,725**	**$778,429**	**$795,043**	**$810,717**	**$825,452**	**$839,251**	**$852,113**	**$864,039**	**$875,028**	**$885,078**	**$894,187**

Equity Investment	**$362,786**
Debt Investment	**$1,088,357**
Debt Ratio (Percent of Total Capital)	**75%**
Profitability Measures:	
NPV @ Real 2.54% discount rate	$529,581
NPV @ 3.19% After Tax WACC	$498,799
NPV @ Real 9.38% equity cost of capital	$309,790
Payback Period @ Real 2.54% discount rate	12
Payback Period @ 3.19% After Tax WACC	13
Payback Period @ Real 9.38% equity cost of capital	#N/A
Payback Period (Recovery of Initial Investment)	15
IRR	10.0%
Real Discount Rate	2.5%
Real Equity Cost Rate	9.4%

San Vicente Revenue/Operations Assumptions	
Case	Mid Value
Capacity Revenue Basis	Mid-Point of High and Low Value
Percent of Potential Ancillary Services Sales Volume	60%
San Vicente Construction Cost	1324

San Vicente Pro Forma Financial Projections

High Value Case (2014$)

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Operating Revenues:																													
Electric Sales Value	$13,752	$14,268	$13,965	$14,398	$14,700	$14,215	$13,761	$14,333	$14,421	$14,209	$14,723	$14,607	$14,738	$14,813	$15,095	$15,943	$16,132	$15,754	$15,385	$15,024	$14,672	$14,328	$13,992	$13,664	$13,344	$13,031	$12,726	$12,428	$12,137
Capacity Value	$108,909	$108,220	$109,471	$107,563	$109,360	$109,437	$110,941	$110,179	$111,054	$111,614	$111,860	$112,082	$111,810	$111,900	$113,169	$112,512	$113,298	$110,643	$108,049	$105,517	$103,044	$100,629	$98,270	$95,967	$93,718	$91,521	$89,376	$87,282	$85,236
Ancillary Services Value	$37,695	$38,474	$37,461	$39,198	$39,635	$40,521	$41,105	$42,448	$43,619	$44,619	$45,032	$46,166	$46,904	$47,433	$48,626	$51,105	$52,014	$50,795	$49,604	$48,442	$47,306	$46,198	$45,115	$44,058	$43,025	$42,017	$41,032	$40,070	$39,131
Other Revenue/Value	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Operating Revenue/Value	**$160,356**	**$160,961**	**$160,897**	**$161,159**	**$163,695**	**$164,173**	**$165,807**	**$166,959**	**$169,094**	**$170,443**	**$171,615**	**$172,856**	**$173,452**	**$174,145**	**$176,890**	**$179,560**	**$181,444**	**$177,192**	**$173,039**	**$168,983**	**$165,023**	**$161,155**	**$157,378**	**$153,689**	**$150,087**	**$146,569**	**$143,134**	**$139,780**	**$136,503**
Operating Expenses:																													
Energy Pumping Cost	$7,962	$9,416	$11,097	$12,352	$13,870	$15,431	$17,021	$19,033	$20,403	$22,156	$23,954	$25,819	$27,733	$30,321	$31,833	$33,931	$36,115	$35,269	$34,442	$33,635	$32,847	$32,077	$31,325	$30,591	$29,874	$29,174	$28,490	$27,822	$27,170
Fixed O&M	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,360	$15,000	$14,648	$14,305	$13,970	$13,642	$13,323	$13,010	$12,705	$12,408	$12,117	$11,833	$11,556
Variable O&M	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Operating Expenses	**$23,322**	**$24,776**	**$26,457**	**$27,712**	**$29,230**	**$30,791**	**$32,381**	**$34,393**	**$35,763**	**$37,516**	**$39,314**	**$41,179**	**$43,093**	**$45,681**	**$47,193**	**$49,291**	**$51,475**	**$50,269**	**$49,091**	**$47,940**	**$46,817**	**$45,719**	**$44,648**	**$43,601**	**$42,579**	**$41,581**	**$40,607**	**$39,655**	**$38,726**
Cash Available for Debt Service	$137,034	$136,185	$134,440	$133,447	$134,465	$133,382	$133,426	$132,566	$133,331	$132,926	$132,302	$131,677	$130,359	$128,465	$129,697	$130,268	$129,969	$126,923	$123,948	$121,043	$118,206	$115,436	$112,730	$110,088	$107,508	$104,988	$102,527	$100,124	$97,778
Senior Debt Service:																													
Interest Payment for Tranche A	$78,714	$75,979	$73,271	$70,590	$67,931	$65,293	$62,674	$60,072	$57,485	$54,909	$52,344	$49,786	$47,233	$44,684	$42,134	$39,583	$37,028	$34,465	$31,893	$29,309	$26,710	$24,093	$21,456	$18,796	$16,109	$13,393	$10,644	$7,860	$5,038
Principal Payment for Tranche A	$13,797	$14,364	$14,954	$15,568	$16,207	$16,873	$17,566	$18,287	$19,038	$19,820	$20,634	$21,482	$22,364	$23,283	$24,239	$25,234	$26,271	$27,350	$28,473	$29,642	$30,860	$32,127	$33,447	$34,820	$36,250	$37,739	$39,289	$40,903	$42,583
Total Senior Debt Service	$92,511	$90,343	$88,225	$86,157	$84,138	$82,166	$80,240	$78,360	$76,523	$74,730	$72,978	$71,268	$69,597	$67,966	$66,373	$64,818	$63,298	$61,815	$60,366	$58,951	$57,570	$56,220	$54,903	$53,616	$52,359	$51,132	$49,934	$48,763	$47,620
	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Cash Available for Subordinate Debt Service	$44,524	$45,843	$46,215	$47,289	$50,327	$51,216	$53,186	$54,206	$56,808	$58,197	$59,324	$60,409	$60,762	$60,499	$63,324	$65,451	$66,670	$65,108	$63,582	$62,092	$60,636	$59,215	$57,827	$56,472	$55,148	$53,856	$52,594	$51,361	$50,157
Subordinate Debt Service:																													
Interest Payment for Tranche C	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Principal Payment for Tranche C	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Other Fees for Tranche C	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Subordinate Debt Service	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Cash Flow Net Total Debt Service	**$44,524**	**$45,843**	**$46,215**	**$47,289**	**$50,327**	**$51,216**	**$53,186**	**$54,206**	**$56,808**	**$58,197**	**$59,324**	**$60,409**	**$60,762**	**$60,499**	**$63,324**	**$65,451**	**$66,670**	**$65,108**	**$63,582**	**$62,092**	**$60,636**	**$59,215**	**$57,827**	**$56,472**	**$55,148**	**$53,856**	**$52,594**	**$51,361**	**$50,157**
Income Taxes	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
After-Tax Operating Cash Flow	$44,524	$45,843	$46,215	$47,289	$50,327	$51,216	$53,186	$54,206	$56,808	$58,197	$59,324	$60,409	$60,762	$60,499	$63,324	$65,451	$66,670	$65,108	$63,582	$62,092	$60,636	$59,215	$57,827	$56,472	$55,148	$53,856	$52,594	$51,361	$50,157
After Tax Interest Income	$1,693	$1,718	$1,690	$1,662	$1,634	$1,609	$1,584	$1,561	$1,539	$1,516	$1,496	$1,476	$1,458	$1,442	$1,426	$1,409	$1,394	$1,371	$1,339	$1,307	$1,277	$1,247	$1,218	$1,189	$1,161	$1,134	$1,107	$1,082	$1,056
Net Reserve Fund Transfers	-$3,420	-$329	-$372	-$308	-$356	-$369	-$380	-$455	-$358	-$426	-$440	-$458	-$473	-$591	-$425	-$527	-$549	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
After Tax Cash Flow / Funds	**$42,797**	**$47,232**	**$47,532**	**$48,643**	**$51,605**	**$52,455**	**$54,389**	**$55,312**	**$57,989**	**$59,287**	**$60,379**	**$61,427**	**$61,746**	**$61,349**	**$64,325**	**$66,332**	**$67,516**	**$66,479**	**$64,921**	**$63,399**	**$61,913**	**$60,462**	**$59,045**	**$57,661**	**$56,310**	**$54,990**	**$53,701**	**$52,443**	**$51,213**
Annual Debt Service Coverage Ratios:																													
Senior Debt	2.99	2.98	2.94	2.93	2.95	2.93	2.93	2.92	2.93	2.93	2.92	2.91	2.88	2.85	2.87	2.89	2.89	2.89	2.89	2.89	2.89	2.89	2.89	2.89	2.89	2.89	2.89	2.89	2.89
Subordinate Debt	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total Annual Debt Service Coverage Ratio	**2.99**	**2.98**	**2.94**	**2.93**	**2.95**	**2.93**	**2.93**	**2.92**	**2.93**	**2.93**	**2.92**	**2.91**	**2.88**	**2.85**	**2.87**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**
After Tax Cash Flow Distribution:																													
Equity Investor 1	$42,797	$47,232	$47,532	$48,643	$51,605	$52,455	$54,389	$55,312	$57,989	$59,287	$60,379	$61,427	$61,746	$61,349	$64,325	$66,332	$67,516	$66,479	$64,921	$63,399	$61,913	$60,462	$59,045	$57,661	$56,310	$54,990	$53,701	$52,443	$51,213
Cumulative After Tax Cash Flow	**$42,797**	**$90,029**	**$137,561**	**$186,204**	**$237,808**	**$290,264**	**$344,653**	**$399,965**	**$457,954**	**$517,240**	**$577,620**	**$639,047**	**$700,793**	**$762,142**	**$826,467**	**$892,799**	**$960,315**	**$1,026,794**	**$1,091,714**	**$1,155,114**	**$1,217,027**	**$1,277,489**	**$1,336,534**	**$1,394,195**	**$1,450,505**	**$1,505,495**	**$1,559,196**	**$1,611,638**	**$1,662,852**

Equity Investment	**$147**
Debt Investment	**$1,468,088**
Debt Ratio (Percent of Total Capital)	**100%**
Profitability Measures:	
NPV @ Real 2.54% discount rate	$847,648
NPV @ 6.93% After Tax WACC	$532,057
NPV @ Real 9.38% equity cost of capital	$430,111
Payback Period @ Real 2.54% discount rate	1
Payback Period @ 6.93% After Tax WACC	1
Payback Period @ Real 9.38% equity cost of capital	1
IRR	29159.0%
Real Discount Rate	2.5%
Real Equity Cost Rate	9.4%

San Vicente Revenue/Operations Assumptions	
Case	High Value
Capacity Revenue Basis	LMS 100
Percent of Potential Ancillary Services Sales Volume	90%
San Vicente Construction Cost (Million)	$1,319

APPENDIX C – PROJECT AND COST ASSUMPTIONS

San Vicente Pumped Storage Project
Feasibility Study Cost Assumptions and Clarifications

This memorandum provides an update to the assumptions and clarifications with regard to the development of the cost estimates for the San Vicente Pumped Storage Project Economic and Financial Feasibility Study dated March 14, 2014. This update is based on the results of the Additional Studies Technical Memorandum dated September 15, 2015, for the Project. The goals of the costs estimates were to assist in the screening of potential upper reservoir site locations and help establish benchmark costs for economic and financial analyses to assist in determining the economic viability of a pumped storage project at San Vicente.

1. Upper Reservoir. The following assumptions and clarifications were considered for developing the costs of the upper reservoir sites.
    a. Available topographic maps were used to locate potential upper reservoir sites. This included developing stage-area-volume capacity information to aid in establishing the dam's crest/spillway elevations relative to maximum and minimum operating levels and the respective storage requirement.
    b. Grading of the upper reservoir site included an area 20% larger than the surcharged area of the reservoir. A unit cost of $5/SF was used to account for grading activities in preparation of reservoir lining. Considering this cost over this entire area is conservative.
    c. For the dam cross section, a 20-foot wide crest was assumed with a 0.8H:1V downstream slope. The longitudinal dam profile was estimated from the available topographic maps. A unit price of $200/CY was used to account for the RCC. Costs for RCC typically range from $75-$150/CY depending upon the volume of the RCC work. It is assumed the RCC unit price is sufficient to cover other incidentals associated with the dam, such as mechanical/electrical equipment for outlet works, monitoring equipment, and other miscellaneous items.
    d. For the dam foundation, it was assumed that competent bedrock will be on average 10 feet below the ground surface. The volume of excavation down to bedrock was based on this average depth and the associated footprint of the dam. A unit price of $60/CY was assumed for excavation, hauling, and spoiling the material onsite. An allowance for grouting the bedrock below the dam footprint and abutments was assumed to add an additional 10% to the dam foundation costs.
    e. It was assumed that the entire area of the upper reservoir would be asphalt lined. A unit price of $100/SY was assumed for the asphalt lining with a drainage system.
    f. The inlet/outlet structure for the upper reservoir was assumed to be of the horizontal type, and its sizing was based on a 1 fps approach velocity. The structure was also assumed to have a trumpet shape with a ratio of 3.0. Conservatively, all walls, slabs,

and the roof of the structure were assumed to be 4-foot thick reinforced concrete, and all piers were assumed to be 6-foot thick. An average unit concrete cost of $500/CY was used for the slabs on grade, walls, and elevated slabs.

g. The amount of excavation for the inlet/outlet structure was assumed to be equal to the volume of structure concrete, plus 20%. A unit cost of $60/CY was assumed for this excavation to cover the excavation, hauling, and spoiling the material within the reservoir area.

h. An allowance for inlet/out structure trashracks and associated equipment was assumed based on the area of the trashracks that resulted from the 1 FPS approach velocity assumption. A unit weight of 130 PSF was assumed for the trashracks at a unit cost of $2.00/LB.

i. To allow maintenance activities on the pressure tunnel, a gate house structure was assumed in the inlet/outlet structure area. The plan of the gate house structure was sized according to the pressure tunnel diameter to accommodate a maintenance gate within the pressure tunnel. A unit cost of $125/SF was assumed for the gate house structure. Allowances of $200,000 and $75,000 were assumed, respectively, for gate hoisting equipment and miscellaneous building support systems. The estimated cost of the pressure tunnel gates (i.e. one main and one backup gate) was based on the diameter of the pressure tunnel, a unit weight of 250LB/SF, and a unit price of $4.00/LB.

2. Lower Reservoir Inlet/Outlet Structure. The following assumptions and clarifications were considered for developing the costs for the lower reservoir inlet/outlet structure.

   a. The inlet/outlet structure for the lower reservoir was assumed to be of the vertical type because the low operating level of the lower reservoir was reduced to EL 618, making the usage of the horizontal type inlet/outlet structure extremely expensive and in most cases not practical. The sizing of the inlet/out structure was based on a 1 FPS approach velocity. The structure was also assumed to be circular in shape. Conservatively, all walls, slabs, and the roof of the structure were assumed to be 4-foot thick reinforced concrete, and all piers were assumed to be 6-foot thick. An average unit concrete cost of $600/CY was used for the slabs on grade, walls, and elevated slabs.

   b. The amount of excavation for the inlet/outlet structure for the lower reservoir was assumed based on open-cut methods behind a cellular cofferdam with sufficient area around the inlet/outlet structure to allow uniform flow in and around the structure during operation. A unit cost of $60/CY was assumed for this excavation. A 25% bulking factor was applied to the excavated material for hauling purposes. Due to the location of the excavation site, a unit cost of $30/CY was also assumed for hauling and spoiling of this material near the reservoir area.

c. An allowance for inlet/out structure trashracks and associated equipment was assumed based on the area of the trashracks that resulted from the 1 FPS approach velocity assumption. A unit weight of 130 PSF was assumed for the trashracks at a unit cost of $2.00/LB.
d. For installation of the lower reservoir inlet/outlet structure, it was assumed that the reservoir can be lowered to EL 618 so that a cellular cofferdam can be installed to facilitate excavation for and construction of the inlet/outlet structure. The size of the cellular cofferdam was assumed to be 45 feet in height and 54 feet in diameter. The length of the cofferdam varies depending on the alternative's inlet/out structure size and location within the reservoir. A unit cost of $75,000/LF was assumed for the installation and removal of the cellular cofferdam. An allowance of $1,000,000 was also assumed for miscellaneous costs, such as dewatering.
e. To allow maintenance activities on the tailrace tunnel, a gate house structure was assumed in the inlet/outlet structure area. The plan of the gate house structure was sized according to the tailrace tunnel diameter to accommodate a maintenance gate within the tailrace tunnel. A unit cost of $125/SF was assumed for the gate house structure. Allowances of $200,000 and $75,000 were assumed, respectively, for gate hoisting equipment and miscellaneous building support systems. The estimated cost of the tailrace tunnel gates (i.e. one main and one backup gate) was based on the diameter of the pressure tunnel, a unit weight of 250LB/SF, and a unit price of $4.00/LB. A shaft from the gate house at EL 800 to the tailrace tunnel would allow the gate to access the tunnel. The cost of the gate shaft was estimated in a similar fashion as that for the tailrace tunnel.

3. <u>Powerhouse Cavern.</u> The following assumptions and clarifications were considered for developing the costs of the powerhouse cavern.
    a. The powerhouse cavern size was determined based on the following:
        i. Unit bay equal to twice the unit runner diameter.
        ii. 30-foot wide bay between units.
        iii. 35-foot access bay.
        iv. 60-foot service bay.
        v. 40-foot electrical bay (one for each unit).
        vi. 30-foot wide corridor for valve and auxiliary bay.
        vii. 30-foot wide corridor for control, offices, and shops.
        viii. Crown height equal to 1/4 of the powerhouse width.
        ix. 30 feet from crown to the powerhouse operating floor.
        x. Height from the operating floor to the runner centerline equal to 3.5 times the runner diameter.
        xi. Height from the runner centerline to the bottom of the powerhouse equal to 2.5 times the runner diameter.

b. The powerhouse excavation volume was based on the sizing provided in 2a above. For excavation costs, a unit price of $100/CY was assumed for drilling and blasting the excavated material. Because of the underground location, a unit cost of $60/CY was also assumed for loading, hauling, and disposing the excavated material onsite. A 25% bulking factor was applied to the excavated volume for hauling purposes.
c. It was assumed that some rock bolting will be required to stabilize the resulting powerhouse cavern excavation. For the powerhouse walls, a 50 SF rock bolt pattern was assumed, while for the roof, a 25 SF rock bolt pattern was assumed to determine the number of rock bolts for the powerhouse. The average length of the rock bolts was assumed to be 50 feet, and a $20/FT unit cost was used to account for rock bolt installation.
d. To account for the possibility of additional treatment being required for the resulting exposed excavated rock surface, it was assumed that 50% of the resulting excavated powerhouse walls would receive shotcrete surfacing. Conservatively, a unit cost of $50/SF was assumed.
e. For first and second stage concrete work within the powerhouse cavern, we typically assume that the volume of concrete is equal to 40% of the powerhouse cavern excavation. Conservatively, a unit cost of $800/CY was assumed for all types of concrete, whether it is mass or structural concrete.
f. Architectural treatments and miscellaneous structural steel components within powerhouses are usually a small cost item. For this estimate, we conservatively assumed an allowance of 10% of the powerhouse concrete costs for architectural treatments and miscellaneous structural steel items, such as handrailings, etc.

4. Access Tunnel. The following assumptions and clarifications were considered for developing the costs of the access tunnel to the powerhouse cavern.
    a. Tunnel slope is 8%. This slope is reasonable for vehicular access and establishes the tunnel length for quantities and costing.
    b. Tunnel dimensions (23 feet wide by 20 feet tall – horseshoe shape) are sufficient for transport of major equipment to the cavern powerhouse from ground surface.
    c. Unit cost for drill and blast excavation means and methods was assumed to be $80/CY. Because of the underground location, a unit cost of $30/CY was also assumed for loading, hauling, and disposing the excavated material onsite. A 25% bulking factor was applied to the excavated volume for hauling purposes.
    d. An average 1-foot thickness was assumed for the access tunnel floor paving at a conservative unit cost of $400/CY.
    e. To account for the possibility of additional treatment being required for stability purposes for the resulting exposed excavated rock surface of the access tunnel walls, it was assumed that the entire tunnel walls would receive shotcrete surfacing. Conservatively, a unit cost of $50/SF was assumed.

f. An allowance of 20% of the shotcrete cost was assumed for lighting, drains, and other miscellaneous items for the access tunnel.

5. Cable Tunnel. The following assumptions and clarifications were considered for developing the costs of the cable tunnel to the powerhouse cavern.
    a. Tunnel slope is 20%. This slope is reasonable for carrying the main power feed from the cavern powerhouse to the surface substation, serving as an emergency escape in the event the access tunnel is unsafe, and establishing the tunnel length for quantities and costing.
    b. Tunnel dimensions (15 feet wide by 15 feet tall – horseshoe shape) are sufficient for carrying the main power feed and serving as an emergency escape route.
    c. Other assumptions and clarifications are similar to those listed above in Item 4 for the access tunnel.

6. Pump Turbine/Motor Generator. The following assumptions and clarifications were considered for developing the costs for the pump-turbines/motor-generators and their associated major mechanical/electrical equipment.
    a. The pump-turbine/motor-generator equipment was sized according to the head, flow, and head losses associated with each alternative's physical configuration, including runner diameter and submergence to establish the units setting elevation.
    b. A unit cost of $400/kW was assumed for the furnishing and installing of fixed speed, pump-turbine/motor-generator equipment. This unit cost is a typical value used at this stage of project development and often quoted by vendors/suppliers of this equipment. For variable speed, pump-turbine/motor-generator equipment, the unit cost was adjusted based on general information received from vendors/suppliers that the additional cost for variable speed units equates to approximately 50% of the fixed speed, motor-generator cost. In addition, the pump-turbine/motor-generator unit cost was adjusted for multiple units. It was assumed that the pump-turbine/motor-generator unit cost for the 4 unit option was 50% greater than the 2 unit option based on general information received from vendors/suppliers.

7. Pressure Tunnel. The following assumptions and clarifications were considered for developing the costs for the pressure tunnel.
    a. Pressure tunnel velocity was assumed to be 25 FPS, a typical value for pressure tunnels/penstocks. The velocity establishes the tunnel cross section for determining quantities and costs.
    b. A steel liner was assumed for the pressure tunnel.
    c. A 1-foot thickness was assumed for liner installation (i.e. excavated diameter equals liner diameter plus 2 feet) to determine the required total excavation diameter.

d. Unit cost for drill and blast excavation means and methods for the tunnel was assumed to be $80/CY for both the shaft and longitudinal sections. Because of the underground location, a unit cost of $30/CY was also assumed for loading, hauling, and disposing the excavated material onsite. A 25% bulking factor was applied to the excavated volume for hauling purposes.
e. An allowance of 15% of the excavation cost was assumed for temporary supports during the tunnel excavation work.
f. The steel liner thickness and weight, including an allowance for stiffners, were determined based on the tunnel pressure and handling requirements. A unit cost of $4.00/LB was assumed for the supply and installation of the liner.
g. The cost for back-grouting the liner in place (i.e. the 1-foot over excavation thickness assumed required for the liner installation) was assumed to be $400/CY.

8. Tailrace Tunnel. The following assumptions and clarifications were considered for developing the costs for the tailrace pressure tunnel.
    a. Tailrace tunnel velocity was assumed to be 15 FPS. The velocity establishes the tunnel cross section for determining quantities and costs.
    b. Since the tailrace tunnel is a low-pressure tunnel, a concrete liner was assumed.
    c. A 2.5-foot thickness was assumed for a liner installation (i.e. excavated diameter equals liner diameter plus 5 feet) to determine the required total excavation diameter.
    d. Unit cost for drill and blast excavation means and methods for the tunnel was assumed to be $65/CY for the longitudinal section. Because of the underground location, a unit cost of $30/CY was also assumed for loading, hauling, and disposing the excavated material onsite. A 25% bulking factor was applied to the excavated volume for hauling purposes.
    e. An allowance of 15% of the excavation cost was assumed for temporary supports during the tunnel excavation work.
    f. The concrete liner thickness was assumed to be 2.5 feet thick. A unit price of $600/CY was assumed.

9. Balance of Plant Mechanical Equipment. The following assumptions and clarifications were considered for developing the costs for the balance of plant mechanical equipment.
    a. Various costs for this equipment were derived from past project experience.
    b. Allowances of 25%, 15%, and 50% of the mechanical equipment costs were used for valves, instruments, and piping/accessories, respectively.

10. Balance of Plant Electrical Equipment. The following assumptions and clarifications were considered for developing the costs for the balance of plant electrical equipment.
    a. Various costs for this equipment were derived from past project experience.

b. Allowances of $2,000,000 and $1,500,000 were used for grounding and lighting, respectively.
c. Allowances of 25% and 40% of the electrical equipment costs were used for raceway and cable, respectively.

11. Substation. The following assumptions and clarifications were considered for developing the costs for the 230 kV substation interconnection.
    a. The intertie connection is assumed at the existing SDG&E Sycamore Canyon Substation. Existing substation is configured in a breaker and a half layout with existing physical space to interconnect two bays.
    b. Cost of the substation at the powerhouse site and the interconnection substation was estimated at $7,433,000 for breakers, switches, structures, and protection and is based on experience from past projects.

12. Transmission. The following assumptions and clarifications were considered for developing the costs for the transmission line.
    a. Costs were developed based on a double circuit 230 kV line using the WECC Transmission Cost Calculator.
    b. A 1.4 multiplier was applied to the overall costs to account for "rolling hills" type of terrain.
    c. Transmission line costs were based on a transmission line length from the centroid of Site B to the existing Sycamore Substation. This cost was estimated at $11,350,000. This cost was used for all sites.

13. Roads and Sitework. The following assumptions and clarifications were considered for developing the costs for roads and sitework.
    a. An allowance of $6,000,000 was used for roads and sitework.

14. Indirect. The following assumptions and clarifications were considered for developing the costs for indirects.
    a. An allowance of 5% of the direct construction cost was assumed for design engineering, as well as for the CM/resident engineering. For a project of this size, this level of allowance for these two items is typical.
    b. An allowance of $8,000,000 was assumed for permitting and licensing.
    c. An allowance $5,000,000 was assumed for Authority administrative and other project support costs.
    d. It was assumed that 120 acres would be required for each site. Land costs were assumed to be $50,000/acre. It was also assumed that 5-10 acres would be required for easements for project facilities at an estimated cost of $35,000.

15. Line Item Contingency Analysis. The level of accuracy of the cost estimates will vary from line item to line. The following table provides a breakdown of the contingency by line item based on the perceived accuracy in estimating the particular item. For this illustration, only Site B3 is shown. Some general comments about the distribution of the contingency among the line items are as follows:
    a. Because of potential unknowns concerning subsurface conditions (i.e. rock conditions for tunneling and excavation), a higher percentage of contingency would be assumed to apply to the powerhouse cavern and to the pressure, tailrace, access, and cable tunnels line items.
    b. In general, equipment costs are better quantifiable at an early stage of a project; thus, a lower contingency percentage would be assumed to apply to those line items (i.e. pump turbines/ motor generators and balance of plant mechanical and electrical equipment).
    c. Depending upon the final site configuration, costs for roads, sitework, and land may vary greatly; thus, a higher percentage of contingency would be assumed to apply to those line items.
    d. A higher percent contingency would also be assumed to apply to licensing, permitting, and Owner administrative costs to account for general unknowns associated with dealing with the federal, state, and local regulatory agencies, including FERC and the DSOD.

PARAMETRIC PUMPED STORAGE PRELIMINARY DESIGN MODEL	COST SUMMARY		
ALTERNATIVE ======>	B3		B3
COMMENT ========>	500 MW - Daily Cycle 8hrs Storage - Larger Upper Reservoir		
TECHNICAL PARAMETERS			
GROSS CAPACITY	540		540
NET CAPACITY	500		500
NUMBER OF UNITS	4		4
UNIT CAPACITY	125		125
GENERATING HOURS AT RATED	8.00		8.00
PUMPING HOURS AT RATED	9.61		9.61
DAILY GENERATION (MW-HRS)	4000		4000
ANNUAL GENERATION (70% CF)	1,022,000		1,022,000
		Line Item Contingency	Total
DIRECT CONSTRUCTION COST			
POWERHOUSE STRUCTURE	$ 75,700,000	30%	$ 98,410,000
UPPER RESERVOIR	$ 235,000,000	25%	$ 293,750,000
INLET / OUTLET STRUCTURES (2)	$ 76,800,000	40%	$ 107,520,000
POWER TUNNEL /SHAFT	$ 27,900,000	40%	$ 39,060,000
TAILRACE TUNNEL	$ 14,700,000	40%	$ 20,580,000
ACCESS TUNNEL	$ 15,540,000	30%	$ 20,202,000
CABLE TUNNEL	$ 3,290,000	30%	$ 4,277,000
PUMP TURBINE / MOTOR GENERATORS	$ 458,000,000	10%	$ 503,800,000
BALANCE OF PLANT - MECHANICAL	$ 15,100,000	10%	$ 16,610,000
BALANCE OF PLANT - ELECTRICAL	$ 38,500,000	10%	$ 42,350,000
SUBSTATION - PLANT	$ 7,433,000	25%	$ 9,291,250
TRANSMISSION	$ 11,350,000	25%	$ 14,187,500
ROADS AND SITEWORK	$ 6,000,000	40%	$ 8,400,000
TOTAL DIRECT CONSTRUCTION COST	$ 985,313,000		$ 1,178,437,750
INDIRECTS			
ENGINEERING % OF TDC	5%		
ENGINEERING COST	$ 49,265,650	20%	$ 59,118,780
CM/RESIDENT ENGINEERING % OF TDC	5%		
CM/RESIDENT ENGINEERING COST	$ 49,265,650	20%	$ 59,118,780
PERMITTING AND LICENSING	$ 8,000,000	35%	$ 10,800,000
OWNER ADMIN / MARKETING COSTS	$ 5,000,000	60%	$ 8,000,000
LAND / EASEMENT COSTS	$ 6,035,000	30%	$ 7,845,500
TOTAL INDIRECT COSTS	$ 117,566,300		$ 144,883,060
TOTAL PROJECT DIRECT COST	$ 1,102,879,300		$ 1,323,320,810
CONTINGENCY ALLOWANCE (%)	20%		
CONTINGENCY ALLOWANCE	$ 220,575,860		
PARAMETRIC COST ESTIMATE	$ 1,324,000,000		$ 1,324,000,000
COST PER kW	$ 2,648		$ 2,648

APPENDIX D – TWO UNIT OPTION SIZING AND COSTS SPREADSHEETS

PARAMETRIC PUMPED STORAGE PRELIMINARY DESIGN MODEL	COST SUMMARY	COST SUMMARY	COST SUMMARY	COST SUMMARY
BLACK & VEATCH H&HS				
ALTERNATIVE ======>	A1	B3	C3	D3
COMMENT ========>	500 MW - Daily Cycle 8 hrs Storage	500 MW - Daily Cycle 8hrs Storage - Larger Upper Reservoir	500 MW - Daily Cycle 8 hrs Storage - Larger Upper Reservoir	500 MW - Daily Cycle 8 hrs Storage - Larger Upper Reservoir
TECHNICAL PARAMETERS				
GROSS CAPACITY	540	540	540	540
NET CAPACITY	500	500	500	500
NUMBER OF UNITS	2	2	2	2
UNIT CAPACITY	250	250	250	250
GENERATING HOURS AT RATED	8.00	8.00	8.00	8.00
PUMPING HOURS AT RATED	9.61	9.61	9.61	9.61
DAILY GENERATION (MW-HRS)	4000	4000	4000	4000
ANNUAL GENERATION (70% CF)	1,022,000	1,022,000	1,022,000	1,022,000
DIRECT CONSTRUCTION COST				
POWERHOUSE STRUCTURE	$ 54,400,000	$ 71,200,000	$ 76,700,000	$ 61,000,000
UPPER RESERVOIR	$ 170,000,000	$ 235,000,000	$ 152,000,000	$ 271,000,000
INLET / OUTLET STRUCTURES (2)	$ 49,300,000	$ 76,800,000	$ 67,100,000	$ 72,400,000
POWER TUNNEL /SHAFT	$ 174,400,000	$ 27,900,000	$ 33,100,000	$ 76,100,000
TAILRACE TUNNEL	$ 17,600,000	$ 14,700,000	$ 16,700,000	$ 24,000,000
ACCESS TUNNEL	$ 16,530,000	$ 14,460,000	$ 14,010,000	$ 15,150,000
CABLE TUNNEL	$ 3,500,000	$ 3,070,000	$ 2,970,000	$ 3,210,000
PUMP TURBINE / MOTOR GENERATORS	$ 260,000,000	$ 329,000,000	$ 349,000,000	$ 293,000,000
BALANCE OF PLANT - MECHANICAL	$ 13,100,000	$ 13,100,000	$ 13,100,000	$ 13,100,000
BALANCE OF PLANT - ELECTRICAL	$ 25,500,000	$ 25,500,000	$ 25,500,000	$ 25,500,000
SUBSTATION - PLANT	$ 7,433,000	$ 7,433,000	$ 7,433,000	$ 7,433,000
TRANSMISSION	$ 11,350,000	$ 11,350,000	$ 11,350,000	$ 11,350,000
ROADS AND SITEWORK	$ 6,000,000	$ 6,000,000	6,000,000	$ 6,000,000
TOTAL DIRECT CONSTRUCTION COST	$ 809,113,000	$ 835,513,000	774,963,000	$ 879,243,000
INDIRECTS				
ENGINEERING % OF TDC	5%	5%	5%	5%
ENGINEERING COST	$ 40,455,650	$ 41,775,650	38,748,150	$ 43,962,150
CM/RESIDENT ENGINEERING % OF TDC	5%	5%	5%	5%
CM/RESIDENT ENGINEERING COST	$ 40,455,650	$ 41,775,650	38,748,150	$ 43,962,150
PERMITTING AND LICENSING	$ 8,000,000	$ 8,000,000	8,000,000	$ 8,000,000
OWNER ADMIN / MARKETING COSTS	$ 5,000,000	$ 5,000,000	5,000,000	$ 5,000,000
LAND / EASEMENT COSTS	$ 6,035,000	$ 6,035,000	6,035,000	$ 6,035,000
TOTAL INDIRECT COSTS	$ 99,946,300	$ 102,586,300	96,531,300	$ 106,959,300
TOTAL PROJECT DIRECT COST	$ 909,059,300	$ 938,099,300	871,494,300	$ 986,202,300
CONTINGENCY ALLOWANCE (%)	20%	20%	20%	20%
CONTINGENCY ALLOWANCE	$ 181,811,860	$ 187,619,860	174,298,860	$ 197,240,460
PARAMETRIC COST ESTIMATE	$ 1,091,000,000	$ 1,126,000,000	$ 1,046,000,000	$ 1,184,000,000
COST PER kW	$ 2,182	$ 2,252	2,092	$ 2,368

PARAMETRIC PUMPED STORAGE PRELIMINARY DESIGN MODEL	GENERAL SIZING	GENERAL SIZING	GENERAL SIZING	GENERAL SIZING
BLACK & VEATCH H&HS				
ALTERNATIVE ======>	A1	B3	C3	D3
SITE	A	B	C	D
COMMENT ========>	Daily Cycle 8 hrs Storage	Daily Cycle 8 hrs Storage	Daily Cycle 8 hrs Storage	Daily Cycle 8 hrs Storage
GENERAL SIZING ASSUMPTIONS				
COMPOSITION OF CYCLE EFFICIENCY - GENERATING				
WATER CONDUCTORS	97.40%	97.40%	97.40%	97.40%
TURBINE	92.00%	92.00%	92.00%	92.00%
GENERATOR	98.00%	98.00%	98.00%	98.00%
TRANSFORMER	99.50%	99.50%	99.50%	99.50%
SUBTOTAL GENERATING	87.38%	87.38%	87.38%	87.38%
COMPOSITION OF CYCLE EFFICIENCY- PUMPING				
WATER CONDUCTORS	97.60%	97.60%	97.60%	97.60%
PUMP	92.00%	92.00%	92.00%	92.00%
MOTOR	98.70%	98.70%	98.70%	98.70%
TRANSFORMER	99.50%	99.50%	99.50%	99.50%
SUBTOTAL PUMPING	88.18%	88.18%	88.18%	88.18%
TOTAL CYCLE EFFICIENCY	77.05%	77.05%	77.05%	77.05%
OPERATING CYCLE	Daily	Daily	Daily	Daily
PROJECT CAPACITY (GROSS MW)	540	540	540	540
PLANT GENERATING CAPACITY (NET MW)	500	500	500	500
NUMBER OF UNITS	2	2	2	2
UNIT GENERATING CAPACITY (MW)	250	250	250	250
CHARGE / DISCHARGE RATIO	1.08	1.08	1.08	1.08
AVG PUMPING LOAD OVER CYCLE CAPACITY (MW)	540	540	540	540
GENERATING HOURS	8.00	8.00	8.00	8.00
GENERATING ENERGY (MW-HRS)	4,000	4,000	4,000	4,000
PUMPING HOURS	9.6	9.6	9.6	9.6
PUMPING ENERGY (MW-HRS)	5,191	5,191	5,191	5,191
MAX GROSS HEAD (FT)	1,488	892	982	1,105
MIN GROSS HEAD (FT)	1,244	653	693	771
AVG GROSS HEAD (FT)	1,366	773	838	938
PLANT FLOW - GENERATING CYCLE (CFS)	4,947	8,748	8,069	7,205
UNIT FLOW - GENERATING CYCLE (CFS)	2,474	4,374	4,035	3,602
PLANT FLOW PUMPING CYCLE (CFS)	4,117	7,280	6,715	5,995
UNIT FLOW PUMPING CYCLE (CFS)	2,058	3,640	3,357	2,998
UPPER RESERVOIR OPERATION				
UPPER RESERVOIR MAX OP LEVEL - ACTIVE (FT MSL)	2,106	1,510	1,600	1,723
UPPER RESERVOIR MIN OP LEVEL - ACTIVE (FT MSL)	2,008	1,417	1,457	1,535
UPPER RESERVOIR FLOOR EL (FT MSL)	1,998	1,407	1,447	1,525
UPPER RESERVOIR SURCHARGE EL (FT MSL)	2,115	1,520	1,620	1,733
UPPER RESERVOIR ACTIVE DEPTH (FT)	98	93	143	188
UPPER RESERVOIR DEAD DEPTH (FT)	10	10	10	10
UPPER RESERVOIR SURCHARGE DEPTH (FT)	9	10	20	10
TOTAL RESERVOIR DEPTH (FT)	117	113	173	208
UPPER RESERVOIR AREA AT SURCHARGE (ACRES)	110	89	69	90
UPPER RESERVOIR AREA AT FLOOR (ACRES)	29	50	9	8

PARAMETRIC PUMPED STORAGE PRELIMINARY DESIGN MODEL	GENERAL SIZING	GENERAL SIZING	GENERAL SIZING	GENERAL SIZING
BLACK & VEATCH H&HS				
UPPER RESERVOIR AREA AT MAX OP (ACRES)	72	89	69	90
UPPER RESERVOIR AREA AT MIN OP (ACRES)	35	53	18	11
SURCHARGE VOLUME (ACRE-FT)	667	175	1,380	900
OPERATING VOLUME (ACRE-FT)	5,116	6,603	6,221	9,164
DEAD VOLUME	320	1,064	90	225
TOTAL STORAGE	6,103	7,842	7,691	10,289
UPPER RES GEN VOLUME REQ (A-F)	3,271	5,784	5,335	4,763
UPPER RES PUMP VOLUME REQ (A-F)	3,271	5,784	5,335	4,763
RATIO ACTUAL / REQ STORAGE	1.56	1.14	1.17	1.92
LOWER RESERVOIR OPERATION				
LOWER RESERVOIR MAX OP LEVEL	764.00	764.00	764.00	764.00
LOWER RESERVOIR MIN OP LEVEL	618.00	618.00	618.00	618.00
LOWER RESERVOIR OPERATING RANGE (FT) (ITERATION REQUIRED)	2.20	3.90	3.60	2.95
LOWER RESERVOIR AREA AT MAX OP (ACRES)	1,664	1,664	1,664	1,664
LOWER RESERVOIR AREA AT MIN OP (ACRES) -- ASSUME - TO MAX OP	1,583	1,583	1,583	1,583
OPERATING VOLUME REQUIRED (ACRE FT)	3,271	5,784	5,335	4,763
CALCULATED VOLUME (ACRE FT) (ITERATION)	3,572	6,332	5,845	4,789
ACTUAL RESERVOIR MIN LEVEL	761.80	760.10	760.40	761.05
	ok	ok	ok	ok
PUMPED STORAGE METRICS				
DISTANCE FROM UPPER TO LOWER RESERVOIR (FT)	16,810	3,960	5,020	11,620
L/H RATIO (GROSS HEAD BASIS)	12.3	5.1	6.0	12.4

PARAMETRIC PUMPED STORAGE PRELIMINARY DESIGN MODEL	UPPER RESERVOIR	UPPER RESERVOIR	UPPER RESERVOIR	UPPER RESERVOIR
BLACK & VEATCH H&HS	SVPSP	SVPSP	SVPSP	SVPSP
RESERVOIR SITE	A1	B3	C3	D3
UPPER RESERVOIR TYPE				
ALIGNMENT	LINEAR	LINEAR	LINEAR	LINEAR
TYPE OF DAM	GRAVITY	GRAVITY	GRAVITY	GRAVITY
CONSTRUCTION MATERIAL	RCC	RCC	RCC	RCC
CREST ELEVATION (FT MSL) (A)	2,115	1,520	1,620	1,733
GRADING AND SITE PREPARATION				
UPPER RESERVOIR AREA (SURCHARGE+20%) (ACRES)	132	107	83	108
UPPER RESERVOIR AREA (SURCHARGE+20%) (SF)	5,749,920	4,652,208	3,606,768	4,704,480
UPPER RESERVOIR GRADING UNIT PRICE ($/SF)	$ 5.00	$ 5.00	$ 5.00	$ 5.00
UPPER RESERVOIR GRADING COST ($)	$ 28,749,600	$ 23,261,040	$ 18,033,840	$ 23,522,400
DAM 1 CREST LENGTH (FT) (D)	1,425	1,760	1,173	2,323
DAM 1 FLOOR ELEV (FT MSL) (B)	1,880	1,360	1,360	1,440
HEIGHT MAX (H)	235.0	160.0	260.0	293.0
ABUTMENT HORIZ DISTANCE (E)	470	320	520	586
FOUNDATION BASE LENGTH (FT)	485	1,120	133	1,151
AVERAGE LENGTH (FT)	948	1,040	847	1,455
CREST WIDTH (FT)	20	20	20	20
BASE WIDTH (FT)	98.3	73.3	106.7	117.7
AVG WIDTH (FT)	59.2	46.7	63.3	68.8
CROSS SECTION AREA (SF)	13,904	7,467	16,467	20,168
DAM VOLUME (CY)	487,933	287,605	516,260	1,086,467
FOUNDATION PLAN AREA (SF)	93,171	76,267	90,293	171,146
EXCAVATION DEPTH (FT)	10	10	10	10
EXCAVATION VOLUME (CY)	34,508	28,247	33,442	63,387
RCC UNIT PRICE ($/CY)	$ 200	$ 200	$ 200	$ 200
EXCAVATION UNIT PRICE ($/CY)	$ 60	$ 60	$ 60	$ 60
ALLOWANCE FOR GROUTING, ETC	10%	10%	10%	10%
RCC COST	$ 97,586,651	$ 57,520,988	$ 103,252,099	$ 217,293,322
EXCAVATION COST	$ 2,070,463	$ 1,694,815	$ 2,006,519	$ 3,803,248
SUBTOTAL	$ 99,657,114	$ 59,215,802	$ 105,258,617	$ 221,096,570
ALLOWANCE	$ 9,965,711	$ 5,921,580	$ 10,525,862	$ 22,109,657
TOTAL COST DAM 1	$ 109,622,826	$ 65,137,383	$ 115,784,479	$ 243,206,227
DAM 2 CREST LENGTH (FT) (D)	1,340	838	1,508	-
DAM 2 FLOOR ELEV (FT MSL) (B)	2,040	1,440	1,600	-
HEIGHT MAX (H)	75.0	80.0	20.0	-
ABUTMENT HORIZ DISTANCE (E)	150	160	40	-
FOUNDATION WIDTH "C" FT	1,040	518	1,428	-
AVERAGE LENGTH (FT)	745	499	774	-
CREST WIDTH (FT)	20	20	20	-
BASE WIDTH (FT)	45.0	46.7	26.7	-
AVG WIDTH (FT)	32.5	33.3	23.3	-
CROSS SECTION AREA (SF)	2,438	2,667	467	-
DAM VOLUME (CY)	67,257	49,284	13,378	-
FOUNDATION PLAN AREA (SF)	33,525	23,287	20,640	-
EXCAVATION DEPTH (FT)	10	10	10	-
EXCAVATION VOLUME (CY)	12,417	8,625	7,644	-
RCC UNIT PRICE ($/CY)	$ 200	$ 200	$ 200	-
EXCAVATION UNIT PRICE ($/CY)	$ 60	$ 60	$ 60	-
ALLOWANCE FOR GROUTING, ETC	10%	10%	10%	-
RCC COST	$ 13,451,389	$ 9,856,790	$ 2,675,556	$ -
EXCAVATION COST	$ 745,000	$ 517,481	$ 458,667	$ -
SUBTOTAL	$ 14,196,389	$ 10,374,272	$ 3,134,222	$ -
ALLOWANCE	$ 1,419,639	$ 1,037,427	$ 313,422	-

PARAMETRIC PUMPED STORAGE PRELIMINARY DESIGN MODEL	UPPER RESERVOIR	UPPER RESERVOIR	UPPER RESERVOIR	UPPER RESERVOIR
BLACK & VEATCH H&HS	SVPSP	SVPSP	SVPSP	SVPSP
RESERVOIR SITE	A1	B3	C3	D3
UPPER RESERVOIR TYPE				
ALIGNMENT	LINEAR	LINEAR	LINEAR	LINEAR
TYPE OF DAM	GRAVITY	GRAVITY	GRAVITY	GRAVITY
CONSTRUCTION MATERIAL	RCC	RCC	RCC	RCC
CREST ELEVATION (FT MSL) (A)	2,115	1,520	1,620	1,733
TOTAL COST DAM 2	$ 15,616,028	$ 11,411,699	$ 3,447,644	-

PARAMETRIC PUMPED STORAGE PRELIMINARY DESIGN MODEL	UPPER RESERVOIR	UPPER RESERVOIR	UPPER RESERVOIR	UPPER RESERVOIR
BLACK & VEATCH H&HS	SVPSP	SVPSP	SVPSP	SVPSP
RESERVOIR SITE	A1	B3	C3	D3
UPPER RESERVOIR TYPE				
ALIGNMENT	LINEAR	LINEAR	LINEAR	LINEAR
TYPE OF DAM	GRAVITY	GRAVITY	GRAVITY	GRAVITY
CONSTRUCTION MATERIAL	RCC	RCC	RCC	RCC
CREST ELEVATION (FT MSL) (A)	2,115	1,520	1,620	1,733
DAM 3 CREST LENGTH (FT) (D)	838	838	1,500	-
DAM 3 FLOOR ELEV (FT MSL) (B)	2,100	1,440	1,600	-
HEIGHT MAX (H)	15.0	80.0	20.0	-
ABUTMENT HORIZ DISTANCE (E)	30	160	40	-
FOUNDATION WIDTH "C" FT	778	518	1,420	-
AVERAGE LENGTH (FT)	434	499	770	-
CREST WIDTH (FT)	20	20	20	-
BASE WIDTH (FT)	25.0	46.7	26.7	-
AVG WIDTH (FT)	22.5	33.3	23.3	-
CROSS SECTION AREA (SF)	338	2,667	467	-
DAM VOLUME (CY)	5,425	49,284	13,309	-
FOUNDATION PLAN AREA (SF)	10,850	23,287	20,533	-
EXCAVATION DEPTH (FT)	10	10	10	-
EXCAVATION VOLUME (CY)	4,019	8,625	7,605	-
RCC UNIT PRICE ($/CY)	$ 200	$ 200	$ 200	-
EXCAVATION UNIT PRICE ($/CY)	$ 60	$ 60	$ 60	-
ALLOWANCE FOR GROUTING, ETC	10%	10%	10%	-
RCC COST	$ 1,085,000	$ 9,856,790	$ 2,661,728	-
EXCAVATION COST	$ 241,111	$ 517,481	$ 456,296	-
SUBTOTAL	$ 1,326,111	$ 10,374,272	$ 3,118,025	-
ALLOWANCE	$ 132,611	$ 1,037,427	$ 311,802	-
TOTAL COST DAM 3	$ 1,458,722	$ 11,411,699	$ 3,429,827	-
DAM 4 CREST LENGTH (FT) (D)	-	1,006	2,700	-
DAM 4 FLOOR ELEV (FT MSL) (B)	-	1,280	1,600	-
HEIGHT MAX (H)	-	240.0	20.0	-
ABUTMENT HORIZ DISTANCE (E)	-	480	40	-
FOUNDATION WIDTH "C" FT	-	46	2,620	-
AVERAGE LENGTH (FT)	-	743	1,370	-
CREST WIDTH (FT)	-	20	20	-
BASE WIDTH (FT)	-	100.0	26.7	-
AVG WIDTH (FT)	-	60.0	23.3	-
CROSS SECTION AREA (SF)	-	14,400	467	-
DAM VOLUME (CY)	-	396,267	23,679	-
FOUNDATION PLAN AREA (SF)	-	74,300	36,533	-
EXCAVATION DEPTH (FT)	-	10	10	-
EXCVATION VOLUME (CY)	-	27,519	13,531	-
RCC UNIT PRICE ($/CY)	-	$ 200	$ 200	-
EXCAVATION UNIT PRICE ($/CY)	-	$ 60	$ 60	-
ALLOWANCE FOR GROUTING, ETC	-	10%	10%	-
RCC COST	-	$ 79,253,333	$ 4,735,802	$ -
EXCAVATION COST	-	$ 1,651,111	$ 811,852	$ -
SUBTOTAL	-	$ 80,904,444	$ 5,547,654	-
ALLOWANCE	-	$ 8,090,444	$ 554,765	$ -
TOTAL COST DAM 4	-	$ 88,994,889	$ 6,102,420	$ -
DAM 5 CREST LENGTH (FT) (D)		3,100		
DAM 5 FLOOR ELEV (FT MSL) (B)		1,490		
HEIGHT MAX (H)		30.0		
ABUTMENT HORIZ DISTANCE (E)		60		
FOUNDATION WIDTH "C" FT		2,980		
AVERAGE LENGTH (FT)		1,580		
CREST WIDTH (FT)		20		

PARAMETRIC PUMPED STORAGE PRELIMINARY DESIGN MODEL	UPPER RESERVOIR	UPPER RESERVOIR	UPPER RESERVOIR	UPPER RESERVOIR
BLACK & VEATCH H&HS	SVPSP	SVPSP	SVPSP	SVPSP
RESERVOIR SITE	A1	B3	C3	D3
UPPER RESERVOIR TYPE				
ALIGNMENT	LINEAR	LINEAR	LINEAR	LINEAR
TYPE OF DAM	GRAVITY	GRAVITY	GRAVITY	GRAVITY
CONSTRUCTION MATERIAL	RCC	RCC	RCC	RCC
CREST ELEVATION (FT MSL) (A)	2,115	1,520	1,620	1,733
BASE WIDTH (FT)		30.0		
AVG WIDTH (FT)		25.0		
CROSS SECTION AREA (SF)		750		
DAM VOLUME (CY)		43,889		
FOUNDATION PLAN AREA (SF)		47,400		
EXCAVATION DEPTH (FT)		10		
EXCVATION VOLUME (CY)		17,556		
RCC UNIT PRICE ($/CY)		$ 200		
EXCAVATION UNIT PRICE ($/CY)		$ 60		
ALLOWANCE FOR GROUTING, ETC		10%		
RCC COST		$ 8,777,778		
EXCAVATION COST		$ 1,053,333		
SUBTOTAL		$ 9,831,111		
ALLOWANCE		$ 983,111		
TOTAL COST DAM 4		$ 10,814,222		
TOTAL UPPER RESERVOIR DAM COST	$ 155,447,176	$ 211,030,931	$ 146,798,210	$ 266,728,627
UPPER RESERVOIR FLOOR AREA	1,283,046	2,088,570	398,320	329,324
TOTAL SURFACE AREA OF RESERVOIR (SY)	142,561	232,063	44,258	36,592
ASPHALT LINER WITH DRAIN SYSTEM ($/SY)	$ 100.00	$ 100.00	$ 100.00	$ 100.00
LINER COST	$ 14,256,067	$ 23,206,333	$ 4,425,778	$ 3,659,156
TOTAL UPPER RESERVOIR COST	$ 170,000,000	$ 235,000,000	$ 152,000,000	$ 271,000,000
UPPER RESERVOIR COST PER A-F	$ 47,600	$ 37,200	$ 26,100	$ 73,600

	PARAMETRIC PUMPED STORAGE PRELIMINARY DESIGN MODEL	TUNNEL LAYOUT	TUNNEL LAYOUT	TUNNEL LAYOUT	TUNNEL LAYOUT
	BLACK & VEATCH H&HS	SVPSP	SVPSP	SVPSP	SVPSP
	OPTION	A1	B3	C3	D3
	ACCESS TUNNEL				
	ACCESS TUNNEL PORTAL ELEVATION (FT MSL)	800	800	800	800
	RUNNER CENTERLINE (FT MSL)	457.0	480.0	484.0	475.0
	LOWER RESERVOIR MIN OP ELEV (FT MSL)	618.0	618.0	618.0	618.0
	UPPER RESERVOIR FLOOR ELEV (FT MSL)	1,998.0	1,407.0	1,447.0	1,525.0
	OPERATING FLOOR ELEV (FT MSL)	508.1	544.6	552.5	532.5
	DEPTH - SETTING BASED (FT)	161.0	138.0	134.0	143.0
	DEPTH - ACCESS BASED (FT)	291.9	255.4	247.5	267.5
	ACCESS TUNNEL GRADE (%)	8.00%	8.00%	8.00%	8.00%
	ACCESS TUNNEL LENGTH (INCLINED FT)	3,649	3,193	3,094	3,344
	TAILRACE TUNNEL				
	TAILRACE TUNNEL HORZ (FT)	3,170	1,910	2,270	3,500
	TAILRACE TUNNEL VERTICAL (FT)	126	103	99	108
	TAILRACE TUNNEL SLOPE (%)	3.97%	5.39%	4.36%	3.09%
	TAILRACE TUNNEL LENGTH (FT)	3,173	1,913	2,272	3,502
	POWER TUNNEL / SHAFT				
	POWER TUNNEL LENGTH (FT)	13,640	2,050	2,750	8,120
	POWER TUNNEL TOTAL VERTICAL DIST (FT)	1,541	927	963	1,050
	POWER TUNNEL GRADE	4%	4%	4%	4%
	POWER TUNNEL RISE (FT)	545.60	82.00	110.00	324.80
	POWER SHAFT BOTTOM EL (FT MSL)	1,002.60	562.00	594.00	799.80
	POWER SHAFT LENGTH (FT)	995.4	845.0	853.0	725.2
	POWER CABLE / EMERGENCY TUNNEL				
	OPERATING FLOOR EL (FT MSL)	508.1	544.6	552.5	532.5
	TUNNEL PORTAL ELEVATION (FT MSL)	800.0	800.0	800.0	800.0
	TUNNEL RISE (FT)	291.9	255.4	247.5	267.5
	TUNNEL GRADE (%)	20%	20%	20%	20%
	TUNNEL LENGTH (FT)	1,460	1,277	1,237	1,338
	POWERHOUSE DISTANCE FROM UPPER RES I/O (FT)	13,640.0	2,050.0	2,750.0	8,120.0
	POWERHOUSE DISTANCE FROM LOWER RES I/O (FT)	3,170.0	1,910.0	2,270.0	3,500.0
	TOTAL DISTANCE UPPER/LOWER RES I/O (FT)	16,810	3,960	5,020	11,620

PARAMETRIC PUMPED STORAGE PRELIMINARY DESIGN MODEL	ACCESS TUNNEL	ACCESS TUNNEL	ACCESS TUNNEL	ACCESS TUNNEL
BLACK & VEATCH H&HS	SVPSP	SVPSP	SVPSP	SVPSP
OPTION	A1	B3	C3	D3
ACCESS TUNNEL				
ACCESS TUNNEL PORTAL ELEVATION (FT MSL)	800	800	800	800
ACCESS TUNNEL GRADE (%)	8%	8%	8%	8%
ACCESS TUNEL LENGTH (INCLINED FT)	3,649	3,193	3,094	3,344
ACCESS TUNNEL HEIGHT (FT)	20.00	20.00	20.00	20.00
ACCESS TUNNEL FLOOR WIDTH	23.00	23.00	23.00	23.00
TUNNEL CONFIGURATION	HORSESHOE	HORSESHOE	HORSESHOE	HORSESHOE
WALL HEIGHT -STRAIGHT (FT)	10.00	10.00	10.00	10.00
ROOF RADIUS (FT)	11.50	11.50	11.50	11.50
CROSS SECTION AREA (SF)	438	438	438	438
TUNNEL VOLUME (CF)	1,596,875	1,397,391	1,353,881	1,463,582
TUNNEL VOLUME (CY)	59,144	51,755	50,144	54,207
EXCAVATION UNIT PRICE ($/CY)	$ 80.00	$ 80.00	$ 80.00	$ 80.00
EXCAVATION COST ($)	$ 4,731,481	$ 4,140,418	$ 4,011,500	$ 4,336,540
BULKING FACTOR	1.25	1.25	1.25	1.25
HAULING AND DISPOSAL VOL (CY)	73,929	64,694	62,680	67,758
HAUL AND DISPOSE UNIT PRICE ($/CY)	$ 30.00	$ 30.00	$ 30.00	$ 30.00
HAUL AND DISPOSE COST ($)	$ 2,217,882	$ 1,940,821	$ 1,880,391	$ 2,032,753
FLOOR PAVING THICKNESS (FT)	1.00	1.00	1.00	1.00
FLOOR PAVING VOLUME (CY)	3,108	2,720	2,635	2,849
FLOOR PAVING UNIT PRICE ($/CY)	$ 400	$ 400	$ 400	$ 400
FLOOR PAVING COST ($)	$ 1,243,327	$ 1,088,009	$ 1,054,132	$ 1,139,545
WALL ROCK PROTECTION TYPE	SHOTCRETE	SHOTCRETE	SHOTCRETE	SHOTCRETE
WALL PROTECTION AREA (SF)	138,859	121,512	117,729	127,268
WALL PROTECTION UNIT PRICE ($/SF)	$ 50	$ 50	$ 50	$ 50
WALL PROTECTION COST	$ 6,942,934	$ 6,075,613	$ 5,886,440	$ 6,363,402
ALLOWANCE FOR LIGHTS AND DRAINS (%)	20%	20%	20%	20%
LIGHTS AND DRAINS COST	$ 1,388,587	$ 1,215,123	$ 1,177,288	$ 1,272,680
TOTAL ACCESS TUNNEL COST	$ 16,530,000	$ 14,460,000	$ 14,010,000	$ 15,150,000

	PARAMETRIC PUMPED STORAGE PRELIMINARY DESIGN MODEL	TAILRACE TUNNEL	TAILRACE TUNNEL	TAILRACE TUNNEL	TAILRACE TUNNEL
	BLACK & VEATCH H&HS	SVPSP	SVPSP	SVPSP	SVPSP
	OPTION	A1	B3	C3	D3
	TUNNEL LENGTH (FT)	3,172.5	1,912.8	2,272.2	3,501.7
	PUMPING FLOW (CFS)	4,116.9	7,279.9	6,714.9	5,995.4
	PUMPING VELOCITY (FPS)	15.0	15.0	15.0	15.0
	TUNNEL AREA REQUIRED (SF)	274.46	485.32	447.66	399.69
	TUNNEL RADIUS REQUIRED (FT)	9.3	12.4	11.9	11.3
	TUNNEL DIAMETER REQUIRED (FT)	18.7	24.9	23.9	22.6
	TUNNEL DIA ALLOWANCE FOR LINER	5.00	5.00	5.00	5.00
	EXCAVATION DIAMETER (FT)	23.70	29.86	28.88	27.56
	EXCAVATION AREA PER FOOT (SF)	440.87	700.14	654.74	596.45
	EXCVATION VOLUME (CY)	51,802	49,600	55,099	77,355
	EXCAVATION UNIT PRICE ($/CY)	$ 65.00	$ 65.00	$ 65.00	$ 65.00
	EXCAVATION COST ($)	$ 3,367,132	$ 3,224,006	$ 3,581,443	$ 5,028,048
	ALLOWANCE FOR TEMP SUPPORTS OF EXCAVATION COST	15%	15%	15%	15%
	TEMP SUPPORTS	$ 505,070	$ 483,601	$ 537,216	$ 754,207
	BULKING FACTOR	1.25	1.25	1.25	1.25
	HAULING AND DISPOSAL VOL (CY)	64,753	62,000	68,874	96,693
	HAUL AND DISPOSE UNIT PRICE ($/CY)	$ 30.00	$ 30.00	$ 30.00	$ 30.00
	HAUL AND DISPOSE COST ($)	$ 1,942,576	$ 1,860,004	$ 2,066,217	$ 2,900,797
	CONCRETE LINER AREA (SF/FT)	166.41	214.81	207.08	196.76
	CONCRETE VOLUME (CY)	19,553	15,218	17,427	25,518
	CONCRETE LINER UNIT COST ($/CY)	$ 600.00	$ 600.00	$ 600.00	$ 600.00
	CONCRETE LINER COST	$ 11,731,748	$ 9,130,821	$ 10,456,195	$ 15,310,654
	TOTAL TAILRACE TUNNEL COST	$ 17,600,000	$ 14,700,000	$ 16,700,000	$ 24,000,000

	PARAMETRIC PUMPED STORAGE PRELIMINARY DESIGN MODEL	CABLE / ESCP TUNNEL	CABLE / ESCP TUNNEL	CABLE / ESCP TUNNEL	CABLE / ESCP TUNNEL
	BLACK & VEATCH H&HS	SVPSP	SVPSP	SVPSP	SVPSP
	OPTION	A1	B3	C3	D3
	TUNNEL PORTAL ELEVATION (FT MSL)	800	800	800	800
	TUNNEL LENGTH (INCLINED FT)	1,460	1,277	1,237	1,338
	ACCESS TUNNEL HEIGHT (FT)	15.00	15.00	15.00	15.00
	ACCESS TUNNEL FLOOR WIDTH	15.00	15.00	15.00	15.00
	TUNNEL CONFIGURATION	HORSESHOE	HORSESHOE	HORSESHOE	HORSESHOE
	WALL HEIGHT -STRAIGHT (FT)	7.50	7.50	7.50	7.50
	ROOF RADIUS (FT)	7.50	7.50	7.50	7.50
	CROSS SECTION AREA (SF)	201	201	201	201
	TUNNEL VOLUME (CF)	293,097	256,483	248,497	268,632
	TUNNEL VOLUME (CY)	10,855	9,499	9,204	9,949
	EXCAVATION UNIT PRICE ($/CY)	$ 60	$ 60.00	$ 60.00	$ 60.00
	EXCAVATION COST ($)	$ 651,328	$ 569,963	$ 552,216	$ 596,961
	BULKING FACTOR	1.25	1.25	1.25	1.25
	HAULING AND DISPOSAL VOL (CY)	13,569	11,874	11,505	12,437
	HAUL AND DISPOSE UNIT PRICE ($/CY)	$ 25.00	$ 25.00	$ 25.00	$ 25.00
	HAUL AND DISPOSE COST ($)	$ 339,233	$ 296,856	$ 287,613	$ 310,917
	FLOOR PAVING THICKNESS (FT)	0.50	0.50	0.50	0.50
	FLOOR PAVING VOLUME (CY)	405	355	344	372
	FLOOR PAVING UNIT PRICE ($/CY)	$ 400	$ 400	$ 400	$ 400
	FLOOR PAVING COST ($)	$ 162,173	$ 141,914	$ 137,496	$ 148,636
	WALL ROCK PROTECTION TYPE	SHOTCRETE	SHOTCRETE	SHOTCRETE	SHOTCRETE
	WALL PROTECTION AREA (SF)	39,080	34,198	33,133	35,818
	WALL PROTECTION UNIT PRICE ($/SF)	$ 50	$ 50	$ 50	$ 50
	WALL PROTECTION COST	$ 1,953,983	$ 1,709,889	$ 1,656,649	$ 1,790,882
	ALLOWANCE FOR LIGHTS AND DRAINS (%)	20%	20%	20%	20%
	LIGHTS AND DRAINS COST	$ 390,797	$ 341,978	$ 331,330	$ 358,176
	TOTAL CABLE TUNNEL COST	$ 3,500,000	$ 3,070,000	$ 2,970,000	$ 3,210,000

	PARAMETRIC PUMPED STORAGE PRELIMINARY DESIGN MODEL	POWER TUNNEL / SHAFT	POWER TUNNEL / SHAFT	POWER TUNNEL / SHAFT	POWER TUNNEL / SHAFT
	BLACK & VEATCH H&HS	SVPSP	SVPSP	SVPSP	SVPSP
	OPTION	A1	B3	C3	D3
	POWER TUNNEL				
	UPPER RESERVOIR FLOOR (FT MSL)	1,998.0	1,407.0	1,447.0	1,525.0
	UNIT CENTERLINE (FT MSL)	457.0	480.0	484.0	475.0
	SHAFT LENGTH (FT)	995.4	845.0	853.0	725.2
	TUNNEL LENGTH (FT)	13,640.00	2,050.00	2,750.00	8,120.00
	GENERATION FLOW (CFS)	4,947	8,748	8,069	7,205
	SELECTED VELOCITY (FPS)	25	25	25	25
	REQUIRED AREA (SF)	197.89	349.93	322.77	288.19
	REQUIRED RADIUS (FT)	7.94	10.56	10.14	9.58
	REQUIRED DIAMETER (FT)	15.88	21.11	20.28	19.16
	REQUIRED CIRCUM. (FT)	49.86	66.30	63.67	60.16
	LINER EXCAVATION DIA ALLOW (FT)	2.00	2.00	2.00	2.00
	EXCVATION DIAMETER (FT)	17.88	23.11	22.28	21.16
	EXCAVATION AREA PER FOOT (SF)	250.89	419.37	389.59	351.50
	EXCVATION VOLUME (CY)	135,995	44,966	51,988	115,150
	EXCAVATION UNIT PRICE ($/CY)	$ 80.00	$ 80.00	$ 80.00	$ 80.00
	EXCAVATION COST ($)	$ 10,879,614	$ 3,597,258	$ 4,159,045	$ 9,211,988
	ALLOWANCE FOR TEMP SUPPORTS OF EXCAVATION COST	15%	15%	15%	15%
	TEMP SUPPORTS	$ 1,631,942	$ 539,589	$ 623,857	$ 1,381,798
	BULKING FACTOR	1.25	1.25	1.25	1.25
	HAULING AND DISPOSAL VOL (CY)	169,994	56,207	64,985	143,937
	HAUL AND DISPOSE UNIT PRICE ($/CY)	$ 30.00	$ 30.00	$ 30.00	$ 30.00
	HAUL AND DISPOSE COST ($)	$ 5,099,819	$ 1,686,215	$ 1,949,552	$ 4,318,120
	STEEL LINER THICKNESS (AVG) (IN)	0.75	0.50	0.50	0.50
	STEEL LINER UNIT WEIGHT (LBS/SF) W/ ALLOWANCE FOR STIFFENERS	50.0	25.0	25.0	25.0
	STEEL LINER UNIT COST ($/LB)	$ 4.00	$ 4.00	$ 4.00	$ 4.00
	STEEL LINER AREA (SF)	729,652	191,927	229,408	532,161
	STEEL LINER WEIGHT (LBS)	36,482,622	4,798,175	5,735,201	13,304,025
	STEEL LINER COST	$ 145,930,489	$ 19,192,702	$ 22,940,805	$ 53,216,099
	BACK-GROUTING THICKNESS (FT)	1.0	1.0	1.0	1.0
	BACK GROUTING AREA (SF/FT)	49.9	66.3	63.7	60.2
	BACK GROUTING VOLUME (CY)	27,024	7,108	8,497	19,710
	BACK GROUTING UNIT COST ($/CY)	$400.00	$400.00	$400.00	$400.00
	BACK GROUTING COST	$ 10,809,666	$ 2,843,363	$ 3,398,638	$ 7,883,866
	TOTAL POWER TUNNEL COST	$ 174,400,000	$ 27,900,000	$ 33,100,000	$ 76,100,000

PARAMETRIC PUMPED STORAGE PRELIMINARY DESIGN MODEL	INLET/OUTLET STRUCTURES	INLET/OUTLET STRUCTURES	INLET/OUTLET STRUCTURES	INLET/OUTLET STRUCTURES
BLACK & VEATCH H&HS	SVPSP	SVPSP	SVPSP	SVPSP
OPTION	A1	B3	C3	D3
UPPER RESERVOIR I/O				
HORIZONTAL TYPE				
PUMPING FLOW - MAX CFS	4117	7280	6715	5995
APPROACH VELOCITY (FPS)	1.00	1.00	1.00	1.00
GATE ROOM ELEV	2,126.0	1,530.0	1,620.0	1,743.0
GATE ROOM AREA (SF)	675.6	1,194.7	1,102.0	983.9
I/O STRUCTURE INVERT (EL)	1,963.0	1,372.0	1,412.0	1,490.0
GATE SHAFT HEIGHT (FT)	147.1	136.9	187.7	233.8
GATE SHAFT LENGTH (FT)	16.0	16.0	16.0	16.0
GATE SHAFT WIDTH (FT)	15.9	21.1	20.3	19.2
GATE SHAFT SLOT AREA (SF)	127.0	168.9	162.2	153.3
INLET AREA REQUIRED (SF)	4,117	7,280	6,715	5,995
INLET HEIGHT(FT)	40.0	40.0	40.0	40.0
INLET WIDTH (FT)	102.9	182.0	167.9	149.9
PENSTOCK OUTSIDE DIAMETER (FT)	15.9	21.1	20.3	19.2
TRIANGLE BASE SLICE WIDTH (FT)	43.5	80.4	73.8	65.4
TRUMPET RATIO	3.0	3.0	3.0	3.0
LENGTH OF TRUMPET (FT)	130.6	241.3	221.4	196.1
GATE SHAFT CONCRETE VOLUME (CY)	692	856	1,128	1,328
THICKNESS OF WALL, SLAB AND ROOF	4.0	4.0	4.0	4.0
BASE SLAB CONCRETE VOLUME (CY)	1,149.0	3,630.8	3,085.5	2,455.4
WALL CONCRETE VOLUME (CY)	1,631.1	3,014.8	2,765.8	2,449.7
ROOF SLAB CONCRETE (CY)	1,149.0	3,630.8	3,085.5	2,455.4
NUMBER OF PIERS	4.0	8.0	7.0	5.0
LENGTH OF PIER (FT)	32.6	60.3	55.3	49.0
WIDTH OF PIER (FT)	6.0	6.0	6.0	6.0
PIER CONCRETE VOLUME (CY)	1,160.6	4,290.2	3,443.9	2,178.7
TOTAL CONCRETE VOLUME	5,089.7	14,566.6	12,380.7	9,539.2
CONCRETE UNIT PRICE ($/CY)	$ 500.00	$ 500.00	$ 500.00	$ 500.00
CONCRETE COST	$ 2,544,871	$ 7,283,283	$ 6,190,331	$ 4,769,587
TRASHRACK WEIGHT (LB/SF)	130.0	130.0	130.0	130.0
STEEL UNIT COST ($/LB)	$ 2.00	$ 2.00	$ 2.00	$ 2.00
TRASHRACK ALLOWANCE	$ 1,070,395	$ 1,892,764	$ 1,745,863	$ 1,558,806
GATE ROOM BUILDING COST @ $125/SF	$ 84,452	$ 149,335	$ 137,745	$ 122,986
GATE ROOM EQUIPMENT COST	$ 779,189	$ 1,166,550	$ 1,097,355	$ 1,009,246
TOTAL GATE ROOM COST	$ 863,641	$ 1,315,885	$ 1,235,100	$ 1,132,232
EXCAVATION HEIGHT	163.0	158.0	208.0	253.0
EXCAVATION LENGTH	-	350.0	-	650
EXCAVATION WIDTH AT GATE ROOM	31.8	42.2	40.6	38.3
EXCAVATION WIDTH IN RESERVOIR	10.7	185.5	39.3	291.5
EXCAVATION VOLUME (CY)	0	116,587	0	502,138
EXCAVATION UNIT PRICE ($/CY)	$ 60.00	$ 60.00	$ 60.00	$ 60.00
EXCAVATON COST	$ -	$ 6,995,248	$ -	$ 30,128,267
EXCAVATION VOLUME -EQUAL CONCRETE VOLUME X1.2	6,107.7	-	14,856.8	-
EXCAVATION UNIT PRICE ($/CY)	$ 60.00	$ 60.00	$ 60.00	$ 50.00
EXCAVATION COST	$ 366,461	$ -	$ 891,408	$ -

TOTAL UPPER I/O COST	$ 4,900,000	$ 17,500,000	$ 10,100,000	$ 17,600,000
LOWER RESERVOIR I/O				
VERTICAL TYPE				
PUMPING FLOW - MAX CFS	4117	7280	6715	5995
APPROACH VELOCITY (FPS)	1.00	1.00	1.00	1.00
GATE HOUSE ELEV	800.0	800.0	800.0	800.0
GATE HOUSE AREA (SF)	42.9	42.9	42.9	42.9
I/O STRUCTURE INVERT (EL)	583.0	583.0	583.0	583.0
GATE SHAFT HEIGHT (FT)	235.7	241.9	240.9	239.6
GATE SHAFT DIAMETER (FT)	40.0	40.0	40.0	40.0
SHAFT ALLOWANCE FOR LINING (FT)	5.0	5.0	5.0	5.0
SHAFT EXCAVATION DIA. (FT)	45.0	45.0	45.0	45.0
SHAFT EXCAVATION VOLUME (CY)	13,877	14,240	14,182	14,104
EXCAVATION UNIT PRICE ($/CY)	60.00	60.00	60.00	60.00
GATE SHAFT EXCAVATION COST	$ 832,605	$ 854,387	$ 850,909	$ 846,262
ALLOWANCE FOR TEMP SUPPORTS OF EXCAVATION	15%	15%	15%	15%
GATE HOUSE SHAFT TEMP SUPPORTS COST ($)	$ 124,891	$ 128,158	$ 127,636	$ 126,939
BULKING FACTOR	1.25	1.25	1.25	1.25
HAULING AND DISPOSAL VOL (CY)	17,346	17,800	17,727	17,630
HAUL AND DISPOSE UNIT PRICE ($/CY)	$ 30.00	$ 30.00	$ 30.00	$ 30.00
HAUL AND DISPOSE COST ($)	$ 520,378	$ 533,992	$ 531,818	$ 528,914
SHAFT CONCRETE LINING VOL. (CY)	2,912	2,989	2,976	2,960
SHAFT DIVIDER CONC. WALL VOL. (CY)	1,397	1,433	1,427	1,420
TOTAL GATE SHAFT CONCRETE (CY)	4,309	4,422	4,404	4,380
CONCRETE UNIT PRICE ($/CY)	$ 600	$ 600	$ 600	$ 600
GATE SHAFT CONC LINING COST ($)	$ 2,585,481	$ 2,653,120	$ 2,642,322	$ 2,627,891
GATE HOUSE BLDG COST @ $125/SF	$ 5,360	$ 5,360	$ 5,360	$ 5,360
GATE HOUSE EQUIPMENT COST ($)	$ 307,000	$ 307,000	$ 307,000	$ 307,000
TOTAL GATE HOUSE COST ($)	$ 312,360	$ 312,360	$ 312,360	$ 312,360
DISTANCE FROM GATE HOUSE TO RESERVOIR (FT)	920.0	660.0	1,270.0	875.0
TUNNEL ADD. LENGTH (FT)	770.0	510.0	1,120.0	725.0
I/O SHAFT DIAMETER (FT) = TUNNEL ID	18.7	24.9	23.9	22.6
I/O SHAFT LENGTH (FT)	74.8	99.5	95.5	90.3
I/O SHAFT ALLOWANCE FOR LINING (FT)	5.0	5.0	5.0	5.0
I/O SHAFT EXCAVATION DIAMETER (FT)	23.7	29.9	28.9	27.6
I/O SHAFT EXCAVATION VOL (CY)	1,221	2,579	2,316	1,994
EXCAVATION UNIT PRICE ($/CY)	$ 60.00	$ 60.00	$ 60.00	$ 60.00
I/O SHAFT EXCAVATION COST ($)	$ 73,276	$ 154,743	$ 138,981	$ 119,633
ALLOWANCE FOR TEMP SUPPORTS OF EXCAVATION COST	15%	15%	15%	15%
I/O TEMP SUPPORTS COST ($)	$ 10,991	$ 23,211	$ 20,847	$ 17,945
BULKING FACTOR	1.25	1.25	1.25	1.25
HAULING AND DISPOSAL VOL (CY)	1,527	3,224	2,895	2,492
HAUL AND DISPOSE UNIT PRICE ($/CY)	$ 30.00	$ 30.00	$ 30.00	$ 30.00
I/O SHAFT HAUL AND DISPOSE COST ($)	$ 45,797	$ 96,714	$ 86,863	$ 74,771

I/O SHAFT CONCRETE LINING VOL. (CY)	461	791	733	658
CONCRETE UNIT PRICE ($/CY)	$ 600	$ 600	$ 600	$ 600
I/O SHAFT CONCRETE LINING COST ($)	$ 276,583	$ 474,774	$ 439,575	$ 394,646
TRASHRACK AREA REQUIRED (SF)	4,117	7,280	6,715	5,995
TRASHRACK HEIGHT (FT)	30.0	30.0	30.0	30.0
TRASHRACK LENGTH (FT)	137.2	242.7	223.8	199.8
NUMBER OF PIERS	12.0	12.0	12.0	12.0
PIER WIDTH (FT)	4.0	4.0	4.0	4.0
TOTAL I/O CIRCUMFERENCE (FT)	185.2	290.7	271.8	247.8
I/O DIAMETER (FT)	59.0	92.6	86.6	78.9
4 X I/O SHAFT DIAMETER (FT)	74.8	99.5	95.5	90.3
I/O DIAMETER (FT) (FINAL)	75.0	100.0	95.0	90.0
I/O ROOF AND SLAB THICKNESS (FT)	4.0	4.0	4.0	4.0
I/O ROOF SLAB CONCRETE VOL. (CY)	654.2	1,163.0	1,049.6	942.0
I/O BASE SLAB CONCRETE VOL. (CY)	613.5	1,091.1	983.3	882.8
I/O PIER CONCRETE VOL. (CY)	125.1	167.0	158.0	149.9
TOTAL I/O CONCRETE VOL. (CY)	1,392.8	2,421.0	2,190.9	1,974.6
I/O CONCRETE UNIT COST ($)	$ 600	$ 600	$ 600	$ 600
I/O CONCRETE COST ($)	$ 835,672	$ 1,452,596	$ 1,314,524	$ 1,184,785
TRASHRACK WEIGHT (LB/SF)	130.0	130.0	130.0	$ 130
STEEL UNIT COST ($/LB)	$ 2.00	$ 2.00	$ 2.00	$ 2.00
TRASHRACK COST ($)	$ 1,462,500	$ 2,074,800	$ 1,952,340	$ 1,829,880
I/O EXCAVATION HEIGHT (FT)	90.0	100.0	98.0	96.0
I/O EXCAVATION LENGTH (FT)	225.0	250.0	245.0	240.0
I/O EXCAVATION WIDTH (FT)	187.5	250.0	237.5	225.0
I/O EXCAVATION VOLUME (CY)	70,313	115,741	105,600	96,000
EXCAVATION UNIT PRICE ($/CY)	$ 60.00	$ 60.00	$ 60.00	$ 60.00
I/O EXCAVATON COST ($)	$ 4,218,750	$ 6,944,444	$ 6,335,972	$ 5,760,000
BULKING FACTOR	1.25	1.25	1.25	1.25
HAULING AND DISPOSAL VOL (CY)	87,891	144,676	131,999	120,000
HAUL AND DISPOSE UNIT PRICE ($/CY)	$ 30.00	$ 30.00	$ 30.00	$ 30.00
I/O EXCVATION HAUL AND DISPOSE COST ($)	$ 2,636,719	$ 4,340,278	$ 3,959,983	$ 3,600,000
COFFERDAM HEIGHT (FT)	45.0	45.0	45.0	45.0
COFFERDAM DIA. (FT)	54.0	54.0	54.0	54.0
COFFERDAM LENGTH (FT)	392	508	496	483
COFFERDAM UNIT COST ($/FT)	$ 75,000	$ 75,000	$ 75,000	$ 75,000
COFFERDAM COST ($)	$ 29,362,500	$ 38,100,000	$ 37,162,500	$ 36,225,000
LOWER RESERVOIR COFFERDAM ALLOWANCE (MISC.)	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000
TOTAL LOWER I/O COST	$ 44,400,000	$ 59,300,000	$ 57,000,000	$ 54,800,000

PARAMETRIC PUMPED STORAGE PRELIMINARY DESIGN MODEL	PHS STRUCTURE	PHS STRUCTURE	PHS STRUCTURE	PHS STRUCTURE
BLACK & VEATCH H&HS	SVPSP	SVPSP	SVPSP	SVPSP
OPTION	A	B3	C3	D3
POWERHOUSE STRUCTURE				
NUMBER OF UNITS	2	2	2	2
RUNNER DIAMETER (FT)	14.60	18.44	19.57	16.42
LENGTH CALCULATION				
ACCESS BAY WIDTH (FT)	35	35	35	35
SERVICE BAY LENGTH (FT)	60	60	60	60
UNIT BAY LENGTH (FT) (20 FT MIN)	29.2	36.9	39.1	32.8
TOTAL UNIT BAY LENGTHS (FT)	58.4	73.8	78.3	65.7
BAY LENGTH BETWEEN UNITS	30.0	30.0	30.0	30.0
TOTAL BAY LENGTHS BETWEEN UNITS (FT)	30.0	30.0	30.0	30.0
ELECTRICAL BAY WIDTH PER UNIT	40.0	40.0	40.0	40.0
TOTAL ELECTRICAL BAY LENGTH	80.0	80.0	80.0	80.0
TOTAL POWERHOUSE LENGTH (FT)	233.4	248.8	253.3	240.7
WIDTH CALCULATION				
VALVE / MECH AUX BAY WIDTH (FT)	30.0	30.0	30.0	30.0
UNIT BAY WIDTH (FT)	24.6	28.4	29.6	26.4
CONTROL ROOM / OFFICE / SHOPS BAY WIDTH (FT)	30.0	30.0	30.0	30.0
TOTAL POWERHOUSE WIDTH (FT)	84.6	88.4	89.6	86.4
POWERHOUSE HEIGHT				
CL RUNNER ELEV (FT MSL)	457.0	480.0	484.0	475.0
CROWN HEIGHT (FT)	21.1	22.1	22.4	21.6
AVG HEIGHT OF CROWN FOR AREA CALC (FT)	10.6	11.1	11.2	10.8
HEIGHT OP FLOOR TO CROWN (FT)	30.0	30.0	30.0	30.0
HEIGHT OP FLOOR TO CL RUNNER (FT)	51.1	64.6	68.5	57.5
OPERATING FLOOR ELEV (FT MSL)	508.1	544.6	552.5	532.5
HEIGHT CL RUNNER TO BOTTOM OF POWERHOUSE (FT)	36.5	46.1	48.9	41.0
TOTAL POWERHOUSE HEIGHT MAX (FT)	138.7	162.8	169.8	150.1
POWERHOUSE HEIGHT FOR VOLUME CALC (FT)	128.2	151.7	158.6	139.3
POWERHOUSE EXCAVATION VOL (CF)	2,530,256	3,338,275	3,599,297	2,896,924
POWERHOUSE EXCAVATION VOL (CY)	93,713	123,640	133,307	107,293
POWERHOUSE EXCAVATION UNIT PRICE ($/CY)	$ 100.00	$ 100.00	$ 100.00	$ 100.00
POWERHOUSE EXCAVATION COST	$ 9,371,319	$ 12,363,980	$ 13,330,730	$ 10,729,347
ROCK BULKING FACTOR	1.25	1.25	1.25	1.25
ROCK VOL -- HAUL AND DISPOSE (CY)	117,141.49	154,549.75	166,634.12	134,116.84
UNIT PRICE -HAUL AND DISPOSE ($/CY)	$ 60.00	$ 60.00	$ 60.00	$ 60.00
HAUL AND DISPOSE COST	$ 7,028,490	$ 9,272,985	$ 9,998,047	$ 8,047,010
EXCAVATION WALL SURFACE AREA (SF)	81,502	102,326	108,785	67,046
ROOF ROCK SURFACE (SF)	19,744	22,003	22,689	20,797

ROCK BOLT PATTERN AREA -WALL (SF)	50	50	50	50
ROCK BOLT PATTERN AREA -ROOF (SF)	25	25	25	25
NUMBER OF ROCKBOLTS - WALL	1,630	2,047	2,176	1,341
NUMBER OF ROCK BOLTS ROOF	790	880	908	832
TOTAL ROCK BOLTS	2,420	2,927	3,083	2,173
AVG ROCK BOLT LENGTH (FT)	50	50	50	50
TOTAL ROCK BOLT LENGTH (FT)	120,990	146,332	154,162	108,640
UNIT COST FOR ROCKBOLTS ($/FT)	$ 20.00	$ 20.00	$ 20.00	$ 20.00
ROCK BOLT COST	$ 2,419,794	$ 2,926,642	$ 3,083,239	$ 2,172,806
SHOTCRETE % OF WALL SURFACE	50%	50%	50%	50%
SURFACE AREA OF SHOTCRETE (SF)	50,623	62,165	65,737	43,922
UNIT COST FOR SHOTCRETE ($/SF)	$ 50.00	$ 50.00	$ 50.00	$ 50.00
SHOTCRETE	$ 2,531,149	$ 3,108,231	$ 3,286,835	$ 2,196,083
TOTAL EXCAVATION COST	$ 21,350,752	$ 27,671,838	$ 29,698,852	$ 23,145,246
POWERHOUSE STRUCTURE COST				
RATIO OF CONCRETE TO EXCAVATED VOLUME	40%	40%	40%	40%
CONCRETE VOLUME	37,485	49,456	53,323	42,917
UNIT COST FOR CONCRETE ($/CY AVG)	$ 800.00	$ 800.00	$ 800.00	$ 800.00
POWERHOUSE CONCRETE COST	$ 29,988,222	$ 39,564,737	$ 42,658,336	$ 34,333,911
ARCHITECTURAL ALLOWANCE	10%	10%	10%	10%
ARCHITECTURAL COST	$ 2,998,822	$ 3,956,474	$ 4,265,834	$ 3,433,391
TOTAL POWERHOUSE STRUCTURE	$ 54,400,000	$ 71,200,000	$ 76,700,000	$ 61,000,000

	PARAMETRIC PUMPED STORAGE PRELIMINARY DESIGN MODEL	MECHANICAL	MECHANICAL	MECHANICAL	MECHANICAL
	BLACK & VEATCH H&HS	SVPSP	SVPSP	SVPSP	SVPSP
	OPTION	A1	B3	C3	D3
	PT/MG COST				
	UNIT CAPACITY	250.00	250.00	250.00	250.00
	NUMBER OF UNITS	2	2	2	2
	RUNNER DIAMETER	1.0	1.0	1.0	1.0
	AVERAGE COST PT/MG PER MW($)	520,000	520,000	520,000	520,000
	BASE PT/MG COST PER UNIT	$ 130,000,000	$ 130,000,000	$ 130,000,000	$ 130,000,000
	COST ADJUSTMENT FOR RUNNER DIAMETER	1.00	1.26	1.34	1.12
	ADJUSTED COST PER UNIT	$ 130,000,000	$ 164,265,691	$ 174,326,156	$ 146,199,197
	PT/MG TOTAL COST	$ 260,000,000	$ 329,000,000	$ 349,000,000	$ 293,000,000
	BALANCE OF PLANT				
	GENERATOR COOLING PUMPS	$ 450,000	$ 450,000	$ 450,000	$ 450,000
	BRIDGE CRANE (300t)	$ 3,000,000	$ 3,000,000	$ 3,000,000	$ 3,000,000
	DRAIN AND DEWATERING PUMPS	$ 200,000	$ 200,000	$ 200,000	$ 200,000
	HVAC	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000
	SERVICE WATER PUMPS	$ 100,000	$ 100,000	$ 100,000	$ 100,000
	POTABLE WATER SKID	$ 50,000	$ 50,000	$ 50,000	$ 50,000
	FIRE PROTECTION SYSTEM	$ 2,000,000	$ 2,000,000	$ 2,000,000	$ 2,000,000
	OIL STORAGE TANKS	$ 60,000	$ 60,000	$ 60,000	$ 60,000
	SUBTOTAL EQUIPMENT	$ 6,860,000	$ 6,860,000	$ 6,860,000	$ 6,860,000
	ALLOWANCE FOR VALVES	25%	25%	25%	25%
	ALLOWANCE FOR INSTRUMENTS	15%	15%	15%	15%
	ALLOWANCE FOR PIPING/ACCESSORIES	50%	50%	50%	50%
	COST FOR VALVES	$ 1,715,000	$ 1,715,000	$ 1,715,000	$ 1,715,000
	COST FOR INSTRUMENTS	$ 1,029,000	$ 1,029,000	$ 1,029,000	$ 1,029,000
	COST FOR PIPING/ACCESSORIES	$ 3,430,000	$ 3,430,000	$ 3,430,000	$ 3,430,000
	ALLOWANCE TOTAL	$ 6,174,001	$ 6,174,001	$ 6,174,001	$ 6,174,001
	BOP MECHANICAL TOTAL	$ 13,100,000	$ 13,100,000	$ 13,100,000	$ 13,100,000
	TOTAL MECHANICAL	$ 274,000,000	$ 343,000,000	$ 363,000,000	$ 307,000,000

Pump Discharge (cfs)	2058	3640	3357	2998
Specific Speed (gpm)	1625.00	2100.00	2000.00	2000.00
Rotational Speed (rpm)	379.88	240.75	253.65	292.25
Adjusted Rotational Speed (rpm)	380.00	240.00	240.00	300.00
Adjusted Specific Speed (gpm)	1625.52	2093.44	1892.35	2053.00
Peripheral Velocity	0.98	1.04	1.06	1.05
Runner Diameter (ft)	14.60	18.44	19.57	16.42
Runner Diameter (m)	4.45	5.62	5.97	5.00
Runner Ratio	1.00	1.26	1.34	1.12
Thoma sigma	0.14	0.22	0.20	0.19
NPSH (ft)	191.24	169.95	167.50	176.22
Atmospheric Pressure Head (ft)	31.42	31.42	31.42	31.42
Setting (ft)	160	136	134	143
Lower Reservoir Min Operating Level (ft)	618.00	618.00	618.00	618.00
Setting Elevation (ft)	458.00	482.00	484.00	475.00
Adjusted Setting (ft)	161.0	138.0	134.0	143.0
Adjusted Runner Elevation (ft)	457.0	480.0	484.0	475.0
Tailrace Horiz (ft)	3170	1910	2270	3500
Tailrace Slope (%)	5.08%	7.23%	5.90%	4.09%

Tailrace Length (ft)	3174	1915	2274	3503
Iterated headloss calculations				
Site	*A1*	*B3*	*C3*	*D3*
Rated Flow (cfs)	2058	3640	3357	2998
P.S. Diameter (ft)	12.00	18.00	17.00	15.00
Distance from Upper to Lower Reservoir (ft)	16810.00	3960.00	5020.00	11620.00
Elevation Difference (ft) (Avg Gross Hd)	1366.00	772.50	837.50	938.00
Tailrace Horiz. Distance (ft)	3170.00	1910.00	2270.00	3500.00
Tailrace Tunnel Length (ft)	2925.00	1667.00	2024.00	3253.00
Headloss (ft) (from calcs)	6.60	4.19	2.10	4.42
Setting Input (ft)	178.12	163.67	134.82	144.94
Setting Output (ft)	153.62	134.74	134.39	140.78

	PARAMETRIC PUMPED STORAGE PRELIMINARY DESIGN MODEL	ELECTRICAL	ELECTRICAL	ELECTRICAL	ELECTRICAL
	BLACK & VEATCH H&HS	SVPSP	SVPSP	SVPSP	SVPSP
	OPTION	A1	B3	C3	D3
	PT/MG COST				
	UNIT CAPACITY	250.00	250.00	250.00	250.00
	NUMBER OF UNITS	2	2	2	2
		1.0	1.0	1.0	1.0
	BOP ELECTRICAL				
	BALANCE OF PLANT COSTS (1)				
	EMERGENCY GENERATOR (1)	$ 200,000	$ 200,000	$ 200,000	$ 200,000
	STEP-UP TRANSFORMER UNIT COST	$ 1,500,000	$ 1,500,000	$ 1,500,000	$ 1,500,000
	STEP-UP TRANSFORMER COST	$ 3,000,000	$ 3,000,000	$ 3,000,000	$ 3,000,000
	BUS FROM XFMR TO SURFACE	$ 2,000,000	$ 2,000,000	$ 2,000,000	$ 2,000,000
	ISOPHASE BUS - GEN TO TRANSFORMERS PER UNIT	$ 500,000	$ 500,000	$ 500,000	$ 500,000
	ISOPHASE BUS DUCT $	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000
	SWITCHGEAR PER UNIT (16 kV)	$ 600,000	$ 600,000	$ 600,000	$ 600,000
	SWITCHGEAR $	$ 1,200,000	$ 1,200,000	$ 1,200,000	$ 1,200,000
	STATION SERVICE XFMR (1)	$ 200,000	$ 200,000	$ 200,000	$ 200,000
	MOTOR CONTROL CENTER PER UNIT	$ 200,000	$ 200,000	$ 200,000	$ 200,000
	MOTOR CONTROL CENTER COST	$ 400,000	$ 400,000	$ 400,000	$ 400,000
	LV PANELS	$ 50,000	$ 50,000	$ 50,000	$ 50,000
	NG AND LINE CUBICLES PER UNIT	$ 125,000	$ 125,000	$ 125,000	$ 125,000
	NG AND LINE CUBICLES $	$ 250,000	$ 250,000	$ 250,000	$ 250,000
	UPS EQUIPMENT	$ 250,000	$ 250,000	$ 250,000	$ 250,000
	BATTERY AND CHARGER	$ 300,000	$ 300,000	$ 300,000	$ 300,000
	SFC EQUIPMENT (PER UNIT)	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000
	SFC EQUIPMENT COST $	$ 2,000,000	$ 2,000,000	$ 2,000,000	$ 2,000,000
	CONTROL / PROT SYSTEM EQUIPMENT	$ 2,200,000	$ 2,200,000	$ 2,200,000	$ 2,200,000
	TOTAL ELECT EQUIPMENT COST	$ 13,000,000	$ 13,000,000	$ 13,000,000	$ 13,000,000
	ALLOWANCE FOR GROUNDING	$ 2,000,000	$ 2,000,000	$ 2,000,000	$ 2,000,000
	ALLOWANCE FOR LIGHTING	$ 1,500,000	$ 1,500,000	$ 1,500,000	$ 1,500,000
	ALLOWANCE FOR RACEWAY	25%	25%	25%	25%
	ALLOWANCE FOR CABLE	40%	40%	40%	40%
	RACEWAY COST $	$ 3,250,000	$ 3,250,000	$ 3,250,000	$ 3,250,000
	CABLE COST $	$ 5,200,000	$ 5,200,000	$ 5,200,000	$ 5,200,000
	TOTAL ELECTRICAL $	$ 25,500,000	$ 25,500,000	$ 25,500,000	$ 25,500,000

	PARAMETRIC PUMPED STORAGE PRELIMINARY DESIGN MODEL	Roadways	Roadways	Roadways	Roadways	
	BLACK & VEATCH H&HS	SVPSP	SVPSP	SVPSP	SVPSP	
	OPTION	A1	B3	C3	D3	
	Roadways					
	Existing					
	Length	20,300.00	25,200.00	10,500.00	9,100.00	15
	Cost $15 per feet	304,500.00	378,000.00	157,500.00	136,500.00	
	New					
	Length	25,600.00	8,900.00	18,100.00	9,300.00	25
	Cost $15 per feet	640,000.00	222,500.00	452,500.00	232,500.00	
	Total Roadways	$945,000	$601,000	$610,000	$369,000	
	Easements					
	Roadways					
	Square Footage	1,377,000	1,023,000	858,000	552,000	
	Subtotal Acres	31.6	23.5	19.7	12.7	
	Tunnels					
	Lengths	21,151	7,923	7,537	3,788	
	Square Footage	634,524	237,683	226,097	113,639	
	Subtotal Acres	14.6	5.5	5.2	2.6	
	Total Acres Easements	46.2	28.9	24.9	15.3	
	Total Easements	$162,000	$102,000	$88,000	$54,000	3500