APPENDIX A:

San Quentin Substation Basis of Design Report

SAN QUENTIN PUMP STATION BASIS OF DESIGN

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EXECUTIVE SUMMARY

The City of San Rafael retained CSW|Stuber-Stroeh Engineering Group (CSW|ST2) to provide a Basis of Design and Concept Plan to replace the San Quentin pump station and portions of the 60-inch diameter outfall pipe. The pump stations was built in 1972 and has been operational for 46 years. During that time the outfall pipe deteriorated to the point where leaks are noticeable at the ground surface when the pumps are in use. The pumps have been maintained, but are passed the efficient operating life and need to be repaired. Furthermore the station itself shows signs of age and continues to settle differentially relative to the outfall pipe and site. Repairing the structure is anticipated to be more expensive than replacement of the pump station. The purpose of the Concept Plan is to review the various options to replace the pump station and outfall pipe and set parameters under which the design will be completed. The Concept Plan provides a visual aid for pump station alternatives, whereas the Basis of Design provides the foundation for future construction documents.

CSW|ST2 completed a field and boundary survey to use as a base map in the design. The survey information includes existing site features, limits of wetland boundary, and property lines. The information may be utilized in future construction documents and for temporary construction easement and/or right of entry determinations.

CSW|ST2 coordinated the City's maintenance staff to better understand existing pump station conditions and flooding concerns within the watershed during large storm events. We subsequently modeled significant storm events to determine appropriate pump alternatives and pipe types and sizes. To establish the physical constraints and opportunities of the site the CSW|ST2 team studied the geotechnical and environmental conditions for inclusion within the Basis of Design and future construction documents.

The intent of the Basis of Design is to give City staff an opportunity to review and comment on the preferred alternatives and layout prior to completing construction documents. As shown in Appendix G, three (3) pump station layouts were considered in two (2) locations. In addition to the alternatives and layouts included herein, we considered relocating the pump station closer to the Bay (Option 2 in Appendix G). This option, however, proved to have significant costs resulting from environmental impacts, mitigation and monitoring, and land acquisition from neighboring private landowner(s). The relocated pump station option is not financially feasible as indicated in Table 7. Further discussion of the environmental challenges are listed in the WRA technical memorandum (Appendix B). As indicated in the Concept plan, locating the new pump station as close to the existing pump station as possible provides the following benefits:

- Maintains existing low point in the channel and lagoon drainage system
- Minimizes impacts to sensitive habitat areas
- Provides close proximity to the existing electrical service resulting in no electrical service relocation
- Provides sufficient area for construction staging
- Provides better access and staging areas including a turnaround for maintenance vehicles

Locating the new pump station in close proximity to the existing is not without some challenges. Those challenges include potential long-term settlement, a greater length of outfall pipe and minimizing the backwater to the outfall pipe and pump caused by tidal fluctuation. CSW|ST2 feels these challenges can be mitigated by including the following in the design:

- Design structural elements to provide a floating foundation for the pump station and distribute loads to the soft underlying bay muds thus minimizing additional settlement and allowing more consistent settlement between the pump station and the outfall pipe.
- Utilize lightweight back fills to decrease the trench loading and settlement.
- Install flap gates to prevent intrusion of bay water into the new storm drain pipe.

Pump station layout is based on recommendations listed in the Hydraulic Institute Standards to increase pump efficiency. Per the findings of the Drainage Study report, either two (2) pumps each with a 100 cfs or three (3) pumps each with a 66 cfs capacity will provide approximately 1-foot freeboard elevation to the maximum water surface elevation indicated by staff (Appendix G). Utilizing three (3) 100 cfs pumps will further increase the freeboard to 2-foot and increase the time between pump runs. The pump type will be axial flow vertical pumps. Additionally, a smaller submersible pump will be utilized for nuisance water between storms and through the dry months. Benefits and constraints for the feasible pump types are listed in Tables 3 and 4. Opinion of probable construction costs for the pump station based on relocating closer to the Bay or adjacent to the existing pump station are listed in Tables 7 and 8. Differential costs associated with utilizing either a (2) or (3) pump configuration with either a pump vault or pressure chamber are indicated in Tables 5 and 6.

INTRODUCTION

The San Quentin Pump Station was constructed over 40 years ago to serve a portion of east San Rafael that was envisioned as a major light industrial area extending toward the Richmond San Rafael Bridge from the canal area. The pump station lifts storm water from the large low-lying detention ponds through the levee for discharge to San Rafael Bay. Under the current pump system, if the pump station loses power or one of the two pumps fail, then flooding occurs in the industrial areas and along Highway 580 leading to the Richmond San Rafael Bridge.

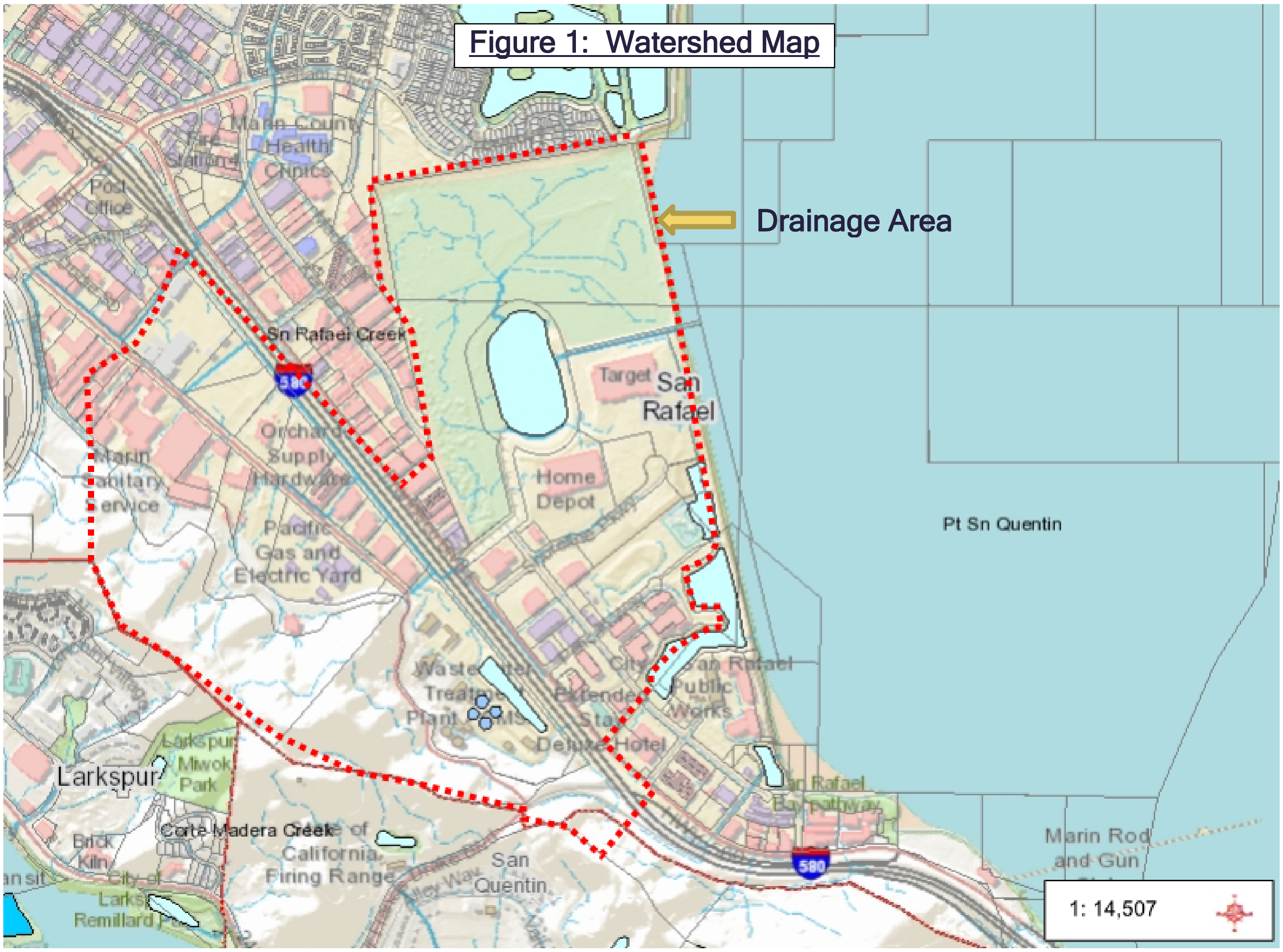

Figure 1: Watershed Map

Regional geologic mapping (California Division of Mines and Geology, 1976) indicates the project site is underlain by artificial fill over Bay Mud with marsh deposits to the north. The pump station is located on former marshland that was reportedly filled in the 1960s and was developed as a pump station in 1973 as a part of the East San Rafael Drainage Assessment District. The surface elevations at the site generally range between +2 and +5 and are protected from the bay by a levee along the San Rafael Bay. At the east end of the site the outfall pipe lies under the levee (elevation +9) before terminating in the outboard bank of the levee. The adjacent ±20-foot high embankment was constructed for the Target store in 2013 and is located immediately south of the outfall pipeline.

The San Quentin Disposal Site (SQDS), located immediately south of the site was a permitted Class III landfill that accepted construction and landscape debris from 1968 to 1987. Regional Water Quality Control Board (RWQCB) landfill closure report (2001) indicates the landfill does not extend onto the pump station site.

HYDROLOGY AND HYDRAULIC STUDY

The San Quentin Pump Station watershed is approximately 403 acres (see Figure 1) and flows into a storage basin created as part of the East San Rafael Drainage Assessment. The watershed consists of Hydrologic Soil Groups “B” and “undefined” (which is assumed to be Group “D”) according to the USDA Soil Survey. Hydrologic models were developed for a double storm event to determine potential flooding of at-risk properties if the detention basin is partially filled from a smaller significant storm which is preceded by a large storm event. Given the slow percolation of the bay muds, we assumed the detention basin will be partially filled. Consequently, we modeled a 5-year, 24-hour storm event followed by the 100-year, 24-hour storm event with a two hour overlap between the two events. Results of the 5- and 100-year peak discharge rates for the 24-hour storm event are indicated below and in the Drainage Study.

Table 1: 24-Hour Rain Event Peak Discharge Rates

Recurrence Interval	Time to Peak (hours)	Peak Discharge Rate (cfs)
5-Year	3.1	153.28
100-Year	3.1	329.10

Anecdotal evidence indicates the parcels on the west side of Highway 101 flood since the current pumps only yield 50 cfs at their peak discharge flows. The at-risk properties are located at an elevation of approximately 4.0 foot (NAVD 88). This elevation was used as the allowable peak water elevation in developing the hydraulic model for the pond and pumps. Results of four (4) different pump sizing configurations based on the maximum 4.0 foot water surface elevation (WSEL) are indicated below and in the Drainage Study.

Table 2: Pump Analysis Results

Pump Flow Rate	Maximum WSEL	Constraints / Benefits		
		Freeboard	Pump On	Pump Off
(2) 50 cfs	3.9	N/A	24 hrs	N/A
(3) 66 cfs	2.9	1’	8 hrs	2 hrs
(2) 80 cfs	3.9	N/A	17 hrs	1 hr
(2) 100 cfs	2.9	1’	10 hrs	2 hrs
(3) 100 cfs	2.1	2’	6 hrs	3 hrs

The analysis indicates that either a three (3) 66 cfs pump system or a two (2) 100 cfs pump system has sufficient capacity to convey the peak discharge rate from the 5-year 24-hour and 100-year 24-hour storm in series while maintaining a 1’ freeboard above the WSEL and allowing for pump rest periods.

PUMP SELECTION

The pump station will house two (2) or three (3) Cascade vertical axial flow pumps. To provide enough head/pressure for the storm water discharged from the pumps to reach the bay, water will be pumped into a pressure chamber which will be connected to the outfall pipe. The pump efficiency for (3) 200 HP pumps capable of 66 cfs is over 81%. The pump efficiency for (2) 300 HP pumps capable of 100 cfs is approximately 80%. The proposed discharge assembly, pressure box will be configured to better drive the outflow from the pump discharges to the outfall pipe through directed discharge assemblies and other miscellaneous equipment housed in the pump station and pressure chamber. These improvements will improve normal operations as well. In our opinion, using (3) vertical axial flow pumps is the preferred option. Utilizing (3) smaller 66 cfs pumps provides flexibility and increase efficiency for the more frequent, smaller storm events while also having the capacity for the 100year storm event. Utilizing (3) 100 cfs pumps provides more flexibility on larger storm events with increased pump rest time and a higher freeboard over the maximum 4.0 foot water surface elevation. The benefits and constraints of the vertical pump are listed below.

Table 3: Vertical Pump Review

Benefits	Constraints
Low Maintenance	Unsuitability of Shallow Sumps
Easy Access	Headloss in Suction & Discharge Assembly
Freshwater Flushing of Bearings	Limited Pump Access
Small Floor Area	Noise Level

Options reviewed for submersible pumps are shown in Appendix E. Flygt pumps capable of handling either 66 or 100 cfs were reviewed. Pump efficiency for (3) 185 HP pump capable of 66 cfs is approximately 81%. The pump efficiency for (2) 230 HP pump capable of 100 cfs is approximately 81%. A smaller 3 HP submersible pump shall be included in the final documents for nuisance water during dry weather season and maintenance purposes. The benefits and constraints of the submersible pump are listed below.

Table 4: Submersible Pump Review

Benefits	Constraints
Availability of Pump Sizes	More Expensive Pump & Motor
Natural Cooling by Stormwater	Need to Submerge Pump
Easy to Remove for Repairs	Limited Motor Sizes
Protection from Dry Well Flooding	

PUMP STATION LOCATION AND LAYOUT

The most cost efficient pump station location is typically at the low point of the watershed. As indicated in the environmental technical memorandum (Appendix B), the existing pump station is already located at the low point. As part of the East San Rafael Drainage Assessment District project, the area was excavated to create a low point at the existing pump station. The area excavated for the lagoon is now considered to be sensitive habitat area (wetland) with special status plant and animal species. Relocating the pump station closer to the bay, as indicated in Option 2 (Appendix G), requires excavation and a net loss of wetlands area for a new drainage channel. Recent Corps regulations favor purchase of credits in mitigation banks over project-sponsored mitigation. The cost of these credits are expected to run approximately $1 million. This cost does not include monitoring requirements or land acquisition costs, which will be required if this option is considered. Locating the pump station closer to the bay places the station between the toe of the building pad for the Target store and the top of the bank of the storage pond. This is a narrow area and does not provide an easy staging area from which to build the station.

Locating a new pump station south of the existing pump station minimizes wetland disturbance and provides the benefit of a relative large construction staging area with good access. As indicated in Options 1 and 3 (Appendix G), the pump station will be located near the existing PG&E power pole. The proximity to the current station should not significantly affect the operation of the existing pump station during construction. As indicated in the Concept plan, CSW|ST2 recommends the new pump station be located close to the existing watershed low point, south of the existing pump station.


Figure 2: Aerial Map

As indicated in the geotechnical report, the planned pump station is feasible from a geotechnical standpoint. The weight of the new pump station is anticipated to be less than the weight of the excavated soil to build the station. , The weight of the removed soil will offset the weight of the new station, minimizing additional settlement of the structure. Primary geotechnical considerations for the project include:

- Excavation through soft Bay Mud
- Providing appropriate temporary support for excavations
- Providing appropriate seismic and structural design for any new structures
- Providing for proper bedding and trench backfill
- Minimizing the extent of excavation and associated backfills for new manholes and other below-grade structures that are underlain by Bay Mud

As indicated in the geotechnical report, the planned pump station is feasible from a geotechnical standpoint. The weight of the new pump station is anticipated to be less than the weight of the excavated soil to build the station. The weight of the removed soil will offset the weight of the new station, minimizing additional settlement of the structure. Primary geotechnical considerations for the project include:

The Motor Control Center and other electrical components are housed outside the pump station. An electrical instrumentation and controls design will be incorporated in the final pump station design. Based upon initial review of the PG&E electrical facilities, the existing transformer will be a ground mounted transformer. As indicated in the Concept plan, an area will be designated for an existing City supplied portable generator. Alarm monitoring and controls will be determined by City staff and incorporated in the final design plans.

DISCHARGE PIPING

Discharge piping and miscellaneous equipment housed in the pump station will be necessary for normal operations. Options for use of a pressure vault or a manifold discharge assembly were reviewed. The current pump station utilizes a pressure vault which connects to a 60inch diameter outfall pipe. A pressure vault minimizes pressure loss, construction costs, and future maintenance.

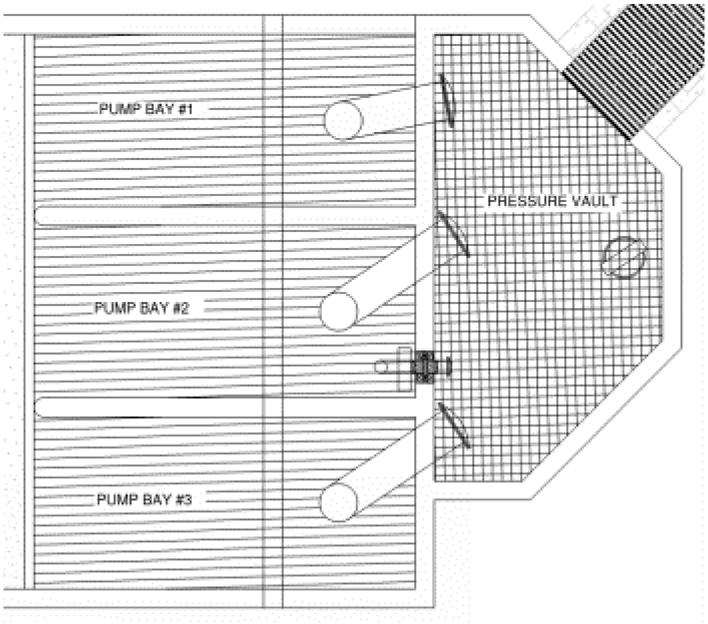

Figure 3: Pressure Vault

Hydraulic calculations for a pressurized manifold system revealed high headloss through the bends and valves, which would require larger pumps further increasing costs. Consequently, the pressure vault is recommended to be used for the final design of the pump station.

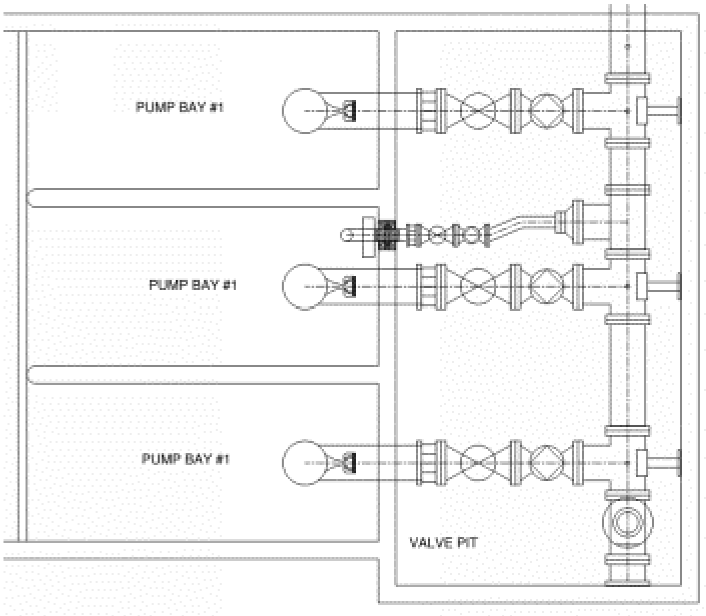

Figure 4: Pressure Manifold

As indicated in the Concept plan, the pressure vault will connect to a pressurized outfall pipe. Based on discussion with City maintenance crews, the existing 60-inch RCP outfall pipe leaks and has settled unevenly in the bay mud causing sags. Due to poor access and presence of water in the existing outfall pipe, TV inspection was not a viable option to determine the existing pipe condition. CSW|ST2 retained Bess Test Lab to utilize Ground Penetrating Radar (GPR) and potholing to help locate the size and magnitude of potential pipe sags. GPR is limited in moist clays as the electromagnetic signal is weak and the results are approximate. Based on results of the GPR, our preliminary opinion is that there are three (3) sags and either a dislocated or broken pipe segment. The magnitude of the sags appears to be less than 12-inches.

CSW|ST2 looked at three potential options to improve the 900 feet of discharge outfall pipe. These options include 1) slip lining the existing 60-inch RCP with the new 48-inch diameter HDPE, 2) installing a Cured in Place Pipe (CIPP) within the 60-inch RCP, and 3) open trench removal of the existing pipe and installing in a new 48-inch diameter HDPE pipe. Given the narrow (25-foot) work area and insignificant headloss, a larger diameter pipe was not considered for open trench construction. The following includes the benefits and constraints of each option.

Option 1 – Slip Line

Slip lining the existing pipe may be feasible if the existing pipe sags and any dislocation(s) are repaired. Location of the existing pipe deficiencies and anomalies are approximate due to limited access. The contractor will be required to dewater the existing storm drain and maintain operation of the existing pump station while thoroughly cleaning and installing the new pipe inside of the existing pipe. The benefits of this option include a smoother lining and less headloss. Slip line rehabilitation technology has been historically successful and works well with long straight pipe segments. Given the environmentally sensitive habitat and limited work area (25-foot wide), slip lining provides a viable solution.

Option 2 – Cured in Place Pipe

The second option, CIPP, requires fixing existing sags and dislocation and then placement of one or two layers of carbon fiber with thermosetting resin inside the existing 60-inch RCP. The impregnated liner is then filled with hot water or steam and held at a temperature above 180°F until the resin chemically reacts, curing to form a new pipe inside the old pipe. Ultraviolet light is an alternative method for curing the CIPP liner. Major factors impacting the thickness of the CIPP liner include the extent of deterioration of the existing pipe, the depth of cover, and the presence of storm and/or groundwater.

The advantage of this method is the liner is thinner than the pipeline materials used for slip lining. The new pipeline is mechanically bonded to the host pipe and movement of the cured pipe is not likely to occur. Since the CIPP pipe essentially coats the existing pipe with a very smooth wall, the outfall pipe will more efficiently convey the storm water to the bay, reducing the headloss in the outfall pipe. CIPP is typically cost-competitive with slip lining. One major drawback with the CIPP method is the potential release of styrene from curing water to the bay. Special catchment may be required to mitigate the potential environmental impact. In addition, the existing outfall discharge pipe requires repairs and dewatering during the CIPP process. Given the environmentally sensitive habitat and potential release of styrene, this option is not included in the Concept plan.

Option 3 – Open Trench for Pipe Replacement

Opencut replacement of the existing discharge pipe with a new 48inch HDPE pipe is a viable option. As indicated in the Concept plan, a new manhole located outside the 100foot BCDC shoreline band is recommended to provide access for future maintenance and to allow installation of a flap gate to prevent tidal water from the bay to enter the outfall pipe. Using a smaller 48inch HDPE will have an equivalent head loss through the outfall pipe as compared with the existing 60inch diameter RCP.

Hazen Williams Equation

$$H_f = \frac{3.022 * V^{1.85} * L}{C^{1.85} * D^{1.165}}$$

where H_f = headloss, ft
V = velocity, ft/s
C = roughness coefficient
D = pipe diameter, ft

$$H_f = \frac{3.022 * 10.2^{1.85} * 986}{130^{1.85} * 4^{1.165}} = 6.1 \text{ ft}$$

48 inch HDPE

$$H_f = \frac{3.022 * 10.2^{1.85} * 986}{100^{1.85} * 5^{1.165}} = 6.7 \text{ ft}$$

60 inch RCP

Disadvantages of installing a new pipe is the limited, narrow length of property and construction cost. A temporary construction easement or Right-of-Entry may be required by the adjacent private land owners.

Geotechnical review indicates the bottom of the new outfall pipeline excavation will typically not extend through the fill soils and into the underlying Bay Mud. Where excavations extend into soft, loose, or otherwise unstable soils, the trench bottoms will be overexcavated a minimum of 18 inches below the planned pipe invert and backfilled with a light weight backfill and/or drain rock.

OPINION OF PROBABLE CONSTRUCTION COST

Throughout the Basis of Design, CSW|ST2 explored a variety of design options with varying approaches to the number and type of pumps, design of the pressure chamber or manifold at the pumps discharge, replacing the outfall, and location of the pump station. The following matrices show the options which could be considered from the various combinations of approaches. Within each cell we have identified a relative cost to the 3pump with pressure chamber and 48" opencut outfall pipe scenario indicated in the opinions of probable construction cost in Tables 7 and 8.

Table 5: Alternatives Cost Analysis for New Pump Station Near Bay

Pumps/Discharge	48" Open-Cut	48" Slip Line	60" CIPP
2 Pumps w/manifold	+75,000	+63,750	+58,750
2 Pumps w/pressure chamber	-237,500	-248,750	-253,750
3 Pumps w/manifold	+312,500	+301,250	+296,250
3 Pumps w/pressure chamber	-	-11,250	-16,250

Table 6: Alternatives Cost Analysis for New Pump Station Near Existing Station

Pumps/Discharge	48" Open-Cut	48" Slip Line	60" CIPP
2 Pumps w/manifold	-237,500	-300,000	-325,000
2 Pumps w/pressure chamber	+75,000	+12,500	-12,500
3 Pumps w/manifold	+312,500	+250,000	+225,000
3 Pumps w/pressure chamber	-	-62,500	-87,500

The matrices demonstrate the relative values of various combinations. In our opinion, the largest variables are the pump station location, use of a pressurized manifold, and use of CIPP in the existing outfall pipe. To explore the pump station location further, we included the anticipated incidental costs which include mitigation, monitoring, and property acquisition. As indicated in Tables 5 and 6, locating the pump station closer to the bay significantly increases the incidental costs. Utilizing a pressurized manifold significantly increases the construction cost and future maintenance cost to maintain the valves. Use of CIPP in the outfall pipe in Tables 5 and 6 does not show the potential high incidental cost for mitigation and monitoring. As previously indicated, use of CIPP is not anticipated due to the sensitive habitat and release of chemicals in the CIPP process.

The Concept plan of the three (3) pump station options are depicted in Appendix (H). The first layout option assumes locating the new pump station adjacent to the existing pump station. This option assumes the use of three (3) vertical axial flow pumps and provides two (2) alternatives for repair/replacement of the existing outfall discharge pipe outside the 100foot BCDC shoreline band. The second option assumes a similar pump layout (three (3) axial flow pumps) and also provides two alternatives for the repair/replacement of the existing out fall. The following two tables show the opinion of probable construction and incidental costs for Option 1 and Option 2:

Table 7: Layout Option 1 (3-Pumping Units)

Construction Cost =	$ 2,940,000
Incidental Expenses =	$ 2,691,640
Total =	$ 5,631,640

Table 8: Layout Option 2 (3-Pumping Units)

Construction Cost =	$	2,981,250
Incidental Expenses =	$	254,000
Total =	$	3,235,250

The two tables show a significant difference between probable costs: $3.2 to $5.6 million. While the outfall pipe line item cost for locating the pump station near the existing station is much higher, the cost is more than offset by the incidental costs of land acquisition and environmental mitigation. Additionally, there is an increase in cost for locating the new pump station closer to the bay resulting from a very confined site.

RECOMENDATIONS

The Basis of Design report covered the following items pertinent to the San Quentin pump station construction and outfall pipe repair/replacement.

- Defined the watershed basin size draining to the San Quentin Pump Station
- Quantified the storm water runoff with the watershed basin based on a 5-year storm event followed by a 100-year storm event
- Confirmed the storage volume within the existing lagoon
- Defined options for locating the new pump station various layout configurations
- Defined the pump unit type, capacity, size, and quantity based on the design WSEL
- Identified existing conditions of the 60-inch RCP
- Identified Repair/replacement options for the pump station outfall discharge piping
- Developed opinions of probable construction and incidental costs for the new pump station

Of the two (2) potential pump station locations, the anticipated incidental cost for environmental mitigation and land acquisition to locate the pump station near the bay is nearly equivalent to the construction cost, which significantly increases the overall project cost. As a result, we recommend relocating the pump station within City lands at the low point of the watershed.

There are two (2) potential pump types appropriate for this application: Vertical axial flow and submersible. Based on lower maintenance requirements, ease of access, and physical site features, we recommend use of vertical axial flow pumps for the main pumps, while utilizing a smaller submersible pump for nuisance water during the dry weather season.

The report reviews the use of two (2) and three (3) pumping units in the new pump station. We recommend using three (3) vertical axial flow pumps either with a 66 or 100 cfs capacity. Three (3) pumps provides more flexibility for operation and maintenance for the more frequent, smaller storm events and larger storm events than options with two (2) pumps. In the three pump system, one (1) pump could be out of operation, and the remaining two pumps could handle a single 100-year storm event without exceeding the 4.0 maximum water surface elevation.

As discussed herein, the outfall can be improved in several ways. At this time we propose bringing both the slip lining and open trench approaches forward into the first construction document phase to best asses the City’s options. As we identify whether or not land acquisition is required, we can determine the best outfall pipe option.

APPENDIX A, SUB-APPENDIX A:

Draft Geotechnical Investigation Report

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GEOTECHNICAL INVESTIGATION
CSW/STUBER-STROEH ENGINEERING GROUP
SAN QUENTIN PUMP STATION RECONSTRUCTION
SAN RAFAEL, CALIFORNIA

March 30, 2018

Job No. 737.299

Prepared For:
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CERTIFICATION

This document is an instrument of service, prepared by or under the direction of the undersigned professionals, in accordance with the current ordinary standard of care. The service specifically excludes the investigation of polychlorinated byphenols, radon, asbestos or any other hazardous materials. The document is for the sole use of the client and consultants on this project. No other use is authorized. If the project changes, or more than two years have passed since issuance of this report, the findings and recommendations must be updated.

MILLER PACIFIC ENGINEERING GROUP (a California corporation)	REVIEWED BY
DRAFT	DRAFT
Eric Dabanian Geotechnical Engineer No. 2526 (Expires 6/30/19)	Scott Stephens Geotechnical Engineer No. 2398 (Expires 6/30/19)

GEOTECHNICAL INVESTIGATION
CSW/STUBER-STROEH ENGINEERING GROUP
SAN QUENTIN PUMP STATION RECONSTRUCTION
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GEOTECHNICAL INVESTIGATION
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SAN RAFAEL, CALIFORNIA

1.0 INTRODUCTION

This report presents the results of our Geotechnical Investigation for the San Rafael Department of Public Works' San Quentin Pump Station Reconstruction Project in San Rafael, California. The site is located east of Francisco Boulevard East and immediately north of the Target Store, as shown on the Site Location Map, Figure 1.

Our work was performed in accordance with our Agreement for Professional Services dated January 10, 2018. The purpose of our Geotechnical Investigation was to explore subsurface conditions and to develop geotechnical criteria for design and construction of the pump station improvements and associated new sewer pipeline. The scope of our services includes:

- Review of geotechnical reference documents regarding development of the existing pump station and the adjacent Target Store.
- Exploration of subsurface conditions with one test boring located within the footprint of the planned pump station.
- Geotechnical laboratory testing to estimate pertinent engineering properties of the soils encountered during our exploration.
- Evaluation of relevant geologic hazards including seismic shaking, settlement, and other hazards.
- Preparing geotechnical recommendations and design criteria related to foundations, lateral pressures, temporary support of excavations, trench backfill, seismic design, and other geotechnical-related items.
- Preparation of this report which summarizes our subsurface exploration and laboratory testing programs, evaluation of relevant geologic hazards, including settlement, and geotechnical recommendations and design criteria.

2.0 PROJECT DESCRIPTION

The project generally consists of replacing the existing pump station and 1,000 feet of discharge pipe with a new pump station located immediately south of the existing pump station. The site is located immediately north of a closed landfill and is underlain by relatively thick deposits of weak, compressible bay mud. We understand the ground around the pump station has experienced roughly 2-feet of settlement since it was constructed in 1972. Repairs have been made to the pump station/discharge pipe connection which continues to settle. The existing pump station is supported on deep driven piles and therefore is likely not experiencing settlement. The proposed improvements are shown on the Preliminary Site Plan, Figure 2.

3.0 SITE CONDITIONS

3.1 Regional Geology

The project site lies within the Coast Ranges geomorphic province of California. Regional topography within the Coast Ranges province is characterized by northwest-southeast trending mountain ridges and intervening valleys that parallel the major geologic structures, including the San Andreas Fault System. The province is also generally characterized by abundant landsliding and erosion, owing in part to its typically high levels of precipitation and seismic activity.

The oldest rocks in the region are the sedimentary, igneous, and metamorphic rocks of the Jurassic-Cretaceous age (190- to 65-million years old) Franciscan Complex. Within Marin County, a variety of sedimentary and volcanic rocks of Tertiary (1.8- to 65-million years old) and Quaternary (less than 1.8-million years old) age locally overlie the basement rocks of the Franciscan Complex. Tectonic deformation and erosion during late Tertiary and Quaternary time (the last several million years) formed the prominent coastal ridges and intervening valleys typical of the Coast Ranges province. The youngest geologic units in the region are Quaternary-age (last 1.8 million years) sedimentary deposits, including alluvial deposits which partially fill most of the valleys and colluvial deposits which typically blanket the lower portions of surrounding slopes.

The project site is located immediately west of San Pablo Bay. Regional geologic mapping (California Division of Mines and Geology, 1976) indicates that the site is underlain by artificial fill over Bay Mud with marsh deposits mapped directly to the north. A Regional Geologic Map and descriptions of the mapped geologic units are shown on Figure 3.

3.2 Seismicity

The project site is located within the seismically active San Francisco Bay Area and will therefore experience the effects of future earthquakes. Earthquakes are the product of the build-up and sudden release of strain along a “fault” or zone of weakness in the earth's crust. Stored energy may be released as soon as it is generated or it may be accumulated and stored for long periods of time. Individual releases may be so small that they are detected only by sensitive instruments, or they may be violent enough to cause destruction over vast areas.

Faults are seldom single cracks in the earth's crust but are typically comprised of localized shear zones which link together to form larger fault zones. Within the Bay Area, faults are concentrated along the San Andreas Fault zone. The movement between rock formations along either side of a fault may be horizontal, vertical, or a combination and is radiated outward in the form of energy waves. The amplitude and frequency of earthquake ground motions partially depends on the material through which it is moving. The earthquake force is transmitted through hard rock in short, rapid vibrations, while this energy becomes a long, high-amplitude motion when moving through soft ground materials, such as Bay Mud.

An “active” fault is one that shows displacement within the last 11,000 years (i.e. Holocene) and has a reported average slip rate greater than 0.1 mm per year. The California Division of Mines and Geology (1998) has mapped various active and inactive faults in the region. These faults, defined as either California Building Code Source Type “A” or “B,” are shown in relation to the project site on the attached Active Fault Map, Figure 4. The nearest known active faults to the site are the San Andreas and Hayward Faults. The San Andreas Fault is located approximately 16.2 kilometers (10 miles) southwest of the site whereas the Hayward Fault is located approximately 11.4 kilometers (7 miles) to the northeast.

3.3 Surface Conditions and Site History

The existing San Quentin Pump Station is located on former marshland that was reportedly filled in the 1960s and was developed as a pump station in 1973 as a part of the East San Rafael Drainage Assessment District. The surface elevations at the site generally range between about +2 and +3, except for the east end of the site where the outfall pipe levee terminates at the shoreline levee which is at elevation +9. An approximately 20-foot high embankment constructed for the Target store is located immediately south of the outfall pipeline.

Topographic mapping by the USGS (1948) shows the site and vicinity as being within the San Francisco Bay. Topographic mapping by the USGS (1959) shows the existing shoreline perimeter levee is in place, extending to Murphy Rock where it makes a 90 degree bend and terminates east of Highway 17. In 1969 additional grading was performed to raise the grades of the existing levees on which the pump station and outfall pipe were constructed. Additional fill was placed in 1972 and 1973 for development of the pump station and outfall pipe. Construction documentation for the pump station, including site grading is included in a report prepared by Harding Lawson Associates (HLA, 1974).

The San Quentin Disposal Site (SQDS), located immediately south of the site was a permitted Class III landfill that accepted construction and landscape debris from 1968 to 1987. Regional Water Quality Control Board (RWQCB) landfill closure report (2001) indicates the landfill does not extend onto the pump station site. The Shoreline Center, located south and southwest of the site was developed in the late 1980s and early 1990s with the Home Depot and other commercial developments. The Target store was developed about 4 or 5 years ago. Kleinfelder (2012) performed extensive subsurface exploration for the Target store and prepared a design level geotechnical report for the project.

3.4 Field Exploration and Laboratory Testing

We explored subsurface conditions at the proposed pump station on February 9, 2018 with one boring at the approximate location shown on Figure 2. The boring was excavated using truck-mounted drilling equipment equipped with 6-inch diameter hollow stem augers to a depth of 51.5 feet below the ground surface. The boring was logged by our engineer and samples were obtained for classification and laboratory testing. Upon completion of the drilling, the boring was backfilled with neat cement grout and/or bentonite chips. Brief descriptions of the terms and methodology used in classifying soils are shown on the Soil Classification Chart, Figure A-1 and the exploratory boring log is presented on Figures A-2 through A-4.

Laboratory testing of relatively undisturbed samples included determination of moisture content, dry density, unconfined compressive strength, and consolidation in general accordance with applicable ASTM standards. The results of moisture, density, and compressive strength tests are shown on the boring log, while consolidation test results are presented on Figures A-5 through A-7. The subsurface exploration and geotechnical laboratory testing program is discussed in further detail in Appendix A.

3.5 Subsurface Conditions and Groundwater

Based on our field exploration, subsurface conditions are generally consistent with geologic mapping and the previous subsurface exploration by Harding Lawson and Associates. Boring 1 is located immediately south of the existing pump station, as shown on Figure 2. The boring encountered about 3-feet of medium dense sandy fill over 9-feet of medium stiff clayey fill over weak, compressible bay mud to the maximum depth explored, 52.5 feet.

Groundwater was encountered at Boring 1 at about 10 feet below ground surface. Because the boring was not left open for an extended period of time, a stabilized depth to groundwater may not have been observed. Groundwater elevations fluctuate seasonally and groundwater levels will likely be near the ground surface during periods of intense rainfall and/or high tides.

3.6 Previous Geotechnical Investigation

Harding Lawson Associates (1972) performed a subsurface exploration of the site which included one exploratory boring at the location of the existing pump station and several other nearby borings for evaluation of improvements to the East San Rafael Drainage Assessment District. The Boring Log for the existing pump station is presented in Appendix A. HLA provided geotechnical recommendations for support of the pump station using deep driven piles that extend below the bottom of the bay mud into dense alluvium.

Kleinfelder (2012) performed a subsurface investigation for the Target store site which included 5 test borings and 15 cone penetration tests (CPTs). The Kleinfelder exploration encountered 5 to 9 feet of landfill cover material comprised of clay, silt, sand and gravel over 21 to 48 feet of landfill material comprised of soil (mostly clay), construction debris (concrete, wood, metal and yard waste) over 49 to 72 feet of bay mud. Beneath the bay mud they encountered 8 to 46 feet of Old Bay Clay and alluvium over bedrock that was encountered at depths ranging from 110 to 153 feet below the ground surface. The Target store is supported on concrete piles that extend to bedrock.

4.0 GEOLOGIC HAZARDS

This section summarizes our review of commonly considered geologic hazards and discusses their potential impacts on the planned improvements. The primary geologic hazards which could affect the proposed development include strong seismic ground shaking, settlement due to ongoing consolidation of the soft bay mud, potentially corrosive soil and shallow groundwater conditions. Other geologic hazards are judged less than significant with regard to the proposed project. Each significant geologic hazard considered is discussed in further detail in the following paragraph.

4.1 Seismic Shaking

The project site will likely experience seismic ground shaking similar to other areas in the seismically active Bay Area. The intensity of ground shaking will depend on the characteristics of the causative fault, distance from the fault, the earthquake magnitude and duration, and site-specific geologic conditions.

While a site specific seismic hazard analysis is beyond the scope of our work for this project, it should be noted that the potential for strong seismic shaking at the project site is high. Due to their proximity and historic rates of activity, the San Andreas and Hayward Faults present the highest potential for severe ground shaking. The significant adverse impact associated with strong seismic shaking is potential damage to the pump station, new pipelines and related improvements. Measures to mitigate the effects of ground shaking should, as a minimum, include using flexible connections and designing any new structures to resist seismic loads as discussed in Section 5.1.

4.2 Liquefaction and Related Effects

Liquefaction refers to the sudden, temporary loss of soil strength during strong ground shaking. This phenomenon can occur in saturated, loose, granular deposits subjected to seismic shaking. Recent advances in liquefaction studies indicate that liquefaction can occur in granular materials with relatively high fines content provided the fines exhibit a plasticity index less than 7. Liquefaction can result in flow failure, lateral spreading, ground movement, settlement, and other related effects. Buried pipelines embedded within liquefied soils may also experience uplift due to buoyancy.

Geologic mapping and the results of our subsurface exploration indicate the project site is underlain by relatively thick deposits of bay mud which are not susceptible to liquefaction. The fill material is mostly comprised of clayey soils and not susceptible to liquefaction. Therefore, we judge the likelihood of damage to the new pump station and outfall pipe due to liquefaction is low.

4.3 Settlement

Significant settlement can occur when new loads are applied to soft, compressible soils such as the bay mud that exists beneath the project site. The rate and magnitude of potential settlements are dependent on the new loads that are applied, the thickness of compressible material and the inherent compressibility properties of the bay mud. We anticipate loads associated with the new pump station and pipeline and will generally be roughly balanced by the soil that is removed during excavation. However, ongoing settlements from fill placement performed in the 1960s and fills placed in 1972 for development of the existing pump station and discharge pipeline are expected to impact the project. Fills from development of the adjacent Target Store are not expected to impact the pump station but will cause additional settlement of the levee that supports the outfall pipeline. Raising grades at the site will also induce additional settlement but we understand that grades will remain as is.

Construction of new below-grade pump station may reduce surface loading and future long-term settlement near the structure, and some minor differential settlements may therefore occur between the pump station and the outfall pipeline. The pump station and pipeline may experience an additional 2 to 4-feet of settlement over the next 30 to 70 years. The pipeline should consist of a flexible material such as HDPE that tolerate differential settlements and should be attached to the pump station with a flexible connection. Future maintenance and repair of the pipeline should be expected as differential settlements occur.

Additional mitigation measures should include minimizing the extent of the excavation and required backfill to reduce the potential for new loads associated with compacted backfill. Lightweight backfill materials should be considered for excavations.

4.4 Corrosive Soils

Corrosive soil can damage buried metallic structures, cause concrete spalling, and deteriorate rebar reinforcement. The project site is underlain by bay mud which typically exhibits high chloride concentrations and low electrical resistivity, each of which are indicators of soluble salts and a higher susceptibility to corrosion. We therefore judge there is a moderate to high risk of damage to new buried facilities and corrosion should be considered during design of the site improvements.

Minimum mitigation measures should include designing concrete structures in accordance with applicable durability requirements outlined in ACI 318. Metallic components should incorporate protective coatings or other measures aimed at improving corrosion resistance. A qualified corrosion engineer should be retained to provide additional mitigation measures as required.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of our subsurface exploration, we judge that the planned pump station and outfall pipeline are feasible from a geotechnical standpoint. Primary geotechnical considerations for the project include: excavation through soft Bay Mud; providing appropriate temporary support for excavations; providing appropriate seismic and structural design for any new structures; providing for proper bedding and trench backfill; and minimizing the extent of excavation and associated backfills for new manholes and other below-grade structures that are underlain by Bay Mud. Additional discussion and recommendations addressing these and other considerations are presented in the following sections.

5.1 Seismic Design

Minimum mitigation of ground shaking includes seismic design of new structures in conformance with the provisions of the most recent edition (2016) of the California Building Code. The magnitude and character of these ground motions will depend on the particular earthquake and the site response characteristics. Based on the interpreted subsurface conditions and proximity of the San Andreas and Hayward Faults, we recommend the CBC coefficients and site values shown in Table 1 be used to calculate the design base shear of the new pump station improvements as applicable.

Table 1 – 2016 California Building Code Seismic Design Criteria

Parameter	Design Value
Site Class	E
Site Latitude	37.956°N
Site Longitude	-122.493°W
Spectral Response (short), S_S	1.500 g
Spectral Response (1-sec), S_1	0.600 g
Site Coefficient, F_a	0.9
Site Coefficient, F_V	2.4

Reference: USGS US Seismic Design Maps accessed on March 16, 2018.

5.2 Earthwork

Earthwork for the pump station improvements and new outfall pipeline should be performed in accordance with the following recommendations:

5.2.1 Excavations

Excavations for the pump station and discharge pipeline will generally encounter medium stiff clayey fill over soft bay mud. Shallow groundwater should also be expected and the contractor should anticipate the need for dewatering and shoring all excavations. In general, Bay Mud deposits are expected below the pump station but are not anticipated along the new outfall pipeline alignment. While not encountered in our borings, the backfill around and below the existing pump station may also include relatively permeable materials which may need to be dewatered prior to construction. Based on our subsurface exploration, we judge the majority of site excavation can be performed with typical equipment, such as medium-size excavators.

In unsupported excavations, the clayey fill soils will be susceptible to caving/sloughing below groundwater and the bay mud will be susceptible to squeezing. Definitions of the various ground behaviors are presented in the Tunnelman's Ground Classification for Soils, Figure 5. In accordance with OSHA soil type designations, the fill and bay mud are considered "Type C" soils. Temporary support for excavations should be installed prior to or during excavation to ensure the safety of workers and to reduce the potential for trench failure and damage to surrounding areas. Shoring and temporary support of excavations is discussed in further detail in Section 5.3

5.2.2 Trench Bottom Stabilization

Based on planned pipeline invert depths and the fill thicknesses observed during our subsurface exploration, we anticipate the bottom of excavations for the new outfall pipeline will typically not extend through the fill soils and into the underlying Bay Mud. However, in areas where excavations extend into soft, loose, or otherwise unstable soils, we recommend the trench bottoms be overexcavated a minimum of 12 inches below the planned pipe invert and backfilled with drain rock. The drain rock should be completely wrapped with a geotextile filter fabric consisting of Mirafi FW300 or an approved equivalent.

5.2.3 Fill Materials

Unless otherwise recommended by SRDPW or the pipe manufacturer, pipe bedding and embedment materials should consist of well-graded sand with 90 to 100 percent of particles passing the No. 4 sieve and no more than 5 percent finer than the No. 200 sieve. Provide the minimum bedding thickness beneath the pipe in accordance with the manufacturer's recommendations (typically 3 to 6 inches).

Fill materials used for pipe backfill should consist of non-expansive materials that are free of organic matter, have a Liquid Limit of less than 40 (ASTM D 4318), a Plasticity Index of less than 20 (ASTM D 4318), and have a minimum R-value of 20 (California Test 301). The fill material should contain no more than 50 percent of particles passing a No. 200 sieve and should have a maximum particle size of 4 inches. Some of the onsite fill soils may be suitable for re-use as trench backfill. The Bay Mud is not suitable for use as backfill and should be removed from the site.

In areas in which the pipe invert elevation is greater than 3 feet below the top of Bay Mud, we recommend using lightweight fill for backfilling to minimize new loads and the potential for settlement. The lightweight fill should be placed up to the top of Bay Mud and should consist of naturally-occurring volcanic rock with a maximum unit weight of 65 pounds per cubic foot, minimum Durability Index of 35 (California Test 229), minimum R-Value of 50 (California Test 301), and should meet the gradation requirements outlined below in Table 2. The lightweight fill should be completely wrapped with a geotextile filter fabric consisting of Mirafi FW300 or an approved equivalent.

Table 2 – Gradation Requirements for Lightweight Fill

Sieve Size	Percentage Passing
1-1/2 inch	100
1 inch	95 to 100
3/4 inch	90 to 100
3/8 inch	15 to 85
No. 4	0 to 9

Reference: Gradation to be determined in conformance with the requirements of California Test 202, except shaking in the sieves must be limited to 5 minutes.

5.2.4 Fill Placement and Compaction

Fill materials should be moisture conditioned to near the optimum moisture content prior to compaction. Properly moisture conditioned fill materials should subsequently be placed in loose, horizontal lifts of 8 inches-thick or less and uniformly compacted to at least 90 percent relative compaction. In pavement areas, the upper 12 inches of backfill should be compacted to at least 95 percent relative compaction. The maximum dry density and optimum moisture content of fill materials should be determined in accordance with ASTM D1557. Where lightweight fill is used, the fill should be placed in loose, horizontal lifts which are lightly compacted using vibratory equipment to avoid crushing of the individual aggregate pieces.

5.3 Foundation and Pump Station Structural Design

The weight of the new pump station will likely be less than the weight of the excavated soil and relatively small volume of crushed rock backfill, so new settlement of the structure is not considered to be a significant issue. If the new improvements will weigh more than the excavated soils, deep foundations may be required. The vertical load of the structure will need to be resisted by a 300-psf skin friction on the sides and a 500 psf soil bearing capacity below the structure. Design criteria for the pump station are summarized in Table 3 and detailed on Figure 6.

A buoyant uplift force will develop when the water level within the pump station is lower than the exterior groundwater level. Under “wintertime” (rainy season) conditions or during a flood event, the groundwater elevation should be assumed to be at the ground surface for design purposes. The design engineer will need to determine the maximum differential between the exterior and interior water levels. Resistance to uplift includes the weight of the structure plus the skin friction on the exterior of the structure. If necessary, the uplift resistance can be increased by structurally extending the foundation beyond the limits of the walls. The buoyant weight of soil above the footing extensions could also be included in the total weight of the structure. Alternatively, helical anchors could be utilized to provide uplift resistance.

The walls of the pump station are expected to be restrained at the top and bottom which prevents lateral deflection of the wall. This type of wall is subject to a uniform lateral pressure distribution instead of the equivalent fluid pressure normally used for cantilevered walls. In addition, the walls need to withstand seismic loading and hydrostatic forces due to potential differential water levels inside and outside of the wet well. Design criteria for the pump station structure walls is presented in Table 4 and detailed on Figure 6.

Table 3 – Pump Station Design Criteria

Condition	Value
Allowable dead load bearing pressure[1]:	500 psf
Base friction:	0.30
Restrained Active Soil Pressure[2,3,4]:	
Above the groundwater table:	35 H psf
Below the groundwater table:	15 H psf
Traffic Loading[2]	
0 to 5 feet below the ground surface	200 psf
5 to 10 feet below the ground surface	50 psf
Hydrostatic Pressure Difference[2,5]:	(63 x Hw) psf
Earthquake Surcharge[2, 4, 6]:	15 H psf
Passive Soil Pressure[7]:	300 pcf

(1) May increase design values by 1/3 for total design loads, including wind and seismic.
(2) Uniform, rectangular lateral pressure distribution.
(3) For compacted soil conditions.
(4) H = Total height of wall (in feet).
(5) Hw = Difference in water level (in feet).
(6) Design for a factor of safety of 1.1 or greater for seismic conditions.
(7) Equivalent Fluid Pressure

The Structural Engineer should design the concrete slab floors to resist the external hydrostatic pressures, as shown on Figure 6.

Deep foundations, while they would limit or eliminate settlement of the new pump station, have been considered but are not recommended due to expected differential settlement between the pump station and the outfall pipe.

5.4 Temporary Support of Excavations

Temporary support of excavations will be required to ensure the safety of workers and to reduce the potential for trench failure and damage to surrounding areas. Shoring types may include trench boxes or shields, driven sheetpiles, vertical hydraulic shores, or other systems. While a variety of systems are available, shoring that applies positive pressure to the side walls of the excavation will be more effective in controlling ground movements and reducing the risk of damage to nearby utilities and structures.

The selected support system should be designed to resist lateral pressures from earth and construction surcharge loads. Watertight shoring systems (e.g. interlocking sheetpiles) which do not allow for drainage should also be designed to resist hydrostatic pressures. As a minimum, shoring systems should be designed based on the criteria provided in Table 4.

Table 4 – Shoring Design Criteria

Parameter	Design Value
Active Earth Pressure, Unrestrained[1]	45 pcf
Active Earth Pressure, Restrained[2]	35 x H psf
Ultimate Passive Resistance, Bay Mud[1]	250 pcf
Minimum Surcharge Pressure[2,3]	125 psf

Notes:

(1) Equivalent fluid pressure.

(2) Rectangular distribution, H is wall height in feet

(3) Apply to upper 10 feet of trench shoring. Surcharge load to be adjusted at the discretion of the Contractor's shoring designer.

Temporary dewatering will be required where excavations extend below the groundwater table. While various systems are available, dewatering would most likely consist of sumps or wells spaced as needed to keep the groundwater level below the excavation bottom. The selection, design, installation, monitoring, and removal of temporary shoring and dewatering should be the responsibility of the Contractor in accordance with their means and methods. The Contractor should be required to submit dewatering plans for review by SRDPW prior to implementation.

6.0 SUPPLEMENTAL GEOTECHNICAL SERVICES

We must review the plans and specifications when they are nearing completion to confirm that the intent of our recommendations has been incorporated and to provide supplemental recommendations as needed. During construction, we must inspect geotechnical items relating to earthwork and new pavement construction. We should observe trench excavations, proper moisture conditioning of soils, fill placement and compaction, and other geotechnical-related work items.

7.0 LIST OF REFERENCES

American Society of Civil Engineers (ASCE) (2010), “Minimum Design Loads for Buildings and Other Structures” (2010 ASCE-7), Structural Engineering Institute of the American Society of Civil Engineers.

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California Division of Mines and Geology, “Geology for Planning in Central and Southeastern Marin County, California, OFR 76-2 S.F. Plate 1D, South Central Marin Geology”, 1976.

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Harding Lawson Associates, “Final Report, Soil Engineering Services During Construction, Flood Control Facilities, East San Rafael Drainage Assessment District No. 1”, 1974.

Kleinfelder, “Design Geotechnical Investigation Report, Proposed Target Store, 125 Shoreline Parkway, San Rafael, CA”, 2012

Occupational Safety and Health Administration (OSHA)(2005), Title 29 Code of Federal Regulations, Part 1926 (www.OSHA.gov).

United States Geological Survey, “San Rafael Quadrangle, California-Marin Co., 7.5 Minute Series (Topographic)”, 1948.

United States Survey, “San Rafael Quadrangle, California-Marin Co., 7.5 Minute Series (Topographic)”, 1959.

APPENDIX A
SUBSURFACE EXPLORATION AND GEOTECHNICAL LABORATORY TESTING

A. SUBSURFACE EXPLORATION

We explored subsurface conditions with one exploratory boring drilled with truck-mounted equipment on February 9, 2018 at the approximate locations shown on the Site Plan, Figure 2. The exploration was conducted under the technical supervision of our Field Engineer who examined and logged the soil materials encountered and obtained samples. The subsurface conditions encountered in the test boring is summarized and presented on the Boring Log, Figures A-2 through A-4.

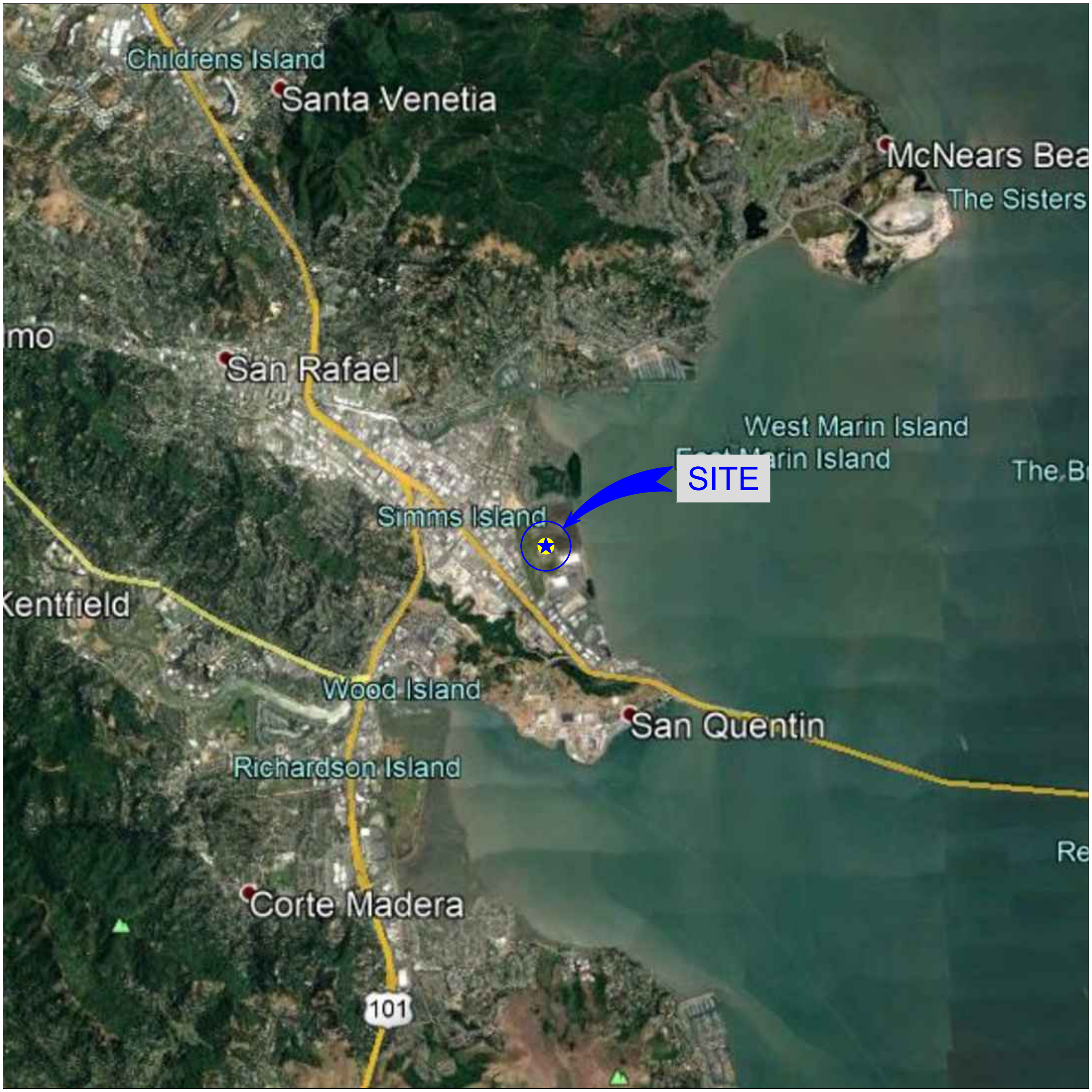
"Undisturbed" samples were obtained using a 3-inch diameter, split-barrel Modified California Sampler with 2.5 by 6-inch tube liners or a Standard Penetration Test (SPT) Sampler. The samplers were driven by a 140-pound hammer at a 30-inch drop. The number of blows required to drive the samplers 18 inches was recorded and is reported on the boring logs as blows per foot for the last 12 inches of driving. Bay Mud was sampled with 30-inch long, 3-inch diameter thin-walled "Shelby" tube sampler which is pushed directly into soft soils rather than driven with a sampling hammer. The samples obtained were examined in the field, sealed to prevent moisture loss, and transported to our laboratory

B. GEOTECHNICAL LABORATORY TESTING

We conducted geotechnical laboratory tests on selected intact samples to classify soils and to estimate engineering properties. The following laboratory tests were conducted in general accordance with the ASTM standard test method cited:

- Laboratory Determination of Water (Moisture Content) of Soil, Rock, and Soil-Aggregate Mixtures, ASTM D 2216
- Density of Soil in Place by the Drive-Cylinder Method, ASTM D 2937
- Unconfined Compressive Strength of Cohesive Soil, ASTM D 2166
- One-Dimensional Consolidation, ASTM D 2435.

The moisture content, dry density and unconfined compression test results are shown on the exploratory boring log, Figures A-2 through A-4 while consolidation test results are shown on Figures A-5 through A-7. The exploratory boring logs, description of soils encountered and the laboratory test data reflect conditions only at the location of the boring at the time they were excavated or retrieved. Conditions may differ at other locations and may change with the passage of time due to a variety of causes including natural weathering, climate and changes in surface and subsurface drainage.



SITE COORDINATES
LAT. 37.9559°
LON. -122.4931°

SITE LOCATION

N.T.S.

REFERENCE: Google Earth, 2018

MPEG MILLER PACIFIC ENGINEERING GROUP

FILENAME: 739.299 Figures.dwg

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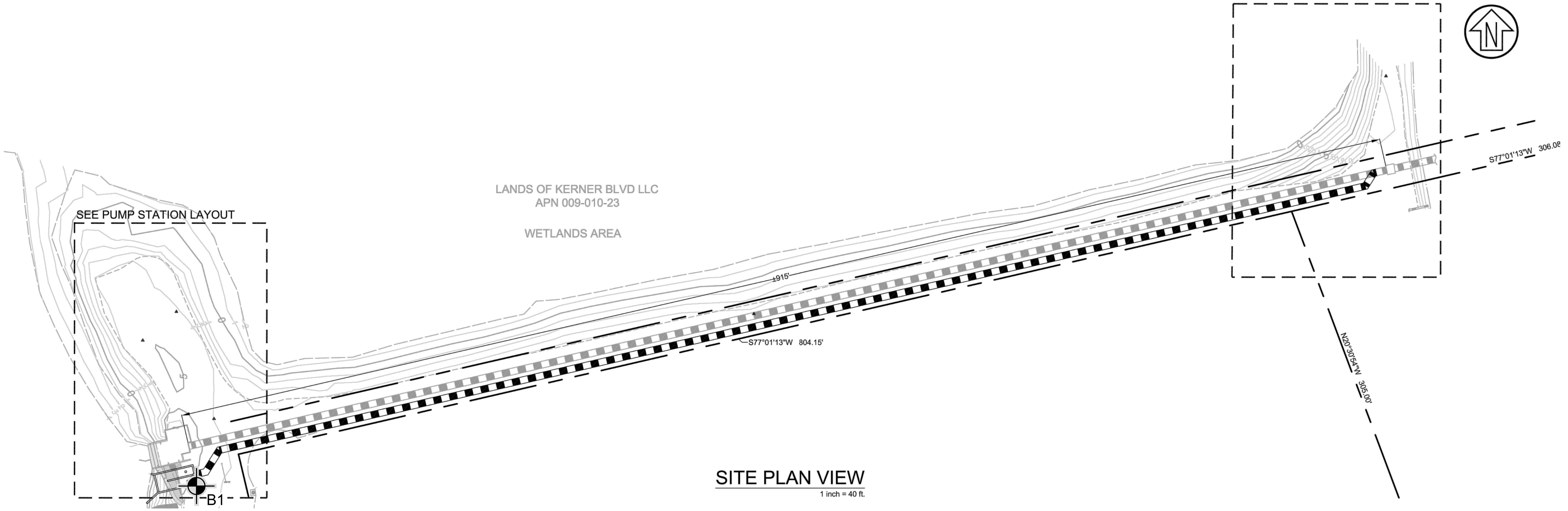
SITE LOCATION MAP

CSW/Stuber-Stroeh
San Quentin Pump Station
San Rafael, California

Project No. 739.299 Date: 3/26/2018

Drawn NGK
Checked

1
FIGURE



SITE PLAN VIEW
1 inch = 40 ft.

⊕ Approximate location of MPEG Boring, February 2018

REFERENCE: Option 1 Site Plan Provided by CSW/Stuber-Stroeh

SCALE
0 40 80 160 FEET

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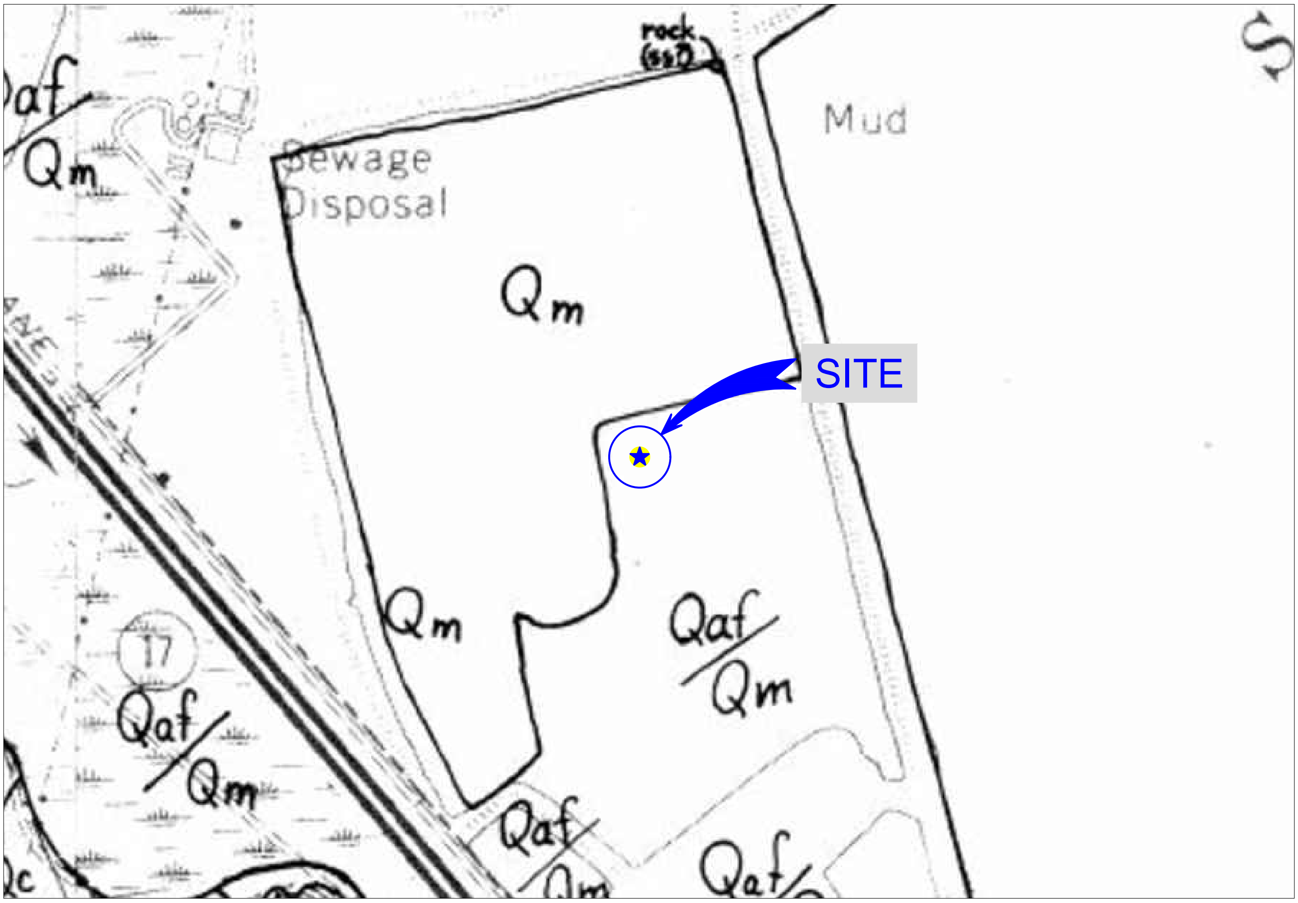
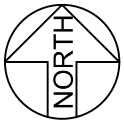
SITE PLAN

CSW/Stuber-Stroeh
San Quentin Pump Station
San Rafael, California
Project No. 739.299 Date: 8/3/2016

Designed EAD
Drawn NGK
Checked EAD

2
FIGURE





REGIONAL GEOLOGIC MAP

(NOT TO SCALE)

LEGEND

Qaf	**Artificial Fill -** Deposits of rock, soil, garbage and trash, or bay mud placed my man upon natural surfaces.
Qm	**Bay Mud -** Marshlands, former marshlands, and mudflats bordering San Francisco and San Pablo Bays. Consist of thick deposits of unconsolidated, low-density, semi-fluid, highly compressible, highly impermeable silty clay.

Reference: Rice, Salem J., et al (1976), "Geology of the Eastern Part of the San Rafael Area, Marin County, California." California Department of Conservation, California Department of Mines and Geology, Open File Report OFR 76-2, Scale 1:12,000.

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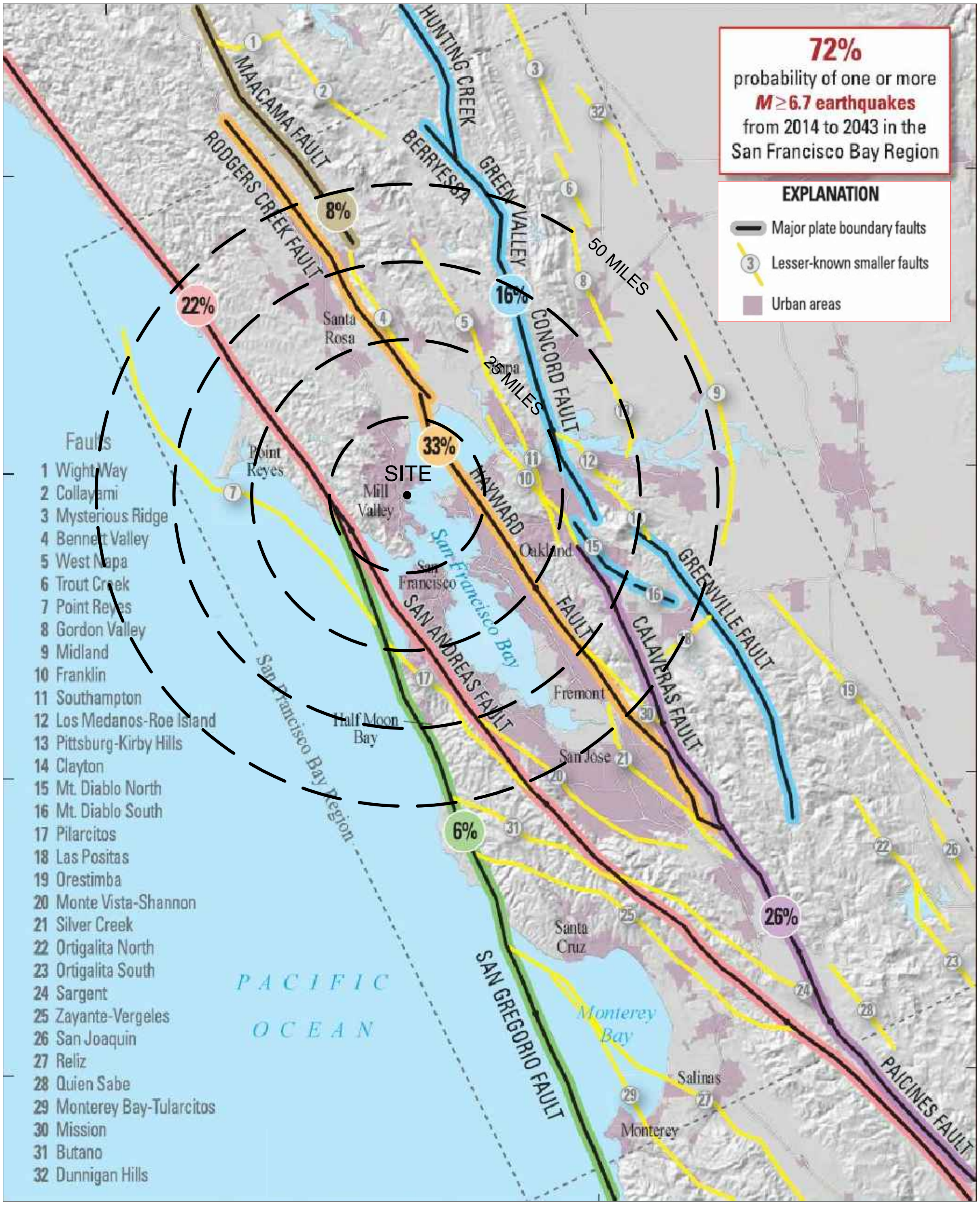
REGIONAL GEOLOGIC MAP

CSW/Stuber-Stroeh
San Quentin Pump Station
San Rafael, California

Project No. 739.299 Date: 3/26/2018

Drawn NGK
Checked

3
FIGURE



SITE COORDINATES
LAT. 37.9559°
LON. -122.4931°

SCALE
0 12.5 25 50 MILES

NORTH

DATA SOURCE:
1) U.S. Geological Survey, U.S. Department of the Interior, "Earthquake Outlook for the San Francisco Bay Region 2014-2043", Map of Known Active Faults in the San Francisco Bay Region, Fact Sheet 2016-3020, Revised August 2016 (ver. 1.1).

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ACTIVE FAULT MAP

CSW/Stuber-Stroeh
San Quentin Pump Station
San Rafael, California

Project No. 739.299 Date: 3/26/2018

Drawn NGK
Checked

4
FIGURE

Tunnelman's Ground Classification for Soils[1]

Classification		Behavior	Typical Soil Types
Firm		Heading can be advanced without initial support, and final lining can be constructed before ground starts to move.	Loess above water table; hard clay, marl, cemented sand and gravel when not highly overstressed.
Raveling	Slow raveling ----- Fast raveling	Chunks or flakes of material begin to drop out of the arch or walls sometime after the ground has been exposed, due to loosening or to over-stress and "brittle" fracture (ground separates or breaks along distinct surfaces, opposed to squeezing ground). In fast raveling ground, the process starts within a few minutes, otherwise the ground is slow raveling.	Residual soils or sand with small amounts of binder may be fast raveling below the water tale, slow raveling above. Stiff fissured clays may be slow or fast raveling depending upon degree of overstress.
Squeezing		Ground squeezes or extrudes plastically into tunnel, without visible fracturing or loss of continuity, and without perceptible increase in water content. Ductile, plastic yield and flow due to overstress.	Ground with low frictional strength. Rate of squeeze depends on degree of overstress. Occurs at shallow to medium depth in clay of very soft to medium consistency. Stiff to hard clay under high cover may move in combination of raveling at excavation surface and squeezing at depth behind surface.
Running	Cohesive - running ----- Running	Granular materials without cohesion are unstable at a slope greater than their angle of repose (+/- 30° – 35°). When exposed at steeper slopes they run like granulated sugar or dune sand until the slope flattens to the angle of repose.	Clean, dry granular materials. Apparent cohesion in moist sand, or weak cementation in any granular soil, may allow the material to stand for a brief period of raveling before it breaks down and runs. Such behavior is cohesive-running.
Flowing		A mixture of soil and water flows into the tunnel like a viscous fluid. The material can enter the tunnel from the invert as well as from the face, crown, and walls, and can flow for great distances, completely filling the tunnel in some cases.	Below the water table in silt, sand, or gravel without enough clay content to give significant cohesion and plasticity. May also occur in highly sensitive clay when such material is disturbed.
Swelling		Ground absorbs water, increases in volume, and expands slowly into the tunnel.	Highly preconsolidated clay with plasticity index in excess of about 30, generally containing significant percentages of montmorillonite.

1 Modified by Heuer (1974) from Terzaghi (1950)

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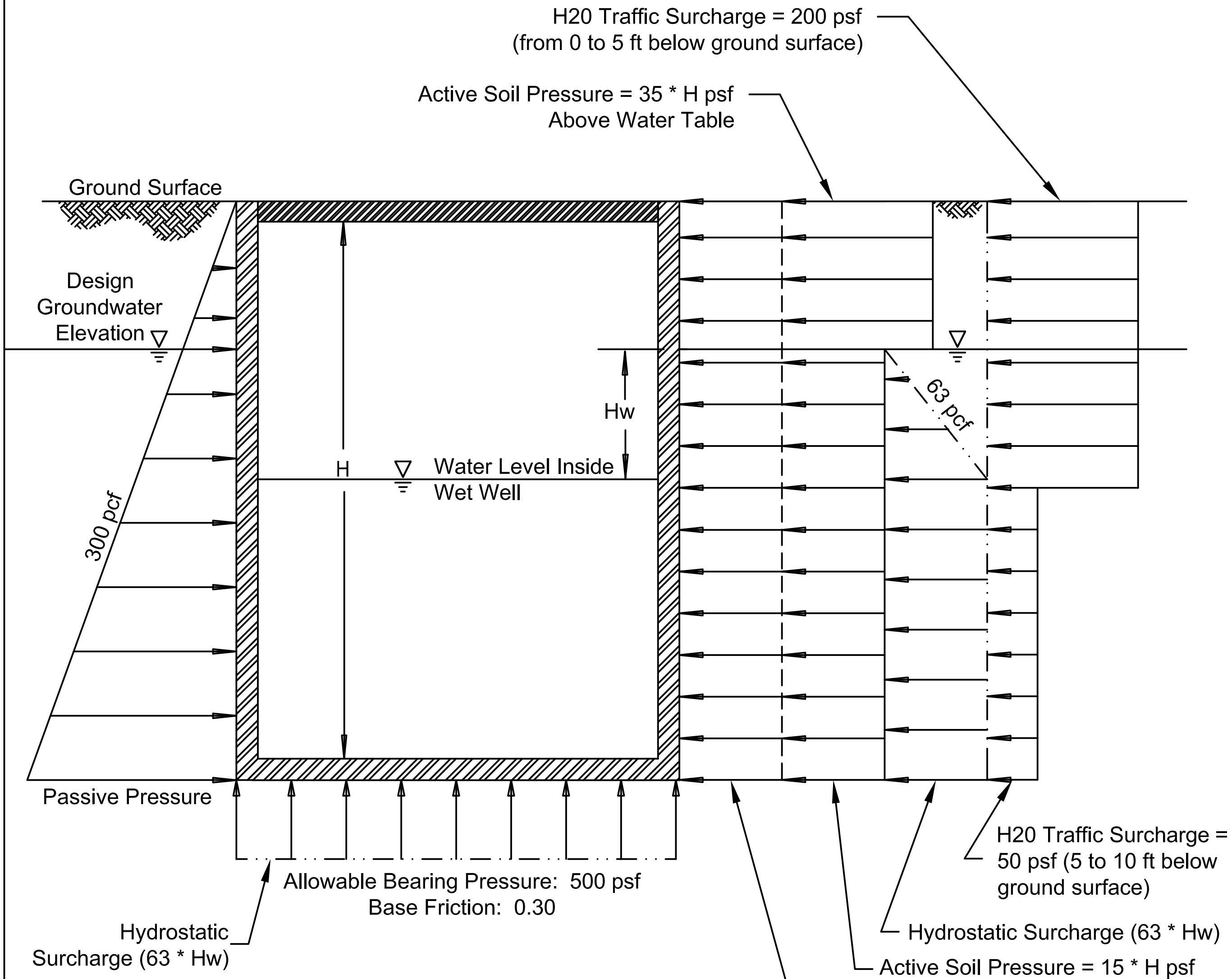
TUNNELMAN'S GROUND CLASSIFICATION

CSW/Stuber-Stroeh
San Quentin Pump Station
San Rafael, California

Project No. 739.299 Date: 3/26/2018

Drawn NGK
Checked

5
FIGURE



WALL DESIGN PRESSURES

(NO SCALE)

Notes:

1.) For seismic conditions, include a uniform seismic surcharge pressure of 15*H psf over wall height (H). Passive resistance may be increased by 1/3 for short term seismic conditions. Design Factor of Safety should be greater than 1.1.

2.) Differential water level (Hw) to be determined by Civil Engineer.

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FILE: 739.299 Wall Pressures.dwg

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LATERAL WALL PRESSURE DIAGRAM

CSW/Stuber-Stroeh
San Quentin Pump Station
San Rafael, California

Project No. 739.299 Date: 3/26/18

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6
FIGURE

MAJOR DIVISIONS		SYMBOL		DESCRIPTION
COARSE GRAINED SOILS over 50% sand and gravel	CLEAN GRAVEL	GW	▨	Well-graded gravels or gravel-sand mixtures, little or no fines
		GP	▨	Poorly-graded gravels or gravel-sand mixtures, little or no fines
	GRAVEL with fines	GM	▨	Silty gravels, gravel-sand-silt mixtures
		GC	▨	Clayey gravels, gravel-sand-clay mixtures
	CLEAN SAND	SW	▨	Well-graded sands or gravelly sands, little or no fines
		SP	▨	Poorly-graded sands or gravelly sands, little or no fines
	SAND with fines	SM	▨	Silty sands, sand-silt mixtures
		SC	▨	Clayey sands, sand-clay mixtures
FINE GRAINED SOILS over 50% silt and clay	SILT AND CLAY liquid limit <50%	ML	▥	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
		CL	▨	Inorganic clays of low to medium plasticity, gravely clays, sandy clays, silty clays, lean clays
		OL	▥	Organic silts and organic silt-clays of low plasticity
	SILT AND CLAY liquid limit >50%	MH	▥	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts
		CH	▨	Inorganic clays of high plasticity, fat clays
		OH	▨	Organic clays of medium to high plasticity
HIGHLY ORGANIC SOILS		PT	▤	Peat, muck, and other highly organic soils
ROCK			▩	Undifferentiated as to type or composition

KEY TO BORING AND TEST PIT SYMBOLS

CLASSIFICATION TESTS

PI	PLASTICITY INDEX
LL	LIQUID LIMIT
SA	SIEVE ANALYSIS
HYD	HYDROMETER ANALYSIS
P200	PERCENT PASSING NO. 200 SIEVE
P4	PERCENT PASSING NO. 4 SIEVE

SAMPLER TYPE

■	MODIFIED CALIFORNIA	⊠	HAND SAMPLER
◿	STANDARD PENETRATION TEST	⊠	ROCK CORE
▨	THIN-WALLED / FIXED PISTON	X	DISTURBED OR BULK SAMPLE

NOTE: Test boring and test pit logs are an interpretation of conditions encountered at the excavation location during the time of exploration. Subsurface rock, soil or water conditions may vary in different locations within the project site and with the passage of time. Boundaries between differing soil or rock descriptions are approximate and may indicate a gradual transition.

STRENGTH TESTS

TV	FIELD TORVANE (UNDRAINED SHEAR)
UC	LABORATORY UNCONFINED COMPRESSION
TXCU	CONSOLIDATED UNDRAINED TRIAXIAL
TXUU	UNCONSOLIDATED UNDRAINED TRIAXIAL
	UC, CU, UU = 1/2 Deviator Stress

SAMPLER DRIVING RESISTANCE

Modified California and Standard Penetration Test samplers are driven 18 inches with a 140-pound hammer falling 30 inches per blow. Blows for the initial 6-inch drive seat the sampler. Blows for the final 12-inch drive are recorded onto the logs. Sampler refusal is defined as 50 blows during a 6-inch drive. Examples of blow records are as follows:

25	sampler driven 12 inches with 25 blows after initial 6-inch drive
85/7"	sampler driven 7 inches with 85 blows after initial 6-inch drive
50/3"	sampler driven 3 inches with 50 blows during initial 6-inch drive or beginning of final 12-inch drive

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SOIL CLASSIFICATION CHART

San Quentin Pump Station
San Rafael, California

Project No. 739.299
Date: 3/27/2018

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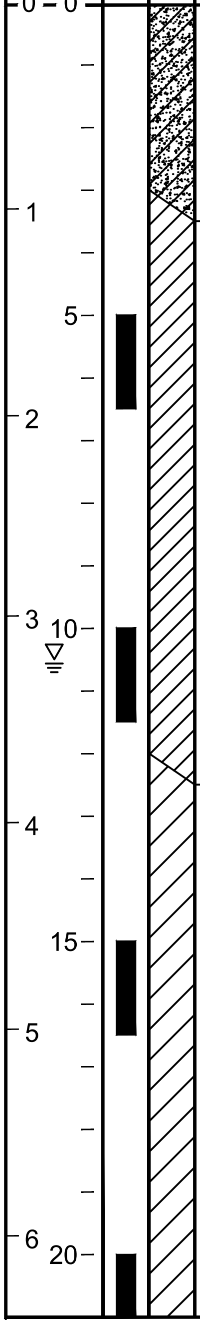
A-1
FIGURE

BORING 1

EQUIPMENT: Truck-Mounted Drill Rig with 8.0-inch Hollow Flight Auger
DATE: 02/09/18
ELEVATION: 5 - feet*
*REFERENCE: Google Earth, 2018



SAND with Gravel (SC)
Dark to light gray, moist, medium dense, fine to coarse grained sand with varying amounts of ¾" angular gravel, lens of low plasticity clay present from 0.5 to 1.0 [Fill]

Gravelly CLAY (CL)
Dark gray with red mottling, moist, medium stiff, low plasticity, ~15-30% angular gravel, typical diameter varies from ¼"- ¾", brick and debris present [Fill]

Auger chattering on large gravels/cobbles at 8.5'

Grades to ~30-50% angular gravels

CLAY (CH)
Gray, wet, soft, highly plastic, highly compressible, impermeable, trace shells, characteristic sulphuric odor, trace silt [Bay Mud]

Cont. on next page

BLOWS / FOOT (1)	DRY UNIT WEIGHT pcf (2)	MOISTURE CONTENT (%)	SHEAR STRENGTH psf (3)	OTHER TEST DATA	OTHER TEST DATA
21	117	10.8			
10					
4					

∇ Water level encountered during drilling
▼ Water level measured after drilling

NOTES:
(1) UNCORRECTED FIELD BLOW COUNTS
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3 = 0.1571 x DRY UNIT WEIGHT (pcf)
(3) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(4) GRAPHIC SYMBOLS ARE ILLUSTRATIVE ONLY

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BORING LOG

San Quentin Pump Station
San Rafael, California

Project No. 739.299
Date: 3/27/2018

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A-2
FIGURE

BORING 1
(CONTINUED)

DEPTH meters	DEPTH feet	SAMPLE	SYMBOL (4)		BLOWS / FOOT (1)	DRY UNIT WEIGHT pcf (2)	MOISTURE CONTENT (%)	SHEAR STRENGTH psf (3)	OTHER TEST DATA	OTHER TEST DATA
	20	■	▨	CLAY (CH) Gray, wet, soft, highly plastic, highly compressible, impermeable, trace shells, characteristic sulphuric odor, trace silt [Bay Mud]	2					
7			▨							
	25		▨							
8			▨							
9	30	▨	▨	As above, Bay Mud		60.5	67.0		CONSOL	
10			▨							
	35		▨							
11			▨							
12			▨							
	40	▨	▨	Cont. on next page						

∇ Water level encountered during drilling
▼ Water level measured after drilling

NOTES:
(1) UNCORRECTED FIELD BLOW COUNTS
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3 = 0.1571 x DRY UNIT WEIGHT (pcf)
(3) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(4) GRAPHIC SYMBOLS ARE ILLUSTRATIVE ONLY

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BORING LOG

San Quentin Pump Station
San Rafael, California

Project No. 739.299
Date: 3/27/2018

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A-3
FIGURE

BORING 1
(CONTINUED)

meters DEPTH feet	SAMPLE	SYMBOL (4)	BORING 1 (CONTINUED)	BLOWS / FOOT (1)	DRY UNIT WEIGHT pcf (2)	MOISTURE CONTENT (%)	SHEAR STRENGTH psf (3)	OTHER TEST DATA	OTHER TEST DATA
40	▨	▨	CLAY (CH) Gray, wet, soft, highly plastic, highly compressible, impermeable, trace shells, characteristic sulphuric odor, trace silt [Bay Mud]		65.5	54.2		CONSOL	
13		▨							
45		▨							
14		▨							
15		▨							
50	▨	▨	As above, Bay Mud		67.3	54.2		CONSOL	
16			End of boring at 52.5 feet Groundwater encountered at 10.5 feet						
55									
17									
18									
60									

▽ Water level encountered during drilling

▼ Water level measured after drilling

NOTES:
(1) UNCORRECTED FIELD BLOW COUNTS
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3 = 0.1571 x DRY UNIT WEIGHT (pcf)
(3) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(4) GRAPHIC SYMBOLS ARE ILLUSTRATIVE ONLY

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BORING LOG

San Quentin Pump Station
San Rafael, California

Project No. 739.299

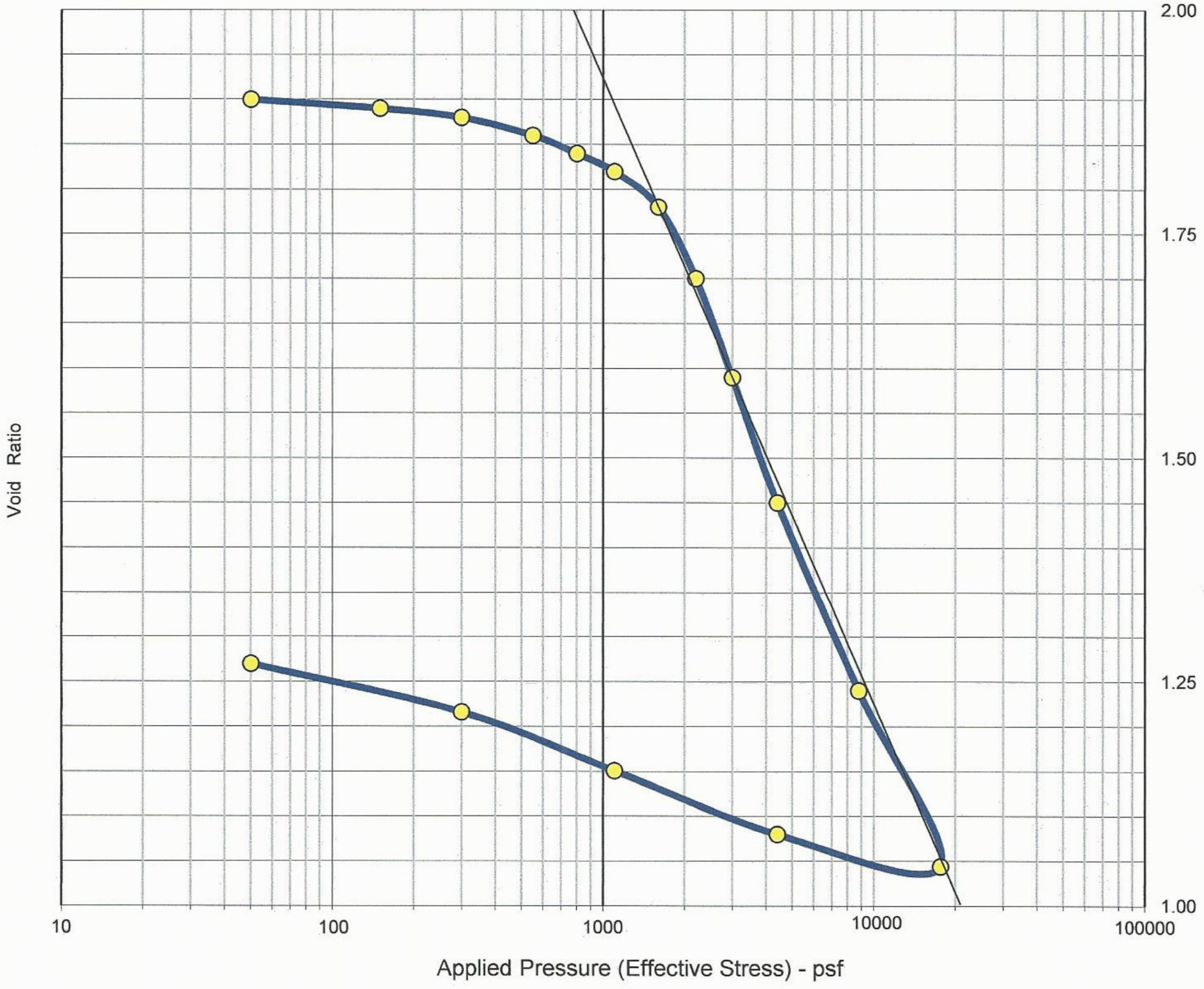
Date: 3/27/2018

Drawn ZMS
Checked

A-4
FIGURE

Consolidation Test Report (ASTM D2435)

Strain Log P-Curve



TEST DATA

Specimen Height, range (in):	1.00-0.7931
Specimen Diameter (in):	2.42
Area (sq in):	4.60
Sample Mass, wet, range (gm):	121.9-106.7
Void Ratio, range:	1.889-1.044
Moisture, range (%):	67.0-46.2
Saturation, range %:	99.2-100.0
Dry Density, range (lbs/cuft):	60.5-76.2
Wet Density, range (lbs/cuft):	101.0-111.4
Matrix Porosity, range (%):	65.4-56.4
Volume, total, range (cc):	75.37-59.78
Volume, soil, range (cc):	26.07-26.07
Volume, void, range (cc):	49.31-33.71

Total/Water Volumes, finals (cc):	59.78/33.71
Void Ratio, initial (calc):	1.891
Void Ratio, final (calc):	1.293
Dry Weight, total (final):	72.99
Compression, loading, total (%)	44.73
Specific Gravity (gm/cc) [assumed]:	2.80

SAMPLE INFORMATION

Sample No.:	07668-1
Sample ID:	B-1 @ 30'-32.5'
Sample Condition:	Shelby Tube
Consolidometer Test Method:	ASTM D2435 - 4 pt unload
Gross Soil/SedimentTexture:	Greenish Gray Clay

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CONSOLIDATION TEST REPORT

San Quentin Pump Station
San Rafael, California

Project No. 739.299
Date: 3/27/2018

Drawn ZMS
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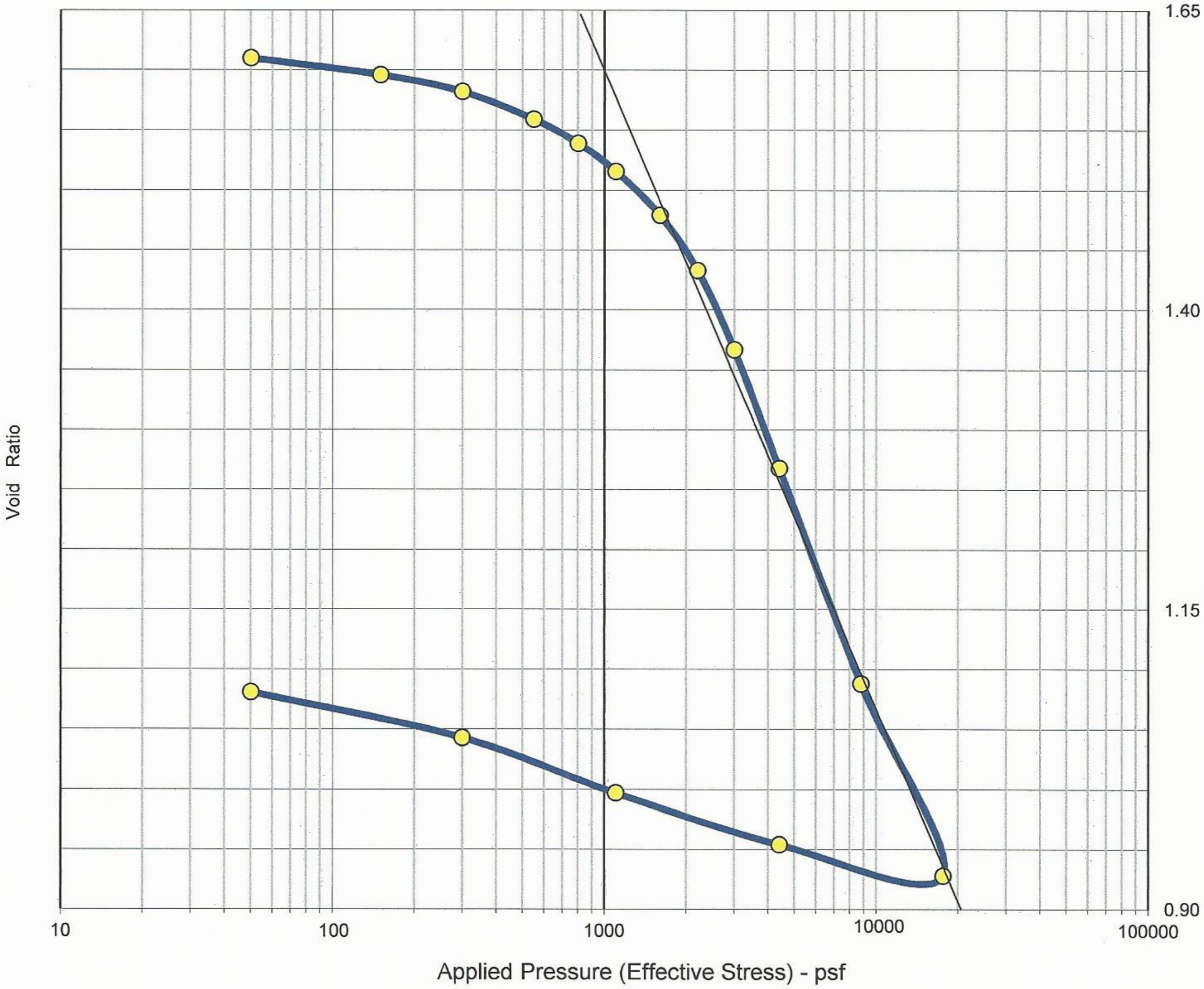
A-5
FIGURE

Consolidation Test Report (ASTM D2435)

Strain Log P-Curve



TEST DATA

Specimen Height, range (in):	**1.00-0.7995**
Specimen Diameter (in):	**2.42**
Area (sq in):	**4.60**
Sample Mass, wet, range (gm):	**124.3-110.6**
Void Ratio, range:	**1.610-0.9271**
Moisture, range (%):	**57.1-39.8**
Saturation, range %:	**97.0-100.0**
Dry Density, range (lbs/cuft):	**65.5-81.9**
Wet Density, range (lbs/cuft):	**102.9-114.6**
Matrix Porosity, range (%):	**61.8-52.3**
Volume, total, range (cc):	**75.37-60.26**
Volume, soil, range (cc):	**28.76-28.76**
Volume, void, range (cc):	**46.61-31.50**

Total/Water Volumes, finals (cc):	**60.26/31.50**
Void Ratio, initial (calc):	**1.620**
Void Ratio, final (calc):	**1.095**
Dry Weight, total:	**79.10**
Compression, loading, total (%)	**42.42**
Specific Gravity (gm/cc) [assumed]:	**2.80**

SAMPLE INFORMATION

Sample No.:	**07668-2**
Sample ID:	**B-1 @ 40'-42.5'**
Sample Condition:	**Shelby Tube**
Consolidometer Test Method:	**ASTM D2435 - 4 pt unload**
Gross Soil/SedimentTexture:	**Greenish Gray Clay**

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CONSOLIDATION TEST REPORT

San Quentin Pump Station
San Rafael, California

Project No. 739.299

Date: 3/27/2018

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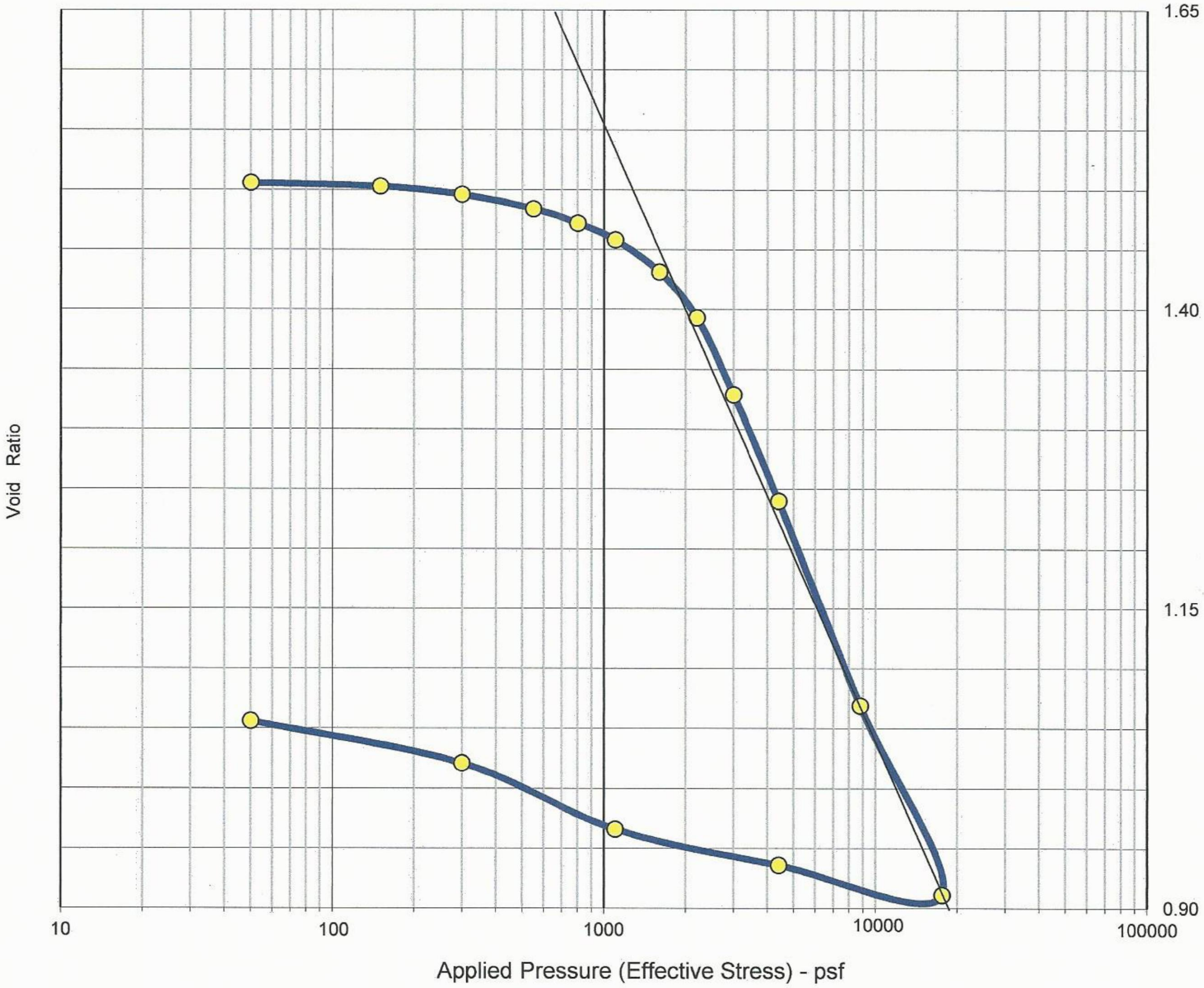
A-6
FIGURE

Consolidation Test Report (ASTM D2435)

Strain Log P-Curve



TEST DATA

Specimen Height, range (in):	1.00-0.8196	Total/Water Volumes, finals (cc):	61.77/31.70
Specimen Diameter (in):	2.42	Void Ratio, initial (calc):	1.506
Area (sq in):	4.60	Void Ratio, final (calc):	1.054
Sample Mass, wet, range (gm):	125.2-112.9	Dry Weight, total:	81.20
Void Ratio, range:	1.506-0.911	Compression, loading, total (%)	39.51
Moisture, range (%):	54.2-39.0	Specific Gravity (gm/cc) [assumed]:	2.80
Saturation, range %:	97.1-100.0		
Dry Density, range (lbs/cuft):	67.3-82.1		
Wet Density, range (lbs/cuft):	103.7-114.1		
Matrix Porosity, range (%):	60.1-51.3		
Volume, total, range (cc):	75.37-61.77		
Volume, soil, range (cc):	30.07-30.07		
Volume, void, range (cc):	45.30-31.70		

SAMPLE INFORMATION

Sample No.:	07668-3
Sample ID:	B-1 @ 50'-52.5'
Sample Condition:	Shelby Tube
Consolidometer Test Method:	ASTM D2435 - 4 pt unload
Gross Soil/SedimentTexture:	Greenish Gray Clay

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CONSOLIDATION TEST REPORT

San Quentin Pump Station
San Rafael, California

Project No. 739.299

Date: 3/27/2018

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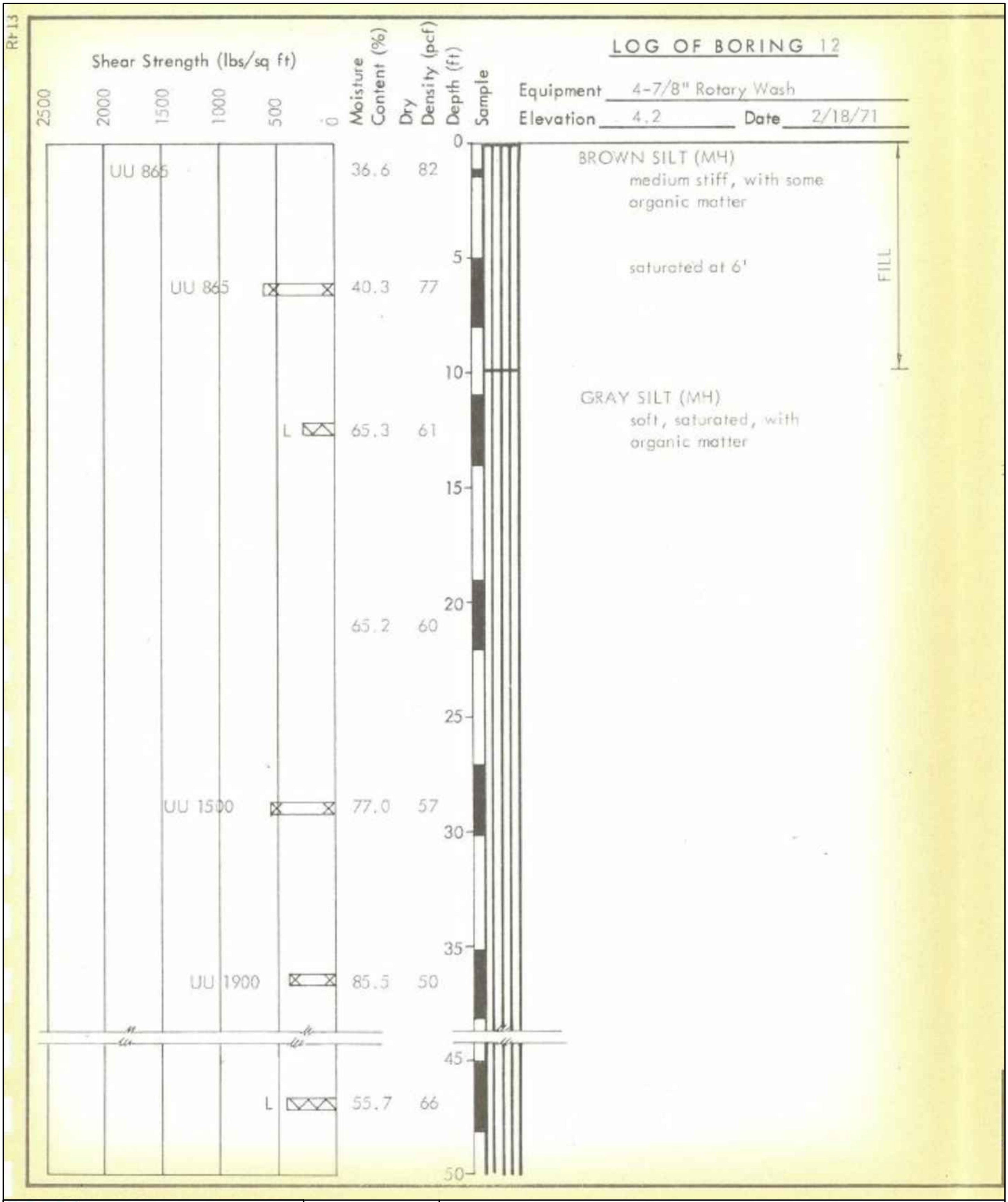
A-7
FIGURE



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REFERENCE BORING LOG

San Quentin Pump Station
San Rafael, California

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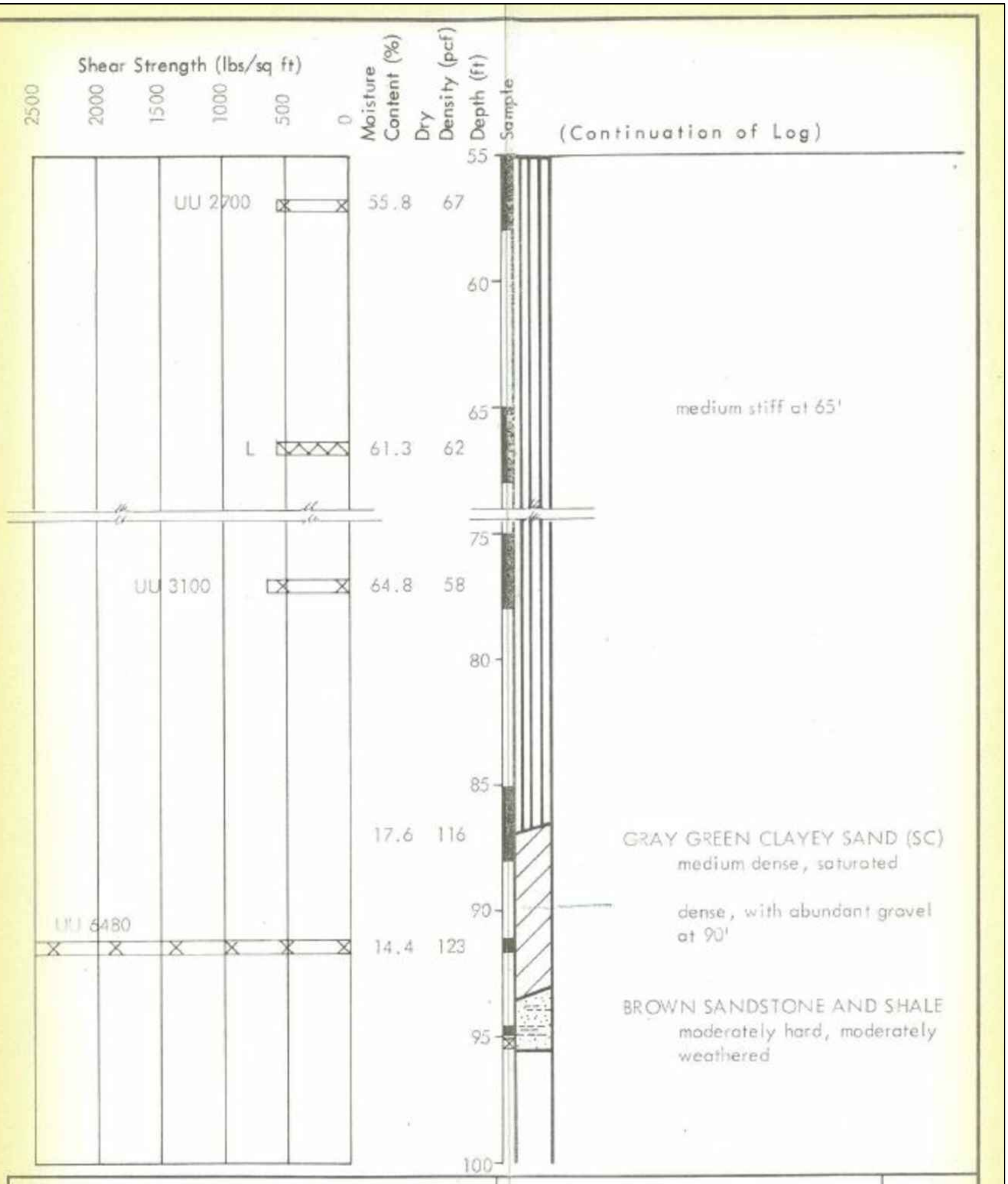
Project No. 739.299 Date: 3/27/2018

A-8
FIGURE



(Continuation of Log)

medium stiff at 65'

GRAY GREEN CLAYEY SAND (SC)
medium dense, saturated

dense, with abundant gravel at 90'

BROWN SANDSTONE AND SHALE
moderately hard, moderately weathered

HARDING, MILLER, LAWSON & ASSOCIATES
Consulting Engineers

Job No: 4419,002.01 Appr: /jd Date 8/6/71

LOG OF BORING 12
East San Rafael Drainage Assessment
District No. 1

PLATE
35

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REFERENCE BORING LOG

San Quentin Pump Station
San Rafael, California

Project No. 739.299 Date: 3/27/2018

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A-9
FIGURE

APPENDIX A, SUB-APPENDIX B:

Environmental Technical Memorandum

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wra
ENVIRONMENTAL CONSULTANTS

Memorandum

To: Rich Souza, P.E.
CSW/Stuber-Stroeh Engineering Group, Inc

Cc:

From: Justin Semion, PWS, Principal
Geoff Reilly, AICP, Sr. Associate Environmental Planner
Jordan Rosencranz, PWS, Regulatory Permitting Specialist

Date: April 20, 2018

Subject: Overview of San Quentin Pump Station Project Alternatives

---

The purpose of this memorandum is to provide an overview of wetlands and biological resources constraints that may be directly or indirectly affected by the proposed Alternatives for the San Quentin Pump Station Project, in San Rafael, Marin County, California (Project; Appendix A, Figures 1 and 2). The third Alternative is a No-Project Alternative, which would not result in any adverse effects to wetlands and biological constraints to the study area, and is therefore not analyzed in this memo. This memo provides analysis for the following components:

1. **Biological and Wetlands Constraints**: Biological and wetlands constraints are the basis for most of the regulatory permitting requirements examined in this memo, and inform some of the logistical construction constraints (such as schedule and mitigation) that can affect overall project cost. The constraints for the Project are reviewed here to provide that background.
2. **Effects Analysis Overview for Two Alternative Pump Station Locations:** This memo presents the two proposed Project Alternatives relative to their potential impacts to wetlands and sensitive species. Indirect Project-related effects are briefly discussed, as well as general avoidance and minimization measures that could be prescribed during the California Environmental Quality Act (CEQA) process or subsequent permitting processes.
3. **Permitting Approach Overview**: Finally, this memo discusses potential permitting process that could result from Project implementation. Any critical differences in required permits across the Alternatives are discussed.

This memo provides these analyses based on the professional experience and judgment of WRA. WRA focuses on wetland resources and permit requirements that have the potential to materially affect project design, feasibility, cost, and timeline, and does not provide a complete analysis of biological resources required to support permitting or CEQA environmental review documentation. The analysis of biological resources constraints is developed based on WRA's expertise surrounding the Project Area, but does not constitute any formal survey, determination of species presence or absence, or jurisdictional delineation.

PROJECT DESCRIPTION

The City of San Rafael proposes to remove and construct a stormwater pump station, a drainage channel, and pipeline in San Rafael, California (Project). The Project is located on City lands in the first alternative (Figure 1) and on both City and lands of Kerner Blvd, LLC in the second alternative (Figure 2). The reconstruction is intended to reduce flood risk to parcels and Highway 580 during a significant storm event.

Project Alternatives

Two Alternative pump station locations have been explored as possible solutions for meeting the Project's purpose and need. The two Alternative locations are described below. As previously mentioned, the No-Project Alternative is not assessed, or discussed further in this memo. The area of potential affect for the two Alternatives are depicted in Figure 1 and Figure 2.

Alternative 1 (Figure 1) – This Alternative proposes:

- Removing and replacing an existing pump station
- Replacing or lining approximately 1,000 linear feet of 60" RCP outfall within a Gravel Road
- Wetlands would be avoided but a minor portion of waters could be impacted by removal and replacement of the pump station

Alternative 2 (Figure 2) – This Alternative proposes:

- Removing and replacing existing pump station
- Abandoning portions of a 60" RCP Outfall
- Add new drainage channel within adjacent wetlands
- Approximately 0.55 acre of impacts to waters/wetlands would occur

REGULATORY BACKGROUND

The following sections explain the regulatory context of the biological assessment, including applicable laws and regulations that were applied to the field investigations and analysis of potential Project impacts and mitigation requirements.

Sensitive Biological Communities: Sensitive biological communities include habitats that fulfill special functions or have special values, such as wetlands, streams, or riparian habitat. These habitats are protected under federal regulations such as the Clean Water Act; state regulations such as the Porter-Cologne Act, the California Department of Fish and Wildlife (CDFW) Streambed Alteration Program, and CEQA; or local ordinances or policies such as city or county tree ordinances, Special Habitat Management Areas, and General Plan Elements.

Waters of the United States

The U.S. Army Corps of Engineers (Corps) regulates “Waters of the United States” under Section 404 of the Clean Water Act. Waters of the U.S. are defined in the Code of Federal Regulations (CFR) as waters susceptible to use in commerce, including interstate waters and wetlands, all other waters (intrastate waterbodies, including wetlands), and their tributaries (33 CFR 328.3). Potential wetland areas, according to the three criteria used to delineate wetlands as defined in the *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987), are identified by the presence of (1) hydrophytic vegetation, (2) hydric soils, and (3) wetland hydrology. Areas that are inundated at a sufficient depth and for a sufficient duration to exclude growth of hydrophytic vegetation are subject to Section 404 jurisdiction as “other waters” and are often characterized by an ordinary high water mark (OHWM). Other waters, for example, generally include lakes, rivers, and streams. The placement of fill material into Waters of the U.S generally requires an individual or nationwide permit from the Corps under Section 404 of the Clean Water Act.

Waters of the State

The term “Waters of the State” is defined by the Porter-Cologne Act as “any surface water or groundwater, including saline waters, within the boundaries of the state.” The Regional Water Quality Control Board (RWQCB) protects all waters in its regulatory scope and has special responsibility for wetlands, riparian areas, and headwaters. These waterbodies have high resource value, are vulnerable to filling, and are not systematically protected by other programs. RWQCB jurisdiction includes “isolated” wetlands and waters that may not be regulated by the Corps under Section 404. Waters of the State are regulated by the RWQCB under the State Water Quality Certification Program which regulates discharges of fill and dredged material under Section 401 of the Clean Water Act and the Porter-Cologne Water Quality Control Act. Projects that require a Corps permit, or fall under other federal jurisdiction, and have the potential to impact Waters of the State, are required to comply with the terms of the Water Quality Certification determination. If a proposed project does not require a federal permit, but does involve dredge or fill activities that may result in a discharge to Waters of the State, the RWQCB has the option to regulate the dredge and fill activities under its state authority in the form of Waste Discharge Requirements.

San Francisco Bay and Shoreline

The San Francisco Bay Conservation and Development Commission (BCDC) has regulatory jurisdiction, as defined by the McAteer-Petris Act, over the Bay and its shoreline, which generally consists of the area between the shoreline and a line 100 feet landward of and parallel to the shoreline. BCDC has two areas of jurisdiction: San Francisco Bay and the Shoreline Band. Definitions of these areas, as described in the McAteer-Petris Act (PRC Section 66610), are given below.

> **San Francisco Bay:** all areas that are subject to tidal action from the south end of the Bay to the Golden Gate (Point Bonita-Point Lobos) and to the Sacramento River line (a line between Stake Point and Simmons Point, extending northeasterly to the mouth of Marshall Cut), including all sloughs, and specifically, the marshlands lying between mean high tide and five feet above mean sea level; tidelands (land lying between mean high tide and mean low tide); and submerged lands (land lying below mean low tide).

> **Shoreline Band:** all territory located between the shoreline of San Francisco Bay as defined above and a line 100 feet landward of and parallel with that line, but excluding any portions of such territory which are included in other areas of BCDC jurisdiction, provided that the Commission may, by resolution, exclude from its area of jurisdiction any area within the shoreline band that it finds and declares is of no regional importance to the Bay.

Other Sensitive Biological Communities

Other sensitive biological communities not discussed above include habitats that fulfill special functions or have special values. Natural communities considered sensitive are those identified in local or regional plans, policies, regulations, or by the CDFW. CDFW ranks sensitive communities as "threatened" or "very threatened" and keeps records of their occurrences in its California Natural Diversity Database (CNDDB; CDFW 2018). Sensitive plant communities are also identified by CDFW (CNPS 2018a). CNDDB vegetation alliances are ranked 1 through 5 based on NatureServe's (2010) methodology, with those alliances ranked globally (G) or statewide (S) as 1 through 3 considered sensitive. Impacts to sensitive natural communities identified in local or regional plans, policies, or regulations or those identified by the CDFW or U.S. Fish and Wildlife Service (USFWS) must be considered and evaluated under CEQA (CCR Title 14, Div. 6, Chap. 3, Appendix G). Specific habitats may also be identified as sensitive in city or county general plans or ordinances.

Sensitive Special-Status Species: Special-status species include those plants and wildlife species that have been formally listed, are proposed as endangered or threatened, or are candidates for such listing under the Federal Endangered Species Act (ESA) or California Endangered Species Act (CESA). These acts afford protection to both listed species and those that are formal candidates for listing. Additionally, CDFW Species of Special Concern, CDFW California Fully Protected species, USFWS Birds of Conservation Concern, and CDFW Special-status Invertebrates are all considered special-status species. Although these aforementioned species generally have no special legal status, they are given special consideration under CEQA.

In addition to regulations for special-status species, most native birds in the United States (including non-status species) are protected by the federal Migratory Bird Treaty Act of 1918 (MBTA) and the California Fish and Game Code (CFGC), i.e., sections 3503, 3503.5 and 3513. Under these laws, deliberately destroying active bird nests, eggs, and/or young is illegal.

Critical Habitat: Critical habitat is a term defined in the ESA as a specific and designated geographic area that contains features essential for the conservation of a threatened or endangered species and that may require special management and protection. The ESA requires federal agencies to consult with the USFWS to conserve listed species on their lands and to ensure that any activities or projects they fund, authorize, or carry out will not jeopardize the survival of a threatened or endangered species. In consultation for those species with critical habitat, federal agencies must also ensure that their activities or projects do not adversely modify critical habitat to the point that it will no longer aid in the species' recovery. In many cases, this level of protection is similar to that already provided to species by the ESA jeopardy standard. However, areas that are currently unoccupied by the species but which are needed for the species' recovery are protected by the prohibition against adverse modification of critical habitat.

BIOLOGICAL CONSTRAINTS ANALYSIS

The Project site is located within San Rafael, Marin County. Sensitive areas adjacent to the Project are salt marshes (coastal wetlands), waters adjacent to the pump station, and shoreline of San Rafael Bay.

The primary biological constraints for the Project are the adjacent salt marshes and waters, and threatened and endangered mammal species that may reside in the adjacent salt marshes (Table 1).

Table 1. Summary of Key Biological Constraints for the San Quentin Pump Station Project

Biological Constraint	*Responsible Agency*	*Location(s) in Project Area*	*Project Considerations*
Jurisdictional waters/wetlands	Corps, RWQCB, BCDC	Salt marsh and waters surrounding and/or in the Project area	Impacts to jurisdictional areas require a permit; permanent loss of waters requires mitigation. The BCDC shoreline band extends 100 feet inward from the edge of the Bay and is also subject to BCDC permit requirements. However, Project Alternatives improvements are just outside of the 100-foot shoreline band.
Salt marsh Harvest Mouse	USFWS, CDFW	Saltmarsh vegetation (specifically pickleweed) and immediately adjacent upland or fringe habitats.	Direct or indirect effects require a USFWS Biological Opinion. Permanent or temporary loss of habitat requires mitigation. Hand removal of vegetation, wildlife exclusion fencing, and biological monitoring likely required.
Non-listed Special-status Plant and Wildlife Species	CEQA, USFWS, CDFW	Entirety of the Project Area	USFWS, CDFW, and CEQA regulations prohibit the removal of active bird nests. To avoid disturbance to active nests, preconstruction surveys and bird deterrence measures may be implemented. Avoidance or minimization measures for other wildlife to be determined during CEQA review.

Jurisdictional Wetlands/Waters and BCDC Shoreline Band

Alternative 1 is primarily located within an existing developed area and would avoid the wetlands to the north; however, the removal of the pump station may result in minor impacts to waters. Alternative 2 would result in direct impacts to 0.55 acre of salt marsh and possibly minor impacts to waters due to the removal of the pump station and installation of the new culvert.

Special-status Species

There are various special-status species that could potentially occur within the Study Area. This memo does not assess the potential for all possible species that could be considered constraints under CEQA. Instead, this memo only addresses species listed under the Federal and/or State Endangered Species Acts which may present construction, feasibility, or permitting constraints for the Project.

Special-status species are known from the area, though generally the species present would be addressed during the CEQA process.

Species that have potential to occur are discussed below.

Salt marsh harvest mouse, (*Reithrodontomys raviventris)* Federal Endangered, State Endangered and CDFW Fully Protected. The salt marsh harvest mouse (SMHM) is a relatively small rodent found only in suitable salt- and brackish-marsh habitat in the greater San Francisco Bay, San Pablo Bay, and Suisun Bay areas. The habitat associated with SMHM has been described as pickleweed-dominated vegetation (Fisler 1965), though more recent studies have shown that SMHM is supported equally in pickleweed-dominated and mixed vegetation (including native and non-native salt- and brackish-marsh species) (Sustaita et al. 2005, Sustaita et al. 2011). SMHM prefers deep, dense vegetative cover between 11.8 and 23.6 inches height (USFWS 1984), though there are indications that shorter stands (5.9 inches is the shortest commonly used) of pickleweed may also support an abundance of this species (Fisler 1965; Shellhammer et al. 1982; USFWS 2013). Another key habitat requirement for this species is upland or tidal refuge habitat, which is used to escape high tides and storm events. Persistent, low numbers of SMHM are also found in grasslands at least 330 feet (100 meters) from the edge of marsh habitat, though their presence in grasslands may be seasonal and opportunistic (USFWS 2013). This species has the potential to be present in or adjacent to the Project site.

Nesting Birds and other Special-Status Wildlife

Most nesting birds in California are protected by the Migratory Bird Treaty Act (MBTA) and California Fish and Game Code (CFGC). As a result of these protections, the removal and disturbance of active nests is prohibited. To avoid impacts to nesting birds, project improvements can occur between September 1 and February 15. Another common measure to avoid impacts to nesting birds is to complete pre-construction surveys for breeding birds prior to construction during the breeding season. The risk of relying on preconstruction surveys is that if nesting birds are found, those nests cannot be removed and are at minimum required to be monitored during construction to ensure that construction is not affecting nesting success. Bird deterrence measures, such as netting, acoustic disturbance mechanisms, and reflective materials, can be put in place to deter bird nesting prior to construction. Experience has shown that these measures can help prevent some nesting, but are somewhat unreliable at completely preventing nest establishment, and consistent (sometimes daily) active management of bird nests as they are created can sometimes be necessary.

CEQA may identify additional species listed by CDFW as species of special concern, whereby the level of impact associated with the preferred alternative may exceed the significance threshold. Generally CEQA mitigation measures require surveys with appropriate performance standards, work windows, biological monitoring or other similar measures to avoid or reduce the impact to a less-than-significant level.

PERMITTING APPROACH OVERVIEW

Table 2 below summarizes the biological and permitting constraints for the Project site. These constraints are discussed in more detail in the text below.

Table 2. Summary of Permit Requirements and Key Biological and Permitting Constraints

Anticipated Permit Requirements	Key Biological and Permitting Constraints
• U.S. Army Corps of Engineers (Corps) Section 404 • San Francisco Bay Regional Water Quality Control Board (RWQCB) Water Quality Certification • U.S. Fish and Wildlife Service (USFWS) Section 7 Consultation	• Agency requirements to minimize fill • Potential effects on federally threatened and endangered bird and mammal species • Potential effects on State threatened and endangered bird and mammal species

As discussed above, based on the current Project description and materials provided to WRA, the following permits may be required from the following agencies for the two Alternatives:

- Corps Section 404 Permit
- RWQCB Water Quality Certification
- USFWS Section 7 Consultation

Corps Individual Permit and RWQCB Water Quality Certification

Alternative 2 would result in impacts to potentially jurisdictional wetlands/waters that exceed the ½-acre threshold to qualify for a Nationwide Permit. Therefore this Alternative would require an Individual Permit. For the Corps to issue an Individual Permit, the Project design is required to meet the standard of the “least environmentally damaging practicable alternative” as determined by an alternatives analysis. The alternatives analysis requires the examination of technically and economically feasible[1] alternatives and gives the Corps the authority to determine the most appropriate design to minimize environmental impacts. In addition, Individual Permits often require NEPA documentation in the form of an Environmental Assessment/Finding of No Significant Impact (EA/FONSI). Similarly, the RWQCB may exert pressure to reduce fill, even if the Nationwide Permit standards are met. RWQCB regulations are much less clear on the requirements to minimize fill and standards applied to examine acceptable levels of fill, which gives much more leeway for staff to make their own decisions regarding acceptability of fill placed in the Bay. The Alternatives would need to provide substantial evidence as to the need for the impacts to jurisdictional areas, and demonstrate that impacts have been avoided to the greatest extent feasible. There is not a known recent precedent for a project of this size and nature

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1 *Corps regulations do include economic feasibility, but no regulatory standards are established to determine what constitutes economic feasibility.*

receiving authorization for the amount of fill potentially involved for each Alternative. Last, the Corps and RWQCB would require mitigation for all jurisdictional areas lost as a result of fill placed by the Project. As discussed further below, the cost for mitigation can be substantial. For these reasons, it is recommended that the total area of impacted waters/wetlands be reviewed to identify means by which fill can be avoided or minimized.

Conversely, Alternative 1 would avoid the wetlands to the north but could result in minor impacts to waters due to the removal of the pump station. As such, this Alternative would avoid the need for an Individual Permit from the Corps, and far less mitigation costs for waters/wetlands, if at all, compared to Alternative 2.

USFWS Section 7 Consultation

The Corps would formally consult with the USFWS in order to determine impacts and mitigation of impacts to species listed as threatened or endangered under the Federal Endangered Species Act (e.g., Salt marsh harvest mouse).

Other Considerations

Mitigation Cost

For projects that result in a net loss of jurisdictional waters, the Corps and RWQCB require mitigation in the form of project-sponsored habitat creation or purchase of credits in a mitigation bank. Recent Corps regulations favor purchase of credits in mitigation banks over project-sponsored mitigation. The price for mitigation is based on recent sales of credits and price quotes from the San Francisco Bay Mitigation Bank, which does offer credits that would be available for purchase for the Project. The cost of those credits is anticipated to be approximately $950,000-1,100,000 per acre, depending on the final impact area. For this reason, it is recommended that Project Alternatives be reviewed to identify means by which impacts to wetlands and other jurisdictional areas can be minimized.

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Geissel, W., H. Shellhammer, and H. T. Harvey. 1988. The Ecology of the Salt Marsh Harvest Mouse (*Reithrodontomys raviventris*) in a Diked Salt Marsh. J. of Mammalogy 69(4): 696-703.

Shellhammer, H.S., Jackson, R., Davilla, W., Gilroy, A.M., Harvey, H.T., and Simons, L. 1982. Habitat Preferences of Salt Marsh Harvest Mice (*Reithrodontomys raviventris*). The Wasmann Journal of Biology. Vol: 40(1-2). pp. 102-144.

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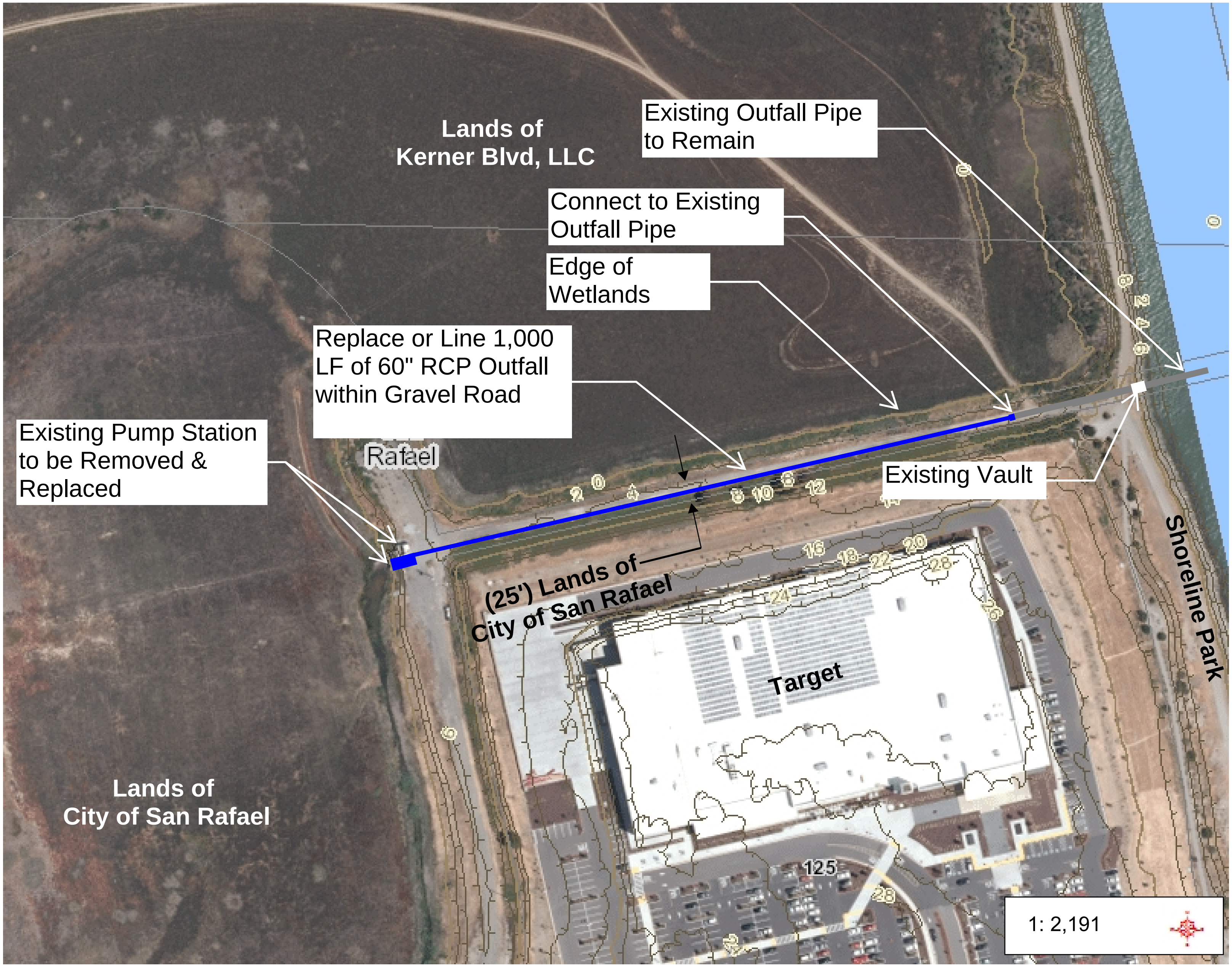
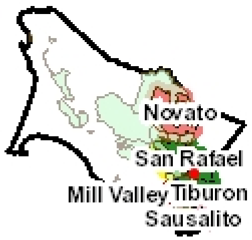
U.S. Fish and Wildlife Service. 1984. Salt marsh harvest mouse and California clapper rail recovery plan. Portland, Oregon.

APPENDIX A. FIGURES

SAN QUENTIN DESIGN OPTIONS





Legend

Parcel Note
- ☐ easement
- ☐ centerline

☐ Parcel

— Trail

Address

☐ Parcel

☐ Condominium Common Area

☐ Mobile Home Pad

☐ City

☐ Community

☐ Marin County Legal Boundary

☐ Other Bay Area County

🟦 Ocean and Bay

2-foot Elevation NAVD88
- — Interior
- — Index

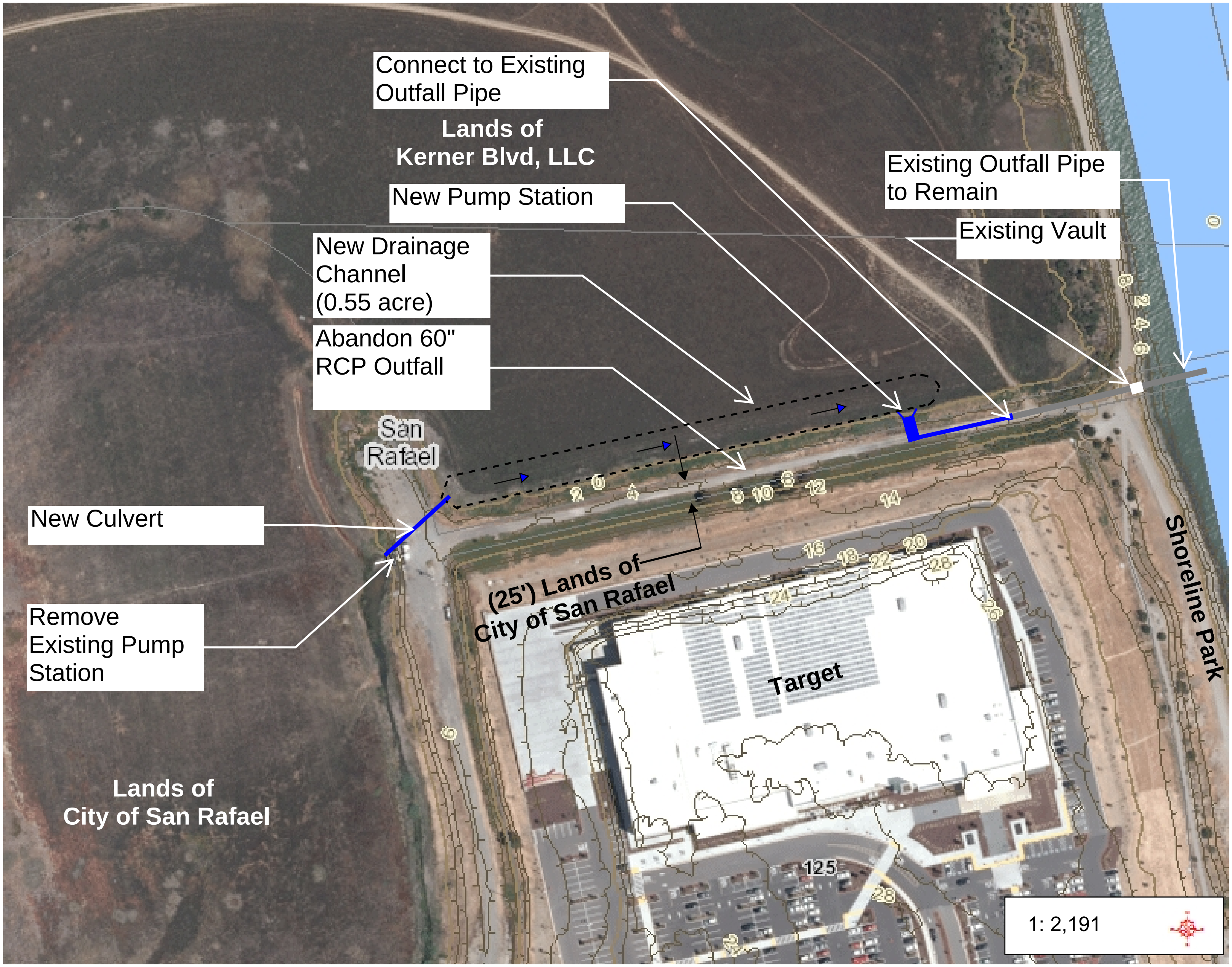
365.2 0 182.59 365.2 Feet

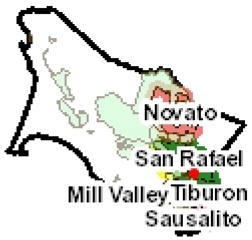
NAD_1983_HARN_StatePlane_California_III_FIPS_0403_Feet

Figure 1 - Alternative 1

Marin Map

SAN QUENTIN DESIGN OPTIONS





Legend

Parcel Note
- ☐ easement
- ☐ centerline

☐ Parcel
— Trail
Address
☐ Parcel
☐ Condominium Common Area
☐ Mobile Home Pad
☐ City
☐ Community
☐ Marin County Legal Boundary
▨ Other Bay Area County
🟦 Ocean and Bay
2-foot Elevation NAVD88
- — Interior
- — Index

365.2 0 182.59 365.2 Feet

NAD_1983_HARN_StatePlane_California_III_FIPS_0403_Feet

Figure 2 - Alternative 2

APPENDIX A, SUB-APPENDIX C:

Drainage Study

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DRAINAGE STUDY

FOR

SAN QUENTIN PUMP STATION

Prepared For:
City of San Rafael
Department of Public Works
111 Morphew Street
San Rafael, CA 94901

Prepared By:
CSW/Stuber-Stroeh Engineering Group, Inc.
45 Leveroni Court
Novato, California 94949
(415)-883-9850

Prepared:
April 20, 2018

CSW|ST2 File No.:
4.1133.02

TABLE OF CONTENTS

1. INTRODUCTION

In this Drainage Study, the existing condition hydrology was analyzed for the San Quentin Pump Station watershed with the intent to size the proposed pump station such that flooding risk to upstream properties is limited. This Study includes an analysis of the watershed, pump system alternatives and available storage.

2. EXISTING CONDITIONS

The San Quentin Pump Station is located in San Rafael, Marin County. The existing pump station consists of two (2) 50 cubic feet per second (cfs) pumps. The pump station discharges to San Francisco Bay.

The San Quentin Pump Station watershed is approximately 403 acres, consisting of urban/commercial development, hillside woods and wetlands. The wetlands act as a storage basin for the pump station. The watershed is bisected by Interstate 580, which includes large roadside ditches for drainage that are inundated during rain events. The watershed consists of Hydrologic Soil Groups "B" and "undefined" (which is assumed to be Group "D") according to the USDA Soil Survey.

Anecdotal evidence indicates that the parcels on the west side of Interstate 580 flood as a result of the existing pump flow rates. This evidence indicates that the existing pump system is insufficient. The at-risk properties are located at an elevation of 4.0'.

See Appendix 7.1 for the Existing Conditions Hydrology Map.

3. SCENARIO ANALYZED

The anecdotal evidence indicates that the existing pump system is insufficient. As such, the proposed design storm was assumed to be the 100-year, 24-hour storm event. However, due to the historic weather patterns for the region, which sees storm events occur in succession, an assumption of a 5-year, 24-hour storm event occurred prior to the 100-year, 24-hour storm event. A storm series, described below, was developed to size the pump station alternatives.

Storm Series:

The proposed storm series analyzed was the 5-year, 24-hour storm event followed by the 100-year, 24-hour storm event with a two hour overlap between the two events.

Assumptions:

- The proposed pump systems will include a two (2) or dual pump alternating system.
- The existing wetlands and highway swales can be utilized for runoff storage.
- Storage available between elevation -2.0 and -1.0 is already filled with water and not available for storage during the storm series.

Pump Parameters:

Parameter	Value
Flood elevation of concern	4.0’
Freeboard Elevation	3.0’
Pump 1 on elevation	-0.5’
Pump 2 on elevation	0.5’
Pump off elevation	-1.0’

4. METHOD OF ANALYSIS

The existing watershed was analyzed using the National Resources Conservation Services (NRCS, formerly the Soil Conservations Survey or SCS) TR 55 Urban Hydrology for Small Watersheds methodology (see Appendix 7.3-NRCS Worksheets). Hydrographs were created for the 5-year, 24-hour storm event and 100-year, 24-hour storm and combined to create the analyzed storm series.

5. FACTORS USED IN ANALYSIS

a. Subbasins: The subbasin identified in these calculations was determined from topographic information, storm drain information and aerial photography taken from Marin Maps Geographical Information System (GIS).

See Appendix 7.1 for the Existing Hydrology Maps.

b. Pump System: Three pump system scenarios were analyzed; two (2) 50 cubic feet per second (cfs) pumps, two (2)80 cfs pumps, and two (2) 100 cfs pumps.

See Appendix 7.5 for the pump analysis.

c. Available Storage: The available storage in the wetlands and swales was determined from available topographic information taken from the Marin Maps GIS.

See Appendix 7.1 for sheet H1-Drainage Area Study.

d. Hydrographs: The hydrographs for the 5-year 24-hour and 100-year 24-hour storm events were determined using the computer modeling program Hydraflow Hydrograph Extension for AutoCAD Civil3D 2016. The computer model utilized the NRCS TR 55 methodology to create the hydrographs. The hydrographs were exported and utilized for the pump sizing calculations. The hydrograph flow data was calculated at 15 minute intervals. Precipitation data was taken from the NOAA Atlas 14, Volume 6, Version 2 Point Precipitation Frequency Estimates (See Appendix 7.2-Precipication Data).

See Appendix 7.4 the 5-Year and 100-Year Storm Event Hydraflow Hydrograph Output.

6. RESULTS AND CONCLUSIONS

Results:

Table 6.1 depicts the 5- and 100-year peak discharge rates for the 24-hour storm event. Table 6.2 indicates the results of the pump sizing analysis in maximum water surface elevation (WSEL).

Table 6.1: 24-Hour Rain Event Peak Discharge Rates

Recurrence Interval	Time to Peak (hours)	Peak Discharge Rate (cfs)
5-Year	3.1	153.28
100-Year	3.1	329.10

Notes:
1. See Appendix 7.3 for time of concentration calculations.
2. See Appendix 7.4 for hydrograph data.

Table 6.2: Pump Analysis Results

Pump Flow Rate	Maximum WSEL	Constraints/Benefits
(2) 50 cfs	3.9	No freeboard, no rest periods for pump
(2) 80 cfs	3.9	No freeboard/allows rest periods for pump
(3) 66 cfs	2.9	Allows 1' freeboard and rest periods for pump
(2) 100 cfs	2.9	Allows 1' freeboard and rest periods for pump

Notes:
1. The elevation where the properties of concern begin to flood is elevation 4.0.
2. Analysis was performed assuming a 5-year, 24-hour event and a 100-year, 24-hour event in series.
3. Storm series duration is 52 hours.

Conclusion: The analysis indicates that a three (3) 66 cfs pump system and a two (2) 100 cfs pump system has sufficient capacity to convey the peak discharge rate form the 5-year 24-hour, 100-year 24-hour storm series maintaining a 1' freeboard below the elevation of concern and allowing for pump rest periods.

7.0 APPENDICES

Appendix 7.1
Maps

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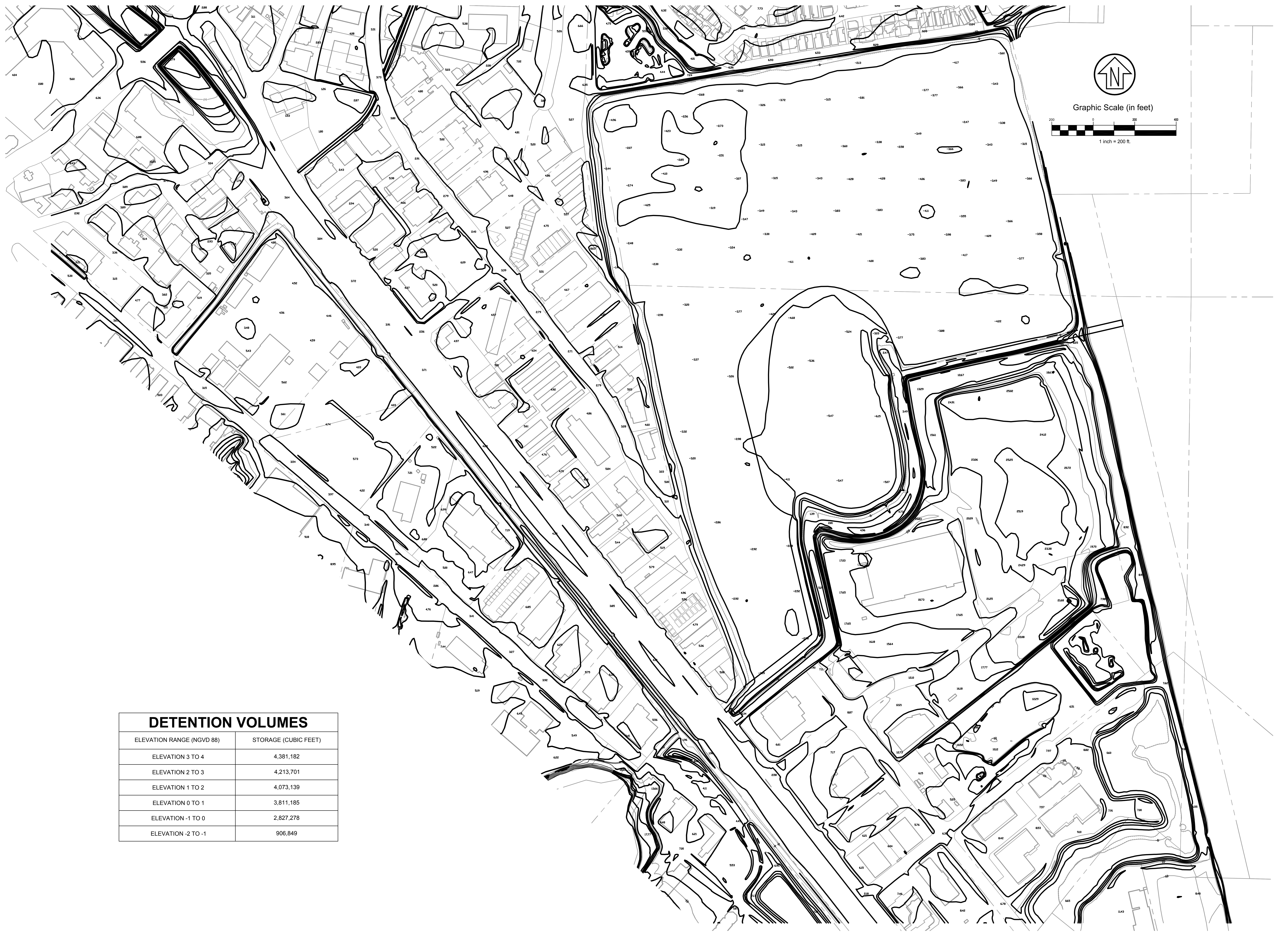

DETENTION VOLUMES

ELEVATION RANGE (NGVD 88)	STORAGE (CUBIC FEET)
ELEVATION 3 TO 4	4,381,182
ELEVATION 2 TO 3	4,213,701
ELEVATION 1 TO 2	4,073,139
ELEVATION 0 TO 1	3,811,185
ELEVATION -1 TO 0	2,827,278
ELEVATION -2 TO -1	906,849

CSW | ST2

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Rev	Date	Description	Designed	Drawn	Checked

SAN QUENTIN PUMP STATION

DRAINAGE AREA STUDY

CITY OF SAN RAFAEL

City Of
San Rafael

County Of
Marin

State Of
California

Prepared Under the Direction of:

Sheet
H1

Scale: 1" = 200'
Date: 01/18/18
Project Number: 4.113.302
Plan File: D-

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Rev	Date	Description	Designed	Drawn	Checked
-	XX/XX/XX	XXX	XXX	XXX	XXX

SAN QUENTIN PUMP STATION
EXISTING CONDITIONS HYDROLOGY MAP

City Of
SAN RAFAEL

County Of
Marin

State Of
California

Prepared Under the Direction of:

Sheet
H2

Scale: 1" = 400'
Date: XX/XX/XX
Project Number: 7.7763.57
Plan File: D-XXXX-XX

W:\AD-NOV\WP\7\776357\Hydrology\H1-Existing Conditions Hydrology Map.dwg 01/05/2018 - 11:08 AM BRIBR 1:1

Appendix 7.2
Precipitation Data

NOAA Atlas 14, Volume 6, Version 2
Location name: San Rafael, California, USA*
Latitude: 37.9553°, Longitude: -122.4913°
Elevation: 26.42 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF tabular | PF graphical | Maps & aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.155** (0.138–0.175)	**0.192** (0.171–0.218)	**0.244** (0.217–0.278)	**0.289** (0.254–0.333)	**0.354** (0.299–0.424)	**0.407** (0.335–0.500)	**0.464** (0.370–0.586)	**0.525** (0.405–0.686)	**0.612** (0.450–0.841)	**0.684** (0.483–0.978)
10-min	**0.222** (0.197–0.251)	**0.275** (0.245–0.313)	**0.350** (0.311–0.399)	**0.415** (0.364–0.477)	**0.508** (0.428–0.608)	**0.584** (0.480–0.717)	**0.665** (0.531–0.840)	**0.752** (0.581–0.983)	**0.878** (0.645–1.21)	**0.980** (0.692–1.40)
15-min	**0.268** (0.239–0.304)	**0.333** (0.296–0.378)	**0.424** (0.376–0.482)	**0.501** (0.440–0.577)	**0.614** (0.518–0.735)	**0.706** (0.580–0.867)	**0.804** (0.642–1.02)	**0.910** (0.703–1.19)	**1.06** (0.780–1.46)	**1.19** (0.837–1.70)
30-min	**0.389** (0.347–0.441)	**0.483** (0.430–0.549)	**0.615** (0.545–0.700)	**0.728** (0.639–0.837)	**0.891** (0.752–1.07)	**1.02** (0.842–1.26)	**1.17** (0.932–1.48)	**1.32** (1.02–1.73)	**1.54** (1.13–2.12)	**1.72** (1.22–2.46)
60-min	**0.555** (0.495–0.629)	**0.690** (0.614–0.783)	**0.877** (0.778–0.999)	**1.04** (0.912–1.20)	**1.27** (1.07–1.52)	**1.46** (1.20–1.80)	**1.67** (1.33–2.11)	**1.88** (1.46–2.46)	**2.20** (1.62–3.02)	**2.46** (1.73–3.51)
2-hr	**0.826** (0.736–0.936)	**1.02** (0.911–1.16)	**1.30** (1.16–1.48)	**1.54** (1.36–1.78)	**1.89** (1.60–2.27)	**2.18** (1.79–2.68)	**2.49** (1.98–3.14)	**2.82** (2.18–3.69)	**3.30** (2.42–4.53)	**3.69** (2.61–5.28)
3-hr	**1.05** (0.935–1.19)	**1.30** (1.16–1.48)	**1.65** (1.46–1.88)	**1.95** (1.72–2.25)	**2.39** (2.02–2.87)	**2.76** (2.27–3.39)	**3.14** (2.51–3.98)	**3.57** (2.76–4.66)	**4.18** (3.07–5.73)	**4.68** (3.30–6.69)
6-hr	**1.54** (1.37–1.74)	**1.90** (1.69–2.16)	**2.41** (2.14–2.75)	**2.85** (2.50–3.28)	**3.48** (2.94–4.17)	**4.00** (3.29–4.91)	**4.54** (3.63–5.75)	**5.14** (3.97–6.72)	**5.99** (4.40–8.23)	**6.69** (4.72–9.56)
12-hr	**2.14** (1.91–2.43)	**2.68** (2.39–3.05)	**3.43** (3.04–3.90)	**4.05** (3.56–4.66)	**4.93** (4.16–5.91)	**5.64** (4.64–6.93)	**6.39** (5.10–8.08)	**7.18** (5.55–9.39)	**8.29** (6.10–11.4)	**9.19** (6.49–13.1)
24-hr	**2.89** (2.61–3.28)	**3.67** (3.30–4.17)	**4.72** (4.24–5.37)	**5.59** (4.98–6.41)	**6.80** (5.88–8.03)	**7.76** (6.58–9.33)	**8.75** (7.26–10.8)	**9.79** (7.92–12.3)	**11.2** (8.76–14.7)	**12.4** (9.35–16.7)
2-day	**3.84** (3.46–4.35)	**4.88** (4.39–5.54)	**6.27** (5.62–7.13)	**7.41** (6.60–8.49)	**8.99** (7.77–10.6)	**10.2** (8.67–12.3)	**11.5** (9.53–14.1)	**12.8** (10.4–16.1)	**14.6** (11.4–19.1)	**16.0** (12.1–21.7)
3-day	**4.40** (3.96–4.99)	**5.60** (5.03–6.35)	**7.18** (6.44–8.17)	**8.48** (7.56–9.72)	**10.3** (8.87–12.1)	**11.6** (9.88–14.0)	**13.1** (10.8–16.1)	**14.5** (11.8–18.3)	**16.6** (12.9–21.7)	**18.1** (13.7–24.5)
4-day	**4.87** (4.38–5.51)	**6.19** (5.57–7.02)	**7.95** (7.13–9.04)	**9.38** (8.35–10.7)	**11.3** (9.80–13.4)	**12.8** (10.9–15.4)	**14.4** (11.9–17.7)	**16.0** (12.9–20.1)	**18.1** (14.1–23.7)	**19.8** (15.0–26.8)
7-day	**5.92** (5.33–6.71)	**7.56** (6.80–8.57)	**9.69** (8.70–11.0)	**11.4** (10.2–13.1)	**13.8** (11.9–16.2)	**15.6** (13.2–18.7)	**17.4** (14.4–21.3)	**19.2** (15.6–24.2)	**21.7** (16.9–28.4)	**23.7** (17.9–31.9)
10-day	**6.89** (6.20–7.81)	**8.81** (7.93–10.00)	**11.3** (10.1–12.8)	**13.3** (11.8–15.2)	**16.0** (13.8–18.9)	**18.0** (15.3–21.6)	**20.0** (16.6–24.6)	**22.1** (17.9–27.8)	**24.8** (19.4–32.5)	**26.9** (20.3–36.4)
20-day	**9.01** (8.11–10.2)	**11.6** (10.4–13.2)	**14.9** (13.3–16.9)	**17.4** (15.5–20.0)	**20.7** (17.9–24.5)	**23.2** (19.7–27.9)	**25.6** (21.2–31.4)	**27.9** (22.6–35.2)	**31.0** (24.2–40.6)	**33.2** (25.1–44.9)
30-day	**10.9** (9.85–12.4)	**14.1** (12.7–16.0)	**18.0** (16.2–20.5)	**21.0** (18.7–24.1)	**24.9** (21.5–29.4)	**27.7** (23.5–33.3)	**30.3** (25.2–37.3)	**32.9** (26.7–41.5)	**36.2** (28.3–47.4)	**38.6** (29.2–52.1)
45-day	**13.5** (12.2–15.3)	**17.4** (15.7–19.7)	**22.1** (19.8–25.1)	**25.6** (22.8–29.4)	**30.1** (26.0–35.5)	**33.3** (28.2–40.0)	**36.3** (30.1–44.6)	**39.1** (31.7–49.3)	**42.7** (33.3–55.9)	**45.2** (34.1–61.0)
60-day	**16.2** (14.6–18.3)	**20.7** (18.6–23.5)	**26.2** (23.5–29.7)	**30.2** (26.9–34.6)	**35.2** (30.5–41.6)	**38.8** (32.9–46.6)	**42.0** (34.9–51.7)	**45.2** (36.5–56.9)	**49.0** (38.2–64.1)	**51.6** (39.0–69.7)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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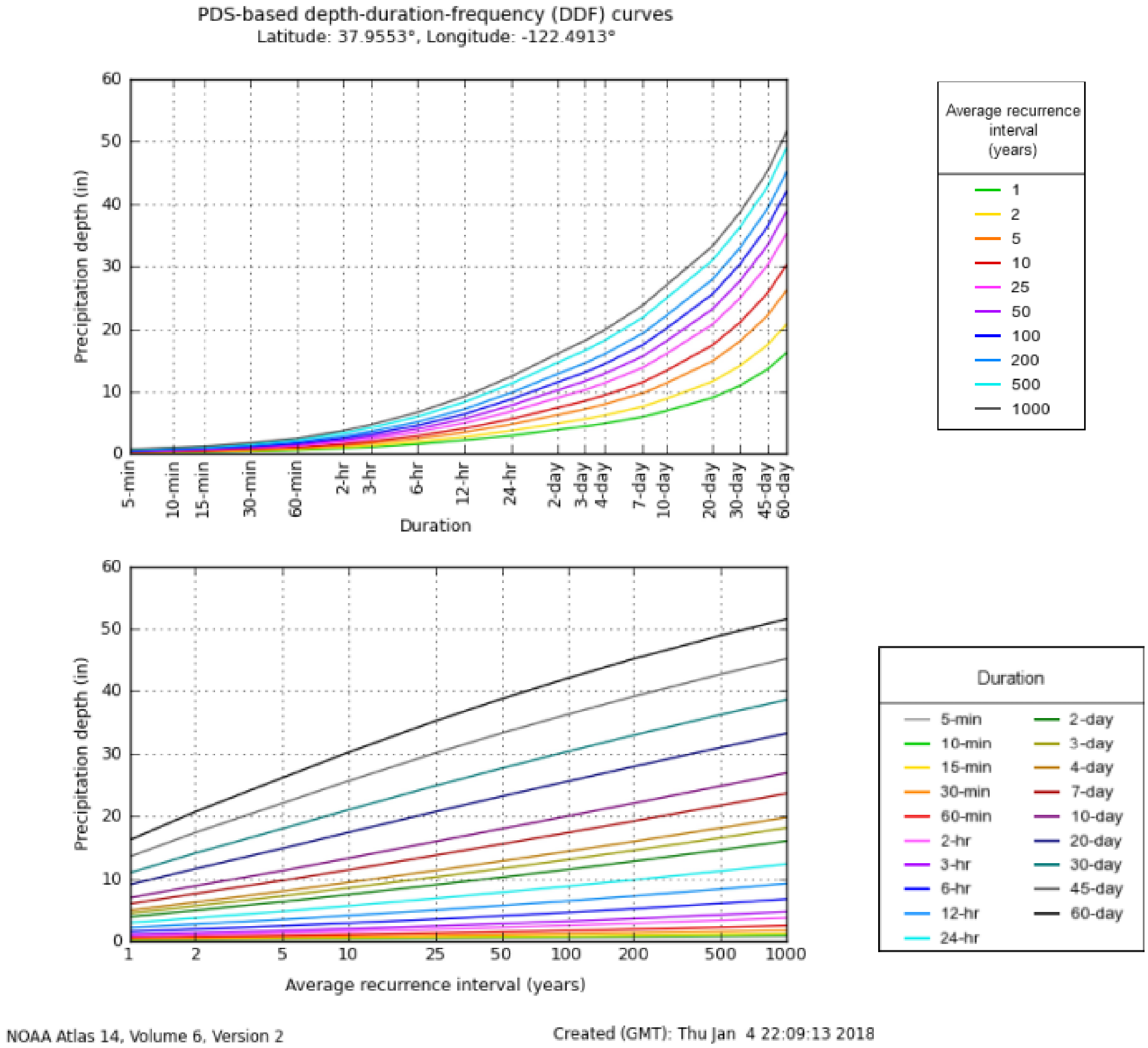
PF graphical


PDS-based depth-duration-frequency (DDF) curves
Latitude: 37.9553°, Longitude: -122.4913°

NOAA Atlas 14, Volume 6, Version 2

Created (GMT): Thu Jan 4 22:09:13 2018

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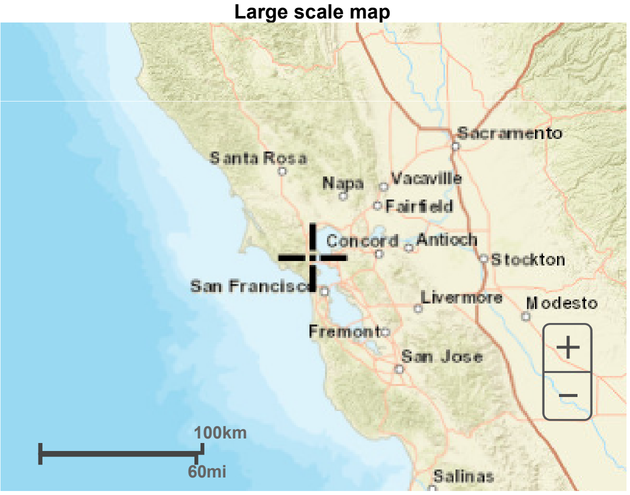
Maps & aerials

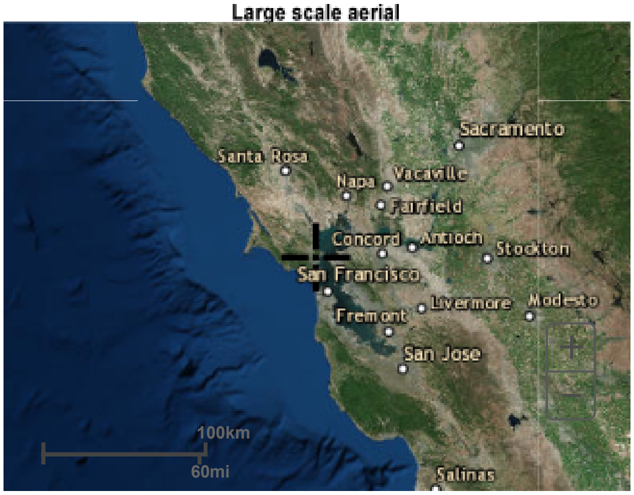
Small scale terrain

Large scale terrain

Large scale map



Large scale aerial



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National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

Appendix 7.3
NRCS Worksheets

Worksheet 2: Runoff curve number and runoff

Project SAN QUENTIN PUMP STATION

By BRB

Date 2/15/18

Location SAN RAFAEL

Checked JAH

Date 2/21/18

Check one: ☑ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN [1/]			Area ☑ acres ☐ mi² ☐ %	Product of CN x area
		Table 2-2	Figure 2-3	Figure 2-4		
UNDEFINED (ASSUME D)	URBAN DISTRICT, COMMERCIAL AND BUSINESS	95			332.3	3156.8
B	WOODS	60			70.9	4254
				Totals ➡	403.2	35822.5

[1/] Use only one CN source per line

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = $\frac{35822.5}{403.2}$ = 88.8 ; **Use CN** ➡ 89

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr	5	10	
Rainfall, P (24-hour)	in	4.72	5.59	
Runoff, Q (Use P and CN with table 2-1, figure 2-1, or equations 2-3 and 2-4)	in	3.51	4.34	

Worksheet 2: Runoff curve number and runoff

Project SAN QUENTIN PUMP STATION	By BRB	Date 2/15/18
Location SAN RAFAEL	Checked JAH	Date 2/21/18

Check one: ☒ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN[1]			Area ☑ acres ☐ mi^2 ☐ %	Product of CN x area
		Table 2-2	Figure 2-3	Figure 2-4		
UNDEFINED (ASSUME D)	URBAN DISTRICT: COMMERCIAL & BUSINESS	95			332.3	31568.5
B	WOODS; FAIR	60			70.9	4254
				Totals ➡	403.2	35822.5

---

[1] Use only one CN source per line

$$\text{CN (weighted)} = \frac{\text{total product}}{\text{total area}} = \frac{35822.5}{403.2} = 88.8 \;;$$

Use CN ➡ 89

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr	25	100	
Rainfall, P (24-hour)	in	6.80	8.75	
Runoff, Q (Use P and CN with table 2-1, figure 2-1, or equations 2-3 and 2-4)	in	5.52	7.43	

SHEET NO. 1

JOB NO. 4113302 JOB SAN QUENTIN PUMP STATION BY BRB DATE 2/15/18

CLIENT ____ SUBJECT RUNOFF CURVE NUMBER CALC. CHK'D JAH DATE 2/21/18

$$Q = \frac{(P-0.2S)^2}{(P+0.8S)} \quad ;$$

Q = RUNOFF (IN)
P = RAINFALL (IN)
S = POTENTIAL MAXIMUM RETENTION AFTER RUNOFF BEGINS (IN)

$$S = \frac{1000}{CN} - 10$$

$$S = \frac{1000}{89} - 10$$

$$\underline{S = 1.23 \text{ IN}}$$

P(24HR, 5 YR) = 4.72IN ; P (RAINFALL) VALUES DETERMINED FROM
P(24HR, 10 YR) = 5.59IN NOAA ATLAS 14, VOLUME 6, VERSION 2
P(24HR, 25 YR) = 6.80IN USING 125 SHORELINE PKWY, SAN RAFAEL,
P(24HR, 100 YR) = 8.75IN CA 94901, USA FOR THE LOCATION.

$$Q = \frac{(P-0.2S)^2}{(P+0.8S)}$$

$$Q_{25} = \frac{(6.8-0.2(1.23))^2}{(6.8+0.8(1.23))}$$

$$\boxed{Q_{25} = 5.52 \text{ IN}}$$

$$Q_{10} = \frac{(5.59-0.2(1.23))^2}{5.59+0.8(1.23)}$$

$$\boxed{Q_{10} = 4.34 \text{ IN}}$$

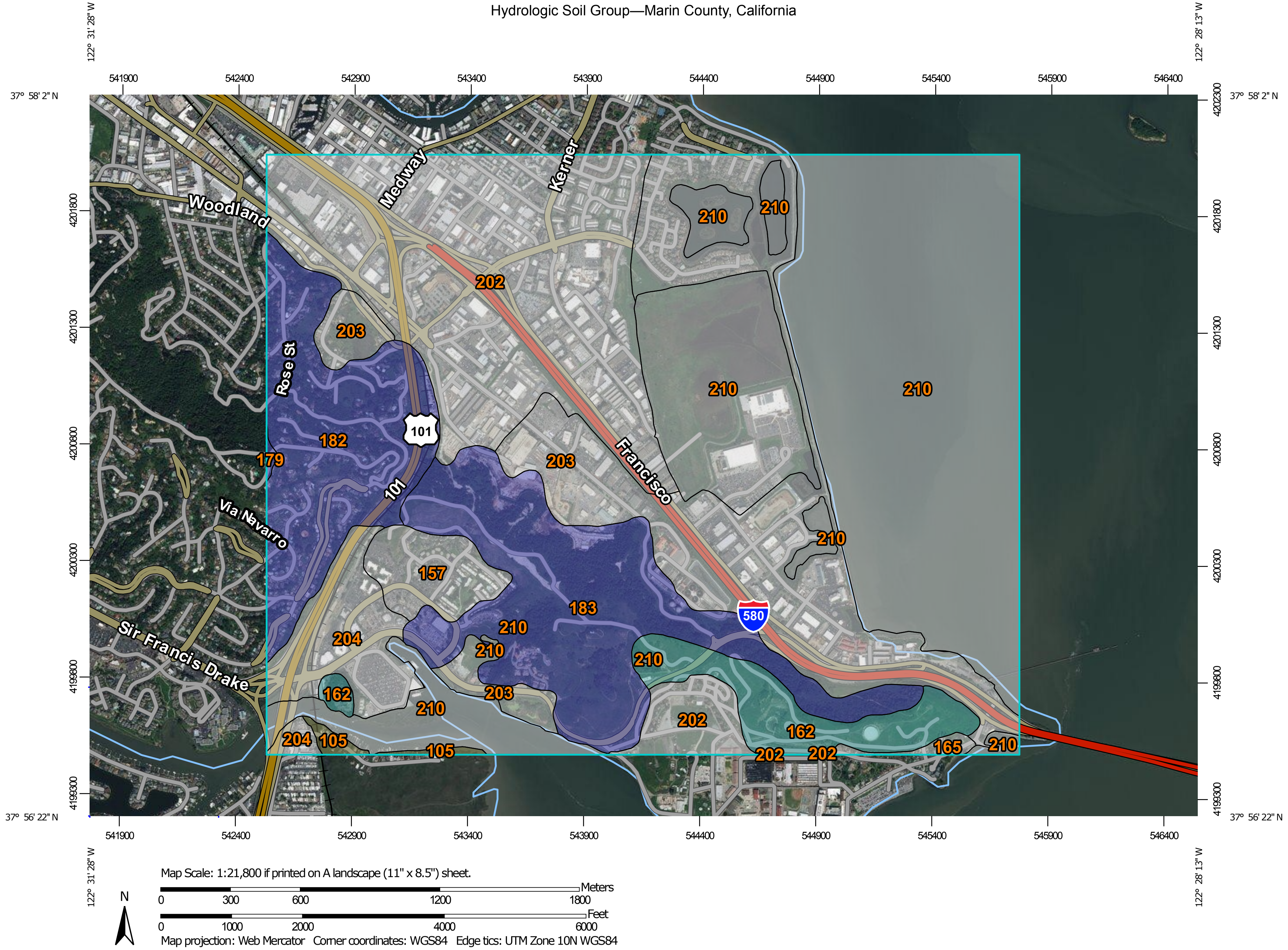
$$Q_{100} = \frac{(8.75-0.2(1.23))^2}{(8.75+0.8(1.23))}$$

$$\boxed{Q_{100} = 7.43 \text{ IN}}$$

$$Q_5 = \frac{(4.72-0.2(1.23))^2}{4.72+0.8(1.23)}$$

$$\boxed{Q_5 = 3.51 \text{ IN}}$$

Hydrologic Soil Group—Marin County, California



Map Scale: 1:21,800 if printed on A landscape (11" x 8.5") sheet.

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)

▭	Area of Interest (AOI)

Soils

Soil Rating Polygons

🟪	A
🟩	A/D
🟦	B
🟫	B/D
🟦	C
🟨	C/D
🟥	D
⬜	Not rated or not available

Soil Rating Lines

〰	A
〰	A/D
〰	B
〰	B/D
〰	C
〰	C/D
〰	D
〰	Not rated or not available

Soil Rating Points

■	A
■	A/D
■	B
■	B/D
■	C
■	C/D
■	D
□	Not rated or not available

Water Features

〰	Streams and Canals

Transportation

┿┿┿	Rails
〰	Interstate Highways
〰	US Routes
〰	Major Roads
〰	Local Roads

Background

■	Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Marin County, California
Survey Area Data: Version 11, Sep 14, 2017

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Dec 31, 2009—Mar 16, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
105	Blucher-Cole complex, 2 to 5 percent slopes	C/D	7.1	0.3%
157	Pits, quarries		43.0	2.1%
162	Saurin-Bonnydoon complex, 15 to 30 percent slopes	C	74.0	3.6%
165	Saurin-Urban land-Bonnydoon complex, 15 to 30 percent slopes		5.7	0.3%
179	Tocaloma-McMullin complex, 30 to 50 percent slopes	B	1.3	0.1%
182	Tocaloma-McMullin-Urban land complex, 30 to 50 percent slopes	B	179.5	8.7%
183	Tocaloma-Saurin association, steep	B	242.3	11.7%
202	Urban land-Xerorthents complex, 0 to 9 percent slopes		416.3	20.1%
203	Xerorthents, fill		316.5	15.3%
204	Xerorthents-Urban land complex, 0 to 9 percent slopes		75.3	3.6%
210	Water		709.9	34.3%
Totals for Area of Interest			**2,071.0**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Worksheet 3: Time of Concentration (T_c) or travel time (T_t)

Project	By	Date
SAN QUENTIN PUMP STATION	BRB	2/15/18
Location	**Checked**	**Date**
SAN RAFAEL	JAH	2/21/18

Check one: ☒ Present ☐ Developed

Check one: ☐ T_c ☐ T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to Tc only)

Segment ID		AB		
1. Surface description (table 3-1)		WOODS		
2. Manning's roughness coefficient, n (table 3-1)		0.40		
3. Flow length, L (total L † 300 ft)	ft	300		
4. Two-year 24-hour rainfall, P_2	in	3.67		
5. Land slope, s	ft/ft	0.20		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{\ 0.5}\ s^{0.4}}$ Compute T_t	hr	0.32	+	= 0.32

Shallow concentrated flow

Segment ID		BC		
7. Surface description (paved or unpaved)		PAVED		
8. Flow length, L	ft	1,140		
9. Watercourse slope, s	ft/ft	0.14		
10. Average velocity, V (figure 3-1)	ft/s	7.5		
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.04	+	= 0.04

Channel flow

Segment ID		CD	DE	
12. Cross sectional flow area, a	ft^2	12.57	140.8	
13. Wetted perimeter, p_w	ft	12.57	40.55	
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft	1.0	3.47	
15 Channel slope, s	ft/ft	0.003	0.001	
16. Manning's roughness coefficient, n		0.014	0.4	
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft/s	5.83	0.27	
18. ~~Flow~~ length, L	ft	730	2620	
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.035	+ 2.70	= 2.74

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) .... Hr 3.10

SHEET NO. 1/6
JOB NO. 4113302 JOB SAN QUENTIN PUMP STATION BY BRB DATE 2/15/18
CLIENT ______ SUBJECT TIME OF CONCENTRATION CHK'D JAH DATE 2/21/18

FOR ALL SECTIONS:
n = MANNING'S COEFFICIENT
S (FT/FT) = SLOPE
P_x (IN) = RAINFALL
V (FT/S) = VELOCITY
A (FT²) = CROSS-SECTIONAL AREA
P_w (FT) = WETTED PERIMETER

SEGMENT AB:

ELEV. A = 222 ft
ELEV. B = 162 ft
L = 300 ft

LAND SLOPE:

$$S = \frac{\text{ELEV. A} - \text{ELEV. B}}{L}$$

$$S = \frac{222 - 162}{300}$$

$$\boxed{S = 0.20\ \text{FT/FT}}$$

P_2 = 3.67 IN ; P_2 IS THE TWO-YEAR 24 HR RAINFALL DETERMINED FROM NOAA ATLAS 14, VOLUME 6, VERSION 2.

n = 0.40 , (FROM TABLE 3-1, WOODS WITH LIGHT UNDERBRUSH)

TIME OF TRAVEL, T_t (HR);

$$T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ S^{0.4}}$$

$$T_t = \frac{0.007\ (0.40 \times 300)^{0.8}}{(3.67^{0.5})(0.20^{0.4})}$$

$$\boxed{T_t = 0.32\ \text{HR}}$$

SEGMENT BC:

L = 1,140 FT
ELEV. B = 162 FT
ELEV. C = 6 FT

WATERCOURSE SLOPE, S (FT/FT):

$$S = \frac{\text{ELEV. B} - \text{ELEV. C}}{L}$$

$$S = \frac{162 - 6}{1,140}$$

$$\boxed{S = 0.14\ \text{FT/FT}}$$

SHEET NO. 2/6

JOB NO. 4113302 JOB SAN QUENTIN PUMP STATION BY BRB DATE 2/15/18

CLIENT ________ SUBJECT TIME OF CONCENTRATION CHK'D JAH DATE 2/21/18

SEGMENT BC CONTINUED:

TIME OF TRAVEL, T_t (HR);

$$T_t = \frac{L}{3600\,V}$$

$$T_t = \frac{1{,}140}{3600(7.5)}$$

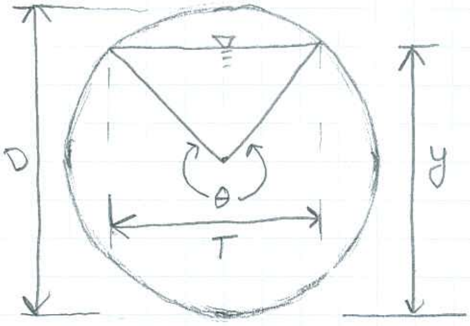
$$\boxed{T_t = 0.04 \text{ HR}}$$

SEGMENT CD:

* 48RCP PIPE, ASSUME FULL. $[\theta = 2\pi]$

$L = 730$ FT
ELEV. C = 6 FT
ELEV. D = 4 FT
$D = 48'' = 4$ FT
$n = 0.014$, (FOR RCP)

D ≡ DIAMETER OF PIPE (FT)
n ≡ MANNINGS ROUGHNESS COEFFICIENT
L ≡ LENGTH
A ≡ CROSS-SECTIONAL AREA
P_w = WETTED PERIMETER



CROSS-SECTIONAL AREA, A (FT²);

$$A = \pi \frac{D^2}{4}$$

$$\downarrow = \pi \left(\frac{4^2}{4}\right)$$

$$\boxed{A = 12.57 \text{ FT}^2}$$

WETTED PERIMETER, P_w (FT);

$$P_w = \frac{\theta}{2} D$$

$$\downarrow = \frac{2\pi}{2}(4)$$

$$\boxed{P_w = 12.57 \text{ FT}}$$

HYDRAULIC RADIUS, r;

$$r = \frac{A}{P_w}$$

$$r = \frac{12.57}{12.57}$$

$$\boxed{r = 1}$$

SHEET NO. 3/6

JOB NO. 4113302 JOB SAN QUENTIN PUMP STATION BY BRB DATE 2/15/18

CLIENT ______ SUBJECT TIME OF CONCENTRATION CHK'D JAH DATE 2/21/18

SEGMENT CD:

CHANNEL SLOPE, S;

$$S = \frac{\text{ELEV. C} - \text{ELEV. D}}{L}$$

$$S = \frac{6-4}{730}$$

$$\boxed{S = 0.003}$$

VELOCITY, V (FT/S);

$$V = \frac{1.49 r^{2/3} S^{1/2}}{n} \quad ;$$

r = HYDRAULIC RADIUS
S = CHANNEL SLOPE
n = MANNING'S ROUGHNESS COEFFICIENT

$$V = \frac{1.49 (1)^{2/3} (0.003)^{1/2}}{0.014}$$

$$\boxed{V = 5.83 \text{ FT/S}}$$

TIME OF TRAVEL, T_t (HR);

$$T_t = \frac{L}{3600 V}$$

$$= \frac{730}{3600(5.83)}$$

$$\boxed{T_t = 0.035 \text{ HR}}$$

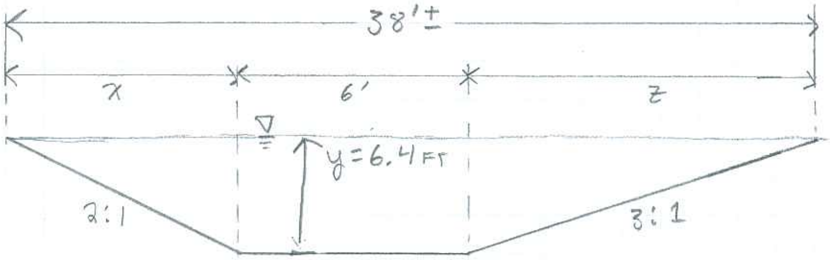
SHEET NO. 4/6

JOB NO. 4113302 JOB SAN QUENTIN PUMP STATION BY BRB DATE 2/15/18

CLIENT SUBJECT TIME OF CONCENTRATION CHK'D JAH DATE 2/21/18

SEGMENT DE:

ELEV. D = 4 FT
ELEV. E = 2 FT
L = 2620 FT



DRAINAGE CHANNEL SECTION

CALCULATING x $ z;

$38 = x + 6 + z$
$32 = x + z$
$\boxed{x = 32 - z}$

$y = \frac{1}{3} z$
$\boxed{z = 3y}$

$y = \frac{1}{2} x$
$\boxed{x = 2y}$

$2y = 32 - 3y$
$5y = 32$
$\boxed{y = 6.4 \text{ FT}}$

CROSS-SECTIONAL FLOW AREA, A (FT²);

$A = \frac{b_1 + b_2}{2}(h)$; WHERE h = depth
b = base (top and bottom)

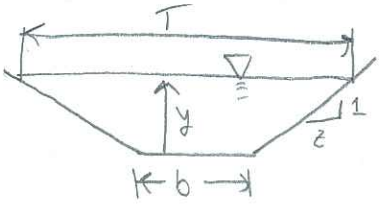
$A = \frac{6 + 38}{2}(6.4)$

$\boxed{A = 140.8 \text{ FT}^2}$

SHEET NO. 5/6

JOB NO. 4113302 JOB SAN QUENTIN PUMP STATION BY BRB DATE 2/15/18

CLIENT SUBJECT TIME OF CONCENTRATION CHK'D JAH DATE 2/21/18



WETTED PERIMETER, P_w (FT);

$$P_w = b + 2y\sqrt{1+z^2}$$

$$P_w = 6 + 6.4\sqrt{1+2^2} + 6.4\sqrt{1+3^2}$$

$$\boxed{P_w = 40.55 \text{ FT}}$$

HYDRAULIC RADIUS; r (FT);

$$r = \frac{A}{P_w}$$

$$r = \frac{140.8}{40.55}$$

$$\boxed{r = 3.47 \text{ FT}}$$

CHANNEL SLOPE, s (FT/FT);

$$s = \frac{\text{ELEV. D} - \text{ELEV. C}}{L}$$

$$s = \frac{4-2}{2620}$$

$$\boxed{s = 0.001 \text{ FT/FT}}$$

MANNING'S ROUGHNESS COEFFICIENT, n;

n=0.40, WOODS WITH LIGHT UNDERBRUSH (TABLE 3-1).

SHEET NO. 6/6

JOB NO. 4113302 JOB SAN QUENTIN PUMP STATION BY BRB DATE 2/15/18

CLIENT _____ SUBJECT TIME OF CONCENTRATION CHK'D JAH DATE 2/21/18

VELOCITY, v (FT/S);

$$v = \frac{1.49 r^{2/3} s^{1/2}}{n}$$

$$= \frac{1.49 (3.47)^{2/3} (0.001)^{1/2}}{0.40}$$

$$\boxed{v = 0.27 \text{ FT/S}}$$

TIME OF TRAVEL, T_t (HR);

$$T_t = \frac{L}{3600 v}$$

$$= \frac{2620}{3600 (0.27)}$$

$$\boxed{T_t = 2.70 \text{ HR}}$$

TIME OF CONCENTRATION, T_c (HR);

$$T_c = \Sigma T_t$$

$$= 0.32 + 0.04 + 0.035 + 2.70$$

$$\boxed{T_c = 3.10}$$

Worksheet 4: Graphical Peak Discharge method

Project San Quentin Pump Station	By BRB	Date 2/15/18
Location San Rafael	Checked JAH	Date 2/21/18

Check one: ☑ Present ☐ Developed

1. Data

Drainage area .... A_m = 0.63 mi² (acres/640)

Runoff curve number ....CN = 89 (From worksheet 2)

Time of concentration .... T_c = 3.10 hr (From worksheet 3)

Rainfall distribution .... = IA (I, IA, II III)

Pond and swamp areas sprea
throughout watershed .... = 0.23 percent of A_m (92ac acres or mi² covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	yr	5	10	
3. Rainfall, P (24-hour)	in	4.72	5.59	
4. Initial abstraction, I_a .... (Use CN with table 4-1)	in	0.247	0.247	
5. Compute I_a/P		0.052	0.044	
6. Unit peak discharge, q_u .... (Use T_c and I_a/P with exhibit 4– IA)	csm/in	77	82	
7. Runoff, Q .... (From worksheet 2) Figure 2-6	in	3.51	4.34	
8. Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond ans swamp area.)		0.97	0.97	
9. Peak discharge, q_p	ft³/s	165.2	217.5	

(Where $q_p = q_u A_m Q F_p$)

Worksheet 4: Graphical Peak Discharge method

Project	By	Date
SAN QUENTIN PUMP STATION	BRB	2/15/18
Location	**Checked**	**Date**
SAN RAFAEL	JAH	2/21/18

Check one: ☑ Present ☐ Developed

1. Data

Drainage area .... A_m = 0.63 mi² (acres/640)

Runoff curve number ....CN = 89 (From worksheet 2)

Time of concentration .... T_c = 3.10 hr (From worksheet 3)

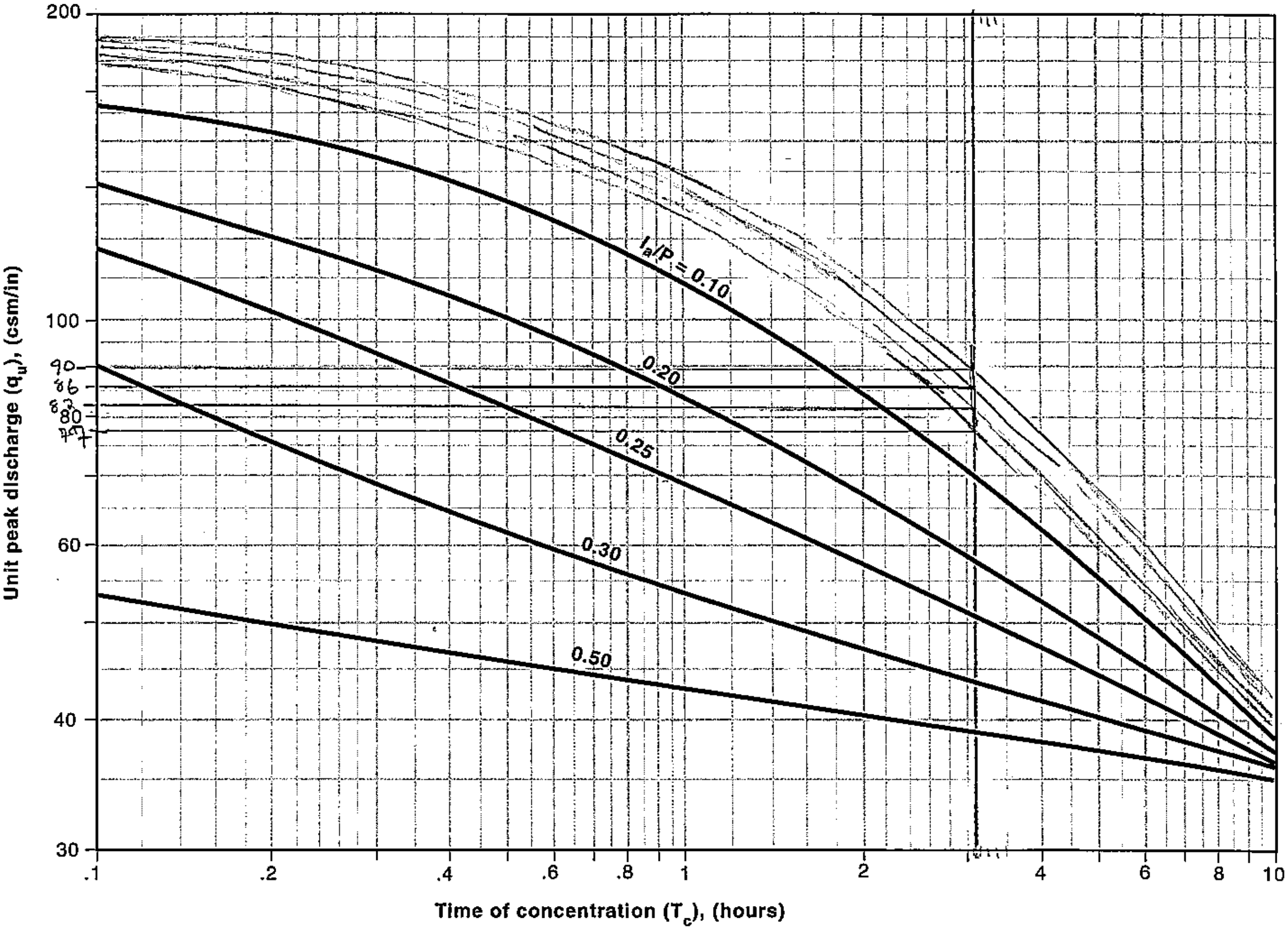
Rainfall distribution .... = IA (I, IA, II III)

Pond and swamp areas sprea throughout watershed .... = 0.23 percent of A_m (92 [✓ acres] or mi² covered)

	Storm #1	Storm #2	Storm #3
2. Frequency .... yr	25	100	
3. Rainfall, P (24-hour) .... in	6.80	8.75	
4. Initial abstraction, I_a .... in (Use CN with table 4-1)	0.247	0.247	
5. Compute I_a/P	0.036	0.028	
6. Unit peak discharge, q_u .... csm/in (Use T_c and I_a/P with exhibit 4– ______)	86	90	
7. Runoff, Q .... in (From worksheet 2) Figure 2-6	5.52	7.43	
8. Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond ans swamp area.)	0.97	0.97	
9. Peak discharge, q_p .... ft³/s	290.10	408.6	

(Where $q_p = q_u A_m Q F_p$)

Exhibit 4-IA Unit peak discharge (q_u) for NRCS (SCS) type IA rainfall distribution



SHEET NO. 1/3

JOB NO. 4113302 JOB SAN QUENTIN PUMP STATION BY BRB DATE 2/15/18

CLIENT ____ SUBJECT PEAK DISCHARGE CALC CHK'D JAH DATE 2/21/18

PEAK DISCHARGE, q_p (ft^3/s)

$q_p = q_u A_m Q F_p$;

q_u = UNIT PEAK DISCHARGE (CSM/IN)

A_m = DRAINAGE AREA (MI^2)

Q = RUNOFF (IN)

F_p = POND AND SWAMP ADJUSTMENT FACTOR

FROM WORKSHEET 4
(GRAPHICAL PEAK DISCHARGE METHOD)

$A_m = 0.63 mi^2$
$CN = 89$
$T_c = 3.10$
RAINFALL DISTRIBUTION = IA

POND AND SWAMP AREAS SPREAD THROUGHOUT WATERSHED = 92 AC

$$\% \text{ of } A_m = \frac{\text{POND AND SWAMP AREA}}{\text{TOTAL AREA}}$$

$$\% \text{ OF } A_m = \frac{92 AC}{403.2 AC}$$

$$\underline{\% \text{ OF } A_m = 0.23\%}$$

RAINFALL INTENSITY, P (24 HR) (IN);

$P_{5YR} = 4.72$ IN SEE RUNOFF CALCS.

$P_{10YR} = 5.59$ IN

$P_{25YR} = 6.80$ IN

$P_{100YR} = 8.70$ IN

SHEET NO. 2/3

JOB NO. 4113302 JOB SAN QUENTIN PUMP STATION BY BRB DATE 2/15/18

CLIENT ____ SUBJECT PEAK DISCHARGE CALC CHK'D JAH DATE 2/21/18

INITIAL ABSTRACTION, I_A (IN); FROM TABLE 4-1 USING CN=89

$\boxed{I_A = 0.247 \text{ IN}}$

I_A/P;

5YR	10YR	25YR	100 YR
$I_A/P = \frac{0.247}{4.72}$	$I_A/P = \frac{0.247}{5.59}$	$I_A/P = \frac{0.247}{6.80}$	$I_A/P = \frac{0.247}{8.75}$
$\boxed{I_A/P = 0.052}$	$\boxed{I_A/P = 0.044}$	$\boxed{I_A/P = 0.036}$	$\boxed{I_A/P = 0.028}$

UNIT PEAK DISCHARGE, q_u (CSM/IN);

USE $T_c = 3.10$ HR (FROM WORKSHEET 3), AND I_A/P WITH EXHIBIT 4-IA.

5YR	10YR	25YR	100YR
$\boxed{q_u = 77 \text{ CSM/IN}}$	$\boxed{q_u = 82 \text{ CSM/IN}}$	$\boxed{q_u = 86 \text{ CSM/IN}}$	$\boxed{q_u = 90 \text{ CSM/IN}}$

POND AND SWAMP ADJUSTMENT FACTOR, F_P;

USE PERCENT POND AND SWAMP AREA = 0.23% WITH TABLE 4-2.

$F_P = 0.97$ FOR ALL STORM FREQUENCIES.

RUNOFF, Q (IN);

FROM WORKSHEET 2, FIGURE 2-6.

5YR	10YR	25YR	100 YR
$\boxed{Q = 3.51 \text{ IN}}$	$\boxed{Q = 4.34 \text{ IN}}$	$\boxed{Q = 5.52 \text{ IN}}$	$\boxed{Q = 7.43 \text{ IN}}$

SHEET NO. 3/3

JOB NO. 4113302 JOB SAN QUENTIN PUMP STATION BY BRB DATE 2/15/18

CLIENT ______ SUBJECT PEAK DISCHARGE CALC. CHK'D JAH DATE 2/21/18

PEAK DISCHARGE, q_p (FT^3/s)

$q_p = q_u A_m Q F_p$;

5YR

$q_p = (77)(0.63)(3.51)(0.97)$

$\boxed{q_p = 165.2 \ FT^3/s}$

10YR

$q_p = (82)(0.63)(4.34)(0.97)$

$\boxed{q_p = 217.5 \ FT^3/s}$

25YR

$q_p = (86)(0.63)(5.52)(0.97)$

$\boxed{q_p = 290.1 \ FT^3/s}$

100YR

$q_p = (90)(0.63)(7.43)(0.97)$

$\boxed{q_p = 408.6 \ FT^3/s}$

Appendix 7.4

5-Year and 100-Year Storm Event Hydraflow Hydrograph Output

Hydraflow Table of Contents

P:\04\41\13302\Calculations_and_Spreadsheets\Hydrology\Hydrographs\San Quentin Pump Station-15 min Interval.gpw

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5

Thursday, 02 / 22 / 2018

5 - Year

100 - Year

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5

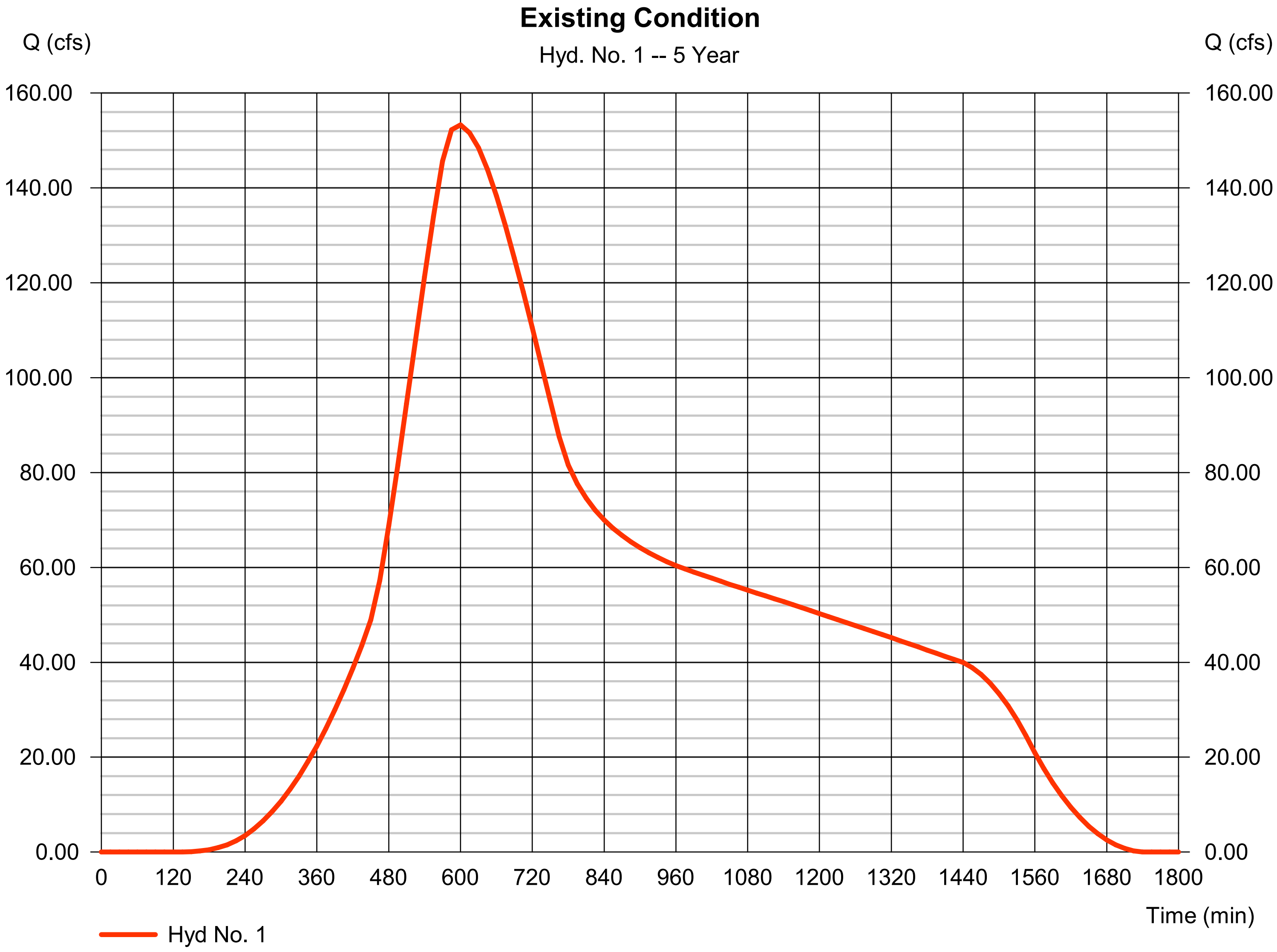
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	153.28	15	600	5,048,861	------	------	------	Existing Condition

Hydrograph Report

Hyd. No. 1

Existing Condition

Hydrograph type	= SCS Runoff	Peak discharge	= 153.28 cfs
Storm frequency	= 5 yrs	Time to peak	= 600 min
Time interval	= 15 min	Hyd. volume	= 5,048,861 cuft
Drainage area	= 403.200 ac	Curve number	= 89
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 186.00 min
Total precip.	= 4.72 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5

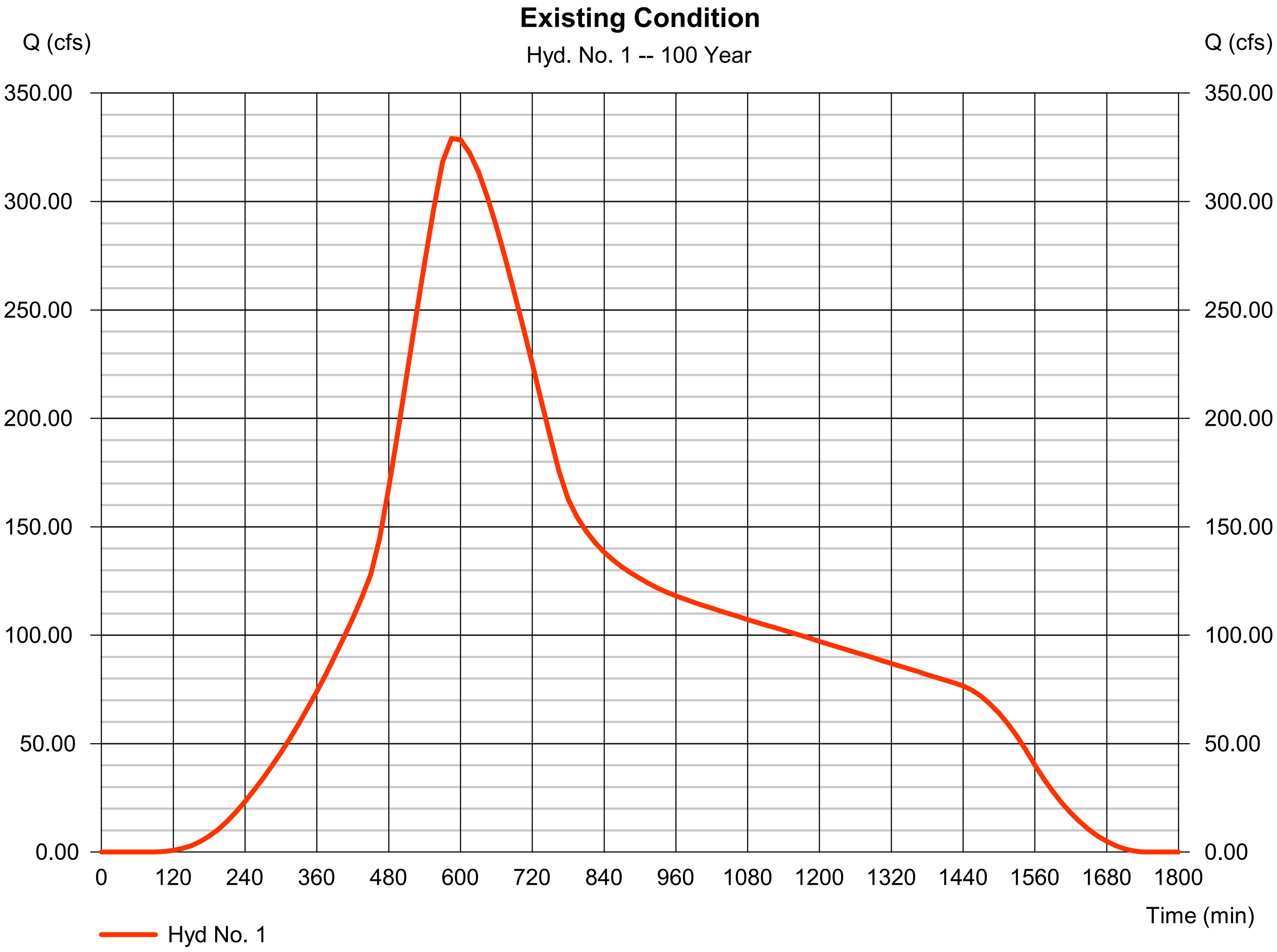
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	329.10	15	585	10,695,580	------	------	------	Existing Condition

Hydrograph Report

Hyd. No. 1

Existing Condition

Hydrograph type	= SCS Runoff	Peak discharge	= 329.10 cfs
Storm frequency	= 100 yrs	Time to peak	= 585 min
Time interval	= 15 min	Hyd. volume	= 10,695,580 cuft
Drainage area	= 403.200 ac	Curve number	= 89
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 186.00 min
Total precip.	= 8.75 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484



Appendix 7.5
Storage Analysis

TWO (2) 50 CFS PUMP SCENARIO

Pump Assumptions

Assume Pump off at elev. = -1.0

Assume Pump 1 on at elev. = -0.5

Assume Pump 2 on at elev. = 0.5

Pump Rate = 50 cfs x 2 = 100 cfs

Time (hr)	Time (min)	Flow In (cfs)	Volume In (cf)	Volume In (acre-ft)	Cumulative Volume (acre-ft)	Cumulative WSEL	Start Pump Sequence	WSEL	Pump 1 On?	Volume Out (cf)	Volume Out (ac-ft)	Pump 2 On?	Volume Out (cf)	Volume Out (ac-ft)		Volume in Pond (ac-ft)	Modeled WSEL
0	0	0.00	0	0.00	0.00	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.00	-1.00
	15	0.00	0	0.00	0.00	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.00	-1.00
	30	0.00	0	0.00	0.00	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.00	-1.00
	45	0.00	0	0.00	0.00	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.00	-1.00
1	60	0.00	0	0.00	0.00	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.00	-1.00
	75	0.00	0	0.00	0.00	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.00	-1.00
	90	0.00	0	0.00	0.00	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.00	-1.00
	105	0.00	0	0.00	0.00	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.00	-1.00
2	120	0.00	0	0.00	0.00	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.00	-1.00
	135	0.01	8	0.00	0.00	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.00	-1.00
	150	0.07	60	0.00	0.00	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.00	-1.00
	165	0.21	192	0.00	0.01	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.01	-1.00
3	180	0.48	434	0.01	0.02	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.02	-1.00
	195	0.90	813	0.02	0.03	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.03	-1.00
	210	1.51	1360	0.03	0.07	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.07	-1.00
	225	2.35	2116	0.05	0.11	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.11	-1.00
4	240	3.47	3121	0.07	0.19	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.19	-1.00
0	255	4.88	4394	0.10	0.29	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.29	-1.00
0	270	6.57	5911	0.14	0.42	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.42	-1.00
0	285	8.51	7663	0.18	0.60	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.60	-1.00
5	300	10.72	9648	0.22	0.82	-0.99	No	-1.0	No	45000	1.03	No	0	0.00		-0.21	-1.00
	315	13.21	11889	0.27	1.09	-0.99	No	-1.0	No	45000	1.03	No	0	0.00		-0.97	-1.00
	330	15.99	14390	0.33	1.42	-0.99	No	-1.0	No	45000	1.03	No	0	0.00		-1.68	-1.00
	345	19.03	17124	0.39	1.82	-0.98	No	-1.0	No	45000	1.03	No	0	0.00		-2.32	-1.01
6	360	22.33	20097	0.46	2.28	-0.98	No	-1.0	No	45000	1.03	No	0	0.00		-2.89	-1.01
	375	25.97	23375	0.54	2.81	-0.97	No	-1.0	No	45000	1.03	No	0	0.00		-3.38	-1.02
	390	29.96	26963	0.62	3.43	-0.97	No	-1.0	No	45000	1.03	No	0	0.00		-3.80	-1.03
	405	34.19	30768	0.71	4.14	-0.96	No	-1.0	No	45000	1.03	No	0	0.00		-4.12	-1.04
7	420	38.68	34810	0.80	4.94	-0.94	No	-0.9	No	45000	1.03	No	0	0.00		-4.36	-1.05
	435	43.53	39173	0.90	5.84	-0.93	No	-0.9	No	45000	1.03	No	0	0.00		-4.49	-1.06
	450	48.95	44053	1.01	6.85	-0.92	No	-0.9	No	45000	1.03	No	0	0.00		-4.51	-1.07
	465	57.30	51573	1.18	8.03	-0.90	No	-0.9	No	45000	1.03	No	0	0.00		-4.36	-1.08
8	480	68.82	61940	1.42	9.46	-0.88	No	-0.9	No	45000	1.03	No	0	0.00		-3.97	-1.09
	495	81.49	73338	1.68	11.14	-0.85	No	-0.9	No	45000	1.03	No	0	0.00		-3.32	-1.10
	510	94.51	85061	1.95	13.09	-0.82	No	-0.8	No	45000	1.03	No	0	0.00		-2.40	-1.10

	525	107.90	97109	2.23	15.32	-0.79	No	-0.8	No	45000	1.03	No	0	0.00		-1.21	-1.10
9	540	121.25	109123	2.51	17.83	-0.75	No	-0.7	No	45000	1.03	No	0	0.00		0.26	-1.10
	555	134.04	120635	2.77	20.60	-0.70	No	-0.7	No	45000	1.03	No	0	0.00		2.00	-1.10
	570	145.68	131114	3.01	23.61	-0.65	No	-0.6	No	45000	1.03	No	0	0.00		3.98	-1.09
	585	152.28	137048	3.15	26.75	-0.59	No	-0.6	No	45000	1.03	No	0	0.00		6.09	-1.08
10	600	153.28	137954	3.17	29.92	-0.52	No	-0.5	No	45000	1.03	No	0	0.00		8.22	-1.06
	615	151.65	136489	3.13	33.05	-0.45	No	-0.4	No	45000	1.03	No	0	0.00		10.32	-1.03
	630	148.48	133629	3.07	36.12	-0.36	No	-0.4	No	45000	1.03	No	0	0.00		12.36	-1.01
	645	143.89	129499	2.97	39.09	-0.28	No	-0.3	No	45000	1.03	No	0	0.00		14.30	-0.97
11	660	138.27	124447	2.86	41.95	-0.18	No	-0.2	No	45000	1.03	No	0	0.00		16.12	-0.94
	675	131.99	118792	2.73	44.68	-0.08	No	-0.1	No	45000	1.03	No	0	0.00		17.82	-0.90
	690	125.25	112722	2.59	47.26	0.03	Yes	No	No	45000	1.03	No	0	0.00		19.37	-0.85
	705	118.11	106297	2.44	49.70	0.14			No	45000	1.03	No	0	0.00		20.78	-0.81
12	720	110.59	99533	2.28	51.99	0.26			No	45000	1.03	No	0	0.00		22.03	-0.76
	735	102.84	92554	2.12	54.11	0.38			No	45000	1.03	No	0	0.00		23.12	-0.71
	750	95.09	85583	1.96	56.08	0.50			No	45000	1.03	No	45000	1.03		23.02	-0.65
	765	87.50	78749	1.81	57.89	0.64			No	45000	1.03	No	45000	1.03		22.76	-0.60
13	780	81.59	73429	1.69	59.57	0.77			No	45000	1.03	No	45000	1.03		22.38	-0.55
	795	77.65	69883	1.60	61.18	0.91			No	45000	1.03	No	45000	1.03		21.92	-0.50
	810	74.58	67124	1.54	62.72	1.05			Yes	45000	1.03	No	45000	1.03		21.40	-0.45
	825	72.03	64829	1.49	64.21	1.19			Yes	45000	1.03	No	45000	1.03		20.82	-0.41
14	840	69.98	62984	1.45	65.65	1.34			Yes	45000	1.03	No	45000	1.03		20.20	-0.36
	855	68.28	61451	1.41	67.06	1.49			Yes	45000	1.03	No	45000	1.03		19.54	-0.32
	870	66.75	60075	1.38	68.44	1.65			Yes	45000	1.03	No	45000	1.03		18.86	-0.27
	885	65.39	58855	1.35	69.79	1.81			Yes	45000	1.03	No	45000	1.03		18.14	-0.23
15	900	64.19	57774	1.33	71.12	1.97			Yes	45000	1.03	No	45000	1.03		17.40	-0.19
	915	63.09	56778	1.30	72.42	2.13			Yes	45000	1.03	No	45000	1.03		16.64	-0.16
	930	62.09	55880	1.28	73.71	2.30			Yes	45000	1.03	No	45000	1.03		15.85	-0.12
	945	61.19	55068	1.26	74.97	2.46			Yes	45000	1.03	No	45000	1.03		15.05	-0.09
16	960	60.39	54351	1.25	76.22	2.64			Yes	45000	1.03	No	45000	1.03		14.23	-0.06
	975	59.66	53698	1.23	77.45	2.81			Yes	45000	1.03	No	45000	1.03		13.40	-0.03
	990	58.99	53092	1.22	78.67	2.99			Yes	45000	1.03	No	45000	1.03		12.55	0.00
	1005	58.35	52515	1.21	79.87	3.17			Yes	45000	1.03	No	45000	1.03		11.69	0.03
17	1020	57.71	51943	1.19	81.07	3.35			Yes	45000	1.03	No	45000	1.03		10.82	0.05
0	1035	57.08	51370	1.18	82.25	3.54			Yes	45000	1.03	No	45000	1.03		9.93	0.08
0	1050	56.44	50800	1.17	83.41	3.73			Yes	45000	1.03	No	45000	1.03		9.03	0.10
0	1065	55.83	50249	1.15	84.57	3.92			Yes	45000	1.03	No	45000	1.03		8.12	0.12
18	1080	55.22	49696	1.14	85.71	4.11			Yes	45000	1.03	No	45000	1.03		7.19	0.13
	1095	54.60	49141	1.13	86.84	4.31			Yes	45000	1.03	No	45000	1.03		6.26	0.15
	1110	54.00	48598	1.12	87.95	4.50			Yes	45000	1.03	No	45000	1.03		5.31	0.16
	1125	53.39	48055	1.10	89.05	4.71			Yes	45000	1.03	No	45000	1.03		4.34	0.17
19	1140	52.78	47506	1.09	90.14	4.91			Yes	45000	1.03	No	45000	1.03		3.37	0.17
	1155	52.17	46949	1.08	91.22	5.11			Yes	45000	1.03	No	45000	1.03		2.38	0.18
	1170	51.54	46389	1.06	92.29	5.32			Yes	45000	1.03	No	45000	1.03		1.38	0.18
	1185	50.92	45826	1.05	93.34	5.53			Yes	45000	1.03	No	45000	1.03		0.36	0.18
20	1200	50.29	45261	1.04	94.38	5.75			Yes	45000	1.03	No	45000	1.03		-0.66	0.18
	1215	49.66	44693	1.03	95.40	5.96			Yes	45000	1.03	No	45000	1.03		-1.70	0.18
	1230	49.03	44123	1.01	96.42	6.18			Yes	45000	1.03	No	45000	1.03		-2.76	0.17

	1245	48.39	43551	1.00	97.42	6.40			Yes	45000	1.03	No	45000	1.03		-3.82	0.16
21	1260	47.75	42977	0.99	98.40	6.62			Yes	45000	1.03	No	45000	1.03		-4.90	0.15
	1275	47.11	42401	0.97	99.38	6.85			Yes	45000	1.03	No	45000	1.03		-5.99	0.14
	1290	46.47	41822	0.96	100.34	7.07			Yes	45000	1.03	No	45000	1.03		-7.10	0.12
	1305	45.82	41242	0.95	101.28	7.30			Yes	45000	1.03	No	45000	1.03		-8.22	0.10
22	1320	45.18	40660	0.93	102.22	7.53			Yes	45000	1.03	No	45000	1.03		-9.35	0.08
	1335	44.53	40077	0.92	103.14	7.76			Yes	45000	1.03	No	45000	1.03		-10.50	0.06
	1350	43.88	39492	0.91	104.04	8.00			Yes	45000	1.03	No	45000	1.03		-11.66	0.03
	1365	43.23	38905	0.89	104.94	8.23			Yes	45000	1.03	No	45000	1.03		-12.83	0.00
23	1380	42.57	38317	0.88	105.82	8.47			Yes	45000	1.03	No	45000	1.03		-14.02	-0.03
	1395	41.92	37727	0.87	106.68	8.71			Yes	45000	1.03	No	45000	1.03		-15.22	-0.06
	1410	41.26	37136	0.85	107.54	8.96			Yes	45000	1.03	No	45000	1.03		-16.43	-0.10
	1425	40.60	36543	0.84	108.37	9.20			Yes	45000	1.03	No	45000	1.03		-17.66	-0.14
24	1440	39.94	35950	0.83	109.20	9.45			Yes	45000	1.03	No	45000	1.03		-18.90	-0.18
	1455	38.88	34996	0.80	110.00	9.70			Yes	45000	1.03	No	45000	1.03		-20.16	-0.23
	1470	37.43	33688	0.77	110.78	9.95			Yes	45000	1.03	No	45000	1.03		-21.45	-0.27
	1485	35.60	32036	0.74	111.51	10.20			Yes	45000	1.03	No	45000	1.03		-22.79	-0.33
25	1500	33.38	30044	0.69	112.20	10.45			Yes	45000	1.03	No	45000	1.03		-24.16	-0.38
	1515	30.80	27722	0.64	112.84	10.71			Yes	45000	1.03	No	45000	1.03		-25.59	-0.44
	1530	27.86	25075	0.58	113.41	10.96			Yes	45000	1.03	No	45000	1.03		-27.08	-0.50
	1545	24.57	22112	0.51	113.92	11.22			No	45000	1.03	No	45000	1.03		-28.64	-0.56
26	1560	20.93	18839	0.43	114.35	11.48			No	45000	1.03	No	45000	1.03		-30.27	-0.63
	1575	17.60	15844	0.36	114.72	11.74			No	45000	1.03	No	45000	1.03		-31.98	-0.70
	1590	14.63	13168	0.30	115.02	11.99			No	45000	1.03	No	45000	1.03		-33.74	-0.78
	1605	12.12	10909	0.25	115.27	12.25			No	45000	1.03	No	45000	1.03		-35.56	-0.86
27	1620	10.17	9156	0.21	115.48	12.52			No	45000	1.03	No	45000	1.03		-37.41	-0.95
	1635	8.89	8002	0.18	115.66	12.78			No	45000	1.03	No	45000	1.03		-39.29	-1.03
	1650	8.36	7525	0.17	115.84	13.04			No	45000	1.03	No	45000	1.03		-41.19	-1.13
	1665	8.65	7785	0.18	116.02	13.30			No	45000	1.03	No	45000	1.03		-43.08	-1.22
28	1680	9.82	8836	0.20	116.22	13.56			No	45000	1.03	No	45000	1.03		-44.94	-1.33
	1695	11.91	10717	0.25	116.46	13.82			No	45000	1.03	No	45000	1.03		-46.76	-1.43
	1710	14.91	13415	0.31	116.77	14.09			No	45000	1.03	No	45000	1.03		-48.52	-1.54
	1725	18.73	16860	0.39	117.16	14.35			No	45000	1.03	No	45000	1.03		-50.20	-1.65
29	1740	23.31	20978	0.48	117.64	14.62			No	45000	1.03	No	45000	1.03		-51.78	-1.77
	1755	28.51	25661	0.59	118.23	14.88			No	45000	1.03	No	45000	1.03		-53.26	-1.89
	1770	34.03	30628	0.70	118.93	15.15			No	45000	1.03	No	45000	1.03		-54.62	-2.01
	1785	39.85	35864	0.82	119.76	15.42			No	45000	1.03	No	45000	1.03		-55.86	-2.14
30	1800	45.97	41377	0.95	120.71	15.70			No	45000	1.03	No	45000	1.03		-56.98	-2.27
	1815	52.48	47235	1.08	121.79	15.97			No	45000	1.03	No	45000	1.03		-57.96	-2.40
	1830	59.38	53440	1.23	123.02	16.25			No	45000	1.03	No	45000	1.03		-58.80	-2.53
	1845	66.55	59895	1.37	124.39	16.53			No	45000	1.03	No	0	0.00		-58.46	-2.66
31	1860	74.01	66610	1.53	125.92	16.81			No	45000	1.03	No	0	0.00		-57.96	-2.79
	1875	81.93	73739	1.69	127.61	17.10			No	45000	1.03	No	0	0.00		-57.30	-2.92
	1890	90.31	81280	1.87	129.48	17.39			No	45000	1.03	No	0	0.00		-56.47	-3.05
	1905	98.92	89030	2.04	131.52	17.69			No	45000	1.03	No	0	0.00		-55.46	-3.18
32	1920	107.87	97083	2.23	133.75	17.99			No	45000	1.03	No	0	0.00		-54.26	-3.30
	1935	117.41	105669	2.43	136.18	18.30			No	45000	1.03	No	0	0.00		-52.87	-3.42
	1950	128.06	115255	2.65	138.82	18.61			No	45000	1.03	No	0	0.00		-51.26	-3.53

	1965	144.89	130400	2.99	141.82	18.93			No	45000	1.03	No	0	0.00		-49.30	-3.64
33	1980	168.14	151326	3.47	145.29	19.26			No	45000	1.03	No	0	0.00		-46.86	-3.75
	1995	193.47	174122	4.00	149.29	19.60			No	45000	1.03	No	0	0.00		-43.89	-3.85
	2010	219.25	197321	4.53	153.82	19.94			No	45000	1.03	No	0	0.00		-40.40	-3.94
	2025	245.53	220973	5.07	158.89	20.30			No	45000	1.03	No	0	0.00		-36.36	-4.02
34	2040	271.50	244351	5.61	164.50	20.67			No	45000	1.03	No	0	0.00		-31.78	-4.09
	2055	296.09	266481	6.12	170.62	21.06			No	45000	1.03	No	0	0.00		-26.69	-4.15
	2070	318.06	286255	6.57	177.19	21.46			No	45000	1.03	No	0	0.00		-21.16	-4.20
	2085	329.10	296187	6.80	183.99	21.87			No	45000	1.03	No	0	0.00		-15.39	-4.24
35	2100	328.46	295610	6.79	190.78	22.30			No	45000	1.03	No	0	0.00		-9.64	-4.26
	2115	322.50	290249	6.66	197.44	22.75			No	45000	1.03	No	0	0.00		-4.01	-4.27
	2130	313.53	282173	6.48	203.92	23.21			No	45000	1.03	No	0	0.00		1.44	-4.26
	2145	301.85	271661	6.24	210.15	23.68			No	45000	1.03	No	0	0.00		6.64	-4.25
36	2160	288.26	259435	5.96	216.11	24.17			No	45000	1.03	No	0	0.00		11.56	-4.22
	2175	273.50	246150	5.65	221.76	24.67			No	45000	1.03	No	0	0.00		16.18	-4.19
	2190	258.01	232205	5.33	227.09	25.18			No	45000	1.03	No	0	0.00		20.48	-4.14
	2205	241.91	217722	5.00	232.09	25.71			No	45000	1.03	No	0	0.00		24.45	-4.09
37	2220	225.23	202710	4.65	236.74	26.24			No	45000	1.03	No	0	0.00		28.07	-4.02
	2235	208.25	187421	4.30	241.05	26.78			No	45000	1.03	No	0	0.00		31.34	-3.95
	2250	191.46	172316	3.96	245.00	27.34			No	45000	1.03	No	0	0.00		34.26	-3.87
	2265	175.19	157670	3.62	248.62	27.90			No	45000	1.03	No	0	0.00		36.84	-3.79
38	2280	162.68	146415	3.36	251.98	28.47			No	45000	1.03	No	0	0.00		39.17	-3.70
	2295	154.39	138955	3.19	255.17	29.04			No	45000	1.03	No	0	0.00		41.33	-3.61
	2310	147.96	133162	3.06	258.23	29.63			No	45000	1.03	No	0	0.00		43.35	-3.51
	2325	142.61	128347	2.95	261.18	30.21			No	45000	1.03	No	0	0.00		45.27	-3.41
39	2340	138.30	124469	2.86	264.03	30.81			No	45000	1.03	No	0	0.00		47.09	-3.30
	2355	134.71	121242	2.78	266.82	31.41			No	45000	1.03	No	0	0.00		48.84	-3.19
	2370	131.50	118347	2.72	269.53	32.02			No	45000	1.03	No	0	0.00		50.53	-3.08
	2385	128.64	115779	2.66	272.19	32.63			No	45000	1.03	No	0	0.00		52.15	-2.96
40	2400	126.11	113503	2.61	274.80	33.25			No	45000	1.03	No	0	0.00		53.72	-2.84
	2415	123.79	111408	2.56	277.35	33.88			No	45000	1.03	No	0	0.00		55.25	-2.72
	2430	121.69	109517	2.51	279.87	34.51			No	45000	1.03	No	0	0.00		56.73	-2.59
	2445	119.78	107806	2.47	282.34	35.15			No	45000	1.03	No	45000	1.03		57.14	-2.46
41	2460	118.10	106290	2.44	284.78	35.79			No	45000	1.03	No	45000	1.03		57.51	-2.33
	2475	116.57	104909	2.41	287.19	36.44			No	45000	1.03	No	45000	1.03		57.85	-2.20
	2490	115.14	103626	2.38	289.57	37.09			No	45000	1.03	No	45000	1.03		58.17	-2.07
	2505	113.79	102407	2.35	291.92	37.75			No	45000	1.03	No	45000	1.03		58.45	-1.94
42	2520	112.45	101203	2.32	294.25	38.41			No	45000	1.03	No	45000	1.03		58.71	-1.80
	2535	111.11	100002	2.30	296.54	39.08			No	45000	1.03	No	45000	1.03		58.94	-1.67
	2550	109.79	98813	2.27	298.81	39.76			No	45000	1.03	No	45000	1.03		59.14	-1.54
	2565	108.52	97665	2.24	301.05	40.44			No	45000	1.03	No	45000	1.03		59.32	-1.40
43	2580	107.24	96519	2.22	303.27	41.12			No	45000	1.03	No	45000	1.03		59.47	-1.27
	2595	105.97	95371	2.19	305.46	41.81			No	45000	1.03	No	45000	1.03		59.59	-1.13
	2610	104.73	94253	2.16	307.62	42.50			No	45000	1.03	No	45000	1.03		59.69	-1.00
	2625	103.49	93138	2.14	309.76	43.20			No	45000	1.03	No	45000	1.03		59.76	-0.86
44	2640	102.24	92014	2.11	311.87	43.91			No	45000	1.03	No	45000	1.03		59.81	-0.73
	2655	100.98	90878	2.09	313.96	44.62			No	45000	1.03	No	45000	1.03		59.83	-0.59
	2670	99.71	89740	2.06	316.02	45.33			Yes	45000	1.03	No	45000	1.03		59.82	-0.46

	2685	98.44	88599	2.03	318.05	46.05			Yes	45000	1.03	No	45000	1.03		59.79	-0.32
45	2700	97.17	87457	2.01	320.06	46.77			Yes	45000	1.03	No	45000	1.03		59.73	-0.19
	2715	95.90	86313	1.98	322.04	47.50			Yes	45000	1.03	No	45000	1.03		59.64	-0.06
	2730	94.63	85168	1.96	324.00	48.23			Yes	45000	1.03	No	45000	1.03		59.53	0.08
	2745	93.36	84021	1.93	325.92	48.96			Yes	45000	1.03	No	45000	1.03		59.40	0.21
46	2760	92.08	82872	1.90	327.83	49.70			Yes	45000	1.03	No	45000	1.03		59.23	0.35
	2775	90.80	81722	1.88	329.70	50.44			Yes	45000	1.03	No	45000	1.03		59.04	0.48
	2790	89.52	80570	1.85	331.55	51.19			Yes	45000	1.03	Yes	45000	1.03		58.83	0.61
	2805	88.24	79417	1.82	333.38	51.95			Yes	45000	1.03	Yes	45000	1.03		58.58	0.74
47	2820	86.96	78263	1.80	335.17	52.70			Yes	45000	1.03	Yes	45000	1.03		58.31	0.88
	2835	85.67	77107	1.77	336.94	53.46			Yes	45000	1.03	Yes	45000	1.03		58.02	1.01
	2850	84.39	75950	1.74	338.69	54.23			Yes	45000	1.03	Yes	45000	1.03		57.69	1.14
	2865	83.10	74792	1.72	340.40	54.99			Yes	45000	1.03	Yes	45000	1.03		57.35	1.27
48	2880	81.81	73633	1.69	342.09	55.77			Yes	45000	1.03	Yes	45000	1.03		56.97	1.40
	2895	80.53	72473	1.66	343.76	56.54			Yes	45000	1.03	Yes	45000	1.03		56.57	1.52
	2910	79.24	71312	1.64	345.39	57.32			Yes	45000	1.03	Yes	45000	1.03		56.14	1.65
	2925	77.94	70150	1.61	347.01	58.10			Yes	45000	1.03	Yes	45000	1.03		55.68	1.77
49	2940	76.65	68987	1.58	348.59	58.89			Yes	45000	1.03	Yes	45000	1.03		55.20	1.90
	2955	74.60	67137	1.54	350.13	59.68			Yes	45000	1.03	Yes	45000	1.03		54.68	2.02
	2970	71.79	64612	1.48	351.61	60.47			Yes	45000	1.03	Yes	45000	1.03		54.09	2.14
	2985	68.25	61427	1.41	353.02	61.27			Yes	45000	1.03	Yes	45000	1.03		53.44	2.27
50	3000	64.00	57596	1.32	354.35	62.07			Yes	45000	1.03	Yes	45000	1.03		52.69	2.38
	3015	59.04	53134	1.22	355.57	62.87			Yes	45000	1.03	Yes	45000	1.03		51.85	2.50
	3030	53.39	48053	1.10	356.67	63.68			Yes	45000	1.03	Yes	45000	1.03		50.88	2.62
	3045	47.08	42368	0.97	357.64	64.48			Yes	45000	1.03	Yes	45000	1.03		49.79	2.73
51	3060	40.10	36094	0.83	358.47	65.29			Yes	45000	1.03	Yes	45000	1.03		48.55	2.84
	3075	33.73	30353	0.70	359.17	66.10			Yes	45000	1.03	Yes	45000	1.03		47.18	2.94
	3090	27.93	25137	0.58	359.74	66.91			Yes	45000	1.03	Yes	45000	1.03		45.69	3.05
	3105	22.71	20439	0.47	360.21	67.73			Yes	45000	1.03	Yes	45000	1.03		44.10	3.15
52	3120	18.05	16248	0.37	360.59	68.54			Yes	45000	1.03	Yes	45000	1.03		42.40	3.24
	3135	13.95	12558	0.29	360.87	69.35			Yes	45000	1.03	Yes	45000	1.03		40.63	3.33
	3150	10.40	9358	0.21	361.09	70.17			Yes	45000	1.03	Yes	45000	1.03		38.78	3.42
	3165	7.38	6642	0.15	361.24	70.98			Yes	45000	1.03	Yes	45000	1.03		36.86	3.51
53	3180	4.89	4399	0.10	361.34	71.80			Yes	45000	1.03	Yes	45000	1.03		34.90	3.58
	3195	2.91	2622	0.06	361.40	72.61			Yes	45000	1.03	Yes	45000	1.03		32.89	3.66
	3210	1.45	1303	0.03	361.43	73.43			Yes	45000	1.03	Yes	45000	1.03		30.85	3.73
	3225	0.48	431	0.01	361.44	74.25			Yes	45000	1.03	Yes	45000	1.03		28.80	3.79

TWO (2) 80 CFS PUMP SCENARIO

Pump Assumptions

Assume Pump off at elev. = -1.0

Assume Pump 1 on at elev. = -0.5

Assume Pump 2 on at elev. = 0.5

Pump Rate = 80 cfs x 2 = 160 cfs

Time (hr)	Time (min)	Flow In (cfs)	Volume In (cf)	Volume In (acre-ft)	Cumulative Volume (acre-ft)	Cumulative WSEL	Start Pump Sequence	WSEL	Pump 1 On?	Volume Out (cf)	Volume Out (ac-ft)	Pump 2 On?	Volume Out (cf)	Volume Out (ac-ft)		Volume in Pond (ac-ft)	Modeled WSEL
0	0	0.00	0	0.00	0.00	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.00	-1.00
	15	0.00	0	0.00	0.00	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.00	-1.00
	30	0.00	0	0.00	0.00	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.00	-1.00
	45	0.00	0	0.00	0.00	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.00	-1.00
1	60	0.00	0	0.00	0.00	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.00	-1.00
	75	0.00	0	0.00	0.00	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.00	-1.00
	90	0.00	0	0.00	0.00	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.00	-1.00
	105	0.00	0	0.00	0.00	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.00	-1.00
2	120	0.00	0	0.00	0.00	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.00	-1.00
	135	0.01	8	0.00	0.00	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.00	-1.00
	150	0.07	60	0.00	0.00	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.00	-1.00
	165	0.21	192	0.00	0.01	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.01	-1.00
3	180	0.48	434	0.01	0.02	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.02	-1.00
	195	0.90	813	0.02	0.03	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.03	-1.00
	210	1.51	1360	0.03	0.07	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.07	-1.00
	225	2.35	2116	0.05	0.11	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.11	-1.00
4	240	3.47	3121	0.07	0.19	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.19	-1.00
0	255	4.88	4394	0.10	0.29	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.29	-1.00
0	270	6.57	5911	0.14	0.42	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.42	-1.00
0	285	8.51	7663	0.18	0.60	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.60	-1.00
5	300	10.72	9648	0.22	0.82	-0.99	No	-1.0	No	0	0.00	No	0	0.00		0.82	-0.99
	315	13.21	11889	0.27	1.09	-0.99	No	-1.0	No	0	0.00	No	0	0.00		1.09	-0.99
	330	15.99	14390	0.33	1.42	-0.99	No	-1.0	No	0	0.00	No	0	0.00		1.42	-0.99
	345	19.03	17124	0.39	1.82	-0.98	No	-1.0	No	0	0.00	No	0	0.00		1.82	-0.98
6	360	22.33	20097	0.46	2.28	-0.98	No	-1.0	No	0	0.00	No	0	0.00		2.28	-0.98
	375	25.97	23375	0.54	2.81	-0.97	No	-1.0	No	0	0.00	No	0	0.00		2.81	-0.97
	390	29.96	26963	0.62	3.43	-0.97	No	-1.0	No	0	0.00	No	0	0.00		3.43	-0.97
	405	34.19	30768	0.71	4.14	-0.96	No	-1.0	No	0	0.00	No	0	0.00		4.14	-0.96
7	420	38.68	34810	0.80	4.94	-0.94	No	-0.9	No	0	0.00	No	0	0.00		4.94	-0.94
	435	43.53	39173	0.90	5.84	-0.93	No	-0.9	No	0	0.00	No	0	0.00		5.84	-0.93
	450	48.95	44053	1.01	6.85	-0.92	No	-0.9	No	0	0.00	No	0	0.00		6.85	-0.92
	465	57.30	51573	1.18	8.03	-0.90	No	-0.9	No	0	0.00	No	0	0.00		8.03	-0.90
8	480	68.82	61940	1.42	9.46	-0.88	No	-0.9	No	0	0.00	No	0	0.00		9.46	-0.88
	495	81.49	73338	1.68	11.14	-0.85	No	-0.9	No	0	0.00	No	0	0.00		11.14	-0.85
	510	94.51	85061	1.95	13.09	-0.82	No	-0.8	No	0	0.00	No	0	0.00		13.09	-0.82

	525	107.90	97109	2.23	15.32	-0.79	No	-0.8	No	0	0.00	No	0	0.00		15.32	-0.79
9	540	121.25	109123	2.51	17.83	-0.75	No	-0.7	No	0	0.00	No	0	0.00		17.83	-0.75
	555	134.04	120635	2.77	20.60	-0.70	No	-0.7	No	0	0.00	No	0	0.00		20.60	-0.70
	570	145.68	131114	3.01	23.61	-0.65	No	-0.6	No	0	0.00	No	0	0.00		23.61	-0.65
	585	152.28	137048	3.15	26.75	-0.59	No	-0.6	No	0	0.00	No	0	0.00		26.75	-0.59
10	600	153.28	137954	3.17	29.92	-0.52	No	-0.5	No	0	0.00	No	0	0.00		29.92	-0.52
	615	151.65	136489	3.13	33.05	-0.45	No	-0.4	Yes	72000	1.65	No	0	0.00		31.40	-0.45
	630	148.48	133629	3.07	36.12	-0.36	No	-0.4	Yes	72000	1.65	No	0	0.00		32.81	-0.37
	645	143.89	129499	2.97	39.09	-0.28	No	-0.3	Yes	72000	1.65	No	0	0.00		34.13	-0.30
11	660	138.27	124447	2.86	41.95	-0.18	No	-0.2	Yes	72000	1.65	No	0	0.00		35.34	-0.22
	675	131.99	118792	2.73	44.68	-0.08	No	-0.1	Yes	72000	1.65	No	0	0.00		36.41	-0.14
	690	125.25	112722	2.59	47.26	0.03	Yes	No	Yes	72000	1.65	No	0	0.00		37.35	-0.05
	705	118.11	106297	2.44	49.70	0.14			Yes	72000	1.65	No	0	0.00		38.13	0.03
12	720	110.59	99533	2.28	51.99	0.26			Yes	72000	1.65	No	0	0.00		38.77	0.12
	735	102.84	92554	2.12	54.11	0.38			Yes	72000	1.65	No	0	0.00		39.24	0.21
	750	95.09	85583	1.96	56.08	0.50			Yes	72000	1.65	No	0	0.00		39.55	0.30
	765	87.50	78749	1.81	57.89	0.64			Yes	72000	1.65	No	0	0.00		39.71	0.39
13	780	81.59	73429	1.69	59.57	0.77			Yes	72000	1.65	No	0	0.00		39.74	0.48
	795	77.65	69883	1.60	61.18	0.91			Yes	72000	1.65	Yes	72000	1.65		38.04	0.56
	810	74.58	67124	1.54	62.72	1.05			Yes	72000	1.65	Yes	72000	1.65		36.27	0.65
	825	72.03	64829	1.49	64.21	1.19			Yes	72000	1.65	Yes	72000	1.65		34.45	0.72
14	840	69.98	62984	1.45	65.65	1.34			Yes	72000	1.65	Yes	72000	1.65		32.59	0.80
	855	68.28	61451	1.41	67.06	1.49			Yes	72000	1.65	Yes	72000	1.65		30.70	0.87
	870	66.75	60075	1.38	68.44	1.65			Yes	72000	1.65	Yes	72000	1.65		28.77	0.93
	885	65.39	58855	1.35	69.79	1.81			Yes	72000	1.65	Yes	72000	1.65		26.82	0.99
15	900	64.19	57774	1.33	71.12	1.97			Yes	72000	1.65	Yes	72000	1.65		24.84	1.05
	915	63.09	56778	1.30	72.42	2.13			Yes	72000	1.65	Yes	72000	1.65		22.84	1.10
	930	62.09	55880	1.28	73.71	2.30			Yes	72000	1.65	Yes	72000	1.65		20.81	1.15
	945	61.19	55068	1.26	74.97	2.46			Yes	72000	1.65	Yes	72000	1.65		18.77	1.19
16	960	60.39	54351	1.25	76.22	2.64			Yes	72000	1.65	Yes	72000	1.65		16.71	1.23
	975	59.66	53698	1.23	77.45	2.81			Yes	72000	1.65	Yes	72000	1.65		14.64	1.26
	990	58.99	53092	1.22	78.67	2.99			Yes	72000	1.65	Yes	72000	1.65		12.55	1.29
	1005	58.35	52515	1.21	79.87	3.17			Yes	72000	1.65	Yes	72000	1.65		10.45	1.31
17	1020	57.71	51943	1.19	81.07	3.35			Yes	72000	1.65	Yes	72000	1.65		8.34	1.33
0	1035	57.08	51370	1.18	82.25	3.54			Yes	72000	1.65	Yes	72000	1.65		6.21	1.34
0	1050	56.44	50800	1.17	83.41	3.73			Yes	72000	1.65	Yes	72000	1.65		4.07	1.35
0	1065	55.83	50249	1.15	84.57	3.92			Yes	72000	1.65	Yes	72000	1.65		1.92	1.36
18	1080	55.22	49696	1.14	85.71	4.11			Yes	72000	1.65	Yes	0	0.00		1.41	1.36
	1095	54.60	49141	1.13	86.84	4.31			Yes	72000	1.65	Yes	0	0.00		0.88	1.36
	1110	54.00	48598	1.12	87.95	4.50			Yes	72000	1.65	Yes	0	0.00		0.35	1.36
	1125	53.39	48055	1.10	89.05	4.71			Yes	0	0.00	Yes	0	0.00		1.45	1.37
19	1140	52.78	47506	1.09	90.14	4.91			Yes	0	0.00	Yes	0	0.00		2.54	1.37
	1155	52.17	46949	1.08	91.22	5.11			Yes	0	0.00	Yes	0	0.00		3.62	1.38
	1170	51.54	46389	1.06	92.29	5.32			Yes	0	0.00	Yes	0	0.00		4.68	1.39
	1185	50.92	45826	1.05	93.34	5.53			Yes	72000	1.65	Yes	0	0.00		4.08	1.40
20	1200	50.29	45261	1.04	94.38	5.75			Yes	72000	1.65	Yes	0	0.00		3.47	1.41
	1215	49.66	44693	1.03	95.40	5.96			Yes	72000	1.65	Yes	0	0.00		2.84	1.42
	1230	49.03	44123	1.01	96.42	6.18			Yes	72000	1.65	Yes	0	0.00		2.20	1.42

	1245	48.39	43551	1.00	97.42	6.40			Yes	72000	1.65	Yes	0	0.00		1.55	1.42
21	1260	47.75	42977	0.99	98.40	6.62			Yes	72000	1.65	Yes	0	0.00		0.88	1.43
	1275	47.11	42401	0.97	99.38	6.85			Yes	0	0.00	Yes	0	0.00		1.86	1.43
	1290	46.47	41822	0.96	100.34	7.07			Yes	0	0.00	Yes	0	0.00		2.82	1.44
	1305	45.82	41242	0.95	101.28	7.30			Yes	0	0.00	Yes	0	0.00		3.76	1.45
22	1320	45.18	40660	0.93	102.22	7.53			Yes	0	0.00	Yes	0	0.00		4.70	1.46
	1335	44.53	40077	0.92	103.14	7.76			Yes	0	0.00	Yes	0	0.00		5.62	1.47
	1350	43.88	39492	0.91	104.04	8.00			Yes	72000	1.65	Yes	0	0.00		4.87	1.48
	1365	43.23	38905	0.89	104.94	8.23			Yes	72000	1.65	Yes	0	0.00		4.11	1.49
23	1380	42.57	38317	0.88	105.82	8.47			Yes	72000	1.65	Yes	0	0.00		3.34	1.50
	1395	41.92	37727	0.87	106.68	8.71			Yes	72000	1.65	Yes	0	0.00		2.55	1.50
	1410	41.26	37136	0.85	107.54	8.96			Yes	72000	1.65	Yes	0	0.00		1.75	1.51
	1425	40.60	36543	0.84	108.37	9.20			Yes	72000	1.65	Yes	0	0.00		0.94	1.51
24	1440	39.94	35950	0.83	109.20	9.45			Yes	72000	1.65	Yes	0	0.00		0.11	1.51
	1455	38.88	34996	0.80	110.00	9.70			Yes	0	0.00	Yes	0	0.00		0.91	1.51
	1470	37.43	33688	0.77	110.78	9.95			Yes	0	0.00	Yes	0	0.00		1.69	1.51
	1485	35.60	32036	0.74	111.51	10.20			Yes	0	0.00	Yes	0	0.00		2.42	1.52
25	1500	33.38	30044	0.69	112.20	10.45			Yes	0	0.00	Yes	0	0.00		3.11	1.53
	1515	30.80	27722	0.64	112.84	10.71			Yes	0	0.00	Yes	0	0.00		3.75	1.53
	1530	27.86	25075	0.58	113.41	10.96			Yes	0	0.00	Yes	0	0.00		4.32	1.54
	1545	24.57	22112	0.51	113.92	11.22			Yes	0	0.00	Yes	0	0.00		4.83	1.56
26	1560	20.93	18839	0.43	114.35	11.48			Yes	0	0.00	Yes	0	0.00		5.26	1.57
	1575	17.60	15844	0.36	114.72	11.74			Yes	0	0.00	Yes	0	0.00		5.63	1.58
	1590	14.63	13168	0.30	115.02	11.99			Yes	72000	1.65	Yes	0	0.00		4.28	1.59
	1605	12.12	10909	0.25	115.27	12.25			Yes	72000	1.65	Yes	0	0.00		2.87	1.60
27	1620	10.17	9156	0.21	115.48	12.52			Yes	72000	1.65	Yes	0	0.00		1.43	1.60
	1635	8.89	8002	0.18	115.66	12.78			Yes	0	0.00	Yes	0	0.00		1.61	1.60
	1650	8.36	7525	0.17	115.84	13.04			Yes	0	0.00	Yes	0	0.00		1.79	1.61
	1665	8.65	7785	0.18	116.02	13.30			Yes	0	0.00	Yes	0	0.00		1.97	1.61
28	1680	9.82	8836	0.20	116.22	13.56			Yes	0	0.00	Yes	0	0.00		2.17	1.62
	1695	11.91	10717	0.25	116.46	13.82			Yes	0	0.00	Yes	0	0.00		2.41	1.62
	1710	14.91	13415	0.31	116.77	14.09			Yes	0	0.00	Yes	0	0.00		2.72	1.63
	1725	18.73	16860	0.39	117.16	14.35			Yes	0	0.00	Yes	0	0.00		3.11	1.64
29	1740	23.31	20978	0.48	117.64	14.62			Yes	0	0.00	Yes	0	0.00		3.59	1.64
	1755	28.51	25661	0.59	118.23	14.88			Yes	0	0.00	Yes	0	0.00		4.18	1.65
	1770	34.03	30628	0.70	118.93	15.15			Yes	0	0.00	Yes	0	0.00		4.88	1.66
	1785	39.85	35864	0.82	119.76	15.42			Yes	0	0.00	Yes	0	0.00		5.71	1.68
30	1800	45.97	41377	0.95	120.71	15.70			Yes	72000	1.65	Yes	72000	1.65		3.35	1.68
	1815	52.48	47235	1.08	121.79	15.97			Yes	72000	1.65	Yes	72000	1.65		1.13	1.69
	1830	59.38	53440	1.23	123.02	16.25			Yes	72000	1.65	Yes	72000	1.65		-0.95	1.68
	1845	66.55	59895	1.37	124.39	16.53			Yes	72000	1.65	Yes	72000	1.65		-2.88	1.68
31	1860	74.01	66610	1.53	125.92	16.81			Yes	72000	1.65	Yes	72000	1.65		-4.66	1.67
	1875	81.93	73739	1.69	127.61	17.10			Yes	72000	1.65	Yes	72000	1.65		-6.27	1.65
	1890	90.31	81280	1.87	129.48	17.39			Yes	72000	1.65	Yes	72000	1.65		-7.71	1.64
	1905	98.92	89030	2.04	131.52	17.69			Yes	72000	1.65	Yes	72000	1.65		-8.97	1.62
32	1920	107.87	97083	2.23	133.75	17.99			Yes	72000	1.65	Yes	72000	1.65		-10.05	1.59
	1935	117.41	105669	2.43	136.18	18.30			Yes	72000	1.65	Yes	72000	1.65		-10.93	1.57
	1950	128.06	115255	2.65	138.82	18.61			Yes	72000	1.65	Yes	72000	1.65		-11.59	1.54

	1965	144.89	130400	2.99	141.82	18.93			Yes	72000	1.65	Yes	72000	1.65		-11.90	1.52
33	1980	168.14	151326	3.47	145.29	19.26			Yes	72000	1.65	Yes	72000	1.65		-11.73	1.49
	1995	193.47	174122	4.00	149.29	19.60			Yes	72000	1.65	Yes	72000	1.65		-11.04	1.46
	2010	219.25	197321	4.53	153.82	19.94			Yes	72000	1.65	Yes	72000	1.65		-9.82	1.44
	2025	245.53	220973	5.07	158.89	20.30			Yes	72000	1.65	Yes	72000	1.65		-8.05	1.42
34	2040	271.50	244351	5.61	164.50	20.67			Yes	72000	1.65	Yes	72000	1.65		-5.75	1.41
	2055	296.09	266481	6.12	170.62	21.06			Yes	72000	1.65	Yes	72000	1.65		-2.93	1.40
	2070	318.06	286255	6.57	177.19	21.46			Yes	72000	1.65	Yes	72000	1.65		0.33	1.40
	2085	329.10	296187	6.80	183.99	21.87			Yes	72000	1.65	Yes	72000	1.65		3.83	1.41
35	2100	328.46	295610	6.79	190.78	22.30			Yes	72000	1.65	Yes	72000	1.65		7.31	1.43
	2115	322.50	290249	6.66	197.44	22.75			Yes	72000	1.65	Yes	72000	1.65		10.66	1.45
	2130	313.53	282173	6.48	203.92	23.21			Yes	72000	1.65	Yes	72000	1.65		13.84	1.49
	2145	301.85	271661	6.24	210.15	23.68			Yes	72000	1.65	Yes	72000	1.65		16.77	1.52
36	2160	288.26	259435	5.96	216.11	24.17			Yes	72000	1.65	Yes	72000	1.65		19.42	1.57
	2175	273.50	246150	5.65	221.76	24.67			Yes	72000	1.65	Yes	72000	1.65		21.76	1.62
	2190	258.01	232205	5.33	227.09	25.18			Yes	72000	1.65	Yes	72000	1.65		23.79	1.67
	2205	241.91	217722	5.00	232.09	25.71			Yes	72000	1.65	Yes	72000	1.65		25.48	1.73
37	2220	225.23	202710	4.65	236.74	26.24			Yes	72000	1.65	Yes	72000	1.65		26.83	1.79
	2235	208.25	187421	4.30	241.05	26.78			Yes	72000	1.65	Yes	72000	1.65		27.82	1.85
	2250	191.46	172316	3.96	245.00	27.34			Yes	72000	1.65	Yes	72000	1.65		28.47	1.91
	2265	175.19	157670	3.62	248.62	27.90			Yes	72000	1.65	Yes	72000	1.65		28.79	1.98
38	2280	162.68	146415	3.36	251.98	28.47			Yes	72000	1.65	Yes	72000	1.65		28.84	2.04
	2295	154.39	138955	3.19	255.17	29.04			Yes	72000	1.65	Yes	72000	1.65		28.73	2.11
	2310	147.96	133162	3.06	258.23	29.63			Yes	72000	1.65	Yes	72000	1.65		28.48	2.17
	2325	142.61	128347	2.95	261.18	30.21			Yes	72000	1.65	Yes	72000	1.65		28.12	2.24
39	2340	138.30	124469	2.86	264.03	30.81			Yes	72000	1.65	Yes	72000	1.65		27.67	2.30
	2355	134.71	121242	2.78	266.82	31.41			Yes	72000	1.65	Yes	72000	1.65		27.15	2.36
	2370	131.50	118347	2.72	269.53	32.02			Yes	72000	1.65	Yes	72000	1.65		26.56	2.42
	2385	128.64	115779	2.66	272.19	32.63			Yes	72000	1.65	Yes	72000	1.65		25.91	2.48
40	2400	126.11	113503	2.61	274.80	33.25			Yes	72000	1.65	Yes	72000	1.65		25.21	2.54
	2415	123.79	111408	2.56	277.35	33.88			Yes	72000	1.65	Yes	72000	1.65		24.46	2.59
	2430	121.69	109517	2.51	279.87	34.51			Yes	72000	1.65	Yes	72000	1.65		23.67	2.64
	2445	119.78	107806	2.47	282.34	35.15			Yes	72000	1.65	Yes	72000	1.65		22.84	2.70
41	2460	118.10	106290	2.44	284.78	35.79			Yes	72000	1.65	Yes	72000	1.65		21.97	2.75
	2475	116.57	104909	2.41	287.19	36.44			Yes	72000	1.65	Yes	72000	1.65		21.08	2.79
	2490	115.14	103626	2.38	289.57	37.09			Yes	72000	1.65	Yes	72000	1.65		20.15	2.84
	2505	113.79	102407	2.35	291.92	37.75			Yes	72000	1.65	Yes	72000	1.65		19.19	2.88
42	2520	112.45	101203	2.32	294.25	38.41			Yes	72000	1.65	Yes	72000	1.65		18.21	2.92
	2535	111.11	100002	2.30	296.54	39.08			Yes	72000	1.65	Yes	72000	1.65		17.20	2.96
	2550	109.79	98813	2.27	298.81	39.76			Yes	72000	1.65	Yes	72000	1.65		16.17	3.00
	2565	108.52	97665	2.24	301.05	40.44			Yes	72000	1.65	Yes	72000	1.65		15.10	3.03
43	2580	107.24	96519	2.22	303.27	41.12			Yes	72000	1.65	Yes	72000	1.65		14.01	3.06
	2595	105.97	95371	2.19	305.46	41.81			Yes	72000	1.65	Yes	72000	1.65		12.89	3.09
	2610	104.73	94253	2.16	307.62	42.50			Yes	72000	1.65	Yes	72000	1.65		11.75	3.12
	2625	103.49	93138	2.14	309.76	43.20			Yes	72000	1.65	Yes	72000	1.65		10.59	3.14
44	2640	102.24	92014	2.11	311.87	43.91			Yes	72000	1.65	Yes	72000	1.65		9.39	3.17
	2655	100.98	90878	2.09	313.96	44.62			Yes	72000	1.65	Yes	72000	1.65		8.17	3.18
	2670	99.71	89740	2.06	316.02	45.33			Yes	72000	1.65	Yes	72000	1.65		6.93	3.20

	2685	98.44	88599	2.03	318.05	46.05			Yes	72000	1.65	Yes	72000	1.65		5.65	3.21
45	2700	97.17	87457	2.01	320.06	46.77			Yes	72000	1.65	Yes	72000	1.65		4.36	3.22
	2715	95.90	86313	1.98	322.04	47.50			Yes	72000	1.65	Yes	72000	1.65		3.03	3.23
	2730	94.63	85168	1.96	324.00	48.23			Yes	72000	1.65	Yes	72000	1.65		1.68	3.23
	2745	93.36	84021	1.93	325.92	48.96			Yes	72000	1.65	Yes	72000	1.65		0.30	3.23
46	2760	92.08	82872	1.90	327.83	49.70			Yes	72000	1.65	Yes	72000	1.65		-1.10	3.23
	2775	90.80	81722	1.88	329.70	50.44			Yes	72000	1.65	Yes	72000	1.65		-2.53	3.22
	2790	89.52	80570	1.85	331.55	51.19			Yes	72000	1.65	Yes	72000	1.65		-3.98	3.22
	2805	88.24	79417	1.82	333.38	51.95			Yes	72000	1.65	Yes	72000	1.65		-5.47	3.20
47	2820	86.96	78263	1.80	335.17	52.70			Yes	72000	1.65	Yes	72000	1.65		-6.98	3.19
	2835	85.67	77107	1.77	336.94	53.46			Yes	72000	1.65	Yes	72000	1.65		-8.51	3.17
	2850	84.39	75950	1.74	338.69	54.23			Yes	72000	1.65	Yes	72000	1.65		-10.07	3.15
	2865	83.10	74792	1.72	340.40	54.99			Yes	72000	1.65	Yes	72000	1.65		-11.66	3.12
48	2880	81.81	73633	1.69	342.09	55.77			Yes	72000	1.65	Yes	72000	1.65		-13.28	3.09
	2895	80.53	72473	1.66	343.76	56.54			Yes	72000	1.65	Yes	72000	1.65		-14.92	3.06
	2910	79.24	71312	1.64	345.39	57.32			Yes	72000	1.65	Yes	72000	1.65		-16.59	3.02
	2925	77.94	70150	1.61	347.01	58.10			Yes	72000	1.65	Yes	72000	1.65		-18.28	2.98
49	2940	76.65	68987	1.58	348.59	58.89			Yes	72000	1.65	Yes	72000	1.65		-20.01	2.93
	2955	74.60	67137	1.54	350.13	59.68			Yes	72000	1.65	Yes	72000	1.65		-21.77	2.88
	2970	71.79	64612	1.48	351.61	60.47			Yes	72000	1.65	Yes	72000	1.65		-23.59	2.83
	2985	68.25	61427	1.41	353.02	61.27			Yes	72000	1.65	Yes	72000	1.65		-25.49	2.77
50	3000	64.00	57596	1.32	354.35	62.07			Yes	72000	1.65	Yes	72000	1.65		-27.47	2.71
	3015	59.04	53134	1.22	355.57	62.87			Yes	72000	1.65	Yes	72000	1.65		-29.56	2.64
	3030	53.39	48053	1.10	356.67	63.68			Yes	72000	1.65	Yes	72000	1.65		-31.76	2.57
	3045	47.08	42368	0.97	357.64	64.48			Yes	72000	1.65	Yes	72000	1.65		-34.09	2.49
51	3060	40.10	36094	0.83	358.47	65.29			Yes	72000	1.65	Yes	72000	1.65		-36.57	2.41
	3075	33.73	30353	0.70	359.17	66.10			Yes	72000	1.65	Yes	72000	1.65		-39.18	2.32
	3090	27.93	25137	0.58	359.74	66.91			Yes	72000	1.65	Yes	72000	1.65		-41.91	2.23
	3105	22.71	20439	0.47	360.21	67.73			Yes	72000	1.65	Yes	72000	1.65		-44.75	2.13
52	3120	18.05	16248	0.37	360.59	68.54			Yes	72000	1.65	Yes	72000	1.65		-47.68	2.02
	3135	13.95	12558	0.29	360.87	69.35			Yes	72000	1.65	Yes	72000	1.65		-50.70	1.91
	3150	10.40	9358	0.21	361.09	70.17			Yes	72000	1.65	Yes	72000	1.65		-53.79	1.79
	3165	7.38	6642	0.15	361.24	70.98			Yes	72000	1.65	Yes	72000	1.65		-56.94	1.66
53	3180	4.89	4399	0.10	361.34	71.80			Yes	72000	1.65	Yes	72000	1.65		-60.14	1.52
	3195	2.91	2622	0.06	361.40	72.61			Yes	72000	1.65	Yes	72000	1.65		-63.39	1.38
	3210	1.45	1303	0.03	361.43	73.43			Yes	72000	1.65	Yes	72000	1.65		-66.67	1.23
	3225	0.48	431	0.01	361.44	74.25			Yes	72000	1.65	Yes	72000	1.65		-69.96	1.07

TWO (2) 100 CFS PUMP SCENARIO

Pump Assumptions

Assume Pump off at elev. = -1.0
Assume Pump 1 on at elev. = -0.5
Assume Pump 2 on at elev. = 0.5

Pump Rate = 100 cfs x 2 = 200 cfs

Time (hr)	Time (min)	Flow In (cfs)	Volume In (cf)	Volume In (acre-ft)	Cumulative Volume (acre-ft)	Cumulative WSEL	Start Pump Sequence	WSEL	Pump 1 On?	Volume Out (cf)	Volume Out (ac-ft)	Pump 2 On?	Volume Out (cf)	Volume Out (ac-ft)		Volume in Pond (ac-ft)	Modeled WSEL
0	0	0.00	0	0.00	0.00	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.00	-1.00
	15	0.00	0	0.00	0.00	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.00	-1.00
	30	0.00	0	0.00	0.00	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.00	-1.00
	45	0.00	0	0.00	0.00	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.00	-1.00
1	60	0.00	0	0.00	0.00	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.00	-1.00
	75	0.00	0	0.00	0.00	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.00	-1.00
	90	0.00	0	0.00	0.00	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.00	-1.00
	105	0.00	0	0.00	0.00	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.00	-1.00
2	120	0.00	0	0.00	0.00	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.00	-1.00
	135	0.01	8	0.00	0.00	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.00	-1.00
	150	0.07	60	0.00	0.00	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.00	-1.00
	165	0.21	192	0.00	0.01	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.01	-1.00
3	180	0.48	434	0.01	0.02	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.02	-1.00
	195	0.90	813	0.02	0.03	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.03	-1.00
	210	1.51	1360	0.03	0.07	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.07	-1.00
	225	2.35	2116	0.05	0.11	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.11	-1.00
4	240	3.47	3121	0.07	0.19	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.19	-1.00
0	255	4.88	4394	0.10	0.29	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.29	-1.00
0	270	6.57	5911	0.14	0.42	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.42	-1.00
0	285	8.51	7663	0.18	0.60	-1.00	No	-1.0	No	0	0.00	No	0	0.00		0.60	-1.00
5	300	10.72	9648	0.22	0.82	-0.99	No	-1.0	No	0	0.00	No	0	0.00		0.82	-0.99
	315	13.21	11889	0.27	1.09	-0.99	No	-1.0	No	0	0.00	No	0	0.00		1.09	-0.99
	330	15.99	14390	0.33	1.42	-0.99	No	-1.0	No	0	0.00	No	0	0.00		1.42	-0.99
	345	19.03	17124	0.39	1.82	-0.98	No	-1.0	No	0	0.00	No	0	0.00		1.82	-0.98
6	360	22.33	20097	0.46	2.28	-0.98	No	-1.0	No	0	0.00	No	0	0.00		2.28	-0.98
	375	25.97	23375	0.54	2.81	-0.97	No	-1.0	No	0	0.00	No	0	0.00		2.81	-0.97
	390	29.96	26963	0.62	3.43	-0.97	No	-1.0	No	0	0.00	No	0	0.00		3.43	-0.97
	405	34.19	30768	0.71	4.14	-0.96	No	-1.0	No	0	0.00	No	0	0.00		4.14	-0.96
7	420	38.68	34810	0.80	4.94	-0.94	No	-0.9	No	0	0.00	No	0	0.00		4.94	-0.94
	435	43.53	39173	0.90	5.84	-0.93	No	-0.9	No	0	0.00	No	0	0.00		5.84	-0.93
	450	48.95	44053	1.01	6.85	-0.92	No	-0.9	No	0	0.00	No	0	0.00		6.85	-0.92
	465	57.30	51573	1.18	8.03	-0.90	No	-0.9	No	0	0.00	No	0	0.00		8.03	-0.90
8	480	68.82	61940	1.42	9.46	-0.88	No	-0.9	No	0	0.00	No	0	0.00		9.46	-0.88
	495	81.49	73338	1.68	11.14	-0.85	No	-0.9	No	0	0.00	No	0	0.00		11.14	-0.85
	510	94.51	85061	1.95	13.09	-0.82	No	-0.8	No	0	0.00	No	0	0.00		13.09	-0.82

	525	107.90	97109	2.23	15.32	-0.79	No	-0.8	No	0	0.00	No	0	0.00		15.32	-0.79
9	540	121.25	109123	2.51	17.83	-0.75	No	-0.7	No	0	0.00	No	0	0.00		17.83	-0.75
	555	134.04	120635	2.77	20.60	-0.70	No	-0.7	No	0	0.00	No	0	0.00		20.60	-0.70
	570	145.68	131114	3.01	23.61	-0.65	No	-0.6	No	0	0.00	No	0	0.00		23.61	-0.65
	585	152.28	137048	3.15	26.75	-0.59	No	-0.6	No	0	0.00	No	0	0.00		26.75	-0.59
10	600	153.28	137954	3.17	29.92	-0.52	No	-0.5	No	0	0.00	No	0	0.00		29.92	-0.52
	615	151.65	136489	3.13	33.05	-0.45	No	-0.4	Yes	90000	2.07	No	90000	2.07		28.92	-0.45
	630	148.48	133629	3.07	36.12	-0.36	No	-0.4	Yes	90000	2.07	No	90000	2.07		27.86	-0.39
	645	143.89	129499	2.97	39.09	-0.28	No	-0.3	Yes	90000	2.07	No	90000	2.07		26.70	-0.33
11	660	138.27	124447	2.86	41.95	-0.18	No	-0.2	Yes	90000	2.07	No	90000	2.07		25.42	-0.27
	675	131.99	118792	2.73	44.68	-0.08	No	-0.1	Yes	90000	2.07	No	90000	2.07		24.02	-0.22
	690	125.25	112722	2.59	47.26	0.03	Yes	No	Yes	90000	2.07	No	90000	2.07		22.47	-0.17
	705	118.11	106297	2.44	49.70	0.14			Yes	90000	2.07	No	90000	2.07		20.78	-0.12
12	720	110.59	99533	2.28	51.99	0.26			Yes	90000	2.07	No	90000	2.07		18.93	-0.08
	735	102.84	92554	2.12	54.11	0.38			Yes	90000	2.07	No	90000	2.07		16.92	-0.04
	750	95.09	85583	1.96	56.08	0.50			Yes	90000	2.07	No	90000	2.07		14.76	-0.01
	765	87.50	78749	1.81	57.89	0.64			Yes	90000	2.07	No	90000	2.07		12.43	0.02
13	780	81.59	73429	1.69	59.57	0.77			Yes	90000	2.07	No	90000	2.07		9.99	0.04
	795	77.65	69883	1.60	61.18	0.91			Yes	90000	2.07	No	90000	2.07		7.46	0.06
	810	74.58	67124	1.54	62.72	1.05			Yes	0	0.00	No	90000	2.07		6.93	0.08
	825	72.03	64829	1.49	64.21	1.19			Yes	0	0.00	No	90000	2.07		6.35	0.09
14	840	69.98	62984	1.45	65.65	1.34			Yes	0	0.00	No	90000	2.07		5.73	0.10
	855	68.28	61451	1.41	67.06	1.49			Yes	0	0.00	No	90000	2.07		5.08	0.11
	870	66.75	60075	1.38	68.44	1.65			Yes	0	0.00	No	90000	2.07		4.39	0.12
	885	65.39	58855	1.35	69.79	1.81			Yes	0	0.00	No	0	0.00		5.74	0.14
15	900	64.19	57774	1.33	71.12	1.97			Yes	0	0.00	No	0	0.00		7.07	0.15
	915	63.09	56778	1.30	72.42	2.13			Yes	0	0.00	No	0	0.00		8.37	0.17
	930	62.09	55880	1.28	73.71	2.30			Yes	0	0.00	No	0	0.00		9.66	0.19
	945	61.19	55068	1.26	74.97	2.46			Yes	90000	2.07	No	0	0.00		8.85	0.21
16	960	60.39	54351	1.25	76.22	2.64			Yes	90000	2.07	No	0	0.00		8.04	0.23
	975	59.66	53698	1.23	77.45	2.81			Yes	90000	2.07	No	0	0.00		7.20	0.25
	990	58.99	53092	1.22	78.67	2.99			Yes	90000	2.07	No	0	0.00		6.36	0.26
	1005	58.35	52515	1.21	79.87	3.17			Yes	90000	2.07	No	0	0.00		5.49	0.27
17	1020	57.71	51943	1.19	81.07	3.35			Yes	90000	2.07	No	0	0.00		4.62	0.28
	1035	57.08	51370	1.18	82.25	3.54			Yes	90000	2.07	No	0	0.00		3.73	0.29
	1050	56.44	50800	1.17	83.41	3.73			Yes	90000	2.07	No	0	0.00		2.83	0.30
	1065	55.83	50249	1.15	84.57	3.92			Yes	90000	2.07	No	0	0.00		1.92	0.30
18	1080	55.22	49696	1.14	85.71	4.11			Yes	90000	2.07	No	0	0.00		1.00	0.31
	1095	54.60	49141	1.13	86.84	4.31			Yes	90000	2.07	No	0	0.00		0.06	0.31
	1110	54.00	48598	1.12	87.95	4.50			Yes	0	0.00	No	0	0.00		1.17	0.31
	1125	53.39	48055	1.10	89.05	4.71			Yes	0	0.00	No	0	0.00		2.28	0.31
19	1140	52.78	47506	1.09	90.14	4.91			Yes	0	0.00	No	0	0.00		3.37	0.32
	1155	52.17	46949	1.08	91.22	5.11			Yes	0	0.00	No	0	0.00		4.45	0.33
	1170	51.54	46389	1.06	92.29	5.32			Yes	0	0.00	No	0	0.00		5.51	0.34
	1185	50.92	45826	1.05	93.34	5.53			Yes	0	0.00	No	0	0.00		6.56	0.36
20	1200	50.29	45261	1.04	94.38	5.75			Yes	90000	2.07	No	0	0.00		5.54	0.37
	1215	49.66	44693	1.03	95.40	5.96			Yes	90000	2.07	No	0	0.00		4.50	0.38
	1230	49.03	44123	1.01	96.42	6.18			Yes	90000	2.07	No	0	0.00		3.44	0.39

	1245	48.39	43551	1.00	97.42	6.40			Yes	90000	2.07	No	0	0.00		2.38	0.39
21	1260	47.75	42977	0.99	98.40	6.62			Yes	90000	2.07	No	0	0.00		1.30	0.40
	1275	47.11	42401	0.97	99.38	6.85			Yes	0	0.00	No	0	0.00		2.27	0.40
	1290	46.47	41822	0.96	100.34	7.07			Yes	0	0.00	No	0	0.00		3.23	0.41
	1305	45.82	41242	0.95	101.28	7.30			Yes	0	0.00	No	0	0.00		4.18	0.42
22	1320	45.18	40660	0.93	102.22	7.53			Yes	0	0.00	No	0	0.00		5.11	0.43
	1335	44.53	40077	0.92	103.14	7.76			Yes	0	0.00	No	0	0.00		6.03	0.44
	1350	43.88	39492	0.91	104.04	8.00			Yes	0	0.00	No	0	0.00		6.94	0.46
	1365	43.23	38905	0.89	104.94	8.23			Yes	0	0.00	No	0	0.00		7.83	0.48
23	1380	42.57	38317	0.88	105.82	8.47			Yes	90000	2.07	No	0	0.00		6.64	0.49
	1395	41.92	37727	0.87	106.68	8.71			Yes	90000	2.07	Yes	0	0.00		5.44	0.51
	1410	41.26	37136	0.85	107.54	8.96			Yes	90000	2.07	Yes	0	0.00		4.23	0.51
	1425	40.60	36543	0.84	108.37	9.20			Yes	90000	2.07	Yes	0	0.00		3.00	0.52
24	1440	39.94	35950	0.83	109.20	9.45			Yes	90000	2.07	Yes	0	0.00		1.76	0.53
	1455	38.88	34996	0.80	110.00	9.70			Yes	90000	2.07	Yes	0	0.00		0.50	0.53
	1470	37.43	33688	0.77	110.78	9.95			Yes	0	0.00	Yes	0	0.00		1.27	0.53
	1485	35.60	32036	0.74	111.51	10.20			Yes	0	0.00	Yes	0	0.00		2.01	0.53
25	1500	33.38	30044	0.69	112.20	10.45			Yes	0	0.00	Yes	0	0.00		2.70	0.54
	1515	30.80	27722	0.64	112.84	10.71			Yes	0	0.00	Yes	0	0.00		3.33	0.55
	1530	27.86	25075	0.58	113.41	10.96			Yes	0	0.00	Yes	0	0.00		3.91	0.56
	1545	24.57	22112	0.51	113.92	11.22			Yes	0	0.00	Yes	0	0.00		4.42	0.57
26	1560	20.93	18839	0.43	114.35	11.48			Yes	0	0.00	Yes	0	0.00		4.85	0.58
	1575	17.60	15844	0.36	114.72	11.74			Yes	0	0.00	Yes	0	0.00		5.21	0.59
	1590	14.63	13168	0.30	115.02	11.99			Yes	0	0.00	Yes	0	0.00		5.52	0.60
	1605	12.12	10909	0.25	115.27	12.25			Yes	0	0.00	Yes	0	0.00		5.77	0.61
27	1620	10.17	9156	0.21	115.48	12.52			Yes	0	0.00	Yes	0	0.00		5.98	0.63
	1635	8.89	8002	0.18	115.66	12.78			Yes	0	0.00	Yes	0	0.00		6.16	0.64
	1650	8.36	7525	0.17	115.84	13.04			Yes	0	0.00	Yes	0	0.00		6.33	0.66
	1665	8.65	7785	0.18	116.02	13.30			Yes	90000	2.07	Yes	0	0.00		4.45	0.67
28	1680	9.82	8836	0.20	116.22	13.56			Yes	90000	2.07	Yes	0	0.00		2.58	0.67
	1695	11.91	10717	0.25	116.46	13.82			Yes	0	0.00	Yes	0	0.00		2.83	0.68
	1710	14.91	13415	0.31	116.77	14.09			Yes	0	0.00	Yes	0	0.00		3.14	0.69
	1725	18.73	16860	0.39	117.16	14.35			Yes	0	0.00	Yes	0	0.00		3.52	0.69
29	1740	23.31	20978	0.48	117.64	14.62			Yes	0	0.00	Yes	0	0.00		4.00	0.70
	1755	28.51	25661	0.59	118.23	14.88			Yes	0	0.00	Yes	0	0.00		4.59	0.71
	1770	34.03	30628	0.70	118.93	15.15			Yes	0	0.00	Yes	0	0.00		5.30	0.72
	1785	39.85	35864	0.82	119.76	15.42			Yes	90000	2.07	Yes	0	0.00		4.05	0.73
30	1800	45.97	41377	0.95	120.71	15.70			Yes	90000	2.07	Yes	0	0.00		2.94	0.74
	1815	52.48	47235	1.08	121.79	15.97			Yes	90000	2.07	Yes	0	0.00		1.96	0.75
	1830	59.38	53440	1.23	123.02	16.25			Yes	0	0.00	Yes	0	0.00		3.18	0.75
	1845	66.55	59895	1.37	124.39	16.53			Yes	0	0.00	Yes	0	0.00		4.56	0.76
31	1860	74.01	66610	1.53	125.92	16.81			Yes	0	0.00	Yes	0	0.00		6.09	0.78
	1875	81.93	73739	1.69	127.61	17.10			Yes	0	0.00	Yes	0	0.00		7.78	0.79
	1890	90.31	81280	1.87	129.48	17.39			Yes	90000	2.07	Yes	0	0.00		7.58	0.81
	1905	98.92	89030	2.04	131.52	17.69			Yes	90000	2.07	Yes	90000	2.07		5.49	0.82
32	1920	107.87	97083	2.23	133.75	17.99			Yes	90000	2.07	Yes	90000	2.07		3.59	0.83
	1935	117.41	105669	2.43	136.18	18.30			Yes	90000	2.07	Yes	90000	2.07		1.88	0.84
	1950	128.06	115255	2.65	138.82	18.61			Yes	90000	2.07	Yes	90000	2.07		0.40	0.84

	1965	144.89	130400	2.99	141.82	18.93			Yes	90000	2.07	Yes	0	0.00		1.32	0.84
33	1980	168.14	151326	3.47	145.29	19.26			Yes	90000	2.07	Yes	0	0.00		2.73	0.85
	1995	193.47	174122	4.00	149.29	19.60			Yes	90000	2.07	Yes	0	0.00		4.66	0.86
	2010	219.25	197321	4.53	153.82	19.94			Yes	90000	2.07	Yes	0	0.00		7.13	0.87
	2025	245.53	220973	5.07	158.89	20.30			Yes	90000	2.07	Yes	90000	2.07		8.07	0.89
34	2040	271.50	244351	5.61	164.50	20.67			Yes	90000	2.07	Yes	90000	2.07		9.54	0.91
	2055	296.09	266481	6.12	170.62	21.06			Yes	90000	2.07	Yes	90000	2.07		11.53	0.94
	2070	318.06	286255	6.57	177.19	21.46			Yes	90000	2.07	Yes	90000	2.07		13.97	0.97
	2085	329.10	296187	6.80	183.99	21.87			Yes	90000	2.07	Yes	90000	2.07		16.64	1.01
35	2100	328.46	295610	6.79	190.78	22.30			Yes	90000	2.07	Yes	90000	2.07		19.29	1.05
	2115	322.50	290249	6.66	197.44	22.75			Yes	90000	2.07	Yes	90000	2.07		21.82	1.10
	2130	313.53	282173	6.48	203.92	23.21			Yes	90000	2.07	Yes	90000	2.07		24.17	1.15
	2145	301.85	271661	6.24	210.15	23.68			Yes	90000	2.07	Yes	90000	2.07		26.27	1.21
36	2160	288.26	259435	5.96	216.11	24.17			Yes	90000	2.07	Yes	90000	2.07		28.09	1.28
	2175	273.50	246150	5.65	221.76	24.67			Yes	90000	2.07	Yes	90000	2.07		29.61	1.34
	2190	258.01	232205	5.33	227.09	25.18			Yes	90000	2.07	Yes	90000	2.07		30.81	1.41
	2205	241.91	217722	5.00	232.09	25.71			Yes	90000	2.07	Yes	90000	2.07		31.68	1.48
37	2220	225.23	202710	4.65	236.74	26.24			Yes	90000	2.07	Yes	90000	2.07		32.20	1.56
	2235	208.25	187421	4.30	241.05	26.78			Yes	90000	2.07	Yes	90000	2.07		32.37	1.63
	2250	191.46	172316	3.96	245.00	27.34			Yes	90000	2.07	Yes	90000	2.07		32.19	1.70
	2265	175.19	157670	3.62	248.62	27.90			Yes	90000	2.07	Yes	90000	2.07		31.68	1.77
38	2280	162.68	146415	3.36	251.98	28.47			Yes	90000	2.07	Yes	90000	2.07		30.91	1.84
	2295	154.39	138955	3.19	255.17	29.04			Yes	90000	2.07	Yes	90000	2.07		29.97	1.91
	2310	147.96	133162	3.06	258.23	29.63			Yes	90000	2.07	Yes	90000	2.07		28.89	1.98
	2325	142.61	128347	2.95	261.18	30.21			Yes	90000	2.07	Yes	90000	2.07		27.70	2.04
39	2340	138.30	124469	2.86	264.03	30.81			Yes	0	0.00	Yes	90000	2.07		28.50	2.10
	2355	134.71	121242	2.78	266.82	31.41			Yes	0	0.00	Yes	90000	2.07		29.21	2.17
	2370	131.50	118347	2.72	269.53	32.02			Yes	0	0.00	Yes	90000	2.07		29.86	2.24
	2385	128.64	115779	2.66	272.19	32.63			Yes	0	0.00	Yes	90000	2.07		30.46	2.31
40	2400	126.11	113503	2.61	274.80	33.25			Yes	90000	2.07	Yes	90000	2.07		28.93	2.37
	2415	123.79	111408	2.56	277.35	33.88			Yes	90000	2.07	Yes	90000	2.07		27.35	2.43
	2430	121.69	109517	2.51	279.87	34.51			Yes	90000	2.07	Yes	90000	2.07		25.74	2.49
	2445	119.78	107806	2.47	282.34	35.15			Yes	90000	2.07	Yes	90000	2.07		24.08	2.55
41	2460	118.10	106290	2.44	284.78	35.79			Yes	90000	2.07	Yes	90000	2.07		22.39	2.60
	2475	116.57	104909	2.41	287.19	36.44			Yes	90000	2.07	Yes	90000	2.07		20.66	2.64
	2490	115.14	103626	2.38	289.57	37.09			Yes	90000	2.07	Yes	90000	2.07		18.91	2.69
	2505	113.79	102407	2.35	291.92	37.75			Yes	90000	2.07	Yes	90000	2.07		17.13	2.72
42	2520	112.45	101203	2.32	294.25	38.41			Yes	90000	2.07	Yes	90000	2.07		15.32	2.76
	2535	111.11	100002	2.30	296.54	39.08			Yes	90000	2.07	Yes	90000	2.07		13.48	2.79
	2550	109.79	98813	2.27	298.81	39.76			Yes	90000	2.07	Yes	90000	2.07		11.62	2.81
	2565	108.52	97665	2.24	301.05	40.44			Yes	90000	2.07	Yes	90000	2.07		9.73	2.84
43	2580	107.24	96519	2.22	303.27	41.12			Yes	90000	2.07	Yes	90000	2.07		7.81	2.85
	2595	105.97	95371	2.19	305.46	41.81			Yes	90000	2.07	Yes	90000	2.07		5.87	2.87
	2610	104.73	94253	2.16	307.62	42.50			Yes	90000	2.07	Yes	90000	2.07		3.90	2.88
	2625	103.49	93138	2.14	309.76	43.20			Yes	90000	2.07	Yes	90000	2.07		1.91	2.88
44	2640	102.24	92014	2.11	311.87	43.91			Yes	90000	2.07	Yes	90000	2.07		-0.11	2.88
	2655	100.98	90878	2.09	313.96	44.62			Yes	90000	2.07	Yes	0	0.00		-0.09	2.88
	2670	99.71	89740	2.06	316.02	45.33			Yes	90000	2.07	Yes	0	0.00		-0.10	2.88

	2685	98.44	88599	2.03	318.05	46.05			Yes	90000	2.07	Yes	0	0.00		-0.13	2.88
45	2700	97.17	87457	2.01	320.06	46.77			Yes	90000	2.07	Yes	0	0.00		-0.19	2.88
	2715	95.90	86313	1.98	322.04	47.50			Yes	90000	2.07	Yes	0	0.00		-0.27	2.88
	2730	94.63	85168	1.96	324.00	48.23			Yes	90000	2.07	Yes	0	0.00		-0.38	2.88
	2745	93.36	84021	1.93	325.92	48.96			Yes	90000	2.07	Yes	0	0.00		-0.52	2.88
46	2760	92.08	82872	1.90	327.83	49.70			Yes	90000	2.07	Yes	0	0.00		-0.69	2.88
	2775	90.80	81722	1.88	329.70	50.44			Yes	90000	2.07	Yes	0	0.00		-0.88	2.87
	2790	89.52	80570	1.85	331.55	51.19			Yes	90000	2.07	Yes	0	0.00		-1.09	2.87
	2805	88.24	79417	1.82	333.38	51.95			Yes	90000	2.07	Yes	0	0.00		-1.33	2.87
47	2820	86.96	78263	1.80	335.17	52.70			Yes	90000	2.07	Yes	0	0.00		-1.60	2.86
	2835	85.67	77107	1.77	336.94	53.46			Yes	90000	2.07	Yes	0	0.00		-1.90	2.86
	2850	84.39	75950	1.74	338.69	54.23			Yes	0	0.00	Yes	0	0.00		-0.16	2.86
	2865	83.10	74792	1.72	340.40	54.99			Yes	0	0.00	Yes	0	0.00		1.56	2.86
48	2880	81.81	73633	1.69	342.09	55.77			Yes	0	0.00	Yes	0	0.00		3.25	2.87
	2895	80.53	72473	1.66	343.76	56.54			Yes	0	0.00	Yes	0	0.00		4.91	2.88
	2910	79.24	71312	1.64	345.39	57.32			Yes	90000	2.07	Yes	0	0.00		4.49	2.89
	2925	77.94	70150	1.61	347.01	58.10			Yes	90000	2.07	Yes	0	0.00		4.03	2.90
49	2940	76.65	68987	1.58	348.59	58.89			Yes	90000	2.07	Yes	0	0.00		3.55	2.91
	2955	74.60	67137	1.54	350.13	59.68			Yes	90000	2.07	Yes	0	0.00		3.02	2.92
	2970	71.79	64612	1.48	351.61	60.47			Yes	90000	2.07	Yes	0	0.00		2.44	2.92
	2985	68.25	61427	1.41	353.02	61.27			Yes	90000	2.07	Yes	0	0.00		1.78	2.93
50	3000	64.00	57596	1.32	354.35	62.07			Yes	90000	2.07	Yes	0	0.00		1.04	2.93
	3015	59.04	53134	1.22	355.57	62.87			Yes	90000	2.07	Yes	0	0.00		0.19	2.93
	3030	53.39	48053	1.10	356.67	63.68			Yes	0	0.00	Yes	0	0.00		1.30	2.93
	3045	47.08	42368	0.97	357.64	64.48			Yes	0	0.00	Yes	0	0.00		2.27	2.94
51	3060	40.10	36094	0.83	358.47	65.29			Yes	0	0.00	Yes	0	0.00		3.10	2.94
	3075	33.73	30353	0.70	359.17	66.10			Yes	0	0.00	Yes	0	0.00		3.79	2.95
	3090	27.93	25137	0.58	359.74	66.91			Yes	0	0.00	Yes	0	0.00		4.37	2.96
	3105	22.71	20439	0.47	360.21	67.73			Yes	0	0.00	Yes	0	0.00		4.84	2.97
52	3120	18.05	16248	0.37	360.59	68.54			Yes	0	0.00	Yes	0	0.00		5.21	2.98
	3135	13.95	12558	0.29	360.87	69.35			Yes	0	0.00	Yes	0	0.00		5.50	3.00
	3150	10.40	9358	0.21	361.09	70.17			Yes	0	0.00	Yes	0	0.00		5.72	3.01
	3165	7.38	6642	0.15	361.24	70.98			Yes	0	0.00	Yes	0	0.00		5.87	3.02
53	3180	4.89	4399	0.10	361.34	71.80			Yes	0	0.00	Yes	0	0.00		5.97	3.04
	3195	2.91	2622	0.06	361.40	72.61			Yes	0	0.00	Yes	0	0.00		6.03	3.05
	3210	1.45	1303	0.03	361.43	73.43			Yes	90000	2.07	Yes	0	0.00		3.99	3.06
	3225	0.48	431	0.01	361.44	74.25			Yes	90000	2.07	Yes	0	0.00		1.94	3.06

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APPENDIX A, SUB-APPENDIX D:

Vertical Pump Specification

CASCADE PUMP COMPANY
10107 South Norwalk Boulevard • PO Box 2767
Santa Fe Springs, California 90670-0767

CURVE NUMBER
AP4212

DATE
03-88

SUPERCEDES
NEW ISSUE

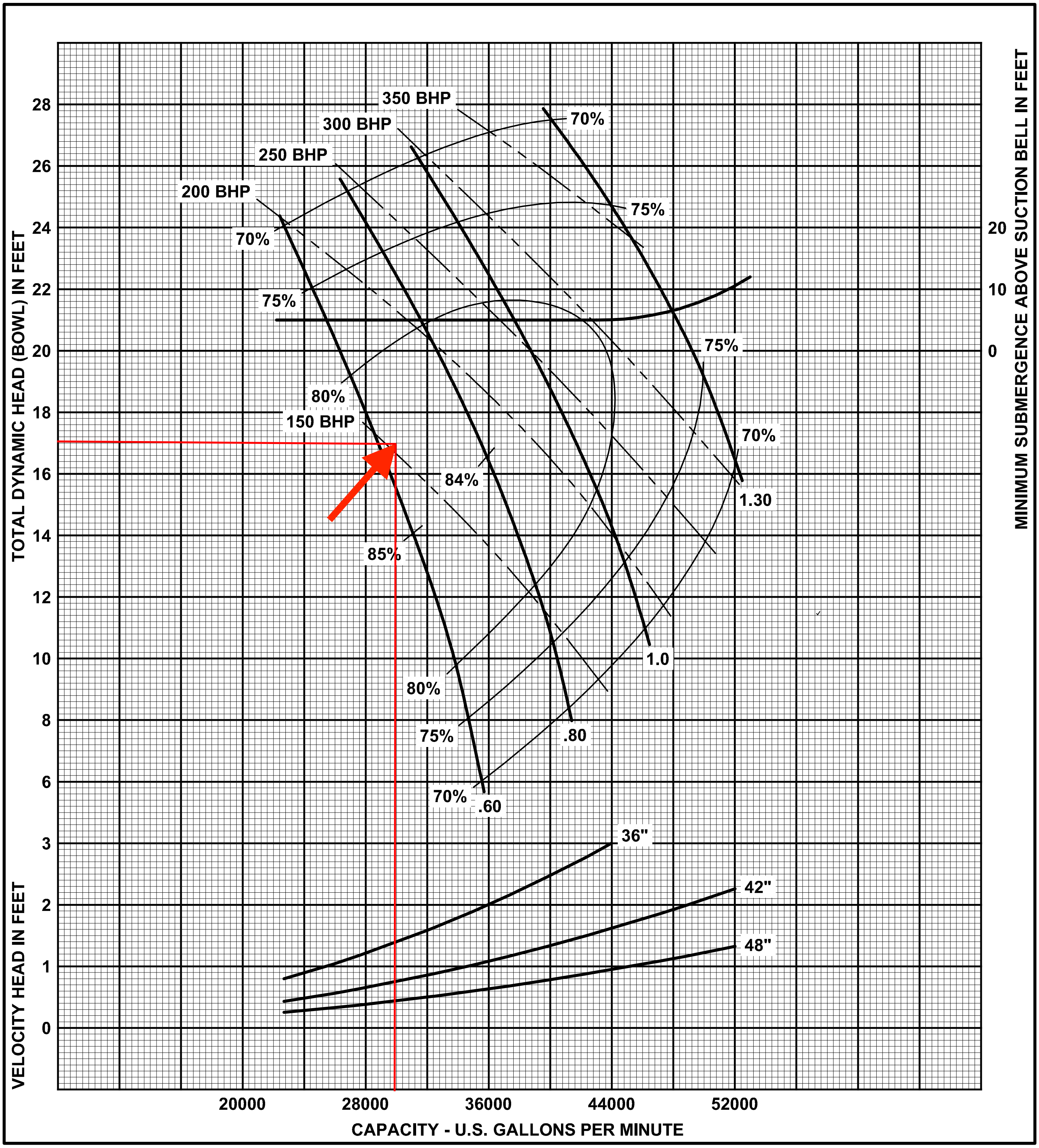
42

AP

**590
RPM**

CASCADE AXIAL FLOW PUMP

30,000 GPM @ 17' TDH



CURVE CHARACTERISTICS BASED ON PUMP PERFORMANCE WITH SPECIFIED AMOUNT OF CLEAR, NON-AERATED, FRESH COLD WATER.

THIS PERFORMANCE CURVE IS FOR ESTIMATING ONLY. CURVE SHOWS SINGLE STAGE PERFORMANCE. FOR MULTIPLE, VARIABLE AND OTHER SPEED APPLICATIONS, CONSULT FACTORY.

CURVE NUMBER
AP4814

DATE
07-92

SUPERCEDES
NEW ISSUE

48

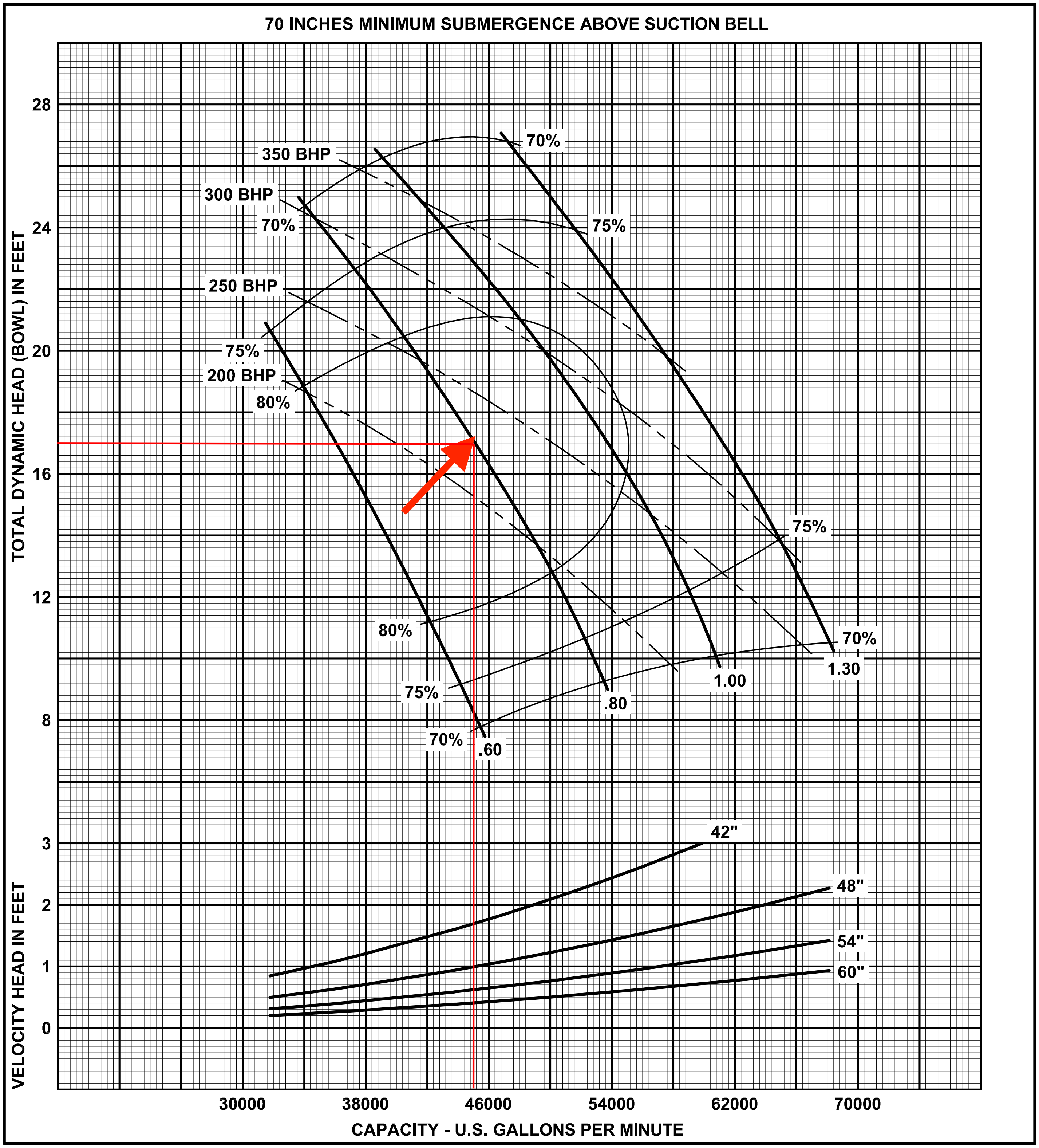
AP

500 RPM

CASCADE PUMP COMPANY
10107 South Norwalk Boulevard • PO Box 2767
Santa Fe Springs, California 90670-0767

45,000 GPM @ 17' TDH

CASCADE AXIAL FLOW PUMP



CURVE CHARACTERISTICS BASED ON PUMP PERFORMANCE WITH SPECIFIED AMOUNT OF CLEAR, NON-AERATED, FRESH COLD WATER.

THIS PERFORMANCE CURVE IS FOR ESTIMATING ONLY. CURVE SHOWS SINGLE STAGE PERFORMANCE. FOR MULTIPLE, VARIABLE AND OTHER SPEED APPLICATIONS, CONSULT FACTORY.

APPENDIX A, SUB-APPENDIX E:

Submersible Pump Specification

PL 7105/865 3~ 1430

Performance curve

Pump

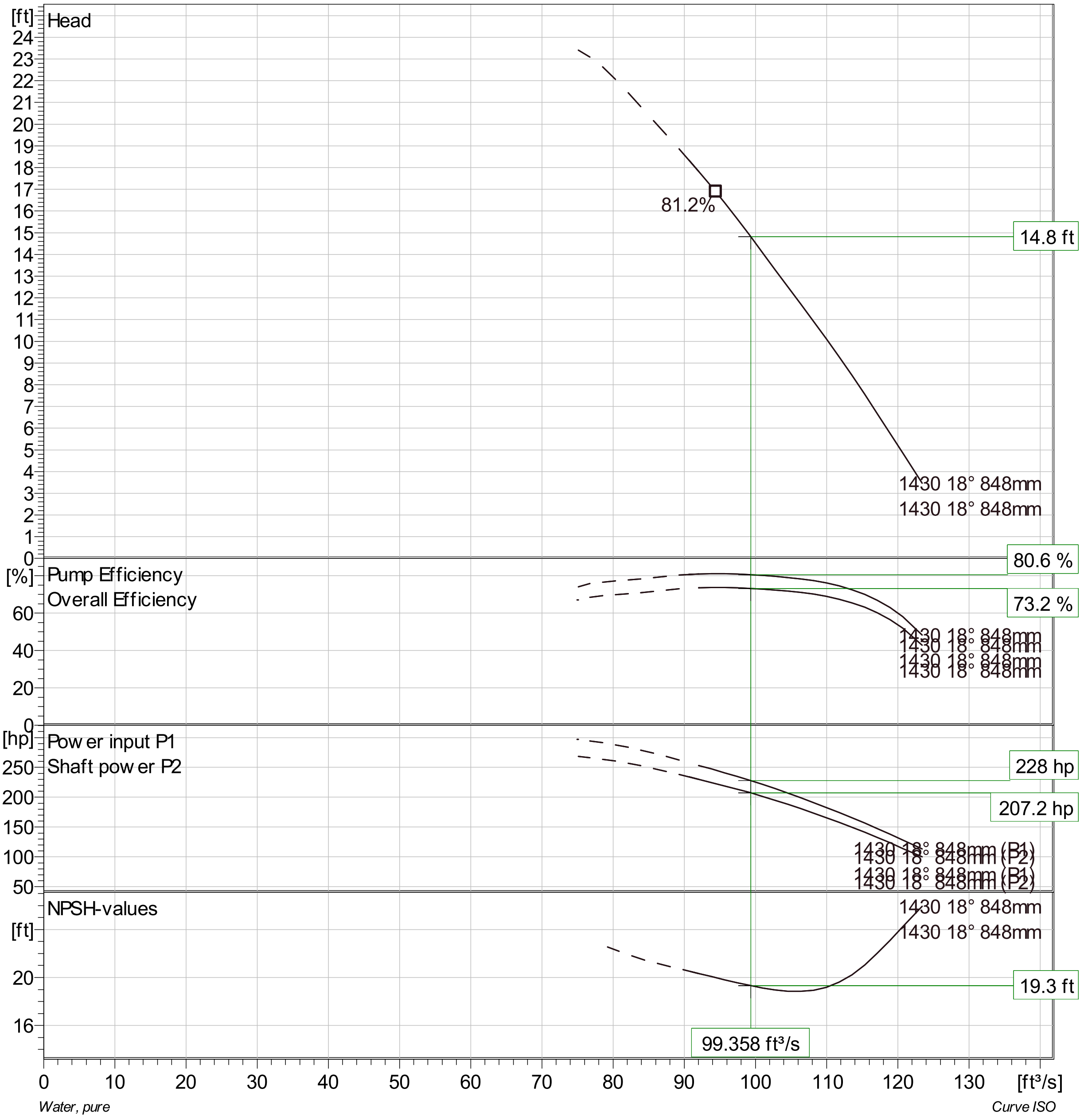
ColDia	47 1/4 inch
Suction Flange Diameter	
Impeller diameter	$33^{3}/_{8}$"
Number of blades	4

Motor

Motor #	P0865.000 54-66-14AA-W 230hp
Stator variant	1
Frequency	60 Hz
Rated voltage	460 V
Number of poles	14
Phases	3~
Rated power	230 hp
Rated current	355 A
Starting current	1290 A
Rated speed	505 rpm

Power factor	
1/1 Load	0.67
3/4 Load	0.61
1/2 Load	0.50

Motor efficiency	
1/1 Load	90.5 %
3/4 Load	90.5 %
1/2 Load	89.0 %

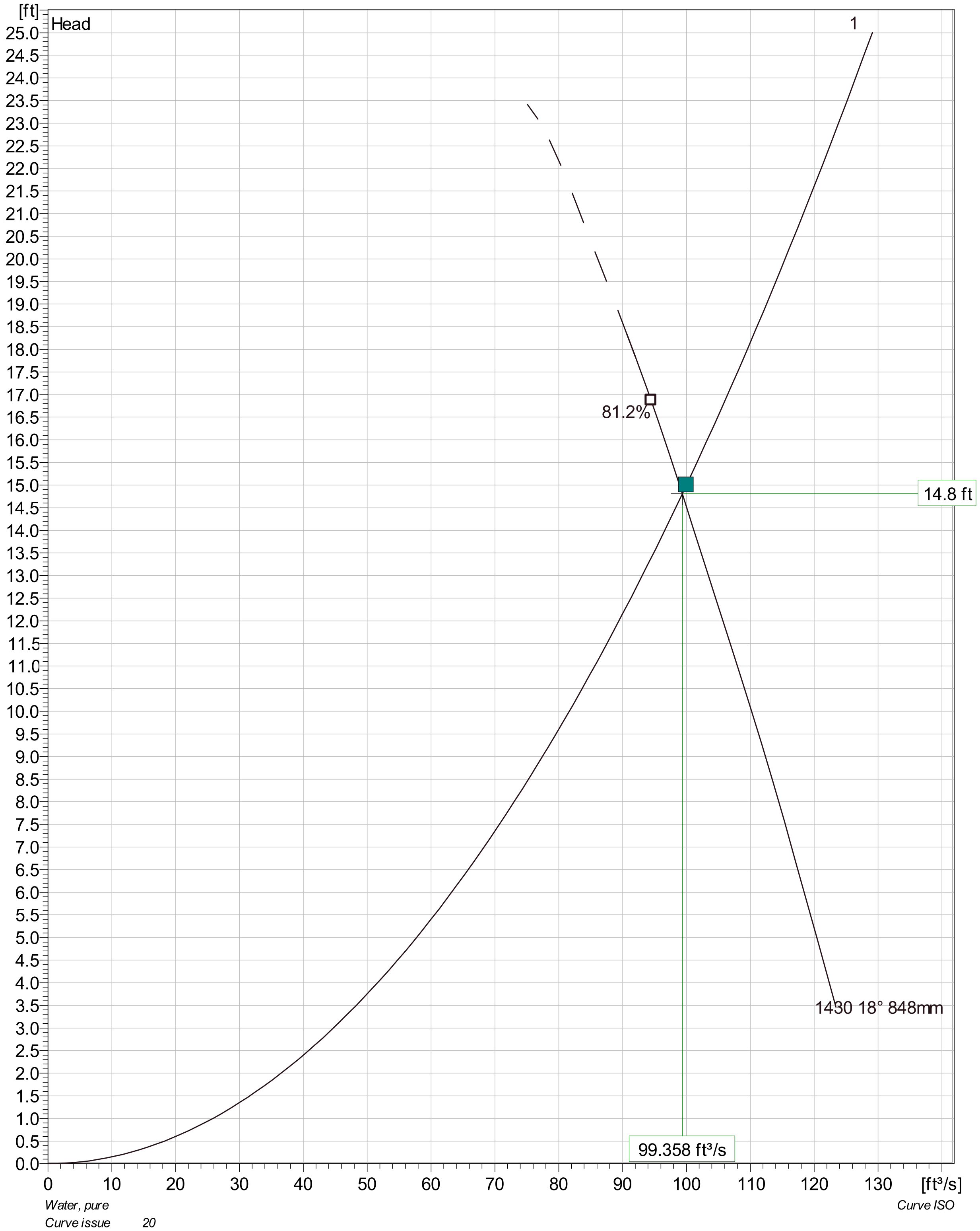


Duty point		**Guarantee**
Flow	**Head**	
100 ft³/s	15 ft	No

Project	Project ID	Created by	Created on	Last update
			2/6/2018	

PL 7105/865 3~ 1430

Duty Analysis



Pumps running /System	Individual pump Flow	Head	Shaft power	Total Flow	Head	Shaft power	Pump eff.	Specific energy	NPSHre
1	99.4 ft³/s	14.8 ft	207 hp	99.4 ft³/s	14.8 ft	207 hp	80.6 %	63.5 kWh/US MG	19.3 ft

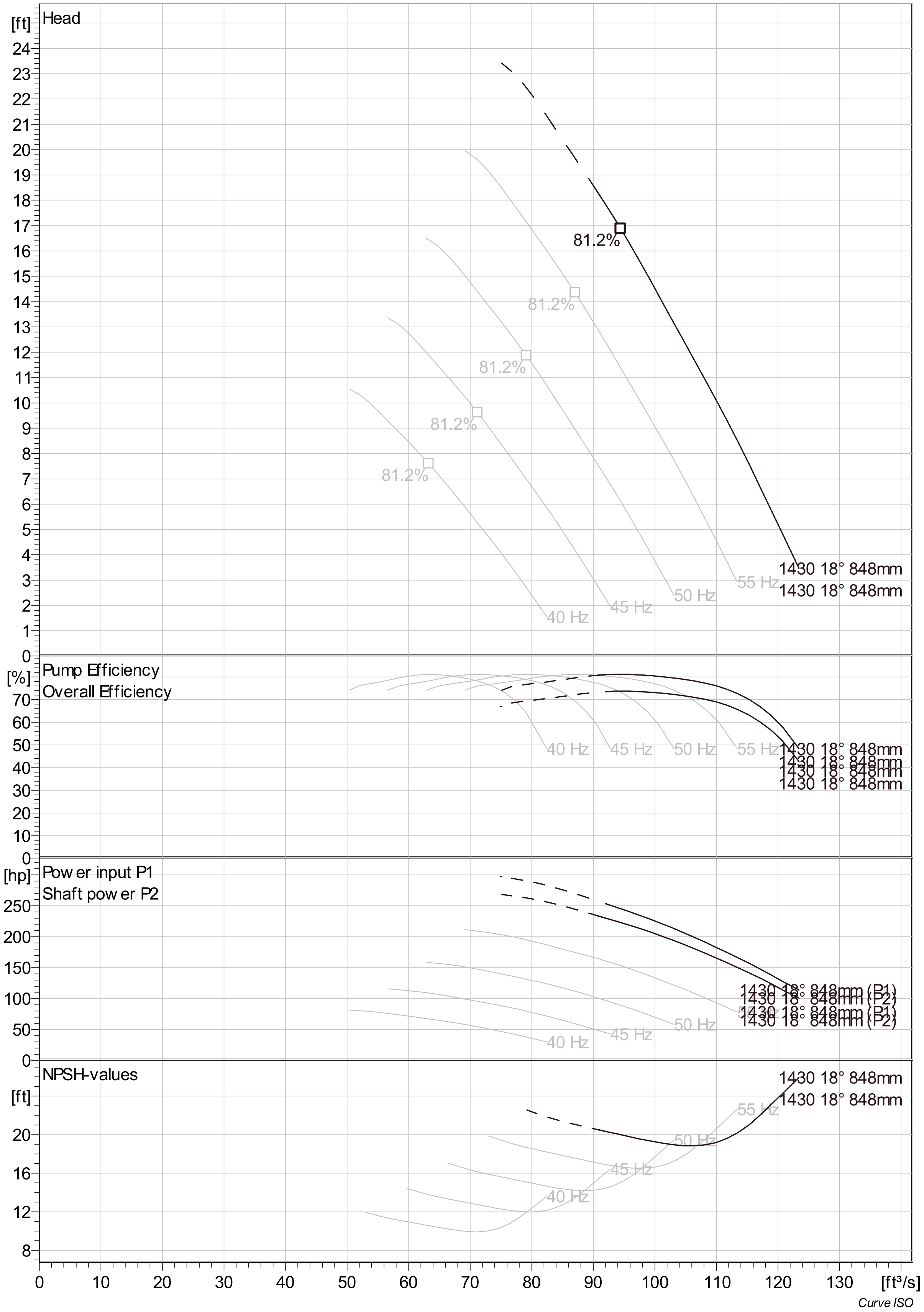
Project	Project ID	Created by	Created on	Last update
			2/6/2018	

xylem

PL 7105/865 3~ 1430

VFD Curve

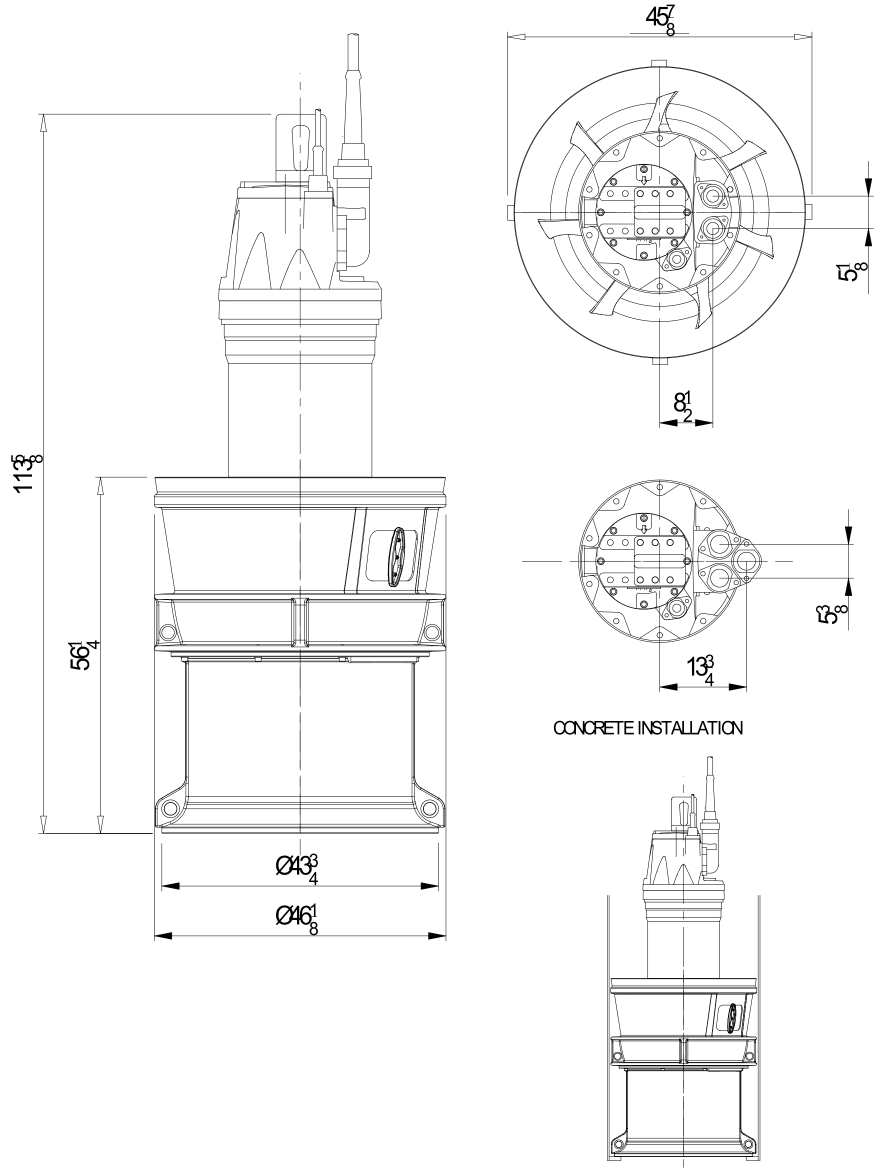
FLYGT



Project	Project ID	Created by	Created on	Last update
			2/6/2018	

PL 7105/865 3~ 1430

Dimensional drawing



FOR INSTALLATION, SEE FLYGT DESIGN RECOMMENDATION.

Weight (lbs)	
Motor	Pump
862/872	7170
865/875	7500

FLYGT
AUTOCAD
DRAWING

Denomination
Dimensional drwg
PL 7105 862/872/865/875

Drawn by NK
Checked by JP
Date 100211
Scale 1:1, 1:2
Reg no 5799
7395100
1

Project	Project ID	Created by	Created on	Last update
			2/6/2018	

PL 7101/836 3~ 505B4

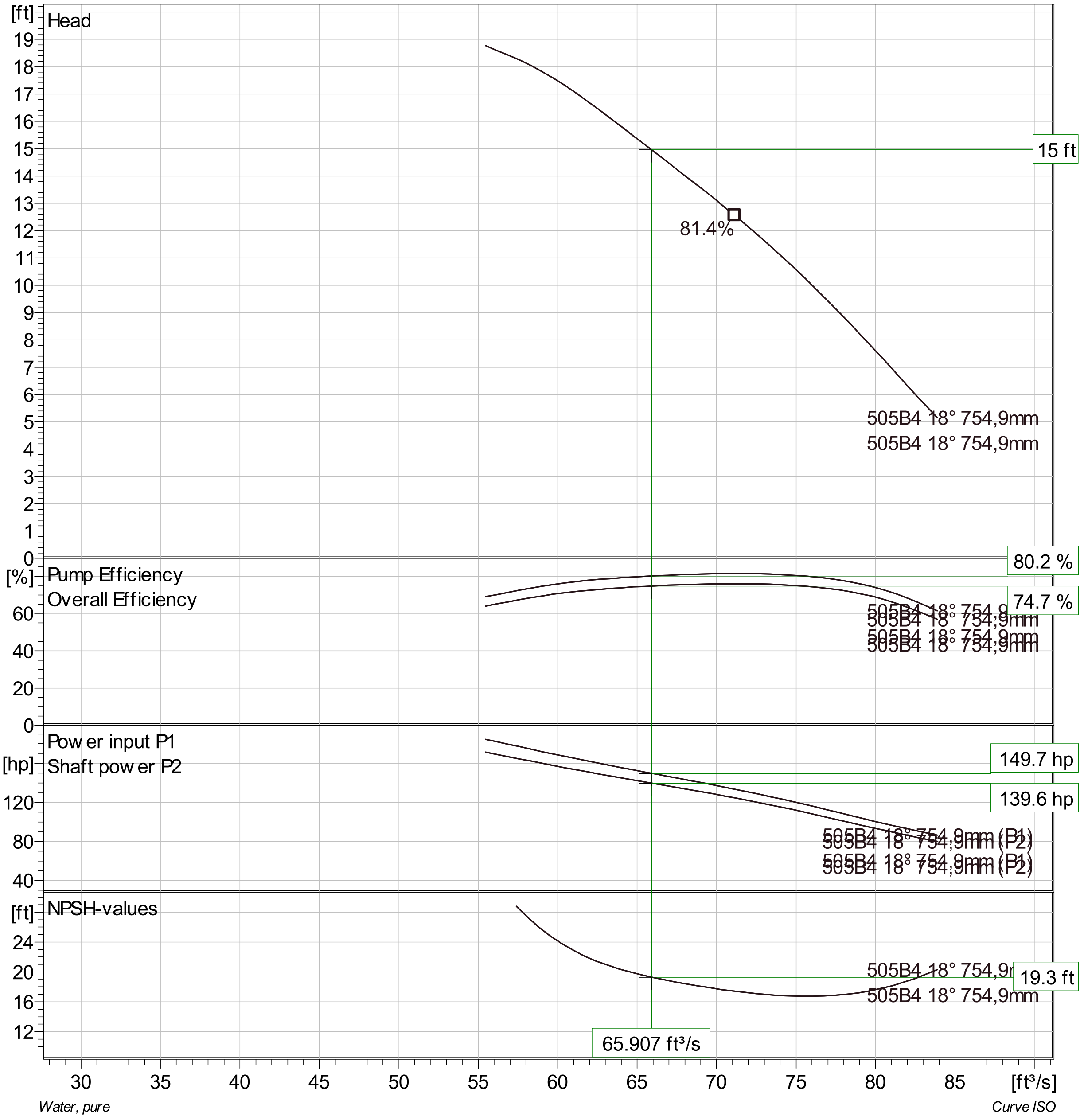
Performance curve

Pump	
ColDia	47 1/4 inch
Suction Flange Diameter	
Impeller diameter	29$^{3}/_{4}$"
Number of blades	4

Motor	
Motor #	P0836.000 54-52-14ID-W 185hp
Stator variant	1
Frequency	60 Hz
Rated voltage	460 V
Number of poles	14
Phases	3~
Rated power	185 hp
Rated current	279 A
Starting current	870 A
Rated speed	505 rpm

Power factor	
1/1 Load	0.67
3/4 Load	0.63
1/2 Load	0.52

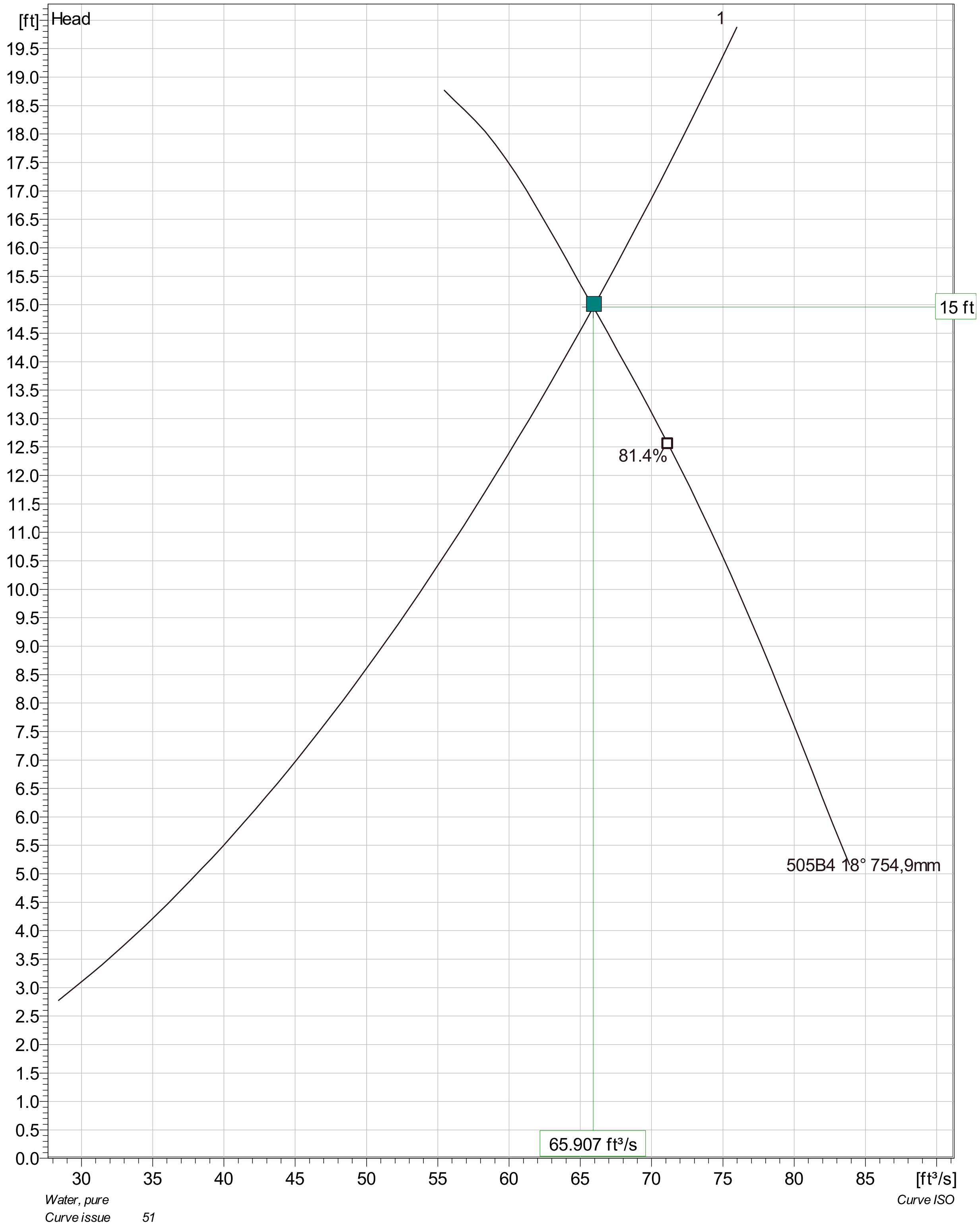
Motor efficiency	
1/1 Load	92.5 %
3/4 Load	93.3 %
1/2 Load	93.0 %



Duty point		**Guarantee**
Flow	**Head**	
66 ft³/s	15 ft	No

Project	Project ID	Created by	Created on	Last update
			2/6/2018	

PL 7101/836 3~ 505B4
Duty Analysis

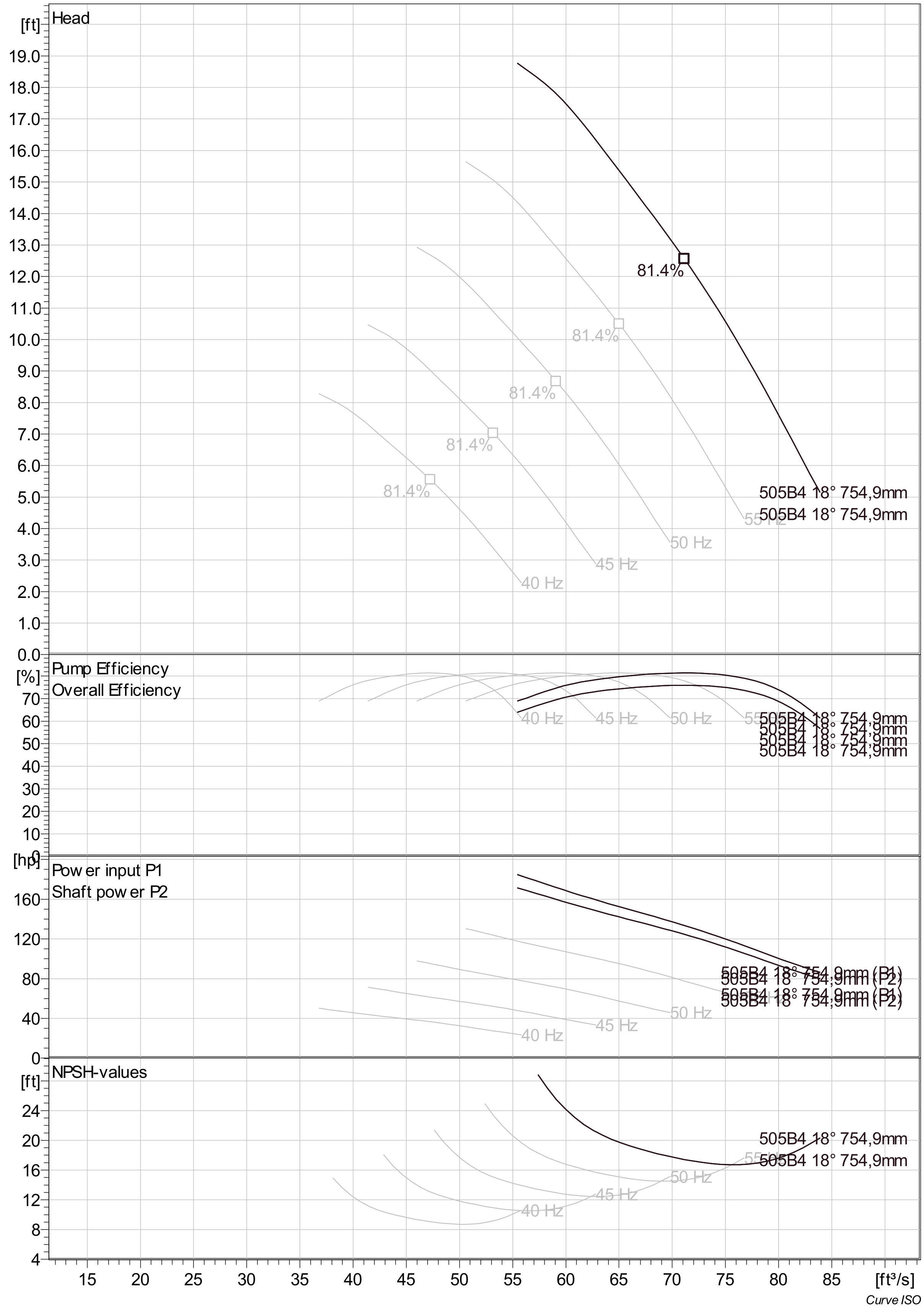


Pumps running /System	Individual pump Flow	Head	Shaft power	Total Flow	Head	Shaft power	Pump eff.	Specific energy	NPSHre
1	65.9 ft³/s	15 ft	140 hp	65.9 ft³/s	15 ft	140 hp	80.2 %	62.9 kWh/US MG	19.3 ft

Project	Project ID	Created by	Created on	Last update
			2/6/2018	

PL 7101/836 3~ 505B4

VFD Curve



Project	Project ID	Created by	Created on	Last update
			2/6/2018	

PL 7101/836 3~ 505B4

Dimensional drawing

Project	Project ID	Created by	Created on	Last update
			2/6/2018	

APPENDIX A, SUB-APPENDIX F:

Opinion of Probable Construction Cost

SAN QUENTIN STORMWATER PUMP STATOIN
Layout Option 1 (3-Pumping Units)
Opinion of Probable Construction Cost

CONSTRUCTION COSTS

ITEM	DESCRIPTION	UNIT	PRICE
1.	**Site Preparation:** Includes mobilization, traffic control, construction fencing, storage, potholing and material handling.	**L.S.**	$100,000
2.	**Demolition:** Includes removal of all equipment, wet well, fencing, excavation, piping, motor control center, and other electrical features.	**L.S.**	$195,000
3.	**Wet Well Installation:** Includes forming, new concrete to the wet well, access hatches, backfill, bar screens, elastomeric coating, and all other appurtenances pertaining to the structure and its operation complete in place.	**L.S.**	$325,000
4.	**Furnish and Install Pumping Units:** Includes three (3) 60 cfs vertical pumps, barrels, mounting materials, testing and all other appurtenances and operations pertaining to the successful installation and operation of all pump units complete in place.	**L.S.**	$615,000
5.	**Furnish and Install Electrical Equipment:** Includes motor control center complete, portable generator connector, automatic transfer switch, transformer, conduit, pull boxes, wiring, connections, lighting, outlets, level controls, alarms, telemetry, power supply connections and all other appurtenances and operations pertaining to the successful installation and operation of the pump station.	**L.S.**	$750,000
6.	**Furnish and Install Outfall Piping Improvements:** Includes new 48" HDPE, SDMH, connections, inspection, testing and clean-up and all other appurtenances pertaining to the successful installation and operation of the pump station complete in place.	**L.S.**	$315,000
7.	**Furnish and Install Site Improvements:** Includes forming, new concrete pad adjacent to the pump station, aggregate base, bollards, fencing, signing, and all other appurtenances pertaining to the site improvements and its operation complete in place.	**L.S.**	$85,000
	Contingency (25%)		$596,250
	CONSTRUCTION COSTS (SUBTOTAL) =		$2,981,250

INCIDENTAL EXPENSES

1.	Environmental Mitigation Allowance (5%)	$127,000.00
2.	Land Acquistion (@ $90/sq.ft. incl appraisals, negotiations)	$ -
3.	Post Construction Monitoring & Maintenance (5%)	$127,000.00
	INCIDENTAL EXPENSES (SUBTOTAL)	$254,000.00

SUMMARY

CONSTRUCTION COSTS	$ 2,981,250
INCIDENTAL EXPENSES	$ 254,000
TOTAL (CONSTRUCTION COSTS + INCIDENTAL EXPENSES) =	**$ 3,235,250**

1. This estimate does not include bonding, Agency fees, permits and other costs not listed above.
2. This estimate should be used as a guide only. Actual cost can only be determined by a contract based on final approved plans or actual construction of facilities.

SAN QUENTIN STORMWATER PUMP STATOIN
Layout Option 1 (3-Pumping Units)
Opinion of Probable Construction Cost

CONSTRUCTION COSTS

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1.	**Site Preparation:** Includes mobilization, traffic control, construction fencing, storage, potholing and material handling.	**L.S.**	$100,000
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	Contingency (25%)		$596,250
	CONSTRUCTION COSTS (SUBTOTAL) =		$2,981,250

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TOTAL (CONSTRUCTION COSTS + INCIDENTAL EXPENSES) = $ 3,235,250

1. This estimate does not include bonding, Agency fees, permits and other costs not listed above.
2. This estimate should be used as a guide only. Actual cost can only be determined by a contract based on final approved plans or actual construction of facilities.

APPENDIX A, SUB-APPENDIX G:

Schematic Layout Options

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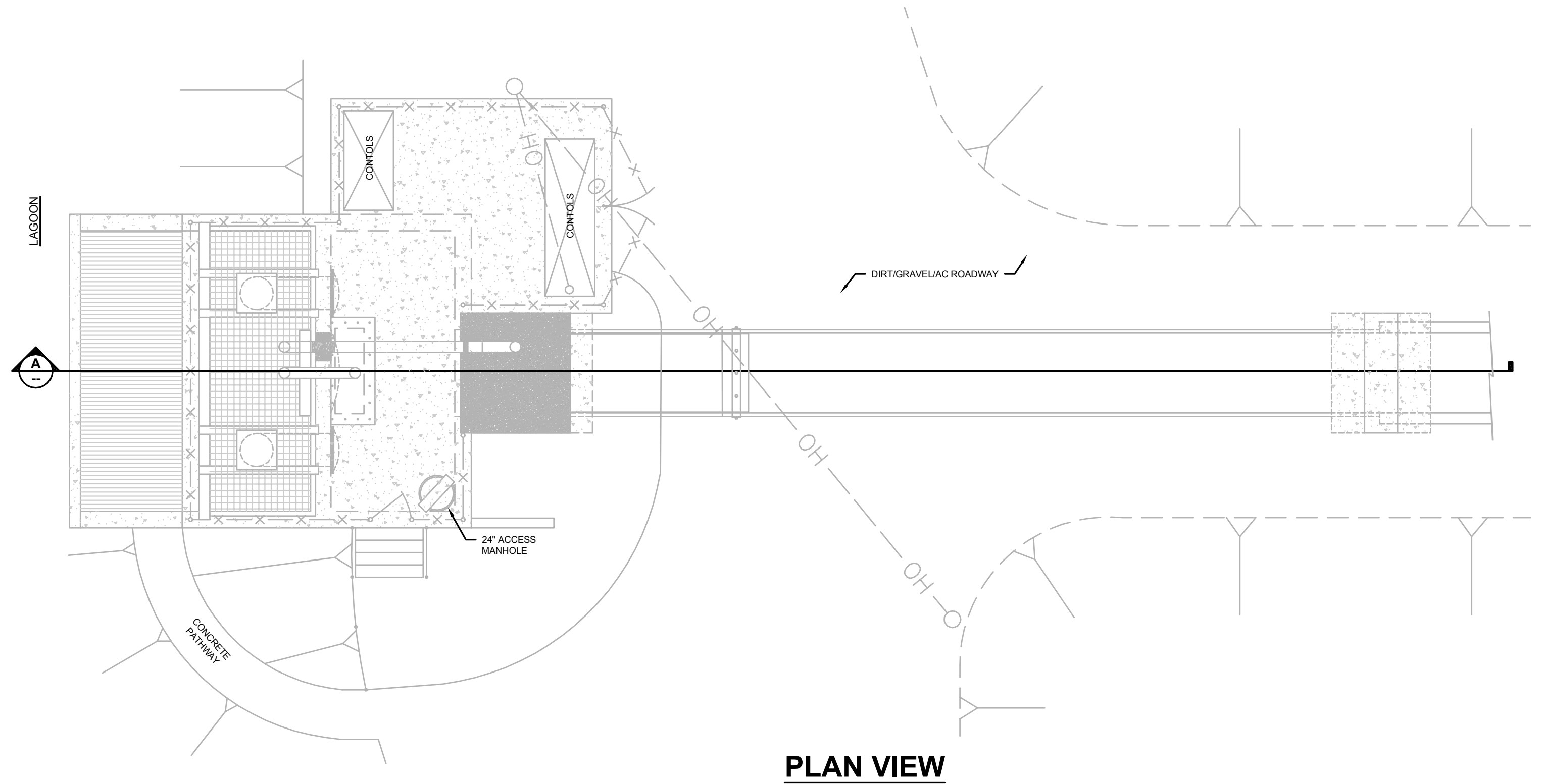
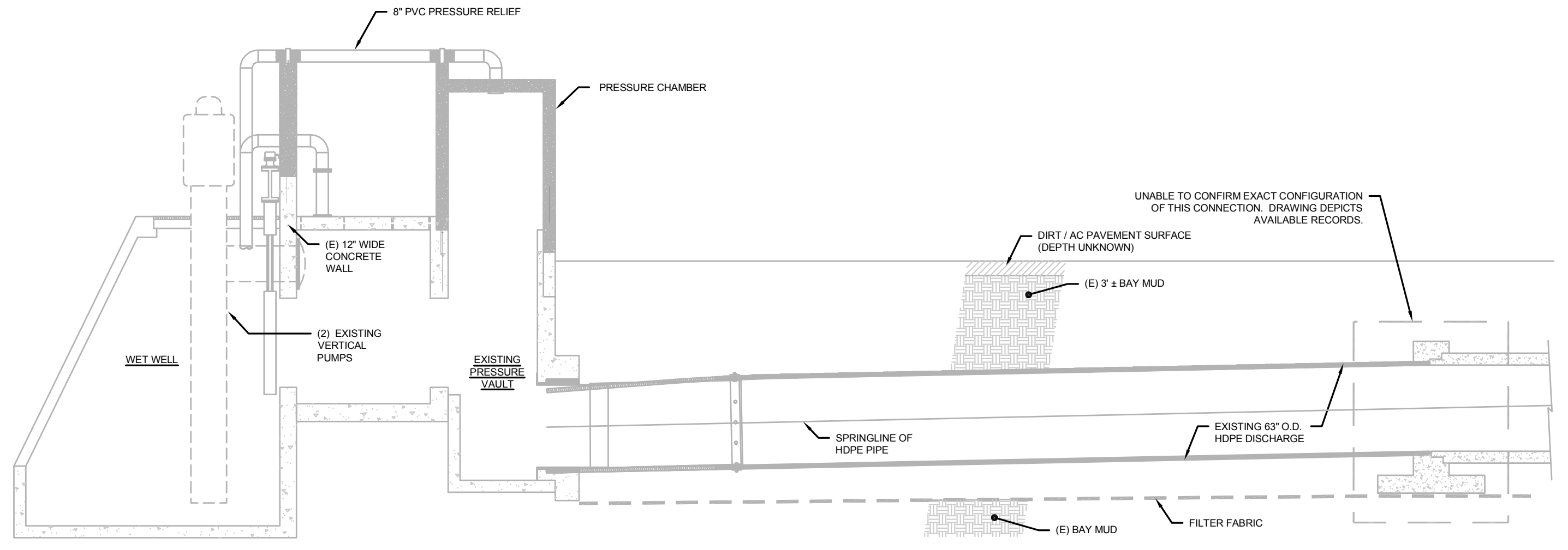


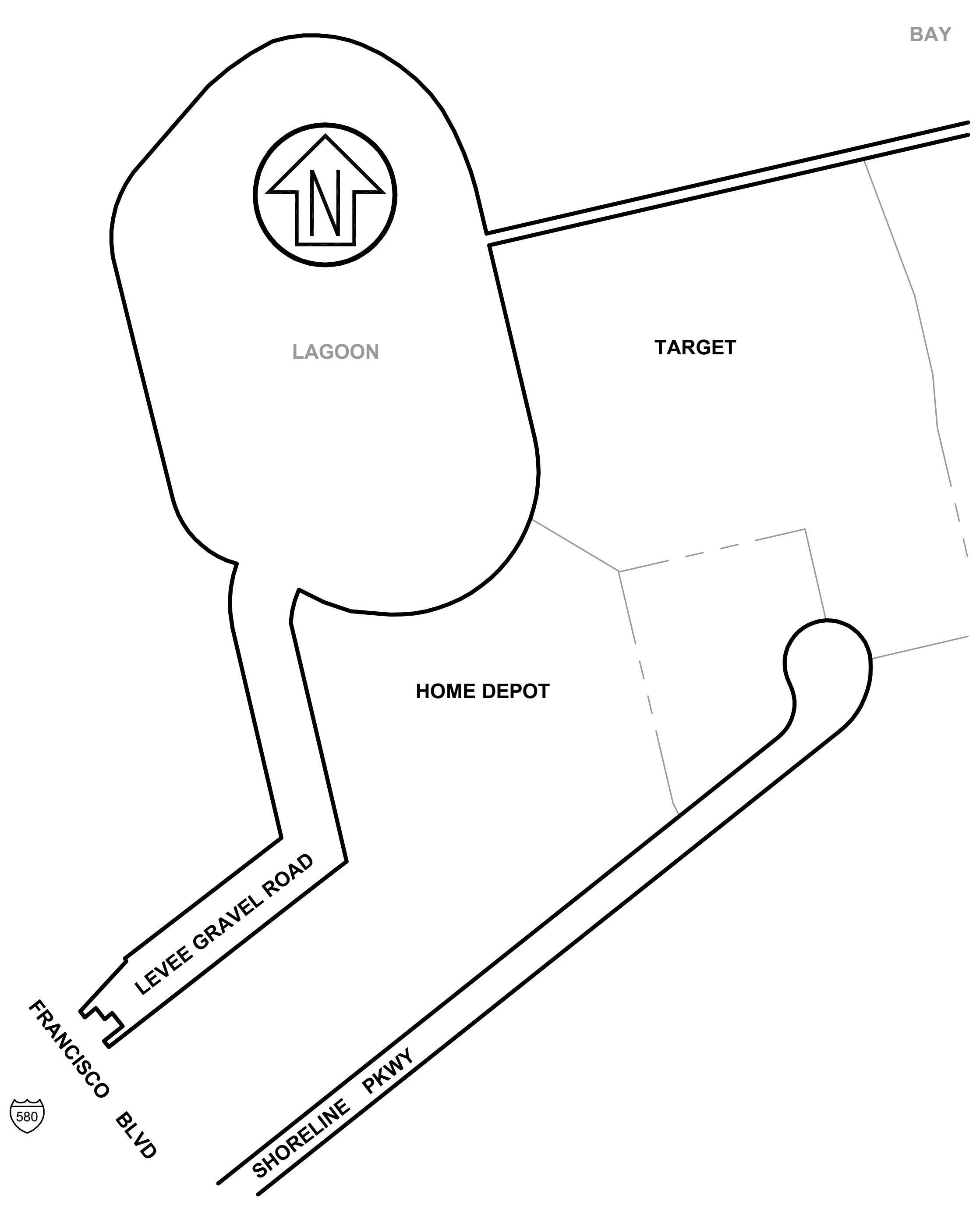
PLAN VIEW



(A) SECTION VIEW

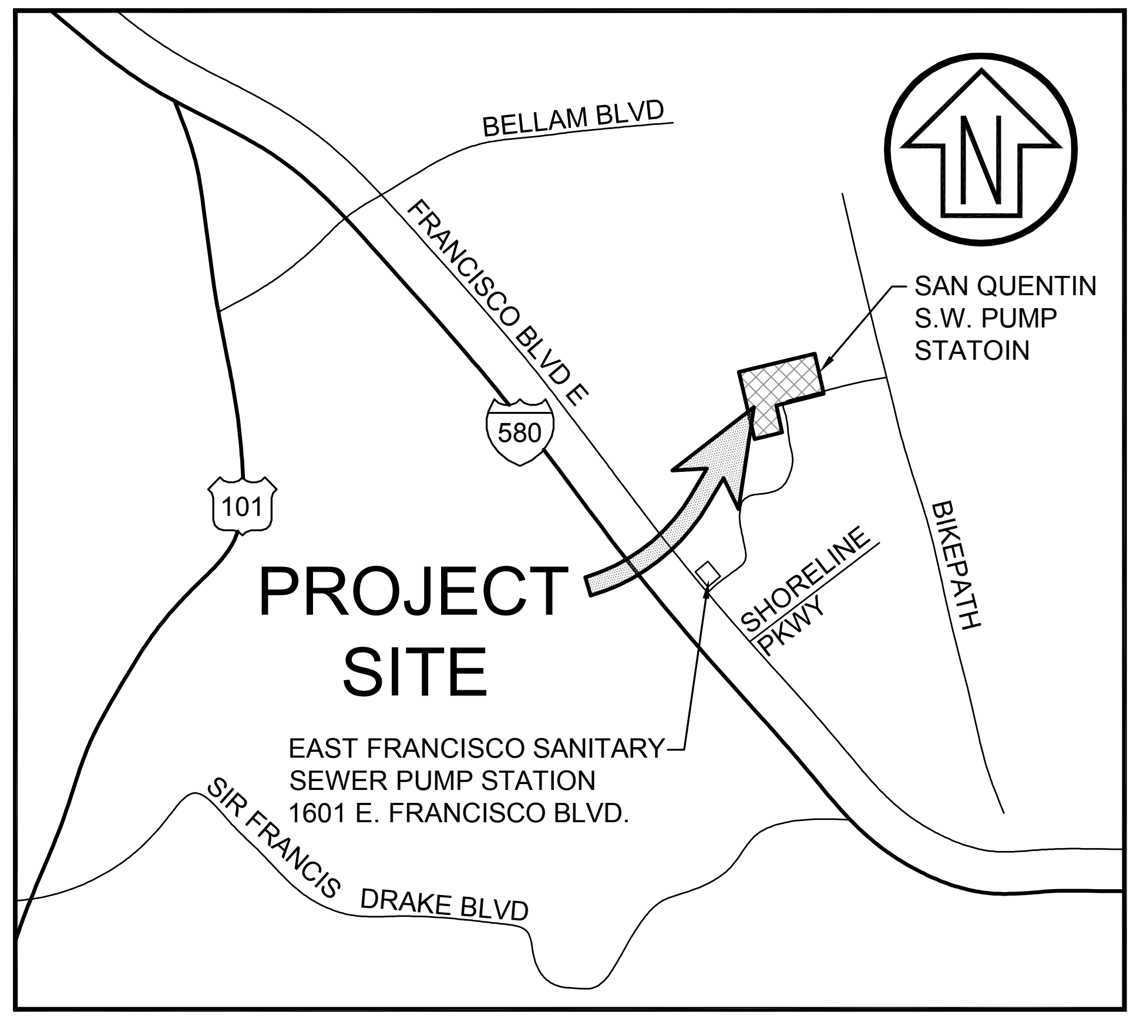
EXISTING PUMP STATION SITE PLAN & SECTION VIEW

1 inch = 10 ft.



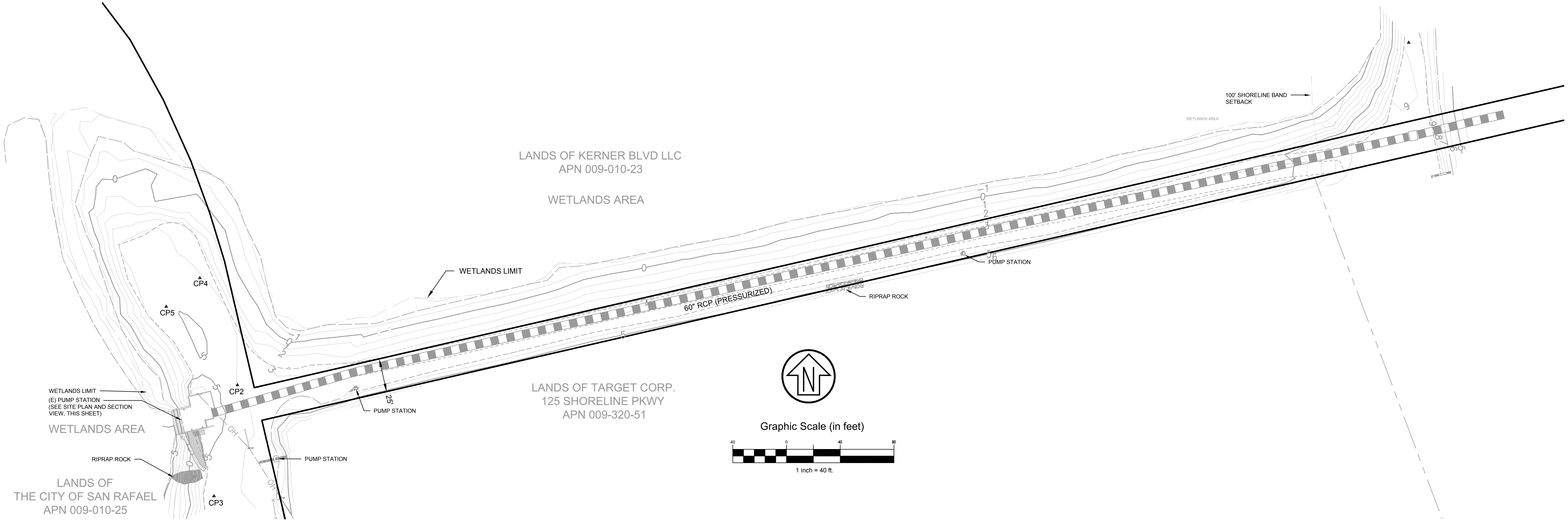
PROPERTY MAP

1 inch = 300 ft.



VICINITY MAP

N.T.S.



EXISTING SITE PLAN

N.T.S.

NO.	REVISION	BY	DATE
-	100% CD	RJS	02-16-16

DESIGNED RJS
DRAWN SAS
CHECKED RJS
APPROVED
DATE

PROJECT NAME
SAN QUENTIN PUMP STATION RECONSTRUCTION PROJECT

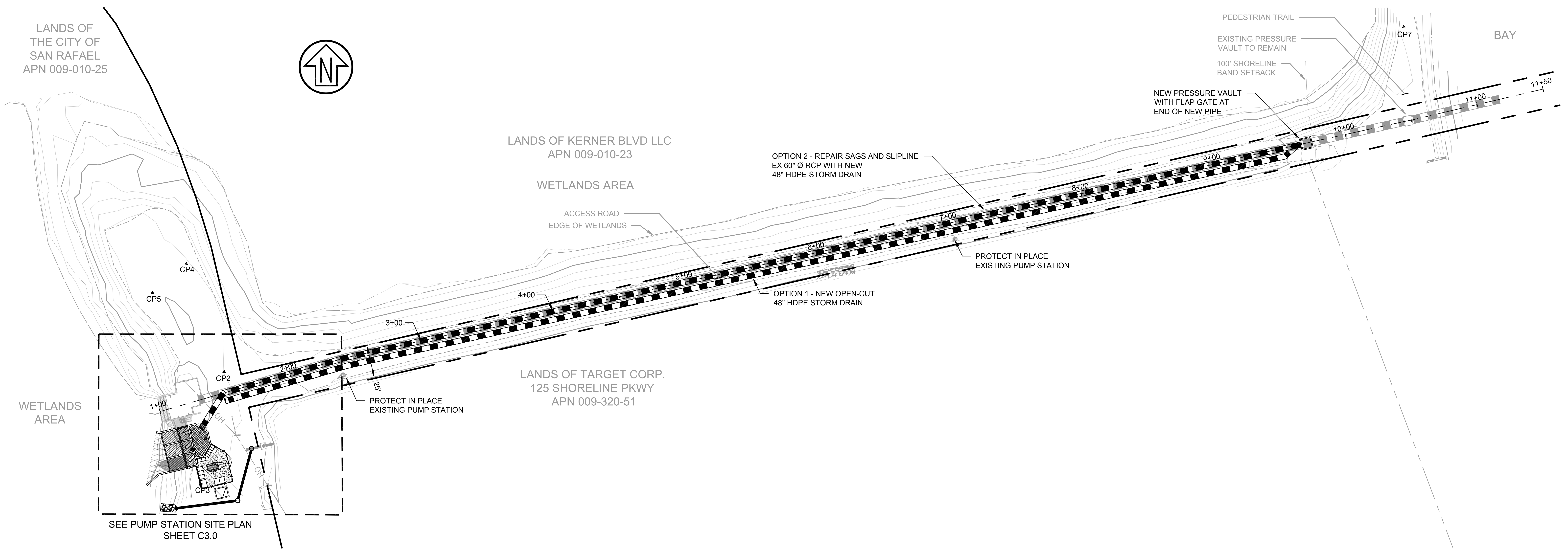
DRAWING NAME
EXISTING CONDITIONS PLAN

SAN RAFAEL COUNTY OF MARIN CALIFORNIA

CSW|ST2
CSW/Stuber-Stroeh Engineering Group, Inc.
45 Leveroni Court
Novato, CA 94949
tel: 415.883.9850
fax: 415.883.9835
Civil & Structural Engineers
Surveying & Mapping
Environmental Planning
Land Planning
Construction Management

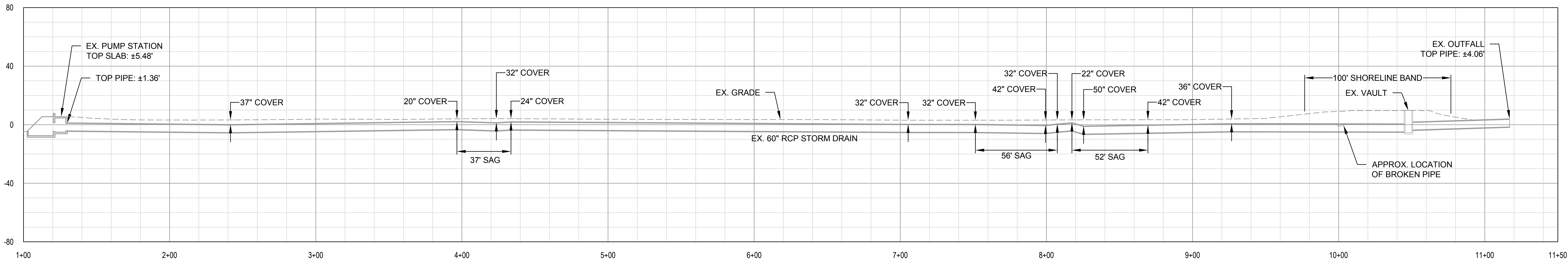
CITY OF SAN RAFAEL
DEPARTMENT OF
PUBLIC WORKS

SCALE: as shown
DATE: April 20, 2018
CITY PROJECT NO.: 11334
SHEET NO.: C1.0
DRAWING: 1 OF 4



STORM DRAIN SITE PLAN

SCALE: 1" = 40'



EXISTING STORM DRAIN PROFILE

SCALE: HOR. 1" = 40' VERT. 1" = 40'

NO.	REVISION	BY	DATE
-	100% CD	RJS	02-16-16
			DATE

DESIGNED RJS
DRAWN SAS
CHECKED RJS
APPROVED
DATE

PROJECT NAME

**SAN QUENTIN PUMP STATION
RECONSTRUCTION PROJECT**

DRAWING NAME

EXISTING PLAN AND PROFILE

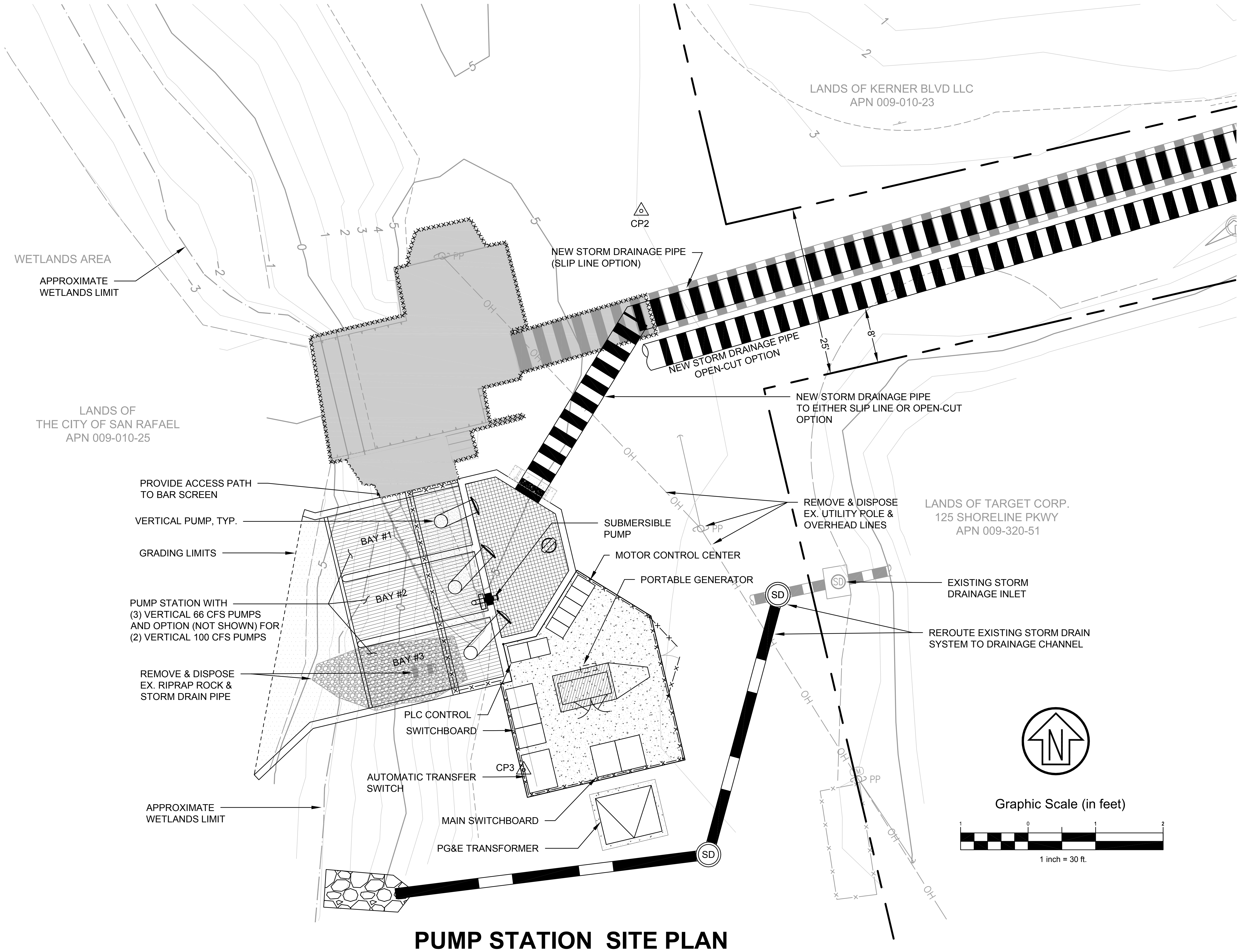
SAN RAFAEL COUNTY OF MARIN CALIFORNIA

C S W | S T 2
CSW/Stuber-Stroeh
Engineering Group, Inc.
45 Leveroni Court
Novato, CA 94949
tel: 415.883.9850
fax: 415.883.9835

Civil & Structural Engineers
Surveying & Mapping
Environmental Planning
Land Planning
Construction Management

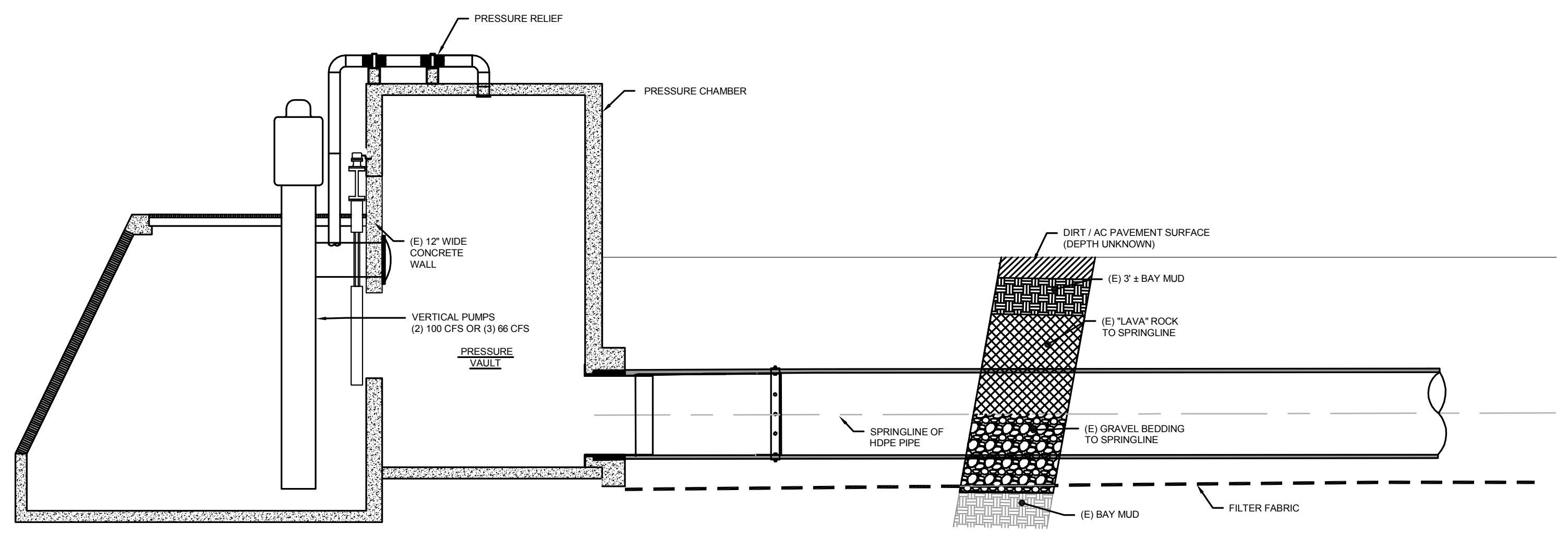
CITY OF SAN RAFAEL
DEPARTMENT OF
PUBLIC WORKS

SCALE: as shown
DATE: April 20, 2018
CITY PROJECT NO.: 11334
SHEET NO.: C2.0
DRAWING: 2 OF 4



PUMP STATION SITE PLAN

1 inch = 10 ft.



PUMP STATION SECTION VIEW

N.T.S.

LEGEND

EXISTING		PROPOSED
EM EM	ELECTRIC METER	EM EM
△	FOUND / SET - CONTROL POINT	△
JP	JOINT POLE (WITH GUY)	N/A
	SIGN	N/A
SD	STORM DRAINAGE - MANHOLE	SD
— —	CENTERLINE	— —
30	CONTOUR - MAJOR	30
	CONTOUR - MINOR	
N/A	REMOVE/DEMOLISH	▨
N/A	CONCRETE PAD	▨
—×—×—	FENCE	—×—×—
— OH — OH —	OVERHEAD UTILITY	N/A
▬	STORM DRAIN	▬

BASIS OF TOPOGRAPHY

TOPOGRAPHY SHOWN AT THE PUMP STATION IS BASED ON A FIELD SURVEY PERFORMED IN JANUARY 2018.

BENCHMARK

VERTICAL CONTROL IS BASED ON CONTROL POINT 2, A MAG NAIL AS SHOWN ON SHEET C2.0 WITH AN ELEVATION OF 3.96 (NAVD 88)

BASIS OF BEARINGS

THE BASIS OF BEARING IS THE MONUMENT LINE OF STATE HIGHWAY 17 (580) FRONTING THE PROPERTY TAKEN AS N38°32'42"W PER BOOK 8 OF SURVEYS PAGE 28, RECORDED APRIL 9, 1969.

GEOTECHNICAL REPORT

DRAFT "GEOTECHNIAL INVESTIGATION, SAN QUENTIN PUMP STATION RECONSTRUCTION, SAN RAFAEL, CALIFORNIA" PREPARED BY MILLER PACIFIC ENGINEERING GROUP DATED MARCH 30, 2018

PROJECT REFERENCES

"AS-BUILT" IMPROVEMENT PLAN OF EAST SAN RAFAEL DRAINAGE ASSESSMENT DISTRICT NO. 1" DATED 1-08-75

U.S.A. NOTIFICATION SERVICE

CALL BEFORE YOU DIG
800-642-2444

NO.	REVISION	BY	DATE
-	100% CD	RJS	02-16-16

DESIGNED RJS
DRAWN SAS
CHECKED RJS
APPROVED
DATE

PROJECT NAME
SAN QUENTIN PUMP STATION RECONSTRUCTION PROJECT

DRAWING NAME
LAYOUT PLAN

SAN RAFAEL COUNTY OF MARIN CALIFORNIA

CSW | ST2
CSW/Stuber-Stroeh Engineering Group, Inc.
45 Leveroni Court
Novato, CA 94949
tel: 415.883.9850
fax: 415.883.9835
Civil & Structural Engineers
Surveying & Mapping
Environmental Planning
Land Planning
Construction Management

CITY OF SAN RAFAEL
DEPARTMENT OF PUBLIC WORKS

SCALE: as shown
DATE: April 20, 2018
CITY PROJECT NO.: 11334
SHEET NO.: C3.0
DRAWING: 3 OF 4

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APPENDIX B:

Biological Resources Memorandum

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WRA
ENVIRONMENTAL CONSULTANTS

MEMORANDUM

To: Richard Souza
CSW/Stuber-Stroeh
Engineering Group, Inc.
45 Leveroni Court
Novato, CA 94949

From: Rhiannon Korhummel
WRA Environmental Consultants
5341 Old Redwood Highway
Ste. 310, Petaluma, CA 94954

cc:

Date: May 2019

Subject: **Biological Resources at the San Quentin Pump Station Project**

The purpose of this letter is to provide the results of the biological resources assessment site visit at the San Quentin Pump Station Reconstruction Project Site (Study Area) in the City of San Rafael, California (Attachment 1, Figure 1). It is WRA's understanding the Project will demolish the existing pump station, construct a new pump station and replace a portion of the existing pipe running between the existing pump and the pump outfall in the bay (Project Area).

The Study Area is within a diked infill area of San Rafael and is bounded to the east by the Bay Trail, to the west and south by commercial facilities, and to the north by muted, diked salt marsh. The Project Area is predominantly located within the developed portion of the Study Area which includes a gravel pathway and the existing pump station, with small portions of ruderal vegetation, salt marsh and open water also present. The open water is a drainage channel connecting the pump to stormwater runoff from nearby developed areas. This channel also receives tidal water through the pipe connecting the bay to the pump station.

Based on the site visit and review of background literature and databases, the Project Area contains three sensitive biological communities, salt marsh, seasonal wetland, and water. The Project Area is not expected to support special-status plant species, however it has moderate potential to support one special-status wildlife species, the salt marsh harvest mouse (*Reithrodontomys raviventris;* SMHM), as well as nesting birds and roosting bats.

Methods

Prior to the site visit, background literature was reviewed to determine the potential presence of sensitive vegetation types, aquatic communities, and special-status plant and wildlife species. Resources reviewed for sensitive vegetation communities and aquatic features include aerial photography, mapped soil types, the California Native Plant Society (CNPS) Online Database

(2018a[1]), the California Department of Fish and Wildlife's (CDFW) California Natural Diversity Database (CNDDB, CDFW 2018[2]), and the US Fish and Wildlife Service (USFWS) Information for Planning and Consultation (IPac) database (USFWS 2018[3]). For database queries, the San Rafael and eight surrounding U.S. Geological Survey (USGS) 7.5-minute quadrangles were included as the focal search area (USGS 1980[4]).

On January 8, 2018, WRA biologists conducted a field assessment of the Study Area to evaluate the potential presence of sensitive vegetation communities and aquatic features and evaluate on-site habitats to determine the potential for occurrence of special-status plant and wildlife species. Observed plant communities, aquatic features, and plant and wildlife species were noted. Site conditions were noted as they relate to habitat requirements of special-status plant and wildlife species known to occur in the vicinity as determined by the background literature research.

The Study Area was assessed in terms of potential biological resources impacts on the redevelopment project. This analysis was performed to a level of detail necessary to understand what types of major biological impacts are likely to be associated with the proposed project with a focus on the Project Area within the Study Area.

The conclusions of this report are based on conditions observed at the time of the field assessments and regulatory policies and practices in place at the time the report was prepared; changes that may occur in the future with regard to conditions, policies, or practices could affect the conclusions presented in this assessment.

Environmental Setting

The Study Area is situated at the base of a slope created from infill which was placed between 1968 and 1987 (Historical Aerials 2018[5]) within an area which was diked in the mid 1950's. The Project Area encompasses the existing pump station and associated underground pipe which runs to the east under the gravel walkway. The Project Area also includes the planned footprint of a new pump station and associated underground culverts.

The majority of the Study Area is composed of biological communities typically located on degraded or impacted natural areas, a result of past and present disturbance including maintenance of utility easements (mowing and other vegetation disturbance), infill, and the effects of urbanization. The northern and western outer edges of the Study Area are dominated by less impacted salt marsh biological community types. The Project Area is located between the ruderal vegetation on the infill soil and the naturally occurring muted salt marsh vegetation within the diked baylands.

Table 1 summarizes the area of each biological community type observed in the Study Area and Project Area. Non-sensitive biological communities are the ruderal/non-native and developed areas. Sensitive biological communities include salt marsh, seasonal wetland, vegetation and

---

[1] California Native Plant Society. 2018a. Online Rare Plant Inventory. Available at: http://rareplants.cnps.org/

[2] California Dept. of Fish and Wildlife California Natural Diversity Database. CDFW 2018. Available at: https://www.wildlife.ca.gov/Data/CNDDB/Maps-and-Data

[3] US. Fish and Wildlife Service. 2018. Information for Planning and Consultation. Available at: https://ecos.fws.gov/ipac/

[4] U.S. Geologic Society.1980. San Rafael 7.5-Minute Topographic Quadrangle.

[5] Historical Aerials. 2018. Available at: https://www.historicaerials.com/

Waters of the U.S./State consisting of a drainage channel (Attachment 1 Figure 2). Descriptions for each biological community are provided below.

Table 1. Biological Communities within the Study Area and Project Area

Biological Community	Acreage within Study Area	Acreage within Project Area
Non-Sensitive		
Developed	0.65	0.20
Ruderal/Non-native	2.51	0.08
Sensitive		
Salt Marsh	0.44	0.01 (363 sq. ft.)
Seasonal Wetland	0.01	0.00
Waters of the U.S./State	0.17	<0.01 (228 sq. ft.)

Non-Sensitive Biological Communities

Developed

Approximately 0.65 acres of developed area is located within the Study Area which includes the existing pump station, the gravel pathway and gravel landing to the north of the existing pump station.

Ruderal/Non-native

Approximately 2.51 acres of ruderal/non-native vegetation is located in the Study Area on uplands along the gravel pathway and gravel landing. The ruderal/non-native vegetation community is composed of areas that are characterized as fennel (*Foeniculum vulgare*) patches and iceplant (*Carpobrotus* spp.) mats. This vegetation type typically occur in ruderal locations which have been partially developed or been used in the past for agriculture. Fennel is dominant or co-dominant in the herbaceous canopy layer with more than 50 percent relative cover. In areas of ice plant, a nearly monotypic mat with emergent non-native grasses and pickleweed (*Salicornia pacifica*) is present.

Additional species within this community includes wild oats (*Avena* sp.), wild radish (*Raphanus sativus*), ripgut brome (*Bromus diandrus*), Bermuda buttercup (*Oxalis pes-caprae*), stinkwort (*Dittrichia graveolens*), crane's bill geranium (*Geranium molle*), Italian thistle (*Carduus pycnocephalus*), bristly ox-tongue (*Helminthotheca echioides*), and perennial pepperweed (*Lepidium latifolium*).

Sensitive Biological Communities

Salt Marsh

The areas of salt marsh habitat best fits Alkali Heath Marsh *(Frankenia salina* Herbaceous Alliance, Pickleweed Mat (*Salicornia pacifica* Herbaceous Alliance), and Salt Grass Flats

(*Distichlis spicata* Herbaceous Alliance) CDFW vegetation alliances (CNPS 2018b). A combined 0.44 acre of salt marsh is located within the Study Area (Figure 2). Alkali heath marsh is located along the edge of the drainage channel north of the existing pump station. The areas of alkali heath marsh are dominated by alkali heath with associated species of curly leaf dock (*Rumex crispus*), Harding grass (*Phalaris aquatica*) and annual grasses. The small area of pickleweed mat which occurs along the northern boundary of the Study Area is the southern edge of a larger expanse of an isolated patch of pickleweed mat; areas of pickleweed mat are nearly 100 percent relative cover of pickleweed. Within the Study Area, salt grass flat is located along the drainage channel south of the existing pump station and on the opposite side of the channel, across from the existing pump station. Areas of salt grass flats are nearly 100 percent relative cover of salt grass with ripgut brome, perennial pepperweed occurring at low cover.

Both alkali heath marsh and pickleweed mat are considered sensitive by CDFW as indicated by an S3 rank; additionally, these communities are wetlands and within jurisdiction of the U.S. Army Corps of Engineers (Corps) and RWQCB under Section 404/401 of the CWA. Salt grass flats are not considered sensitive by CDFW, it is a wetland and within the jurisdiction of the Corps and RWQCB under Section 404/401 of the CWA.

Seasonal Wetland

A 0.01 acre seasonal wetland, dominated by non-native grasses and forbs is located along the eastern edge of the access road near the proposed pump station. Vegetation is dominated by seaside barley (*Hordeum marinum*) and Italian ryegrass (*Festuca perennis*), both of which are facultative wetland species. Redox was observed in the soil, below the rocky road base. Soils were saturated to the surface at the time of the site visit. This community is considered sensitive as it is a potential seasonal wetland which are within the jurisdiction of the Corps and RWQCB under Section 404/401 of the CWA.

Waters of the U.S./State

Approximately 0.17 acre of a drainage channel is located along the western portion of the Study Area. Stormwater runoff enters this channel at Highway 580, additionally tidal water enters this channel through the underground pipe connecting the existing pump and the bay. Water is present throughout the year within this feature, however there is a fluctuation of depth and width throughout the year, with lower depth and smaller width occurring in the summer and fall months (Google Earth 1987-2018). The ordinary high water mark (OHWM) and top-of-bank (TOB) of this feature are similar and were determined based on shift of vegetation, change in topography, and wrack line. Vegetation along the edges of the channel within the Study Area include alkali heath marsh and salt grass flats as described above. Some patches of pickleweed and alkali bulrush were observed within the OHWM of the feature. This channel extends westward to Highway 580 and receives freshwater from stormwater runoff from adjacent developed areas. This channel is considered sensitive because it is within jurisdiction of the Corps and RWQCB under Section 404/401 of the CWA.

Special-Status Species

Plants

Based upon a review of the resources and databases listed above, it was determined that 106 special-status plant species have been documented in the vicinity of the Study Area. The majority of the Study Area (3.2 acres) is dominated by ruderal/non-native vegetation and developed areas. These communities are unlikely to support special status plant species due to presence of aggressive non-native annual and perennial plant species which likely preclude special-status plants. The remaining salt marsh vegetation types comprise 0.44 acre of the 3.78 acre Study Area, and are therefore limited in extent within the Study Area.

Based on assessment of biological communities present within the Study Area, no special status plants are determined to have potential to occur within the Study Area. The Study Area is located within an area which was diked off from the bay within the mid 1950's (Historical Aerials 2018), and has received no direct tidal influence since that time. Known occurrences of nearby special-status plants which are known to occur in the biological communities present within the Study Area have direct tidal influence. Therefore, while the biological communities within the Study Area are potentially suitable for these salt marsh species to occur, the extent is limited, and the isolation of the Study Area from direct tidal influence makes their occurrences unlikely as well.

Wildlife

Eighteen special-status species of wildlife have been recorded in the vicinity of the Project Area in the California Natural Diversity Database[6]. Two of the species are considered extirpated from the region, one species, the California black rail (*Laterallus jamaicensis coturniculus*), is unlikely to occur, and 14 species have no potential to occur on the Study Area due to lack of suitable habitat (see Appendix A). The remaining species, the salt marsh harvest mouse (*Reithrodontomys raviventris*), has a moderate potential to occur within the Study Area. Nesting birds and roosting bats also have the potential to occur within the Study Area.

Salt marsh harvest mouse; Federal Endangered Species, State Endangered, CDFW Fully Protected Species. The salt-marsh harvest mouse (SMHM) is a relatively small rodent found only in suitable salt and brackish marsh habitat in the greater San Francisco Bay, San Pablo Bay, and Suisun Bay areas. This species has been divided into two subspecies: the northern SMHM (*Reithrodontomys raviventris halicoetes*) which lives in the brackish marshes of the San Pablo and Suisun bays, and the southern SMHM (*R. r. raviventris*) which is found in the marshes of San Francisco Bay. The Study Area occurs near the presumed boundary between the northern and subspecies, likely within the range of the southern subspecies, though the exact location of the boundary and whether the two subspecies hybridize are both unknown[7]. The southern subspecies generally persists in smaller and more isolated populations relative to the northern subspecies, as most of the marshes of the South San Francisco Bay are narrow, strip-like marshes and thus support fewer SMHM compared to marshes in the northern portions of the

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[6] California Department of Fish and Wildlife. 2018. California Natural Diversity Data Base (CNDDB). RareFind 5. Natural Heritage Division, California Department of Fish and Game. Sacramento, California. Accessed: November 2018.

[7] Smith, Katherine R, Melissa K Riley, Laureen Barthman–Thompson, Mark J Statham, Sarah Estrella, and Douglas Kelt. 2018. Towards Salt Marsh Harvest Mouse Recovery: Research Priorities. San Francisco Estuary and Watershed Science 16, no. 2.

species' range[8]. Northern marshes also tend to be more brackish, and have a more diverse assemblage of vegetation, thus the northern subspecies is more likely to occur in habitats that are not dominated by pickleweed, which dominates habitat in the southern range[9].

The SMHM was last recorded in the Study Area in 1987. The lack of more recent records is not unusual, especially for a privately owned property where state and Federal resource managers may have difficulty obtaining access, and may not accurately reflect an absence of the species on the Study Area. Pickleweed, alkali heath, and saltgrass-dominated marsh occurs within the Study Area, and these habitat patches are directly connected to over a quarter square kilometer of adjacent, high-quality, pickleweed marsh. However, the wetland complex is completely isolated from any other marshes that could support SMHM, and has a long history of disturbance. If any population-level extinction events occurred in the Study Area and surrounding marsh, there would be virtually no chance of recolonization. However, the marsh is large with abundant upland refuge, so it is possible that a SMHM population has persisted here since the late 1980's. The species is presumed present within the pickleweed and salt grass marsh within the study area, and within suitable habitat in the surrounding marsh.

California black rail, State Threatened, CDFW Fully Protected Species. The California black rail is the resident black rail subspecies that occurs in California coastal salt and brackish marshes from Bodega Bay to Morro Bay, with additional populations known from freshwater marshes near or in the northern Sierra Nevada foothills[10,11]. Important habitat elements for this species within the San Francisco Bay estuary are: 1) emergent marsh dominated by pickleweed, marsh gumplant (*Grindelia stricta*), bulrush (*Scirpus maritimus*), rushes (*Juncus* spp.), and/or cattails (*Typha* spp.); 2) high density of vegetation below four inches in height; 3) high marsh elevation with transitional upland vegetation; 4) large total area of contiguous marsh; 5) proximity to a major water source; and, 6) isolation from disturbance[12]. This species feeds primarily on invertebrates. Black rails are extremely secretive and very difficult to glimpse or flush; identification typically relies on voice. Nests are placed on the ground in dense wetland vegetation.

There are no records of black rails within or adjacent to the Study Area, but there are observations about half a mile north of the Study Area and about a mile south of the Study Area recorded within the last decade[1]. However, the Study Area does not contain the important habitat elements identified by Spautz et al. (2005), and is subject to regular but relatively minor disturbance (e.g., pedestrians and off-leash dogs). Black rail are unlikely to occur within the Study Area.

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[8] U.S. Fish and Wildlife Service. 2010. Five Year Review for the Salt Marsh Harvest Mouse (*Reithrodontomys raviventris*). U.S. Fish and Wildlife Service. Sacramento, CA.

[9] Smith, Katherine R, Melissa K Riley, Laureen Barthman–Thompson, Isa Woo, Mark J Statham, Sarah Estrella, and Douglas A Kelt. 2018. Towards Salt Marsh Harvest Mouse Recovery: A Review. San Francisco Estuary and Watershed Science 16, no. 2

[10] Eddleman, W.R., R.E. Flores and M. Legare. 1994. Black Rail (*Laterallus jamaicensis*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/123.

[11] Richmond, O.M., J. Tecklin, and S.R. Beissinger. 2008. Distribution of California Black Rails in the Sierra Nevada Foothills. J. of Field Ornithology 79(4): 381-390.

[12] Spautz, H., N. Nur, and D. Stralberg. 2005. California Black Rail (*Laterallus jamaicensis coturniculus*) Distribution and Abundance in Relation to Habitat and Landscape Features in the San Francisco Bay Estuary. USDA Forest Service Gen. Tech. Rep. PSW-GTR-191: 465-468.

Nesting Birds. Within the Study Area, native birds may nest on the ground, in shrubbery, and on infrastructure. Most native birds have baseline protections under the federal Migratory Bird Treaty Act of 1918 (MBTA) as well as the California Fish and Game Code (CFGC). Under these laws/codes, the intentional killing, collecting or trapping of covered species, including their active nests (those with eggs or young), is prohibited[13]. Work in the Study Area could lead to damage or mortality to nests, or disturbance of adults leading to abandonment of nests.

Roosting Bats. The pump station that is to be demolished in the Study Area may support roosting bats. Bats could potentially use the structure for hibernation, or for maternity roosting. Hibernation roosting usually occurs between the fall and early spring in California. Disturbing bats during hibernation has high metabolic costs to the animals and can lead to reduced survival. Maternity colonies are composed of adult females and young, and disturbance of these can lead to abandonment of the colony, and/or mortality of young. The pump station contains abundant crevices that could accommodate roosting bats, and while the structure is small and subject to regular disturbance by a transient that sleeps under the structure, the potential for bat roosting cannot be ruled out.

Discussion of Impacts

The proposed project would impact two sensitive biological communities, and potentially wildlife including salt marsh harvest mouse, nesting birds, and roosting bats. Figure 3 in Attachment 1 depicts impact types and biological communities impacted. Potential impacts and proposed mitigation measures for each impact are discussed below.

Potential Impact BIO-1: The proposed project will temporarily impact 151 square feet of Waters of the U.S./State through the removal of the existing pump station. Soil and material from the existing structure may enter the Waters during deconstruction of the existing pump station. Additionally, removal of material will cause turbidity within the Waters. Once the existing pump station is removed, the existing bank will be re-contoured and approximately 736 square feet (0.02 acre) of Waters of the U.S. and associated salt marsh habitat would be gained (Figure 3).

Mitigation Measure BIO-1: The applicant shall obtain a Section 404 permit from the Corps, and a Section 401 Certification from the Regional Water Quality Control Board (RWQCB). Mitigation measures will be incorporated into the permits, which the project proponent shall follow. The following avoidance and minimization measures are proposed as a part of the permit applications:

1. Best management practices shall be employed to reduce impacts to vegetation and to limit erosion. Vegetation removal should be minimized to the greatest extent feasible. Areas in which vegetation is removed should be replanted or seeded with native plants appropriate for the site. Erosion control measures, such as the use of silt fencing or straw wattles, should be implemented in areas of ground disturbance or vegetation removal.

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[13] The U.S. Department of the Interior recently issued guidance clarifying that the MBTA only applies to intentional/deliberate killing, harm or collection of covered species (including active nests) (USDOI 2017). According to the guidance, unintentional impacts to birds/nests that occur within the context of otherwise lawful activities are not MBTA violations. However, ambiguity remains regarding application of the CFGC, as well as the extent to which minimization and avoidance measures are still required under the MBTA. Additionally, challenges to the Opinion are anticipated.

2. All impacts to this drainage channel from deconstruction will be temporary as vegetation is expected to recolonize the excavated areas. To reduce potential temporary impacts to waters in the Project Area, best management practices shall be employed to reduce impacts associated with excavation and grading including erosion and sedimentation. Best management practices recommended by the Marin Countywide Water Pollution Prevention Program shall be implemented to minimize pollutants carried from the Project Area in runoff. The project shall comply with terms of the San Francisco Bay Region Municipal Regional Stormwater National Pollutant Discharge Elimination System Permit.
3. All staging, maintenance, and storage of construction equipment shall be performed in a manner to preclude any direct or indirect discharge of fuel, oil, or other petroleum products into the drainage channel or salt marsh vegetation. No other debris, rubbish, creosote-treated wood, soil, silt, sand, cement, concrete or washings thereof, or other construction related materials or wastes shall be allowed to enter into or be placed where they may be washed by rainfall or runoff into the drainage channel or salt marsh vegetation. All such debris and waste shall be picked up daily and properly disposed of at an appropriate site.
4. No equipment shall be operated in areas of flowing or standing water. No fueling, cleaning, or maintenance of vehicles or equipment will take place within any areas where an accidental discharge to the drainage channel or salt marsh vegetation may occur.
5. Disturbance or removal of vegetation shall not exceed the minimum necessary to complete construction.
6. Where areas of bare soil other than in the excavated drainage channel are exposed during the rainy season, sediment and erosion control measures shall be used to prevent sediment from entering waters in the drainage channel or salt marsh vegetation. Sediment and erosion control structures shall be monitored and repaired or replaced as needed. Build-up of soil behind silt fences shall be removed promptly and any breaches or undermined areas repaired promptly. Revegetation of disturbed surfaces other than the excavated drainage channel shall occur prior to the start of the first rainy season after construction.
7. The work area shall be delineated where necessary with orange construction fencing in order to minimize impacts to habitat beyond the work limit.

After implementation of mitigation measures required for the permits, impacts would be less than significant.

Potential Impact BIO-2: Approximately 77 square feet of Waters of the U.S./State will be permanently impacted through the development of the new pump station. The proposed project includes placing fill within the Waters to stabilize and support the concrete slab upon which the new pump station will be placed.

Mitigation Measure BIO-2: Prior to filling of jurisdictional waters, or construction activities within Corps or RWQCB jurisdiction, necessary regulatory permits will be obtained from the appropriate agencies. Regulatory permits to be obtained include a Corps Permit, Regional Water Quality

Control Board Section 401 Water Quality Certification and/or Waste Discharge Requirement. Prior to proposed filling of jurisdictional waters, compliance with all regulatory agency permit conditions shall be demonstrated. Permanent impacts to jurisdictional wetlands or waters will be mitigated at a minimum 1:1 ratio on a functions and values basis by: (1) replacing permanent impacted features through bank recontouring at the old pump station location to create new area of waters and wetlands in the Study Area; (2) purchasing an appropriate amount of mitigation credits by an approved mitigation bank, or (3) another type of mitigation as approved by the Corps and/or RWQCB through the permitting process. Additionally, Mitigation Measure (MM) BIO-1 above will be implemented. With the implementation of these measures, the Project impact on waters of the U.S. and State will be less than significant.

Potential Impact BIO-3: Approximately 246 square feet of salt marsh habitat (salt grass mats) will be permanently impacted through the development of the new pump station and an additional 116 square feet will be temporarily impacted through the removal of the existing station.

Mitigation Measure BIO-3: Same as MM BIO-1 and MM BIO-2. After implementation of mitigation measures required for the permits, impacts would be less than significant.

Potential Impact BIO-4: Temporary disturbance to SMHM within, and adjacent to the Study Area, and injury or mortality to SMHM within the Study Area.

Mitigation Measure BIO-4: Mitigation measures for avoidance and minimization of effects to SMHM shall be incorporated into the permits or required authorizations and specifications, which the project proponent will follow. The following avoidance and minimization measures are proposed as a part of the permit application:

1. A qualified biological monitor (i.e., biologist whose credentials for SMHM monitoring have been previously approved by the USFWS) shall be present on-site during all construction work taking place adjacent to emergent marsh, including all vegetation removal and initial ground-disturbing work in these areas. The biological monitor shall document compliance with the Action permit conditions and all take avoidance and minimization measures. The monitor(s) shall have the authority to halt construction, if necessary, if there is the potential for a listed species to be harmed or when non-compliance events occur. The biological monitor(s) will be the contact person for any employee or contractor who might inadvertently kill or injure a listed species, or anyone who finds a dead, injured, or entrapped listed species.

2. If any mouse is observed at any time during construction, work shall not be initiated or shall be stopped immediately by the biological monitor until the mouse leaves the vicinity of the work area of its own accord. The biological monitor or any other persons at the site shall not pursue, capture, or handle any mouse observed.

3. Night work is not anticipated and will be avoided to the fullest extent feasible. If night work is necessary, all lighting shall be directed away from marsh and wetland areas to avoid impacting the natural behavior of SMHM.

4. All vehicles and heavy equipment stored outside of exclusion fencing, and in the vicinity of suitable SMHM habitat shall be checked for mice before work commences each morning.

5. When construction activities are to take place in potential SMHM habitat (emergent marsh and upland areas within 50 feet of emergent marsh), vegetation removal in work areas shall be performed to remove cover and render these areas unattractive to SMHM.

    a. Only non-motorized equipment or hand-held motorized equipment (i.e., string trimmers) shall be used to remove the vegetation.

    b. Vegetation shall be cut in at least two passes: with the first pass cutting vegetation at approximately half of its height above the ground (mid-canopy) and the next pass, or subsequent passes, cutting vegetation to ground-level or no higher than 1 inch.

    c. The biological monitor shall inspect areas of vegetation removal immediately prior to the initiation of removal to search for SMHM and “flush” small mammals out of the area and toward adjacent tidal marsh areas that will not be subject to removal. If any mouse is observed, work shall be stopped immediately by the biological monitor until the mouse leaves the vicinity of the vegetation removal of its own accord.

    d. Vegetation removal will start in the position furthest from the highest quality and most accessible SMHM habitat outside of the work area, and progress toward that habitat, such that SMHM are protected to the greatest degree possible as they move out of the focal area.

    e. Cut vegetation will be removed from the exclusion area (work area) so that no cut vegetation remains there once the exclusionary fence is installed, to discourage SMHM from being attracted to the area.

    f. All non-native, invasive vegetation removed will be discarded at a location outside of any tidal marsh areas to prevent reseeding.

6. Following completion of vegetation removal, temporary exclusionary fencing shall be installed to isolate work areas and prevent SMHM from entering work areas during construction.

    a. The fencing shall be installed between suitable habitat areas (e.g., salt marsh) and the defined work area (or areas) adjacent to suitable habitat immediately following vegetation removal and prior to the start of construction/excavation activities. Areas to be fenced should include the vicinity of the old and new pump structures and the area to be graded to the north of the pumps. As there is no suitable habitat for SMHM adjacent to the linear work area where the underground pipe is to be replaced, fencing would have limited value there.

    b. The fence shall consist of a non-textured, slick material that does not allow SMHM to pass through or climb, or silt fence with slick tape (or an effectively similar material) a minimum of 6 inches wide fixed to the fence to render it non-climbable. The bottom should be buried to a depth of at least 4 inches so that animals cannot crawl under the fence. Fence height should be at least 12 inches higher than the highest adjacent vegetation with a maximum height of 4 feet.

c. Fence posts should be placed facing the work area side (i.e., vegetation-cleared side) and not the side of the fencing facing intact habitat areas. The fencing shall be installed under the supervision of a biological monitor.

d. The biological monitor shall routinely inspect exclusionary fencing to ensure that it remains intact and effective. Fencing deficiencies noted will immediately reported to the contractor and repaired promptly.

After implementation of mitigation measures required for the permits, impacts would be less than significant.

<u>Potential Impact BIO-5</u>: Damage to bird nests and injury or mortality to eggs or chicks, or disturbance of nesting adults resulting in reduced clutch survival or nest abandonment.

<u>Mitigation Measure BIO-5</u>: Mitigation measures for avoidance and minimization of effects to nesting birds will be incorporated into the permits or required authorizations and specifications, which the project proponent shall follow. For the avoidance of impacts to native nesting birds protected by the MBTA and CFGC, the following avoidance and minimization measures are proposed as a part of the permit applications:

1. Project activities should be initiated to the extent feasible, outside of the nesting season. The nesting season is defined here a as being from February 1 to August 31 and therefore work should commence between September 1 and January 31.
2. If this is not possible, and project activities are initiated during the nesting season, then WRA recommends that a nesting bird survey be conducted by a qualified wildlife biologist no more than 14 days prior to the start of project activities.
3. If nests are identified, a no-disturbance buffer should be implemented to avoid impacts to nesting birds and should remain in place until all young are fledged or the nest otherwise becomes inactive. Buffers typically range from 25 feet to 500 feet depending on the species.

After implementation of mitigation measures required for the permits, impacts would be less than significant.

<u>Potential Impact BIO-6</u>: Disturbance of roosting bats, or injury or mortality of bat pups (young).

<u>Mitigation Measure BIO-6</u>: Mitigation measures for avoidance and minimization of effects to roosting bats will be incorporated into the permits or required authorizations and specifications, which the project proponent shall follow. The following avoidance and minimization measures are proposed as a part of the permit applications:

1. Preconstruction surveys for bats should be conducted by a qualified biologist no less than 14 days prior to removal of the pump house if the work should begin during the

maternity roosting season (April 1 through August 31) or during the hibernation season (November 1 through February 28).

2. If special-status bat species are detected during surveys, appropriate, species and roost specific mitigation measures will be developed. Such measures may include postponing demolition of the pump house until the end of the maternity roosting season.
3. Demolition of the pump house can be conducted outside of the maternity roosting and hibernation seasons (during the months of September, October and March) without performing preconstruction bat surveys.

After implementation of mitigation measures required for the permits, impacts would be less than significant.

Conclusion

The proposed project will temporarily impact 343.25 square feet and permanently impact 76.56 square feet of Waters of the U.S./State through the removal and installation of the pumps. Approximately 253.8 square feet of salt grass flats will be permanently impacted while 6.19 square feet will be temporarily impacted. Temporary disturbance, injury and/or mortality to SMHM through project activities, and disturbance and/or mortality to roosting bats and nesting birds are also potential significant impacts. However, after implementation of mitigation measures required for the permits, impacts would be less than significant.

If you have any questions, feel free to contact me at korhummel@wra-ca.com or 707-238-5680.

Regards,

Rhiannon Korhummel

Attachment 1: Figures

Attachment 1

Figures

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Sources: National Geographic, WRA | Prepared By: njander, 5/22/2019

Figure 1. Project Site Regional Location Map

San Quentin Pump Station Replacement Project
San Rafael, California

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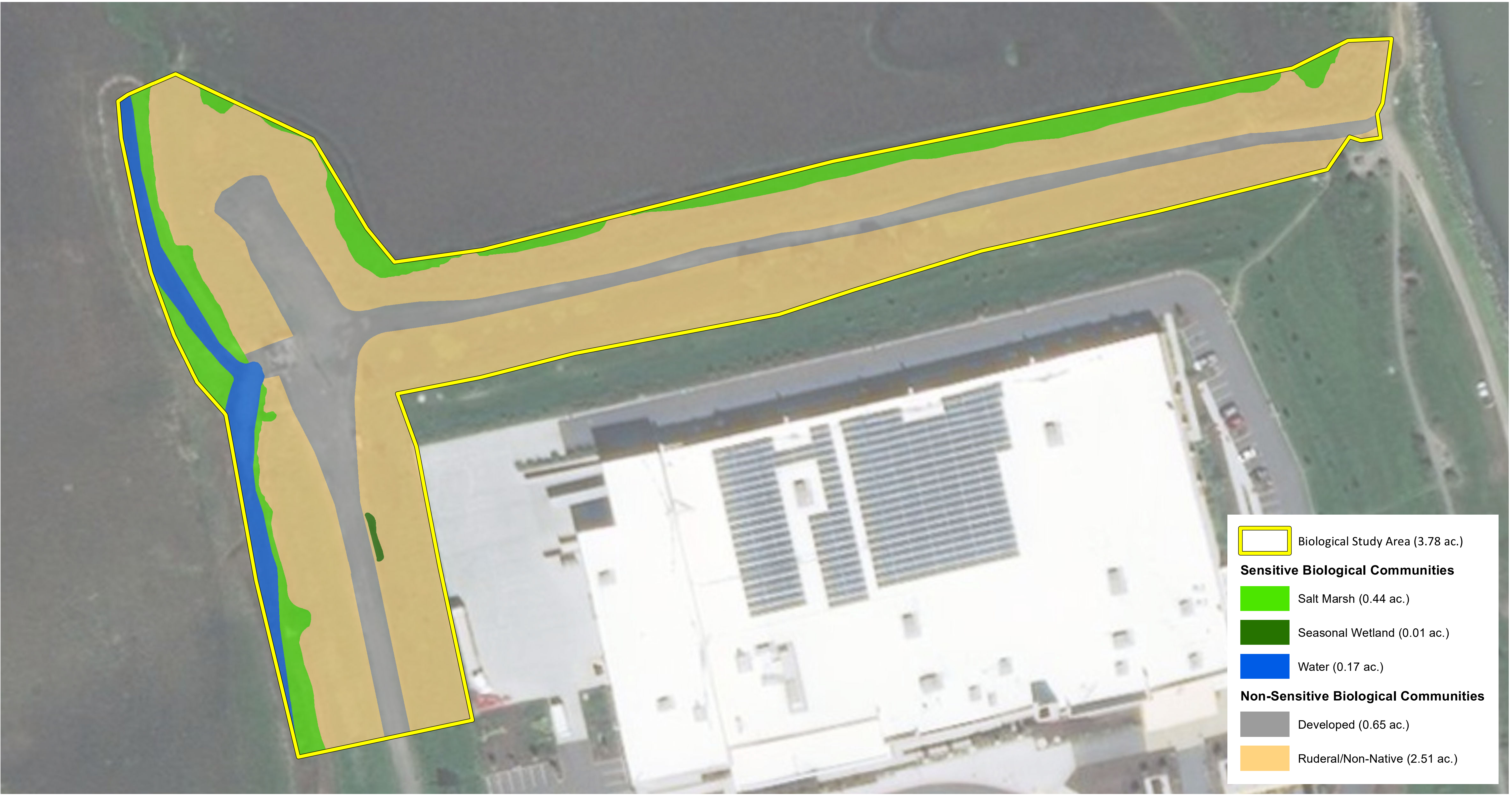

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Sources: 2016 DigitalGlobe Aerial, WRA | Prepared By: njander, 4/25/2019

Figure 2. Biological Communities in the Study Area

San Quentin Pump Station Replacement Project
San Rafael, California

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	Impact Type			
	Permanent		**Temporary**	
Biological Communities	**Acres**	**Sq. Ft.**	**Acres**	**Sq. Ft.**
Salt Marsh	0.01	246.67	0.00	116.24
Water	0.00	76.56	0.00	151.25
Seasonal Wetland	0.00	0.00	0.00	0.00

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Sources: 2016 DigitalGlobe Aerial, WRA | Prepared By: njander, 5/23/2019

Figure 3. Impacts in the Study Area

San Quentin Pump Station Replacement Project
San Rafael, California

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APPENDIX C:

Archaeological Survey Report and Historic Resource Evaluation Report

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ARCHAEOLOGICAL SURVEY REPORT AND HISTORIC RESOURCE EVALUATION REPORT

SAN QUENTIN PUMP STATION
RECONSTRUCTION PROJECT
SHORELINE PARKWAY
SAN RAFAEL, MARIN COUNTY, CA

APN 009-010-25

Prepared for:

The City of San Rafael
Department of Public Works
111 Morphew Street
San Rafael, CA 94901

Prepared by:

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15 Third Street
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Project No: ALTA2018-93

Key Words: USGS 7.5’ San Quentin; 5.2-acre Survey Coverage; Township 1 North, Range 6 West, Unsectioned Portion of Wetlands Area, Mount Diablo Base and Meridian; Positive Results Sacred Lands Search; Historic-era Resource Determined Non-eligible.

May 9, 2019

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I. SUMMARY OF FINDINGS

The following Archaeological Survey Report (ASR) documents the adequacy of identification efforts and presents the results of investigations within the Study Area boundaries. The study was designed to identify any archaeological, historical, or cultural resources located within the project area. Fieldwork was conducted on January 17, 2019 by Sarah King Narasimha and Nicholas Radtkey, archaeologists with Alta Archaeological Consulting (ALTA). The survey entailed a cultural resources inventory of the entire Area of Potential Effects (APE) using transect intervals no greater than 10 meters apart along with the evaluation of the current pump station for historical significance. Ground surface visibility was moderate (25-30%) due to dense seasonal grasses and imported road fill. One cultural resource, a historic-era pump station, was identified within the project area and evaluated in this report. The project, as presently designed, is not anticipated to have an adverse effect on cultural resources and should be allowed to proceed.

II. INTRODUCTION

A cultural resources inventory was conducted to satisfy requirements of the California Environmental Quality Act (CEQA) of 1970, and the responsibilities codified in Public Resource Code sections 5097, and its implementing guidelines 21082 and 21083 and Section 106 of the National Historic Preservation Act (NHPA) of 1966, and Title 36, Part 63 of the Code of Federal Regulations. An archaeological field survey was completed by ALTA on January 17, 2019 for the purpose of identifying cultural resources within the project area. One cultural resource, a historic-era pump station, was identified within the project area and evaluated in this report. The resulting document addresses these regulatory responsibilities.

Qualifications of Preparer

Mr. DeGeorgey holds a Masters of Arts degree in Anthropology from the California State University, Chico. He has 24 years professional archaeological experience working for both the public sector and private agencies engaged in the management of cultural resources in Northern California. Mr. DeGeorgey meets the Secretary of the Interior’s standard for cultural resource specialists involved in preservation activities at all levels of government involving historic-era and prehistoric-era archaeological resources. Mr. DeGeorgey currently serves as an elected official on the Standards Board of the Registry of Professional Archaeologist where he is responsible for enforcement of the organizations code of conduct and standards of research performance. He maintains an active role in the Society for California Archaeology, Society for American Archaeology, the Register of Professional Archaeologists, and local historical organizations.

III. PROJECT LOCATION AND DESCRIPTION

The project is situated within the City of San Rafael in eastern Marin County within the southeast area of San Rafael adjacent San Rafael Bay (Figure 1). The project area is situated on the USGS 7.5’ San Quentin Quadrangle map in Township 1 North, Range 6 West, in an unsectioned portion of a coastal wetland in the Mount Diablo Base and Meridian (Figure 2). The project area is situated on one 3.5 acre parcel (APN 009-010-25). The physical address of the property is Shoreline Drive, San Rafael, California. The project area is situated on a wetland flat along the San Rafael Bay shoreline.

The City of San Rafael, is proposing to reconstruct the present pump station and facilities located on the project parcel. The project will involve the removal of obsolete utility poles, replacement of a 63 inch storm drain pipe, and reconstruction of the pump station facility. New pumping units, electrical utilities, and drainage pipes will be installed in the facility. The facility will not have any permanent piles beneath it, but will sit on a concrete slab which sits on the bay mud. This is intended to minimize the differential settlement between the pump station and the outfall pipe. The new facility is proposed to hold 292 cubic yards of water, as opposed to the current structure's 213 cubic yard capacity. The net change in ground coverage proposed by the project will be a gain of 15 square feet. A total of 617 cubic yards of soil are to be cut, while 305 cubic yards are to be filled, leaving 312 cubic yards of soil to be exported from the project area. The exported soils will remain on the parcel, on a spit peninsula. Sheet piles will be driven around the facility to prevent water from entering the new well during construction.

The project area will be accessible from a levee road connecting it to Francisco Boulevard East. The APE constitutes the entire parcel, which includes the pump station and the storm drain alignment. The eastern edge of the project area runs parallel to the Bay Trail. The vertical APE is expected to extend up to approximately ten feet below surface.

IV. BACKGROUND

As the significance of cultural resources is best assessed with regard to environmental and cultural contexts, descriptions of the natural and cultural setting of the project region are presented below.

Environment

The project area is situated within the Coast Range geologic province (Jenkins 1969). The northern Coast Ranges are a geologic province comprised of numerous rugged north-south trending ridges and valleys that run parallel to a series of faults and folds. Formation of these ranges is generally attributed to events associated with subduction of the Pacific Plate beneath the western border of North America. The bedrock that underlies the region is a complex assemblage of highly deformed, fractured, and weathered sedimentary, igneous, and metamorphic rocks. The bedrock geology of the project area consists of Jurassic-Cretaceous age Franciscan Formation rock (Schoenherr 1995:7). Rocks of this formation, the oldest in the area, are often weakly metamorphosed, and consist of greywacke shale interspersed with discontinuous bodies of ultramafic rock such as greenstone, schist, and serpentine. The repeated folding and faulting is reflected in the complex structure of Franciscan rocks and area topography (Schoenherr 1995:265).

The project area is situated on a wetland flat bordering the San Rafael Bay on the north side of the San Quentin Peninsula. The vegetation community surrounding the project area consists mainly of high grasses with sparse deciduous forest. Common hardwood trees in the region include California bay laurel (*Umbellularia californica*), Valley oak (*Quercus lobata*), Interior live oak (*Quercus wislizeni*), and Coast live oak (*Quercus agrifolia*). Softwoods include Coast redwood (*Sequoia sempervirens*) and Monterey pine (*Pinus radiata*). Throughout the North Coast Ranges, many trees imported into the region have thrived, particularly blue-gum eucalyptus *(Eucalyptus globulus*) (Little 1980). The project area is situated in the southern portion of highly-developed San Rafael. The parcel is surrounded on three sides by industrial parks and housing developments.

Figure 1. Vicinity Map

USGS 7.5' San Quentin Quad.
(2013 National Geographic Society)
T1N, R6W, Wetlands Area, MDBM

San Quentin Pump Station
Reconstruction Project
Shoreline Parkawy
San Rafael, CA

ALTA 2018-93
Map Date: 4/22/2019

Figure 2. Project Location


Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Figure 3. Area of Potential Effects

The vegetation community immediately surrounding the project area consists partly of salt marsh. Tidal marshes are defined by vascular plants, algal mats, and phytoplankton (Adam 1990; Mitsch and Gosselink 2000). These plants perform much of the primary production in these ecotones, which support animal and plant populations alike. Salt marsh ecotones are considered to have among the highest biodiversity of worldwide ecotones for their capacity to host both neighboring biotic communities and their own habitats. Salt marshes support numerous avian communities, providing essential cover for nesting (Wasson and Woolfolk 2011:1). These sensitive ecotones are often under threat of destruction. This threat is not manifested in coastal development alone, but also in grazing, pollution, and the effects of rising sea levels (Greenberg 2006:5-7).

Prehistory

The cultural chronology of the project area is within the overlapping areas of the North Coast Ranges chronologies and a multitude of Bay Area chronologies. Over half a century of archaeological investigations in the North Coast Ranges and the San Francisco Bay has revealed a record of hunter-gatherer occupation spanning over 10,000 years. A number of cultural chronologies have been developed for the North Coast Ranges (cf. Basgall 1982; Fredrickson and White 1988; Hildebrandt and Hayes 1984; Jones and Hayes 1993; Layton 1990; Meighan 1955; White and King 1993; White et al. 2002). Fredrickson's (1973, 1974) work in the North Coast Ranges provides a chronological basis upon which most studies in the region have worked, and is summarized below:

The *Paleo-Indian Period* (12000-8000 BP) is represented as a hunting adaptation characterized by large fluted projectile points. The *Lower Archaic Period* (8000-5000 BP) is distinguished by an emphasis on plant exploitation as evidenced by high frequencies of milling tools. The *Middle Archaic Period* (5000-3000 BP) is characterized by the introduction of mortar and pestle technology and the assumed exploitation of acorns. The *Upper Archaic Period* (3000-1500 BP) is represented growing social complexity marked by status differentiation, complex trade networks, and the development of "group oriented religious activities" (Fredrickson 1974:48). The *Emergent Period* (1500 BP-colonization) is marked by the use/introduction of bow and arrow technology, expansion of exchange relations, and the establishment of clearly defined territorial systems (Fredrickson 1973, 1974).

Meanwhile, three major taxonomic systems have been developed for the San Francisco Bay Area. These include (1) the Central California Taxonomic System, (2) the Archaic-Emergent Culture History Scheme, and (3) a Hybrid System that combines aspects of several schemes. The Central California Taxonomic System (CCTS) attempted to create *horizons* based on temporally diagnostic artifacts and mortuary customs (Beardsley 1948, 1954; Lillard et al. 1939; Gerow 1954). Three horizons were defined- Early, Middle, and Late. After the advent of radiocarbon dating technology in the 1950s, archaeologists attempted to test the relative sequence of the CCTS with chronometric dates (Fredrickson 1973, 1974; Heizer 1958; Ragir 1972). These studies found that the horizon system in the CCTS did not allow for regional and cultural inconsistencies, and overstated the relationship between region and temporal change in artifacts (White et al. 2002).

The Archaic-Emergent Culture History Scheme attempted to refine the variation of relative chronologies into defined cultural units. *Patterns* are basic economic/cultural adaptations that are bound geographically, as were the three horizons of CCTS. *Aspects* are smaller-scale variants of patterns, which represent regional adaptations and styles and are bound more temporally. *Phases* are smaller scale variants of aspects, based on similarities and differences within related artifact types and trends (Bennyhoff and Fredrickson 1969). This taxonomic system has largely defined Bay Area archaeology, and can be broken into four distinct patterns: the Borax Lake Pattern (8000-6000

BP), the Windmiller Pattern (6000-2000 BP), the Berkeley Pattern (6000-1500 BP), and the Augustine Pattern (1450-150 BP). These patterns define distinct temporal regional trends in diet, tool manufacture, trade, and ceremonial artifacts.

Later studies have advocated for a hybrid system that utilizes the Early-Middle-Late structure proposed in CCTS, while including cultural units of patterns, aspects and phases. These specific cultural units have been demonstrated through current shell bead chronology studies within the Bay Area, referred to as Dating Scheme D (Groza 2002; Groza et al 2011). Temporally distinct shell beads made of the purple olive snail (*Olivella spp.*) were widely traded beginning in the middle Holocene, extending as far as the central Great Basin. Because these are widely-distributed, relatively resilient organic artifacts, they have served as subjects for radiometric dating studies in order to solidify dates within relative chronologies throughout California and the Great Basin (e.g. Bennyhoff and Hughes 1987; Vellanoweth 2001). These radiometric studies have resulted in the development of relative and exact chronologies, known widely as *dating schemes.*

Dating Scheme D refines Bennyhoff and Hughes's (1987) Scheme B1, which itself refined Heizer's (1958) Scheme A. While Scheme A was based on radiocarbon dates from 17 samples, and Scheme B was based on 180 uncalibrated dates from varied artifacts, Scheme D is based on 140 radiocarbon dates from beads made of *Olivella* shells and radiometric dates from five mass bead-lots. Groza's work advanced the chronology of many bead types by as much as 200 years forward (Milliken et al. 2007). Scheme D has refined the chronology of certain beads into 200 to 300-year discrete time periods. These beads only represent units of time. Accordingly, they have no implications for cultures specifically, but are used to identify relative chronology. These units of time are referred to as *bead style horizons* (Groza et al. 2011:18). In the present investigation, we intend to use this hybrid system that adopts conventional terminology consistent with the Scheme D dating sequence, with bead style horizons labeled within the Early, Middle, and Late Periods and based on the bead type nomenclature established by Milliken et al. (2007) and Groza et al. (2011).

Ethnography

The Coast Miwok, who inhabited this region prior to European-American intrusion, were distributed across Sonoma and Marin Counties. The following ethnographic summary is not intended as a thorough description of Coast Miwok culture but instead is meant to provide a background to the present cultural resource investigation with specific references to the project area. In this section, the past tense is sometimes used when referring to native peoples because this is a historical study. This convention is not intended to suggest that Coast Miwok people only existed in the past. To the contrary, the Coast Miwok have strong cultural and social identities today.

The Coast Miwok were one of the California Penutian Language speaking groups and closely related to the Lake Miwok (Kelly 1978:414). The Coast Miwok occupied the northwest coast of California from the mouth of the Golden Gate in the south, to approximately 5 miles north of Bodega Bay in the north, to approximately 4 miles east of Sonoma Creek (Barrett 1908; Kelly 1978). Barrett (1908) divides Coast Miwok speakers into two distinct dialects: Western/Bodega and Southern/Marin.

The Coast Miwok followed a cyclical pattern of subsistence, exploiting resources that were available on a seasonal basis. The Coast Miwok had a diversified subsistence economy based on fishing, hunting and gathering with a particular dependence on acorns. Important marine resources included fish, eels, clams, mussels, and seaweed, while terrestrial resources included acorns, bear, deer, elk, and small game (Kelly 1978:416). The Coast Miwok had a rich culture of religion, ritual and dance, with music and games being a large part of their cultural expression. Birds were of particular importance (Kelly 1978).

The Coast Miwok were among the first California Native peoples to encounter Euro-Americans, meeting Sir Francis Drake in 1579. During the late eighteenth and early nineteenth century, many Coast Miwoks were subjected to missionization at San Francisco, San Rafael, and Sonoma, as well as labor at Fort Ross under the Russians (Milliken 1995). Many diseases swept through Marin Peninsula tribes, notable one in 1802, which decimated the Coast Miwok populations of that area (Milliken 1995:179). In 1850, a year after the end of the American conquest of California, the Coast Miwok population was estimated at 250 (Kelly 1978:414).

There were historically 44 recorded villages within the Coast Miwok territory, many of which provide present place names including Cotati, Petaluma and Olompali (Kelly 1978:415). Ethnographic accounts indicate that the Coast Miwok resided in large villages, each of which had a headman, but cannot be said to have a universal tribal organization. Milliken (1995) indicates that the project area lies in a border region between the *Habasto* tribal group. The *Habasto* occupied Point San Pedro, as well as valley lands to the north and south (Milliken 1995:242). The village of *awa'niwī* was located on the north side of the city of San Rafael (Barrett 1908:308). No ethnographically described villages are located within the project area.

History

Early Exploration

The earliest exploration of the Marin coast was possibly during Sir Francis Drake's 1579 voyage up and down the western coast of North America. He named northern California New Albion after his homeland, with the intent of securing the area for the British crown (Munro-Fraser 1880:18). The Spanish made a foray into the area in 1602 with three ships under the command of Don Sebastian Vizcaino. However, the definitive discovery of the San Francisco Bay did not occur until 1769, when the Portola-Crespi party arrived by land. The party became the first non-Native peoples to see the San Francisco Bay. By 1776, a military presidio and Catholic mission, San Francisco de Asís, were established. Mission San Rafael Arcángel was founded in 1817. Marin County is purported to be named after a Native American chieftain, who died at the San Rafael mission in 1834 (Munro-Fraser 1880:88).

Euro-American Settlement

The first permanent non-indigenous settlements in the area were made within the missions in San Francisco, which attracted those who would later claim the multiple land grants in Marin to the north. Mission San Rafael Arcángel was established in a valley where the City of San Rafael would develop in 1817. The mission was originally founded as a sanitarium for ailing Natives. The mission originally consisted of a church, hospital, monastery, and storehouses. The sanitarium became a full mission by 1928, but only flourished for another decade and was abandoned by 1846 (Krell 2012:296). The Gold Rush began in 1848 and brought a massive influx of prospectors to Marin County. San Rafael became a hub for supplies for the miners. Marin County was one of California's original 27 counties, created in 1850 by the State Legislature. The San Rafael post office was established in 1851 (Gudde 2004:343).

The project area is situated in wetlands between two historic-era ranchos- Rancho San Pedro, Santa Margarita y Las Gallinas to the north, and Rancho Punta de Quintin to the south. Under the Spanish and later Mexican government, large tracts of land (*ranchos*) were granted to claimants with a military service record and Mexican citizenship (Gates 1971:1). In 1844, Governor Manuel

Micheltorena granted Rancho San Pedro, Santa Margarita y Las Gallinas to Timothy Murphy. Murphy was an Irish employee of Hartnell and Company with Mexican citizenship. This rancho consisted of 21,679 acres. This land included Mission San Rafael Arcángel and points north, including land adjacent to the project area. In 1840, Governor Juan Bautista Alvarado granted John B.R. Cooper, a well-established Mexican citizen married to the Carrillo family, rights to Rancho Punta San Quentin. This 8,877 acre grant consisted of lands encompassing San Quentin, San Anselmo, Greenbrae, Kentfield, and southern portions of modern San Rafael (Beck and Haase 1974:29; Gudde 2004:343). After the conclusion of the Mexican American War, land grants were tried for validity under the Land Act of 1851 (Gates 1971:1). In 1856, Murphy's rancho was confirmed in full (Munro-Fraser 1880). Murphy died in 1853, and the rancho was split between family members. Cooper sold Rancho Punta de Quintin to Benjamin Buckelew, who filed with the Commission in 1853. The grant was confirmed in 1857 (Hoffman 1862)

The Northwest Pacific Railroad in San Rafael

The area of San Rafael grew rapidly starting with the gold rush. Afterward it became an important hub for the North Pacific Railroad transporting redwood lumber and other cargo throughout the latter half of the 1800s (Stindt 1964). The first railroad built in San Rafael was the San Rafael and San Quentin Railroad in the 1860s. This railroad was purchased by the North Pacific Railroad in 1869 and was quickly connected to Tomales. This railroad loaded up redwood lumber along the Mendocino Coast and transferred it to San Quentin Point where it was then loaded onto ferries bound for San Francisco (Stindt 1964:20). A line from Petaluma to San Rafael connected with this railroad by 1878. The San Francisco and San Rafael Railroad Company was established in 1882 for the purpose of building a railroad from San Rafael to Tiburon, which was completed in 1884. Tiburon officially became the southern terminus of the North Pacific Coast Railroad (Stindt 1964:22). Aside from cargo, passenger trains frequently traveled through San Rafael on their way to the San Francisco ferries. In 1875 the main line passenger terminal was shifted from Sausalito to San Quentin. The passenger trains took this route until 1884. The San Rafael Railroad became the North Pacific Coast Railroad by 1895 and remained so until 1906 when entire railroad system from Cazadero to San Quentin and Sausalito was incorporated into the Northwestern Pacific Railroad (Stindt 1964:49).

San Quentin State Prison

The San Quentin State Prison, located approximately one mile south of the project area, is one of the oldest prisons in the United States. The prison was established during the gold rush era in 1852 to handle the influx of crime that came along with the boom in population. Convicts built the prison over the next two years, with the prison containing 48 windowless cells meant to hold 250 inmates (Tikkanen 2017). The prison was under private management for the first eight years with inhumane living conditions and corrupt management. The state took the prison over in 1860. The inmates began publishing the *Wall City News* in the 1920s, a newspaper that was published within the walls of the prison into the 1950s (Tikkanen 2017).

Wetlands Reclamation

The shores of the San Francisco Bay have been subject to the continuous changes wrought by industrialization. Prior to industrialization, many current diked baylands were parts of tidal marshes surrounding the Bay. These wetlands covered over 10,000 acres (SFBCDC 1982:1-2). Mining up the Sacramento River beginning in the 1840s inundated the San Francisco Bay with sediments. Natural watersheds were dammed and diverted, reducing the amounts of freshwater available to salt marshes, and reducing the biodiversity of wetlands (SFBCDC 1892:2-3). In the twentieth century, wetlands along the shores of the Bay were diked and filled to create space for urban development. By 2006, 95 percent of Bay Area wetlands had been destroyed by diking and filling

(Sloan 2006:147). By 1982, about 3542 acres of former wetlands were owned by flood control districts, restructured to drain excess runoff in the event of heavy storms (SFBCDC 1982:2).

Archaeological Site Sensitivity Assessment

The project area has a low sensitivity for cultural resources. Historically, the project area was part of the waters of San Rafael bay. The area was diked and reclaimed during the mid-20th century as part of reclamation efforts (USGS 1956, 1960) (Figure 4). As such, there is a low sensitivity for encountering either prehistoric or historic-era archaeological resources.

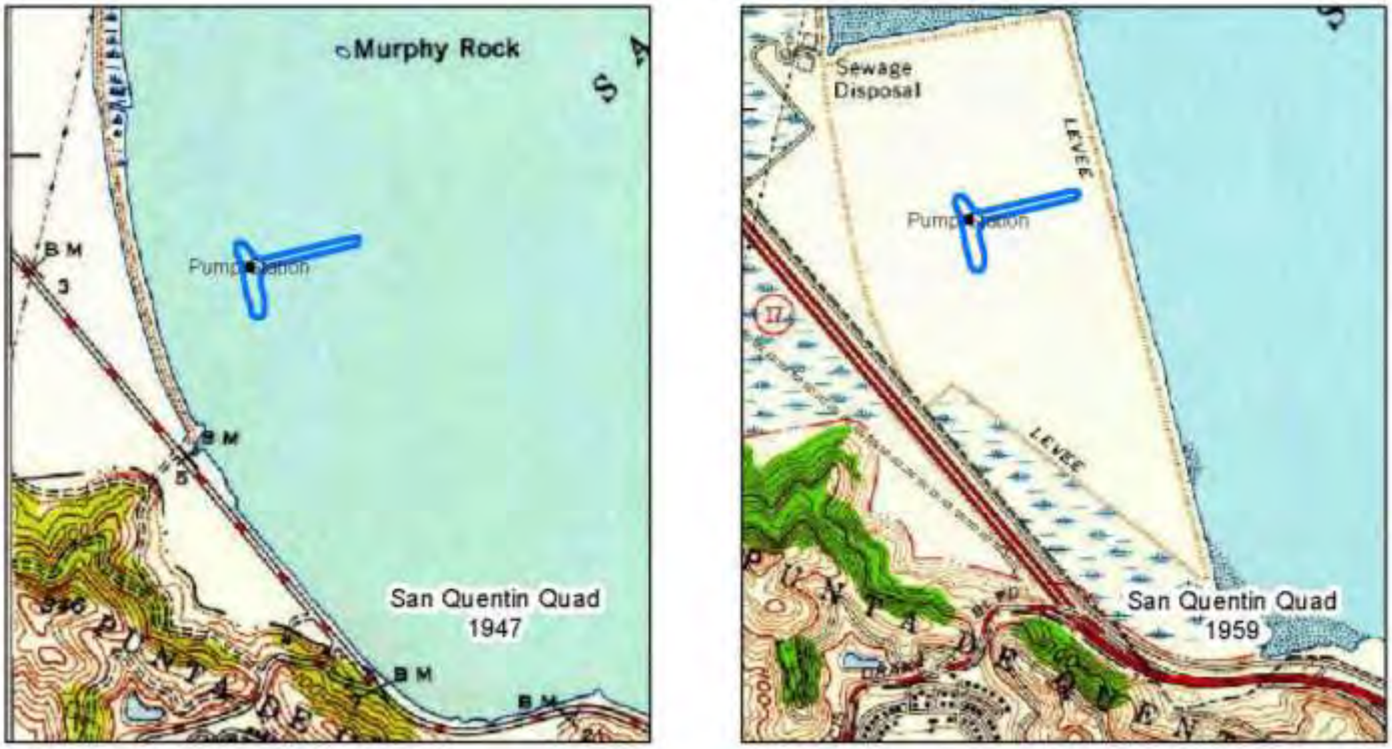

Figure 4. USGS 7.5' San Quentin Quadrangle, 1947 and 1959. 1:24,000 scale.

V. SOURCES CONSULTED

The records search and literature review for this study were done to: (1) determine whether known cultural resources had been recorded within or adjacent to the study area; and (2) to assess the likelihood of unrecorded cultural resources based on archaeological, ethnographic, historical documents and literature, and the environmental setting of nearby sites.

Records Search

On December 13, 2018, Marlene McVey, archaeologist with ALTA, conducted a records search (File Number 18-1121) at the Northwest Information Center (NWIC) located on the campus of Sonoma State University. The NWIC, an affiliate of the State of California Office of Historic Preservation, is the official state repository of archaeological and historical records and reports for an 18-county area that includes Marin County. The records search included a review of all study reports on file within a one-half mile radius of the project area. Sources consulted include

archaeological site and survey base maps, survey reports, site records, historic General Land Office (GLO) maps.
Included in the review were:

- *California Inventory of Historical Resources* (California Department of Parks and Recreation 1976)
- *California Historical Landmarks* for Marin County (CA-OHP 1990)
- California Points of Historical Interest (CA-OHP 1992)
- Historic Properties Directory Listing (CA-OHP April 2012)
- *Historic Properties Directory* includes the National Register of Historic Places (April 2012) of the California Historical Landmarks and California Points of Historical Interest

Review of historic registers and inventories indicate that no historical resources are present in the project area. No National Register listed or eligible properties are located within the 0.5-mile visual area of the APE.

A review of archaeological site and survey maps reveal that 36 cultural resources studies have been previously performed within a one-half mile radius of the current project area (Table 1). Approximately 20 percent of the one-half mile radius has been previously surveyed. There have been no previous cultural resource studies conducted within the project area.

Table 1. Summary of Previous Cultural Resource Studies within Search Radius

Report	Authors	Year	Report Title
S-001165	Cindy Desgrandchamp and Matthew Clark	1978	Pipeline and Water Treatment Plant Facilities, Marin County.
S-001668	Mark Rudo	1979	A Cultural Resources Reconnaissance Within the East San Rafael Baylands.
S-001896	David Chavez	1980	Archaeological Inspection of 1060 Andersen Drive - AP 18-181-35 and AP 18-143-07 (letter report).
S-002301		1980	Archaeological Resources on Point San Quentin
S-002301a		1980	Archaeological Resources on Point San Quentin: Report on Monitoring of Geological Test Borings and Preliminary Archaeological Testing
S-002860	David Chavez	1982	Proposed Roadway Extension Project on Andersen Drive (letter report).
S-006424	Cindy Desgrandchamp and David Chavez	1984	Archaeological Resources Evaluation for the Central Marin Sanitation Wastewater Transportation Facilities Improvement Project - Phase II, Marin County, California (EPA Project No. C-06-2467-21)
S-009125	Allan G. Bramlette	1987	Preliminary Cultural Resources Assessment for Planned Modification and Maintenance of San Rafael Creek in the Town of San Rafael, Marin County, California
S-010760	Terry Jones, Robert Gross, and Denise O'Connor	1989	Historic Properties Survey Report for Construction of High Occupancy Vehicle Lanes on Route 101 from Lucky Drive to San Pedro Road and Modifications of Routes 101/580 Interchange, in Cities of San Rafael and Larkspur, Marin County, 4-MRN-101, P.M. 8.4/12.7 04232-115750
S-010760a	Terry Jones	1989	Archaeological Survey Report for the Marin HOV Gap Closure, City of San Rafael, Marin County, California 4-MRN-101, P.M. 8.4/12.7 04232-115750
S-010760b	Denise O'Connor	1988	Historic Architectural Survey Report for Construction of High Occupancy Vehicle Lanes on Route 101 from Lucky Drive to San

Report	Authors	Year	Report Title
			Pedro Road and the Upgrading of the Route 101/580 Interchange 4-MRN-101, P.M. 8.4/12.7 04232-115750
S-010760c	Stephen D. Mikesell	1989	Historical Resources Evaluation Report, Northwestern Pacific Railroad Tracks Within Project APE, 4-MRN-101, P.M. 8.4/12.7 04232-115750
S-010760d		1999	Historic Property Survey Report for the Marin HOV Gap Closure, City of San Rafael, Marin County, California, 04-MRN-101, PM 8.4/12.7, 04-115750
S-010760e	Katherine M. Dowdall and Nelson B. Thompson	1999	First Addendum Positive Archaeological Survey Report for the Marin HOV Gap Closure, City of San Rafael, Marin County, California 04-MRN-101, PM 8.4/12.7 EA 4232-115750
S-010760f	Jeffrey A. Lindley and Daniel Abeyta	1999	FHWA990311B: Historic Property Survey Report; 04-MRN-101, PM 8.4/12.7. HOV Gap Closure, State Route 101, City of San Rafael, Marin County, California
S-010760g	Andrew Hope	1999	Addeundum Historic Property Survey Report, For the Marin-101 HOV Gap Closure Project, in the City of San Rafael, Marin County, 04-Mrn-101, P.M. 8.2/12.7, EA 4232-115750
S-012801		1991	Cultural Resources Technical Report, Municipal Water District Water Supply Project
S-012801a	Anmarie Medin	1991	An Archaeological Investigation of CA-MRN-80, San Rafael, Marin County, California (letter report)
S-012801b	Anmarie Medin	1991	An Archaeological Investigation of CA-MRN-151, Novato, Marin County, California (letter report)
S-013102		1982	Evaluation of a Buried Archaeological Site on the Central Marin Wastewater Management Treatment Plant Site, Clean Water Grant C-06-2467-110
S-016949	William Roop	1991	A Cultural Resources Evaluation of a Proposed Reclaimed Water Pipeline in the San Quentin Point, Corte Madera, Larkspur, Kentfield and San Rafael Areas
S-022013	Cassandra Chattan	1996	Results of Archaeological Monitoring at the Marin Recycling Center, Jacoby Street, San Rafael, California
S-026045	Richard Carrico, Theodore Cooley, and William Eckhardt	2000	Cultural Resources Reconnaissance Survey and Inventory Report for the Metromedia Fiberoptic Cable Project, San Francisco Bay Area and Los Angeles Basin Networks
S-027679	Elizabeth Bedolla	2003	Results of Archaeological Monitoring Program for Improvements to Jacoby Street, Located at the Marin Sanitary Service Property, San Rafael, Marin County, CA (ARS 03-037) (letter report)
S-037429	William Roop	2010	A Cultural Resources Evaluation of the Marin Sanitary Service Parcel, Jacoby Street, San Rafael, Marin County, California
S-037740	Theadora Fuerstenberg	2010	San Quentin Area Bike and Pedestrian Access Cultural and Paleontological Resources Constraints Study, near San Quentin State Prison, Marin County, California (LSA #ALT0903) (letter report)
S-043588	Lorna Billat	2013	Collocation Submission Packet, Kerner Blvd & Larkspur Street, CCU0654, 104 Windward Way, San Rafael, 94901
S-043588a	Dana Supernowicz	2013	Architectural Evaluation Study of the Kerner Boulevard & Larkspur Street Project, AT&T Mobility site # CCU0654, 104 Windward Way,San Rafael, Marin county, CA 94901
S-044351	Emily Darko	2014	Archaeological Survey Report for the Proposed Freeway Performance Initiative Project, Marin County, California, 04-MRN-101, PM 0.0/27.6, 04-MRN-580, PM 2.4/4.5, EA 151600
S-044351a	Emily Darko	2013	Extended Phase I Archaeological Testing at CA-MRN-157 (P-21-000182) and CA-MRN-4 (P-21-000035) for the Proposed Freeway Performance Initiative Project, Hwy 101 and 580, Marin County, 04-MRN-101, PM 0.0/27.6, 04-MRN-580, PM 2.4/4.5, EA 151600
S-048525	Madeline Bowen	2014	Historic Architectural Survey Report for the Sonoma-Marin Area Rail Transit (SMART) Rail Corridor, San Rafael to Larkspur Project, Marin County, California

Report	Authors	Year	Report Title
S-048942	Adrian R. Whitaker	2016	Historic Property Survey Report for the Richmond-San Rafael Bridge Access Improvement Project, Contra Costa and Marin Counties, California
S-048942a	Chandra Miller	2015	Historical Resources Evaluation Report for the Richmond-San Rafael Bridge Access Improvement Project, Contra Costa and Marin Counties, California 04-MRN-580-PM 0.03/3.16, 04-CC-580-PM-4.98/7.79, ID 0414000552; EA 04-2J6800
S-048942b	Adrian R. Whitaker, Michelle Rich, and Chandra Miller	2016	Archaeological Survey Report for the Richmond-San Rafael Bridge Access Improvement Project, Contra Costa and Marin Counties, California 04-MRN-580-PM 0.03/3.16, 04-CC-580-PM-4.98/7.79, ID 0414000552; EA 04-2J6800
S-048942c	Laura R. Murphy	2016	Extended Phase I Archaeological Report for the Richmond-San Rafael Bridge Access Improvement Project, Contra Costa and Marin Counties, California 04-MRN-580-PM 0.03/3.16, 04-CC-580-PM-4.98/7.79, ID 0414000552; EA 04-2J6800
S-048942d	Brett Rushing and Julianne Polanco	2016	FHWA_2016_0210_001 Determinations of Eligibility for the Proposed Richmond-San Rafael Bridge (28 0100) Access Improvement Project, Contra Costa and Marin Counties, CA

Four cultural resources are present within the one-half mile records search radius (Table 2). There are three prehistoric and one historic-era resources. No cultural resources are documented within the project area.

Table 2. Summary of Previous Cultural Resource Studies within Search Radius

Primary Number	Trinomial	Age	Resource Name
P-21-000458	CA-MRN-525	Prehistoric	
P-21-000529	CA-MRN-603	Prehistoric	
P-21-000536	CA-MRN-79	Prehistoric	Nelson No. 79
P-21-004111		Historic	PG&E Ignacio-San Rafael Electrical Tower # 09/49

Site P-21-000458 (CA-MRN-526) is a prehistoric chert quarry situated on a ridge. The site consists of the quarry and a lithic scatter of high quality chert flakes (Davoren 1982). The site is approximately 0.4 miles southwest of the project area.

Site P-21-000529 (CA-MRN-603) is a prehistoric midden site situated next to a spring. The site consists of a shallow shell midden with two projectile points, a few chert flakes and two faunal bones (Crew 1982). The site is approximately 0.25 miles southwest of the project area.

Site P-21-000536 (CA-MRN-79) is a prehistoric shell midden site situated beneath some oaks along a hillside. The site consists of a shell mound with a portion of a pestle on the surface (Nelson 1907). The site is approximately 0.4 miles south of the project area.

Site P-21-004111 is a historic-era PG&E electrical transmission tower situated on the bay flat adjacent to San Pablo Bay. The tower is Tower No. 09/49 of the PG&E Ignacio-San Rafael transmission line (Supernowicz 2013). The site is approximately 0.4 miles north of the project area.

Historic Map Review

Review of historic maps of the area was completed to better understand the timing of development within the project area and recognize historic features. The following historic maps and references were reviewed as part of this investigation.

Austin, H. and F. Whitney
1873 Map of Marin County California. 1:63,360 scale.

Board of Tide Land Commissioners
1870 Map No. 2 of Salt Marsh and Tide Lands Situated in the County of Marin. 1:7920 scale.

Dodge, George M.
1892 Marin County 1892 Wall Map, 1:48,000 scale.

United States Coast and Geodetic Survey
1948 San Pablo Bay Nautical Chart, 1:40,000 scale.
1957 Entrance to San Francisco Bay Nautical Chart, 1:40,000 scale.
1958 San Pablo Bay Nautical Chart, 1:40,000 scale.

United States Geological Survey
1895 San Francisco Topographic Map, 1:62,500 scale.
1899 San Francisco Topographic Map, 1:62,500 scale.
1915 San Francisco Topographic Map, 1:62,500 scale.
1947 San Quentin Topographic Map, 1:24,000 scale.
1959 San Quentin Topographic Map, 1:24,000 scale.
1960 San Quentin Topographic Map, 1:24,000 scale.
1973 San Quentin Topographic Map, 1:24,000 scale.
1980 San Quentin Topographic Map, 1:24,000 scale.
1993 San Quentin Topographic Map, 1:24,000 scale.
1995 San Quentin Topographic Map, 1:24,000 scale.

The earliest map of the area (BTLC 1870) shows the project area as part of the waters of San Rafael Bay. The San Quentin and San Rafael Railroad runs to San Quentin Point to the west along the historic coastline. By 1892, the project area is under the ownership of Mackay and Flood (Dodge 1892). Consistently, the project area is depicted underwater until land reclamation efforts began in 1958 (Austin and Whitney 1873; Dodge 1892; USGS 1948; USCGS 1948; 1957). By 1959, the USGS depicts the sea beyond the salt marshes as reclaimed land, adding a few miles of land to the east side of San Rafael (USGS 1959) (Figure 4). In addition, a sewage disposal plant is depicted to the northeast of the project area and the San Rafael Bridge was built (USGS 1959). In succeeding decades no substantive alterations are depicted within the project area (USGS 1973, 1980). By 1993, a road is present leading to the pump station (USGS 1993; 1995). The only structure depicted on the project parcel is the San Quentin Pump Station, which was built in 1971. This structure is not specifically depicted on any map sources.

Ethnographic Literature Review

Available ethnographic literature was reviewed to identify cultural resources in the project vicinity. The following sources were consulted.

Barrett, Samuel A.
1908 The Ethnogeography of the Pomo and Neighboring Indians. *University of California Publications in American Archaeology and Ethnology* 6(1):1-332.

Kroeber, A. L.
1925 Handbook of the Indians of California. *Bureau of American Ethnology* Bulletin 78. Government Printing Office, Washington D.C.

Kelly, Isabel
1978 Coast Miwok. In *Handbook of North American Indians Volume 8, California*. Smithsonian Institute, Washington.

Merriam, Clinton Hart
1907 Distribution and Classification of the Mewan Stock of California. *American Anthropologist* 9(2):338-357.

Milliken, Randall
1995 *A Time of Little Choice: The Disintegration of Tribal Culture in the San Francisco Bay Area 1769-1810*. Ballena Press Anthropological Papers No. 43, Menlo Park, CA.

Nelson, Nels C.
1909 Shellmounds of the San Francisco Bay Region. *University of California Publications in American Archaeology and Ethnology* 7(4):310-348.

Slaymaker, Charles M.
1982 A Model for the Study of Coast Miwok Ethnogeography. PhD dissertation, Department of Anthropology, University of California, Davis.

The Coast Miwok occupied the lands surrounding San Rafael (Barrett 1908:Map 1). The closest ethnographically described village to the project area is the village of *awa'niwī*, located on the north side of San Rafael approximately two miles northwest of the project area (Barrett 1908:309; Kelly 1978:415). The nearest resource identified in this review was plotted by Nelson (1909), who depicted a shell mound 0.5 miles to the southeast of the project area, on the northern shore of the San Quentin Peninsula near the modern intersection of Sir Francis Drake Boulevard and Interstate 580.

Native American Consultation

The Native American Heritage Commission (NAHC) was contacted via email to request a review of the Sacred Lands file and to request a list of Native American contacts in this area. The response letter dated March 4, 2019 by Steven Quinn (NAHC Staff Services Analyst) indicated that the search of the Sacred Lands File had a **positive** result. The NAHC response letter identified two Native

American individuals (Gene Buvelot and Greg Sarris) associated with the Federated Indians of the Graton Rancheria that may have knowledge of cultural resources within the project area.

Federated Indians of the Graton Rancheria
6400 Redwood Drive, Suite 300
Rohnert Park, CA 94928

On January 31, 2019 consultation letters were sent to both Native American individuals listed by the NAHC. In a letter dated February 28, 2019, Buffy McQuillen, Tribal Historic Preservation Officer with the Federated Indians of the Graton Rancheria, responded to state that the Tribe requests formal consultation for the project.

On April 23, 2019, Theo Sanchez, City of San Rafael, provided the draft Archaeological Survey Report to Buffy McQuillen for review and comment. Later that day, Buffy McQuillen replied by email to provided comments on the draft report.

On May 7, 2019, Alex DeGeorgey spoke with Buffy McQuillen over the phone to discuss her comments on the draft report. Buffy stated that the positive result for the Sacred Lands File are the prehistoric shell mound sites that are documented in the vicinity of the project area. No Sacred Sites are present within the project area proper. Buffy requested that the tribe be contacted if previously unidentified cultural resources are discovered during project implementation.

To date, no additional communications have been completed. Appendix B provides documentation of Native American correspondences.

VI. FIELD METHODS

ALTA staff archaeologists Sarah King Narasimha and Nicholas Radtkey conducted a field survey of the project on January 17, 2019. Project design drawing, project maps and aerial imagery were used to correctly identify the project area. Ground surface visibility was moderate (25-30%) due to dense seasonal grasses and imported gravel road fill. The entire APE and the access road was surveyed using intensive survey coverage with transects no greater than 10 meter intervals. A total of about 5.2 acres of land was surveyed (Figure 5). Digital photos were taken of the project area and surroundings (Attachment C). Survey efforts included an evaluation of the current pump station to determine historical and/or architectural significance.

VII. STUDY FINDINGS, REGULATORY CONTEXT, HISTORIC RESOURCE EVALUATION AND MANAGEMENT RECOMMENDATIONS

Study Findings

A cultural resources evaluation was conducted to satisfy requirements of Section 106 of the NHPA (36 CFR 800) to identify any archaeological, historical, or cultural resources located within the San Quentin Pump Station Project area. No cultural resources were identified within the project area as a result of the records search or literature review. Review of the Sacred Lands file by the NAHC identified the presence of a cultural resource within the project vicinity and recommended consultation with local tribes. During the archaeological field survey a historic-era pump station was identified. The structure was evaluated for eligibility for listing on the NRHP and/or the CRHR.

Figure 5. Survey Coverage

San Quentin Pump Station (Site 2018-93-01)

The San Quentin Pump Station was constructed in 1971. It is a single-level structure designed to pump excess storm water into the San Francisco Bay. This structure consists of a semi-subterranean water pumping apparatus, topped by a concrete ground-level platform with electrical apparatuses. The structure is primarily constructed of unpainted concrete, with steel chain link fencing built into the structure's upper level and painted steel apparatuses.

The greatest dimensions of this pump station are approximately 26 feet north to south by 33 feet east to west. The foundation of the structure sinks approximately 15 feet below ground level, to level with the marshlands to its west. From ground level, the structure stands approximately 12 feet above ground level, for a total height of approximately 27 feet. The wet well on the western side of the pump station drains water from the adjacent lagoon. This part of the structure measures 20 feet wide by 16 feet deep by 19 feet tall. The screen on this wet well is slanted at a 66 degree angle, and is made of galvanized steel bars. The wet well is emptied by two vertical pumps, which project six feet above the ground level platform. These pumps feed a concrete pressure vault. The pressure vault, located on the southwestern corner of the station, is a rectangular concrete tower. It measures six feet by six feet at its base, and stands ten feet above ground level. Most of the water pumping apparatus is buried. The pump station is connected to a buried 63 inch outfall pipe that leads approximately 1000 feet east before emptying into the Bay.

The platform surrounding the pump station consists of two sections. The primary section is composed of the ceiling of the wet well and the chamber leading to the pressure vault. An adjacent section of concrete platform wraps around the northeastern corner of the top of the wet well ceiling. This adjacent section houses two electrical utility boxes. One box contains controls for the pump station, while the other receives electricity from an adjacent power pole.

Regulatory Context

Federal and state criteria have been established for the determination of historical resource significance as defined in National Register (NR) criteria contained in National Register Bulletin 16 (U.S. Department of the Interior 1986:1) and for the purposes of CEQA under Section 5024.1(g) of the Public Resource Code and Section 15064.5 of the State CEQA Guidelines.

The NHPA applies to certain projects undertaken requiring approval by federal agencies. Property owners, planners, developers, as well as State and local agencies are responsible for complying with NHPA's requirements regarding the identification and treatment of historic and prehistoric cultural resources. Under NHPA, cultural resources must be evaluated to determine their eligibility for listing in the NR. If an archaeological resource is determined ineligible for listing on the NR, then the resource is released from management responsibilities and a project can proceed without further cultural resource considerations. Similarly, the CEQA applies to certain projects undertaken requiring approval by State and/or local agencies. Under CEQA, cultural resources must be evaluated to determine their eligibility for listing in the California Register of Historic Resources (CRHR). If a cultural resource is determined ineligible for listing on the CRHR the resource is released from management responsibilities and a project can proceed without further cultural resource considerations.

The San Quentin Pump Station was evaluated for eligibility for listing on the NRHP per the four criteria established in 36 CFR 60.4: Criteria for evaluation and for listing on the CRHR per Sections 15064.5 (b), 21083.2, and 21084.1 of the Public Resource Code (PRC) and the CEQA Guidelines (California Code of Regulations Title 14, Section 15064.5).

As set forth in Title 36, Part 63 of the Code of Federal Regulations, for a cultural resource to be deemed significant under the NHPA and thus eligible for listing on the NR, it must meet at least one of the following criteria:

> (A) associated with events that have made a significant contribution to the broad patterns of our history; or
> (B) associated with the lives of persons significant in our past; or
> (C) embodies distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
> (D) yielded, or may be likely to yield, information important in prehistory or history.

Furthermore, in order to be considered eligible for listing on the NR, a property must retain aspects of integrity, or its ability to convey its historical significance. These aspects are as follows: Location, Design, Setting, Materials, Workmanship, Feeling, and Association.

As set forth in Section 5024.1(c) of the Public Resources Code for a cultural resource to be deemed "important" under CEQA and thus eligible for listing on the California Register of Historic Resources (CRHR), it must meet at least one of the following criteria:

> (1) is associated with events that have made a significant contribution to the broad patterns of California History and cultural heritage; or
> (2) is associated with the lives of persons important to our past; or
> (3) embodies the distinctive characteristics of a type, period, region, or method of construction, or represents the work of an important creative individual, or possess high artistic value; or
> (4) has yielded or is likely to yield, information important to prehistory or history.

Archaeological resources are commonly evaluated with regard to Criteria D/4 (research potential). Historic-era structures older than 50 years are most commonly evaluated in reference to Criteria 1/A (important events), Criteria B/2 (important persons) or Criteria C/3 (architectural value). To be considered eligible under these criteria the property must retain sufficient integrity to convey its important qualities. Integrity is judged in relation to seven aspects including: location, design, setting, materials, workmanship, feeling, and association.

Historic Resource Evaluation

Historic Resource Evaluation of San Quentin Pump Station

The San Quentin Pump Station does not fulfill Criterion A/1 of the National Register Criteria for Evaluation or the California Register of Historical Resources Criteria for Designation. The pump station is associated with the reclamation of San Francisco Bay marshes and wetlands. This location is one of many wetlands reclaimed for urban development in the 20th century. However, these events are not significant enough to national, state, or regional history to associate the pump station with a pattern of history significant to the cultural heritage of the United States or California.

No documentation indicates the association of the pump station with significant local, state, or national persons. No architect or builder is known at present. Therefore, the pump station fails to fulfill Criterion B/2.

The pump station does not demonstrate aesthetic qualities that speak to an investment of artistic consideration in its design. Rather, the design qualities and construction qualities indicate a primary emphasis on functionality. The pump station does not represent a type, period, region, or method of construction. With these considerations, the pump station fails to fulfill Criterion C/3.

Considering its relatively recent construction and its location on relatively recently reclaimed land, the pump station and its vicinity are unlikely to yield any information important to the history of the region or the nation.

The integrity of the pump station has been damaged due to decades of use in a marine environment. Crumbling concrete and leaking pipes have impacted the station's structural integrity. The foundation of the pump station demonstrates vandalism through spray painting and chipping of concrete. Apparatuses on the pump station have been changed over the decades since its construction in 1971, including electrical utilities and enclosures, altering any potential historical appearance. Therefore, while the pump station retains the aspects of location and setting, continued alteration diminishes the aspects of design, materials, workmanship, feeling, and association.

In sum, the San Quentin Pump Station does not fulfill Criterion A/1 through D/4 of the National Register Criteria for Evaluation or the California Register of Historical Resources Criteria for Designation, nor does it retain enough integrity to convey its significance. This survey deems the pump station ineligible for inclusion on the National Register of Historic Places or the California Register of Historical Resources. Considering this evaluation, the project should be allowed to proceed without regulatory concerns relating to the pump station as a cultural resource.

Management Recommendations

We make the following recommendations to ensure that cultural resources are not adversely affected by the proposed project. The project should be allowed to proceed given the following recommendations.

Unanticipated Discovery of Cultural Resources

If previously unidentified cultural resources are encountered during project implementation, avoid altering the materials and their stratigraphic context. A qualified professional archaeologist should be contacted to evaluate the situation. The Federated Indians of the Graton Rancheria should be contacted to solicit their input with regard to proposed treatment and disposition of materials. Project personnel should not collect cultural resources. Prehistoric resources include, but are not limited to, chert or obsidian flakes, projectile points, mortars, pestles, and dark friable soil containing shell and bone dietary debris, heat-affected rock, or human burials. Historic resources include stone or abode foundations or walls; structures and remains with square nails; and refuse deposits or bottle dumps, often located in old wells or privies.

Encountering Native American Remains

Although unlikely, if human remains are encountered, all work must stop in the immediate vicinity of the discovered remains and the County Coroner and a qualified archaeologist must be notified immediately so that an evaluation can be performed. If the remains are deemed to be Native American and prehistoric, the Native American Heritage Commission must be contacted by the Coroner so that a "Most Likely Descendant" can be designated and further recommendations regarding treatment of the remains is provided.

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Attachment A – Records Search Results

ARCHAEOLOGICAL SURVEY REPORT
HISTORIC RESOURCE EVALUATION

SAN QUENTIN PUMP STATION
RECONSTRUCTION PROJECT
SHORELINE PARKWAY
SAN RAFAEL, MARIN COUNTY, CA

APN 009-010-25

Notice of Confidentiality:

Information in Attachment A discloses the location of sensitive cultural resources and is therefore confidential. Per California Government Code 6245 and 6245.10, as well as the National Historic Preservation Act of 1996 Section 304, the information in Attachment A has been removed to maintain confidentiality.

Attachment B – Native American Consultation

ARCHAEOLOGICAL SURVEY REPORT
HISTORIC RESOURCE EVALUATION

SAN QUENTIN PUMP STATION
RECONSTRUCTION PROJECT
SHORELINE PARKWAY
SAN RAFAEL, MARIN COUNTY, CA

APN 009-010-25

Confidential Information

This report contains confidential information. The distribution of material contained in this report is restricted to a need to know basis. To deter vandalism, artifact hunting, and other activities that can damage cultural resources, the location of cultural resources should be kept confidential. The provision protecting the confidentially of archaeological resources is in California Government Code 6245 and 6245.10, and the National Historic Preservation Act of 1996, Section 304.

Local Government Tribal Consultation List Request

Native American Heritage Commission
1550 Harbor Blvd, Suite 100
West Sacramento, CA 95691
916-373-3710
916-373-5471 – Fax
nahc@nahc.ca.gov

Type of List Requested

☒ **CEQA Tribal Consultation List (AB 52)** *– Per Public Resources Code § 21080.3.1, subs. (b), (d), (e) and 21080.3.2*

☐ **General Plan (SB 18)** *- Per Government Code § 65352.3.*

Local Action Type:

☐ **General Plan** ___ **General Plan Element** ___ **General Plan Amendment**

___ **Specific Plan** ___ **Specific Plan Amendment** ___ **Pre-planning Outreach Activity**

Required Information

Project Title: San Quentin Pump Station Replacement

Local Government/Lead Agency: City of San Rafael - Department of Public Works

Contact Person: Hunter Young, Senior Engineer

Street Address: 111 Morphew St

City: San Rafael, CA **Zip:** 94901

Phone: 415-485-3408 **Fax:**

Email: hunter.young@cityofsanrafael.org

Specific Area Subject to Proposed Action

County: Marin **City/Community:** San Rafael

Project Description:

The City of San Rafael is replacing the existing deteriorated San Quentin Pump Station. Project plans involve building a replacement station directly to the south of the existing station, minimizing disturbance to the surrounding wetlands and providing the benefit of the relatively large existing construction staging area with good access. The current station would be demolished after the new station becomes operational. Slip lining would then be used to improve the leaking and sagging discharge outfall pipe.

Additional Request

☒ **Sacred Lands File Search** - ***Required Information:***

USGS Quadrangle Name(s): San Quentin

Township: 1N **Range:** 6W **Section(s):** Wetlands Area, MDBM

STATE OF CALIFORNIA **Gavin Newsom, Governor**

NATIVE AMERICAN HERITAGE COMMISSION
Cultural and Environmental Department
1550 Harbor Blvd., Suite 100
West Sacramento, CA 95691 Phone: (916) 373-3710
Email: nahc@nahc.ca.gov
Website: http://www.nahc.ca.gov

March 4, 2019

Theo Sanchez
City of San Rafael – Department of Public Works

VIA Email to: theo.sanchez@cityofsanrafael.org

RE: Native American Tribal Consultation, Pursuant to the Assembly Bill 52 (AB 52), Amendments to the California Environmental Quality Act (CEQA) (Chapter 532, Statutes of 2014), Public Resources Code Sections 5097.94 (m), 21073, 21074, 21080.3.1, 21080.3.2, 21082.3, 21083.09, 21084.2 and 21084.3, San Quentin Pump Station Replacement Project, Marin County

Dear Mr. Sanchez:

Pursuant to Public Resources Code section 21080.3.1 (c), attached is a consultation list of tribes that are traditionally and culturally affiliated with the geographic area of the above-listed project. Please note that the intent of the AB 52 amendments to CEQA is to avoid and/or mitigate impacts to tribal cultural resources, (Pub. Resources Code §21084.3 (a)) ("Public agencies shall, when feasible, avoid damaging effects to any tribal cultural resource.")

Public Resources Code sections 21080.3.1 and 21084.3(c) require CEQA lead agencies to consult with California Native American tribes that have requested notice from such agencies of proposed projects in the geographic area that are traditionally and culturally affiliated with the tribes on projects for which a Notice of Preparation or Notice of Negative Declaration or Mitigated Negative Declaration has been filed on or after July 1, 2015. Specifically, Public Resources Code section 21080.3.1 (d) provides:

> Within 14 days of determining that an application for a project is complete or a decision by a public agency to undertake a project, the lead agency shall provide formal notification to the designated contact of, or a tribal representative of, traditionally and culturally affiliated California Native American tribes that have requested notice, which shall be accomplished by means of at least one written notification that includes a brief description of the proposed project and its location, the lead agency contact information, and a notification that the California Native American tribe has 30 days to request consultation pursuant to this section.

The AB 52 amendments to CEQA law does not preclude initiating consultation with the tribes that are culturally and traditionally affiliated within your jurisdiction prior to receiving requests for notification of projects in the tribe's areas of traditional and cultural affiliation. The Native American Heritage Commission (NAHC) recommends, but does not require, early consultation as a best practice to ensure that lead agencies receive sufficient information about cultural resources in a project area to avoid damaging effects to tribal cultural resources.

The NAHC also recommends, but does not require that agencies should also include with their notification letters, information regarding any cultural resources assessment that has been completed on the area of potential effect (APE), such as:

1. The results of any record search that may have been conducted at an Information Center of the California Historical Resources Information System (CHRIS), including, but not limited to:

    - A listing of any and all known cultural resources that have already been recorded on or adjacent to the APE, such as known archaeological sites;

    - Copies of any and all cultural resource records and study reports that may have been provided by the Information Center as part of the records search response;

    - Whether the records search indicates a low, moderate, or high probability that unrecorded cultural resources are located in the APE; and

    - If a survey is recommended by the Information Center to determine whether previously unrecorded cultural resources are present.

2. The results of any archaeological inventory survey that was conducted, including:

    - Any report that may contain site forms, site significance, and suggested mitigation measures.

      All information regarding site locations, Native American human remains, and associated funerary objects should be in a separate confidential addendum, and not be made available for public disclosure in accordance with Government Code section 6254.10.

3. The result of any Sacred Lands File (SLF) check conducted through the NAHC was positive. Please contact the Federated Indians of Graton Rancheria on the attached list for more information.

4. Any ethnographic studies conducted for any area including all or part of the APE; and

5. Any geotechnical reports regarding all or part of the APE.

Lead agencies should be aware that records maintained by the NAHC and CHRIS are not exhaustive and a negative response to these searches does not preclude the existence of a tribal cultural resource. A tribe may be the only source of information regarding the existence of a tribal cultural resource.

This information will aid tribes in determining whether to request formal consultation. In the event that they do, having the information beforehand will help to facilitate the consultation process.

If you receive notification of change of addresses and phone numbers from tribes, please notify the NAHC. With your assistance, we can assure that our consultation list remains current.

If you have any questions, please contact me at my email address: steven.quinn@nahc.ca.gov.

Sincerely,

Steven Quinn

Steven Quinn
Associate Governmental Program Analyst

Attachment

Native American Heritage Commission
Native American Contacts List
3/4/2019

Federated Indians of Graton Rancheria
Gene Buvelot
6400 Redwood Drive, Ste 300
Rohnert Park ,CA 94928
gbuvelot@gratonrancheria.com
(415) 279-4844 Cell
(707) 566-2288 ext 103

Coast Miwok
Southern Pomo

Federated Indians of Graton Rancheria
Greg Sarris, Chairperson
6400 Redwood Drive, Ste 300
Rohnert Park ,CA 94928
gbuvelot@gratonrancheria.com
(707) 566-2288 Office
(707) 566-2291 Fax

Coast Miwok
Southern Pomo

This list is current as of the date of this document and is based on the information available to the Commission on the date it was produced.

Distribution of this list does not relieve any person of statutory responsibility as defined in Section 7050.5 of the Health and Safety Code,Section 5097.94 of the Public Resources Code, or Section 5097.98 of the Public Resources Code.

This list is only applicable for contacting local Native American Tribes for the proposed:
San Quentin Pump Station Replacement Project.

FEDERATED INDIANS OF
GRATON
RANCHERIA

Submitted via electronic email: Theo Sanchez (theo.sanchez@cityofsanrafael.org)

February 28, 2019

RE: Formal Request for Tribal Consultation Pursuant to the California Environmental Quality Act (CEQA), Public Resources Code section 21080.3.1, subds. (b), (d) and (e) for the San Quentin Pump Station Replacement Project in San Rafael, APN 009-010-25, adjacent to Target property at 123 Shoreline Pkwy, San Rafael.

Dear Agency Representative:

This letter constitutes a formal request for tribal consultation under the provisions of the California Environmental Quality Act (CEQA) (Public Resources Code section 21080.3.1 subdivisions (b), (d) and (e) for the mitigation of potential project impacts to tribal cultural resource for a project within the Federated Indians of Graton Rancheria's ancestral lands.

Receiving this letter sets forth the Tribe's formal request for consultation on the following topics checked below, which shall be included in consultation if requested (Public Resources Code section 21080.3.2, subd. (a):

___x__ Alternatives to the project
___x__ Recommended mitigation measures
___x__ Significant effects of the project

The Tribe also requests consultation on the following discretionary topics checked below (Public Resources Code section 21080.3.2, subd. (a):

___x__ Type of environmental review necessary
___x__ Significance of tribal cultural resources, including any regulations, policies or standards used by your agency to determine significance of tribal cultural resources
___x__ Significance of the project's impacts on tribal cultural resources
___x__ Project alternatives and/or appropriate measures for preservation or mitigation that we may recommend, including, but not limited to:

(1) Avoidance and preservation of the resources in place, pursuant to Public Resources Code section 21084.3, including, but not limited to, planning and construction to avoid the resources and protect the cultural and natural context, or planning greenspace, parks or other open space, to incorporate the resources with culturally appropriate protection and management criteria;
(2) Treating the resources with culturally appropriate dignity taking into account the tribal cultural values and meaning of the resources, including but not limited to the following:

a. Protecting the cultural character and integrity of the resource;
b. Protection the traditional use of the resource; and
c. Protecting the confidentiality of the resource.

(3) Permanent conservation easements or other interests in real property, with culturally Appropriate management criteria for the purposes of preserving or utilizing the resources or places.

(4) Protecting the resource.

Additionally, the Tribe would like to receive any cultural resources assessments or other assessments that have been completed on all or part of the project's potential "area of project effect" (APE), including, but not limited to:

1).The results of any record search(es) conducted at an archaeological information center of the California Historical Resources Information System (CHRIS), including, but not limited to:

   (a) Any known cultural resources that have already been recorded on or adjacent to the potential APE;
   (b) Whether the probability is low, moderate or high that cultural resources are located in the potential APE; and
   (c) If a survey is required to determine whether previously unrecorded cultural resources are present in the potential APE.

2). The results of any archaeological inventory survey that was conducted of all or part of the potential APE, including, but not limited to:

   (a) Any report that may contain site forms, site significance, and suggested mitigation measures.

3). The results of any Sacred Lands File searches conducted through the Native American Heritage Commission for all or part of the potential APE;
4). Any ethnographic studies conducted for any area including all or part of the potential APE; and

5) Any geotechnical reports regarding all or part of the potential APE.

We would like to remind your agency that CEQA Guidelines section 15126.4, subdivision (b)(3) states that preservation in place is the preferred manner of mitigating impacts to archaeological sites. Section 15126.4, subd. (b)(3) of the CEQA Guidelines has been interpreted by the California Court of Appeal to mean that "feasible preservation in place must be adopted to mitigate impacts to historical resources of an archaeological nature unless the lead agency determines that another form of mitigation is available and provides superior mitigation of impacts." *Madera Oversight Coalition v. County of Madera* (2011) 199 Cal.App.4th 48, disapproved on other grounds, *Neighbors for Smart Rail v. Exposition Metro Line Construction Authority* (2013) 57 Cal.4th 439.

The Tribe would like to begin consultation within 30 days of your receipt of this letter. Please contact my office at (707) 566-2288 or by email at bmcquillen@gratonrancheria.com as the person who will serve as the lead contact on behalf of the Tribe.

Sincerely,

Buffy McQuillen

Buffy McQuillen, THPO/NAGPRA
Federated Indians of Graton Rancheria

Attachment C – Photo Sheet

ARCHAEOLOGICAL SURVEY REPORT
HISTORIC RESOURCE EVALUATION

SAN QUENTIN PUMP STATION
RECONSTRUCTION PROJECT
SHORELINE PARKWAY
SAN RAFAEL, MARIN COUNTY, CA

APN 009-010-25

Confidential Information

This report contains confidential information. The distribution of material contained in this report is restricted to a need to know basis. To deter vandalism, artifact hunting, and other activities that can damage cultural resources, the location of cultural resources should be kept confidential. The provision protecting the confidentially of archaeological resources is in California Government Code 6245 and 6245.10, and the National Historic Preservation Act of 1996, Section 304.

TH000067, view northwest, 1/17/2019: View of the southeast corner of pump station.

TH000069, view southwest, 1/17/2019: View of the northeast corner of pump station.

TH000071, view southeast, 1/17/2019: View of northwest corner of pump station.

TH000073, view northeast, 1/17/2019: view of the southwest corner of the pump station.

TH000075, view northwest, 1/17/2019: Overview of pump station, utility pole and lagoon.

TH000079, view west, 1/17/2019: Overview of access road which covers storm drain pipe.

TH000081, view east, 1/17/2019: Overview of outfall pipe access and bay water disturbance.

TH000083, northeast, 1/17/2019: Overview of southern access road to pump station from Francisco Blvd.

Attachment D – Site Record

ARCHAEOLOGICAL SURVEY REPORT
HISTORIC RESOURCE EVALUATION

SAN QUENTIN PUMP STATION
RECONSTRUCTION PROJECT
SHORELINE PARKWAY
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State of California The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
PRIMARY RECORD

Primary #
HRI #
Trinomial
NRHP Status Code: 6Z
Other Listings
Review Code
Reviewer Date

Page 1 **of** 6 ***Resource Name or #:** 2018-93-01

P1. Other Identifier: San Quentin Pump Station

***P2. Location:** ☐ **Not for Publication** ☒ **Unrestricted**

***a. County:** Marin
***b. USGS 7.5' Quad:** San Quentin **Date:** 2015 **T**1N; **R**6W; Unsectioned portion of wetlands; Mount Diablo **B.M.**
c. Address: 1597 Francisco Boulevard East City: San Rafael Zip
d. UTM: 10N 544527 mE/ 4201093 mN
e. Other Locational Data: From the intersection of Bellam Boulevard and Francisco Boulevard East, drive south for approximately 0.8 miles. Turn left onto an unmarked road immediately north of 1599 Francisco Boulevard East. Follow this road along the marsh lands for 0.4 miles.

***P3a. Description:** The San Quentin Pump Station is a single-level structure designed to pump excess storm water into the San Francisco Bay. This structure consists of a semi-subterranean water pumping apparatus, topped by a concrete ground-level platform with electrical apparatuses. The structure is primarily constructed of unpainted concrete, with steel chain link fencing built into the structure's upper level and painted steel apparatuses. *(See Continuation Sheet, page 4)*

***P3b. Resource Attributes:** HP9. Public Utility Building

***P4. Resources Present:** ☐ Building ☒ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5a. Photograph

P5b. Description of Photo: View southeast, 01/17/2018, TH000071. Overview of pump station.

***P6. Date Constructed/Age and Source:**
☒ Historic: 1971

***P7. Owner and Address:**
City of San Rafael
1400 Fifth Avenue
San Rafael, CA 94901

***P8. Recorded by:**
Nicholas Radtkey, B.A.
Sarah King Narasimha, M. Phil.
Alta Archaeological Consulting
15 Third Street
Santa Rosa, CA 95401

***P9. Date Recorded:**
01/17/2018

***P10. Survey Type:** Intensive, 10m intervals

***P11. Report Citation**:
DeGeorgey, Alex, Sarah King Narasimha, and Nicholas Radtkey
2019 Archaeological Survey Report and Historic Resource Evaluation for San Quentin Pump Station Reconstruction Project, Shoreline Parkway, San Rafael, Marin County, CA. Manuscript on file at the Northwest Information Center of the California Historic Resources Inventory System.

***Attachments:** ☐NONE ☒Location Map ☒Continuation Sheet ☒Building, Structure, and Object Record ☐Archaeological Record ☐District Record ☐Linear Feature Record ☐Milling Station Record ☐Rock Art Record ☐Artifact Record ☐Photograph Record ☐ Other (List):

BUILDING, STRUCTURE, AND OBJECT RECORD

B1. Historic Name: Unknown.
B2. Common Name: San Quentin Pump Station.
B3. Original Use: Removal of overflow water from marshlands. B4. Present Use: Same.

***B5. Architectural Style:** Unknown.

***B6. Construction History:** The pump station was built in 1971 to drain the artificially constructed wetlands east of Shoreline Parkway (Guerin 2018). Electrical apparatuses on this structure appear to have been replaced within the last 10 years.

***B7. Moved?** ☒No ☐Yes ☐Unknown **Date:** NA **Original Location:** NA
***B8. Related Features:** None.

B9a. Architect: Unknown. b. Builder: Unknown.
***B10. Significance:** Urban development. **Theme:** Wetland reclamation **Area:** Marin County
Period of Significance: 1970s **Property Type:** Structure **Applicable Criteria:** NA.

Historical Context

The shores of the San Francisco Bay have been subject to the continuous changes wrought by industrialization. Prior to industrialization, many current diked baylands were parts of tidal marshes surrounding the Bay. These wetlands covered over 10,000 acres (SFBCDC 1982:1-2). Mining up the Sacramento River beginning in the 1840s inundated the San Francisco Bay with sediments. Natural watersheds were dammed and diverted, reducing the amounts of freshwater available to salt marshes, and reducing the biodiversity of wetlands (SFBCDC 1982:2-3). In the twentieth century, wetlands along the shores of the Bay were diked and filled to create space for urban development. By 2006, 95 percent of Bay Area wetlands had been destroyed by diking and filling (Sloan 2006:147). By 1982, about 3542 acres of former wetlands were owned by flood control districts, restructured to drain excess runoff in the event of heavy storms (SFBCDC 1982:2). (*See Continuation Sheet, page 4)*

B11. Additional Resource Attributes: HP9. Public Utility Building

***B12. References:**

Guerin, Bill
2018 San Rafael City Council Agenda Report. Electronic document: http://cityofsanrafael.granicus.com/MetaViewer.php?view_id=38&event_id=1101&meta_id=131083, accessed 16 January 2019.

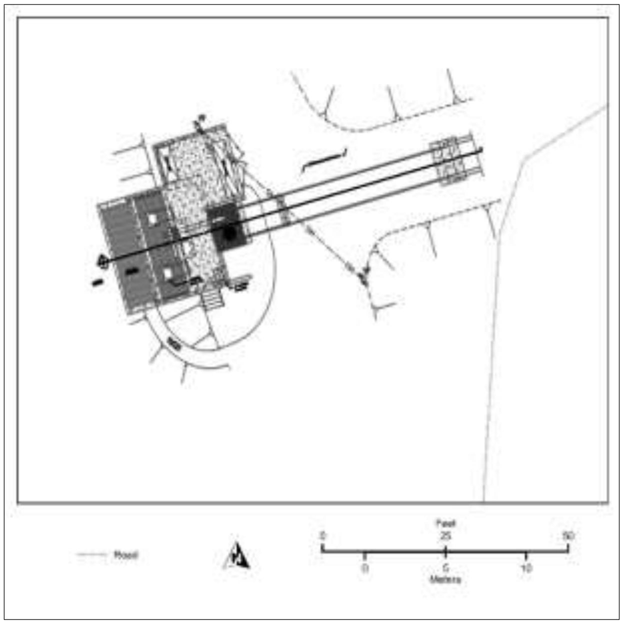
San Francisco Bay Conservation and Development Commission (SFBCDC)
1982 Diked Historic Baylands of San Francisco Bay. Staff Report.

Sloan, Doris
2006 *Geology of the San Francisco Bay Region.* California Natural History Guides 79. University of California Press, Berkeley.

B13. Remarks: None.

***B14. Evaluator:** Nicholas Radtkey, B.A.
***Date of Evaluation:** 01/14/2018.

(This space reserved for official comments.)

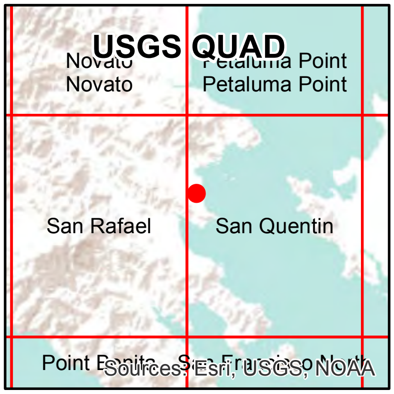


State of California -- The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
LOCATION MAP

Primary #
HRI #
Trinomial

Page 3 of 6

*Resource Name or #: 2018-93-01



QUAD: San Quentin 2013 (National Geographic Society)
T1N, R6W, Unsectioned portion Mount Diablo Base Meridan

N
1:24,000
Miles
0 0.25 0.5 1
0 0.25 0.5 1
Kilometers

ARCHAEOLOGICAL CONSULTING

Map Date: 3/4/2019

DPR 523J (1/95)

***Required Information**

Page 4 of 6 *__Resource Name or #__: 2018-93-01

***Recorded by:** N. Radtkey; S. King Narasimha ***Date:** 01/17/2018 ☒ Continuation ☐Update

P3a. Description (continued from page 1)

The greatest dimensions of this pump station are approximately 26 feet north to south by 33 feet east to west. The foundation of the structure sinks approximately 15 feet below ground level, to level with the marshlands to its west. From ground level, the structure stands approximately 12 feet above ground level, for a total height of approximately 27 feet. The wet well on the western side of the pump station drains water from the adjacent lagoon. This part of the structure measures 20 feet wide by 16 feet deep by 19 feet tall. The screen on this wet well is slanted at a 66 degree angle, and is made of galvanized steel bars. The wet well is emptied by two vertical pumps, which project six feet above the ground level platform. These pumps feed a concrete pressure vault. The pressure vault, located on the southwestern corner of the station, is a rectangular concrete tower. It measures six feet by six feet at its base, and stands ten feet above ground level. Most of the water pumping apparatus is buried.

The platform surrounding the pump station consists of two sections. The primary section is composed of the ceiling of the wet well and the chamber leading to the pressure vault. An adjacent section of concrete platform wraps around the northeastern corner of the top of the wet well ceiling. This adjacent section houses two electrical utility boxes. One box contains controls for the pump station, while the other receives electricity from an adjacent power pole.

The pump station is connected to a buried 63 inch HDPE outfall pipe that leads approximately 1000 feet east before emptying into the ocean.

B10. Significance (continued from page 2)

Statement of Significance

The San Quentin Pump Station does not fulfill Criterion A/1 of the National Register Criteria for Evaluation or the California Register of Historical Resources Criteria for Designation. The pump station is associated with the reclamation of San Francisco Bay marshes and wetlands. This location is one of many wetlands reclaimed for urban development in the 20th century. However, these events are not significant enough to national, state, or regional history to associate the pump station with a pattern of history significant to the cultural heritage of the United States or California.

No documentation indicates the association of the pump station with significant local, state, or national persons. No architect or builder is known at present. Therefore, the pump station fails to fulfill Criterion B/2.

The pump station does not demonstrate aesthetic qualities that speak to an investment of artistic consideration in its design. Rather, the design qualities and construction qualities indicate a primary emphasis on functionality. The pump station does not represent a type, period, region, or method of construction. With these considerations, the pump station fails to fulfill Criterion C/3.

Considering its relatively recent construction and its location on relatively recently reclaimed land, the pump station and its vicinity are unlikely to yield any information important to the prehistory or history of the region or the nation.

The integrity of the pump station has been damaged through neglect and alteration. Crumbling concrete and leaking pipes have impacted the station's structural integrity. The foundation of the pump station demonstrates vandalism through spray painting and chipping of concrete. Apparatuses on the pump station have been changed over the decades since its construction in 1971, including electrical utilities and enclosures, altering any potential historical appearance. Therefore, while the pump station retains the aspects of location and setting, continued alteration diminishes the aspects of design, materials, workmanship, feeling, and association.

In sum, the San Quentin Pump Station does not fulfill Criterion A/1 through D/4 of the National Register Criteria for Evaluation or the California Register of Historical Resources Criteria for Designation, nor does it retain enough integrity to convey its significance. This survey deems the pump station *ineligible* for inclusion on the National Register of Historic Places or the California Register of Historical Resources.

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Primary#
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CONTINUATION SHEET

Page 5 of 6 ***Resource Name or #**: 2018-93-01

***Recorded by:** N. Radtkey; S. King Narasimha ***Date:** 01/17/2018 ☒ Continuation ☐Update

TH000067, view northwest, 1/17/2019: View of the southeast corner of pump station.

TH000069, view southwest, 1/17/2019: View of the northeast corner of pump station.

State of California ♁ Natural Resources Agency
DEPARTMENT OF PARKS AND RECREATION

Primary#
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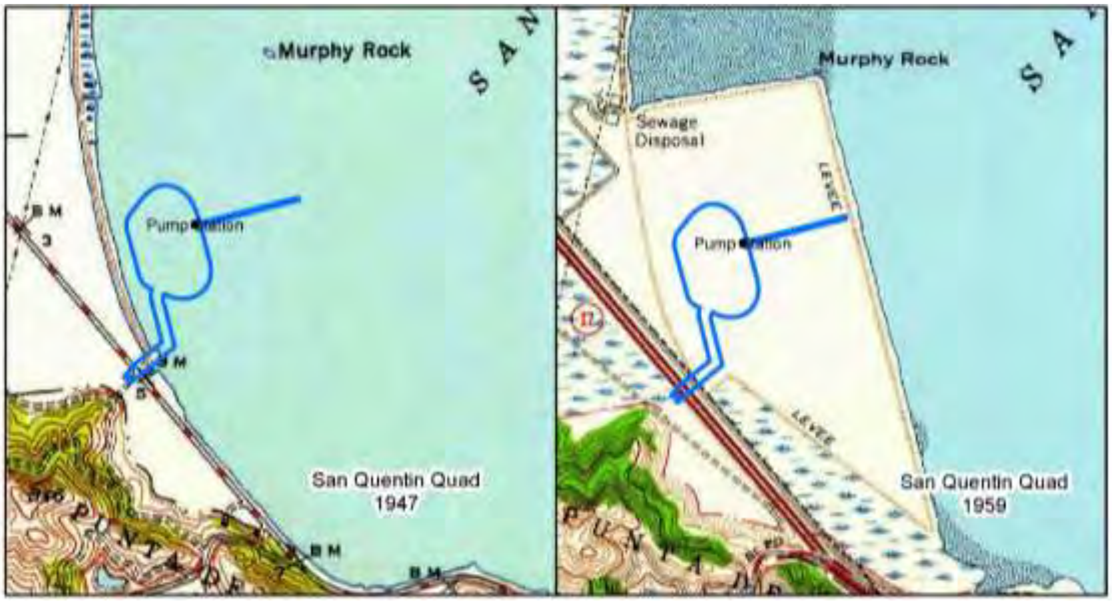
CONTINUATION SHEET

Page 6 of 6 ***Resource Name or #**: 2018-93-01
***Recorded by:** N. Radtkey; S. King Narasimha ***Date:** 01/17/2018 ☒ Continuation ☐Update

TH000073, view northeast, 1/17/2019: view of the southwest corner of the pump station.



USGS 7.5' San Quentin Quadrangle, 1956 and 1960. Blue polygon depicts present parcel boundary. 1:24,000 scale.

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