TISCORNIA MARSH HABITAT RESTORATION AND SEA LEVEL RISE ADAPTATION PROJECT

Draft Environmental Impact Report
SCH # 2021020362
City Case No. UP21-001, ED21-002, IS21-001
Canal Street/Spinnaker Point Drive

Prepared for
City of San Rafael

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ACRONYMS AND ABBREVIATIONS

$\mu g/m^3$	micrograms per cubic meter
µPa	microPascal
AADT	average annual daily traffic
AB	Assembly Bill
AB 32 Scoping Plan	Climate Change Scoping Plan
ABAG	Association of Bay Area Governments
Alquist-Priolo Act	Alquist-Priolo Earthquake Fault Zoning Act
APN	Assessor's Parcel Number
ARB	California Air Resources Board
BAAQMD	Bay Area Air Quality Management District
BACT	best available control technology
BASMAA	Bay Area Stormwater Management Agencies Association
Bay	San Rafael Bay
Bay Trail	San Francisco Bay Trail
BayWAVE	Marin Bay Waterfront Adaptation Vulnerability Evaluation
BCDC	San Francisco Bay Conservation and Development Commission
BERD	Built Environment Resources Directory
BFE	base flood elevation
BMP	best management practice
CAAQS	California ambient air quality standards
CAL FIRE	California Department of Forestry and Fire Protection
CalEEMod	California Emissions Estimator Model
California Register	California Register of Historical Resources
Caltrans	California Department of Transportation
CAP	criteria air pollutant
CARB	California Air Resources Board
CCAP	Climate Change Action Plan
CCAP 2030	Final Draft Climate Change Action Plan 2030
CCR	California Code of Regulations
CDFW	California Department of Fish and Wildlife
CDPR	California Department of Pesticide Regulation
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CGS	California Geological Survey

CHP	California Highway Patrol
CHRIS	California Historical Resources Information System
City	City of San Rafael
CNDDB	California Natural Diversity Database
CNEL	Community Noise Equivalent Level
CNPS	California Native Plant Society
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
Commission	City of San Rafael Planning Commission
CRPR	California Rare Plant Rank
CWA	Clean Water Act
CY	cubic yards
dB	decibels
dBA	A-weighted decibels
DOC	California Department of Conservation
DOI	U.S. Department of the Interior
DPM	diesel particulate matter
DPR	California Department of Pesticide Regulation
DPS	Distinct Population Segment
DTSC	California Department of Toxic Substances Control
DWR	California Department of Water Resources
EIR	environmental impact report
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESA	Environmental Science Associates
ESCP	Erosion and Sediment Control Plan
FEMA	Federal Emergency Management Agency
FESA	federal Endangered Species Act
FHWA	Federal Highway Administration
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FIRM	Flood Insurance Rate Mapping
FMMP	Farmland Mapping and Monitoring Program
FR	Federal Register
Friant Ranch Case	*Sierra Club v. County of Fresno* case
FTA	Federal Transit Administration
FWCA	Fish & Wildlife Coordination Act
g/s	gram(s) per second
GE	geotechnical engineer
General Plan 2020	*The City of San Rafael General Plan 2020*
GHG	greenhouse gas

GIS	geographic information system
GPS	global positioning system
GWP	global warming potential
HMBP	Hazardous Materials Business Plan
HMRT	Hazardous Materials Response Team
HRA	health risk assessment
Hz	Hertz
IPaC	Information for Planning and Consultation
IPCC	Intergovernmental Panel on Climate Change
ISP	Invasive Spartina Project
LCFS	Low Carbon Fuel Standard
L_{dn}	day-night average sound level
L_{eq}	energy-equivalent sound level
LGP	low ground pressure
LID	Low-Impact Development
L_{max}	instantaneous maximum noise level
LRA	Local Responsibility Area
LSAA	Lake or Streambed Alteration Agreement
LSM	Less than Significant with Mitigation significance determination
LTS	Less than Significant significance determination
MAS	Marin Audubon Society
MBTA	Migratory Bird Treaty Act
MCSTOPP	Marin County Stormwater Pollution Prevention Program
MEIR	maximally exposed individual receptor
MHW	mean high water
MLD	Most Likely Descendant
MMRP	mitigation monitoring and reporting program
MMWD	Marin Municipal Water District
Mph	miles per hour
MS4	municipal separate storm sewer system
MTAC	Metropolitan Transportation Commission
MTL	mean tide level
NAAQS	National Ambient Air Quality Standards
NAHC	Native American Heritage Commission
National Register	National Register of Historic Places
NAVD88	North American Vertical Datum of 1988
NBWA	North Bay Watershed Association
NI	No Impact significance determination
NLD	National Levee Database
NMFS	National Marine Fisheries Service
NO	nitric oxide

NO_2	nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
Non-VHFHSZ	Non-Very High Fire Hazard Severity Zone
NOP	notice of preparation
NO_X	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NPPA	California Native Plant Protection Act
NRCS	Natural Resources Conservation Service
NWIC	Northwest Information Center
OEHHA	Office of Environmental Health Hazard Assessment
PG&E	Pacific Gas and Electric Company
PM	particulate matter
PM_{10}	particulate matter 10 microns or less in diameter
$PM_{2.5}$	particulate matter 2.5 microns or less in diameter
Ppm	parts per million
PPV	peak particle velocity
PRC	Public Resources Code
Project, Proposed Project	Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation Project
PSD	Prevention of Significant Deterioration
RCNM	Roadway Construction Noise Level
RMS	root mean square
ROG	reactive organic gases
RWQCB	Regional Water Quality Control Board
SB	Senate Bill
SCWA	Sonoma County Water Agency
SEL	sound exposure level
SFBAAB	San Francisco Bay Area Air Basin
SO_2	sulfur dioxide
SR	State Route
SRCS	San Rafael City Schools
STRAW	Students and Teachers Restoring a Watershed
SU	Significant and Unavoidable significance determination
SUSUMP	Standard Urban Stormwater Management Plans
SVP	Society of Vertebrate Paleontology
SWL	still water elevation level
SWPPP	Stormwater Pollution Prevention Plan
SWRCB	State Water Resources Control Board
TAC	toxic air contaminant
TCM	Transportation Control Measure
TDM	Transportation Demand Management

TMDL	Total Maximum Daily Load
TWL	Total Water Level
U.S. 101	U.S. Highway 101
USACE	U.S. Army Corps of Engineers
USC	United States Code
USDOT	United States Department of Transportation
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VdB	vibration decibels
VMT	vehicle miles traveled
WEAT	Worker Environmental Awareness Training
WGCEP	Working Group on California Earthquake Probabilities
ZEV	Zero Emissions Vehicle

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EIR GLOSSARY

100-year base flood elevation (BFE): As defined by the Federal Emergency Management Agency (FEMA), the elevation to which the 100-year flood is anticipated to rise. The BFE is computed based on the 1-percent-annual-chance total water level, which includes the still-water elevation and wave runup. (FEMA defines "still water" as the flood level not including the effects of waves or tsunamis, but including storm surge and astronomic tide.) BFEs vary because of varying wave exposure and shoreline geometry.

100-year flood: A flood with a magnitude that has a 1 in 100 chance (1 percent probability) of occurring in any given year. The "100-year floodplain" encompasses lands with a 1 percent annual chance of such a flood.

500-year flood: A flood event that has a 0.2 percent probability of being exceeded in any given year.

Anthropogenic greenhouse gas emissions: Greenhouse gas emissions derived from the combustion of fossil fuels, as well as byproducts of certain human-managed biological processes, such as wastewater treatment.

Basin plan: A document that establishes the beneficial uses to be protected for the waters within a specified area, water quality objectives to protect those uses, and an implementation program for achieving the objectives.

Bay Mud: Highly plastic clay and silt estuary deposits that formed mudflats and marshlands throughout the margins of the Bay Area. Bay Mud was formed when eroded fine-grained silt and clay particles that were carried down streams to San Francisco Bay met the relatively quiet bay waters.

Biogenic greenhouse gas emissions: Greenhouse gas emissions derived from natural sources, including natural decomposition of biomass (non-fossilized organic matter from plants, animals, and microorganisms).

Carbon dioxide–equivalent (CO_2e) emissions: A way of measuring the different global warming potentials of various greenhouse gases emitted as a result of human activities. ("Warming potential" is the amount of heat trapped in the atmosphere by a certain mass of the gas.) Carbon dioxide (CO_2) is the most common reference gas for climate change, so emissions of other greenhouse gases are quantified and reported as CO_2-equivalent emissions.

Coarse beach: A man-made beach constructed of coarse-grained materials like gravel and cobbles.

Criteria air pollutant (CAP): As identified by the U.S. Environmental Protection Agency, an air pollutant that is a threat to public health and welfare. CAPs are called "criteria" air pollutants because standards have been established for each to meet specific public health and welfare criteria.

Critical habitat: Habitat needed to support the recovery of listed species.

Cumulative impact: An environmental impact created by the combination of the proposed project being evaluated and other projects causing related impacts: "….the change in the environment which results from the incremental impact of the project added to other closely related past, present, and reasonably foreseeable probable future projects. Cumulative impacts can result from individual minor but collectively significant projects taking place over a period of time" (CEQA Guidelines Section 15355(b)).

Diked marsh: For purposes of this EIR, the City-owned area north of the Pickleweed Park playfields.

Ecotone: An area that acts as a transition or boundary between two ecosystems, such as an area of marshland between a river and the riverbank. Because this area is influenced by the two bordering ecosystems, a higher variety of species can be found within an ecotone. An ecotone can act as a buffer zone protecting the neighboring ecosystem from possible environmental damage; for example, a wetland area could absorb pollutants, preventing them from seeping into a river or estuary.

Ecotone slope: For purposes of this EIR, a slope that would be constructed along the raised, setback levee along the south end of Tiscornia Marsh, as well as the new levee between the soccer field and the diked marsh. The ecotone slope would be planted with native vegetation adapted to historic ecotones, intermixing high marsh and upland species adapted to infrequent flooding and salinity.

Flood Insurance Rate Mapping (FIRM) program: A program administered by FEMA that designates areas where flooding could occur during 100-year and 500-year flood events.

Habitat Area of Particular Concern: A subset of Essential Fish Habitat that exhibits one or more of the following traits: rare, stressed by development, provides important ecological functions for federally managed species, or especially vulnerable to anthropogenic degradation.

Flexible jetty: A jetty made of granular, porous material such as cobble instead of concrete.

Freeboard: As defined by the U.S. Army Corps of Engineers, a factor of safety usually expressed in feet above a flood level for purposes of designing flood protection facilities and for floodplain management. Freeboard tends to compensate for factors such as wave action, bridge obstructions, and the hydrologic effect of urbanization of the watershed.

Maximally exposed individual receptor: As defined by the U.S. Environmental Protection Agency, the single individual with the highest exposure (to an air pollutant) in a given population. Used synonymously with “worst-case.”

Mean high-water mark: For ocean and coastal waters, the line on the shore established by the average of all high tides. The high-water mark is established by survey based on available tidal data, preferably averaged over 18.6 years to reflect the variations in tides. If such data are unavailable, less precise information and methods may be used, such as physical markings, lines of vegetation, or a comparison with another area with similar physical characteristics for which tidal data are readily available.

Natural community: An assemblage of plant species that occur together in the same area and are defined by species composition and relative abundance.

Non-point source: With regard to surface water quality, a pollutant source that does not have a single, identifiable discharge point, but is rather a combination of many sources.

Ordinary high-water mark: “[T]hat line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of the soil, destruction of terrestrial vegetation, the presence of litter or debris, or other appropriate means that consider the characteristics of the surrounding area” (Code of Federal Regulations Title 33, Section 328.3[c][7]).

Outboard: Bay-adjacent.

Point source: With regard to surface water quality, any discernible, confined, and discrete conveyance of pollutants to a water body (such as a pipe discharge) from a source such as an industrial facility or wastewater treatment plant.

San Rafael Canal: An informal name used locally to refer to San Rafael Creek between U.S. Highway 101 and San Rafael Bay. This EIR uses the formal name of San Rafael Creek for this area.

Scenic vista: A location from which the public can experience a unique and exemplary view, typically from an elevated vantage point that offers a panoramic view of great breadth and depth.

Seiche: A water-level oscillation in an enclosed or semi-enclosed body of water such as a lake, reservoir, or harbor that results from a seismic event, wind stress, volcanic eruption, underwater landslide, or local basin reflection of a tsunami.

Sensitive natural community: A natural community designated by a resource agency, such as the California Department of Fish and Wildlife, or in local policies and regulations, that is generally considered to have important functions or values for wildlife and/or is recognized as declining in extent or distribution, and is considered threatened enough to warrant some level of protection.

Sensitive receptor (air quality): A member of a population subgroup sensitive to the health effects of air pollutants. As defined by the Bay Area Air Quality Management District, these subgroups include children, adults, and seniors occupying or residing in residential dwellings, schools, day care centers, hospitals, and senior-care facilities.

Sensitive viewer: A viewer with a strong stake or interest in the quality of the landscape and a greater sensitivity to changes that degrade or detract from the visual character of an area. Examples include travelers on designated scenic routes, park visitors, cyclists, pedestrians, and tourists; and for lighting and glare, people in residential buildings.

Sound exposure level: A metric that provides an indication of the amount of acoustical energy contained in a sound event.

Toxic air contaminant (TAC): An airborne substance that can cause adverse human health effects. TACs may be emitted by common sources such as gasoline stations, automobiles, dry cleaners, industrial operations, and painting operations. Health effects can be either short-term (acute) or long-term (chronic), and may include injury or illness. TACs can also be carcinogenic (cause cancer).

Tsunami: An ocean wave generated by vertical movement of the sea floor, normally associated with earthquakes or volcanic eruptions.

Viewer exposure: The variables that affect the viewing conditions of a site: landscape visibility (ability to see the landscape); viewing distance (proximity of viewers to the project); viewing angle (whether the project would be viewed from a superior, inferior, or level line of sight); extent of visibility (whether the line of sight is open and panoramic to the project area or restricted by terrain, vegetation, and/or structures); and duration of view.

Viewshed: An area of land, water, or other urban or environmental element that is visible to the human eye from a fixed vantage point.

Visual character: A general description of the visual attributes of a particular setting. An area's visual character is defined to provide the context within which the viewing public is likely to perceive the visual quality of a particular site or locale.

Visual quality: The overall visual impression or attractiveness of a site or locale as determined by its aesthetic qualities (such as color, variety, vividness, coherence, uniqueness, harmony, and pattern).

Waters of the U.S.: Wetlands and non-wetland bodies of water that meet specific criteria as defined in the Code of Federal Regulations and applicable U.S. Army Corps of Engineers guidance.

SUMMARY

S.1 Introduction

The Marin Audobon Society is proposing, in partnership with the City of San Rafael (City), the Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation Project (Proposed Project, or Project). The Proposed Project would restore former tidal marshlands and improve the shoreline levee on a 28-acre site at the confluence of San Rafael Creek and San Rafael Bay. The Project site includes the 21-acre Tiscornia Marsh property and approximately 500 feet of shoreline levee/trail owned by the Marin Audubon Society, as well as currently diked salt marsh within Pickleweed Park, approximately 1,800 feet of shoreline levee/trail, and a portion of the former Schoen Park (now a vacant lot) owned by the City. Proposed Project activities would reconstruct the highly eroded Tiscornia Marsh, reconnect the diked marsh in Pickleweed Park to tidal inundation, and fortify the local shoreline against sea level rise.

The City is the lead agency responsible for California Environmental Quality Act (CEQA) environmental review. CEQA requires the preparation of an environmental impact report (EIR) when a project could significantly affect the physical environment. The City determined that the Proposed Project would have the potential to cause significant environmental impacts, and that preparation of an EIR was therefore required for the Project to comply with CEQA.

The City has prepared this EIR to provide the City Council, the public, and responsible and trustee agencies considering this Project with information about the potential physical effects, both beneficial and adverse, on the local and regional environment of implementing the Project. This EIR was prepared in compliance with CEQA (California Public Resources Code, Sections 21000 et seq.) and the CEQA Guidelines (California Code of Regulations Title 14, Chapter 3, Sections 15000 et seq.). This EIR describes the Project under consideration by the City. The document characterizes the Project setting, discloses the range of potential environmental impacts of the Proposed Project, and identifies mitigation measures for those impacts that would be significant. The EIR also addresses cumulative adverse impacts to which the proposed Project could make a substantial contribution. Also, as required under CEQA, it describes and evaluates potentially feasible alternatives to the Project that could avoid or reduce significant impacts while still meeting most of the Project's objectives.

S.2 Project Objectives

The goal of the Proposed Project is to enhance the ecological function of the Tiscornia Marsh property and increase flood protection for the Canal neighborhood, while maintaining the community value of the Albert J. Boro Community Center and Pickleweed Park. Specific Project objectives originating from this overarching goal include:

- Restore tidal marsh on the Project site to improve ecological function and habitat quantity, quality, and connectivity (including upland transition zones) for native marsh species and marsh-upland transition species, including special-status species.
- Protect Project site marshlands from future marsh edge erosion.
- Increase the level of flood protection for the Canal neighborhood and other nearby communities of central San Rafael.
- Create sustainable benefits that consider future environmental changes such as sea level rise and sedimentation.
- Maintain and improve public access to passive recreational and outdoor education opportunities (e.g., hiking, jogging, bird watching).

S.3 Summary of Project Description

Tiscornia Marsh would be restored to its former extent by beneficially reusing dredged material from local sources. A coarse beach would be constructed along the bayside edge of the restored marsh to resist future erosion. Tidal action would also be restored to the City-owned diked marsh at the north end of Pickleweed Park. The major components of the Project are:

- Required sequencing of in-water work in order to protect water quality, primarily requiring constructing containment of the work area prior to dredged material placement.
- Reuse of excavated material as on-site fill as much as possible, to avoid trucking material off site.
- Expected timing of receiving dredged sediment from a navigational dredging project to use as marsh material.

Altogether, the Proposed Project would reconstruct approximately 4 acres of eroded tidal marsh, preserve and protect the approximately 8 remaining acres of Tiscornia Marsh, and restore approximately 5 acres of diked marsh (City-owned area north of the Pickleweed Park playfields) by reconnecting it to tidal inundation. The Project would also construct a new approximately 600-foot levee on the south side of the existing diked marsh and improve approximately 1,100 feet of shoreline levee to achieve greater flood protection, public access, and habitat benefits.

S.4 Summary of Impacts and Mitigation Measures

Table S-1 summarizes the impacts of the Project. For each impact considered significant or potentially significant, the table lists the recommended mitigation measures. Table S-1 is intended to provide a summary of the Project's impacts and mitigation measures, which are described in detail in Chapter 3, *Environmental Setting, Impacts, and Mitigation Measures* and Appendix B, *Topics Not Requiring Detailed Environmental Analysis*; please refer to those EIR sections for a complete discussion of impacts.

TABLE S-1
SUMMARY OF IMPACTS AND MITIGATION MEASURES

Impact	Level of Significance prior to Mitigation	Mitigation Measure	Level of Significance After Mitigation
Aesthetics, EIR Section 3.2			
Impact 3.2-1: The Project would not have a substantial adverse effect on a scenic vista.	LTS	No mitigation required.	LTS
Impact 3.2-2: The Project would not conflict with applicable zoning and other regulations governing scenic quality.	LTS	No mitigation required.	LTS
Impact 3.2-3: The Project would not create a new source of substantial light or glare that would adversely affect day or nighttime views in the area.	LTS	No mitigation required.	LTS
Impact 3.2-4: The Project, combined with other reasonably foreseeable future projects in the Project vicinity, would not result in significant cumulative impacts related to aesthetics or visual resources.	LTS	No mitigation required.	LTS
Air Quality, EIR Section 3.3			
Impact 3.3-1: The Project would not conflict with or obstruct implementation of the applicable air quality plan.	LTS	No mitigation required.	LTS
Impact 3.3-2: The Project could result in a cumulatively considerable net increase of a criteria air pollutant for which the SFBAAB is in nonattainment under applicable federal and state ambient air quality standards.	LTSM	**Mitigation Measure 3.3-1: BAAQMD Basic Construction Measures.** The Project applicant and/or its construction contractors shall comply with the following applicable BAAQMD Basic Construction Mitigation Measures: ***BAAQMD Basic Construction Measures*** 1. All exposed surfaces (e.g., parking areas, staging areas, soil piles, graded areas, and unpaved access roads) shall be watered two times per day. 2. All haul trucks and railcars transporting soil, sand, or other loose material off-site shall be covered. 3. All visible mud or dirt track-out onto adjacent public roads shall be removed using wet power vacuum street sweepers at least once per day. The use of dry power sweeping is prohibited. 4. All vehicle speeds on unpaved roads shall be limited to 15 mph. 5. All roadways, driveways, and sidewalks to be paved shall be completed as soon as possible. Building pads shall be laid as soon as possible after grading unless seeding or soil binders are used.	LTS

TABLE S-1 (CONTINUED)
SUMMARY OF IMPACTS AND MITIGATION MEASURES

Impact	Level of Significance prior to Mitigation	Mitigation Measure	Level of Significance After Mitigation
Air Quality, EIR Section 3.3 (cont.)			
Impact 3.3-2 (cont.)		6. Idling times shall be minimized either by shutting equipment off when not in use or reducing the maximum idling time to five minutes (as required by the California airborne toxics control measure Title 13, Section 2485 of the California Code of Regulations [CCR]). Clear signage shall be provided for construction workers at all access points. 7. All construction equipment shall be maintained and properly tuned in accordance with manufacturer's specifications. All equipment shall be checked by a certified visible emissions evaluator. 8. Post a publicly visible sign with the telephone number and person to contact at the City of San Rafael regarding dust complaints. This person shall respond and take corrective action within 48 hours. BAAQMD's phone number shall also be visible to ensure compliance with applicable regulations.	
Impact 3.3-3: The Project could expose sensitive receptors to substantial pollutant concentrations.	LTSM	**Mitigation Measure 3.3-1: *BAAQMD Basic Construction Measures.*** (See Impact 3.3-2.) **Mitigation Measure 3.3-2: *EPA Tier 4 Engines*.** The Project applicant and/or its construction contractors shall be required to use off-road diesel construction equipment compliant with EPA Tier 4 nonroad engine standards. Before construction activities begin, the construction contractor and/or the Project applicant shall prepare an equipment list that identifies each piece of off-road equipment to be operated at the Project site by its equipment identification number and demonstrates that each piece of equipment meets EPA Tier 4 nonroad engine standards. The list shall be made available at the construction site and shall be updated when new or replacement construction equipment is brought to the site.	LTS
Impact 3.3-4: The Project would not result in emissions that lead to odors affecting a substantial number of people.	LTS	No mitigation required.	LTS
Impact 3.3-5: The Project could result in cumulative emissions of air pollutants.	LTSM	**Mitigation Measure 3.3-2: EPA Tier 4 Engines.** (Refer to Impact 3.3-3).	LTS
Biological Resources, EIR Section 3.4			
Impact 3.4-1: Construction or operation of the Project could have a substantial effect on special-status birds, common nesting migratory birds, or raptors in the study area.	LTSM	**Mitigation Measure 3.4-1: General Construction-related Mitigation Measures** • A qualified biologist (4-year college degree in biology or related field and demonstrated experience with the species of concern) shall provide Worker Environmental Awareness Training (WEAT) to field management and construction personnel. Communication efforts and training shall take place during pre-construction meetings so that construction personnel are aware of their responsibilities and the importance of compliance. WEAT shall identify the types of sensitive resources located in the study area and the measures required to avoid impacts on these resources. Materials covered in the training program shall include environmental rules and regulations for the specific Project and requirements for limiting activities to the construction right-of-way and avoiding demarcated sensitive resource areas.	LTS

TABLE S-1 (CONTINUED)
SUMMARY OF IMPACTS AND MITIGATION MEASURES

Impact	Level of Significance prior to Mitigation	Mitigation Measure	Level of Significance After Mitigation
Biological Resources, EIR Section 3.4 (cont.)			
Impact 3.4-1 (cont.)		• If new construction personnel are added to the Project, the contractor shall ensure the new personnel receive WEAT before starting work. A sign-in sheet of those contractor individuals who have received the training shall be maintained by the Project proponent. A representative shall be appointed during the WEAT to be the contact for any employee or contractor who might inadvertently kill or injure a listed species or who finds a dead, injured, or entrapped individual. • All vehicle operators shall limit speed to 15 miles per hour (mph) within the Project site. • No erosion control materials shall contain any plastic or monofilament netting. To avoid attracting predators, all food-related trash items shall be bagged and removed daily. **Mitigation Measure 3.4-2: Avoid and Minimize Impacts on California Black Rail and California Ridgway's Rail** • To minimize or avoid the loss of individual California black rail and California Ridgway's rail, construction activities, including vegetation management activities requiring heavy equipment, adjacent to the tidal marsh areas (within 500 feet [150 meters] or a distance determined in coordination with the USFWS or CDFW, shall be avoided during the breeding season from February 1 through August 31. • If areas within or adjacent to rail habitat cannot be avoided during the breeding season, protocol-level surveys shall be conducted to determine rail nesting locations. The surveys shall focus on potential habitat that could be disturbed by construction activities during the breeding season to ensure that rails are not breeding in these locations. Survey methods for rails shall follow the *Site-Specific Protocol for Monitoring Marsh Birds*, which was developed for use by USFWS and partners to improve bay-wide monitoring accuracy by standardizing surveys and increasing the ability to share data (Wood et al. 2017). Surveys are concentrated during the approximate period of peak detectability, January 15 to March 25, and are structured to efficiently sample an area in three rounds of surveys by broadcasting calls of target species during specific periods of each survey round. Call broadcasts increase the probability of detection compared to passive surveys when no call broadcasting is employed. This protocol has since been adopted by the Invasive Spartina Project (ISP) and Point Blue Conservation Science to survey California Ridgway's rails at sites throughout San Francisco Bay Estuary. The survey protocol for California Ridgway's rail is summarized below. – Previously used survey locations (points) should be used when available to maintain consistency with past survey results. Adjacent points should be at least 200 meters apart along transects in or adjacent to areas representative of the marsh. Points should be located to minimize disturbances to marsh vegetation. Up to eight points can be located on a transect.	

TABLE S-1 (CONTINUED)
SUMMARY OF IMPACTS AND MITIGATION MEASURES

Impact	Level of Significance prior to Mitigation	Mitigation Measure	Level of Significance After Mitigation
Biological Resources, EIR Section 3.4 (cont.)			
Impact 3.4-1 (cont.)		– At each transect, three surveys (rounds) are to be conducted, with the first round of surveys initiated between January 15 and February 6, the second round performed February 7 to February 28, and the third round March 1 to March 25. Surveys should be spaced at least 1 week apart, and the period between March 25 to April 15 can be used to complete surveys delayed by logistical or weather issues. A FESA Section 10(a)(1)(A) permit is required to conduct active surveys. – Each point on a transect shall be surveyed for 10 minutes each round. A recording of calls available from the USFWS is broadcast at each point. The recording consists of 5 minutes of silence, followed by a 30-second recording of California Ridgway's rail vocalizations, followed by 30 seconds of silence, followed by a 30-second recording of California black rail, followed by 3.5 minutes of silence. • If no breeding California black rail or California Ridgway's rail are detected during surveys, or if their breeding territories can be avoided by 500 feet (150 meters), then Project activities may proceed at that location. • If protocol surveys determine that breeding California black rail and/or California Ridgway's rail are present in the project area, the following measures would apply to Project activities conducted during their breeding season (February 1- August 31): – Construction activities would not occur within 500 feet of a detected Ridgway's rail or black rail call center. – A USFWS- and CDFW-approved biologist shall be on site during construction activities occurring within 500 feet (150 meters) of any other suitable rail breeding habitat. – All other biologists that may need to access the tidal marsh outside of the active construction period or be on site during construction for activities beyond 500 feet from suitable rail breeding habitat, shall be trained in black rail and Ridgway's rail biology, identification, and vocalizations, and shall be familiar with both species of rail and their nests. – If a California black rail or California Ridgway's rail vocalizes or flushes within 10 meters, it is possible that a nest or young are nearby. If an alarmed bird or nest is detected, work shall be stopped, and workers shall leave the immediate area carefully and quickly. An alternate route shall be selected that avoids this area, and the location of the sighting shall be recorded to inform future activities in the area. – All construction crews working in the marsh during rail breeding season shall be trained and supervised by a USFWS- and CDFW-approved rail biologist.	

TABLE S-1 (CONTINUED)
SUMMARY OF IMPACTS AND MITIGATION MEASURES

Impact	Level of Significance prior to Mitigation	Mitigation Measure	Level of Significance After Mitigation
Biological Resources, EIR Section 3.4 (cont.)			
Impact 3.4-1 (cont.)		– If any activities shall be conducted during the rail breeding season in California black rail or California Ridgway's rail-occupied marshes, biologists shall have maps or global positioning system (GPS) locations of the most current occurrences on the site. **Mitigation Measure 3.4-3: Nesting Bird Protection Measures** The City and/or its contractor(s) shall implement the following during construction of the Project: • Removal of trees and scrub vegetation shall occur outside the bird nesting season (February 1 to August 31), to the extent feasible. • If removal of trees and vegetation cannot be fully accomplished outside of the nesting season, a qualified biologist shall conduct pre-construction nesting surveys within 7 days prior to the start of such activities or after any construction breaks of 10 days or more. Surveys shall be performed for the study area and suitable habitat within 250 feet of the Project site to locate any active raptor (birds of prey) nests or rookeries. • If active nests are located during the pre-construction bird nesting survey, the qualified biologist shall evaluate if the schedule of construction activities could affect the active nests and the following measures shall be implemented based on their determination: – If construction is not likely to affect the active nest, it may proceed without restriction; however, a biologist shall regularly monitor the nest to confirm there is no adverse effect and may revise their determination at any time during the nesting season. In this case, the following measure would apply. – If construction may affect the active nest, the biologist shall establish a no-disturbance buffer in coordination with CDFW. Typically, these buffer distances are 100 feet for passerines and 250 feet for raptors. These distances may be adjusted depending on the level of surrounding ambient activity (e.g., if the Project site is adjacent to a road or active trail) and if an obstruction, such as a building, is within line-of-sight between the nest and construction. For bird species that are federally and/or state-listed sensitive species (i.e., fully protected, endangered, threatened, species of special concern), a City representative or qualified biologist shall coordinate with the USFWS and/or CDFW regarding modifications to nest buffers, prohibiting construction within the buffer, modifying construction, or removing or relocating active nests that are found on the site. – Any birds that begin nesting within the Project area and survey buffers amid construction activities are assumed to be habituated to construction-related or similar noise and disturbance levels. A qualified biologist shall coordinate with the USFWS and/or CDFW and determine if no work exclusion zones shall be established around active nests in these cases.	

TABLE S-1 (CONTINUED)
SUMMARY OF IMPACTS AND MITIGATION MEASURES

Impact	Level of Significance prior to Mitigation	Mitigation Measure	Level of Significance After Mitigation
Biological Resources, EIR Section 3.4 (cont.)			
Impact 3.4-2: The Project could have substantial adverse effects on salt marsh harvest mouse and salt marsh wandering shrew.	LTSM	**Mitigation Measure 3.4-4: Avoid and Minimize Impacts on Salt Marsh Harvest Mouse and Salt Marsh Wandering Shrew** • Ground disturbance to suitable salt marsh harvest mouse habitat (including, but not limited to pickleweed, and emergent salt marsh vegetation) shall be avoided to the extent feasible. Where salt marsh harvest mouse habitat cannot be avoided (such as for channel excavation, access routes and grading, or anywhere else that vegetation could be trampled or crushed by work activities), vegetation shall be removed to ground level from the ground disturbance work area plus a 5-foot buffer around the area, as well as any access routes within salt marsh harvest mouse habitat, utilizing mechanized hand tools or by another method approved by the USFWS and CDFW. Vegetation height shall be maintained at or below 5 inches above ground. Vegetation removal in salt marsh harvest mouse habitat shall be conducted under the supervision of the USFWS- and CDFW-approved biologist. • To protect salt marsh harvest mouse from construction-related traffic, access roads, haul routes, and staging areas within 50 feet of salt marsh harvest mouse habitat shall be bordered by temporary exclusion fencing; or other wildlife exclusion fencing as specified in federal or state permits. The fence should be made of a material that does not allow salt marsh harvest mouse to climb or pass through, of a minimum above-ground height of 30 inches, and the bottom should be buried to a depth of at least 6 inches so that mice cannot crawl under the fence. Any supports for the salt marsh harvest mouse exclusion fencing (e.g., t-posts) shall be placed on the inside of the Project site. The last 5 feet of the fence shall be angled away from the road to direct wildlife away from the road. A USFWS- and CDFW-approved biologist with previous salt marsh harvest mouse experience shall be on site during fence installation and shall check the fence alignment prior to vegetation clearing and fence installation to ensure that no salt marsh harvest mice are present. • Salt marsh harvest mouse marsh habitat that must be accessed by mini-excavators or other vehicles to complete Project construction (e.g., excavating smaller channels) shall be protected through use of low ground pressure (LGP) equipment, wooden or PVC marsh mats, or other method approved by the USFWS and CDFW following vegetation removal (see 2nd bullet, above). • Construction activities related to restoration and infrastructure shall be scheduled to avoid extreme high tides when there is potential for salt marsh harvest mouse to move to higher, drier grounds, such as ruderal and grassland habitats. No Project activities shall be conducted within 50 feet of suitable tidal marsh or other salt marsh harvest mouse habitat within 2 hours before and after an extreme high tide event (6.5 feet or higher measured at the Golden Gate Bridge and adjusted to the timing of local high tides) or when the adjacent marsh is flooded unless wildlife exclusion fencing has been installed around the work area.	LTS

TABLE S-1 (CONTINUED)
SUMMARY OF IMPACTS AND MITIGATION MEASURES

Impact	Level of Significance prior to Mitigation	Mitigation Measure	Level of Significance After Mitigation
Biological Resources, EIR Section 3.4 (cont.)			
Impact 3.4-2 (cont.)		• All construction equipment and materials shall be staged on existing roadways and away from suitable salt marsh harvest mouse habitat when not in use. All construction equipment shall be visually inspected prior to work activities each day for signs of salt marsh harvest mouse or any other wildlife. • Vegetation shall be removed from all non-marsh areas of disturbance (driving roads, grading and stockpiling areas) to discourage the presence of salt marsh harvest mouse. • A USFWS- and CDFW-approved biologist with previous salt marsh harvest mouse monitoring and/or surveying experience shall be on site during construction activities occurring in suitable habitat. The USFWS- and CDFW-approved biologist has the authority to stop Project activities if any of the requirements associated with these measures are not being fulfilled. If a harvest mouse is observed in the work area, construction activities shall cease in the immediate vicinity of the potential salt marsh harvest mouse. The individual shall be allowed to leave the area before work is resumed. If the individual does not move on its own volition, the USFWS-approved biologist would contact USFWS (and CDFW if appropriate) for further guidance on how to proceed. • If the USFWS- and CDFW-approved biologist has requested work stoppage because of take of any of the listed species, or if a dead or injured salt marsh harvest mouse is observed, the USFWS and CDFW shall be notified within 1 day by email or telephone.	
Impact 3.4-3: Construction or operation of the Project could have a substantial effect on special-status plants.	LTSM	**Mitigation Measure 3.4-5: Special-Status Plant Protection** • Prior to the start of construction, a qualified biologist shall conduct a properly timed special-status plant survey for Marin knotweed (*Polygonum marinense*), Suisun Marsh aster (*Symphyotrichum lentum*), Congested-headed hayfield tarplant (*Hemizonia congesta* subsp. *congesta*), and Point Reyes bird's-beak (*Chloropyron maritimum* ssp. *palustre*) within the species' suitable habitat within the Project work limits. The survey shall follow the CDFW Protocols for Surveying and Evaluating Impacts on Special Status Native Plant Populations and Sensitive Natural Communities (CDFW 2018). If special-status plant species are identified within the Project work limits, then the biologist shall establish an appropriate buffer area for each plant population to exclude activities that directly remove or alter the habitat of, or result in indirect adverse impacts on, the special-status plant species. A qualified biologist shall oversee installation of a temporary, mesh-type construction fence (Tensor Polygrid or equivalent) at least 4 feet (1.2 meters) tall around any established buffer areas to prevent encroachment by construction vehicles and personnel. The qualified biologist shall determine the exact location of the fencing. The fencing shall be strung tightly on posts set at maximum intervals of 10 feet (3 meters) and shall be checked and maintained weekly until all construction is complete. The buffer zone established by the fencing shall be marked by a sign stating:	LTS

TABLE S-1 (CONTINUED)
SUMMARY OF IMPACTS AND MITIGATION MEASURES

Impact	Level of Significance prior to Mitigation	Mitigation Measure	Level of Significance After Mitigation
Biological Resources, EIR Section 3.4 (cont.)			
Impact 3.4-3 (cont.)		– *"This is habitat of [list rare plant(s)], and must not be disturbed. This species is protected by [the ESA of 1973, as amended/CESA/California Native Plant Protection Act]."* • If direct impacts cannot be avoided, the City shall require the project sponsor to prepare a plan for minimizing the impacts by one or more of the following methods: (1) salvage and replant plants at the same location following construction; (2) salvage and relocate the plants to a suitable off-site location with long-term assurance of site protection; (3) collect seeds or other propagules for reintroduction at the site or elsewhere; or (4) payment of fees in lieu of preservation of individual plants, to be used for conservation efforts elsewhere**.** The City shall review and approve the plan. • The success criterion for any seeded, planted, and/or relocated plants shall be full replacement at a 1:1 ratio after 5 years. Monitoring surveys of the seeded, planted, or transplanted individuals shall be conducted for a minimum of 5 years, to ensure that the success criterion can be achieved at year 5. If it appears the success criterion would not be met after 5 years, contingency measures may be applied. Such measures shall include, but not be limited to: additional seeding and planting, altering or implementing weed management activities, or introducing or altering other management activities. • Any special-status plant species observed during surveys shall be reported to the CDFW and submitted to the CNDDB and reported to USFWS, if federally-listed.	
Impact 3.4-4: The Proposed Project could have a substantial adverse effect, either directly or through habitat modification, on marine species identified as a candidate, sensitive, or special-status species in local or regional plans, policies or regulations, or by the CDFW, USFWS, or NOAA.	LTSM	**Mitigation Measure 3.4-6: Fish and Marine Mammal Protection During Pile Driving** Prior to the start of any in-water construction that would require pile driving, the Project sponsor shall prepare a NOAA-approved sound attenuation monitoring plan to protect fish and marine mammals, and the approved plan shall be implemented during construction. This plan shall provide detail on the sound attenuation system, detail methods used to monitor and verify sound levels during pile driving activities (if required based on projected in-water noise levels), and describe methods to reduce impact pile-driving in the aquatic environment to an intensity level less than 120 dB (RMS) continuous noise level for marine mammals at a distance of 1,640 feet. The plan shall incorporate, but not be limited to, the following elements: • All in-water construction shall be conducted within the established environmental work window between June 1 and November 30, designed to avoid potential impacts on fish species. • To the extent feasible, vibratory pile drivers shall be used for the installation of all support piles. Vibratory pile driving shall be conducted following the USACE "Proposed Procedures for Permitting Projects that will Not Adversely Affect Selected Listed Species in California." The USFWS and NMFS completed Section 7 consultation on this document, which establishes general procedures for minimizing impacts on natural resources associated with projects in or adjacent to jurisdictional waters.	LTS

TABLE S-1 (CONTINUED)
SUMMARY OF IMPACTS AND MITIGATION MEASURES

Impact	Level of Significance prior to Mitigation	Mitigation Measure	Level of Significance After Mitigation
Biological Resources, EIR Section 3.4 (cont.)			
Impact 3.4-4 (cont.)		• If NOAA sound level criteria for marine mammals are exceeded during vibratory hammer pile installation, a NOAA-approved biological monitor shall be available to conduct surveys before and during pile driving to inspect the work zone and adjacent waters for marine mammals. The monitor shall be present as specified by NMFS during impact pile driving and ensure that: – The safety zones established in the sound monitoring plan for the protection of marine mammals are maintained. – Work activities are halted when a marine mammal enters a safety zone and resumed only after the animal has left the area or has not been observed for a minimum of 15 minutes.	
Impact 3.4-5: The Project could have substantial adverse effects on jurisdictional wetlands, other Waters of the United States and Waters of the State.	LTS	No mitigation required.	LTS
Impact 3.4-6: The Project could interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites.	LTSM	**Mitigation Measure 3.4-6: Fish and Marine Mammal Protection During Pile Driving**	LTS
Impact 3.4-7: The Project could conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance and could conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan.	LTS	**Mitigation Measure 3.4-7: Tree Ordinance** • Any tree-related work (removal, planting, or pruning) shall adhere to the City of San Rafael Municipal Code Section 11.12. Specifically, written permit must be issued to cut, prune, break, injure, or remove any living tree in, upon, or along any public street, sidewalk, or walkway in the city or cut, disturb, or interfere in any way with the roots of any tree in, upon, or along any street, sidewalk, or walkway, or spray with any chemical or insecticide any tree in, upon, or along any public street, sidewalk, or walkway, or place any sign, poster, or other fixture on any tree or tree guard, or injure, misuse, or remove any device placed to protect any tree in, upon, or along any public street, sidewalk, or walkway in the city. Whenever any *tree* shall be cut down or removed in or from any sidewalk area, its butt and roots shall be dug up and removed, or cut level with the ground, as directed by the public works department. • In the erection or repair of any building or structure, guards shall be placed around all nearby trees in, upon, or along the public streets, sidewalks, and walkways within the city as shall prevent injury to them.	LTS

TABLE S-1 (CONTINUED)
SUMMARY OF IMPACTS AND MITIGATION MEASURES

Impact	Level of Significance prior to Mitigation	Mitigation Measure	Level of Significance After Mitigation
Biological Resources, EIR Section 3.4 (cont.)			
Impact 3.4-8: The Project could have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the CDFW, USFWS, or NMFS.	LTS	No mitigation required.	LTS
Impact 3.4-9: Cumulative loss of sensitive biological resources during construction and operations.	LTSM	No mitigation required.	LTS
Greenhouse Gas Emissions, EIR Section 3.5			
Impact 3.5-1: The Project could generate GHG emissions that would exceed the Bay Area Air Quality Management District's threshold of significance for GHG emissions.	LTS	No mitigation required.	LTS
Impact 3.5-2: The Project could conflict with applicable plans, policies, and regulations adopted for the purposes of reducing GHG emissions.	LTS	No mitigation required.	LTS
Hydrology/Water Quality, EIR Section 3.6			
Impact 3.6-1: The Project could violate water quality standards or waste discharge requirements or otherwise substantially degrade water quality.	LTS	No mitigation required.	LTS
Impact 3.6-2: The Project could substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river or through the addition of impervious surfaces, in a manner that would result in substantial erosion or siltation on or off site; substantially increase the rate or amount of surface runoff in a manner that would result in flooding on or off site; create or contribute runoff water that would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff; or impede or redirect flood flows.	LTS	No mitigation required.	LTS

TABLE S-1 (CONTINUED)
SUMMARY OF IMPACTS AND MITIGATION MEASURES

Impact	Level of Significance prior to Mitigation	Mitigation Measure	Level of Significance After Mitigation
Hydrology/Water Quality, EIR Section 3.6 (cont.)			
Impact 3.6-3: The Project could risk the release of pollutants in flood hazard, tsunami, or seiche zones.	LTS	No mitigation required.	LTS
Impact 3.6-4: The Project could conflict with or obstruct the implementation of a water quality control plan or sustainable groundwater management plan.	LTS	No mitigation required.	LTS
Impact 3.6-5: The Project, combined with cumulative development in the Project vicinity, would not result in significant cumulative impacts relative to hydrology or water quality.	LTS	No mitigation required.	LTS
Agriculture and Forest Resources, Appendix B. Initial Study Section 2			
Impact B.2-a: Would the project convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	NI	No mitigation required.	NI
Impact B.2-b: Would the project conflict with existing zoning for agricultural use, or a Williamson Act contract?	NI	No mitigation required.	NI
Impact B.2-c: Would the project conflict with existing zoning for, or cause rezoning of, forest land (as defined in Public Resources Code Section 12220(g)), timberland (as defined by Public Resources Code Section 4526), or timberland zoned Timberland Production (as defined by Government Code Section 51104(g))?	NI	No mitigation required.	NI
Impact B.2-d: Would the project result in the loss of forest land or conversion of forest land to non-forest use?	NI	No mitigation required.	NI
Impact B.2-e: Would the project involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland to non-agricultural use or conversion of forest land to non-forest use?	NI	No mitigation required.	NI

TABLE S-1 (CONTINUED)
SUMMARY OF IMPACTS AND MITIGATION MEASURES

Impact	Level of Significance prior to Mitigation	Mitigation Measure	Level of Significance After Mitigation
Agriculture and Forest Resources, Appendix B. Initial Study Section 2 (cont.)			
Impact B.2-f: Would the Project in combination with reasonably foreseeable future projects, result in significant cumulative impacts on farmland and forestry resources?	NI	No mitigation required.	NI
Cultural Resources, Appendix B. Initial Study Section 3			
Impact B.3-a: Would the project cause a substantial adverse change in the significance of a historical resource as defined in Section 15064.5?	LTS	No mitigation required.	LTS
Impact B.3-b: Would the project cause a substantial adverse change in the significance of an archaeological resource as defined in Section 15064.5?	LTSM	**Mitigation Measure CUL-1: Cultural Resources Awareness Training and Inadvertent Discovery of Archaeological Resources or Tribal Cultural Resources** Prior to authorization to proceed, a qualified archaeologist, defined as an archaeologist meeting the U.S. Secretary of the Interior's Professional Qualification Standards for Archeology, shall conduct a training program for all construction and field workers involved in site disturbance. On-site personnel shall attend a mandatory pre-Project training that shall outline the general archaeological sensitivity of the area and the procedures to follow in the event an archaeological resource and/or human remains are inadvertently discovered. If pre-contact or historic-era archaeological resources are encountered during Project implementation, all construction activities within 100 feet shall halt, and a qualified archaeologist shall inspect the find within 24 hours of discovery and notify the City of the initial assessment. Pre-contact archaeological materials might include obsidian and chert flaked-stone tools (e.g., projectile points, knives, scrapers) or toolmaking debris; culturally darkened soil ("midden") containing heat-affected rocks, artifacts, or shellfish remains; stone milling equipment (e.g., mortars, pestles, handstones, or milling slabs); and battered stone tools, such as hammerstones and pitted stones. Historic-era materials might include building or structure footings and walls, and deposits of metal, glass, and/or ceramic refuse. If the City determines, based on recommendations from a qualified archaeologist and a Native American representative (if the resource is pre-contact indigenous related), that the resource may qualify as a historical resource or unique archaeological resource (as defined in CEQA Guidelines Section 15064.5) or a tribal cultural resource (as defined in Public Resources Code [PRC] Section 21080.3), the resource shall be avoided if feasible. Consistent with Section 15126.4(b)(3), this may be accomplished through planning construction to avoid the resource, incorporating the resource within open space, capping and covering the resource, or deeding the site into a permanent conservation easement. If avoidance is not feasible, the City shall consult with appropriate Native American tribes (if the resource is pre-contact indigenous related), and other appropriate interested parties to determine treatment measures to avoid, minimize, or mitigate any potential impacts to the resource pursuant to	LTS

Table S-1 (Continued)
Summary of Impacts and Mitigation Measures

Impact	Level of Significance prior to Mitigation	Mitigation Measure	Level of Significance After Mitigation
Cultural Resources, Appendix B. Initial Study Section 3 (cont.)			
Impact B.3-b (cont.)		PRC Section 21083.2, and CEQA Guidelines Section 15126.4. This shall include documentation of the resource and may include data recovery (according to PRC Section 21083.2), if deemed appropriate, or other actions such as treating the resource with culturally appropriate dignity and protecting the cultural character and integrity of the resource (according to PRC Section 21084.3).	
Impact B.3-c: Would the project disturb any human remains, including those interred outside of formal cemeteries?	LTSM	**Mitigation Measure CUL-2: Inadvertent Discovery of Human Remains** If potential human remains are encountered, all work shall halt within 100 feet of the find and the City shall be contacted by on-site construction crews. The City shall contact the Marin County coroner in accordance with PRC Section 5097.98 and Health and Safety Code Section 7050.5. If the coroner determines that the remains are Native American, the coroner shall contact the NAHC. As provided in PRC Section 5097.98, the NAHC shall identify the person or persons believed to be the Most Likely Descendant (MLD). The MLD shall make recommendations for the means of treating, with appropriate dignity, the human remains and any associated grave goods, as provided in PRC Section 5097.98.	LTS
Impact B.3-d: Would the project in combination with reasonably foreseeable future projects, result in significant cumulative impacts to archeological resources or human remains?	LTSM	**Mitigation Measure CUL-1: Cultural Resources Awareness Training and Inadvertent Discovery of Archaeological Resources or Tribal Cultural Resources** **Mitigation Measure CUL-2: Inadvertent Discovery of Human Remains**	LTS
Energy, Appendix B. Initial Study Section 4			
Impact B.4-a: Would the project result in potentially significant environmental impact due to wasteful, inefficient, or unnecessary consumption of energy resources, during project construction or operation?	LTS	No mitigation required.	LTS
Impact B.4-b: Would the project conflict with or obstruct a state or local plan for renewable energy or energy efficiency?	LTS	No mitigation required.	LTS
Impact B.4-c: Would the project in combination with reasonably foreseeable future projects, result in significant energy impacts?	LTS	No mitigation required.	LTS

TABLE S-1 (CONTINUED)
SUMMARY OF IMPACTS AND MITIGATION MEASURES

Impact	Level of Significance prior to Mitigation	Mitigation Measure	Level of Significance After Mitigation
Geology and Soils, Appendix B. Initial Study Section 5			
Impact B.5-a.i: Would the project directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42?	NI	No mitigation required.	NI
Impact B.5-a.ii: Would the project directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving strong seismic ground shaking?	LTS	No mitigation required.	LTS
Impact B.5-a.iii: Would the project directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving seismic-related ground failure, including liquefaction?	LTS	No mitigation required.	LTS
Impact B.5-a.iv: Would the project directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving landslides?	LTS	No mitigation required.	LTS
Impact B.5-b: Would the project result in substantial soil erosion or the loss of topsoil?	LTS	No mitigation required.	LTS
Impact B.5-c: Would the project be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?	LTS	No mitigation required.	LTS
Impact B.5-d: Would the project be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial direct or indirect risks to life or property?	NI	No mitigation required.	NI

TABLE S-1 (CONTINUED)
SUMMARY OF IMPACTS AND MITIGATION MEASURES

Impact	Level of Significance prior to Mitigation	Mitigation Measure	Level of Significance After Mitigation
Geology and Soils, Appendix B. Initial Study Section 5			
Impact B.5-e: Would the project have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?	NI	No mitigation required.	NI
Impact B.5-f: Would the project directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	NI	No mitigation required.	NI
Impact B.5-g: Would the project in combination with reasonably foreseeable future projects, result in significant cumulative impacts related to geology, soils or paleontological resources?	LTS	No mitigation required.	LTS
Hazards and Hazardous Materials, Appendix B. Initial Study Section 6			
Impact B.6-a: Would the Project create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	LTS	No mitigation required.	LTS
Impact B.6-b: Would the Project create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	LTS	No mitigation required.	LTS
Impact B.6-c: Would the Project emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	LTS	No mitigation required.	LTS
Impact B.6-d: Would the Project be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?	NI	No mitigation required.	NI

TABLE S-1 (CONTINUED)
SUMMARY OF IMPACTS AND MITIGATION MEASURES

Impact	Level of Significance prior to Mitigation	Mitigation Measure	Level of Significance After Mitigation
Hazards and Hazardous Materials, Appendix B. Initial Study Section 6 (cont.)			
Impact B.6-e: For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard or excessive noise for people residing or working in the project area?	NI	No mitigation required.	NI
Impact B.6-f: Would the project impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?	NI	No mitigation required.	NI
Impact B.6-g: Would the project expose people or structures, either directly or indirectly, to a significant risk of loss, injury, or death involving wildland fires?	LTS	No mitigation required.	LTS
Impact B.6-h: Would the project in combination with reasonably foreseeable future projects, result in significant cumulative impacts related to hazards and hazardous materials?	LTS	No mitigation required.	LTS
Land Use and Planning, Appendix B. Initial Study Section 7			
Impact B.7-a: Would the Project physically divide an established community?	NI	No mitigation required.	NI
Impact B.7-b: Would the Project cause a significant environmental impact due to a conflict with any land use plan, policy, or regulation adopted for the purpose of avoiding or mitigating an environmental effect?	NI	No mitigation required.	NI
Impact B.7-c: Would the project in combination with reasonably foreseeable future projects, result in significant cumulative impacts to land use?	NI	No mitigation required.	NI
Mineral Resources , Appendix B. Initial Study Section 8			
Impact B.8-a: Would the Project result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	NI	No mitigation required.	NI

TABLE S-1 (CONTINUED)
SUMMARY OF IMPACTS AND MITIGATION MEASURES

Impact	Level of Significance prior to Mitigation	Mitigation Measure	Level of Significance After Mitigation
Mineral Resources , Appendix B. Initial Study Section 8 (cont.)			
Impact B.8-b: Would the Project result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plan?	NI	No mitigation required.	NI
Impact B.8-c: Would the project in combination with reasonably foreseeable future projects, result in significant cumulative impacts to mineral resources?	NI	No mitigation required.	NI
Noise, Appendix B. Initial Study Section 9			
Impact B.9-a: Would the project result in generation of a substantial temporary or permanent increase in ambient noise levels in the vicinity of the project in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?	LTS	No mitigation required.	LTS
Impact B.9-b: Would the project result in generation of excessive groundborne vibration or groundborne noise levels?	LTS	No mitigation required.	LTS
Impact B.9-c: For a project located within the vicinity of a private airstrip or an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?	NI	No mitigation required.	NI
Impact B.9-d: Would the project in combination with reasonably foreseeable future projects, result in significant noise or vibration impacts?	LTS	No mitigation required.	LTS
Population Housing, Appendix B. Initial Study Section 10			
Impact B.10-a: Would the project induce substantial unplanned population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?	NI	No mitigation required.	NI

TABLE S-1 (CONTINUED)
SUMMARY OF IMPACTS AND MITIGATION MEASURES

Impact	Level of Significance prior to Mitigation	Mitigation Measure	Level of Significance After Mitigation
Population Housing, Appendix B. Initial Study Section 10 (cont.)			
Impact B.10-b: Would the project displace substantial numbers of existing people or housing, necessitating the construction of replacement housing elsewhere?	NI	No mitigation required.	NI
Impact B.10-c: Would the Project, in combination with reasonably foreseeable future projects, result in significant cumulative impacts on population and housing?	NI	No mitigation required.	NI
Public Services, Appendix B. Initial Study Section 11			
Impact B.11-a.i: Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered government facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times, or other performance objectives for fire protection?	LTS	No mitigation required.	LTS
Impact B.11-a.ii: Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered government facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times, or other performance objectives for police protection?	LTS	No mitigation required.	LTS
Impact B.11-a.iii: Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered government facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times, or other performance objectives for schools?	LTS	No mitigation required.	LTS

TABLE S-1 (CONTINUED)
SUMMARY OF IMPACTS AND MITIGATION MEASURES

Impact	Level of Significance prior to Mitigation	Mitigation Measure	Level of Significance After Mitigation
Public Services, Appendix B. Initial Study Section 11 (cont.)			
Impact B.11-a.iv: Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered government facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times, or other performance objectives for parks?	LTS	No mitigation required.	LTS
Impact B.11-a.v: Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered government facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times, or other performance objectives for other public facilities?	LTS	No mitigation required.	LTS
Impact B.11-b: Would the project in combination with reasonably foreseeable future projects, result in significant cumulative impacts to public services?	LTS	No mitigation required.	LTS
Recreation, Appendix B. Initial Study Section 12			
Impact B.12-a: Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	LTS	No mitigation required.	LTS
Impact B.12-b: Does the project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?	LTS	No mitigation required.	LTS
Impact B.12-c: Would the project in combination with reasonably foreseeable future projects, result in significant cumulative impacts to recreation resources?	LTS	No mitigation required.	LTS

TABLE S-1 (CONTINUED)
SUMMARY OF IMPACTS AND MITIGATION MEASURES

Impact	Level of Significance prior to Mitigation	Mitigation Measure	Level of Significance After Mitigation
Transportation and Traffic, Appendix B. Initial Study Section 13			
Impact B.13-a: Would the project conflict with a program plan, ordinance or policy addressing the circulation system, including transit, roadway, bicycle and pedestrian facilities?	LTS	No mitigation required.	LTS
Impact B.13-b: Would the project conflict or be inconsistent with CEQA Guidelines section 15064.3, subdivision (b)?	LTS	No mitigation required.	LTS
Impact B.13-c: Would the project substantially increase hazards due to a geometric design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?	LTSM	**Mitigation Measure TRAN-1 Construction Traffic Control Plan** Prior to the issuance of construction permits, the construction contractor shall prepare and submit a Construction Traffic Control Plan to the City of San Rafael Public Works Department for approval. The Construction Traffic Control Plan must be prepared in accordance with both the California Department of Transportation Manual on Uniform Traffic Control Devices and Work Area Traffic Control Handbook and must address, at a minimum, the following issues: 1) Placing temporary signing, lighting, and traffic control devices if required, including, but not limited to, appropriate signage along access routes to indicate the presence of heavy vehicles and construction traffic; 2) Provision of construction personnel at driveway on Spinnaker Point Drive leading to construction staging area to direct traffic, pedestrians, and bicyclists while trucks are turning into and out of the driveway. 3) Notification of all construction activities with San Rafael City Schools at least two months in advance, so that it may make proper accommodations for any possible limitations to access at Bahia Vista Elementary School. San Rafael City Schools shall be notified of the timing, location, and duration of construction activities. The construction contractor shall be required to ensure that construction of the Proposed Project does not inhibit vehicle, bicycle, pedestrian, and/or school bus service through inclusion of such provisions in the construction contract.	LTS
Impact B.13-d: Would the result in inadequate emergency access?	LTS	No mitigation required.	LTS
Impact B.13-e: Would the project in combination with reasonably foreseeable future projects, result in significant cumulative impacts to Transportation?	LTSM	**Mitigation Measure TRAN-1 Construction Traffic Control Plan** (Refer to Impact XVII-c)	LTS

TABLE S-1 (CONTINUED)
SUMMARY OF IMPACTS AND MITIGATION MEASURES

Impact	Level of Significance prior to Mitigation	Mitigation Measure	Level of Significance After Mitigation
Tribal Cultural Resources, Appendix B. Initial Study Section 14			
Impact B.14-a: Would the project cause a substantial adverse change in the significance of a tribal cultural resource, defined in PRC Section 21074 as either a site, feature, place, cultural landscape that is geographically defined in terms of the size and scope of the landscape, sacred place, or object with cultural value to a California Native American tribe, and that is listed or eligible for listing in the California Register of Historical Resources, or in a local register of historical resources as defined in PRC Section 5020.1(k)?	LTSM	**Mitigation Measure CUL-1: Cultural Resources Awareness Training and Inadvertent Discovery of Archaeological Resources or Tribal Cultural Resources** (Refer to Impact V-b)	LTS
Impact B.14-b: Would the project cause a substantial adverse change in the significance of a tribal cultural resource, defined in PRC Section 21074 as either a site, feature, place, cultural landscape that is geographically defined in terms of the size and scope of the landscape, sacred place, or object with cultural value to a California Native American tribe, and that is a resource determined by the lead agency, in its discretion and supported by substantial evidence, to be significant pursuant to criteria set forth in subdivision (c) of PRC Section 5024.1. In applying the criteria set forth in subdivision (c) of PRC Section 5024.1, the lead agency shall consider the significance of the resource to a California Native American tribe?	LTSM	**Mitigation Measure CUL-1: Cultural Resources Awareness Training and Inadvertent Discovery of Archaeological Resources or Tribal Cultural Resources** (Refer to Impact V-b)	LTS
Tribal Cultural Resources, Appendix B. Initial Study Section14 (cont.)			
Impact B.14-c: Would the project in combination with reasonably foreseeable future projects, result in significant cumulative impacts to tribal cultural resources?	LTSM	**Mitigation Measure CUL-1: Cultural Resources Awareness Training and Inadvertent Discovery of Archaeological Resources or Tribal Cultural Resources** (Refer to Impact V-b)	LTS
Utilities and Service Systems, Appendix B. Initial Study Section 15			
Impact B.15-a: Would the project require the relocation or construction of new or expanded water, wastewater treatment, stormwater drainage, electric power, natural gas, or telecommunications facilities, the construction or relocation of which could cause significant environmental effects?	LTS	No mitigation required.	LTS

TABLE S-1 (CONTINUED)
SUMMARY OF IMPACTS AND MITIGATION MEASURES

Impact	Level of Significance prior to Mitigation	Mitigation Measure	Level of Significance After Mitigation
Utilities and Service Systems, Appendix B. Initial Study Section 15 (cont.)			
Impact B.15-b: Would the project have sufficient water supplies available to serve the project and reasonably foreseeable future development during normal, dry, and multiple dry years?	LTS	No mitigation required.	LTS
Impact B.15-c: Would the project result in a determination by the wastewater treatment provider which serves the project that it has inadequate capacity to serve the project's projected demand in addition to the provider's existing commitments?	LTS	No mitigation required.	LTS
Impact B.15-d: Would the project be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs and would not impair the attainment of solid waste reduction goals?	LTS	No mitigation required.	LTS
Impact B.15-e: Would the project comply with federal, state, and local management and reduction statues and regulations related to solid waste?	LTS	No mitigation required.	LTS
Impact B.15-f: Would the Project, in combination with reasonably foreseeable future projects, result in significant cumulative impacts related to disruption of utility service or relocation of utilities?	LTS	No mitigation required.	LTS
Wildfire, Appendix B. Initial Study Section 16			
Impact B.16-a: Would the project substantially impair an adopted emergency response plan or emergency evacuation plan?	LTS	No mitigation required.	LTS
Impact B.16-b: Due to slope, prevailing winds, and other factors, exacerbate wildfire risks, and thereby expose project occupants to, pollutant concentrations from a wildfire or the uncontrolled spread of a wildfire?	LTS	No mitigation required.	LTS
Impact B.16-c: Would the project require the installation or maintenance of associated infrastructure (such as roads, fuel breaks, emergency water sources, power lines or other utilities) that may exacerbate fire risk or that may result in temporary or ongoing impacts to the environment?	LTS	No mitigation required.	LTS

TABLE S-1 (CONTINUED)
SUMMARY OF IMPACTS AND MITIGATION MEASURES

Impact	Level of Significance prior to Mitigation	Mitigation Measure	Level of Significance After Mitigation
Wildfire, Appendix B. Initial Study Section 16 (cont.)			
Impact B.16-d: Would the project expose people or structures to significant risks, including downslope or downstream flooding or landslides, as a result of runoff, post-fire slope instability, or drainage changes?	LTS	No mitigation required.	LTS
Impact B.16-e: Would the Project, in combination with reasonably foreseeable future projects, result in significant cumulative impacts associated with wildfire?	NI	No mitigation required.	NI

NOTES:
LTS Less than Significant
LTSM Less than Significant with Mitigation
NI No Impact
SU Significant and Unavoidable

S.5 Summary of Project Alternatives

The CEQA Guidelines, Section 15126.6(a), state that an EIR must describe and evaluate a reasonable range of alternatives to the project that would feasibly attain most of the project's basic objectives and would avoid or substantially lessen any identified significant adverse environmental effects of the project. The CEQA Guidelines (Section 15126.6(e)) require the identification of an environmentally superior alternative to the Proposed Project. If it is determined that the "no project" alternative would be the environmentally superior alternative, then the EIR shall also identify an environmentally superior alternative among the other project alternatives (Section 15126.6[e][2]). To determine the environmentally superior alternative, the impacts of all the alternatives were compared to determine which alternative would have the least adverse effects.

The following sections describe the CEQA alternatives considered in this EIR, and provides a comparison of the alternatives.

S.5.1 Alternative 1: No Project Alternative

In the event that the City does not approve the Proposed Project, the restoration of Tiscornia Marsh and the City-owned diked marsh would not occur. The eroded area outboard of the existing Tiscornia Marsh would not be reconstructed, and the diked marsh would not be reconnected to tidal activity. The new levee north of the soccer field would not be constructed, and the levees to the west and south of Tiscornia Marsh would not be raised and/or widened. In addition, the coarse beach feature would not be constructed to prevent additional erosion of the marsh. The levee trails would not be resurfaced with asphalt.

S.5.2 Alternative 2: Reduced Project – Reduce Tiscornia Marsh Restoration

Alternative 2 would include the same Project elements as the Proposed Project; however, the south side of the marsh would be reduced; therefore, reducing the total fill required and the overall amount of construction activities. Specifically, the portion of restored tidal marsh and constructed coarse beach would not be extended to the location of the tidal channel.

S.5.3 Alternative 3: Reduced Project – Eliminate Diked Marsh Restoration

Alternative 3 would include most of the same Project elements on the eastern side of the site as the Proposed Project and would include the restoration of Tiscornia Marsh, construction of the coarse beach, raised southern and eastern levee, and constructed southern ecotone. However, the diked marsh would not be converted to tidal marsh; the new levee between the diked marsh and Pickleweed Park would not be constructed, and the new tidal channels at the north end of the site would not be constructed. Alternative 3 would require the least amount of construction, other than the No Project Alternative.

S.5.4 Comparison of Alternatives

Alternative 1 would eliminate the short-term construction effects relative to the Proposed Project. However, under Alternative 1, the restoration of Tiscornia Marsh and the City-owned diked marsh would not occur and the existing levees would not be raised and improved; thus, the adjacent areas would continue to be vulnerable to flooding. Alternative 1 would not meet any of the Project objectives.

Alternative 2 would not avoid the significant effects of the Proposed Project; however, the impacts would be lessened with the reduced construction footprint. Alternative 2 would only partially meet Project objectives, by eliminating restoration of the southern portion of the marsh. Thus, Alterative 2 provides a reduced habitat benefit. Further, without improvement of the southern part of the Project, ongoing erosion would extend into the northern portion of the Project site, affecting the efficacy of the Project, and somewhat reducing the expected lifetime of the improved levees from 2070 (under the Proposed Project).

Alternative 3 includes the least amount of construction activity, other than the No Project Alternative. While Alternative 3 would not avoid the significant effects of the Proposed Project, the impacts would be lessened with the reduced construction footprint. Thus, Alternative 3 is the environmentally preferred alternative. However, Alternative 3 would only partially meet Project objectives, by eliminating restoration of the diked marsh to tidal marsh and eliminating the new northern levee and ecotone. Thus, Alterative 3 provides the least habitat benefit and smallest flood protection benefit, other than the No Project Alternative. Further, without improvement of the diked marsh, the northwestern part of the Project area would be more vulnerable to extreme tidal flooding and sea level rise, and the expected lifetime of the improved levees would be less than 2070 (under the Proposed Project).

S.6 Areas of Controversy and Issues to be Resolved

Pursuant to Section 15123(b)(2) of the CEQA Guidelines, an EIR shall identify areas of controversy known to the lead agency, including issues raised by agencies and the public and the issues to be resolved.

During the planning process, inquiries to the City included Project alternatives, maintenance of the marsh, public access to the marsh, the levee's effectiveness over time, and widening of the Project's scope to include other area levees. In addressing these inquiries, the City has clarified that the marsh and coarse beach would not be available to public access; and the scope and Project area will not be expanded beyond the boundaries of the site because adding other levee areas to the Project would not meet the overall objectives of the Project. Further, the City has clarified that 2050 is the defined Project timeline. There are no other issues to be resolved or areas of controversy other than the choice among alternatives and choice of mitigation measures.

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CHAPTER 1
Introduction

1.1 Purpose of the EIR

The City of San Rafael (City) is the lead agency responsible for preparing this environmental impact report (EIR) under the California Environmental Quality Act (CEQA). CEQA requires the preparation of an EIR when a project could significantly affect the physical environment. The City determined that the Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation Project (Proposed Project, or Project) could potentially cause significant environmental impacts, and that preparation of an EIR was therefore required for the Project to comply with CEQA.

The City has prepared this EIR to inform the City's Planning Commission (Commission), the public, and responsible and trustee agencies reviewing the Proposed Project about the potential physical effects of the Proposed Project, both beneficial and adverse, on the local and regional environment. This EIR was prepared in compliance with CEQA (California Public Resources Code, Sections 21000 et seq.) and the CEQA Guidelines (California Code of Regulations Title 14, Sections 15000 et seq.).

This EIR describes the Proposed Project under consideration by the City. The document characterizes the Project setting, discloses the range of potential environmental impacts of the Proposed Project, and identifies mitigation measures for impacts identified as significant. The EIR also addresses cumulative adverse impacts to which the Proposed Project could make a substantial contribution. Also, as required under CEQA, it describes and evaluates potentially feasible alternatives to the Proposed Project that could avoid or reduce significant impacts while still meeting most of the Project's objectives.

1.2 EIR Process

1.2.1 Early Public Engagement

In order to obtain early public input in the Project planning process prior to initiation of CEQA by the City of San Rafael, the Marin Audubon Society, as the Project sponsor, worked with the Multicultural Center of Marin (MCM), a group that is deeply involved in the local community through a variety of existing programs (e.g., co-organizing a Día de los Muertos festival with the Canal Neighborhood community, providing fellowships and mentoring programs for transitional youth and youth in conflict, producing radio and online shows hosted in Spanish and English, leading the Marin Rapid Response Network to safeguard the civil rights of community members targeted by Immigration and Customs Enforcement [ICE] raids, etc.). With the goal of engaging the Project site's diverse surrounding communities in the planning process, MCM conducted outreach activities to educate the communities adjacent to the Project site about sea level rise, nature-based adaptation solutions, and the adaptation and resiliency goals of the proposed Project at Tiscornia Marsh.

MCM held two in-person public meetings to reach local communities and solicit input on the Project, one in January and one in April of 2018. These meetings were held locally and were supported with childcare services, food, and Spanish and Vietnamese translation services. A community site walk was also held in April of 2018, supported by on-site translation services, which included posters of potential Project conceptual alternatives and a tour of the site describing potential Project components. All three of these meetings were advertised with outreach flyers in Spanish and English and through local community events. A third public meeting was held virtually in October, 2020, with live Spanish and Vietnamese translation services. MCM has also created a public-facing website for the Project in Spanish and English; produced a radio show and short video to educate community members on flooding, sea level rise, and the proposed Project to encourage participation in the planning process; created online information sheets in Spanish covering the Project alternatives and information on flooding and sea level rise; and engaged local non-profits as potential partners (e.g., community councils, schools, Parent Services Project, Canal Alliance) to help reach additional community members.

1.2.2 Notice of Preparation and Scoping

In accordance with Section 15082 of the CEQA Guidelines, the City, as the CEQA lead agency, prepared and disseminated a notice of preparation (NOP) for this EIR. The NOP contains a description of the Proposed Project, a summary of existing conditions at the Project location, maps of the Project site, and a summary of the probable environmental effects of the Proposed Project to be addressed in the EIR, as well as instructions for joining the scoping meeting and for submitting written comments. On January 25, 2021, the NOP was mailed to interested parties, including individuals, and to federal, state, and local agencies, and was posted by the California State Clearinghouse beginning on February 19, 2021 and by the Marin County Clerk. The 30-day scoping period for the Project remained open through February 26, 2021. On February 23, 2021, the City held a Project scoping and update meeting to receive comments on the scope of the EIR.

The City received three comment letters from federal and state agencies and local organizations during the comment period. The City's staff report, NOP, and comment letters are included in Appendix A.

1.2.3 Draft EIR

This Draft EIR is available for review and comment by federal, state, and local agencies and interested organizations and individuals for a 45-day period identified in the notice shown inside the front cover of the document. Notice of this Draft EIR has also been sent directly to every agency, person, or organization that commented on the NOP. During the public comment period, written comments on the adequacy of the Draft EIR may be submitted electronically to:

Theo Sanchez, Associate Civil Engineer
City of San Rafael
Theo.Sanchez@cityofsanrafael.org

All written comments must be submitted to the City by Tuesday, October 26, 2021, at 5:00pm. During this 45-day review period, copies of the Draft EIR will be available for public review at the City of San Rafael, Tiscornia Marsh Project Website:

https://www.cityofsanrafael.org/tiscornia-marsh/

Should you require access to a physical copy of the Draft EIR, one will be available at:

City Hall, Community Development Department
1400 Fifth Avenue, Top Floor
San Rafael, CA 94901

The City will also conduct a public hearing to receive oral comments on the adequacy of the analysis included in the Draft EIR. The meeting will be held on:

Date:	Tuesday, October 26, 2021
Time:	7:00 p.m.
Location:	www.youtube.com/cityofsanrafael. Instructions on how to participate online will be available on the YouTube channel.

COVID-19 ADVISORY NOTICE: Consistent with Executive Orders No. N-25-20 and No. N-29-20 from the State of California and the Marin County March 16, 2020 Shelter in Place Order, the San Rafael Planning Commission hearing listed above WILL NOT be physically open to the public and the meeting will be streamed live to YouTube at the web address listed above.

1.2.4 Final EIR

All written comments received on the adequacy of this Draft EIR during the public review period will be addressed in a “response-to-comments” document that, together with this Draft EIR, will constitute the Final EIR. The response-to-comments document will also present any changes to the Draft EIR resulting from public and agency input, as well as changes initiated by City staff.

Before any decision to approve, revise, or reject the Proposed Project, the Commission will review the Final EIR and consider certifying the document at a regularly scheduled Commission meeting. Upon EIR certification, the City may proceed with Project approval actions. Approval of the Proposed Project would include written findings for each significant adverse environmental effect identified in the EIR (CEQA Guidelines Section 15091). At the time that CEQA findings are adopted, the City would also adopt a mitigation monitoring and reporting program (MMRP) for adopted mitigation measures (discussed further below).

1.2.5 Mitigation, Monitoring, and Reporting

Although the CEQA Guidelines do not require that the specific reporting or monitoring program be included in the EIR, California law requires lead agencies to adopt a Mitigation Monitoring and Reporting Program (MMRP) for those mitigation measures that are conditions of project approval and that are necessary to reduce or avoid significant effects on the environment. All adopted measures will be included in an MMRP to ensure CEQA compliance during Project implementation (CEQA Guidelines Section 15097(a)).

1.3 Organization of the EIR

Before this chapter, this EIR contains a summary chapter, which provides a concise overview of the document. The Executive Summary chapter allows the reader to review a summary of the analysis of potentially significant effects, proposed mitigation measures, residual environmental impacts after mitigation, and alternatives to the Proposed Project that would reduce or avoid effects on the environment. The Executive Summary culminates with the Summary of Environmental Impacts and Mitigation Measures, a table that lists each identified environmental impact, associated mitigation measures, and the level of significance of each significant impact following mitigation.

Following this chapter, this EIR has been organized as follows:

Chapter 2, *Project Description*. This chapter provides a detailed description of the Proposed Project, including the Project vicinity, existing facilities, construction information, and anticipated maintenance requirements. It presents a discussion of existing operations, Project needs, and Project objectives, along with a brief overview of anticipated regulatory requirements.

Chapter 3, *Environmental Setting, Impacts, and Mitigation Measures*. Each environmental topic applicable to the Proposed Project is discussed in a separate section of this chapter. Each section contains a description of the setting (existing environmental and regulatory setting) and the environmental impacts that could result from the Proposed Project. Each section also presents feasible mitigation measures for significant adverse impacts. The criteria used to assess the significance of adverse environmental effects are identified, and the significance of the impact both before and after mitigation is reported.

Chapter 4, *Other CEQA Issues*. This chapter describes the Proposed Project's growth inducement potential and the significant and irreversible environmental changes of the Proposed Project.

Chapter 5, *Alternatives*. This chapter evaluates a range of alternatives to the Proposed Project, including the No Project Alternative, which is required by CEQA.

Chapter 6, *EIR Preparers*. This chapter lists the persons who prepared this EIR and their affiliations.

1.4 References

No references are cited in this chapter.

CHAPTER 2
Project Description

2.1 Introduction

2.1.1 Project Location

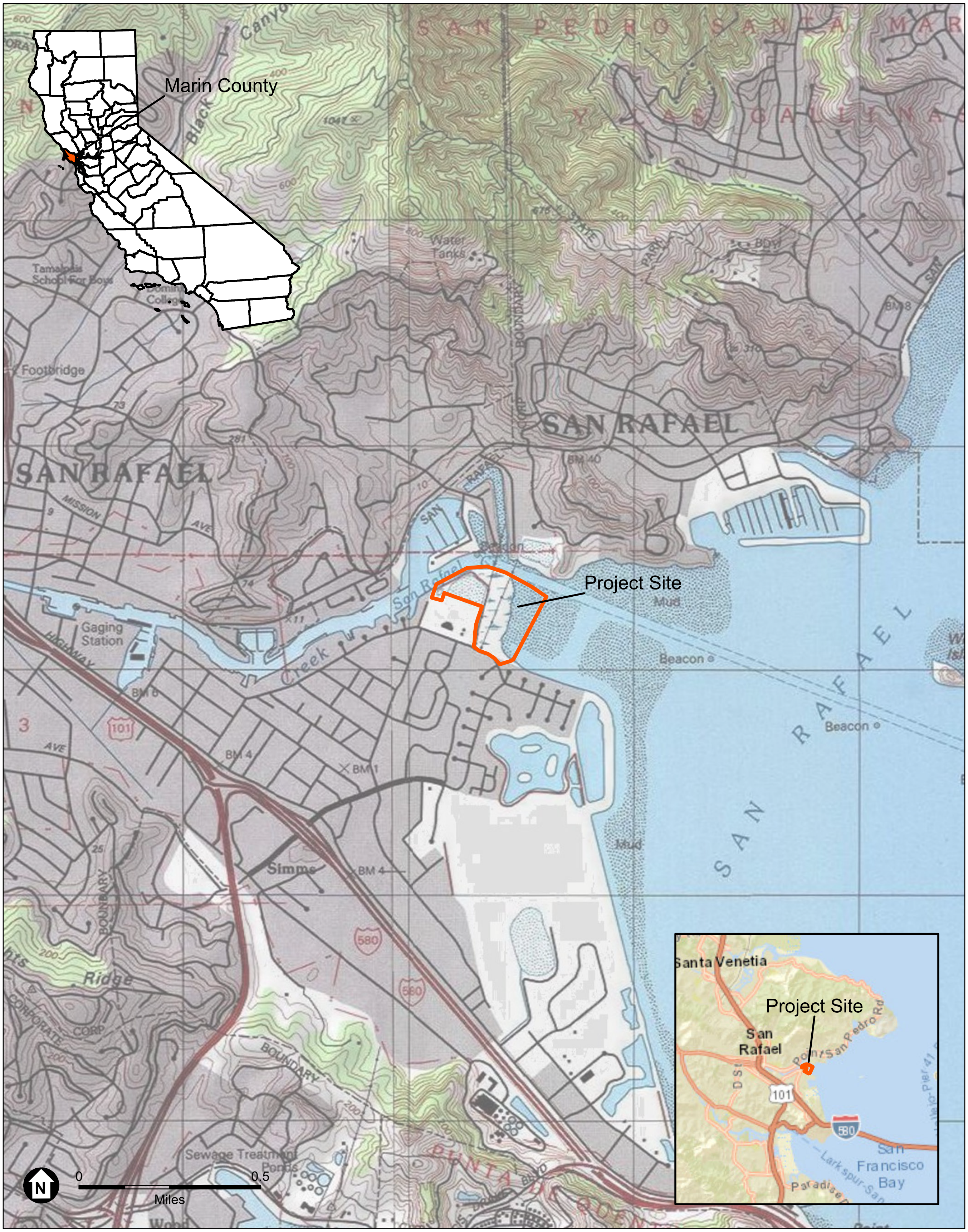
The Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation Project (Proposed Project) would restore former tidal marshlands and improve a shoreline levee on a 28-acre site at the confluence of San Rafael Creek and San Rafael Bay (**Figure 2-1**). The Project site is along the north boundary of the Canal neighborhood in central San Rafael, at Assessor's Parcel Numbers (APNs) 009-142-01, 009-032-06, 009-032-08, and 009-032-09.

Tiscornia Marsh is bounded on the west by the Albert J. Boro Community Center and Pickleweed Park. To the north is the mouth of San Rafael Creek, which transitions into San Rafael Bay (Bay).[1] The location of former Schoen Park (removed by the City of San Rafael in 2019) lies south of the Tiscornia Marsh shoreline levee, on the southeastern portion of the Project site, bordered by Spinnaker Point Drive (**Figure 2-2**). The shoreline levee that traverses the Project site, which is used as a recreational trail, is part of the shoreline flood protection system for the southeastern shoreline of the creek. The existing shoreline levee encloses Albert J. Boro Community Center and Pickleweed Park and then extends east along the Bay shoreline, past the Spinnaker and Baypoint developments and the Canalways property, and then onto the Richmond-San Rafael Bridge area. The west end of the existing shoreline levee ends on the west side of Pickleweed Park, adjacent to private residences, transitioning to lower ground elevations and an inconsistent flood protection system on private property along the south bank of the creek.

2.1.2 Project Background

The Project site includes the 21-acre Tiscornia Marsh property and approximately 500 feet of shoreline levee/trail owned by Marin Audubon Society (MAS), as well as currently diked salt marsh within Pickleweed Park, approximately 1,800 feet of shoreline levee/trail, and a portion of former Schoen Park (now a vacant lot) owned by the City of San Rafael (City). Proposed Project activities would reconstruct the highly eroded Tiscornia Marsh, reconnect the diked marsh in Pickleweed Park to tidal inundation, and fortify the local shoreline against sea level rise.

1 San Rafael Creek between Highway 101 and San Rafael Bay is often referred to locally as the San Rafael Canal; however, the formal name of San Rafael Creek is used throughout this EIR.



SOURCE: USGS, Esri

Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation Project

Figure 2-1
Regional Setting

ESA

SOURCE: Aerial Imagery: Esri

Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation Project

Figure 2-2
Project Location Existing Conditions

ESA

The low-lying Canal neighborhood adjacent to Tiscornia Marsh is currently at risk to coastal flooding, as is a significant extent of central San Rafael that occupies what was once tidal marshlands and open bay. The area is currently in the Federal Emergency Management Agency (FEMA) 100-year floodplain[2] and will be increasingly susceptible to flood hazards as sea level rises, as described in Marin County's recent Marin Bay Waterfront Adaptation Vulnerability Evaluation (BayWAVE; BVB Consulting 2017). Much of the Canal neighborhood lies below high tide elevations, requiring pump stations to remove stormwater and shoreline levees to protect against coastal flooding. The reach of San Rafael Creek shoreline upstream of the Project site is vulnerable to flooding, as many buildings have encroached on the shoreline edge and there is no formal flood protection system.

The roughly 2,300 feet of shoreline levee on the Project site is an un-accredited earthen berm, which varies in height and does not meet the FEMA freeboard requirements, with much of its length below the required elevation of the 100-year base flood elevation (BFE)[3] plus 3 feet of freeboard. A segment of the levee on the southern end of the Project site, near the former Schoen Park, is even lower, below the 100-year BFE level. Portions of the shoreline levee segment on the Tiscornia Marsh and Pickleweed Park properties are therefore at risk of overtopping during an extreme coastal flood event, resulting in flooding of low-lying portions of the adjacent Canal neighborhood.

In addition, the tidal marshlands have experienced considerable erosion over the past 30 years, retreating as much as 200 feet, with approximately 3 acres lost. This erosion has resulted in a significant loss of habitat for the endangered Ridgway's rail and salt marsh harvest mouse, migratory shorebirds, and other important marsh wildlife. The habitat impacts of the marsh loss are exacerbated by the current lack of a functional wetland-upland transition along the marsh's landward boundary, which currently transitions abruptly to the steep levee embankment.

Both of these conditions are expected to worsen in the coming decades as sea level rises. Sea level rise of about 8 inches has already occurred in the last century, and several feet or more of sea level rise is projected by the end of this century. By elevating Bay water levels, sea level rise will increase the frequency and severity of flooding along the City's shoreline.

2.1.3 Goals and Objectives

The goal of the Proposed Project is to enhance the ecological function of the Tiscornia Marsh property and increase flood protection for the Canal neighborhood, while maintaining the community value of the Albert J. Boro Community Center and Pickleweed Park.

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2 A 100-year flood is a flood event with a magnitude that has a 1 in 100 chance (1 percent probability) of occurring in any given year. The 100-year floodplain therefore encompasses lands with a 1 percent annual chance of such flooding.

3 The 100-year base flood elevation is defined by FEMA as the computed elevation to which the 100-year flood, or 1 percent annual chance flood, is anticipated to rise.

Specific Project objectives originating from this overarching goal include:

- Restore tidal marsh on the Project site to improve ecological function and habitat quantity, quality, and connectivity (including upland transition zones) for native marsh species and marsh-upland transition species, including special status species.
- Protect Project site marshlands from future marsh edge erosion.
- Increase the level of flood protection for the Canal neighborhood and other nearby communities of central San Rafael.
- Create sustainable benefits that consider future environmental changes such as sea level rise and sedimentation.
- Maintain and improve public access to passive recreational and outdoor education opportunities (e.g., hiking, jogging, bird watching).

2.1.4 Anticipated Approvals and Permits

The anticipated regulatory permits and consultations that would be needed for the Project are identified in **Table 2-1** below. These potential permitting requirements are preliminary and may change during pre-application coordination with the regulatory agencies or as the Project design develops.

TABLE 2-1
ANTICIPATED REGULATORY REQUIREMENTS

Agency	Governing Regulation	Potential Requirement
Federal		
U.S. Army Corps of Engineers	Clean Water Act Section 404, Rivers and Harbors Act Section 10	Nationwide Permit Pre-Construction Notification or Individual Permit
U.S. Fish and Wildlife Service	Endangered Species Act (ESA), Fish & Wildlife Coordination Act (FWCA), Migratory Bird Treaty Act (MBTA)	Federal ESA Section 7 Consultation
National Marine Fisheries Service	Endangered Species Act and Magnuson-Stevens Fishery Conservation and Management Act	Federal ESA Section 7 and Magnuson-Stevens Fishery Conservation and Management Act Consultation
State Historic Preservation Office (SHPO)	Section 106 of the National Historic Preservation Act	Federal undertaking (i.e., permit or funding)
State		
California Department of Fish and Wildlife	Fish and Game Code Section 1602	Lake and Streambed Alteration Agreement
California Department of Fish and Wildlife	California Endangered Species Act (CESA), Fish and Game Code Section 2081	CESA Incidental Take Permit
State Water Resources Control Board	National Pollutant Discharge Elimination System (NPDES)	Storm Water Pollution Prevention Plan for Construction Activities
San Francisco Bay Regional Water Quality Control Board	Clean Water Act Section 401; Porter-Cologne Water Quality Act	Water Quality Certification/Waste Discharge Requirements
State Lands Commission		Lease or lease amendment

**TABLE 2-1 (CONT.)
ANTICIPATED REGULATORY REQUIREMENTS**

Agency	Governing Regulation	Potential Requirement
Local/Regional		
Bay Conservation and Development Commission (BCDC)	McAteer-Petris Act	Administrative Permit
City of San Rafael		Use Permit, Environmental and Design Review Permit, Tidelands Permit, Encroachment Permit, Grading Permit

2.2 Project Description

The Proposed Project would restore Tiscornia Marsh to its 1950s-era extent by beneficially reusing dredged material from local sources. A coarse beach (man-made beach constructed of course-grained materials like gravel and cobbles) would be constructed along the bayside edge of the restored marsh to resist future erosion. Tidal action would also be restored to the City-owned diked marsh at the north end of Pickleweed Park. Altogether, the Project would reconstruct approximately 4 acres of eroded tidal marsh, preserve and protect the approximately 8 remaining acres of Tiscornia Marsh, and restore approximately 5 acres of diked marsh by reconnecting it to tidal inundation. The Project would also construct a new approximately 600-foot levee on the south side of the existing diked marsh and improve approximately 1,100 feet of existing shoreline levee to achieve greater flood protection, public access, and habitat benefits. Major Project elements are shown in **Figure 2-3** and summarized below.[4]

2.2.1 Coarse Beach Construction

A coarse beach would be constructed beyond the edge of Tiscornia Marsh to provide transitional habitat and nature-based erosion protection. The coarse beach feature would be approximately 50 to 60 feet wide, extending from the marsh's bayside mudflat to an approximate elevation of 9 feet above sea level. The relatively narrow beach is not intended for recreational use, and therefore has no direct land access (the beach would be separated from the southern shoreline by a small tidal channel). The planned crest elevation is designed to protect the area behind the beach from high tides, wave runup, and erosion during an average year's storm events. The crest of the beach would be planted with high marsh vegetation and would transition gradually to newly created tidal marsh on the landward side.

4 The Project Description for this EIR, including overall description of Project elements, construction approach and phasing, and operations and maintenance approach is summarized from the draft Preliminary Design Report prepared by environmental engineers supporting MAS in the development planning of the Project (ESA 2021). The Preliminary Design Report was supplemented by the environmental engineers during preparation of the EIR. Should the EIR be certified, and the EIR approved, the Project Design would be further advanced and some project elements may be refined. However, it is expected that the overall Project would be consistent with the description herein.

SOURCE: Aerial Imagery: Esri

Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation Project

Figure 2-3
Proposed Project Elements

ESA

This coarse-grained feature would emulate naturally occurring beaches in San Francisco Bay, consisting predominantly of gravel, with larger cobbles (e.g., 4- to 9-inch diameter) used for the beach subgrade. Coarser beach materials such as gravels and cobbles would be more durable against storm events and less likely to drift laterally into San Rafael Creek.

The coarse beach would provide multiple benefits, including increasing the stability of eroding shorelines; creating aquatic, transitional, and/or wetland habitats; and providing a platform for ecosystem adaptation to sea level rise. Over time, the coarse beach is expected to persist as sea level rises, responding by adjusting its profile landward and upward.

A series of retention groins, constructed of wood and/or rock, would be incorporated into the beach to restrict longshore drift and retain sufficient sand and gravel in the beach profile. In addition, a flexible (i.e. made of granular, porous material instead of concrete) jetty structure constructed of suitably sized cobble would be built at the north end of the new marsh and beach to reduce erosion and prevent the movement of beach sediment into the creek. Where feasible, features may be incorporated in the lower, subtidal portion of the jetty structure to enhance its potential as aquatic habitat.

2.2.2 Eroded Tidal Marsh Reconstruction

The existing mudflat bayside of Tiscornia Marsh would be filled to recreate approximately 4 acres of tidal marsh. The marsh would be created by placing locally obtained dredged sediments compatible with the existing marsh, along with soils excavated on site for other Project elements, into the mudflat. Imported sediments would be dredged mechanically, transported to the site via barge, and mechanically unloaded and placed in the existing mudflat.

Prior to dredged fill placement, a coarse containment berm (that would later be further built out as the coarse beach) would be constructed along the water's edge of the new marsh area, the crest of which would be high enough to contain dredged material and isolate the work area from open waters. Other Project features (i.e., the existing shoreline levee) and protection measures (e.g., coir logs) would contain the south and west sides of the fill placement area, respectively. Placed material would slowly consolidate because of draining and drying.

Following fill placement, a tidal channel would be excavated along the existing marsh edge to connect to the existing marsh channel system that drains to the creek. To the extent feasible, the new channel would expose and/or recreate the overhanging vegetation at the marsh edge to provide suitable foraging conditions for Ridgway's rail.

2.2.3 Diked Marsh Restoration

The diked marsh bordering Pickleweed Park is at mid-marsh elevation and dominated by pickleweed, but it is isolated from the tidal action of the Bay by the shoreline levee. Tidal action would be restored by lowering and breaching the shoreline levee and excavating a tidal channel network of one to three branching channels, connecting the diked marsh to the Bay through the breached levee. Portions of the levee around the diked marsh would be lowered and revegetated to create disconnected high marsh and upland transitional habitat, disconnected by the breached areas from consistent land access to deter terrestrial predators (e.g., house cats). Two non-native palm trees would be removed for this work. Up to 150 linear feet of riprap armoring along the banks of the creek (as seen in Figure 2-3) would also be removed.

For this reintroduction of tidal inundation to occur, a new levee would be constructed on the south side of the diked marsh, adjacent to the existing soccer field (shown on Figure 2-5), before the outboard (bay-adjacent) levee is breached (see Section 2.2.4, *Shoreline Levee Improvements,* for further discussion). There is a small City-owned pond west of the diked marsh (shown on Figure 2-2) that is disconnected from adjacent habitats and has limited ecological value. This triangular pit is fenced off and has no known drainage inlet or outlet. A portion of the pit would be partially filled to connect the west end of the new levee to the existing shoreline (see Section 2.2.4, *Shoreline Levee Improvements*).

2.2.4 Shoreline Levee Improvements

The Project's shoreline levees were designed in accordance with U.S. Army Corps of Engineers guidance (USACE 2000), including a seismic deformation analysis as recommended by guidance developed for the California Department of Water Resources (DWR; URS 2015). Levee improvements were designed to approximately 13 feet above sea level, providing 3 feet of freeboard above FEMA's current 100-year BFE for the Project area of 10 feet (FEMA 2021). This would require raising the existing levees 1-4 feet, depending on their current height (e.g., the existing levee on the west side of the Project site would be raised by 4 feet, while the levee on the east side of the soccer field would only be raised by 1 foot). This design elevation considers an approximate 50-year timeline for the Project, and anticipated sea level rise to roughly 2070 under a medium–high risk aversion scenario as defined by the state's sea level rise planning guidance. The medium–high risk aversion scenario equates to a one in 200 chance that sea level rise would meet or exceed the probability projections of 2.4 to 2.6 feet for 2060 or 3.1 to 3.5 feet by 2070 (California Natural Resources Agency and California Ocean Protection Council 2018). The levee crests were designed to a width of approximately 12 feet, allowing space for future raising to address actual sea level rise by 2070.

The shoreline levee/trail around the diked marsh would be lowered and breached to restore tidal inundation (see Section 2.2.3, *Diked Marsh Restoration*) and would be replaced with a new levee along the north side of the soccer field, approximately 200 to 400 feet behind the location of the existing perimeter levee. The new levee would be approximately 12 feet wide at the crest, and the total levee footprint would be approximately 70 feet wide, including the ecotone slope (see Section 2.2.5, *Ecotone Slope Development*). There are currently two design options for tying the west end of the new levee into the shoreline (both represented in Figure 2-3). The west tie-off option would partly depend on the City's future plans for the existing stormwater line that runs north-south along the west side of the Project site and outfalls into San Rafael Creek. Either of the alignments described below could accommodate the City's future plans to potentially install a trash capture device at the end of the existing storm drain to comply with new law.[5] The decision

[5] The State Water Resources Control Board enacted the Trash Amendments in December, 2015 as part of the Trash Implementation Program, requiring all trash larger than 5 millimeters be captured prior to discharge into water bodies. The Trash Amendments apply to all Phase I and II permittees under the National Pollutant Discharge

of which design option to implement would be made in coordination with the City, as the plan to install the trash capture device is further developed.

Under the first option (west levee tie-off option 1), the new levee would connect to the existing trail on the west side of the diked marsh and soccer field and follow it to the existing shoreline levee. The trail and approximately 250 feet of shoreline levee west of the trail would be raised by approximately 4 feet to match the design elevation of the new levee. Under the second option (west levee tie-off option 2), the new levee would extend approximately 150 feet directly west to the northwest corner of the site, and would be partly set back from the shoreline, cutting off the existing subsurface stormwater line (as seen on Figure 2-2) where it intersects with the levee. This would require that a small stormwater outlet channel be excavated to the north of the new levee through the tidal marsh and into the creek. For either option the pond would be partially filled, and the remaining area would be graded and planted to function as wetlands (freshwater wetland under west levee tie-off option 1, and tidal wetland under west levee tie-off option 2).

The remainder of the existing levee (approximately 1,100 feet on the west and south sides of the existing Tiscornia Marsh) would be raised and/or widened in place (requiring a setback) to provide habitat benefits and uniform flood protection meeting regional standards. The existing levee between Pickleweed Park and the west side of Tiscornia Marsh would be raised 1 to 2 feet, creating a more defined approximately 12-foot-wide crest, but no grading is proposed in or adjacent to the marsh in this segment. The levee along the south end of Tiscornia Marsh would be set back landward, partially onto City property, to accommodate levee raising and the proposed ecotone slope (see Section 2.2.5, *Ecotone Slope Development* below). The levee crest would be approximately 12 feet wide and the total levee footprint, accounting for the ecotone slope, would be approximately 80 feet wide. The toe of the ecotone would be at the edge of the existing marsh, which is closer to the levee at the west end, and farther away at the east end. Therefore, the amount of encroachment onto adjacent City property would vary from 20 to 30 feet, west to east. This activity for setback levee improvements would require the removal of five existing trees, including three pines, one small (10-inch) oak, and a cluster of non-native acacias.

Construction of the new and setback levees would include excavation of sandy foundation soils, which would be backfilled with imported, less permeable levee material. All improved levee segments would also include asphalt-paved trails at the levee crest once completed, to provide a uniform surface for public access (whereas the existing trail segments are unpaved).

2.2.5 Ecotone Slope Development

The new and setback levee segments described above would include a gradually sloped ecotone transition to the outboard marsh. This ecotone transition would provide both ecological and flood benefits (including high tide refugia for native marsh wildlife and shoreline erosion protection through wave-dampening), and would allow for marsh landward transgression under future sea level rise.

Elimination System (NPDES) municipal separate storm sewer systems (MS4) permits, including the City of San Rafael. Permittees must be in full compliance by December, 2030.

An ecotone slope would be constructed along the raised, setback levee along the south end of Tiscornia Marsh, as well as the new levee between the soccer field and the diked marsh. The ecotone slope on the south end of Tiscornia Marsh would be located where feasible between existing and/or restored marsh and the shoreline levee. Each segment would be approximately 500 linear feet, for a total length of 1,000 feet. The ecotone would be sloped at 10:1 (horizontal: vertical) and would be approximately 30 feet wide, totaling roughly 0.7 acre.

The ecotone slopes would be planted with native vegetation adapted to historic ecotones, intermixing high marsh and upland species adapted to infrequent flooding and salinity. Planted vegetation would include grasses, shrubs, and herbs that serve as essential cover for wildlife species, including small marsh mammals, and secretive marsh birds, protecting them from predation. To be effective as high tide refugia, the plants must be tall enough to extend roughly 1 foot above the highest tide elevations in winter. The ecotone slopes would be temporarily irrigated during the initial plant establishment period (2 to 3 years).

2.3 Project Construction

2.3.1 Construction Schedule, Hours, and Workforce

The planned construction schedule is summarized in **Table 2-2** below. Project construction activities would occur from approximately 8:00 a.m. to 5:00 p.m., Monday through Friday. The daily construction work force would vary depending on the construction activity; however, it is expected that the maximum daily workforce would be 19 workers.

TABLE 2-2
CONSTRUCTION SCHEDULE OVERVIEW

	Phase 1 (Year 1)				Phase 2 (Year 2 or 3)				Phase 3 (Year 3 or 4*)			
Construction Activity	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
Site Preparation, Access, and Staging												
Coarse Beach Construction												
Shoreline Levee and Ecotone Improvements												
Eroded Tidal Marsh Reconstruction									drying *			
Diked Marsh Restoration												
Trail surfacing												

NOTES:
* Drying/consolidation of imported dredged material would take 6 to 18 months (shown as 6 months above). The timing of Phase 3 (Year 3 or 4) would depend on actual time needed for adequate drying, conditioning, and consolidation.

2.3.2 Construction Phasing

Construction of the Proposed Project would occur in three phases, over at least 3 years, beginning in 2023.[6] Most activities would occur during months of July through December, with the factors considered in the proposed work sequence including:

- Required sequencing of in-water work in order to protect water quality, primarily requiring constructing containment of the work area prior to dredged material placement.
- Reuse of excavated material as on-site fill as much as possible, to avoid trucking material off site.
- Expected timing of receiving dredged sediment from a navigational dredging project to use as marsh material.

Phase 1 (planned for summer and fall of 2023) would include site preparation (e.g., staging area development, vegetation clearing, temporary road improvements, and installation of the temporary in-water crane platform). Phase 1 would also include initial construction of the coarse beach (i.e., a coarse containment berm that would later be built up to create the coarse beach; see **Figure 2-4**) to serve as temporary containment of dredged fill material.

Phase 2 (planned for 2024 or later, depending on the availability of dredged sediment as explained below) would include construction of the new levee behind the diked marsh and improvement of the existing shoreline levee. Material generated from excavating the levee foundation would be placed on site to help reconstruct the eroded tidal marsh, but additional material (i.e., dredge sediment) would also be required to build out the new marsh. Dredged material would be placed between the existing marsh and the new containment berm. The exact timing of dredged material placement would be closely coordinated with planned dredging of source material in order to avoid storing the dredged material on site; therefore, Phase 2 may be postponed by 1 year or more until dredged material is known to be available and the Project site is prepared for fill placement. After dredged material is placed, it would be dried and conditioned over 6 to 18 months until it is consolidated.

Phase 3 would occur once the dredged material is dried and consolidated, most likely in fall of 2025 (or later if additional drying is needed or if the availability of source material for the marsh is delayed). This final phase would include building up and final shaping of the coarse beach and tidally connecting the new marsh to the Bay. Phase 3 would also include restoring the diked marsh by excavating a new tidal channel connection and lowering and breaching the existing shoreline perimeter levee around the diked marsh. Excavated material would be used to raise areas of localized settlement on the new levee crest (built in Phase 2) or within the newly created marsh. In this phase, the levee crest trails on the new and improved levee segments would be surfaced.

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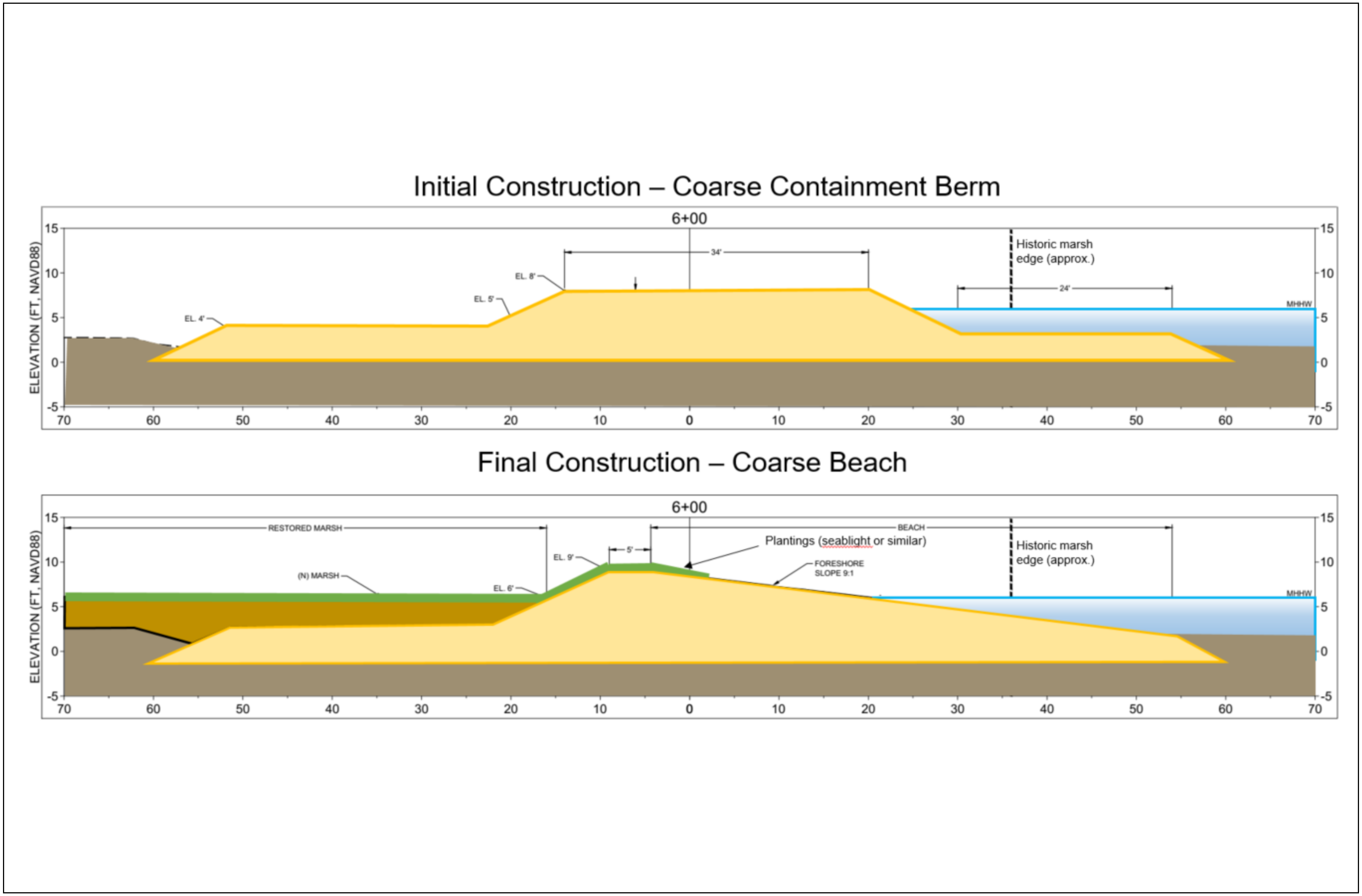
[6] It is noted that, should regulatory permits be received by spring 2022, Project construction could begin in summer and fall 2022.



SOURCE: ESA and Hultgren-Tillis

Figure 2-4
Beach Construction Phases

A summary of general construction activities by phase and year is outlined below:

Phase 1 – 2023:

- Site preparation including staging area development, installation of erosion and sediment control measures, and selective vegetation clearing and tree removal.
- Over-water installation of a crane platform on San Rafael Creek.
- Construction of a temporary access road across Tiscornia Marsh and placement of a temporary culvert underneath the temporary access road at existing channel crossings.
- Construction of the coarse containment berm (i.e., initial construction of the coarse beach, see Figure 2-4) to serve as a land-based access route and as containment of the placed dredged material.

Phase 2 – 2024 (or 2025):

- Completion of levee improvements, including foundation excavation, fill import and placement for levee raising and/or widening and ecotone slope development, and new levee construction.
- Placement of excavated material from the levee subgrade into eroded tidal marsh area (using land-based equipment).
- Water-based import and unloading of dredged material from the crane platform into the eroded marsh area.
- Mechanical placement, drying, and conditioning of dredged material to recreate the tidal marsh.
- Seeding, planting, temporary irrigation, and erosion and sediment control installation on the ecotone slopes at the new levee and setback levee.

Phase 3 – 2025 (or 2026-27):

- Removal of the temporary culvert and other dewatering equipment installed in Phase 1.
- Placement and shaping of material on top of the containment berm to complete construction of the coarse beach, and planting the crest (Figure 2-4).
- Excavation of tidal channels within the reconstructed/restored portion of Tiscornia Marsh, connecting to the existing channel, following consolidation of dredged material.
- Restoration of diked marsh, including tidal channel excavation and lowering/breaching the shoreline perimeter levee to restore tidal action to the diked marsh.
- Placement of final lift on new levee and improved levee segments and surfacing with asphalt pavement.

Phasing of Trail Closures

The existing trails along the levee and the perimeter of Pickleweed Park would need to be closed to public access at certain times during construction. The trail would be closed approximately 3 months each year of construction, most likely between September and November. During this time, users of the San Francisco Bay Trail (Bay Trail) east of the site may need to access Pickleweed Park by crossing to the sidewalk on the south side of Spinnaker Point Drive. The trail surface would consist of compacted gravel until it is paved during the final year of construction.

During Phase 1, the trail segment along the east side of the soccer field would likely be used as temporary construction access during initial construction of the coarse beach. The trail segments along the west and north sides of the soccer field would remain open as spur trails. During Phase 2, the trails would again be closed for approximately 3 months until levee improvements are complete. The trails would be reopened to the public while dredged material is being placed and consolidated. In Phase 3, the trails would again be temporarily closed for approximately 3 months to allow final levee grading and asphalt surfacing of the trail.

2.3.3 Construction Methods

Construction activities at the Project site would require a combination of barge access and land access. A crane platform, offloading locations, and a temporary access road along the constructed beach crest and through existing Tiscornia Marsh would be required. Construction staging areas and potential access routes and offloading areas for all phases of construction are shown on **Figure 2-5.**

Construction activities would be required for levee creation and improvements, marshplain restoration and creation, beach installation, and revegetation. Construction activities are described in detail below.

Site Preparation, Access, and Staging

Equipment Staging

Equipment staging areas would be located in upland areas outside of sensitive habitats. The empty lots adjacent to the Community Center and east of former Schoen Park would be used for materials staging and equipment fueling and maintenance (Figure 2-5). The need for, and specific location of, additional staging areas would be determined by the contractor at the time of construction based on field conditions. These areas would be clearly demarcated in the field, and erosion control structures (e.g., straw wattles, silt fences) would be installed around them in accordance with the Project Stormwater Pollution Prevention Plan (SWPPP) to prevent the transport of sediments and/or construction contaminants into surrounding areas. The staging areas would be used off and on throughout the 3- to 4-year construction period.

Temporary Crane Platform

A temporary crane platform would be installed along San Rafael Creek near the northeast corner of the Project site to unload materials and equipment brought in via barge. The platform would be a pile-supported steel and timber deck, approximately 30 square feet in size. The platform would be supported by 12 to 16 steel piles, approximately 18 inches in diameter and driven 60 to 70 feet deep using a vibratory hammer. The platform would remain in place for 1 to 3 years while the coarse beach and eroded marsh area are being constructed. Following construction, the platform would be completely removed and transported off site.

SOURCE: ESA, 2020; Base - Google Earth, 2020

Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation Project

Figure 2-5
Temporary Construction Access and Staging

ESA

Temporary Barge Offloading Locations

Material for construction of the coarse beach may be transported to the site partly via barge, as an alternative to trucking. Barges would employ standard safety measures, such as buoys, lighting, and signage. Two potential locations have been identified to allow land-based offloading of materials delivered by barge (in addition to the offloading described above at the crane platform), both of which are adjacent to the point shown on Figure 2-5. These locations were selected because there is no fringing marsh and they are already armored with riprap. Therefore, significant improvements at these locations are not anticipated. The use of multiple potential offloading location is intended help expedite the process of delivering material to the new marsh and coarse beach.

Temporary Access Roads

Dredged material for marsh reconstruction would be imported and placed from the waterside of Tiscornia Marsh as much as possible, to minimize impacts on neighbors and existing marsh habitat. However, land-based import and placement of construction materials would be needed for construction of levee improvements and portions of coarse beach construction.

Temporary access roads would be located along existing trails or other currently disturbed areas to the extent feasible. The existing looped trail around the diked marsh and soccer field would be used as an equipment access road during construction of the levee improvements and diked marsh restoration. This road would also be temporarily used for hauling when beach material is transported by barge and then offloaded with land-based equipment (e.g. off-road trucks). A temporary access road would also be constructed in the diked marsh, mainly within the footprint of the new tidal channel. This temporary road would be completely removed in conjunction with tidal channel excavation.

As described in Sections 2.2 and 2.3, the initial construction of the coarse beach would be a coarse containment berm to contain dredged material as it is placed for tidal marsh reconstruction. The coarse containment berm would also be sufficiently wide to allow one-way access for land-based equipment. A temporary access road would be constructed across Tiscornia Marsh (in an east-west direction) to allow looped construction access. The temporary road would be approximately 20 feet wide and would either be constructed of timber mats or temporary fill built up to a height of 3 feet. The road would be located at narrower portions of the marsh to reduce the area of disturbance and would include culverts over the existing tidal channel to maintain tidal flows to the south portion of the marsh. Any access roads and/or crane pads required on the existing mudflat would be constructed in stages in accordance with geotechnical recommendations to avoid soil failures (e.g., creating mud waves). All access road materials would be completely removed following construction.

Vegetation Removal

Removal of existing vegetation would be minimized. Existing pickleweed vegetation in the diked marsh would be removed within the footprint of the new levee ecotone, located on the south side of the existing diked marsh, and within the footpring of marsh channel excavation. Vegetation clearing would be performed in a manner protective of the salt marsh harvest mouse (e.g., using hand tools). Removed pickleweed would be salvaged and reused, as feasible. Removal of trees would occur in former Schoen Park as needed for the new levee and ecotone on the south side of the existing

Tiscornia Marsh, and selective removal of non-native palm trees would occur in the marsh. Any trees (including the root system) removed in the process of diked marsh restoration and levee improvement construction as described in Sections 2.2 and 2.3 would be chipped and spread on site as wood mulch. If any native trees need to be removed, they would be replaced on site.

Shoreline Levee Improvements and Ecotone Slope Development

Most of the work for levee improvements would be earthwork, performed using land-based earthmoving equipment, including excavators, loaders, bulldozers, and articulated trucks. Approximately 6,000 cubic yards of material would be created due to excavation of the foundation soils for levee improvements, which would then be backfilled with imported, less permeable soils. The excavated material would be placed in the eroded marsh area to begin reconstruction of the marsh.

Levee and Ecotone Fill Placement

Approximately 18,000 cubic yards of fill material would be imported from an upland source(s) up to 20 miles away and placed on site for levee improvements and ecotone slope construction. Fill material would be trucked to the site on City streets and unloaded within the Project site. Levee fill material would be spread in lifts and mechanically compacted using a sheepsfoot compactor or similar machine. The estimated fill volumes account for anticipated settlement, expected to vary from 1 to 3 feet.

The ecotone slopes would be planted by hand with container plants and plugs in coordination with organizations such as Students and Teachers Restoring a Watershed (STRAW) and Conservation Corps North Bay, volunteer programs who perform vegetation planting efforts (along with other services) . A temporary drip irrigation system would be installed if needed for planting establishment in the first 2 to 3 years but would be completely removed after the plants have established. Additional temporary erosion and sediment control measures, such as straw wattles, would be installed on the levee and ecotone slopes as needed and removed once construction was completed.

Trail Surfacing

Approximately 2 to 3 years after initial construction, a final layer of fill would be placed on the crest of the new levee and improved levee segments to provide a uniform surface and address any short-term settlement. The levee crest would then be paved with asphalt concrete to provide a consistent trail surface. Further, the trail would be consistent with San Francisco Bay Trail Design Guidelines.[7] The trails would include seating areas and signage.

Diked Marsh Restoration

Restoration in the diked marsh would entail excavation of approximately 3,500 cubic yards for tidal channel construction and levee lowering. Excavated material would be reused on site as fill material for the eroded marsh area or for the final lift on the new levee and improved levee

[7] For more information regarding the San Francisco Bay trail Design Guidelines, see: https://baytrail.org/about-the-trail/building-the-trail/.

segments. Excavated material would be wet, but not to the degree that prohibits earth-handling or requires excessive processing. Any drying operations would be performed within the limits of fill placement.

The tidal channel would be excavated prior to lowering and breaching the perimeter levee, in isolation of tidal waters. The temporary access road through the diked marsh, as described above under *Temporary Access Roads*, would be further excavated to create a tidal channel, approximately 600 feet long and 20 feet wide. Channel excavation in the diked marsh would be performed using a long-reach excavator staged on the temporary access road.

The perimeter levee would be lowered and a single levee breach, 4 feet deep and 20 feet wide, would be excavated in the northeastern portion to connect the new tidal channel to Tiscornia Marsh. The levee breach would be accomplished by one or more excavators staged on the perimeter levee, starting at the proposed breach location, and working southward.

Following excavation, all temporary access mats and/or any temporary fill would be removed. Riprap removal along San Rafael Creek would be performed using equipment (e.g., long-reach excavators, dragline, etc.) staged on the perimeter levee trail. The lowered portions of the perimeter levee would be at marshplain elevation and are expected to revegetate through natural recruitment.

Coarse Beach Construction

The coarse beach would be constructed in stages to meet geotechnical requirements and to facilitate reconstruction of the historic footprint of Tiscornia Marsh. As discussed in Sections 2.2 and 2.3, the initial construction of the coarse beach would be a coarse containment berm that would be high enough to contain dredged material as it is placed for eroded tidal marsh reconstruction, isolate the work area from open water, and serve as a temporary access road for land-based equipment. After reconstruction of the eroded marsh area is finished, construction of the coarse beach would be completed by placing and shaping imported material on top of the previously constructed coarse containment berm to create a gently sloping beach. The raised crest would protect the area behind the beach from high tides, wave runup, and erosion during an average year's storm events. Proposed phased construction of the beach is shown in section view in Figure 2-4.

The beach along with its supporting retention groins and jetty structure would be constructed together within similar methods and phasing. Construction materials (approximately 26,000 cubic yards in total) would be transported to the site by truck, barge, or both. Beach material brought in by barge would be unloaded by crane or potentially by conveyor, either staged on the crane platform or the perimeter access road. The coarse containment berm and subsequent beach would then be constructed progressively from one or each end, with materials being placed from the northern crane platform, and/or from the southern shoreline using low-pressure land-based equipment (e.g., bulldozer, excavator, and/or track trucks) staged on the partially constructed berm as it is built.

Given the soft, saturated sediments to be used for tidal marsh reconstruction, synthetic geotextile fabric would be placed underneath the coarse containment berm/beach to stabilize the foundation and reduce sinking. Fill would be placed on either side of the coarse containment berm for stability, to prevent the formation of mud waves. The stable fill material would be capped with marsh soils or reshaped to function as the beach as construction progresses. A soil filter would also be installed on the landward face of the containment berm crest to reduce its permeability during tidal marsh reconstruction. The filter would consist of 1- to 2-foot layers of progressively coarser material, placed over biodegradable filter fabric. Fine, clayey material on the face would reduce permeability of the coarse containment berm/beach core and reduce flow in both directions; during high tides, the soil filter would help reduce tidal seepage into the containment cell, and during low tides the soil filter would reduce turbidity releases to Bay waters. Prior to fill placement for the tidal marsh reconstruction, sediment curtains would also be installed along the perimeter of the exposed mudflat during low tide.

Following reconstruction of the tidal marsh, the final phase of beach installation would be performed, which includes import and placement of additional coarse fill material (i.e., gravel, cobbles), shaping the beach, and planting the crest with upland and marsh transition native plant species.

Eroded Tidal Marsh Reconstruction

Dredged Material Sources

There are three potential sources of dredged material, all of which are ongoing dredging operations that utilize either the Montezuma (located at the eastern edge of the Suisun Marsh) or Open Ocean (located in the Pacific Ocean, near the Golden Gate Bridge) dredge disposal site. The City is currently partnering with the USACE on dredging the navigation canal of San Rafael Creek. If the timing aligns, canal dredging would provide sufficient dredged material for the Proposed Project. The volumes of sediment from dredging marinas and private docks range from between 1,000 and 66,000 cubic yards. It is possible that one to three local dredging projects could provide suitable fill volume required for the Proposed Project, which would require approximately 25,000 cubic yards of imported material in addition to the 6,000 cubic yards of fill material created from on-site Project activities (i.e., levee foundation soils excavation). In addition, the Larkspur Ferry Terminal is dredged by the Golden Gate Bridge, Highway and Transportation District every 4 to 5 years. One dredge cycle for the ferry terminal generates more than enough material needed for Tiscornia Marsh restoration.

Dredged Material Containment

Protection measures such as coir logs would be installed along the landside (west) of Tiscornia Marsh to protect the existing marsh from incidental sediment deposition. The partially constructed beach (i.e., coarse containment berm) would contain dredged material on the waterside (east). The south end of the fill placement area would be contained by the new ecotone slope adjacent to the setback shoreline levee.

Dredged Material Placement

Dredged material would be transported by barge to the Project site and unloaded by crane, staged on the temporary crane platform. Unloaded material would be placed and spread using a crane and/or an amphibious excavator in the mudflat. A line may be rigged between the crane and a remote anchor, which would allow the crane bucket to be pulled a long distance (sometimes referred to as skyline or Sauerman dredges). Any access roads and/or crane pads located in the mudflats would be constructed in stages to avoid soil failures (e.g., creating mud waves).

Overhead electrical transmission lines traverse the existing marsh, and one power tower owned by PG&E is located within the footprint of the new marsh. Dredged material would be placed in a manner that maintains safe distance from the overhead power lines. In addition, material would be carefully placed around the power tower footings in a protective manner that does not cause settlement or other damage.

On-site conditioning of the dredged material would be important to shape the new marsh. Initially, low-ground pressure dozers and/or amphibious excavators would be used to place the dredged material throughout the new marsh. As material is dewatered, it would be further dried and conditioned using a low-ground pressure dozer pulling a disk.

Water Management

Water removal and management are key considerations for placed dredged material, which would have high water content. Water needs to be consistently drained and removed from the marsh placement area to allow drying and consolidation of sediments. Water would be removed using temporary flap-gated culvert(s) that gravity drain to the Bay during low tide, supplemented by pumps. The water removal system would be sized to handle seepage from dredged material dewatering, seepage through the containment cell, as well as periodic tidal overtopping during spring tides (from the marsh side). Any removed water would be treated for sediment removal in a settling basin or similar feature (located on the mudflat where marsh reconstruction would occur) prior to discharge to the Bay. Interior berms would be constructed to subdivide the marsh placement area into cells to facilitate material drying and treatment of removed water prior to discharge. It is anticipated that dredged fill placement and consolidation would occur over 1 to 2 years (with drying and conditioning occurring over 6 to 18 months).

Final Marsh Restoration and Tidal Connection

When the site is ready to reintroduce tidal action (i.e., once the fill material has properly consolidated after 6 to 18 months), a new tidal channel would be excavated to connect to the existing tidal marsh channel that drains toward San Rafael Creek. The channel would be approximately 20 feet wide and 1,000 feet long, running generally along the existing edge of the eroding marsh. Excavated material would be spread in thin layers on the surface of the newly created marsh. The newly restored tidal marsh is expected to revegetate with appropriate marsh vegetation through natural recruitment.

2.3.4 Construction Equipment

Major Project elements would be constructed using a combination of land-based and marine equipment. The anticipated types of equipment for each Project element, and the total number of days in operation (assuming an 8-hour work day), are presented in **Table 2-3**.

TABLE 2-3
CONSTRUCTION EQUIPMENT

Construction Activity	Phase	Equipment-Days												
		Excavators	Off-road Trucks	Rubber Tired Loaders	Track-mounted Bulldozer	Water Truck	Highway Trucks	Sheepsfoot Compactor	Barge-mounted Pile Driver /Crane	Tug and Barge	Dragline	Amphibious Excavator	Low Pressure Bulldozer	Low Pressure Track Truck
Site Preparation, Access, and Staging														
Temporary Crane Platform	1								5					
Temporary Access Roads	1		10	5	5	5		5						
Coarse Beach Construction														
Initial Beach Construction	1								77	23	77	77	77	155
Final Lift and Shaping	3								9	3	9	9	9	19
Levee Improvements														
Foundation Over Excavation & Placement	2	20	20	20		20						20	20	
Imported Fill Placement & Compaction	2				60	60	180	120						
Final Levee Lift	3													
Eroded Tidal Marsh Reconstruction														
Imported Dredged Material	2								87	26	87	87	173	
Drying, Shaping, and Channel Excavation	2											40	40	
Diked Marsh Restoration														
Lowering of Existing Levee	3	7	7		7	7		7						
Excavation of Tidal Channel	3	5	5			5						5	5	
Trail Improvements														
Trail Surfacing	3				2	2	2	2						
TOTAL		**32**	**42**	**25**	**74**	**99**	**182**	**134**	**178**	**52**	**173**	**238**	**324**	**174**

2.3.5 Earthwork Volumes

Most Project elements entail earthwork. **Table 2-4** below summarizes the approximate cut and fill volumes, as well as the destination for excavated material, and proposed sources of fill material. Excavated material would be reused as on-site fill as much as possible. While it is expected that levee foundation soils removed are sandy soils appropriate for reuse for the tidal marsh reconstruction; it is possible that some portion of the foundation soils would require export and disposal offsite, and additional imported soil would then be required for the tidal marsh reconstruction.

TABLE 2-4
ESTIMATED EARTHWORK VOLUMES

Project Element	Earthwork Item	Volume (cubic yards)	Material Destination/ Source
Excavation Items			
Diked Marsh Restoration	New tidal channel	1,500	Eroded marsh fill
Levee Improvements	Foundation soils removal	6,000	Eroded marsh fill
Diked Marsh Restoration	Levee lowering	2,000	Final lift of levee improvements or offsite disposal (if needed)
Diked Marsh Restoration	Rip Rap Removal	400	Beach foundation or offsite disposal/reuse
Fill Items			
Levee Improvements	Levee construction	18,000	Imported soil (via truck)
Coarse Beach Construction	Coarse beach material	26,000	Imported cobble and gravel (via truck and/or barge)
Eroded Tidal Marsh Reconstruction	Portion of marsh fill	6,000	Onsite excavated material
Eroded Tidal Marsh Reconstruction	Remainder of marsh	25,000	Imported dredge material (via barge)

2.4 Operations and Maintenance

Physical and biological monitoring would be conducted at the completion of Project construction and at 1, 3, 5, and 10 years post-construction. The restored wetland habitats would be largely self-maintaining after the initial period of vegetation establishment. Anticipated maintenance for the tidal marsh, ecotone slopes, and coarse beach during the 3- to 5-year establishment period would include manual removal of invasive plants, using mechanical means, and the temporary irrigation of ecotone slope plantings. While unlikely, use of localized herbicides would be employed, if highly invasive species become present at the site.

In addition, the levee segments and trails that were constructed or improved as part of the Project would be periodically inspected to identify maintenance needs. At a minimum, levees would be inspected annually via pedestrian levee crest surveys to identify any localized settlement, rodent holes, or other conditions that could compromise the levee integrity.

Post-construction monitoring for the Project is anticipated to lead only to minor repair and maintenance activities, which may include the following:

- Manual hand removal of any obstructions that may be blocking tidal channels (e.g., sediment and/or debris), if needed.
- Periodic grading, fill placement, and trail resurfacing due to additional settlement/subsidence, or earthquake damage that occurs after initial construction period (anticipated to occur once, or possibly twice, in the first 10 years after construction).
- Grading and filling of any settlement cracks that occur along the new levee, particularly at the connection to the existing trail.
- Minor repair and/or bank protection of any erosion scarps that may threaten the levee.
- Additional manual vegetation management beyond the initial establishment period, including weed control and replanting to be done by hand, and/or extended temporary watering, as needed.

If monitoring identifies that an unanticipated type or intensity of activity is required to address repairs or adaptive management needs in addition to or more complex than those suggested above, such activity would be considered a future project. As mentioned in Section 2.2.4, Project shoreline levees were designed with consideration of sea level rise projections to roughly 2070. Any future levee raising to provide protection to 2070would be considered a future project.

2.5 References

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CHAPTER 3
Environmental Setting, Impacts, and Mitigation Measures

3.1 Introduction to the Analysis

3.1.1 Scope of the EIR

This chapter of the environmental impact report (EIR) presents the environmental and regulatory setting, impacts, and mitigation measures for the technical issue areas applicable to the Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation Project (Proposed Project, or Project). The environmental analysis provided is organized according to the California Environmental Quality Act (CEQA) resource areas as outlined in Appendix G of the CEQA Guidelines. Sections 3.2 through 3.6 present the following resource areas addressed in this EIR:

- 3.2 Aesthetics
- 3.3 Air Quality
- 3.4 Biological Resources
- 3.5 Greenhouse Gas Emissions
- 3.6 Hydrology and Water Quality

All other resource areas from CEQA Guidelines Appendix G were analyzed in an initial study, included as **Appendix B** to this EIR. During this evaluation, it was determined that the Project would result in no impact or a less-than-significant impact related to the resource areas listed below, requiring no (or minimal) mitigation measures; therefore, these resource areas are not discussed in detail in the EIR:

- Agriculture and Forestry Resources
- Cultural Resources
- Energy
- Geology and Soils
- Hazards and Hazardous Materials
- Land Use and Planning

- Mineral Resources
- Noise
- Population and Housing
- Public Services
- Recreation
- Transportation
- Tribal Cultural Resources
- Utilities and Service Systems
- Wildfire

3.1.2 Section Format

Each section contains, as relevant:

- Identification of the technical issue areas being evaluated in the section.
- The environmental and regulatory setting.[1]
- Standards of significance.
- The method of analysis.
- An assessment of Project impacts.
- Recommended mitigation measures that would reduce or avoid significant impacts, as applicable.

The environmental and regulatory setting discussion presented in each of resource area section summarizes the conditions existing before implementation of the Project, and provides a point of reference (or baseline) for assessing the environmental impacts of the proposed Project. Each discussion of impacts and mitigation measures includes an impact statement (presented in **bold text**), an explanation of the impact (as it relates to the Project), an analysis of the impact's significance, identification of relevant mitigation measures if applicable, and an evaluation of whether the identified mitigation measures would reduce the magnitude of identified impacts. Each impact statement is assigned a number based on the section and the order they appear (for example, 3.2-1, 3.2-2, etc., for impacts in Section 3.2). Mitigation measures for each impact are numbered in order (for example, 3.2-1, 3.2-2, etc., for mitigation measures in Section 3.2).

3.1.3 Significance Determinations

The significance criteria used in this EIR are based on CEQA Guidelines Appendix G, with some modifications. The significance criteria used to analyze each environmental resource topic are

[1] Per CEQA Guidelines Section 15125, an EIR must include a description of the physical environmental conditions in the vicinity of the project, as they exist at the time the notice of preparation is published, or if no notice of preparation is published, at the time environmental analysis is commenced, from both a local and regional perspective.

presented in each section of Chapter 3 before the discussion of impacts. The categories used to designate impact significance are described below.

- **No Impact.** A project is considered to have no impact if there is no potential for impacts, or if the environmental resource does not exist within the project area or the area of potential effect. For example, there would be no impact related to wastewater disposal if the Project would not involve the production of wastewater.
- **Less than Significant.** This determination applies if there is a potential for some limited impact, but not a substantial adverse effect that qualifies under the significance criterion as a significant impact. No mitigation is required for impacts determined to be less than significant.
- **Less than Significant with Mitigation.** This determination applies to impacts that either could be or would be significant and likely to occur, but for which feasible mitigation is available to reduce the impacts to a less-than-significant level. Some of the impact significance determinations in this EIR are conservative, in that although there is no known information to suggest a definite significant impact, those impacts are treated as significant and mitigation measures are proposed to reduce those impacts to less than significant.
- **Significant and Unavoidable.** This determination applies to impacts that either could be or would be significant, but for which no feasible mitigation has been identified to reduce the impacts to a less-than-significant level. Some mitigation might be available to lessen the impact, but the residual effect remains significant, and therefore the impact is considered unavoidable.

In determining the significance of a Project impact, the analysis first describes the nature, frequency, magnitude, and/or severity of a potential effect and then determines that it either would be significant or less than significant, or that no impact would occur, based on the appropriate significance criteria.

3.1.4 Approach to the Cumulative Projects Scenario and Cumulative Impact Analysis

CEQA Analysis Requirements

As defined in CEQA Guidelines Section 15355, a cumulative impact is an environmental impact that is created by the combination of the proposed project being evaluated and other projects causing related impacts. CEQA Guidelines Section 15130 requires that an EIR discuss a project's contribution to cumulative impacts. The cumulative impact analysis may be less detailed than the analysis of a given project's individual effects (CEQA Guidelines Section 15130(b)). The cumulative impact from several projects is defined as "….the change in the environment which results from the incremental impact of the project added to other closely related past, present, and reasonably foreseeable probable future projects. Cumulative impacts can result from individual minor but collectively significant projects taking place over a period of time" (CEQA Guidelines Section 15355(b)).

Section 15130(b) of the CEQA Guidelines requires one of the following approaches for an adequate discussion of significant cumulative impacts of a project:

- A list of past, present, and probable future projects producing related or cumulative impacts, including, if necessary, those projects outside the control of the agency.
- A summary of projections contained in an adopted general plan or related planning document or in an adopted or certified environmental document that described or evaluated regional or area-wide conditions contributing to the cumulative impact.

The cumulative impact analysis in this EIR specifically uses the first ("list") approach.

Related Projects

Geographic Context

The geographic area that could be affected by implementation of the Proposed Project in combination with other projects varies depending on the type of environmental resource being considered. The impact analysis in this EIR considers different geographic areas as appropriate to each impact. Many cumulative impacts (such as impacts on biological resources) would occur within the immediate vicinity of a project (adjacent to or within one-half mile); some impacts (such as impacts on hydrology and water quality) affect the local watershed; and some impacts are regional (such as air quality impacts related to criteria pollutant emissions).

The Proposed Project would restore former tidal marshlands and improve the shoreline levee at the confluence of San Rafael Creek and San Rafael Bay. (The Project site lies along the northern boundary of the Canal neighborhood in central San Rafael. Tiscornia Marsh is bounded on the west by the Albert J. Boro Community Center and Pickleweed Park. To the north is the mouth of San Rafael Creek, and to the east is San Rafael Bay. The location of the former Schoen Park (converted by the City of San Rafael in 2019) lies south of the Tiscornia Marsh shoreline levee, on the southeastern portion of the Project site, bordered by Spinnaker Point Drive (see Figure 2-2).

List of Cumulative Plans and Projects

Table 3.1-1 lists past, present, and reasonably foreseeable probable future projects within and near the Project site whose impacts could add to the impacts of the Proposed Project. For each project, this table presents the planning jurisdiction, a brief description, the distance of that project to the Project site, and the project's estimated construction schedule. The cumulative project information listed in Table 3.1-1 is based on information supplied by the City of San Rafael, as well as information from other entities, review of EIRs, and review of information posted on agency websites. The list includes planned, approved, reasonably foreseeable, and recently constructed projects of various purposes, such as infrastructure repair/enhancement, flood control, water supply, and recreation improvements.

TABLE 3.1-1
PROJECTS IN THE VICINITY OF THE PROPOSED PROJECT EVALUATED FOR CUMULATIVE IMPACTS

Project Name	Location	Project Description	Distance from the Proposed Project	Potential Cumulative Impact Topics	Lead Agency	Schedule/Status
Pickleweed Field and Park Project	50 Canal Street, San Rafael	Planning, design, and construction of improvements to Pickleweed Park and Field. The work will convert the field at Pickleweed to synthetic turf for year-round access and install several other recreation features.	Adjacent to Tiscornia Marsh	Air Quality, Biological Resources, Transportation	City of San Rafael Department of Public Works	Design and planning phase, 2020–2021 Construction projected to be complete in 2025
Schoen Park Conversion to Parking	On Canal Street near the junction with Spinnaker Point Drive, San Rafael	Planning, design, and construction of revisions to Schoen Park. The modifications will create approximately 20 new parking spaces in the previous footprint of Schoen Park.	Adjacent to Tiscornia Marsh	Air Quality, Biological Resources, Transportation	City of San Rafael Department of Public Works	Design and planning phase, 2019–2021 Construction projected to begin in 2021
Canal Neighborhood Pedestrian Safety Improvements	Various locations	Proposed improvements and safety enhancements that include installations of: • Americans with Disabilities Act curb ramps • Rapid rectangular flashing beacons • Quick-build bulb-outs • Street lighting	Within approximately 5 miles of Tiscornia Marsh	Air Quality, Transportation	City of San Rafael Department of Public Works	Construction to begin 2021
The Village at Loch Lomond Marina Project	110 Loch Lomond Drive, San Rafael	Construction of improvements to the playground area on the eastern jetty and the entrance to the breakwater.	Approximately 4 miles northeast of Tiscornia Marsh	Biological Resources, Hydrology and Water Quality	City of San Rafael Community Development Department	Construction scheduled to commence in 2021 and be complete by early 2022.
San Rafael General Plan 2040	City of San Rafael	San Rafael's vision for its future, including policies for the future growth and conservation of the city. The Final EIR for the project was made available on May 23, 2021.	Citywide	Air Quality, Biological Resources, Cultural Resources, Hydrology and Water Quality, Transportation	City of San Rafael Community Development Department	Adopted August 2021

TABLE 3.1-1 (CONTINUED)
PROJECTS IN THE VICINITY OF THE PROPOSED PROJECT EVALUATED FOR CUMULATIVE IMPACTS

Project Name	Location	Project Description	Distance from the Proposed Project	Potential Cumulative Impact Topics	Lead Agency	Schedule/Status
San Rafael Creek Operations and Maintenance	Across-the-Flats Channel in San Francisco Bay to the mouth of San Rafael Creek	A seven-year cycle for maintenance dredging to a depth of -8 feet MLLW for the Across-the-Flats Channel in San Francisco Bay to the mouth of San Rafael Creek, and a four-year cycle for maintenance dredging to a depth of -6 feet MLLW for the Inner Canal Channel to the head of navigation at the Grand Street Bridge in the city of San Rafael. The Inner Canal and Across-the-Flats Channels were last dredged in Fiscal Year 2012 to a depth of -5 feet MLLW, with placement of the dredged material at the San Pablo Bay Disposal Site (SF-10), an unconfined aquatic disposal site.	Approximately 0 to 5 miles north and east of Tiscornia Marsh	Air Quality, Biological Resources, Hydrology and Water Quality	U.S. Army Corps of Engineers	In March 2020, the San Rafael Creek Operations and Maintenance Project was awarded $1,378,000 in federal funds for the first step in dredging: the environmental testing and preliminary design for full dredging.
Hampton Inn and Suites	1075 Francisco Boulevard East	The proposed Hampton Inn and Suites Project is for a 185-room hotel and includes guest rooms and guest amenities including a breakfast dining area, meeting rooms, swimming pool, fitness room, guest laundry area, and market. The structure is a contemporary architectural style comprised primarily of aluminum, wood panels, and white plaster. Landscaping will be provided throughout the site including along all property lines and within paved parking areas. The project will include 195 parking spaces for this project.	Approximately 1 mile southwest of Tiscornia Marsh	Air Quality, Greenhouse Gas Emissions, Transportation	City of San Rafael	Approved, construction schedule unknown

NOTES: EIR = environmental impact report; MLLW = mean lower low water

SOURCE: Data compiled by Environmental Science Associates in 2021

3.1.5 References

No references are cited in this section.

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3.2 Aesthetics

This section describes the environmental and regulatory setting of the Project site and surrounding area with respect to aesthetics and visual resources, and presents an analysis of impacts of the Proposed Project on those resources. City best management practices and mitigation measures to avoid or reduce significant impacts are also identified when needed.

3.2.1 Environmental Setting

Visual or aesthetic resources are generally defined as both the natural and built features of the landscape that contribute to the public's experience and appreciation of the environment. The physical aesthetic setting therefore encompasses any area in the Project vicinity from which there are scenic views that could be affected by the Project. Depending on the extent to which a project's presence would alter the perceived visual character and quality of the environment, a visual or aesthetic impact may occur. This discussion defines key terms used in the aesthetics evaluation and describes the Project site and vicinity in terms of their scenic resources.

Concepts and Terminology

Visual character is a general description of the visual attributes of a particular setting. The purpose of defining the visual character of an area is to provide the context within which the viewing public is likely to perceive the visual quality of a particular site or locale. For urban areas, visual character is typically described on the neighborhood level, or in terms of areas with common land use, development intensity, and/or urban design features. For natural and open space settings, visual character is most commonly described in terms of areas with common landscape attributes (e.g., landform, vegetation, water features).

Visual quality is defined as the overall visual impression or attractiveness of a site or locale as determined by its aesthetic qualities (such as color, variety, vividness, coherence, uniqueness, harmony, and pattern).

Scenic vistas are locations from which the public can experience unique and exemplary views, typically from elevated vantage points that offer panoramic views of great breadth and depth.

S*ensitive viewers* are those who have a strong stake or interest in the quality of the landscape and a greater sensitivity to changes that degrade or detract from the visual character of an area. Examples of sensitive viewers include travelers on designated scenic routes, park visitors, cyclists, pedestrians, and tourists. With respect to lighting and glare, sensitive viewers may also include people in residential buildings.

Viewer exposure addresses the variables that affect the viewing conditions of a site. Viewer exposure considers some or all of the following factors: landscape visibility (ability to see the landscape); viewing distance (proximity of viewers to the project); viewing angle (whether the project would be viewed from a superior, inferior, or level line of sight); extent of visibility (whether the line of sight is open and panoramic to the project area or restricted by terrain, vegetation, and/or structures); and duration of view.

A *viewshed* is an area of land, water, or other urban or environmental element that is visible to the human eye from a fixed vantage point.

Visual Study Area

The visual study area for the Proposed Project includes all public areas from which Project components would come into view (e.g., temporary crane platform and other construction and barge offloading equipment for dredge placement, levee improvements, and new levee construction). The Project area is located along San Rafael Creek, in a low-lying marsh area surrounded by residential homes on either side of the waterway, city streets, the Marin Yacht Club (a private yacht club), and the adjacent community center, park, and San Francisco Bay Trail (Bay Trail).

This location offers views of Tiscornia Marsh itself, the adjacent San Rafael Bay and San Rafael Creek, and the Richmond–San Rafael Bridge, as well as views of surrounding hills peppered with residences, and Mount Tamalpais in the distant background. However, topography, trees, shrubs, and residential buildings quickly restrict or block views of the Project site as viewers move away from the site on either side of the creek. Consequently, the visual study area is generally limited to publicly accessible locations on and immediately surrounding the Project site. For example, although the Project site is highly visible from the Bay Trail immediately adjacent to the Project site, the site is no longer visible as soon as the Bay Trail curves around the east side of the Baypoint neighborhood. Similarly, intervening residences, fencing, and vegetation obstruct views of the Project site from all surrounding public roadways, except adjacent segments of Spinnaker Point Drive and Canal Street, on both sides of San Rafael Creek.

The exact boundaries of the visual study area depend on site conditions (viewshed, structures, topography, and vegetation) and are highly site-specific. Site visits were performed in May and June 2021 to further define and assess the visual study area. During the May 2021 visit, representative photographs were taken to document the existing visual conditions of the Project site. **Figure 3.2-1** displays a map of the photo locations and viewing direction. **Figures 3.2-2**, **3.2-3**, **and 3.2-4** present 12 representative publicly available views of the Project site and adjacent areas, which are used to describe the Project site's visual character in the description of visual character below. The locations of Photos 1 through 4 (Figure 3.2-1) generally delineate the extents of the local viewshed, and thus, the visual study area.

Visual Character of the Project Area

The Project site is located just north and adjacent to the densely populated Canal neighborhood of central San Rafael, at the mouth of San Rafael Creek where it meets San Rafael Bay. The visual character of the Project site and adjacent areas reflects the mix of urban public utility, recreational, and residential land uses in the vicinity: the Albert J. Boro Community Center and Pickleweed Park and adjoining soccer field and children's playground, public open space across the creek and along

SFO\16xxxx\D160888.01 - Tiscornia Marsh Restoration and SLR Adaptation\05 Graphics-GIS-Modeling\Illustrator

SOURCE: ESRI Imagery; ESA, 2021

Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation Project

Figure 3.2-1
Photo Viewpoint Map

ESA

Photo 1 - View of east side of Tiscornia Marsh from the Bay Trail east of the Project Site, on north side of Baypoint Neighborhood

Photo 2 - View of Tiscornia Marsh from adjacent Spinnaker Point Drive near the entrance to the Jean and John Starkweather Shoreline Park.

Photo 3 - View from the north side of Canal Street at Kerner Boulevard, looking over the children's playground on the west side of the existing soccer fields toward the Project Site.

Photo 4 - View of the Project Site from the public open space and trail on the north side of the Canal (opposite the Project Site).

SFO\16xxxx\D160888.01 - Tiscornia Marsh Restoration and SLR Adaptation\05 Graphics-GIS-Modeling\Illustrator

SOURCE: ESA, 2021

Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation Project

Figure 3.2-2
Photos of the Project Site from Nearby Public Vantage Points

ESA

Photo 5 - View from the existing soccer field, facing north toward the diked marsh, where the new levee would be constructed.

Photo 6 - View from the existing soccer field facing east-southeast toward the field's perimeter fencing and Tiscornia Marsh.

Photo 7 - View from the existing trail on the western segment of perimeter levee around the diked marsh, facing southwest toward the City-owned pond.

Photo 8 - View from the access ramp to the easternmost PG&E tower on the Project Site, looking toward the mudflat and eroded Tiscornia Marsh edge.

SFO\16xxxx\D160888.01 - Tiscornia Marsh Restoration and SLR Adaptation\05 Graphics-GIS-Modeling\Illustrator

SOURCE: ESA, 2021

Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation Project

Figure 3.2-3
Photos of the Project Site from Existing Public Spaces on and Adjacent to the Project

ESA

Photo 9 - View over the diked pickleweed marsh toward the soccer fields, from the tip of the existing perimeter levee around the diked marsh.

Photo 10 - View over the diked pickleweed marsh toward Tiscornia Marsh, from the water's edge of the perimeter levee as it turns from the west side ofthe marsh to the north.

Photo 11 - View over Tiscornia Marsh east, from the levee trail on the east side of the existing soccer field.

Photo 12 - View over Tiscornia Marsh from the levee trail on the southwest side of Tiscornia Marsh, just before it turns to the south side of Tiscornia Marsh.

SFO\16xxxx\D160888.01 - Tiscornia Marsh Restoration and SLR Adaptation\05 Graphics-GIS-Modeling\Illustrator

SOURCE: ESA, 2021

Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation Project

Figure 3.2-4
Photos from the Project Site of On-Site and Adjacent Features

ESA

the Bay Trail system, the Marin Yacht Club, private residential homes, and Pacific Gas and Electric Company (PG&E) infrastructure. One can view both naturalistic features (e.g., Tiscornia Marsh, vegetated hills, shoreline trails) and built features (e.g., a public playground, soccer field, transmission towers, residential buildings) in close proximity and in the far distance.

As the photographs in Figures 3.2-2 through 3.2-4 demonstrate, open views through the Project site and immediate vicinity provide scenic vistas with views of Mount Tamalpais, the Richmond–San Rafael Bridge, and hills and ridgelines, and of the marsh ecosystems on the Project site itself. The visual quality of the Project area is generally high, defined by the vivid colors of the marsh, vegetated hills, and nearby residences, as well as the localized dynamic shifts between built and natural features and the aesthetic variety that creates. However, as the photographs in these figures also demonstrate, vegetation and structures sometimes obstruct or partially obstruct views of the Project site even from very close by (e.g., Photo 3); PG&E transmission towers sometimes disrupt the continuity of scenic views (e.g., Photo 4); and the area's hilly topography often draws the viewer's eyes up and away from the low-lying Project site itself (e.g., Photos 2, 5, and 8).

Views of the Project Site from Nearby Public Vantage Points

Approaching the Project site from the east along the Bay Trail (Photo 1) or from Spinnaker Point Drive (Photo 2), the Project site is highly visible but is not the focus of the view. The viewer's eyes are drawn up and away from the low-lying marsh vegetation and trails toward the PG&E towers in the middleground and the vegetated hills in the background.

From just southwest of the Project site at the children's playground (Photo 3), the viewer can see the nearby soccer fields and may be able to make out the area designated for construction equipment storage and where the west side of the new levee would tie in to the shoreline. However, in this location, the vast majority of the Project site is obstructed from view by vegetation and there is not an open or expansive view past the immediate surroundings.

From the public open space across San Rafael Creek (Photo 4), which also approximates a view of the Project site from the bay waters at the mouth of the creek, the Project site is again highly visible, but it is not the focus of the view. The viewer's eyes are drawn to the looming Mount Tamalpais in the background, to the disruption created by the PG&E tower in the middleground, and then perhaps to the light-refracting water itself; but neither the marsh and mudflat nor the levees of the Project site (or even the soccer field) stand out.

It can be noted from Photos 1 through 4 that the Project site does not provide gathering places (e.g., park benches, picnic tables) that encourage static and contemplative viewing of the site. Rather, recreationists and other viewers of the Project site would be moving past or through the site on trails, sidewalks, or via boat, or would be engaged in play and supervision activities at the children's playground.

Views from Public Vantage Points On and Adjacent to the Project Site

Figure 3.2-3 presents a series of photographs of the Project site from existing public spaces on and adjacent to the site. Photo 5 depicts a view from the existing soccer field behind the Albert J.

Boro Community Center and Pickleweed Park, facing north toward the diked marsh. The location shown in the middleground, on the northern extent of the soccer field, is where the new levee would be constructed under the Proposed Project. As one can see, the viewer's eyes are immediately drawn to the large, looming vegetated hill in the background, and to the vegetation in the middleground. The diked marsh is somewhat visible, but it is partially obstructed by the ridge along the north side of the field, which even blocks much of the fence line from view.

Photo 6 is another view from the soccer field, this time facing east-southeast toward the existing Tiscornia Marsh. The view of the low-lying marsh from this vantage point is blocked by vegetation, the intervening fence line, and mainly by the sloped rise of the field up to the fence line and trail. Viewers from these vantage points would be focused on playing soccer or observing a soccer match, and perceiving visual or scenic resources would not be their main objective.

The City-owned pond is visible in the right-side middleground of Photo 7, which was taken from the existing trail on the western segment of the perimeter levee around the diked marsh, facing southwest directly along the trail. This view is also representative of what a viewer would see of the west side of the Project site from a passing boat on San Rafael Creek, as its location is only 25 feet from the shoreline. As one can see from Photo 7, the pond is not a focus of this view, particularly because viewers would be moving past this vantage point while hiking or boating, rather than standing still. The view from this point is dominated by the marsh vegetation and trees on either side of the trail, in the foreground, middleground, and background, which frame the trail as the central feature. This view is not particularly scenic or expansive; the scenic quality of this view is instead derived from the vivid colors of vegetation.

A view over Tiscornia Marsh looking toward the Albert J. Boro Community Center and Pickleweed Park is presented in Photo 8, which was taken from the access ramp to the eastern on-site PG&E tower but also approximates a view one would see if traveling via boat into or out of the creek from San Rafael Bay. Mount Tamalpais is in the background, but the foreground features take precedence over other views of the mountain; the highly eroded marsh edge appears in sharp relief, and the mudflat appearing in the immediate foreground is less visually appealing than other features in view.

Views from the Project Site of On-Site and Adjacent Features

Photos 9 and 10 in Figure 3.2-4 present two different views from the perimeter trail (that would be breached or degraded as part of the Proposed Project) over the diked pickleweed marsh toward the existing soccer field and toward the existing portion of Tiscornia Marsh. These views approximate views one might see from San Rafael Creek off the northwestern side of the currently diked marsh. These views show that the diked marsh appears relatively expansive in relation to other parts of the Project site; portions of the slightly elevated soccer field are visible, but Tiscornia Marsh is not. The visual quality of these views comes from the presence of marsh vegetation in the foreground and the distant vegetated hills in the background.

Photos 11 and 12 show two different views from the levee trail on the east side of the Project site: one from the east side of the soccer field (Photo 11) and one from the southwest corner of

Tiscornia Marsh, just before the trail turns to the south side of the marsh (Photo 12). From the vantage point shown in Photo 11, the marsh vegetation fills a portion of the view, but the viewer's eyes are drawn to the visual line created by the Richmond–San Rafael Bridge in the background, blending into the line of the cobbled shoreline and residential homes lining the shoreline in the middleground. Looking the other way over Tiscornia Marsh toward the northeast (Photo 12), the marsh vegetation offers some visual quality, but again, the eyes are mainly drawn to the colors, variety, and contrast of the vegetated and populated hill in the background.

Light and Glare at the Project Site

Lighting in the immediate Project area comes from a mix of natural and built sources, given the surrounding urban environment. Nighttime lighting near the Project site includes overhead street lights in the community center parking lot and along Spinnaker Point Drive/Canal Street, headlights from passing cars on Spinnaker Point Drive/Canal Street and from boats passing in San Rafael Bay and San Rafael Creek, and light from residential buildings along Spinnaker Point Drive/Canal Street. Lighting is also provided from homes across the creek at the end of Summit Avenue and Sea Way, and from docked boats at the Marin Yacht Club.

3.2.2 Regulatory Setting

Federal Regulations

No federal regulations related to aesthetic resources are applicable to the Proposed Project.

State Regulations

California State Scenic Highway Program

The California Department of Transportation (Caltrans) designates highways as scenic highways based on how much of the landscape can be seen by travelers, the scenic quality of the landscape, and the extent to which views are compromised by development. There are no state-designated scenic highways in Marin County (Caltrans 2021); however, portions of U.S. Highway 101 (U.S. 101), State Route (SR) 1, and SR 37 in Marin County are identified as eligible state scenic highways. The eligible portions of U.S. 101 and SR 37 are located more than 8 miles north of the Project site, and SR 1 is more than 10 miles west of the Project site at its closest point. The Richmond–San Rafael Bridge (Interstate 580), located approximately 2 miles away and visible from the Project site, is not designated or eligible for listing as a state scenic highway.

Local Plans and Policies

The City of San Rafael General Plan 2020

The City of San Rafael General Plan 2040 (General Plan 2040), adopted in 2021, serves as the current general plan for the City. The General Plan 2040 sets forth policies for conservation and development and outlines specific programs and actions for implementing these policies. According to the General Plan 2040, the major features that create the City's visual character are local hills and ridgelines, the bay, creeks and wetlands, San Rafael Creek, tree cover, transportation corridors, neighborhoods, and downtown San Rafael (City of San Rafael 2021).

Aesthetic resources policies in the plan focus on preservation of hillside and ridgeline views and setbacks from open waters, such as San Rafael Creek and San Rafael Bay. These policies are incorporated into the Neighborhoods Element, Community Design Element, and Open Space Element of the General Plan 2040. The following policies and programs are relevant to the location and context of the proposed Project's visual impacts analysis:

> ***Policy NH-3.2. San Rafael Canal.*** Promote the San Rafael Canal as a community-wide asset for public and marine related uses. Public access and views of the water should be improved, and sensitive wildlife habitat should be protected.
>
> > *Program NH-3.2A: Design Plan and Vision for the Canalfront.* Continue implementation of the Canalfront Conceptual Design Plan, including circulation and access improvements and development of a waterfront paseo.
>
> ***Policy NH-3.5: Waterfront Design.*** Require new buildings along the Canal waterfront to provide public views of the water and accommodate public access to the shoreline. Design factors important in reviewing specific development proposals include pedestrian access, waterfront setbacks, view protection and enhancement, habitat protection, architectural design quality, and landscaping.
>
> > *Program NH-3.5A: Canalfront Design Guidelines*. Use the development review process to implement the 2009 Design Guidelines for the Canal Waterfront, including requirements for a 25' waterside setback for new buildings and a 10' paseo along the waterfront. Amenities such as seating, lighting, and bike racks should be provided along the shoreline. The Design Guidelines include provisions for building materials, architecture, lighting, signage, views, public open space, landscaping, street furniture, streets and sidewalks, and sustainability.
>
> ***Policy CDP-1.2: Natural Features.*** Recognize and protect the key natural features that shape San Rafael's identity, including the Bay, local hills and ridgelines, creeks and wetlands, tree cover, and views of Mt. Tamalpais and other natural landmarks. Height limits and other building standards should respect San Rafael's natural topography and reinforce its sense of place, including the character and boundaries of individual neighborhoods.
>
> ***Policy CDP-1.4: Waterfront Identity.*** Strengthen San Rafael's identity as a waterfront city, providing improved visual and physical access to San Pablo Bay, San Rafael Bay, and the San Rafael Canal.
>
> > *Program CDP-1.4A: Canalfront Design Plan***.** Implement the Canalfront Conceptual Design Plan (2009) recommendations. Development near the shoreline should maximize views to the water and public access to the shoreline.
>
> ***Policy CDP-1.5: Views.*** Respect and enhance to the greatest extent possible, views of the Bay and its islands; wetlands, marinas, and canal waterfront; hillsides and ridgelines; Mt. Tamalpais; Marin Civic Center; and St. Raphael's bell tower; as seen from streets, parks, and public pathways.

Policy PROS-3.1: Open Space Frame. Retain and protect San Rafael's open space frame, including open space on the city's perimeter and the network of open spaces that define and connect the city's neighborhoods. Open space should be recognized as essential to wildlife, environmental and human health, psychological well-being, and as a natural means of separating communities, preventing sprawl, and providing visual relief.

Program PROS-3.1A: Criteria for Open Space Protection. Use the following criteria for identifying and prioritizing open space parcels for future protection (the criteria are not listed in any particular order):

… b. Aesthetics (visual backdrop or edge, unique site features, shorelines, ridgelines)…

Canalfront Conceptual Design Plan

In 2009, the City completed the Conceptual Design Plan for the segment of San Rafael Creek informally known as the San Rafael Canal (City of San Rafael 2009). The plan recognizes this segment of the creek as a defining feature of San Rafael that provides recreational, aesthetic, and environmental benefits. Among the recommendations are development of a waterfront paseo from downtown to Pickleweed Park on the south bank, and along the Montecito waterfront on the north bank. The plan envisions a thriving Canalfront with maritime presence, sailing, boating, rafting, kayaking, and fishing, and where habitat for birds and plants is restored, creating a healthier ecosystem.

Compatibility with the Canalfront Conceptual Design Plan is relevant to visual resources because of the aesthetics-related General Plan Policy CD-5a, listed above. The Project site lies within the Pickleweed Park area of the plan, and is near the Canal Street area of the plan. The following recommendations of the plan for both of these areas are relevant to the visual context and analysis of aesthetic resources at the Project site:

Canal Street Recommendations:

- Develop a continuous publicly accessible pedestrian walkway on the waterfront as opportunity arises.

Pickleweed Park Recommendations:

- Provide a path accessible for maintenance vehicles and pedestrians around the perimeter of Pickleweed Park, while also maintaining the natural character of the existing trail.
- Provide seating areas for wildlife observation in Pickleweed Park.
- Enhance habitat along the shoreline and within the park where possible.
- Provide interpretive signage along the Bay Trail path around the waterfront edge of Pickleweed Park.

3.2.3 Impacts and Mitigation Measures

Significance Criteria

The criteria used to determine the significance of impacts related to aesthetics are based on Appendix G of the CEQA Guidelines. The Proposed Project would have a significant impact if it would:

- Have a substantial adverse effect on a scenic vista.
- Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway.
- In non-urbanized areas, substantially degrade the existing visual character or quality of public views of the site and its surroundings (public views are those that are experienced from publicly accessible vantage points), or, if the project is in an urbanized area, conflict with applicable zoning and other regulations governing scenic quality.
- Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area.

Approach to Analysis

The aesthetic resources impact analysis is based on field observations conducted by Environmental Science Associates in May and June 2021; review of Project maps and drawings; aerial and ground-level photographs; and review of a variety of data in the record, such as local planning documents. The analysis identifies potential temporary (short-term) and permanent (long-term) Project impacts on scenic vistas; on scenic resources (those occurring within a state-designated scenic highway corridor); and on the visual character and quality of the Project site as seen from public urban locales, recreational facilities, and open space areas. The analysis does not address aesthetic changes to views from private residences, private roads, or the private Marin Yacht Club.

With respect to analysis of effects on aesthetic character and quality, San Rafael is considered an urbanized area, as defined in CEQA Guidelines Section 15387, and as mapped by the U.S. Census (U.S. Census Bureau 2012). As discussed in Section 3.2.2, *Regulatory Setting*, no federal or state policies regulating visual resources would apply to the Project, but there are relevant local plans and policies. The analysis below considers the potential for the Project to conflict with these plans and policies.

Construction Impacts

The evaluation of temporary visual impacts considers whether Project construction activities could substantially degrade scenic vistas, scenic resources, and the lighting environment.

Operational Impacts

Permanent visual impacts are assessed based on the Project's potential to substantially alter scenic resources (e.g., by removing trees and other landscaping, raising levees), alter the urban recreation landscape in a manner that would adversely affect a scenic vista, or create excessive glare or nighttime lighting that would adversely affect those sensitive to the effects of light and glare.

Topics Considered and Determined to Have No Impact

The following topics are considered to have no impact based on the Proposed Project's characteristics, its geographical location, and/or underlying site conditions. Therefore, these topics are not addressed further in this document for the following reasons:

- ***Degradation of existing visual character or quality of public views of the site and its surroundings in non-urbanized areas:*** The Project site is within the limits and jurisdictional boundaries of the City of San Rafael. San Rafael is considered an urbanized area as defined in CEQA Guidelines Section 15387, and as mapped by the U.S. Census (U.S. Census Bureau 2012). It is adjacent to residential land uses of the Canal neighborhood and a popular community center and park owned by the City. The Project site is located in an urbanized area; therefore, relative to an examination of visual character or quality of public views in a non-urbanized area, the Project would have no impact.
- ***Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway:*** There are no designated state scenic highways in Marin County (Caltrans 2021). Portions of U.S. 101, SR 1, and SR 37 have been identified as eligible for listing; however, the eligible portions of U.S. 101 and SR 37 are located more than 8 miles north of the Project site, and SR 1 is more than 10 miles west of the Project site at its closest point. The Richmond–San Rafael Bridge (Interstate 580), located approximately 2 miles away and visible from the Project site, is not designated or eligible for listing as a state scenic highway. Therefore, no scenic highways exist on or within the visual study area of the Project site, and the Project would have no impact on scenic resources within a state scenic highway.

Impact Summary

Table 3.2-1 provides a summary of Project impacts related to aesthetics.

TABLE 3.2-1
SUMMARY OF AESTHETICS IMPACTS

Impact Statement	Construction	Operation
Impact 3.2-1: The Project would not have a substantial adverse effect on a scenic vista.	LTS	LTS
Impact 3.2-2: The Project would not conflict with applicable zoning and other regulations governing scenic quality.	LTS	LTS
Impact 3.2-3: The Project would not create a new source of substantial light or glare that would adversely affect day or nighttime views in the area.	LTS	LTS
Impact 3.2-4: The Project, combined with other reasonably foreseeable future projects in the Project vicinity, would not result in significant cumulative impacts related to aesthetics or visual resources.	LTS	LTS

NOTE: LTS = less than significant

Impact Analysis

Impact 3.2-1: The Project would not have a substantial adverse effect on a scenic vista. (*Less than Significant*)

Construction

Implementation of the Proposed Project could cause temporary construction-related impacts on scenic vistas. The Project would require construction of a coarse beach feature, levee raising and construction, and mechanical placement of on-site excavated and imported material into the eroded tidal marsh area to be restored. It would also require site preparation activities (e.g., installation of a temporary crane platform and access roads, vegetation removal) and demobilization activities (e.g., removal of temporary roads, culverts, and equipment, and seeding and planting).

This work would require various pieces of construction equipment, such as excavators, bulldozers, trucks, compactors, and a tugboat and barge. This equipment would be stored on-site during construction of the Project, which would occur approximately six months out of the year over the three-to-four-year construction period. The location of staging and storage areas, access routes, and the crane platform can be seen in Figure 2-5.

As discussed previously in the *Visual Study Area* section, the viewshed around the Project site is limited by topography, trees, shrubs, and residential buildings, which quickly restrict or block views of Proposed Project components as viewers move away from the site, on either side of San Rafael Creek. Consequently, much of the Project construction activities and equipment would not be visible from public streets or other public vantage points.

Public views of construction activities would be further limited by closures of the shoreline trails at the Project site. (Figure 2-5 shows the construction access routes that would lead to trail closures during the construction season.) Recreationists and other visitors to the Project area whose views of the Project site could be affected are therefore limited to the following:

- Recreationists and other visitors who would approach from the Bay Trail or Spinnaker Point Drive from the north side of the Spinnaker Point/Bay Point neighborhood (Figure 3.2-2, Photos 1 and 2).
- Users of the Albert J. Boro Community Center and Pickleweed Park and associated soccer field and children's playground (Figure 3.2-2, Photo 3; Figure 3.2-3, Photos 5 and 6).
- Boaters traveling by the Project site in San Rafael Bay or San Rafael Creek (Figure 3.2-3, Photos 7 and 8; Figure 3.2-4, Photos 9 and 10).
- Users of the public open space on the north side of the creek (Figure 3.2-2, Photo 4).

All these viewers would be moving past or through the site as they boat or hike, or would be actively engaged in activities on the playground or soccer field. The Project site does not include gathering places (e.g., park benches, picnic tables) that encourage static, contemplative viewing of the site.

Although Project construction activities would be visible to viewers approaching the site from the east, the construction equipment in the marsh or on the levee trails would not be the focal point of their view, as discussed previously in the *Visual Character of the Study Area* section. The viewer's eyes are drawn up and away from the low-lying marsh vegetation and trails toward the PG&E towers in the middleground and the vegetated hills in the background. The crane (when present) would likely be the most visible feature, but would be minimized in comparison to the large transmission towers and expansive hills in the background.

For users of the community center, soccer fields, and playground, most views of the Project site would be blocked as well. From the children's playground, the only portion of the Project site that a viewer would likely see is the equipment staging area, but this would be highly obstructed by the surrounding vegetation. The most exposed viewers would be those using the soccer field; however, as discussed in the *Visual Character of the Study Area* section, views from the soccer field toward the location of proposed new levee construction are dominated by the vibrant, vegetated hill in the background to the north, and views of Tiscornia Marsh are obstructed by vegetation to the east. The partially obstructed surrounding marsh areas are not the focus. Construction equipment would be visible during construction of the new levee and during levee improvement activities, given the close proximity, but this work would occur over a single construction season and the remaining Project construction activities would be relatively screened from view. In addition, users of the children's playground and the soccer field would be present for specific purposes: playing or supervising children on the playground, or playing or watching a soccer match on the field. These activities, not the perception and enjoyment of specific views or vistas, would be the focus of attention.

As for those traveling by boat who may catch views of the Project site from San Rafael Creek or San Rafael Bay, the viewpoint would not be static, but rather would be consistently changing as the boat passes by. Depending on their position at any given moment, boaters might see views of the west levee tie-in work (Photo 7); views of the new levee construction beyond the diked marsh, perimeter levee degrade work, or diked marsh restoration activities (Photos 9 and 10); or views of the eroded Tiscornia Marsh and dredge placement activities (Photo 8).

As discussed in Section 2.2.4, *Shoreline Levee Improvements*, in Chapter 2, *Project Description*, there are two potential options for the west levee tie-off, both of which would partially fill the City-owned pond. Under option 1, the north side would be filled to allow the 4 feet of shoreline levee raising at this location required to meet the new levee's design elevation; under option 2, the south side of the pond would be filled to allow for the extension of the new levee to meet the shoreline.

In either case, as one can see from Photo 7, the pond is not a focus of this view. The view from this point is dominated by the marsh vegetation and trees on either side of the trail, which frame the trail as the central feature. Construction activities would occur on this section of levee trail as well (either raising this portion of levee under option 1 or degrading it under option 2), but this view is not particularly scenic or expansive. Some visual appeal can be derived from the vivid colors of the vegetation, but the trees screen views past the immediate foreground.

In Photos 9 and 10, views that a boater might see while moving toward the tip of the perimeter levee, the diked marsh appears relatively expansive compared to other parts of the Project site; portions of the slightly elevated soccer field are visible, but Tiscornia Marsh is not. The visual focus of these views is on the expanse of marsh vegetation in the foreground and the distant vegetated hills in the background; the middleground blends together beyond the diked marsh in a mix of vegetation, fence line, and field equipment (i.e., the soccer goal). From this vantage point, work in the diked marsh, such as tidal channel excavation, would be highly visible, but work beyond the marsh, such as construction of the new levee, would not stand out. Diked marsh restoration activities would require a relatively light construction footprint, involving five pieces of equipment over approximately seven equipment-days to lower the existing levee, and five pieces of equipment over approximately five equipment-days to excavate the tidal channel. These activities would occur relatively quickly over a single construction season; further, views by boaters passing by would be relatively fleeting, and viewers would be distracted by the task of driving and viewing the changing landscape and movement around them.

Similar to the views over the diked marsh discussed above, Photo 8 presents a view that a boater may have over Tiscornia Marsh, looking toward the Albert J. Boro Community Center and Pickleweed Park, if traveling via boat into or out of the creek from San Rafael Bay. Mount Tamalpais is in the background, but the foreground features take slight precedence over other views of the mountain, as the highly eroded marsh edge appears in sharp relief, and the expansive mudflat appearing in the immediate foreground is less visually appealing than other features in view and distracts from them. All activities involved in the reconstruction of Tiscornia Marsh (e.g., construction of the coarse beach, dredge placement, tidal channel excavation) would be highly visible from this viewpoint. However, as mentioned above, views by boaters passing by would be fleeting, and boaters would be distracted by driving their boats, looking toward their destinations, and viewing the many scenic hillsides around them on either side of the creek.

From the public open space across San Rafael Creek, the viewer’s eyes are drawn to the enormity of Mount Tamalpais in the background and then to the disruption created by the PG&E tower in the middleground. Construction in and around the marsh areas and levee trails would be visible, but the distance, the viewer’s likely movement as they walk through the open space on the public trail, and the relative scale of the transmission tower and mountain would minimize the Project site’s visual distinctness.

There is only a limited number of public vantage points with views onto the Project site that present scenic or panoramic views, and a lack of gathering places for contemplative views of the site. Viewers would be engaged in specific activities (i.e., hiking, boating, playing), and localized screening is present on the site from topography and vegetation. For these reasons, and given the context of the low-lying Project site relative to mountains, hills, and built structures like the Richmond–San Rafael Bridge, Project construction would not have a substantial adverse effect on a scenic vista. This impact would be ***less than significant***.

Mitigation: None required.

Operation

Once completed, the Proposed Project would create new opportunities for visitors to access scenic views within the Project site because the currently graveled shoreline levee trails would be paved and made more accessible. The new and improved levee segments would be approximately 1–4 feet taller than under current conditions, but the main public vantage point where this would be a visible change is from the existing soccer field. As seen in Figure 3.2-3, Photos 5 and 6, raised levees would not significantly alter the view to the north of the expansive hillside communities or the view to the east of the already obstructed Tiscornia Marsh. San Rafael Bay would remain visible beyond the field to the east, as the existing levee along the eastern side of the soccer field would be raised by only about 1 foot, and views of San Rafael Creek (to the north) are already obstructed by the existing perimeter levee. Viewers at this vantage point would be actively engaged in playing or watching a soccer match, moving quickly and focused on the activities taking place on the field, as opposed to the surrounding views.[1]

The existing views of the rest of the site would remain largely unchanged, benefiting from the expanded and restored tidal marsh systems, which would provide superior habitat for a range of native wildlife. From the public open space across San Rafael Creek, if one focused on the Project site rather than the expansive view of Mount Tamalpais, the expanded marsh ecosystem would be visible, as opposed to mudflat. A viewer would be able to see the new levee on the north side of the soccer field, but neither this new location for a levee nor the increased height of the existing levees would alter or block views of the community center, vegetated hills, or mountain from this distance. The coarse beach would be visible as well, but like the levees, it would appear low-lying from this distance. Further, the beach would blend in with the marsh, as it would be planted with high marsh vegetation at the crest and would be constructed to transition gradually to the newly created tidal marsh on its landward side.

Approaching the Project site from the east, along the Bay Trail or Spinnaker Point Drive, the main Project features that would be visibly different are the setback levee and the coarse beach. The setback levee would be closer to Spinnaker Point Drive and raised by 1–4 feet, so the view in Figure 3.2-2, Photo 2, would reflect a less expansive grassy area leading up to the levee toe, which would then slope upward like a linear mound to the levee crest. However, this view would not noticeably differ from existing conditions, as the levee and ecotone in this area would be planted and revegetated and the slight changes in topography would not block views of the prominent hillsides or bay that dominate this perspective. Similarly, the coarse beach would be visible from views along the Bay Trail to the east of the Project site, as represented in Figure 3.2-2, Photo 1; however, this portion of the shoreline is sporadically cobbled, and the beach feature (to be created from cobbles that would be visible from this viewing angle) would blend in to some degree with the existing cobble. The beach feature would not block views of the bay but would block the low-lying marsh from this angle; however, as one can see in Photo 1, the marsh is difficult to see from this distance under existing conditions because of how low it is and its highly eroded state. In general, the entire Project site, including the shoreline levees and soccer fields, is

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1 Preparation of visual simulations was considered for the aesthetics impact analysis but it was concluded to be unnecessary, given the relatively minimal vertical change introduced by Project features and the limited viewpoints from which this vertical change would be visible or obstruct scenic views as discussed in this analysis.

minimized in this view, appearing as a strip of green at the bottom of the tree-covered hillsides in the background. The view from the east would remain focused on the vegetated hillsides in the background and the bay waters in the foreground, just as it is under current conditions.

Approaching from the west, the Project site would remain completely screened from view as it is now, obstructed by vegetation, the fence line, and the community center. Views from the children's playground would similarly remain unchanged, as the west tie-in of the new levee would be obstructed and screened by vegetation and distance.

From the shoreline trails through and along the Project site, once reopened, views would also remain largely unchanged. The levees would be approximately 1–4 feet higher than under current conditions, providing a slightly more elevated and clear view of surrounding vistas to users of the trail system. The coarse beach feature would be visible, particularly from the levee trail on the east side of the Project site; however, this feature would blend into the marsh from this angle, as noted above, because of its gradual slope and the high marsh and marsh vegetation that would cover it. It would appear as a continuation of the marsh due to this vegetative cover, with slight elevation appearing much like a small topographic feature at the far side of the marsh. At approximately 9 feet above sea level, the coarse beach would not be tall enough to block the current views of San Rafael Bay, the shoreline, and the Richmond–San Rafael Bridge from this vantage point, particularly because the trail itself would be raised higher as well.

As for the rest of the trails on-site, rather than using the existing perimeter trail north of the currently diked marsh, hikers would use the new levee trail on the north side of the soccer field, but views of the creek, bay, and surrounding hillsides would remain unaltered by this change. Viewers looking from the new trail across the creek would experience marsh in the foreground, but given the height of the levee trail over the low-lying marsh, views would remain unobstructed.

Boaters passing the Project site as they move along San Rafael Creek or San Rafael Bay would experience some of the changes noted above. Depending on their angle, boaters would perceive an expanded, larger Tiscornia Marsh, less mudflat, a coarse beach feature that blends into the marsh, and a slightly different trail orientation on the west side of the Project site. However, these features would not obstruct views of Mount Tamalpais, the surrounding hills, or other scenic vistas. Much of the view from the water would remain unchanged, as the new levee behind the currently diked marsh would blend into the soccer field, and the view of the diked marsh would remain as is, except that the perimeter levee would be degraded or breached in certain locations.

For the reasons discussed above and, as noted previously, because viewers would be engaging in specific activities (i.e., hiking, boating, playing) as they move past or through the Project site, Project operation would not have a substantial adverse effect on scenic vistas. This impact would be ***less than significant***.

Mitigation: None required.

Impact 3.2-2: The Project would not conflict with applicable zoning and other regulations governing scenic quality. (*Less than Significant*)

The Project site is designated in the General Plan 2040 as Parks, Recreation, and Open Space and as Conservation (City of San Rafael 2021) and is zoned as Parks/Open Space, Planned Development, and Water Zoning Districts with a Wetlands Overlay and a Canalfront Review Overlay (City of San Rafael 2021). The General Plan 2040 and Zoning Code outline setback and height requirements for development along the bayfront and Canalfront, and other local regulations governing scenic quality are outlined in the *Local Plans and Policies* section.

The Proposed Project would not reduce setbacks by introducing any structures closer to San Rafael Creek or San Rafael Bay that would impede views. Although levee height would increase by approximately 1–4 feet and the coarse beach would be constructed to approximately 9 feet above sea level, this is much lower than the "low-scale" building development allowed by the site's Canalfront Review Overlay. Further, as discussed above, these features would not obstruct existing views of the area's hillsides, ridgelines, the bay or creek, or other prominent or scenic views in the area. The raised and new levees and the new coarse beach feature would only alter views while viewers are on or directly adjacent to the Project site. Views nearby are screened either by other vegetation or topographic features or by structures, or are dominated by views of hillsides and mountains, where views of the low-lying marsh that may be partially obstructed by these features are not highly visible under current conditions. Views from the public open space across San Rafael Creek, the adjacent soccer field, the surrounding waterways, or from the Project site itself would change to some degree as a result of the raising and reorientation of the levees and installation of the coarse beach, but these components would not alter or obstruct the defining features of the views (e.g., those of mountains, hillsides, San Rafael Bay, and the Richmond–San Rafael Bridge).

Other policies discussed in the *Local Plans and Policies* section call for maximizing the use and views of the water, providing pedestrian access to the waterfront and publicly accessible walkways, protecting wildlife habitat, enhancing bay wetlands and views of the Canalfront, and providing seating areas and signage around Pickleweed Park. The Proposed Project would not conflict with any of these policies. Conversely, by protecting sensitive wildlife areas, enhancing habitat, adding seating and signage to the new trails, encouraging natural vegetation, and improving public access, the Proposed Project would advance the policies and programs set forth in the General Plan 2040 (NH-3.2 and 3.2A, NH-3.5 and 3.5A, CDP-1.2, CDP-1.4 and 1.4A, CDP-1.5, and PROS-3.1 and 3.1A) and the recommendations in the Canalfront Conceptual Design Plan. Therefore, neither construction nor operation of the Proposed Project would conflict with applicable zoning or other regulations governing scenic quality. This impact would be ***less than significant***.

Mitigation: None required.

Impact 3.2-3: The Project would not create a new source of substantial light or glare that would adversely affect day or nighttime views in the area. (*Less than Significant*)

The City of San Rafael has established allowable construction hours in its municipal code, which restricts construction activities to between 7:00 a.m. and 6:00 p.m., Monday through Friday, and between 9:00 a.m. and 6:00 p.m. on Saturdays (Section 8.13.050(A) of the San Rafael Municipal Code). Project construction activities are proposed to occur from approximately 8:00 a.m. to 5:00 p.m., Monday through Friday. The proposed construction hours would not include nighttime work. Construction equipment would be stored at the Project site during the construction season, which would have the potential to create some glare effects from the headlights of passing vehicles; however, the Project site is bordered by residential neighborhoods and local streets (not throughways), and heavy nighttime traffic is therefore not anticipated.

Because Project construction would occur during the daylight hours and would not use portable lighting, and because Project operation does not call for the installation of any permanent lighting, the Project would not create a new source of substantial light or glare that would adversely affect day or nighttime views in the area. This impact would be ***less than significant***.

Mitigation: None required.

Cumulative Impacts

Impact 3.2-4: The Project, combined with other reasonably foreseeable future projects in the Project vicinity, would not result in significant cumulative impacts related to aesthetics or visual resources. (*Less than Significant*)

As explained in Section 3.1.4, *Approach to the Cumulative Projects Scenario and Cumulative Impact Analysis*, the geographic area that could be affected by implementation of the Proposed Project in combination with other projects varies depending on the type of environmental resource being considered. In the case of aesthetic resources, the geographic scope of the analysis for cumulative impacts is limited to the viewshed of the Project site. As stated previously, topography, trees, shrubs, and residential buildings quickly restrict or block views of the Project site as viewers move away from the site, on either side of San Rafael Creek. For example, although the Project components are highly visible from the Bay Trail immediately adjacent to the Project site, they are no longer visible as soon as the Bay Trail curves around the east side of the Spinnaker Point/Bay Point neighborhood. Similarly, intervening residences, fencing, and vegetation obstruct views of the Project site from all surrounding public roadways, except adjacent segments of Spinnaker Point Drive and Canal Street, on both sides of the creek. Therefore, the scope of cumulative impacts in this analysis focuses on the Project site and immediate vicinity (conservatively defined as 0.25 mile from the Project site).

Eight foreseeable projects are planned to begin construction in San Rafael between 2021 and 2025 (Table 3.1-1 in Section 3.1, *Introduction to the Analysis*). Of these eight projects, four are located within 0.25 mile of the Project site: the Pickleweed Field and Park Project, Schoen Park Conversion to Parking, two of the five locations planned for the Canal Neighborhood Pedestrian Safety Improvements Project, and the San Rafael Creek Operations and Maintenance Project. The Schoen Park Conversion to Parking and Canal Neighborhood Pedestrian Safety Improvements would require minor construction to begin in 2021. Therefore, this construction should be complete before construction of the Proposed Project would begin in 2023, thus negating the chance for a cumulative impact on aesthetic resources to result from implementation of the Proposed Project in combination with these projects.

Construction of the San Rafael Creek Operations and Maintenance Project and the Pickleweed Field and Park Project may occur at the same time as construction of the Proposed Project. The Pickleweed Field and Park Project, adjacent to the Project site, is planned to be constructed between 2021 and 2025. This project would convert the Pickleweed Field to synthetic turf for year-round access and install several other recreation features. It would likely involve the limited use of off-road construction equipment, which from a distance would blend in with the other similar equipment that would be used for the Proposed Project. In addition, construction of this project would necessitate the closure of the soccer field, thus significantly reducing the already limited potential public vantage points of the Project site.

The San Rafael Creek Operations and Maintenance Project would involve dredging the creek to a depth of -8 feet mean lower low water line to the mouth of San Rafael Creek, adjacent to Tiscornia Marsh. This project has no established timeline for dredging activity. This project would likely involve the limited use of dredging equipment and possibly trucks or barges to transport dredged materials. This equipment would be similar to the barge and offloading equipment used by the Proposed Project; further, because this project would occurs throughout San Rafael Creek and San Rafael Bay, equipment would be located adjacent to the Project site for a limited period of time.

For the reasons discussed (timing of the projects, closure of public vantage points, and similar and minor equipment use in comparison to the Proposed Project), the Project, in combination with other projects in the cumulative scenario, would not cause a significant, adverse cumulative impact on aesthetic resources.

Mitigation: None required.

3.2.4 References

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3.3 Air Quality

This section describes the environmental and regulatory setting of the Project site and surrounding area with respect to air quality, including criteria air pollutants (CAPs), toxic air contaminants (TACs), and odors. An analysis of impacts of the Proposed Project on air quality is also provided. The section identifies the appropriate CEQA baseline, then presents a review and summary of the criteria used for determining the significance of environmental impacts, followed by an analysis of impacts relevant to Project implementation. Mitigation measures are also identified, as relevant, to reduce and minimize the intensity of impacts associated with the Project. If needed, Bay Area Air Quality Management District (BAAQMD) best management practices (BMPs) and mitigation measures to avoid or reduce significant impacts are also identified. For a discussion of impacts associated with greenhouse gas (GHG) emissions, see Section 3.5, *Greenhouse Gas Emissions*.

3.3.1 Introduction

Criteria Air Pollutants

The U.S. Environmental Protection Agency (EPA) has identified certain air pollutants that are a threat to public health and welfare. These pollutants are called "criteria" air pollutants because standards have been established for each of them to meet specific public health and welfare criteria (see Section 3.3.3, *Regulatory Setting*). The following CAPs are a concern in the air basin.

Ozone

Ozone is a respiratory irritant and an oxidant that increases susceptibility to respiratory infections in humans. It can also cause substantial damage to vegetation and other materials, when present in sufficiently high atmospheric concentrations. Ozone is not emitted directly into the atmosphere. Instead, it is a secondary air pollutant that is produced in the atmosphere through a complex series of photochemical reactions involving reactive organic gases (ROG) and nitrogen oxides (NO_X). ROG and NO_X are known as precursor compounds for ozone. Significant ozone production generally requires ozone precursors to be present in a stable atmosphere with strong sunlight for approximately three hours.

Ozone is a regional air pollutant because it is not emitted directly by sources, but is formed as a secondary pollutant downwind from sources of ROG and NO_X under the influence of wind and sunlight. Ozone concentrations tend to be higher in the late spring, summer, and fall, when long sunny days combine with regional subsidence inversions to create conditions conducive to the formation and accumulation of secondary photochemical compounds like ozone.

Ozone can cause the muscles in the airways to constrict, potentially leading to wheezing and shortness of breath (EPA 2019a). Ozone can make it more difficult to breathe deeply and vigorously; cause shortness of breath and pain when taking a deep breath; cause coughing and a sore or scratchy throat; inflame and damage the airways; aggravate lung diseases such as asthma, emphysema, and chronic bronchitis; increase the frequency of asthma attacks; make the lungs more susceptible to infection; continue to damage the lungs even when the symptoms have disappeared; and cause chronic obstructive pulmonary disease (EPA 2019a). Long-term exposure to ozone is linked to aggravation of asthma, and is likely to be one of many causes of asthma development; long-term exposures to higher concentrations of ozone may also be linked to permanent lung damage, such as abnormal lung development in children (EPA 2019a). Inhalation of ozone causes inflammation and irritation of the tissues lining human airways, causing and worsening a variety of symptoms, and exposure to ozone can reduce the volume of air that the lungs breathe in and cause shortness of breath (ARB 2019).

The people most at risk from breathing air containing ozone include people with asthma, children, older adults, and people who are active outdoors, especially outdoor workers (EPA 2019a). Children are at greatest risk from exposure to ozone because their lungs are still developing and they are more likely to be active outdoors when ozone levels are high, which increases their exposure (EPA 2019a). Studies show that children are no more or less likely to suffer harmful effects than adults; however, children and teens may be more susceptible to ozone and other pollutants because they spend nearly twice as much time outdoors and are engaged in more vigorous activities than adults (ARB 2019). Children breathe more rapidly than adults and inhale more pollution per pound of their body weight than adults and are less likely than adults to notice their own symptoms and avoid harmful exposures. Further research may be able to better distinguish between health effects in children and adults (ARB 2019).

Nitrogen Oxides

Nitrogen dioxide (NO_2) is an air quality pollutant of concern because it acts as a respiratory irritant. NO_2 is a major component of the group of gaseous nitrogen compounds commonly referred to as NO_X. A precursor to ozone formation, NO_X is produced by fuel combustion in motor vehicles, industrial stationary sources (such as refineries, power plants, and chemical manufacturing facilities), ships, aircraft, and rail transit. Typically, NO_X emitted from fuel combustion is in the form of nitric oxide (NO) and NO_2, with the vast majority (95 percent) of the NO_X emissions being composed of NO. NO is converted to NO_2 in the atmosphere when it reacts with ozone or undergoes photochemical reactions. Short-term exposures to NO_2 can potentially aggravate respiratory diseases, particularly asthma, leading to respiratory symptoms (such as coughing, wheezing, or difficulty breathing), hospital admissions, and visits to emergency rooms; longer exposures to elevated concentrations of NO_2 may contribute to the development of asthma and potentially increase susceptibility to respiratory infections (EPA 2019b).

Carbon Monoxide

Carbon monoxide (CO) is a nonreactive pollutant that is a product of incomplete combustion; it is mostly associated with emissions from motor vehicle traffic. High CO concentrations develop primarily during winter when periods of light winds combine with the formation of ground-level temperature inversions (typically from the evening through early morning). These conditions result in reduced dispersion of vehicle emissions. Motor vehicles also exhibit increased CO emission rates at low air temperatures. When inhaled at high concentrations, CO combines with hemoglobin in the blood and reduces the oxygen-carrying capacity of the blood. This results in reduced levels of oxygen reaching the brain, heart, and other body tissues. This condition is especially critical for people with cardiovascular diseases, chronic lung disease, or anemia.

Particulate Matter

Particulate matter 10 microns or less in diameter (PM_{10}) and particulate matter 2.5 microns or less in diameter ($PM_{2.5}$) represent fractions of particulate matter that can be inhaled into air passages and the lungs, and can cause adverse health effects. Particulate matter in the atmosphere results from many kinds of dust- and fume-producing industrial and agricultural operations, fuel combustion, and atmospheric photochemical reactions. Some sources of particulate matter, such as demolition and construction activities, are more local in nature, while others, such as vehicular traffic, have a more regional effect. Very small particles of certain substances (e.g., sulfates and nitrates) can cause lung damage directly, or can contain adsorbed gases (e.g., chlorides or ammonium) that may be injurious to health. According to a study prepared by the California Air Resources Board (ARB), exposure to ambient $PM_{2.5}$, particularly diesel particulate matter (DPM), can be associated with approximately 14,000 to 24,000 premature annual deaths per year statewide (ARB 2010). Particulate matter also can damage materials and reduce visibility.

Toxic Air Contaminants

TACs are airborne substances that are capable of causing short-term (acute) and/or long-term (chronic or carcinogenic, i.e., cancer-causing) adverse human health effects (injury or illness). TACs include both organic and inorganic chemical substances. They may be emitted from a variety of common sources including gasoline stations, automobiles, dry cleaners, industrial operations, and painting operations. The current California list of TACs includes approximately 200 compounds, including DPM emissions from diesel-fueled engines (ARB 2011).

3.3.2 Environmental Setting

Regional Topography, Meteorology, and Climate

The Project site is located within the San Francisco Bay Area Air Basin (SFBAAB). Air quality in the basin is influenced by such natural factors as topography, meteorology, and climate, in addition to the presence of existing air pollution sources and ambient conditions. The air basin's Mediterranean climate steers storm tracks away from the region from May through October (i.e., the dry season). Storms more often affect the region during the wet season from November through April. Marin County's proximity to the Pacific Ocean and exposure to onshore breezes provides generally very good air quality in the county and at the Project site.

Annual temperatures in Marin County average in the mid-50s (degrees Fahrenheit), ranging from the low 40s on winter mornings to the mid-70s during summer afternoons. Daily and seasonal oscillations of temperature are small because of the moderating effects of the nearby San Francisco Bay and the Pacific Ocean. In contrast with the steady temperature regime, rainfall is highly variable and confined almost exclusively to November through April. Precipitation varies widely from year to year, as shifts in the annual storm track of a few hundred miles can mean the difference between a very wet year and drought conditions.

Atmospheric conditions such as wind speed and direction, and variable air temperatures interact with the physical features of the landscape to influence the movement and dispersal of air pollutants, regionally. In southern Marin County, the distance from the ocean is short and elevations are lower, resulting in higher incidence of more humid maritime air in that area. The complex terrain in central Marin County creates sufficient friction to slow the airflow. The prevailing wind directions throughout Marin County are generally from the northwest. Air pollution potential is highest in eastern Marin County, where most of the population is located in semi-sheltered valleys. In the southeast, the influence of marine air keeps pollution levels low (BAAQMD 2017a).

Existing Air Quality

As required by the 1970 federal Clean Air Act, and discussed above, EPA initially identified six air pollutants (i.e., criteria air pollutants or CAPs]) that are pervasive in urban environments and for which state and federal health-based ambient air quality standards have been established. EPA has regulated the CAPs by developing specific public health and welfare–based criteria as the basis for setting permissible levels. Ozone, carbon monoxide (CO), particulate matter (PM), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and lead are the CAPs originally identified by EPA. Since that time, subsets of PM have been also identified for which permissible levels have been established. These include PM_{10} and $PM_{2.5}$, which respectively measure 10 microns or less and 2.5 microns or less in diameter.

BAAQMD is the regional agency with jurisdiction for regulating air quality within the nine-county SFBAAB. The region's air quality monitoring network provides information on ambient concentrations of CAPs at various locations in the San Francisco Bay Area. **Table 3.3-1** presents a five-year summary for the period 2015 to 2019 of the highest annual CAP concentrations, collected at the air quality monitoring station operated and maintained by BAAQMD at 534 4th Street in San Rafael, approximately 1 mile west of the Project site. Table 3.3-1 also compares measured pollutant concentrations with the most stringent applicable ambient air quality standards (state or federal). Concentrations shown in **boldface** indicate an exceedance of the standard.

Table 3.3-1 shows that, according to published data, the most stringent applicable standards for ozone (state one-hour standard of 0.09 parts per million [ppm] and the federal eight-hour standard of 0.07 ppm) were not exceeded in Marin County from 2015 through 2018; however, both the one-hour and eight-hour standards were exceeded once in 2019 (BAAQMD 2021).

As presented in Table 3.3-1, the state 24-hour PM_{10} standard was exceeded on four monitored occasions from 2015 through 2019 in San Rafael, two in 2017 and two in 2018. Because PM_{10} data are monitored every 12 days by BAAQMD, it may be conservatively estimated that the state 24-hour PM_{10} standard was exceeded on up to 48 days per year from 2014 through 2018: 24 days in 2017 and 24 days in 2018 (BAAQMD 2021).

The state 24-hour $PM_{2.5}$ standard was exceeded on 23 days from 2015 through 2019 in San Rafael: two in 2015, eight in 2017, and 13 in 2018. Many of these exceedances of the 24-hour $PM_{2.5}$ standard can be attributed to the October 2017 and November and December 2018 wildfires in Northern California. There were no exceedances of the state 24-hour $PM_{2.5}$ standard in either 2016 or 2019. The state annual-average standards for PM_{10} and $PM_{2.5}$ were not exceeded from 2015 through 2019 (BAAQMD 2021).

TABLE 3.3-1
SUMMARY OF MARIN COUNTY AIR QUALITY MONITORING DATA (2015–2019)

Pollutant	Most Stringent Applicable Standard	Number of Days Standards Were Exceeded and Maximum Concentrations Measured[a]				
		2015	2016	2017	2018	2019
Ozone						
- Days 1-Hour Standard Exceeded		0	0	0	0	**1**
- Maximum 1-Hour Concentration (ppm)	>0.09 ppm[b]	0.08	0.08	0.09	0.07	0.09
- Days 8-Hour Standard Exceeded		0	0	0	0	**1**
- Maximum 8-Hour Concentration (ppm)	>0.07 ppm[c]	0.07	0.07	0.06	0.05	0.08
Carbon Monoxide						
- Days 1-Hour Standard Exceeded		0	0	0	0	0
- Maximum 1-Hour Concentration (ppm)	>20 ppm[b]	1.4	1.4	2.6	2.0	1.4
- Days 8-Hour Standard Exceeded		0	0	0	0	0
- Maximum 8-Hour Concentration (ppm)	>9 ppm[b]	0.9	1.0	1.6	1.6	0.9
Suspended Particulates (PM_{10})						
- Days 24-Hour Standard Exceeded[d]		0	0	**2**	**2**	0
- Maximum 24-Hour Concentration (μg/m^3)	>50 μg/m^3 [b]	42	27	**94**	**166**	33
- Annual Average (μg/m^3)	>20 μg/m^3 [b]	16	14	18	19	14
Suspended Particulates ($PM_{2.5}$)						
- Days 24-Hour Standard Exceeded		**2**	0	**8**	**13**	0
- Maximum 24-Hour Concentration (μg/m^3)	>35 μg/m^3	**36**	16	**75**	**168**	20
- Annual Average (μg/m^3)	>12 μg/m^3 [b, c]	10	8.6	9.7	11	6.4
Nitrogen Dioxide						
- Days 1-Hour Standard Exceeded		0	0	0	0	0
- Maximum 1-Hour Concentration (ppm)	>0.1 ppm[c]	0.04	0.05	0.05	0.06	0.05

NOTES:

Bold values are in excess of applicable standard.

μg/m^3 = micrograms per cubic meter; ND = No data or insufficient data; $PM_{2.5}$ = particulate matter 2.5 microns or less in diameter; PM_{10} = particulate matter 10 microns or less in diameter; ppm = parts per million.

a. Number of days exceeded is for all days in a given year, except for PM_{10}. PM_{10} has been monitored every 12 days effective January 2013.
b. State standard, not to be exceeded.
c. Federal standard, not to be exceeded.
d. Particulate matter PM_{10} is based on a sampling schedule of one out of every six days, for a total of approximately 60 samples per year.

SOURCE: BAAQMD 2021.

There were no exceedances of the CO or NO_2 standards during the five-year study period.

Toxic Air Contaminants and Local Health Risks and Hazards

In addition to CAPs, as discussed above, individual projects emit TACs as well. TACs collectively refer to a diverse group of air pollutants that may cause chronic (i.e., long-duration) and acute (i.e., severe but short-term) adverse effects on human health, including carcinogenic effects. Human health effects of TACs include birth defects, neurological damage, cancer, and death. There are hundreds of different types of TACs with varying degrees of toxicity. Thus, individual TACs vary greatly in the health risk they present; at a given level of exposure, one TAC may pose a hazard that is many times greater than another.

Unlike CAPs, TACs are not subject to ambient air quality standards, but are regulated by BAAQMD using a risk-based approach to determine which sources and which pollutants to control as well as the degree of control. A *health risk assessment* (HRA) is an analysis that estimates human health exposure to toxic substances, and when considered together with information regarding the toxic potency of the substances, an HRA provides quantitative estimates of health risks.[1]

Exposures to fine PM ($PM_{2.5}$) are strongly associated with mortality, respiratory diseases, and poor lung development in children, and other health effects, such as hospitalization for cardiopulmonary disease. As described below, diesel particulate matter (DPM), a byproduct of diesel fuel combustion, is also of concern.

Diesel Particulate Matter

ARB identified DPM as a TAC in 1998, based primarily on evidence demonstrating cancer effects in humans (ARB 1998). The estimated cancer risk from exposure to diesel exhaust is much higher than the risk associated with any other TAC routinely measured in the region. The exhaust from diesel engines includes hundreds of different gaseous and particulate components, many of which are toxic. Mobile sources such as trucks and buses are among the primary sources of diesel emissions, and concentrations of DPM are higher near heavily traveled highways.

ARB estimated that as of 2000, the average Bay Area cancer risk from exposure to DPM, based on a population-weighted average ambient DPM concentration, is approximately 480 in one million, which is much higher than the risk associated with any other toxic air pollutant routinely measured in the region. The statewide risk from DPM, as determined by ARB, declined from 750 in one million in 1990 to 570 in one million in 1995; by 2012, ARB estimated the average statewide cancer risk from DPM to be 520 in one million (ARB 2009). This calculated cancer risk value from ambient air exposure in California can be compared against the lifetime probability of being diagnosed with cancer in the United States, from all causes, which for men is more than 40 percent (based on a sampling of 17 regions nationwide), or greater than 400,000 in one million, according to the American Cancer Society (2020).

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1 In general, a health risk assessment is required if BAAQMD concludes that projected emissions of a specific air toxic compound from a proposed new or modified source suggest a potential public health risk. The applicant is then subject to a health risk assessment for the source in question. Such an assessment generally evaluates chronic, long-term effects, estimating the increased risk of cancer as a result of exposure to one or more TACs.

In 2000, ARB approved a comprehensive Diesel Risk Reduction Plan to reduce diesel emissions from both new and existing diesel-fueled vehicles and engines. Subsequent board regulations apply to new trucks and diesel fuel. The regulation is intended to result in an 80 percent decrease in statewide diesel health risk in 2020 as compared with the diesel risk in 2000.

Despite notable emission reductions, ARB recommends that proximity to sources of DPM emissions be considered in the siting of new sensitive land uses. ARB notes that these recommendations are advisory and should not be interpreted as defined “buffer zones,” and that local agencies must balance other considerations, including transportation needs, the benefits of urban infill, community economic development priorities, and other quality of life issues. With careful evaluation of exposure, health risks, and affirmative steps to reduce risk where necessary, ARB’s position is that infill development, mixed-use, higher density, transit-oriented development, and other concepts that benefit regional air quality can be compatible with protecting the health of individuals at the neighborhood level (ARB 2005).

Studies have demonstrated that DPM from diesel-fueled engines is a human carcinogen and that chronic (long-term) inhalation exposure to DPM poses a chronic health risk. Health effects from carcinogenic air toxics are usually described in terms of individual cancer risk. Individual cancer risk is the likelihood that a person exposed to air toxic concentrations over a 30-year period will contract cancer, based on the use of standard risk-assessment methodology. The maximally exposed individual represents the worst-case risk estimate, based on a theoretical person continuously exposed for a lifetime at the point of highest DPM concentration in the air. This is a highly conservative assumption, because most people do not remain at home all day and residents change residences an average of every 11–12 years. In addition, this methodology assumes that residents are experiencing outdoor concentrations for the entire exposure period.

Soil Contamination and Naturally Occurring Asbestos

Marin County is among the identified counties where ultramafic bedrock materials are present. These bedrock materials contain naturally occurring asbestos particles or fibers, which could be disturbed during excavation activities. However, no serpentine soils are present on the Project site, which indicates that the Project site is not underlain by materials that contain naturally occurring asbestos.

Sensitive Receptors

Air quality does not affect every individual in the population in the same way, and some groups are more sensitive to adverse health effects than others. Population subgroups sensitive to the health effects of air pollutants include the elderly and the young; population subgroups with higher rates of respiratory disease, such as asthma and chronic obstructive pulmonary disease; and populations with other environmental or occupational health exposures (e.g., indoor air quality) that affect cardiovascular or respiratory diseases. BAAQMD defines *sensitive receptors* as children, adults, and seniors occupying or residing in residential dwellings, schools, day care centers, hospitals, and senior-care facilities (BAAQMD 2017a). Workers are not considered sensitive receptors because all employers must follow regulations set forth by the U.S. Occupational Safety and Health Administration to ensure the health and well-being of their employees.

The proximity of sensitive receptors to motor vehicles is an air pollution concern, especially in densely developed urban areas where building setbacks are limited and roadway volumes are higher than most other parts of the Bay Area. Vehicles also contribute to particulates by generating road dust and through tire wear.

The Project site is within a primarily residential neighborhood that includes schools and day care centers, with the sensitive residential and school/daycare receptors located nearest the site described as follows. Figure 2-3 in Chapter 2 shows that existing residences on the south side of Spinnaker Point Drive are as close as 150 feet from proposed raised levee and ecotone construction. Additionally, existing residences along the terminus of Sorrento Way would be adjacent to proposed staging areas and approximately 200 feet from the proposed new levee for the diked marsh. The Project site is adjacent to the Pickleweed Children's Center, a preschool. Bahia Vista Elementary School is located approximately 300 feet south of the Project site.

Baseline Conditions

Existing Sources of Air Pollutant Emissions

Existing sources of CAP emissions at the Project site consist mainly of vehicles traveling on roadways south of the Project site. There is one existing stationary source of TACs within 1,000 feet of the Project site. The City of San Rafael Department of Public Works operates a standby diesel generator at its property located at 3780 Kerner Boulevard, approximately 200 feet south of Canal Street.

Existing Sources of Odors

The BAAQMD CEQA Guidelines identify land uses that have the potential to generate continuous odors and odor complaints during operation. These include wastewater treatment plants, landfills, confined-animal facilities, composting stations, food manufacturing plants, refineries, and chemical plants (BAAQMD 2017a). There are no substantial odor-generating facilities within 1,000 feet of the project site.

3.3.3 Regulatory Setting

Federal Regulations

The 1970 Clean Air Act (last amended in 1990) requires that regional planning and air pollution control agencies prepare a regional air quality plan to outline the measures by which both stationary and mobile sources of pollutants will be controlled to achieve all ambient air quality standards by the deadlines specified in the act. These ambient air quality standards are intended to protect the public health and welfare, and they specify the concentration of pollutants (with an adequate margin of safety) to which the public can be exposed without adverse health effects. They are designed to protect those segments of the public most susceptible to respiratory distress, which include asthmatics, the very young, the elderly, people weak from other illness or disease, or persons engaged in strenuous work or exercise. Healthy adults can tolerate occasional exposure to air pollution levels that are somewhat above ambient air quality standards before adverse health effects are observed.

Table 3.3-2 summarizes current California ambient air quality standards (CAAQS) and national ambient air quality standards (NAAQS) and the SFBAAB's attainment status. In general, the SFBAAB experiences low concentrations of most pollutants when compared to federal standards, except for ozone and particulate matter (PM_{10} and $PM_{2.5}$), for which standards are exceeded periodically (see Table 3.3-1).

TABLE 3.3-2
STATE AND FEDERAL AMBIENT AIR QUALITY STANDARDS AND ATTAINMENT STATUS FOR THE SAN FRANCISCO BAY AREA AIR BASIN

Pollutant	Averaging Time	State (CAAQS[a])		Federal (NAAQS[b])	
		Standard	Attainment Status	Standard	Attainment Status
Ozone	1-hour	0.09 ppm	**N**	NA	See Note c
	8-hour	0.070 ppm	**N**	0.070 ppm[d]	**N**/Marginal
Carbon monoxide (CO)	1-hour	20 ppm	A	35 ppm	A
	8-hour	9 ppm	A	9 ppm	A
Nitrogen dioxide (NO_2)	1-hour	0.18 ppm	A	0.100 ppm	U
	Annual	0.030 ppm	NA	0.053 ppm	A
Sulfur dioxide (SO_2)	1-hour	0.25 ppm	A	0.075 ppm	A
	24-hour	0.04 ppm	A	0.14 ppm	A
	Annual	NA	NA	0.03 ppm	A
Particulate matter (PM_{10})	24-hour	50 μg/m^3	**N**	150 μg/m^3	U
	Annual[e]	20 μg/m^3 [f]	**N**	NA	NA
Fine particulate matter ($PM_{2.5}$)	24-hour	NA	NA	35 μg/m^3	**N**
	Annual	12 μg/m^3	**N**	12 μg/m^3	U/A
Sulfates	24-hour	25 μg/m^3	A	NA	NA
Lead	30-day	1.5 μg/m^3	A	NA	NA
	Cal. Quarter	NA	NA	1.5 μg/m^3	A
	Rolling 3-month average	NA	NA	0.15	U
Hydrogen sulfide	1-hour	0.03 ppm	U	NA	NA
Visibility-reducing particles	8-hour	See Note g	U	NA	NA

NOTES:

A = Attainment; **N** = Nonattainment; U = Unclassified; NA = Not Applicable, no applicable standard

μg/m^3 = micrograms per cubic meter; $PM_{2.5}$ = particulate matter 2.5 microns or less in diameter; PM_{10} = particulate matter 10 microns or less in diameter; ppm = parts per million

a. CAAQS = California ambient air quality standards. CAAQS for ozone, CO (except Lake Tahoe), SO_2 (1-hour and 24-hour), NO_2, PM, and visibility-reducing particles are values that are not to be exceeded. All other state standards shown are values not to be equaled or exceeded.
b. NAAQS = national ambient air quality standards. NAAQS, other than ozone and particulates, and those based on annual averages or annual arithmetic means, are not to be exceeded more than once a year. The 8-hour ozone standard is attained when the 3-year average of the fourth highest daily concentration is 0.08 ppm or less. The 24-hour PM_{10} standard is attained when the 3-year average of the 99th percentile of monitored concentrations is less than the standard. The 24-hour $PM_{2.5}$ standard is attained when the 3-year average of the 98th percentile is less than the standard.
c. The U.S. Environmental Protection Agency revoked the national 1-hour ozone standard on June 15, 2005.
d. This federal 8-hour ozone standard was approved by the U.S. Environmental Protection Agency in October 2015 and became effective on December 28, 2015.
e. State standard = annual geometric mean; national standard = annual arithmetic mean.
f. In June 2002, the California Air Resources Board established new annual standards for $PM_{2.5}$ and PM_{10}.
g. Statewide visibility-reducing particle standard (except Lake Tahoe Air Basin): Particles in sufficient amount to produce an extinction coefficient of 0.23 per kilometer when the relative humidity is less than 70 percent. This standard is intended to limit the frequency and severity of visibility impairment due to regional haze and is equivalent to a 10-mile nominal visual range.

SOURCES: BAAQMD 2017b; EPA 2021.

In June 2004, the Bay Area was designated as a marginal nonattainment area of the national eight-hour ozone standard.[2] EPA lowered the national eight-hour ozone standard from 0.80 to 0.75 ppm effective May 27, 2008. In October 2015, EPA designated the Bay Area as a marginal nonattainment region for the 0.70 ppm ozone standard established in 2015. The SFBAAB is in attainment for other criteria pollutants, with the exception of the 24-hour standards for $PM_{2.5}$, for which the Bay Area is designated as "Unclassified." "Unclassified" is defined by the Clean Air Act as any area that cannot be classified, on the basis of available information, as meeting or not meeting the primary or secondary NAAQS for the pollutant.

On January 9, 2013, EPA issued a final rule to determine that the Bay Area attains the 24-hour $PM_{2.5}$ national standard. This EPA rule suspends key State Implementation Plan requirements as long as monitoring data continue to show that the Bay Area attains the standard. Despite this EPA action, the Bay Area will continue to be designated as "nonattainment" for the national 24-hour $PM_{2.5}$ standard until BAAQMD submits a "redesignation request" and a "maintenance plan" to EPA, and EPA approves the proposed redesignation.

State Regulations

Although the federal Clean Air Act established NAAQS, individual states retained the option to adopt more stringent standards and to include other pollution sources. California had already established its own air quality standards when federal standards were established; because of the unique meteorological conditions in California, there are considerable differences between the CAAQS and the NAAQS, as shown in Table 3.3-2. The California ambient standards tend to be at least as protective as the national ambient standards and are often more stringent.

In 1988, the California Legislature enacted the California Clean Air Act (California Health and Safety Code Sections 39600 et seq.). Like its federal counterpart, the California Clean Air Act called for the designation of areas as attainment or nonattainment, but based on state ambient air quality standards rather than the federal standards. As indicated in Table 3.3-2, the SFBAAB is designated as "nonattainment" under the state standards for ozone (both one-hour and eight-hour), PM_{10}, and $PM_{2.5}$. The SFBAAB is designated as "attainment" for other pollutants.

Off-Road Emissions Regulation for Compression-Ignition Engines and Equipment

Engines designated as non-road engines by EPA are known as off-road engines in California state regulations implemented by ARB. Similar to the EPA Non-road Diesel Rule, the Off-Road Emissions Regulation for New Compression-Ignition Engines and Equipment applies to diesel engines such as those found in construction, general industrial, and terminal equipment. Initially adopted in 2000 and amended in 2004, the regulation establishes Tier emissions standards, test procedures, and warranty and certification requirements. For some model years and engine sizes, the ARB Tier emission standards are more stringent than the EPA standards.

2 "Marginal nonattainment area" means an area designated marginal nonattainment for the one-hour national ambient air quality standard for ozone.

California Air Resources Board In-Use Off-Road Diesel Vehicle Regulation

ARB adopted the In-Use Off-Road Diesel Vehicle Regulation in July 2007 and amended the regulation in December 2011. This regulation requires owners of off-road mobile equipment powered by diesel engines 25 horsepower or larger to meet the fleet-average or best available control technology (BACT) requirements for NO_X and PM emissions by January 1 of each year. The regulation also establishes idling restrictions, limitations on buying and selling older off-road diesel vehicles (Tier 0), reporting requirements, and retrofit and replacement requirements. The requirements and compliance dates vary by fleet size; performance requirements began for large fleets in 2014, for medium fleets in 2017, and for small fleets in 2019. Requirements regarding idling, disclosure, reporting, and labeling took effect in 2008 and 2009. The Diesel Off-Road On-line Reporting System is an online tool designed to help fleet owners report their off-road diesel vehicle inventories and actions taken to reduce vehicle emissions to ARB, as required by the In-Use Off-Road Diesel Vehicle Regulation.

Regional Regulations

Bay Area Air Quality Management District

BAAQMD is the regional agency with jurisdiction over the nine-county region located within the SFBAAB. The Association of Bay Area Governments, Metropolitan Transportation Commission, county transportation agencies, cities and counties, and various nongovernmental organizations also participate in the effort to improve air quality through a variety of programs. These programs include the adoption of regulations and policies, as well as implementation of extensive education and public outreach programs. BAAQMD is responsible for attaining and maintaining air quality in the region within the NAAQS and CAAQS. Specifically, BAAQMD monitors ambient air pollutant levels throughout the region and develops and implements strategies to attain the applicable federal and state standards.

BAAQMD currently does not have authority to regulate emissions from motor vehicles, as that is done at the state level. Specific rules and regulations adopted by BAAQMD limit the emissions that can be generated by various stationary sources, and identify specific pollution reduction measures that must be implemented in association with various activities. These rules regulate not only emissions of the six CAPs, but also TAC emissions sources. Stationary sources are regulated through BAAQMD’s permitting process and standards of operation. Through this permitting process, including an annual permit review, BAAQMD monitors the generation of stationary emissions and uses this information in developing its air quality plans. Any sources of stationary emissions constructed as part of the Proposed Project would be subject to the BAAQMD Rules and Regulations. Both federal and state ozone plans rely heavily upon stationary source control measures set forth in BAAQMD’s Rules and Regulations.

BAAQMD has also identified a series of BMPs for the control of fugitive dust generated during construction activities. These measures, which focus on reducing dust generated by excavation, material movement, and movement of off-road equipment on unpaved surfaces, are considered sufficient to reduce dust-related impacts to a less-than-significant level (BAAQMD 2017a).

Bay Area Air Quality Planning Relative to State and Federal Standards

For state air quality planning purposes, the SFBAAB is classified as a serious nonattainment area for the one-hour ozone standard. The "serious" classification triggers various plan submittal requirements and transportation performance standards. One such requirement is that BAAQMD update the Clean Air Plan every three years to reflect progress in meeting the air quality standards and to incorporate new information regarding the feasibility of control measures and new emission inventory data (Sections 40924 and 40925 of the California Health and Safety Code). The Bay Area's record of progress in implementing previous measures must also be reviewed. The plans for the air basin are prepared with the cooperation of the Metropolitan Transportation Commission and Association of Bay Area Governments.

In April 2017, BAAQMD adopted the 2017 Clean Air Plan, whose primary goals are to protect public health and to protect the climate (BAAQMD 2017c). The plan includes a wide range of proposed control measures to reduce combustion-related activities, decrease fossil fuel combustion, improve energy efficiency, and decrease emissions of potent GHGs. The 2017 Clean Air Plan updates the Bay Area 2010 Clean Air Plan and complies with state air quality planning requirements, as codified in the California Health and Safety Code (although the 2017 plan was delayed beyond the code's three-year update requirement). The SFBAAB is designated as nonattainment for both the one- and eight-hour state ozone standards. In addition, emissions of ozone precursors in the air basin contribute to air quality problems in neighboring air basins. Under these circumstances, state law requires the Clean Air Plan to include all feasible measures to reduce emissions of ozone precursors and to reduce the transport of ozone precursors to neighboring air basins.

The 2017 Clean Air Plan contains 85 measures to address reduction of several pollutants: ozone precursors, particulate matter, air toxics, and GHGs. Other measures focus on a single type of pollutant, potent GHGs such as methane and black carbon that consists of harmful fine particles that affect public health. These control strategies are grouped into the following categories:

- Stationary Source Measures
- Transportation Control Measures
- Energy Control Measures
- Building Control Measures
- Agricultural Control Measures
- Natural and Working Lands Control Measures
- Waste Management Control Measures
- Water Control Measures
- Super GHG Control Measures

Under the California Clean Air Act, BAAQMD is required to develop an air quality attainment plan for criteria pollutants that are designated as nonattainment within the air basin. Several components of the Proposed Project may be subject to BAAQMD rules and regulations governing criteria pollutants, TACs, and odorous compounds, even though permits may not be required.

Local Plans and Policies

The City of San Rafael 2040 General Plan

The Conservation and Climate Change Element of the General Plan 2040 includes the following policies and program related to air quality and the Proposed Project (City of San Rafael 2021):

> **Goal C-2:** Clean Air Reduce air pollution to improve environmental quality and protect public health.
>
> > ***Policy C-2.4*****:** Particulate Matter Pollution Reduction Promote the reduction of particulate matter from roads, parking lots, construction sites, agricultural lands, wildfires, and other sources.
> >
> > > *Program C-2.4A: Particulate Matter Exposure.* Through development review, require that Best Available Control Technology (BACT) measures (such as setbacks, landscaping, paving, soil and dust management, and parking lot street sweeping) are used to protect sensitive receptors from particulate matter. This should include control of construction-related dust and truck emissions as well as long-term impacts associated with project operations. Where appropriate, health risk assessments may be required to evaluate risks and determine appropriate mitigation measures.

3.3.4 Impacts and Mitigation Measures

Significance Criteria

The criteria used to determine the significance of impacts related to air quality are based on Appendix G of the CEQA Guidelines. The Proposed Project would have a significant impact if it would:

- Conflict with or obstruct implementation of the applicable air quality plan.
- Result in a cumulatively considerable net increase of any criteria pollutant for which the region is in nonattainment under an applicable federal or state ambient air quality standard.
- Expose sensitive receptors to substantial pollutant concentrations.
- Result in other emissions (such as those leading to odors) adversely affecting a substantial number of people.

The analysis presented in this technical section uses the methodologies provided in the BAAQMD CEQA Guidelines, as updated in 2017 (BAAQMD 2017c). The City of San Rafael, as lead agency, has determined that Appendix D of the BAAQMD CEQA Guidelines, combined with BAAQMD's Revised Draft Options and Justification Report, provide substantial evidence to support the applicable thresholds. Therefore, the City has determined that they are appropriate for use in this analysis. The methods and specific thresholds used to judge the significance of the Proposed Project's air quality impacts are identified below.

Methodology

Air Quality Plans

BAAQMD recommends that the lead agency approving a project that requires an air quality plan consistency determination analyze the project with respect to the following questions:

(1) Does the project support the primary goals of the 2017 Clean Air Plan?

(2) Does the project include applicable control measures from the 2017 Clean Air Plan?

(3) Does the project disrupt or hinder implementation of any 2017 Clean Air Plan control measures?

If the answers to the first two questions are "yes" and the third question is answered "no," BAAQMD considers the project consistent with the 2017 Clean Air Plan.

Any project that would not support the goals of the 2017 Clean Air Plan would not be considered consistent with the plan. The recommended measure for determining the Proposed Project's support of these goals is identifying consistency with the CEQA thresholds of significance. If the CEQA thresholds of significance are exceeded, then the Project would not be considered to support the 2017 Clean Air Plan's goals, and the associated impact would be significant.

Criteria Pollutants

The analysis of CAP emissions considers the impacts related to emissions of nonattainment pollutants and their precursors. Project-related construction equipment would not directly emit ozone. However, the ozone precursors ROG and NO_x would be emitted; therefore, along with particulate matter, ROG and NO_X were the focus of the impact assessment.

Because ozone is formed through a complex photochemical reaction between NO_x and ROG in the atmosphere with the presence of sunlight, the impacts of ozone are typically considered on a basinwide or regional basis instead of a localized basis. The ambient air quality standards for ozone are concentration-based; they are not based on the contributions of their precursor pollutants (i.e., NO_X and ROG). It is not necessarily the mass of precursor pollutants that causes human health effects, as opposed to the concentration of the resulting ozone or particulate matter. Ozone formation is complex and a nonlinear relationship exists between a concentration of ozone and its precursor gases. For this reason, and given the state of environmental science modeling at this time, it is infeasible to convert specific emissions levels of NO_X or ROG emitted in a particular area to a particular ozone concentration in that area. Meteorology, the presence of sunlight, seasonal impacts, and other complex chemical factors all combine to determine the ultimate concentration and location of ozone (SCAQMD 2014; SJVAPCD 2014).

To determine the Proposed Project's impacts related to a contribution to an existing or projected air quality violation, and to potential to result in a cumulatively considerable net increase of any CAP or associated precursors, the Project's estimated direct and indirect exhaust emissions were compared to the significance thresholds. For short-term construction emissions, the significance thresholds are 54 pounds per day for ROG, NO_X, and $PM_{2.5}$ and 82 pounds per day for PM_{10}.

Only the exhaust portions of $PM_{2.5}$ and PM_{10} emissions were compared to the construction thresholds.

BAAQMD considers implementation of its recommended mitigation measures for fugitive dust sufficient to reduce impacts of construction-related fugitive dust to a less-than-significant level. Therefore, BAAQMD recommends that analyses focus on implementing dust control measures rather than comparing estimated levels of fugitive dust to a quantitative significance threshold.

Community Health Risk

Impacts of the Proposed Project related to exposure of sensitive receptors or the general public to substantial pollutant concentrations were evaluated by assessing the health risks posed by the placement of new sources of TAC emissions near existing sensitive receptors. Specifically, according to BAAQMD, the Project would have a significant air quality impact if the construction phase would expose persons to substantial levels of TACs, such that the probability of contracting cancer would exceed 10 in one million, or if it would expose persons to pollutants such that a chronic Hazard Index of 1.0 would be exceeded. The Project would not include any new sources of TAC emissions and would have no operational health risk impacts. The Project's only source of TAC emissions would be DPM exhaust emitted by off-road equipment and heavy-duty trucks during construction.

In addition, a significant impact would occur if construction of the Proposed Project would result in an incremental increase in annual-average ambient concentrations of $PM_{2.5}$ of more than 0.3 microgram per cubic meter ($\mu g/m^3$). The Project would have a significant cumulative health risk impact if the combined cancer risk associated with all local permitted stationary sources and major roadways plus the risks associated with the Project at the maximally exposed individual would exceed 100 in one million, would result in a non-cancer Hazard Index exceeding 10, or would result in an incremental increase in annual-average $PM_{2.5}$ concentrations exceeding 0.8 $\mu g/m^3$ (BAAQMD 2017c).

Odors

Impacts of the Proposed Project related to the creation or exposure of a substantial number of people to objectionable odors were evaluated based on the potential for the Project to generate odors that could affect nearby sensitive receptors.

Approach to Analysis

The Proposed Project's construction-related emissions were quantified using the methods described below for comparison to the BAAQMD project-level thresholds discussed previously.

Construction Emissions

Exhaust emissions of CAPs during on-site and off-site Project construction activities were estimated using the latest available version of California Emissions Estimator Model (CalEEMod) version 2020.4.0. CalEEMod was developed by the South Coast Air Quality Management District and other California air districts to assist lead agencies in determining projects' air quality impacts. The model, which combines the databases from ARB's EMFAC and OFFROAD models into a single tool, captured most of the Project's emissions-producing activities associated with construction equipment, worker vehicles, and heavy-duty trucks. A standalone spreadsheet with marine vessel calculations and ARB CAP emission factors was used to derive emissions from operations of a tugboat to maneuver a barge for equipment and materials in San Rafael Bay.

Project assumptions for the air quality analysis were developed based the description of Project construction and phasing, as discussed in Section 2.3, Project Construction. These assumptions included a conservative construction scenario with maximum concurrent activities, which would result in an limited construction schedule (generally September through January) over three consecutive years. The information used for the analysis consisted of a customized phased schedule along with a list of required off-road construction equipment, equipment workdays, worker trips, hauling trips, and mileage of trips required to complete the Project. This information was then entered into CalEEMod to estimate the Proposed Project's annual construction-related mass emissions of CAPs. CalEEMod defaults were used for Project components in which there were no Project-specific data, primarily load factors. **Appendix C**, ***Air Quality and Greenhouse Gas Emissions Supporting Documentation***, contains the construction schedule, emissions spreadsheets, and CalEEMod output sheets used to quantify the Project's construction emissions of CAPs.

As stated in Chapter 2, *Project Description*, reusing excavated material as on-site fill to the extent possible would be encouraged, to avoid trucking material off-site. As another alternative to trucking, material for construction of the coarse beach would be transported to the site partly via barge. Refer to Table 2-4 of the Project Description for specific material volumes associated with Project construction. For the shoreline levee improvements, approximately 6,000 cubic yards of material would be excavated, then backfilled with imported, less permeable soils. Approximately 18,000 cubic yards of additional fill material would be imported, from one or more upland sources up to 20 miles away, and placed on-site for levee improvements and ecotone slope construction. Fill material would be trucked to the site on city streets and unloaded at the driveway on the east side of the Albert J. Boro Community Center and Pickleweed Park. For beach construction, beach material (totaling approximately 26,000 cubic yards) would be transported to the site by barge which would generate emissions considered in this analysis.

The Proposed Project would require approximately 25,000 cubic yards of imported material in addition to the 6,000 cubic yards of fill material created from on-site Project activities (i.e., excavation of levee foundation soils). It is possible that one to four local dredging projects could provide suitable fill volume required for the Project. For example, the Larkspur Ferry Channel is dredged by the Golden Gate Bridge, Highway and Transportation District every four to five years. One dredge cycle for the ferry terminal would generate more than enough of the material needed for the Tiscornia Marsh restoration. The dredge materials from these four local projects are currently hauled by barge to either the Montezuma or Open Ocean dredge disposal site. Both disposal sites are farther from the four dredge locations than the Proposed Project site. Thus, transporting dredged material to the Project site via barge would generate reduced air pollutant emissions compared to transporting the material to these more distant locations for disposal under normal conditions. Therefore, this analysis conservatively assumes that no emissions increase would result from transporting the 25,000 cubic yards of dredge material that would be imported for the Proposed Project.

The Project's construction-period emissions were divided by a conservative estimate of the total number of construction workdays (i.e., 275 workdays) and converted into pounds to derive the average daily construction emissions. Appendix C presents the emissions summary spreadsheet used for these calculations.

Health Risk

A health risk assessment evaluated the risks to nearby receptors from exposure to TACs associated with the Proposed Project (Appendix C). The HRA focused on construction emissions at the Project site, which is considered a new but temporary source. The HRA focused on cancer risks, chronic health hazards, and $PM_{2.5}$ concentrations at residences located near the Project site.

Consistent with the BAAQMD CEQA Guidelines, the following analysis assesses impacts related to health risks and hazards at sensitive receptors in the Project vicinity. Because Project construction would represent a new emissions source, the health risk and hazard impacts are analyzed at the receptor that would be exposed to the maximum risk, hazard, and $PM_{2.5}$ concentrations.

For construction activities, exposure to diesel particulate matter represents the primary health hazard. DPM is a complex mixture of chemicals and particulate matter that has been identified by the State of California as a TAC with potential cancer and chronic non-cancer effects. DPM emissions would be generated during the operation of off-road construction equipment (e.g., excavators, loaders, cranes, graders), on-road heavy-duty vehicles that burn diesel fuel, and marine vessels (e.g., tugboats, barges, crew boats). Although other DPM exposure pathways exist (ingestion, contact with the skin), inhalation is the dominant exposure pathway for both cancer risk and chronic non-cancer health effects. Consequently, the HRA conducted for the Proposed Project evaluated the cancer and chronic non-cancer effects of DPM inhalation only.

Pollutant concentrations were estimated using the American Meteorological Society/ Environmental Protection Agency Regulatory Model Improvement Committee's regulatory air dispersion model (AERMOD version 19191). Each source was modeled with a unitized emissions rate of 1 gram/second (g/s). The modeled concentration at each receptor ($[\mu g/m^3]/[g/s]$) represents a "dispersion factor." The dispersion factor from each source was then multiplied by the source's annual-average emissions rate to determine the annual-average ambient pollutant concentration at every receptor from that source. Each source's resulting pollutant concentrations were added together at each receptor to obtain the final result. For the Proposed Project, three separate sources were included in the dispersion modeling:

- One polygon area source representing the on-site construction equipment in the predominant land-side area of construction activity.
- Two volume sources representing the marine vessels in the predominant water-side area of construction activity.
- One line area source representing heavy-duty truck traffic to and from the Project site.

The above sources represent the worst-case scenario from DPM and $PM_{2.5}$ emissions occurring at the Project's nearest receptor. To identify the maximally exposed individual receptor (MEIR) for the Project, discrete cartesian receptors were placed to simulate the surrounding residences located within 1,000 feet of the Project site. BAAQMD does not require receptors to cover precise locations, but rather, a representative grid of sensitive areas; residential areas modeled were configured with a receptor grid placement of 20 meters by 20 meters. Additionally, receptors were modeled at Bahia Vista Elementary School to confirm the appropriate fraction of time-at-home risk input for the residential receptors' cancer risk equation.[3]

To determine the risk of the Proposed Project to sensitive receptors, unit risk factors from the California Office of Environmental Health Hazard Assessment (OEHHA) guidance were used to convert maximum TAC concentrations to cancer risks and chronic health hazards (OEHHA 2015). The results of the HRA are discussed in the *Impacts and Mitigation Measures* section below. Detailed calculations are presented in Appendix C.

Impact Summary

Table 3.3-3 provides a summary of Project impacts on air quality.

TABLE 3.3-3
SUMMARY OF AIR QUALITY IMPACTS

Impact Statement	Construction
Impact 3.3-1: The Project would not conflict with or obstruct implementation of the applicable air quality plan.	LTS
Impact 3.3-2: The Project could result in a cumulatively considerable net increase of a criteria air pollutant for which the SFBAAB is in nonattainment under applicable federal and state ambient air quality standards.	LTSM
Impact 3.3-3: The Project could expose sensitive receptors to substantial pollutant concentrations.	LTSM
Impact 3.3-4: The Project would not result in emissions that lead to odors affecting a substantial number of people.	LTS
Impact 3.3-5: The Project could result in cumulative emissions of air pollutants.	LTSM

NOTES:
LTS = Less than significant
LTSM = Less than significant with mitigation

Impact Analysis

Impact 3.3-1: The Project would not conflict with or obstruct implementation of the applicable air quality plan. (*Less than Significant*)

Construction and Operation Impacts

The most recently adopted air quality plan for the Project area is BAAQMD's 2017 Clean Air Plan. The 2017 Clean Air Plan focuses on two closely related goals: protecting public health and

3 The recommended values for Fraction of Time at Home when evaluating residential cancer risk are dependent on the estimated cancer risk at the nearest school (OEHHA 2015).

protecting the climate. The 2017 Clean Air Plan is an update to BAAQMD's 2010 Ozone Strategy to comply with state air quality planning requirements and pursue the region's attainment with the NAAQS and CAAQS. The 2017 Clean Air Plan also serves as a multi-pollutant air quality plan to protect public health and the climate. The control strategy of the 2017 Clean Air Plan includes revised, updated, and new measures in the three control measure categories: stationary sources, transportation, and buildings and energy.

2017 Clean Air Plan Transportation Control Measure TR22, Construction, Freight, and Farming Equipment, is the only measure that addresses emissions from a construction project. It provides incentives for the early deployment of electric, Tier 3, and Tier 4 off-road engines used in construction, freight, and farming equipment. This control measure is designated for implementation by BAAQMD to provide incentives and would not be applicable to individual project applicants. Consequently, the Proposed Project would be consistent with the 2017 Clean Air Plan, and this impact would be ***less than significant.***

Notwithstanding the Project's less-than-significant impact with respect to consistency with the 2017 Clean Air Plan, **Mitigation Measure 3.3-2:** ***EPA Tier 4 Engines*** is identified in Impact 3.3-3 to address construction-related health risk impacts, below, which requires the applicant to implement Tier 4 construction equipment. Therefore, the Project would be implementing a measure meeting the intent of Transportation Measure TR22, even though Transportation Measure TR22 is designated for implementation by BAAQMD.

Mitigation: None required.

Impact 3.3-2: The Project could result in a cumulatively considerable net increase of a criteria air pollutant for which the SFBAAB is in nonattainment under applicable federal and state ambient air quality standards. (*Less than Significant with Mitigation*)

The BAAQMD thresholds of significance for construction and operation represent the levels at which a project's individual emissions of criteria air pollutants or precursors would result in a cumulatively considerable contribution to the SFBAAB's existing air quality conditions. If daily average construction or operational emissions, or annual operational emissions of CAPs or precursors would exceed these thresholds, a project would result in a cumulatively significant impact.

As presented in the discussions below, the Proposed Project's construction emissions would not exceed the applicable BAAQMD CAP thresholds. In addition, the Project would not generate substantive long-term operational emissions. Therefore, the Project would not result in a cumulatively considerable net increase in any pollutants for which the SFBAAB is in nonattainment under applicable federal or state ambient air quality standards.

Construction Impacts

Emissions of ROG, NO_X, PM_{10}, and $PM_{2.5}$ from construction equipment, worker trips, hauling trips, and tugboat and work boat operations associated with the Proposed Project would incrementally add to the regional atmospheric loading of these pollutants during Project construction. This analysis conservatively assumes that Project construction would occur over a period of approximately 275 workdays, commencing in September 2023 and finishing in December 2025. **Table 3.3-4** presents the tons of emissions per each work phase and the estimated unmitigated average daily construction exhaust emissions that would be associated with the Project for comparison to the BAAQMD significance threshold for construction emissions.

TABLE 3.3-4
TOTAL UNMITIGATED AVERAGE DAILY CONSTRUCTION EMISSIONS

	Tons			
Parameter	**ROG**	**NO_x**	**Exhaust PM_{10}**	**Exhaust $PM_{2.5}$**
Phase 1 On-site construction and haul trucks	0.18	1.50	0.067	0.062
Phase 1 Marine emissions (tugboat and work boat)	0.17	1.97	0.11	0.10
Phase 2 On-site construction and haul trucks	0.25	2.55	0.096	0.089
Phase 2 Marine emissions (work boat)	0.02	0.22	0.01	0.01
Phase 3 On-site construction and haul trucks	0.055	0.43	0.019	0.017
Phase 3 Marine emissions (tugboat and work boat)	0.04	0.53	0.03	0.03
Total Tons	0.66	6.77	0.313	0.291
Total Workdays	275	275	275	275
Average Daily Emissions (pounds per day)	4.80	49.24	2.28	2.12
BAAQMD Construction Threshold (average pounds per day)	54	54	82	54
Significant Impact?	No	No	No	No

NOTES:
BAAQMD = Bay Area Air Quality Management District; NO_X = nitrogen oxides; $PM_{2.5}$ = particulate matter 2.5 microns or less in diameter; PM_{10} = particulate matter 10 microns or less in diameter; ROG = reactive organic gases
See Appendix C for the emissions estimate calculations and all of the associated assumptions.

SOURCE: Data compiled by Environmental Science Associates in 2021

As shown in Table 3.3-4, estimated emissions of ROG, NOx, PM_{10}, and $PM_{2.5}$ would not exceed the applicable significance thresholds, resulting in a **less-than-significant impact**. While it is expected that levee foundation soils removed are sandy soils appropriate for reuse for the tidal marsh reconstruction; it is possible that some portion of the foundation soils would require export and disposal offsite, and additional imported soil would then be required for the tidal marsh reconstruction. However, the emissions in Table 3.3-4 from on-road truck hauling (2,250 trips) only account for two percent of the total project (NOx) emissions, which are dominated by on-site construction equipment. Therefore, the potential increase in truck transport to accommodate additional export and import of foundational soil, if required, would only marginally increase project NOx emissions and the impact would remain less than significant should this additional transport be required.

In addition to exhaust emissions, emissions of fugitive dust would be generated by Project-related construction activities associated with grading and earth disturbance, travel on paved and unpaved roads, and other construction-related activities. With regard to fugitive dust emissions, the BAAQMD CEQA Guidelines focus on implementing dust control measures rather than comparing estimated levels of fugitive dust to quantitative significance thresholds. Chapter 2, *Project Description*, does not include any Project-specific measures for controlling fugitive dust emissions; therefore, a **potentially significant impact** would result from non-exhaust particulate emissions associated with construction activities.

To reduce cumulatively considerable impacts related to emissions of fugitive dust associated with Project construction to a less-than-significant level, implementation of **Mitigation Measure 3.3-1**, which includes BAAQMD's applicable recommended fugitive dust control measures, would be required. Implementing Mitigation Measure 3.3-1 would reduce the impact associated with fugitive dust emissions to a less-than-significant level by requiring implementation of BAAQMD's applicable recommended fugitive dust control measures. With implementation of Mitigation Measure 3.3-1, Project construction would not result in a cumulatively considerable net increase of fugitive dust emissions, and the impact would be **less than significant with mitigation**.

Mitigation Measures

Mitigation Measure 3.3-1: BAAQMD Basic Construction Measures. The Project applicant and/or its construction contractors shall comply with the following applicable BAAQMD Basic Construction Mitigation Measures:

BAAQMD Basic Construction Measures

1. All exposed surfaces (e.g., parking areas, staging areas, soil piles, graded areas, and unpaved access roads) shall be watered two times per day.
2. All haul trucks and railcars transporting soil, sand, or other loose material off-site shall be covered.
3. All visible mud or dirt track-out onto adjacent public roads shall be removed using wet power vacuum street sweepers at least once per day. The use of dry power sweeping is prohibited.
4. All vehicle speeds on unpaved roads shall be limited to 15 mph.
5. All roadways, driveways, and sidewalks to be paved shall be completed as soon as possible. Building pads shall be laid as soon as possible after grading unless seeding or soil binders are used.
6. Idling times shall be minimized either by shutting equipment off when not in use or reducing the maximum idling time to five minutes (as required by the California airborne toxics control measure Title 13, Section 2485 of the California Code of Regulations [CCR]). Clear signage shall be provided for construction workers at all access points.
7. All construction equipment shall be maintained and properly tuned in accordance with manufacturer's specifications. All equipment shall be checked by a certified visible emissions evaluator.
8. Post a publicly visible sign with the telephone number and person to contact at the City of San Rafael regarding dust complaints. This person shall respond and take corrective action within 48 hours. BAAQMD's phone number shall also be visible to ensure compliance with applicable regulations.

Impact Significance After Mitigation: Less than Significant. The project applicant and contractors would implement Mitigation Measure 3.3-1 (BAAQMD Basic Construction Measures) for construction activities. This measures would ensure that the Project fully addresses BAAQMD thresholds for control of fugitive dust.

Impact 3.3-3: The Project could expose sensitive receptors to substantial pollutant concentrations. (*Less than Significant with Mitigation*)

Construction Impacts

The HRA quantified cancer risks, chronic non-cancer health hazards, and average annual $PM_{2.5}$ concentrations for nearby receptors based on the Project's annual-average PM_{10} and $PM_{2.5}$ emissions, and compared these to BAAQMD's corresponding thresholds of significance (Appendix C). To evaluate cancer health impacts, the maximum incremental cancer risk from inhalation exposure to TACs was calculated following the guidelines established by OEHHA. Non-cancer health risk is based on hazard indices established by OEHHA for chronic (long-term) exposures.

Assuming that construction of the Project would occur in three periods spanning three years between 2023 and 2025, the annual-average construction emissions associated with the Project were determined for the purpose of the HRA. It was assumed that the MEIR would be exposed to the annual-average TAC concentrations throughout the construction period; however, during the actual construction process, the location of equipment would vary within the Project site, and TAC concentrations at the MEIR would change. Placement of discrete cartesian receptors, as described above, allowed for an examination of TAC concentrations throughout the vicinity of construction activities.

Construction-related PM_{10} exhaust emissions, calculated as described in the *Approach to Analysis* section, were used as a surrogate for DPM emissions. This assumption is also conservative because DPM represents a portion of total particulate emissions from exhaust that is closer to the $PM_{2.5}$ fraction, but is consistent with regulatory guidance.

Annual-average emissions rates for the worst-case construction scenario were converted from tons per year to grams per second to estimate annual-average concentrations, which included the polygon area source, volume sources, and line area source. The variable-emissions scenario in AERMOD was used to accurately restrict construction emissions to occur only within daytime construction hours.

Once the Project's DPM concentrations at the sensitive receptors were calculated, OEHHA's Risk Assessment Guidelines were used to derive both cancer and non-cancer chronic risks. Consistent with the BAAQMD CEQA Guidelines, a three-year exposure duration was used, with exposure starting in the third trimester to most conservatively assume a child in utero. Including this life stage applies the most conservative weighting for exposures to account for increased sensitivity to carcinogens from late pregnancy through childhood, known as an Age Specific Factor. The OEHHA default breathing rates and fraction at time of residence for all age groups were also included.

Table 3.3-5 presents the unmitigated HRA results for the Proposed Project's construction period, based on OEHHA calculation methodologies.

TABLE 3.3-5
RESULTS OF HEALTH RISK ASSESSMENT FOR UNMITIGATED PROJECT CONSTRUCTION[A]

Parameters	Cancer Risk[b]	$PM_{2.5}$[c]	Chronic HI[d]
Maximally Exposed Individual Receptor (resident)	12.9	0.05	0.01
BAAQMD Thresholds of Significance	**10**	**0.3**	**1.0**
Exceeds Threshold?	*Yes*	*No*	*No*

NOTES:
BAAQMD = Bay Area Air Quality Management District; HI = Hazard Index; $PM_{2.5}$ = particulate matter 2.5 microns or less in diameter
a. The results represent the health risks associated with construction of the Project.
b. Chances in 1 million.
c. Particulate matter of 2.5 microns or less concentration is expressed as annual average in micrograms per cubic meter (µg/m^3).
d. Hazard Indices (HI) are dimensionless.
SOURCE: Data compiled by Environmental Science Associates in 2021 (see Health Risk Assessment in Appendix C)

The maximum annual-average $PM_{2.5}$ concentration would be 0.05 µg/m^3 at the MEIR, which would not exceed BAAQMD's significance threshold of 0.3 µg/m^3. TAC exposure from the Project's construction emissions would result in a maximum chronic hazard index of 0.01, which is below the BAAQMD threshold of 1.0. However, based on the assessment methods described above, the MEIR would be exposed to an incremental cancer risk of 12.9 in 1 million, which is greater than the BAAQMD threshold of 10 in 1 million. Therefore, overall Project-related construction activities would expose existing sensitive receptors to substantial pollutant concentrations, and this impact would be **significant**.

Implementing **Mitigation Measure 3.3-2** would reduce cancer risks from Project construction to below the applicable threshold. Mitigation Measure 3.3-2 would require the project applicant and/or its construction contractors to use EPA Tier 4 engines for the off-road construction equipment. This would minimize toxic airborne risks associated with the diesel combustion exhaust from Project construction. **Table 3.3-6** presents the HRA results associated with the Proposed Project's mitigated construction emissions.

TABLE 3.3-6
RESULTS OF HEALTH RISK ASSESSMENT FOR MITIGATED PROJECT CONSTRUCTION[A]

Parameter	Cancer Risk[b]	$PM_{2.5}$[c]	Chronic HI[d]
Maximally Exposed Individual Receptor (resident)	4.9	0.02	<0.01
BAAQMD Thresholds of Significance	**10**	**0.3**	**1.0**
Exceeds Threshold?	*No*	*No*	*No*

NOTES:
BAAQMD = Bay Area Air Quality Management District; HI = Hazard Index; $PM_{2.5}$ = particulate matter 2.5 microns or less in diameter
a. The results represent the health risks associated with construction of the Project.
b. Chances in 1 million.
c. Particulate matter of 2.5 microns or less concentrations are expressed as annual average in micrograms per cubic meter (µg/m^3).
d. Hazard Indices (HI) are dimensionless.
SOURCE: Data compiled by Environmental Science Associates in 2021 (see Health Risk Assessment in Appendix C)

Based on implementation of Mitigation Measure 3.3-2 as summarized above, the MEIR would be exposed to an incremental cancer risk of 4.9 in 1 million, which is below the BAAQMD threshold of 10 in 1 million. Overall, mitigated Project-related construction activities would not expose existing sensitive receptors to substantial pollutant concentrations.

Mitigation Measures

Mitigation Measure 3.3-1: ***BAAQMD Basic Construction Measures.*** (See Impact 3.3-2.)

Mitigation Measure 3.3-2: ***EPA Tier 4 Engines*****.** The Project applicant and/or its construction contractors shall be required to use off-road diesel construction equipment compliant with EPA Tier 4 nonroad engine standards. Before construction activities begin, the construction contractor and/or the Project applicant shall prepare an equipment list that identifies each piece of off-road equipment to be operated at the Project site by its equipment identification number and demonstrates that each piece of equipment meets EPA Tier 4 nonroad engine standards. The list shall be made available at the construction site and shall be updated when new or replacement construction equipment is brought to the site.

Impact Significance after Mitigation: Less than Significant. The Project applicant and contractors would implement Mitigation Measure 3.3-1 (BAAQMD Basic Construction Measures) to minimize the generation and emission of dust during construction, and Mitigation Measure 3.3-2 (EPA Tier 4 Engines), which requires the use of cleaner burning engines and would reduce TAC emissions below the established threshold.

Impact 3.3-4: The Project would not result in emissions that lead to odors affecting a substantial number of people. ***(Less than Significant)***

Construction Emissions

BAAQMD has developed a list of recommended odor screening distances for specific odor sources. If a proposed project would include the operation of an odor source, the screening distances should be used to evaluate the impact on existing sensitive receptors. BAAQMD recommends using the screening distances as indicators for the amount of additional analysis required, rather than as the sole indicator of impact significance (BAAQMD 2010). Combustion of diesel fuel by off-road equipment, harbor craft, and heavy-duty trucks used to construct the Project may generate emissions that lead to odors. However, BAAQMD does not have an odor screening distance for construction activity, and thus, this methodology cannot be relied upon for this impact assessment. As described in Section 3.3.2, *Environmental Setting*, there are sensitive receptors (e.g., residences, schools) in the immediate vicinity of the Project site.

Diesel combustion emissions from Project construction would be temporary, intermittent, and spatially dispersed, and therefore, the associated odors would dissipate quickly. Odor impacts associated with diesel combustion during construction activities would be **less than significant**.

During excavation activities, organic materials would be temporarily exposed to the air. However, such exposure is not anticipated to result in substantial emission of odors, because water levels would be drawn down below the organic layer, allowing sediments to partially dry out, rather than stagnating and generating odors. Also, Project construction activities would include the covering of this layer early during the construction period. As a result, this impact would be **less than significant**.

Mitigation: None required.

Cumulative Impacts

Impact 3.3-5: The Project could result in cumulative emissions of air pollutants. (*Less than Significant with Mitigation*)

Criteria Pollutants (Less than Significant)

As discussed above, regional air pollution is by its very nature largely a cumulative impact. Emissions from past, present, and future projects contribute to the region's adverse air quality on a cumulative basis. No single project by itself would be sufficient in size to result in regional nonattainment of ambient air quality standards. Instead, a project's individual emissions contribute to existing cumulative adverse air quality impacts (BAAQMD 2017a:2-1).

The project-level thresholds for CAP emissions are based on the levels below which new sources are not anticipated to result in a considerable net increase in nonattainment CAP emissions. Therefore, the cumulative CAP emissions analysis is presented in Impact 3.3-2. As discussed in Impact 3.3-2, the Proposed Project would not result in a cumulatively considerable contribution to regional CAP emissions, and the cumulative impact would be **less than significant**.

Toxic Air Contaminants (Less than Significant with Mitigation)

In accordance with BAAQMD guidance for a complex source, all TAC and $PM_{2.5}$ sources within a 1,000-foot radius of the maximally exposed individual receptor were identified. The evaluation followed a conservative approach to evaluate the Proposed Project's cumulative health risks, using BAAQMD's Health Risk Screening and Distance Multiplier Tools. The results were as follows:

- One existing permitted stationary source was located within 1,000 feet of the unmitigated construction MEIR.
- No permitted stationary sources were located within 1,000 feet of the mitigated construction MEIR.
- No highways or major roadways were found within 1,000 feet of either the unmitigated or mitigated MEIR.
- The cancer and non-cancer chronic risks and annual-average $PM_{2.5}$ concentrations were calculated and are included in **Table 3.3-7** and **Table 3.3-8**. See Appendix C for the detailed calculations and methods used to derive these values.

TABLE 3.3-7
RESULTS OF CUMULATIVE UNMITIGATED PROJECT HEALTH RISK ASSESSMENT[A]

Source	Health Risks at the MEIR		
	Cancer Risk[b]	$PM_{2.5}$[c]	Chronic Hi[d]
Project	12.9	0.05	0.01
Highway/Major Street[e]	–	–	–
Stationary Sources[f]	0.57	<0.01	0.01
Cumulative	13.5	0.05	0.01
BAAQMD Thresholds of Significance	**100**	**0.8**	**10.0**
Exceeds Threshold?	*No*	*No*	*No*

NOTES:

BAAQMD = Bay Area Air Quality Management District; HI = Hazard Index; MEIR = maximally exposed individual receptor; $PM_{2.5}$ = particulate matter 2.5 microns or less in diameter

a. The results represent the cumulative health risks associated with construction of the Project and all other sources of toxic air contaminant (TAC) and $PM_{2.5}$ emissions within a 1,000-foot radius of the MEIR.
b. Chances in 1 million.
c. Concentrations are expressed as micrograms per cubic meter (μg/m^3).
d. Hazard indices (HI) are dimensionless.
e. No highways or major streets (annual average daily traffic >10,000) within 1,000 feet of the MEIR.
f. One permitted stationary source within 1,000 feet of the MEIR: City of San Rafael Department of Public Works' (FACID 17906) generators.

SOURCE: Data compiled by Environmental Science Associates in 2021 (see Health Risk Assessment in Appendix C)

TABLE 3.3-8
RESULTS OF CUMULATIVE MITIGATED PROJECT HEALTH RISK ASSESSMENT[A]

Source	Health Risks at the MEIR		
	Cancer Risk[b]	$PM_{2.5}$[c]	Chronic Hi[d]
Project	4.9	0.02	<0.01
Highway/Major Street[e]	--	--	--
Stationary Sources[f]	--	--	--
Cumulative	4.9	0.02	<0.01
BAAQMD Thresholds of Significance	**100**	**0.8**	**10.0**
Exceeds Threshold?	*No*	*No*	*No*

NOTES:

BAAQMD = Bay Area Air Quality Management District; HI = Hazard Index; MEIR = maximally exposed individual receptor; $PM_{2.5}$ = particulate matter 2.5 microns or less in diameter

a. The results represent the cumulative health risks associated with construction of the Project and all other sources of toxic air contaminant (TAC) and $PM_{2.5}$ emissions within a 1,000-foot radius of the MEIR.
b. Chances in 1 million.
c. Concentrations are expressed as micrograms per cubic meter (μg/m^3).
d. Hazard indices (HI) are dimensionless.
e. No highways or major streets (annual average daily traffic >10,000) within 1,000 feet of the MEIR.
f. No permitted stationary sources within 1,000 feet of the MEIR.

SOURCE: Data compiled by Environmental Science Associates in 2021 (see Health Risk Assessment in Appendix C)

Table 3.3-7 and Table 3.3-8 present the results of the cumulative HRA for the unmitigated and mitigated Project construction periods, respectively. Based on the assessment methods described above, the unmitigated and mitigated MEIRs would be exposed to an incremental cancer risk of up to 13.5 in 1 million and 4.9 in 1 million, respectively. Both of these risk levels are below BAAQMD's cumulative threshold of 100 in 1 million. The annual-average $PM_{2.5}$ concentration at the unmitigated and mitigated MEIRs would be to 0.05 μg/m^3 and 0.02 μg/m^3, respectively, both below the cumulative threshold of 0.8 μg/m^3. The chronic non-cancer hazard index would be up to 0.01, which is below the cumulative threshold of 10.0.

Implementing Mitigation Measure 3.3-2, described above under Impact 3.3-3, would reduce cancer risks from Project construction to below the applicable threshold by requiring the use of off-road diesel construction equipment compliant with EPA Tier 4 nonroad engine standards. The health risk impact would not be cumulatively considerable, and the cumulative impact would be **less than significant with mitigation**.

Mitigation Measures

Mitigation Measure 3.3-2: *EPA Tier 4 Engines*. (See Impact 3.3-3.)

3.3.5 References

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3.4 Biological Resources

This section addresses impacts on biological resources that may result from construction and operation of the Proposed Project. The analysis of terrestrial biological resources addresses areas both within the Project footprint and adjacent habitats outside of these boundaries. In instances where only the Project footprint is referenced, the term "Project site" is used within this section. The term "study area" is used to describe the greater area of biological analysis for potential impacts, and includes Tiscornia Marsh, Pickleweed Park, Albert J. Boro Community Center and Pickleweed Park, and potential upland staging areas. The study area also includes aquatic habitat within the construction footprint, the adjacent San Rafael Creek, and San Rafael Bay. Terrestrial resources described in this section include vegetation communities, such as tidal salt marsh, diked marsh, tidal waters/mudflat, pond, and associated wildlife; and special-status plants and wildlife (federal or state endangered, threatened, proposed, and candidate species; and state species of concern).

The analysis of aquatic resources addresses native fish species and their aquatic habitat, as well as marine mammals and other sensitive natural communities, within the Project site and the greater study area. Special-status fish aquatic species included in this section are those designated by federal or state agencies as endangered, threatened, or proposed for listing, candidate species; and state or local species of concern. The existing hydrology and water quality conditions within the study area are discussed only as they relate to fisheries resources, with a more detailed discussion of impacts on hydrology and water quality provided in Section 3.6, *Hydrology and Water Quality*.

This section identifies the federal, state, and local regulations pertaining to biological resources expected in the study area. Information used in the preparation of this report included regional biological studies the California Department of Fish and Wildlife (CDFW) California Natural Diversity Database (CNDDB; CDFW 2021), California Native Plant Society Electronic Inventory (CNPS 2021), U.S. Fish and Wildlife Service (USFWS) Information for Planning and Consultation (IPaC) species list (USFWS 2021), reconnaissance-level field surveys, and other biological literature.

Habitat types and associated wildlife were identified using records, field observations, and aerial imagery. Environmental Science Associates biologists conducted two reconnaissance-level surveys of the study area on December 19, 2019 and May 13, 2020 to gather information and verify existing data on habitat types, sensitive natural communities, and potential habitat use of wildlife on and surrounding the Project site. The findings of this review were summarized in the *Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation Project Habitat Assessment* (ESA 2020).

3.4.1 Environmental Setting

Regional Setting

The study area is located in Marin County along San Rafael Bay. Marin County has a diverse topography and microclimate, and has an associated high diversity of vegetation and wildlife, although development in the region has resulted in a substantial reduction in land available for native flora and fauna. The study area is within the City of San Rafael at the mouth of San Rafael Creek, a tidal channel that is largely confined by urban development.

Project Setting

The description of habitat types presented herein is based on field observations, review of previous biological studies using terminology from the standard *Preliminary Descriptions of the Terrestrial Natural Communities of California* (Holland 1986). Plant communities generally correlate with wildlife habitat types, which were classified and evaluated using *A Guide to Wildlife Habitats of California* (Mayer and Laudenslayer 1988). The following habitat types occur in the study area: ruderal/nonnative grassland, turf, coastal scrub, landscaped, developed, tidal salt marsh, diked marsh, tidal waters/mudflat, and pond (**Table 3.4-1**). The distribution of habitat types within the study area is presented in **Figure 3.4-1**. Dominant vegetation and wildlife observed during the reconnaissance surveys are described below for each habitat type.

TABLE 3.4-1
HABITAT TYPES BY ACREAGES

Habitat Type	Acreage[a]
Upland Habitat Types	
Ruderal/Non-Native Grassland	1.43
Turf	4.72
Coastal Scrub	0.32
Landscaped	3.32
Developed	3.90
Aquatic Habitat Types	
Tidal Salt Marsh	7.59
Diked Marsh	3.95
Tidal Waters/Mudflat	12.75
Pond	0.07
TOTAL	**38.05**

NOTES:
a. GIS calculations may not reflect exact acreage of study area due to rounding.

Vegetative Communities and Wildlife Habitat Types

Upland Habitat Types

Ruderal/Non-native Grassland/Turf

Terrestrial portions of the study area are dominated by ruderal vegetation and non-native grassland. These habitats are most prevalent in areas subject to frequent disturbances often due to maintenance activities or heavy use. Within the study area, this habitat occurs mostly along the trail and is characterized by the dense growth of non-native grasses and forbs. Common non-native grasses frequent within the study area include wild oat (*Avena* spp.), Italian ryegrass (*Festuca perennis*), ripgut brome (*Bromus diandrus*), soft chess (*Bromus hordeaceus*), seaside barley (*Hordeum marinum*), and foxtail barley (*Hordeum murinum*). Non-native invasive forbs within this habitat include fennel (*Foeniculum vulgare*), bristly oxtongue (*Helminthotheca echioides*), and wild radish (*Raphanus sativus*). Some native grasses and herbs occur intermittently throughout the ruderal vegetation and non-native grassland including pineapple

SOURCE: aerial (ESRI)

Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation Project

Figure 3.4-1
Habitat Types

ESA

weed (*Matricaria discoidea*) and meadow barley (*Hordeum brachyantherum*). Several native and non-native trees occur within the ruderal/non-native grassland along the trails including coast live oak (*Quercus agrifolia*), Canary Island date palm (*Phoenix canariensis*), and acacia (*Acacia* sp.). Turf occurs at the soccer field in the study area. The field appears regularly mowed and contains non-native grasses and forbs including annual blue grass (*Poa annua*) and clover (*Trifolium* spp.).

In areas adjacent to trails and parks that are utilized by humans, wildlife use is likely limited. Canada geese (*Branta canadensis*) were seen foraging in the turf during the reconnaissance survey. Some other common wildlife that may use non-native grassland and ruderal habitats include western fence lizard (*Sceloporus occidentalis*), black-tailed jackrabbit (*Lepus californicus*) and other small mammals, and western meadowlark (*Sturnella neglecta*). The non-native grassland and ruderal habitat in areas directly adjacent to tidal and non-tidal wetlands are important as refugia habitat for marsh wildlife during high tides, storms, and flood events. Scattered trees next to the trail likely provide minimal wildlife habitat, but may provide foraging and nesting habitat for a variety of birds.

Coastal Scrub

A small strip of uplands between the tidal marsh and trail is comprised of coastal scrub habitat, dominated by shrubs such as California sagebrush (*Artemisia californica*) and coyote brush (*Baccharis pilularis*). This area was planted several years ago by STRAW (Students and Teachers Restoring a Watershed) and Point Blue Conservation Science. The area contains several non-native and invasive species including pride of madeira (*Echium candicans*), dwarf mallow (*Malva neglecta*), and Canarian sea lavender (*Limonium perezii*), as well as non-native grasses and herbs found in the non-native grassland/ruderal habitat. Some native grasses and herbs also occur throughout the scrub habitat including creeping wildrye (*Elymus triticoides*) and California mugwort (*Artemesia douglasiana*).

The coastal scrub habitat in the study area provides refugia habitat for marsh wildlife during high tide, storm, and flood events. Birds that may forage within coastal scrub habitat include San Pablo song sparrow (*Melospiza melodia samuelis*), white-crowned sparrow (*Zonotrichia leucophrys*), and red-winged blackbird (*Agelaius phoeniceus*).

Landscaped

Several different landscaped areas exist within the study area surrounding the Albert J. Boro Community Center and Pickleweed Park, and nearby trails (see Appendix D). Several trees are found throughout these landscaped areas including sweet gum (*Liquidambar styraciflua*) and black oak (*Quercus kelloggii*). Mowed grassy areas and wood-chipped areas exist under the tree canopy. Mowed turf areas include mostly non-native grasses and herbs also found in the soccer field turf.

Trees can generally provide nesting, roosting, and foraging habitat for many species of birds. However, because these trees are near developed areas, they may only provide nesting opportunities to birds willing to nest near areas of frequent human disturbance, such as California scrub jay (*Aphelocoma californica*), northern mockingbird (*Mimus polyglottos*), and house finch (*Haemorhous mexicanus*). Other wildlife that may inhabit these areas include raccoon (*Procyon lotor*) and Virginia opossum (*Didelphis virginiana*).

Developed

Developed areas include the community center buildings, a parking lot, and paved and unpaved trails (see Photos 1, 4, and 5 in the Photo attachment of Appendix D). The unpaved trail around the study area separates the tidal marsh from the diked marsh, soccer field, and other landscaped and developed areas. Trees and shrubs are found scattered throughout the developed areas surrounding the parking lot and buildings and include non–native species such as golden rain tree (*Koelreuteria paniculata*), Marina strawberry tree (*Arbutus* x 'Marina'), and Crimson bottlebrush (*Callistemon citrinus*).

These trees can provide habitat to birds and other wildlife, but the buildings and paved areas themselves support few biological resources. The unpaved trail is likely used by wildlife to move between other wetland and upland habitats. Developed areas provide limited wildlife habitat and usually support only generalist, and sometimes non-native wildlife species that are tolerant of human presence and activities, such as house sparrow (*Passer domesticus*) and Virginia opossum.

Transition Zone

The transition zone within the study area encompasses upland habitat types adjacent to the tidal marsh. In the study area, the transition zone is a very narrow band, typically 5 to 30 feet wide, that begins at the edge of the tidal marsh and contains ruderal/non-native grassland or coastal scrub habitat before it abuts against the pedestrian trail. The transition zone is important refugia habitat for marsh wildlife during high tides, storms, and flood events. However, because the transition zone is so narrow and close to developed areas, wildlife utilizing this transition zone may be exposed to excessive predation.

Aquatic Habitat Types

Aquatic resources within the study area that have potential to be considered federally or state jurisdictional include the aquatic habitat types described below. The aquatic habitats were mapped based on aerial imagery and the two reconnaissance-level surveys of the study area. The distribution of aquatic habitat types (tidal marsh, diked marsh, tidal waters, and pond) in the study area is shown in Figure 3.4-1.

Tidal Salt Marsh

Tidal salt marsh, found along the edge of San Rafael Bay and San Rafael Creek in the study area, is typical of tidal salt marsh in San Rafael Bay and contains low and mid-high marsh zones. Due to the small size of the tidal salt marsh and the mix of the mid and high marsh plants at this site, the latter two zones are lumped below into the mid-high marsh zone. Vegetation communities in tidal wetlands are defined by tidal hydroperiod, salinity, soils, drainage, and species competition.

Low Marsh Zone

The low marsh zone consists of the marsh directly adjacent to San Rafael Bay, San Rafael Creek, and adjacent to small channels within the interior of the marsh. Low marsh generally occurs between elevations 3.3 and 5.5 feet North American Vertical Datum (NAVD), or approximately mean tide level (MTL) to mean high water (MHW) (ESA 2018). The dominant plant species within the low marsh zone is California cordgrass (*Spartina foliosa*).

Mid-High Marsh Zone

The mid-high marsh zone occurs in the band between the uplands and trail and the narrow strip of low marsh along the San Rafael Bay shoreline. Mid-high marsh habitat generally occurs between 5.5 and 7.3 feet NAVD, or between MHW and the highest tide (ESA 2018).

Vegetation within this zone is dominated by pickleweed (*Salicornia pacifica*). Jaumea (*Jaumea carnosa*) is also present in the lower elevations of the mid-high marsh zone. Many other species are found at the upper elevations of the high marsh and at the edge between high marsh and uplands including native salt grass (*Distichlis spicata*), alkali heath (*Frankenia salina*), and gumplant (*Grindelia stricta*). Both the size in area and the amount of plant diversity are greater in the mid-high marsh than in the low marsh zone within the study area. Some other native species encountered intermittently within the mid-high marsh habitat include marsh rosemary (*Limonium californicum*) and fat hen (*Atriplex prostrata*).

Tidal salt marsh vegetation throughout the study area provides nesting and foraging opportunities and cover for marsh bird species, including mallard (*Anas platyrhynchos*), great blue heron (*Ardea herodias*), great egret (*Ardea alba*), marsh wren (*Cistothorus palustris*), San Pablo song sparrow, red-winged blackbird, salt marsh common yellowthroat *(Geothlypis trichas sinuousa),* and small mammals such as raccoon and California vole (*Microtus californicus*).

Raptors that are typical of marsh habitats include northern harrier (*Circus hudsonius*), red-tailed hawk (*Buteo jamaicensis*), white-tailed kite (*Elanus leucurus*), and American kestrel (*Falco sparverius*). During winter high tides, ducks that may be found in tidal marsh environments include northern shoveler (*Anas clypeata*), American wigeon (*Anas americana*), northern pintail (*Anas acuta*), gadwall (*Anas strepera*), and canvasback (*Aythya valisineria*).

Special-status wildlife that may occur within tidal marsh habitats includes salt marsh harvest mouse (*Reithrodontomys raviventris*), California Ridgway's rail (*Rallus obsoletus obsoletus*), and California black rail (*Laterallus jamaicensis*).

Diked Marsh

Diked marsh habitat in the study area is dominated by pickleweed and contains varying densities of this plant. With a slight increase in elevation, pickleweed intergrades into areas composed of an assortment of hydrophytic species including, natives salt grass and alkali heath, and non-natives fat hen and rabbitsfoot grass (*Polypogon monspeliensis*). Most of the diked marsh in the study area occurs west of the tidal salt marsh, behind the levee/trail. However, two other smaller areas of diked marsh occur in the northwest area of the study area around a pond and in an area of lower elevation (refer to Figure 3.4-1).

Similar to tidal salt marsh, diked marsh can provide nesting, foraging, and refugia habitat for wildlife associated with tidal marsh vegetation. The lower water levels and sparse vegetation can attract foraging and nesting shorebirds such as sandpiper (*Calidris* spp.), black-necked stilt

(*Himantopus mexicanus),* American avocet (*Recurvirostra americana*), short-billed dowitcher (*Limnodromus griseus*), and killdeer (*Charadrius vociferous*). Northern harrier commonly hunt over open marshes such as those on the Project site. Diked marshes also provide habitat for small rodents that occur in the tidal marshes in the region including salt marsh harvest mouse.

Tidal Waters

San Rafael Bay, San Rafael Creek, and small channels within the tidal marsh are characterized by open water bordered by stands of cordgrass. The tidal waters within the study area occur within intertidal elevations and thus are mudflat at low tide (see Photos 3 and 6 in the Photo attachment of Appendix D). Subtidal habitat occurs in San Rafael Creek and in San Rafael Bay adjacent to the study area where elevations are below the tide range and the substrate is, as a result, continuously submerged. Intertidal mudflat occurs upslope of the subtidal areas and in a few smaller tidal channels within the study area and is generally devoid of vegetation.

Mudflat within San Rafael Bay provides foraging opportunities for shorebirds. Migratory shorebirds that may forage in the mudflats along San Rafael Bay and San Rafael Creek during low tide, as well as the channel banks, include dunlin (*Calidris alpina*), willet (*Tringa semipalmata*), black-necked stilt, American avocet, marbled godwit (*Limosa fedoa*), and several sandpiper species.

During winter high tide, the shallow waters may provide habitat for dabbling ducks such as mallard, northern shoveler, and gadwall; and the deeper waters may provide foraging and resting habitat for grebes, cormorants, and diving ducks.

San Rafael Creek and the nearshore waters of San Rafael Bay provide shallow subtidal and intertidal benthic estuarine habitat for a wide variety of fish, wildlife, and marine invertebrate species. Riprap and other shoreline structures, such as piles, provide some solid substrates. A 12-month aquatic habitat survey of the creek and nearshore waters adjacent to Tiscornia Marsh was conducted for the U.S. Army Corps of Engineers (USACE) by the USFWS in 1989 (Weinrich 1990). Benthic samples at the mouth of the creek yielded numerous polychaete worms, as well as clams and snails. Three species of crabs were found: Dungeness (*Metacarcinus magister*), red rock (*Cancer productus*), and yellow shore crabs (*Hemigrapsus oregonensis*). Twenty-two species of fish were captured in the creek and in San Rafael Bay during the yearlong survey. The most common species (accounting for 91 percent of the total fish captured) were northern anchovy (*Engraulis mordax*), shiner perch *(Cymatogaster aggregata),* yellowfin goby *(Acanthogobius flavimanus)*, threadfin shad *(Dorosoma petenense)*, and butter sole *(Isopetta isolepis)*. Seventeen species captured are endemic to California waters. Five introduced species were captured: Mississippi silverside (*Menidia audens*), threadfin shad, striped bass (*Morone saxatilis*), yellowfin goby, and chameleon goby (*Tridentiger trigonocephalos*). Other aquatic species found included jellyfish, comb jellies, and two species of bay shrimp (Weinrich 1990).

From 2015 through 2020, Environmental Science Associates conducted annual fish sampling in the (restored) Hamilton Wetlands Preserve, approximately 6 miles north of Tiscornia Marsh. Based on proximity of the study area to the Hamilton Wetlands Preserve, these surveys are a useful record of fish species that may occur within this portion of the San Francisco Bay-Delta.

This would include San Rafael Bay and the tidal portions of San Rafael Creek. The Hamilton Wetlands Preserve surveys resulted in the capture and identification of approximately 2,500 individual fish, representing 12 native species: northern anchovy, Pacific herring (*Clupea pallasii*), Pacific staghorn sculpin (*Leptocottus armatus*), three-spined stickleback (*Gasterosteus aculeatus*), topsmelt (*Atherinops affinis*), California halibut (*Paralichthys californicus*), and Chinook salmon (*Oncorhynchus tshawytscha*); as well as non-native species: chameleon goby, yellowfin goby, rainwater killifish (*Lucania parva*), Shokihaze goby (*Tridentiger barbatus*), and striped bass (ESA et al. 2021).

Pond

A small created pond occurs in the northwest corner of the study area near San Rafael Creek. The open water pond may provide foraging and resting habitat for waterfowl and migrating birds, but contains marginal habitat for wildlife due to its small size, steep pond edges with limited cover, and a tall fence around the pond (see Photo 8 in the Photo attachment of Appendix D).

Special-Status Species

A number of species known, or with potential, to occur in the study area vicinity are protected pursuant to federal and/or state endangered species laws, or have been designated Species of Special Concern by the CDFW. In addition, Section 15380(b) of the CEQA Guidelines provides a definition of rare, endangered, or threatened species that are not included in any listing.[1] Species recognized under these terms are collectively referred to as "special-status species." For the purposes of this EIR, special-status species include the following:

1. Species listed or proposed for listing as threatened or endangered under the federal Endangered Species Act (FESA) (50 CFR 17.12 [listed plants], 17.11 [listed animals], and various notices in the Federal Register [FR] [proposed species]).
2. Species that are candidates for possible future listing as threatened or endangered under the FESA (61 FR 40, February 28, 1996).
3. Species listed or proposed for listing by the State of California as threatened or endangered under the California Endangered Species Act (CESA) (14 Cal. Code Regs. 670.5).
4. Species designated by the CDFW as species of special concern.[2]
5. Species designated as "fully protected" by the state (there are about 35, most of which are also listed as either endangered or threatened).[3]

[1] For example, vascular plants listed as rare or endangered or as List 1 or 2 by CRPR are considered to meet Section 15380(b).

[2] A California species of special concern is one that: has been extirpated from the state; meets the state definition of threatened or endangered but has not been formally listed; is undergoing or has experienced serious population declines or range restrictions that put it at risk of becoming threatened or endangered; and/or has naturally small populations susceptible to high risk from any factor that could lead to declines that would qualify it for threatened or endangered status.

[3] The "fully protected" classification was California's initial effort in the 1960s to identify and provide additional protection to those animals that were rare or faced possible extinction. The designation can be found in the Fish and Game Code.

6. Raptors (birds of prey), which are specifically protected by California Fish and Game Code Section 3503.5.[4]
7. Plants listed as rare or endangered under the California Native Plant Protection Act (California Fish and Game Code, Section 1900 et seq.).
8. Species that meet the definitions of rare and endangered under CEQA. CEQA Section 15380 provides that a plant or animal species may be treated as "rare or endangered" even if not on one of the official lists (CEQA Guidelines, Section 15380).
9. Plants considered to be "rare, threatened or endangered in California" under the California Rare Plant Ranking system (CRPR), which includes Rank 1A, 1B, 2A, and 2B as well as some Rank 3 and 4[5] plant species.

Appendix D provides a comprehensive list of the special-status species considered in the evaluation of the Proposed Project. This list was created following review of the CNDDB (CDFW 2021), CNPS Electronic Inventory (CNPS 2021), and the USFWS IPaC report (USFWS 2021). Based on a review of the biological literature of the region, recent biological reports for the study area, and an evaluation of the study area's habitat conditions (ESA 2020), Environmental Science Associates determined whether each species has a low, moderate, or high potential to occur in the study area.

Species with a low potential to occur are species whose current distribution or range does not include the study area, or species whose specific habitat requirements are not present (e.g., riparian forest). Species with a moderate potential to occur are those for whom suitable foraging or breeding habitat is present in the study area, even though the species has not been recently observed in the study area. A species was determined to have a high potential for occurrence if moderate to high quality habitat is present within the study area in addition to the area being included in the documented range of the species. Species observed or with a moderate to high potential to occur within the study area are discussed in detail below.

Species Assessed in Detail

Of the special-status plants, animals, and fish presented in Appendix D, and other managed U.S. fisheries species and special status marine species, only the following species have a moderate to high potential to occur within the study area and are described in detail below:

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[4] The inclusion of birds protected by Fish and Game Code Section 3503.5 is in recognition of the fact that these birds are substantially less common in California than most other birds, having lost much of their habitat to development, and that the populations of these species are therefore substantially more vulnerable to further loss of habitat and to interference with nesting and breeding than most other birds. It is noted that a number of raptors and owls are already specifically listed as threatened or endangered by state and federal wildlife authorities.

[5] Rank 3 plants may be analyzed under CEQA Guidelines Section 15380 if sufficient information is available to assess impacts to such plants. Factors such as regional rarity vs. statewide rarity should be considered in determining whether cumulative impacts to a Rank 4 plant are significant even if individual project impacts are not. CRPR Rank 3 and 4 plants may be considered regionally significant if, for example, the occurrence is located at the periphery of the species' range, or exhibits unusual morphology, or occurs in an unusual habitat/substrate. For these reasons, CRPR Rank 3 and 4 plants should be included in the special-status species analysis. Rank 3 and 4 plants are also included in the CNDDB Special Vascular Plants, Bryophytes, and Lichens List (CNDDB, 2021).

Plants

- Marin knotweed (*Polygonum marinense*)
- Suisun Marsh aster (*Symphyotrichum lentum*)
- Congested-headed hayfield tarplant (*Hemizonia congesta* subsp. *congesta*)
- Point Reyes bird's-beak (*Chloropyron maritimum* ssp. *palustre*)

Birds

- California black rail (*Laterallus jamaicensis coturniculus*)
- California Ridgway's rail (*Rallus obsoletus obsoletus*)
- Northern harrier (*Circus cyaneus*),
- Salt marsh common yellowthroat (*Geothlypis trichas sinuousa*)
- San Pablo song sparrow (*Melospiza melodia samuelis*)

Fish

- Chinook salmon (*Oncorhynchus tshawytscha*)
- Steelhead (*O. mykiss*)
- Green sturgeon (*Acipenser medirostris*)
- Longfin smelt *(Spirinchus thaleichthys)*
- Pacific herring (*Clupea pallasii*)

Mammals

- Salt marsh harvest mouse (*Reithrodontomys raviventris*)
- Salt-marsh wandering shrew (*Sorex vagrans halicoetes*)
- Pacific harbor seal (*Phoca vitulina richardsi*)
- California sea lion (*Zalophus californianus*)
- Harbor porpoise (*Phocoena phocoena*)

Of these species, California Ridgway's rail, San Pablo song sparrow, and salt marsh harvest mouse have been detected within the study area.

Special-Status Plants

Four special-status plants were determined to have a moderate likelihood to occur within the study area, and are described below. Other plant species were determined unlikely to occur based on a lack of suitable specific habitat conditions (e.g., vernal pools), associated habitat communities are not present (e.g., chaparral), lack of suitable soil conditions, or because the study area is below the elevation range of the species.

Point Reyes bird's-beak (*Chloropyron maritimum* ssp. *palustre*) is a California Rare Plant Rank (CRPR) 1B.2 species. Point Reyes bird's-beak is found in the heavy clay soils of coastal salt marshes of northern San Francisco Bay and occurs at the upper end of tidal zones. It is associated with pickleweed, salt grass, fat hen, and jaumea and is rarely found in non-tidal conditions. Point Reyes bird's-beak is an annual herb in the broomrape family (Orobanchaceae) that blooms from May to October. It typically occurs in low growing marsh vegetation in coastal salt marshes at elevations ranging from 0 to 30 feet. Point Reyes bird's-beak is known to occur 1.8 miles to the south and 3.2 miles to the north from the study area within historic tidal marshes. Potentially suitable tidal marsh habitat exists in the study area; however, the tidal marsh in the study area was recently formed (within the last 50 to 150 years) and therefore likely less biologically diverse than most historic tidal marshes in the area that were formed between 2,000 and 5,000 years ago and potentially less likely to contain rare plants such as Point Reyes bird's-beak than historic tidal marshes.

Marin knotweed (*Polygonum marinense*), a CRPR 3.1 species, is an annual forb in the knotweed family (Polygonaceae) that blooms from May to August. It typically occurs in salt and brackish marshes between 0 to 30 feet. This species has been documented along the Marin County shoreline 2.7 miles from the study area to the north and 1.9 miles to the south in historic tidal marshes. Potentially suitable tidal marsh habitat exists in the study area; however, the tidal marsh in the study area was recently formed and therefore likely less biologically diverse than most historic tidal marshes and potentially less likely to contain rare plants such as Marin knotweed than historic tidal marshes.

Suisun Marsh aster (*Symphyotrichum lentum*), a CRPR 1B.2 species, is a perennial forb in the sunflower family (Asteraceae) that blooms from May to November. It typically occurs along sloughs and channels in dense marsh vegetation in freshwater and coastal brackish marsh habitat at elevations ranging from 0 to 10 feet. The plant is a tall (3 to 6 feet) perennial with fairly large violet heads having ray flowers 10 to 12 mm (half-inch) long. Historic occurrences exist along the San Pablo Bay shoreline in Marin, although the most recent observation occurs 4.2 miles from the study area across San Pablo Bay. Potentially suitable tidal marsh habitat exists in the study area.

Congested-headed hayfield tarplant (*Hemizonia congesta* subsp. *congesta*), a CRPR 1B.2 species, is an annual forb in the sunflower family (Asteraceae) that can have a wide blooming period between April to November. It typically occurs in grassy sites and marsh edges at elevations below 330 feet. Three occurrences exist between 4 and 5 miles to the west and north of the study area. Non-native grasslands between the trail and diked and tidal marsh provide suitable habitat for this species within the study area.

Special-Status Animals

Fish and wildlife species that have a moderate to high likelihood to occur within the study area are described below.

Special-Status Fish

Chinook salmon. The Chinook salmon (Oncorhynchus tshawytscha) that inhabit the San Francisco Bay are comprised of three distinct races: winter-run, spring-run, and fall/late fall-run.[6] These races are distinguished by the seasonal differences in adult upstream migration, spawning,

[6] These races are referred to as Evolutionarily Significant Units.

and juvenile downstream migration. Chinook salmon are anadromous fish, spending 3 to 5 years at sea before returning to freshwater to spawn. These fish pass through San Francisco Bay waters to reach their upstream spawning grounds. In addition, juvenile salmon migrate through the Bay en route to the Pacific Ocean.

Sacramento River winter-run Chinook salmon, listed as endangered under FESA and CESA, migrate through the San Francisco Bay from December through July with a peak in March (Moyle 2002). Central Valley spring-run Chinook, listed as threatened under FESA and CESA, migrate to the Sacramento River from March to September with a peak spawning period between late August and October (Moyle 2002). The Central Valley fall/late fall-run Chinook salmon is a California species of special concern.

While all three Chinook salmon races are found in the San Francisco Bay, the Central Valley fall/late fall-run is the only race that spawns in San Francisco Bay tributary streams. However, most stream habitat in the San Francisco Bay lacks the necessary flow regime, habitat availability, and/or water quality to support spawning salmonids. Additionally, individuals are rarely documented within the Project study area or the immediate vicinity, and any occurrence would only be temporary as the surrounding Bay habitat is primarily used as a migration corridor between the Pacific Ocean and spawning habitat in the Central Valley (IEP 2018).

Steelhead. Similar to Chinook salmon, steelhead (O. mykiss) within California are subdivided into Distinct Population Segments (DPS) based on their life history. Within the central San Francisco Bay, both the federally threatened Central California Coast and federally threatened California Central Valley steelhead may use the channel habitat adjacent to the Project study area as a migratory corridor from the Pacific Ocean to spawning habitat.

While Central California Coast steelhead are known to occur within multiple central San Francisco Bay streams, none are in proximity to the Project study area. The nearest watershed that supports Central California Coast steelhead is the Corte Madera Creek watershed, which empties into San Francisco Bay approximately 3 miles south of the Project study area (Leidy et al. 2005). As such, any occurrence of Central California Coast steelhead within the Project study area would be temporary, and only occur as steelhead move through the open water habitat adjacent to the Project site during migration between the Pacific Ocean and freshwater spawning grounds.

Green sturgeon. The federally threatened, southern DPS of North American green sturgeon (Acipenser medirostris) is the most widely distributed member of the sturgeon family and the most marine-oriented of the sturgeon species, entering rivers only to spawn. Within bays and estuaries, sufficient water flow is required to allow adults to successfully orient to the incoming flow and migrate upstream to spawning grounds. Green sturgeon migrating between the Pacific Ocean and spawning habitat in the Sacramento River watershed typically travel directly through San Pablo Bay, passing through Raccoon Strait adjacent to Angel Island, and out the Golden Gate Bridge (Kelly et al. 2007). So while sturgeon do have the potential to temporarily occur year-round within the Project area, their preferred migration routes suggest a low likelihood for presence. However, green sturgeon has the potential to be present throughout all marine portions of the study area at any time of the year.

Longfin smelt. The longfin smelt (Spirinchus thaleichthys) is a small, slender-bodied pelagic fish listed as threatened under the CESA and is a candidate for listing under the FESA. Longfin smelt are most likely to occur within the central San Francisco Bay during the late summer months before migrating upstream in fall and winter. During winter months, when fish are moving upstream to spawn, high outflows may push many fish back into the San Francisco Bay (Moyle 2002).

Pacific herring. Pacific herring (Clupea pallasii) are a CDFW-managed species and are protected within the San Francisco Bay under the Marine Life Management Act, which provides guidance, in the form of Fisheries Management Plans, for the sustainable management of California's historic fisheries. CDFW, in partnership with the fishing industry and conservation groups, is currently updating the Pacific Herring Fisheries Management Plan, which will formalize a strategy for the future management of the fishery.

The Pacific herring is a small schooling marine fish that enters estuaries and bays to spawn. This species is known to spawn along the San Francisco Bay waterfronts and attach its egg masses to eelgrass, seaweed, and hard substrates such as pilings, breakwater rubble, and other hard surfaces. An individual can spawn only once during the season, and the spent female returns to the ocean immediately after spawning. Spawning usually takes place between October and March, with a peak between December and February. After hatching, juvenile herring typically congregate in the San Francisco Bay during the summer and move into deeper waters in the fall. The waterfront adjacent to the Project site is not known to be a spawning area for herring (CDFW 2019b). As such, herring are not expected to occur within the aquatic portion of the study area.

Birds

California black rail. California black rail is listed as threatened under CESA and is a state fully protected species. More than 90 percent of California black rails are located in the marshes of northern San Francisco Bay, primarily San Pablo Bay and Suisun Bay. Black rails prefer marshes that are close to water, are large (interior more than 50 meters from edge), away from urban areas, and brackish to fresh with a high proportion of pickleweed (*Salicornia pacifica*), maritime bulrush (*Bolboschoenus maritimus*), and marsh gumplant (*Grindelia stricta var. angustifolia*), rush (*Juncus* spp.), and cattails (*Typha* spp.) (Spautz et al. 2005). This species nests and forages in tidal emergent wetland. California black rail has not been detected during rail surveys within Tiscornia Marsh (OEI 2011–2020). Several occurrences are documented within 5 miles of the study area (CDFW 2021). The nearest species occurrence is documented on the north side of the mouth of San Rafael Creek, in 2012 (CDFW 2021). Black rail has a moderate potential to occur in the study area.

California Ridgway's rail. The California Ridgway's rail (formerly known as the California clapper rail) is a federally endangered, state endangered, and California fully protected species. The California Ridgway's rail is the resident rail subspecies of northern and central California, and is currently restricted to the San Francisco Bay Estuary, with the largest populations occurring in remnant salt marshes of south San Francisco Bay. The California Ridgway's rail occurs only within salt and brackish marshes. In south and central San Francisco Bay, the California Ridgway's rail typically inhabits salt marshes dominated by pickleweed and cordgrass. Breeding occurs from mid-March through July, with peak activity in late April to late May.

The California Ridgway's rail is a secretive, hen-like waterbird that lives in salt and brackish tidal marshes in the San Francisco Bay. This species once occupied coastal California tidal marshes from Humboldt Bay southward to Morro Bay, and estuarine marshes of San Francisco Bay and San Pablo Bay to the Carquinez Strait (Raabe et al. 2010). Resident populations are currently limited to San Francisco Bay, San Pablo Bay, Suisun Bay, and associated tidal marshes.

The California Ridgway's rail occurs almost exclusively in tidal salt and brackish marshes with unrestricted daily tidal flows, adequate invertebrate prey food supply, well-developed tidal channel networks, and suitable nesting and escape cover during extreme high tides (Raabe et al. 2010). The California Ridgway's rail depends on mudflats or very shallow water within a network of tidal channels where there are both abundant invertebrate populations and taller plant material to provide cover, refuge during high tides, nesting opportunities above high tides and wave action, and protection from predators. The California Ridgway's rail relies on marsh plants such as Pacific cordgrass (*Spartina foliosa*), bulrush (*Bolboschoenus maritimus*), and pickleweed for breeding and feeding.

As part of the San Francisco Estuary Invasive Spartina Project, annual monitoring of the California Ridgway's rail at treatment sites has been conducted since 2010. California Ridgway's rails were detected in Tiscornia Marsh in 2010, 2011, 2012, 2016, 2017, and 2018. Monitoring recorded a highest minimum count of six California Ridgway's rails in 2016, 11 in 2017, and five in 2018 (OEI 2016, 2018a, 2018b). However, California Ridgway's rails were not detected during surveys in 2019 (OEI 2020). The California Ridgway's rail has a high potential to occur in the study area.

Northern Harrier, Salt Marsh Common Yellowthroat, San Pablo Song Sparrow, and Nesting Birds protected by the Migratory Bird Treaty Act

Northern harrier, salt marsh common yellowthroat, and San Pablo song sparrow are California Species of Special Concern. The study area provides suitable foraging habitat for northern harrier in the tidal and diked marsh, and nesting habitat for this ground-nesting species in diked marsh and a few isolated upland areas. The study area provides suitable nesting habitat in emergent marsh vegetation and tall, dense ruderal vegetation for salt marsh common yellowthroat and San Pablo song sparrow. It is likely that common species, also subject to provisions of the Migratory Bird Treaty Act (MBTA), such as house finch (*Haemorhous mexicanus*), northern mockingbird (*Mimus polyglottos*), and California towhee (*Melozone crissalis*), nest in the study area. Bird species listed under FESA and CESA, as well as non- listed birds, are afforded conservation protections. Breeding birds are protected under California Fish and Game Code Section 3503, and raptors are protected under Section 3503.5. In addition, Section 3513 of the Code and the federal MBTA (16 USC, Sec. 703 Supp. I, 1989) prohibit the killing, possession, or trading of migratory birds. Finally, Section 3800 of the Code prohibits the taking of non-game birds, which are defined as birds occurring naturally in California that are not game birds or fully protected species.

As discussed below under the *Regulatory Setting*, most migratory birds are protected from harm by the MBTA, and most breeding birds in California are protected under the California Fish and Game Code (Section 3503).

Mammals

Salt marsh harvest mouse. Salt marsh harvest mouse is listed as endangered under both FESA and CESA, and is a state fully protected species. Salt marsh harvest mouse are small, native rodents that are endemic to the salt marshes and adjacent diked wetlands of San Francisco Bay. Salt marsh harvest mice are listed as federally and state endangered species. This species is a California fully protected species. Suitable habitat for salt marsh harvest mouse is present in the tidal and diked marshes in the study area. It is anticipated salt marsh harvest mouse will occupy suitable pickleweed and marsh habitats within the study area.

The salt marsh harvest mouse is endemic to the marshes which border San Francisco, San Pablo, and Suisun Bays. There are two subspecies of salt marsh harvest mouse: the northern subspecies (*Reithrodontomys raviventris halicoetes*) is found in the Marin Peninsula and San Pablo and Suisun Bays (Shellhammer and Barthman-Thompson 2015). The southern subspecies (*R. r. raviventris*) lives in the marshes of Corte Madera, Richmond and South San Francisco Bay (Shellhammer and Barthman-Thompson 2015). Occurrence of both subspecies within this small range is highly fragmented.

The primary habitat of the salt marsh harvest mouse is the middle to upper zone of salt and brackish marshes. The salt marsh harvest mouse is dependent on dense vegetation cover, usually in the form of pickleweed (*Salicornia pacifica*, the dominant salt marsh vegetation in the Bay) and other salt-dependent or salt-tolerant vegetation. Optimal salt marsh harvest mouse habitat has dense vegetative cover with a high percentage cover of pickleweed, and has contiguous dense and tall cover in which the mice can escape extreme water levels without excessive exposure to predation. Salt marsh harvest mouse may also move into grasslands adjacent to marshes during extreme high tides if dense cover is present. The mouse is largely herbivorous with pickleweed known to be its primary food source. Loss of habitat due to the diking and filling of wetlands has been the major factor contributing to the decline of the salt marsh harvest mouse.

Trapping studies conducted in 1990 for the USACE resulted in the capture of 14 salt marsh harvest mice in Tiscornia Marsh and 15 in the adjacent diked wetland in Pickleweed Park (Flannery and Bias 1990 as reported in USACE 1992). No other records of recent captures or trapping efforts in the area have been found; however, based on habitat suitability, resource agencies would likely assume the presence of this species for the purposes of Project environmental compliance. The salt marsh harvest mouse has a high potential to occur within the tidal marsh and diked marsh in the study area.

Salt marsh wandering shrew. The salt marsh wandering shrew (*Sorex vagrans halicoetes*) is a species of special concern and occurs within the central and south San Francisco Bay. It occurs in salt marsh communities along the southern parts of San Francisco Bay. In general, salt marsh shrews prefer areas of salt marsh with dense cover and mid to high marsh habitat about 6 to 8 feet above sea level, which provide adequate cover and nesting places along with plentiful supply of invertebrates (CDFG 1998).

The closest CNDDB occurrence was observed 6 miles east of the study area in salt marsh along the Richmond shoreline in 1985. The study area provides fairly isolated salt marsh habitat, and winter flooding and high tides remove vital suitable habitat for this species in winter and spring within the study area, creating marginally suitable habitat for this species. This species could occur in the study area, given the geographical range of the species, and marginally suitable habitat.

Pacific harbor seal. Pacific harbor seal (*Phoca vitulina richardsi*) is a permanent resident in the San Francisco Bay and is routinely seen in waters near the Project site. Harbor seals are protected under the Marine Mammal Protection Act. They have been observed as far upstream in the Delta and Sacramento River as the City of Sacramento, although their use of the habitat north of Suisun Bay is irregular (Goals Project 2000).

The closest location to the Project site where harbor seals are known to haul out year-round is on Castro Rocks. Castro Rocks comprise several outcroppings between Castro Point and Red Rock Island immediately south of the Richmond-San Rafael Bridge. Individual seals may occasionally haul out farther to the west and southwest of the main haul-out site, depending on space availability and conditions at the main haul-out area. Harbor seals feed in the deepest waters of the Bay, with the region from the Golden Gate Bridge to Treasure Island and south to the San Mateo Bridge being the principal feeding sites (Kopec and Harvey 1995). Harbor seals feed on a variety of fish, such as perch, gobies, herring, and sculpin.

California sea lion. The California sea lion (Zalophus californianus) lives in the San Francisco Bay-Delta and is protected by the Marine Mammal Protection Act. A common, abundant marine mammal, they are found throughout the West Coast, generally within 10 miles of shore. They breed in Southern California and the Channel Islands, after which they migrate up the Pacific coast to the Bay. They haul out on offshore rocks, sandy beaches, and onto floating docks, wharfs, vessels, and other man-made structures in the Bay and coastal waters. California sea lions feed on a wide variety of seafood, mainly squid and fish and sometimes even clams. Commonly eaten fish and squid species include salmon, hake, Pacific whiting, anchovies, herring, schooling fish, rockfish, lamprey, dog fish, and market squid. California sea lions may occasionally haul out at Castro Rock and thus may forage in the waters adjacent to the Project site.

Harbor porpoise. Harbor porpoise (Phocoena phocoena) inhabit northern temperate and subarctic coastal and offshore waters. In the North Pacific, they are found from Japan north to the Chukchi Sea and from Monterey Bay, California to the Beaufort Sea. The primary food for harbor porpoises is fish and squid. They are most often observed in bays, estuaries, harbors, and fjords less than 650 feet deep, like the central San Francisco Bay and are unlikely to occur north of Richmond-San Rafael and are thus unlikely to occur within the aquatic portion of the study area.

Managed U.S. Fisheries Species

Under the Magnuson-Stevens Act (see *Regulatory Setting* for a description), as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-297), the National Marine Fisheries Service (NMFS), Fishery Management Councils, and federal agencies are required to cooperatively protect essential fish habitat for commercially important fish species such as Pacific coast groundfish, salmon, and coastal pelagic fish and squid. As defined by the U.S. Congress, Essential Fish Habitat includes “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.” Fish species that are found in the study area and are protected by federal Fishery

Management Plans prepared by regional Fishery Management Councils under the Magnuson-Stevens Act are listed in **Table 3.4-2**. All of the aquatic habitat within the study area is identified as Essential Fish Habitat for fish identified in the Pacific coast groundfish, salmon, and coastal pelagic fisheries management plans under the Magnuson-Stevens Act.

TABLE 3.4-2
FISH MANAGED UNDER THE MAGNUSON-STEVENS ACT

Fisheries Management Plan	Species, Common Name	Species, Scientific Name	Life Stage[a]	Abundance
Coastal Pelagic	Northern anchovy	*Engraulis mordax*	J, A	Abundant
	Pacific sardine	*Sardinops japonicus*	J, A	Present
	Pacific herring	*Clupea pallasii*	E, J, A	Present
	Jacksmelt	*Atherinopsis californiensis*	J, A	Present
	Night smelt	*Spirinchus starksi*	J, A	Present
	Topsmelt	*Atherinops affinis*	J, A	Present
	Surf smelt	*Hypomesus pretiosus*	J, A	Present
Pacific Groundfish	Big skate	*Raja binoculata*	J, A	Present
	Leopard shark	*Triakis semifasciata*	J, A	Present
	Spiny dogfish	*Squalus suckleyi*	J, A	Present
	Lingcod	*Ophiodon elongates*	J, A	Present
	Brown rockfish	*Sebastes auriculatus*	J	Present
	Bocaccio	*Sebastes paucispinis*	J	Present
	English sole	*Parophrys vetulus*	J, A	Present
	Curlfin sole	*Pleuronichthys decurrens*	J, A	Present
	Pacific sanddab	*Citharichthys sordidus*	J, A	Present
	Sand sole	*Psettichthys melanostictus*	J, A	Present
Pacific Coast Salmon	Chinook salmon	*Oncorhynchus tshawytscha*	J, A	Seasonally Present

NOTES:
a. A = Adult; J = Juvenile; E = Egg.
SOURCES: PFMC (2019, 2020, 2021). CDFW IEP unpublished midwater trawl data (2018) 2017.

Sensitive Natural Communities

Natural communities are assemblages of plant species that occur together in the same area and are defined by species composition and relative abundance. Sensitive natural communities are designated by various resource agencies, such as CDFW, or in local policies and regulations, and are generally considered to have important functions or values for wildlife and/or are recognized as declining in extent or distribution, and are considered threatened enough to warrant some level of protection. CDFW tracks communities it believes to be of conservation concern through its *California Sensitive Natural Community List* (CDFW 2019a, Sawyer et al. 2009).

The diked marsh and tidal marsh habitat types, described in Section 3.4.1 above and shown on Figure 2-3, both contain sensitive natural communities. The diked marsh and mid-high tidal marsh zones are both sensitive natural communities because they are dominated by pickleweed which corresponds to the Pickleweed Mat Alliance in the California Sensitive Natural Community List (CDFW 2019a, Sawyer et al. 2009). The low tidal marsh zone is dominated by California cordgrass, which corresponds to the California Cordgrass Marsh Alliance. Both the Pickleweed Mat Alliance and California Cordgrass Marsh Alliance have a State Rarity Ranking of S3.

Habitat Areas of Particular Concern

Eelgrass (*Zostera marina*) is a native marine vascular plant found globally within soft-bottom bays and estuaries and is considered a Habitat Area of Particular Concern. Habitat Areas of Particular Concern are a subsets of Essential Fish Habitat that exhibit one or more of the following traits: rare, stressed by development, provide important ecological functions for federally managed species, or are especially vulnerable to anthropogenic degradation. Eelgrass has been afforded special management considerations by CDFW, USFWS, NMFS, U.S. Environmental Protection Agency (EPA), and the San Francisco Bay Conservation and Development Commission. The species is found from middle Baja California and the Sea of Cortez to northern Alaska along the west coast of North America, and is common in healthy, shallow bays and estuaries. The depth to which this species can grow is a function of light penetration. At greater depths, light is reduced to a level below which photosynthesis is unable to meet the metabolic demands of the plant to sustain net growth.

In the San Francisco Bay-Delta, eelgrass beds occur on soft bottom substrate in shallow areas (typically less than -1.5-meter depth at mean low tide level). Eelgrass beds are extremely dynamic, expanding and contracting seasonally and annually depending on the quality of the site. Consequently, they serve as an indicator community for the overall health of an estuary. Eelgrass plays many roles within the estuary system. It clarifies water through sediment trapping and habitat stabilization. It also provides benefits of nutrient transformation and water oxygenation. Eelgrass serves as a primary producer in a detrital-based food-web and is further directly grazed upon by invertebrates, fish, and birds. It supports epiphytic plants and animals that, in turn, are grazed upon by other invertebrates, larval and juvenile fish, and birds. Eelgrass is a nursery area for many commercially and recreationally important finfish and shellfish species, including those that are resident within bays and estuaries, nearly all of the anadromous fish species found along the Pacific coast, and oceanic species, which enter the estuaries to breed or spawn. Besides providing important habitat for fish, eelgrass habitat is also considered an important resource supporting migratory birds during critical life stages, including migratory periods.

Comprehensive eelgrass surveys of the San Francisco Bay-Delta have been conducted in 1987, 2003, 2009, and 2014. The 1987 survey reported a total of 316 acres of eelgrass beds in San Francisco Bay-Delta (Merkel & Associates 2014). The 2009 and 2014 surveys, which employed both high-resolution acoustic mapping and helicopter aerial imagery, reported 3,707 and 2,790 acres of eelgrass beds, respectively present in San Francisco Bay-Delta. No eelgrass beds are present within the aquatic portions of the study area; however, a handful of small (< 0.1 acre) patches of eelgrass were mapped offshore of Bay Point Lagoon south of the study area in 2014. The beds are located beyond potential impact from Project activities.

Critical Habitat

The aquatic portions of the Project site are designated as critical habitat by NMFS for a handful of special-status fish species. Critical habitat is habitat needed to support the recovery of listed species. Importantly, critical habitat for spring and winter-run Chinook salmon is not found with the study area.

Central Valley Steelhead. Critical habitat for the Central Valley steelhead is designated throughout accessible stream habitat within the Central Valley (NMFS 2005). The primary migration corridor, through Raccoon Straight north of Angel Island, is also designated as critical habitat for this DPS. Due to their importance in supporting the movement of this DPS between the Pacific Ocean and spawning and rearing habitat in the Central Valley, the waters of the study area are also designated as critical habitat.

Central California Coast Steelhead. Critical habitat includes all natal spawning and rearing waters, migration corridors, and estuarine areas that serve as rearing areas accessible to listed steelhead in coastal river basins, from the Russian River to Aptos Creek (inclusive), and the drainages of San Francisco and San Pablo Bays. Also included are adjacent riparian zones, all waters of San Pablo Bay west of the Carquinez Bridge, and all waters of San Francisco Bay to the Golden Gate Bridge (USFWS 2000). Critical habitat is designated within the aquatic portions of the study area.

Green Sturgeon. The critical habitat designation for green sturgeon includes the coastal marine habitat off California from Monterey Bay, north and east to include waters in the Strait of Juan de Fuca, Washington, and extends from mean higher high water to a depth of 358 feet (109 meters) (74 FR 52300). Within San Francisco Bay, critical habitat includes the Sacramento River, the Sacramento-San Joaquin Delta, and Suisun, San Pablo, and all of San Francisco Bay. This designation includes the aquatic portion of the study area.

3.4.2 Regulatory Setting

This subsection briefly describes federal, state, and local regulations, permits, and policies pertaining to biological resources and wetlands as they apply to the Proposed Project.

Federal Regulations

Federal Endangered Species Act

The federal Endangered Species Act (FESA) protects listed plant and wildlife species from harm or “take,” which is broadly defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct. Take can also include habitat modification or degradation that directly results in the death or injury of a listed wildlife species. An activity can be defined as take even if it is unintentional or accidental. Listed plant species are provided less protection than listed wildlife species. Listed plant species are legally protected from take under the FESA only if they occur on federal lands or if the Project requires a federal action, such as a Section 404 permit from the USACE. The USFWS has jurisdiction over wildlife species that are federally listed as threatened and endangered under the FESA, while NMFS has jurisdiction over marine species and anadromous fish that are federally listed as threatened and endangered. Species that are candidates for listing under the FESA are not granted these protections under the FESA. Consultation with either the USFWS or NMFS would be required for the Project since the USACE will need to issue a permit for the Project. During consultation, the potential for take would be determined and, if take is expected to occur, the necessary conditions to allow the issuance of an incidental take permit would be imposed.

Areas of habitat considered essential to the conservation of a listed endangered or threatened species may be designated as critical habitat, which is protected under FESA. There is no critical habitat designated in the study area.

Federal Migratory Bird Treaty Act

The MBTA is the domestic law that affirms and implements a commitment by the United States to four international conventions (with Canada, Mexico, Japan, and Russia) for the protection of a shared migratory bird resource. Unless and except as permitted by regulations, the MBTA encompasses whole birds, parts of birds, and bird nests and eggs. The FESA defines take as "…harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect any threatened or endangered species." Harm may include significant habitat modification where it actually kills or injures a listed species through impairment of essential behavior (e.g., nesting or reproduction). This would include the protection of nests for all species that are on the List of Migratory Birds, most recently updated in the Federal Register (50 CFR 10.13) in 2013.

All native bird species occurring in the study area are protected by the MBTA and could be affected by the proposed project.

Federal Clean Water Act

Wetlands are ecologically complex habitats that support a variety of both plant and animal life. The federal government defines and regulates other waters, including wetlands, in Section 404 of the Clean Water Act. Wetlands are "*areas that are inundated or saturated by surface water or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions*" (33 CFR § 328.3[c] and 40 CFR 230.3). Under normal circumstances, the federal definition of wetlands requires the presence of three identification parameters: wetland hydrology, hydric soils, and hydrophytic vegetation.

The regulations and policies of various federal agencies (e.g., USACE, EPA, and USFWS) mandate that the filling of wetlands be avoided unless it can be demonstrated that there is no practicable alternative to filling. The USACE has primary federal responsibility for administering regulations that concern waters and wetlands in the study area under the statutory authority of the Rivers and Harbors Appropriation Act (Sections 9 and 10) and the Clean Water Act (Section 404).

Pursuant to Section 10 of the Rivers and Harbors Appropriation Act of 1899 (33 USC § 403), the USACE regulates the construction of structures in, over, or under, excavation of material from, or deposition of material into navigable waters. In tidal areas, the limit of navigable water under Section

10 is the elevation of the mean high-water mark;[7] in nontidal waters, it is the ordinary high-water mark.[8] Larger streams, rivers, lakes, bays, and oceans are examples of navigable waters regulated under Section 10 of the Rivers and Harbors Appropriation Act. The act prohibits the unauthorized obstruction or alteration of any navigable water (33 USC § 403). Navigable waters under the act are those "*subject to the ebb and flow of the tide and/or are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce*" (33 CFR § 329.4). Typical activities requiring Section 10 permits are construction of piers, wharves, bulkheads, marinas, ramps, floats, intake structures, cable or pipeline crossings, and dredging and excavation.

Section 404 of the federal Clean Water Act (33 USC 1251 et seq. [1972]) prohibits the discharge of dredged or fill material into waters of the United States, including wetlands, without a permit from USACE. The agency's jurisdiction in tidal waters under Section 404 extends to the high-tide line or high-tide mark, simply indicating a point on the shore where water reaches a peak height at some point each year.

The Clean Water Act prohibits the discharge of any pollutant without a permit. Implicit in the act's definition of *pollutant* is the inclusion of dredged or fill material regulated by Section 404 (33 USC § 1362). The discharge of dredged or fill material typically means adding into waters of the United States materials such as concrete, dirt, rock, pilings, or side-cast material for the purpose of replacing an aquatic area with dry land or raising the elevation of an aquatic area. Activities typically regulated under Section 404 include the use of construction equipment such as bulldozers, and the leveling or grading of sites where jurisdictional waters occur.

Marine Mammal Protection Act

The Marine Mammal Protection Act of 1972, as amended, establishes a federal responsibility for the protection and conservation of marine mammal species by prohibiting the harassment, hunting, capture, or killing of any marine mammal. The primary authority for implementing the act belongs to the USFWS and NMFS.

Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Act (16 USC 1801–1884) of 1976, as amended in 1996 and reauthorized in 2007, applies to fisheries resources and fishing activities in federal waters. Federal waters extend to 200 miles offshore. Conservation and management of U.S. fisheries, development of domestic fisheries, and phasing out of foreign fishing activities are the main objectives of the legislation.

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7 The mean high-water mark, with respect to ocean and coastal waters, is defined as the line on the shore established by the average of all high tides. It is established by survey based on available tidal data (preferably averaged over a period of 18.6 years because of the variations in tide). In the absence of such data, less precise methods to determine the mean high water mark are used, such as physical markings, lines of vegetation or comparison of the area in question with an area having similar physical characteristics for which tidal data are readily available.

8 The ordinary high-water mark is defined in 33 CFR § 328.3[c][7] as "that line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of the soil, destruction of terrestrial vegetation, the presence of litter or debris, or other appropriate means that consider the characteristics of the surrounding area."

The Magnuson-Stevens Act defines Essential Fish Habitat as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. The act, as amended through 2007, sets forth a number of new mandates for NMFS, regional Fishery Management Councils, and federal action agencies to identify Essential Fish Habitat and to protect important marine and anadromous fish habitat. The Magnuson-Stevens Act provided NMFS with legislative authority to regulate fisheries in the United States in the area between 3 miles and 200 miles offshore, and established eight regional Fishery Management Councils that manage the harvest of the fish and shellfish resources in these waters. The councils, with assistance from NMFS, are required to develop and implement Fishery Management Plans, which include the delineation of Essential Fish Habitat for all managed species. A Fisheries Management Plan is a plan to achieve specified management goals for a fishery and is comprised of data, analyses, and management measures. Essential Fish Habitat that is identified in a management plan applies to all fish species managed by that plan, regardless of whether the species is a protected species or not. Federal agency actions that fund, permit, or carry out activities that may adversely affect Essential Fish Habitat are required under Section 305(b), in conjunction with required Section 7 consultation under the FESA, to consult with NMFS regarding potential adverse effects of their actions on Essential Fish Habitat and to respond in writing to NMFS' recommendations.

The waters of San Francisco Bay are designated as Essential Fish Habitat for fish managed under three Fisheries Management Plans. These include species of commercially important fish and sharks managed in the Pacific Coast Groundfish and Coastal Pelagic Species Management Plans. In addition, the Pacific Coast Salmon Management Plan, which includes Chinook salmon, identifies all of the San Francisco Bay as Essential Fish Habitat (USACE 2009).

State Regulations

California Endangered Species Act

Under the California Endangered Species Act (CESA), CDFW has the responsibility for maintaining a list of threatened and endangered species (California Fish and Game Code Section 2070). CDFW also maintains a list of candidate species, which are species formally under review for addition to either the list of endangered species or the list of threatened species.

The CESA prohibits the take of plant and animal species that the California Fish and Game Commission has designated as either threatened or endangered in California. "Take" in the context of this regulation means to hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill a listed species (California Fish and Game Code Section 86). The take prohibitions also apply to candidates for listing under the CESA. However, Section 2081 of the act allows CDFW to issue permits for the minor and incidental take of species by an individual or permitted activity listed under the act. Unlike the FESA, species that are candidates for state listing are granted the same protections as listed species under the CESA.

In accordance with the requirements of the CESA, an agency reviewing a project within its jurisdiction must determine whether any state-listed endangered or threatened species could be present in the project area. The agency also must determine whether the project could have a potentially significant impact on such species. In addition, CDFW encourages informal consultation on any project that could affect a candidate species. During consultation, the potential for take would be determined and, if take is expected to occur, the terms of an incidental take permit would be developed.

California Fish and Game Code Sections 1602, 3503, 3511, 4150, 4700, 5050, and 5515

Under Sections 1600–1616 of the California Fish and Game Code, the CDFW regulates activities that would substantially divert, obstruct the natural flow of, or substantially change rivers, streams, and lakes through the issuance of a Lake or Streambed Alteration Agreement (LSAA). The jurisdictional limits of the CDFW are defined in Section 1602 of the Fish and Game Code as the "bed, channel, or bank of any river, stream, or lake", although jurisdiction is often interpreted to include adjacent riparian vegetation as well. Activities that would "deposit or dispose of debris, waste, or other material containing crumbled, flaked, or ground pavement where it may pass into any river, stream, or lake" are prohibited by the CDFW unless an LSAA is issued. Any work within channels with a clear bed and banks, such as San Rafael Creek, falls under CDFW jurisdiction and requires an LSAA.

Under Section 3503 of the California Fish and Game Code, it is unlawful to take, possess, or needlessly destroy the nest or eggs of any bird, except as otherwise provided by this code or any regulation made pursuant thereto. Section 3503.3 of the California Fish and Game Code prohibits the take, possession, or destruction of any raptor (birds of prey) in the orders Falconiformes (hawks) or Strigiformes (owls), or of their nests and eggs. Any loss of fertile eggs or nesting raptors, or any activities resulting in nest abandonment, would constitute a significant impact.

The State Fish and Game Code Section 4150 states that all non-game mammals or parts thereof may not be taken or possessed except as otherwise provided in the code or in accordance with regulations adopted by the commission. This section applies to all bat species.

CDFW Fully Protected Species may not be taken or possessed at any time without a permit from CDFW (Section 3511 Birds, Section 4700 Mammals, Section 5050 Reptiles and Amphibians, and Section 5515 Fish).

State Regulation of Wetlands and Other Waters

California's authority in regulating activities in wetlands and waters in the study area resides primarily with the State Water Resources Control Board. The State Water Board, acting through the San Francisco Bay Regional Water Quality Control Board, must certify that a USACE permit action meets state water quality objectives (Clean Water Act Section 401). Any condition of water quality certification is then incorporated into the USACE Section 404 permit authorized for the project.

The State Water Board and Regional Water Board also have jurisdiction over Waters of the State under the Porter-Cologne Water Quality Control Act. They evaluate proposed actions for consistency with the Regional Water Board's Basin Plan, and authorize impacts on Waters of the

State by issuing Waste Discharge Requirements or, in some cases, a waiver of Waste Discharge Requirements.

The San Francisco Bay Conservation and Development Commission has jurisdiction over coastal activities occurring within and around San Francisco Bay and Suisun Marsh. The commission was created by the McAteer-Petris Act (California Government Code Sections 66600−66694). The commission regulates fill, extraction of materials, and substantial change in the use of land, water, and structures in San Francisco Bay and development within 100 feet of the Bay including ensuring the maximum feasible public access consistent with the project. The commission has jurisdiction over all areas of San Francisco Bay that are subject to tidal action, including subtidal areas, intertidal areas, and tidal marsh areas that are between mean high tide and 5 feet above mean sea level.

On April 6, 2021, the State Water Resources Control Board adopted a resolution to confirm that the "State Wetland Definition and Procedures for Discharges of Dredged or Fill Material to Waters of the State" is in effect as state policy for water quality control.

California Native Plant Protection Act

State listing of plant species began in 1977 with the passage of the California Native Plant Protection Act (NPPA), which directed CDFW to carry out the legislature's intent to "preserve, protect, and enhance endangered plants in this state." The NPPA gave the California Fish and Game Commission the power to designate native plants as endangered or rare and to require permits for collecting, transporting, or selling such plants. The CESA expanded upon the original NPPA and enhanced legal protection for plants. The CESA established threatened and endangered species categories, and grandfathered all rare animals—but not rare plants—into the act as threatened species. Thus, there are three listing categories for plants in California: rare, threatened, and endangered.

Marine Life Management Act

Within California, most of the legislative authority over fisheries management is enacted within the Marine Life Management Act. This law directs CDFW and the Fish and Game Commission to issue sport and commercial harvesting licenses, as well as license aquaculture operations. CDFW, through the commission, is the state's lead biological resource agency and is responsible for enforcement of the state's endangered species regulations and the protection and management of all state biological resources.

Local Plans and Policies

The City of San Rafael General Plan 2040 and the San Rafael Municipal Code include a number of policies related to wetland and creek protection and mitigation, to address potential loss of wetlands that may be caused by development; however, those policies do not directly pertain to this Project, which is a wetland and habitat restoration Project. Program element C-1.1C: Tiscornia March Restoration, guides the City to support restoration plans for Tiscornia Marsh (this Project); while Municipal Code Section 14.13.010 encourages restoration of wetland sites.

City of San Rafael Municipal Code

The City of San Rafael provides for the protection of trees in the Municipal Code (Code) Sections 11.12 and 14.25. Section 11.12 outlines permit requirements for any tree-related work (removal, planting, or pruning) and Section 14.25 provides the framework for the Environmental and Design Review permitting process, which includes a section on landscaping design and street tree planting guidelines. The study area may support trees considered protected in accordance with the San Rafael Municipal Code.

11.12.010 - Authority of public works department. The public works department shall have supervision over all matters relating to trees now planted or hereafter to be planted in, upon or along the public streets, sidewalks and walkways within the city. Whenever, by the terms of this chapter, an approval is required or a permit is required for, or a decision made with respect to the performance of any act prior thereto, the approval or permit shall be secured from, and the decisions shall be made by, the public works department.

11.12.030 - Approval and permit. No tree shall be planted in, upon or along any public street, sidewalk or walkway in the city until such tree shall have been first approved, and the place where it is to be planted designated, and a permit granted.

11.12.040 - Placement of trees. Trees shall not be planted along sidewalks less than thirty feet apart irrespective of the size of the lot, except as may be authorized by any permit therefor, and as much further apart as may be directed.

11.12.050 - Cutting, pruning, breaking, injuring, removing, spraying. No person shall, without a written permit issued pursuant to this chapter, cut, prune, break, injure or remove any living tree in, upon or along any public street, sidewalk or walkway in the city or cut, disturb, or interfere in any way with the roots of any tree in, upon or along any street, sidewalk or walkway, or spray with any chemical or insecticide any tree in, upon or along any public street, sidewalk or walkway, or place any sign, poster, or other fixture on any tree or tree guard, or injure, misuse or remove any device placed to protect any tree in, upon or along any public street, sidewalk, or walkway in the city.

Whenever any tree shall, under the authority of a permit issued therefore under this chapter, be cut down or removed in or from any sidewalk area, its butt and roots shall be dug up and removed, or cut level with the ground, as directed by the public works department.

11.12.060 - Protection of trees during construction. In the erection or repair of any building or structure, the owner thereof, or the contractor, if the work is being done by contract, shall place such guards around all nearby trees in, upon or along the public streets, sidewalks and walkways within the city as shall prevent injury to them.

11.12.090 - Interference with tree work prohibited. No person shall prevent, delay or interfere in the planting, pruning, spraying or removing of any tree located in, upon or along a public street, sidewalk or walkway, or in the removal of stone, cement or other substance about the trunk of any such tree, whether the said work be performed by employees of the city or by any independent contractor, or his employees, engaged by the city to perform such work.

No person shall place within two feet of any existing tree, any paving material, weed killing material or other like substance.

14.25.050 – Review criteria. Part G - Landscape Design. The natural landscape should be preserved in its natural state, insofar as practicable, by minimizing grading, and tree and rock removal. The landscaping shall be designed as an integral enhancement of the site, sensitive to natural site features…

4. Street Trees and Landscaping. Street trees shall be shown on plans submitted for a project within the downtown area, and shall be provided and protected in accordance with the city street tree planting guidelines and recommendations of the city arborist. Street trees and landscaping should be consistent with the following:

a. Provide smaller scale, seasonal color and street trees for pedestrian-oriented streets.

b. Provide high-canopy traffic-tolerant trees and landscaped setbacks for primary vehicular circulation streets.

c. Existing mature trees proposed to be removed as part of a project should be replaced with an equivalent number, size and alternate species.

d. Trees proposed to remain shall be protected during construction.

e. All trees shall be installed, protected and pruned in accord with accepted arboricultural standards and practices.

3.4.3 Impacts and Mitigation Measures

Significance Criteria

The criteria used to determine the significance of impacts related to biological resources are based on Appendix G of the CEQA Guidelines. The Proposed Project would have a significant impact if it would:

(a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the CDFW or USFWS.

(b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations, or by the CDFW or USFWS.

(c) Have a substantial adverse effect on state or federally protected wetlands (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means.

(d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites.

(e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance.

(f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan.

Approach to Analysis

Impacts on biological resources are identified and evaluated based on the following: relevant CEQA and local standards, policies, and guidelines; the likelihood that special-status species, sensitive habitats, wetlands and waters, and wildlife corridors are present within the study area; and the potential effects that project construction, operation, and maintenance might have on these resources. The analysis identifies both direct impacts on individual species and impacts resulting from habitat modification, and considers the longevity (short term and temporary or long term and/or permanent) of the potential impact on the biological resource. Special-status resources that were determined to have a low or no potential to occur in the study area are not considered in the impact analysis.

Impact Summary

Table 3.4-3 provides a summary of biological resource impacts and by implementation phase (construction and operations).

TABLE 3.4-3
SUMMARY OF BIOLOGICAL RESOURCES IMPACTS

Impact Statement	Construction	Operation
Impact 3.4-1: Construction or operation of the Project could have a substantial effect on special-status birds, common nesting migratory birds, or raptors in the study area.	LTSM	LTS
Impact 3.4-2: The Project could have substantial adverse effects on salt marsh harvest mouse and salt marsh wandering shrew.	LTSM	LTS
Impact 3.4-3. Construction or operation of the Project could have a substantial effect on special-status plants.	LTSM	LTS
Impact 3.4-4. The Proposed Project could have a substantial adverse effect, either directly or through habitat modification, on marine species identified as a candidate, sensitive, or special-status species in local or regional plans, policies or regulations, or by the CDFW, USFWS, or NOAA.	LTSM	LTS
Impact 3.4-5: The Project could have substantial adverse effects on jurisdictional wetlands, other Waters of the United States and Waters of the State.	LTS	LTS
Impact 3.4-6: The Project could interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites.	LTSM	LTS
Impact 3.4-7: The Project could conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance and could conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan.	LTS	NI
Impact 3.4-8: The Project could have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the CDFW, USFWS, or NMFS.	LTS	LTS
Impact 3.4-9: Cumulative loss of sensitive biological resources during construction and operations.	LTSM	LTSM

NOTES:
LTS = Less than significant
LTSM = Less than significant with mitigation
NI = No Impact

Impact Analysis

Impact 3.4-1: Construction or operation of the Project could have a substantial effect on special-status birds, common nesting migratory birds, or raptors in the study area. (*Less than Significant with Mitigation*)

Construction Impacts

California Black Rail and California Ridgway's Rail

Suitable ground-nesting and foraging habitat for California black rail and California Ridgway's rail is found within tidal marsh portions of the study area. California Ridgway's rails were detected in Tiscornia Marsh in years prior to 2019; however, they were not detected during surveys in 2019 or 2020 (OEI 2020, 2021). California black rail has not been detected during rail surveys within Tiscornia Marsh (OEI 2011–2021). Construction activities that could impact nesting and foraging rails include work in or near suitable rail habitat such as vegetation clearing (in limited areas), use of heavy equipment and dump trucks, placement of temporary fill, and the presence of workers and vehicles.

Impacts could occur on rails during construction during both the breeding and non-breeding seasons. Impacts during the non-breeding season are not considered significant, primarily due to the birds' mobility and ability to access other high-quality foraging habitat in other tidal marsh channels within 3 miles of Tiscornia Marsh. However, equipment staging and Project construction could render the site temporarily unsuitable for breeding rails due to the noise, vibration, and increased activity levels associated with grubbing, earth moving, heavy equipment operation, and increased human presence even when the nest itself is unaffected. These activities could cause the direct destruction of an active nest, or cause birds that have established a nest prior to the start of construction to change their behavior or even abandon an active nest, putting eggs and nestlings at risk for mortality. This would be considered a **significant impact**.

In summary, temporary construction-related impacts could result in significant impacts on California black rail and California Ridgway's rail. However, implementation of **Mitigation Measures 3.4-1 and 3.4-2** would reduce potential construction-related impacts on California Ridgway's rail and California black rail to less-than-significant by providing environmental training to construction personnel, providing general protection measures, avoiding disturbance to rail nesting habitat, conducting pre-construction protocol surveys to identify any active nests, and stopping work if Project activities disturb nesting rails. With implementation of Mitigation Measures 3.4-1 and 3.4-2, construction-related impacts would be **less than significant**.

Northern Harrier, Salt Marsh Common Yellowthroat, San Pablo Song Sparrow, and Nesting Birds Protected by the Migratory Bird Treaty Act

Because special-status bird species and birds protected by the MBTA could nest in trees, shrubs, grasses, emergent vegetation, marsh vegetation, or even on bare ground, all terrestrial parts of the study area are considered potential nesting habitat. Therefore, active nests could be encountered during restoration-related construction activities that could include clearing and grubbing vegetation, excavating tidal channels, use of heavy equipment and dump trucks, and presence of workers and vehicles associated with all aspects of construction.

Impacts could occur on resident and migratory species from construction during both the breeding and non-breeding seasons. Impacts during the non-breeding season are not considered significant, primarily due to the absence of active nests and the birds' mobility and ability to access other high-quality foraging habitat in the region. However, equipment staging and Project construction could render the site temporarily unsuitable for breeding birds due to the noise, vibration, and increased activity levels associated with grubbing, earth moving, heavy equipment operation, and increased human presence even when the nest itself is unaffected. These activities could cause the direct destruction of an active nest, or cause birds that have established a nest prior to the start of construction to change their behavior or even abandon an active nest, putting eggs and nestlings at risk for mortality. This would be considered a **significant impact**.

Implementation of **Mitigation Measures 3.4-1 and 3.4-3** would ensure that the Project would have a **less than significant impact** on nesting birds by providing environmental training to construction personnel, providing general protection measures, identifying active nests, and establishing no-work buffer zones around active nests identified on or near the Project site.

Operational Impacts

Special-status and Common Migratory Birds and Raptors

The creation of foraging and nesting habitat within the Project site would improve conditions for special-status and common migratory birds and raptors. Minimal operations and maintenance activities are anticipated, including ongoing vegetation management, weeding, and debris removal, similar to existing conditions.

Breeding birds could be directly or indirectly impacted by ongoing maintenance activities, including inspection for erosion or rodent damage along the levee tops and slopes, and levee maintenance activities such as mowing and weed control and repair of erosion sites. However, impacts associated with ongoing monitoring and maintenance are expected to be of short duration (i.e., on the order of hours to days) and infrequent, and are a continuation of comparable operations and maintenance activities currently implemented by the City on existing levees. The impacts on California black rail, California Ridgway's rail, and all special-status and protected birds associated with ongoing operations and maintenance are considered **less than significant** because activities would be limited in duration and frequency, and are a continuation of comparable current operations and maintenance activities.

Mitigation Measures

Mitigation Measure 3.4-1: General Construction-related Mitigation Measures

- A qualified biologist (4-year college degree in biology or related field and demonstrated experience with the species of concern) shall provide Worker Environmental Awareness Training (WEAT) to field management and construction personnel. Communication efforts and training shall take place during pre-construction meetings so that construction personnel are aware of their responsibilities and the importance of compliance. WEAT shall identify the types of sensitive resources located in the study area and the measures required to avoid impacts on these resources. Materials covered in the training program shall include environmental rules and regulations for the specific Project and requirements for limiting activities to the construction right-of-way and avoiding demarcated sensitive resource areas.

- If new construction personnel are added to the Project, the contractor shall ensure the new personnel receive WEAT before starting work. A sign-in sheet of those contractor individuals who have received the training shall be maintained by the Project proponent. A representative shall be appointed during the WEAT to be the contact for any employee or contractor who might inadvertently kill or injure a listed species or who finds a dead, injured, or entrapped individual.
- All vehicle operators shall limit speed to 15 miles per hour (mph) within the Project site.
- No erosion control materials shall contain any plastic or monofilament netting.

To avoid attracting predators, all food-related trash items shall be bagged and removed daily.

Mitigation Measure 3.4-2: Avoid and Minimize Impacts on California Black Rail and California Ridgway's Rail

- To minimize or avoid the loss of individual California black rail and California Ridgway's rail, construction activities, including vegetation management activities requiring heavy equipment, adjacent to the tidal marsh areas (within 500 feet [150 meters] or a distance determined in coordination with the USFWS or CDFW, shall be avoided during the breeding season from February 1 through August 31.
- If areas within or adjacent to rail habitat cannot be avoided during the breeding season, protocol-level surveys shall be conducted to determine rail nesting locations. The surveys shall focus on potential habitat that could be disturbed by construction activities during the breeding season to ensure that rails are not breeding in these locations.

  Survey methods for rails shall follow the *Site-Specific Protocol for Monitoring Marsh Birds*, which was developed for use by USFWS and partners to improve bay-wide monitoring accuracy by standardizing surveys and increasing the ability to share data (Wood et al. 2017). Surveys are concentrated during the approximate period of peak detectability, January 15 to March 25, and are structured to efficiently sample an area in three rounds of surveys by broadcasting calls of target species during specific periods of each survey round. Call broadcasts increase the probability of detection compared to passive surveys when no call broadcasting is employed. This protocol has since been adopted by the Invasive Spartina Project (ISP) and Point Blue Conservation Science to survey California Ridgway's rails at sites throughout San Francisco Bay Estuary. The survey protocol for California Ridgway's rail is summarized below.

  – Previously used survey locations (points) should be used when available to maintain consistency with past survey results. Adjacent points should be at least 200 meters apart along transects in or adjacent to areas representative of the marsh. Points should be located to minimize disturbances to marsh vegetation. Up to eight points can be located on a transect.

  – At each transect, three surveys (rounds) are to be conducted, with the first round of surveys initiated between January 15 and February 6, the second round performed February 7 to February 28, and the third round March 1 to March 25. Surveys should be spaced at least 1 week apart, and the period between March 25 to April 15 can be used to complete surveys delayed by logistical or weather issues. A FESA Section 10(a)(1)(A) permit is required to conduct active surveys.

  - Each point on a transect shall be surveyed for 10 minutes each round. A recording of calls available from the USFWS is broadcast at each point. The recording consists of 5 minutes of silence, followed by a 30-second recording of California Ridgway's rail vocalizations, followed by 30 seconds of silence, followed by a 30-second recording of California black rail, followed by 3.5 minutes of silence.

- If no breeding California black rail or California Ridgway's rail are detected during surveys, or if their breeding territories can be avoided by 500 feet (150 meters), then Project activities may proceed at that location.

- If protocol surveys determine that breeding California black rail and/or California Ridgway's rail are present in the project area, the following measures would apply to Project activities conducted during their breeding season (February 1- August 31):

  - Construction activities would not occur within 500 feet of a detected Ridgway's rail or black rail call center.

  - A USFWS- and CDFW-approved biologist shall be on site during construction activities occurring within 500 feet (150 meters) of any other suitable rail breeding habitat.

  - All other biologists that may need to access the tidal marsh outside of the active construction period or be on site during construction for activities beyond 500 feet from suitable rail breeding habitat, shall be trained in black rail and Ridgway's rail biology, identification, and vocalizations, and shall be familiar with both species of rail and their nests.

  - If a California black rail or California Ridgway's rail vocalizes or flushes within 10 meters, it is possible that a nest or young are nearby. If an alarmed bird or nest is detected, work shall be stopped, and workers shall leave the immediate area carefully and quickly. An alternate route shall be selected that avoids this area, and the location of the sighting shall be recorded to inform future activities in the area.

  - All construction crews working in the marsh during rail breeding season shall be trained and supervised by a USFWS- and CDFW-approved rail biologist.

  - If any activities shall be conducted during the rail breeding season in California black rail or California Ridgway's rail-occupied marshes, biologists shall have maps or global positioning system (GPS) locations of the most current occurrences on the site.

Mitigation Measure 3.4-3: Nesting Bird Protection Measures

The City shall require the Project sponsor to implement the following during construction of the Project:

- Removal of trees and scrub vegetation shall occur outside the bird nesting season (February 1 to August 31), to the extent feasible.

- If removal of trees and vegetation cannot be fully accomplished outside of the nesting season, a qualified biologist shall conduct pre-construction nesting surveys within 7 days prior to the start of such activities or after any construction breaks of 10 days or more. Surveys shall be performed for the study area and suitable habitat within 250 feet of the Project site to locate any active raptor (birds of prey) nests or rookeries.

- If active nests are located during the pre-construction bird nesting survey, the qualified biologist shall evaluate if the schedule of construction activities could affect the active nests and the following measures shall be implemented based on their determination:
  - If construction is not likely to affect the active nest, it may proceed without restriction; however, a biologist shall regularly monitor the nest to confirm there is no adverse effect and may revise their determination at any time during the nesting season. In this case, the following measure would apply.
  - If construction may affect the active nest, the biologist shall establish a no-disturbance buffer in coordination with CDFW. Typically, these buffer distances are 100 feet for passerines and 250 feet for raptors. These distances may be adjusted depending on the level of surrounding ambient activity (e.g., if the Project site is adjacent to a road or active trail) and if an obstruction, such as a building, is within line-of-sight between the nest and construction. For bird species that are federally and/or state-listed sensitive species (i.e., fully protected, endangered, threatened, species of special concern), a City representative or qualified biologist shall coordinate with the USFWS and/or CDFW regarding modifications to nest buffers, prohibiting construction within the buffer, or modifying construction.
  - Any birds that begin nesting within the Project area and survey buffers amid construction activities are assumed to be habituated to construction-related or similar noise and disturbance levels. A qualified biologist shall coordinate with the USFWS and/or CDFW and determine if no work exclusion zones shall be established around active nests in these cases.

Impact 3.4-2: The Project could have substantial adverse effects on salt marsh harvest mouse and salt marsh wandering shrew. (*Less than Significant with Mitigation*)

Suitable habitat for salt marsh harvest mouse and salt marsh wandering shrew is found throughout the tidal marsh and diked marsh in the study area. Construction activities that could impact salt marsh harvest mouse and salt marsh wandering shrew include earthwork associated with constructing the levees and ecotone slope, excavating the new tidal channel, constructing the temporary access road across the marsh, and potentially, equipment staging. Levees and ecotone slope would be built in upland, transition zone, and marsh edge habitat. These habitats are used by salt marsh harvest mouse, and possibly salt marsh wandering shrew, especially as refugia during high tides.

Direct impacts that could occur on salt marsh harvest mouse and salt marsh wandering shrew include mortality due to crushing by vehicles, materials staging, heavy equipment, or human activity in suitable salt marsh harvest mouse/salt marsh wandering shrew habitat, or mutilation by mowers or other motorized equipment used for vegetation removal. Indirect impacts could occur if equipment staging, Project construction, or human activity render otherwise suitable habitat temporarily unsuitable due to the lack of accessibility, noise, vibration, and increased activity levels associated with grubbing, earth moving, and heavy equipment operation. Any of these would be considered a significant impact.

Construction impacts on salt marsh harvest mouse and salt marsh wandering shrew would be potentially significant. However, implementation of **Mitigation Measures 3.4-1 and 3.4-4** would reduce potential construction and operations impacts on salt marsh harvest mouse and salt marsh wandering shrew to a less-than–significant level by providing environmental training to construction personnel, providing general protection measures, conducting pre-construction surveys, identification and avoidance of suitable habitat for the species, and where avoidance is not possible, using hand tools to clear vegetation. Further, with implementation of Mitigation Measure 3.4-4, suitable marsh habitat would be protected during work activities, exclusion fencing would separate suitable habitat from adjacent work areas, a biomonitor would be in place to stop work if the species is detected, and work during extreme high tides would be avoided. With implementation of Mitigation Measures 3.4-1 and 3.4-4, construction-related impacts would be **less than significant**.

Operational/Long-term Impacts

Salt marsh harvest mouse and salt marsh wandering shrew could be directly or indirectly impacted by ongoing maintenance activities including inspection for erosion or rodent damage along the levee slopes, and levee maintenance activities such as mowing and weed control and repair of erosion sites. However, impacts associated with ongoing monitoring and maintenance are expected to be of short duration (i.e., on the order of hours to days) and infrequent, and are a continuation of comparable operations and maintenance activities currently implemented by the City on existing levees. The impacts on salt marsh harvest mouse and salt marsh wandering shrew associated with ongoing operations and maintenance are considered **less than significant** because activities would be limited in duration and frequency, are a continuation of comparable current operations and maintenance activities.

Mitigation Measure 3.4-4: Avoid and Minimize Impacts on Salt Marsh Harvest Mouse and Salt Marsh Wandering Shrew

- Ground disturbance to suitable salt marsh harvest mouse habitat (including, but not limited to pickleweed, and emergent salt marsh vegetation) shall be avoided to the extent feasible. Where salt marsh harvest mouse habitat cannot be avoided (such as for channel excavation, access routes and grading, or anywhere else that vegetation could be trampled or crushed by work activities), vegetation shall be removed to ground level from the ground disturbance work area plus a 5-foot buffer around the area, as well as any access routes within salt marsh harvest mouse habitat, utilizing mechanized hand tools or by another method approved by the USFWS and CDFW. Vegetation height shall be maintained at or below 5 inches above ground. Vegetation removal in salt marsh harvest mouse habitat shall be conducted under the supervision of the USFWS- and CDFW-approved biologist.
- To protect salt marsh harvest mouse from construction-related traffic, access roads, haul routes, and staging areas within 50 feet of salt marsh harvest mouse habitat shall be bordered by temporary exclusion fencing; or other wildlife exclusion fencing as specified in federal or state permits. The fence should be made of a material that does not allow salt marsh harvest mouse to climb or pass through, of a minimum above-

ground height of 30 inches, and the bottom should be buried to a depth of at least 6 inches so that mice cannot crawl under the fence. Any supports for the salt marsh harvest mouse exclusion fencing (e.g., t-posts) shall be placed on the side of the fence facing the interior of the Project site. The last 5 feet of the fence shall be angled away from the road to direct wildlife away from the road. A USFWS- and CDFW-approved biologist with previous salt marsh harvest mouse experience shall be on site during fence installation and shall check the fence alignment prior to vegetation clearing and fence installation to ensure that no salt marsh harvest mice are present.

- Salt marsh harvest mouse marsh habitat that must be accessed by mini-excavators or other vehicles to complete Project construction (e.g., excavating smaller channels) shall be protected through use of low ground pressure (LGP) equipment, wooden or PVC marsh mats, or other method approved by the USFWS and CDFW following vegetation removal (see 2nd bullet, above).
- Construction activities related to restoration and infrastructure shall be scheduled to avoid extreme high tides when there is potential for salt marsh harvest mouse to move to higher, drier grounds, such as ruderal and grassland habitats. No Project activities shall be conducted within 50 feet of suitable tidal marsh or other salt marsh harvest mouse habitat within 2 hours before and after an extreme high tide event (6.5 feet or higher measured at the Golden Gate Bridge and adjusted to the timing of local high tides) or when the adjacent marsh is flooded unless wildlife exclusion fencing has been installed around the work area.
- All construction equipment and materials shall be staged on existing roadways and away from suitable salt marsh harvest mouse habitat when not in use. All construction equipment shall be visually inspected prior to work activities each day for signs of salt marsh harvest mouse or any other wildlife.
- Vegetation shall be removed from all non-marsh areas of disturbance (driving roads, grading and stockpiling areas) to discourage the presence of salt marsh harvest mouse.
- A USFWS- and CDFW-approved biologist with previous salt marsh harvest mouse monitoring and/or surveying experience shall be on site during construction activities occurring in suitable habitat. The USFWS- and CDFW-approved biologist has the authority to stop Project activities if any of the requirements associated with these measures are not being fulfilled. If a harvest mouse is observed in the work area, construction activities shall cease in the immediate vicinity of the potential salt marsh harvest mouse. The individual shall be allowed to leave the area before work is resumed. If the individual does not move on its own volition, the USFWS-approved biologist would contact USFWS (and CDFW if appropriate) for further guidance on how to proceed.
- If the USFWS- and CDFW-approved biologist has requested work stoppage because of take of any of the listed species, or if a dead or injured salt marsh harvest mouse is observed, the USFWS and CDFW shall be notified within 1 day by email or telephone.

Impact 3.4-3: Construction or operation of the Project could have a substantial effect on special-status plants. (*Less than Significant with Mitigation*)

Based on available habitat identified during reconnaissance-level surveys, Marin knotweed, Suisun Marsh aster, Congested-headed hayfield tarplant, and Point Reyes bird's-beak may be present within the study area. Implementation of the Project could result in direct impacts on existing populations of these species, if present. Earthwork associated with the Project could result in direct removal or trampling of special-status plants. Therefore, construction could result in potentially significant impacts on the above-named species.

No impacts are identified for ongoing maintenance activities, as the restoration of tidal marshes is expected to be beneficial for special-status plant species due to the overall increase in wetland habitat, which provides habitat for tidal marsh special-status plants, which would benefit Marin knotweed, Suisun Marsh aster, Congested-headed hayfield tarplant, and Point Reyes bird's-beak, if present.

In summary, temporary construction-related impacts would result in significant impacts on special-status plants if special-status plants are present. However, implementation of **Mitigation Measures 3.4-1 and 3.4-5** would reduce potential construction-related impacts on special-status plants to a less-than-significant level. This would be achieved by: conducting pre-construction special-status plant surveys; delineating and avoiding special-status plants within the Project work limits by establishing a no-disturbance buffer, including fencing and signage, around the plant to protect it from construction-related activity; compensating for special-status plant impacts that cannot be avoided; and reporting special-status plant occurrence to the CNDDB. With implementation of Mitigation Measure 3.4-5, construction-related impacts would be less than significant. Operational and long-term effects of the Project would be **less than significant**.

Mitigation Measure 3.4-5: Special-Status Plant Protection

- Prior to the start of construction, a qualified biologist shall conduct a properly timed special-status plant survey for Marin knotweed (*Polygonum marinense*), Suisun Marsh aster (*Symphyotrichum lentum*), Congested-headed hayfield tarplant (*Hemizonia congesta* subsp. *congesta*), and Point Reyes bird's-beak (*Chloropyron maritimum* ssp. *palustre*) within the species' suitable habitat within the Project work limits. The survey shall follow the CDFW Protocols for Surveying and Evaluating Impacts on Special Status Native Plant Populations and Sensitive Natural Communities (CDFW 2018). If special-status plant species are identified within the Project work limits, then the biologist shall establish an appropriate buffer area for each plant population to exclude activities that directly remove or alter the habitat of, or result in indirect adverse impacts on, the special-status plant species. A qualified biologist shall oversee installation of a temporary, mesh-type construction fence (Tensor Polygrid or equivalent) at least 4 feet (1.2 meters) tall around any established buffer areas to prevent encroachment by construction vehicles and personnel. The qualified biologist shall determine the exact location of the fencing. The fencing shall be strung tightly on posts set at maximum intervals of 10 feet (3 meters) and shall be checked and maintained weekly until all construction is complete. The buffer zone established by the fencing shall be marked by a sign stating:
  - "*This is habitat of [list rare plant(s)], and must not be disturbed. This species is protected by [the ESA of 1973, as amended/CESA/California Native Plant Protection Act].*"

- If direct impacts cannot be avoided, the City shall require the project sponsor to prepare a plan for minimizing the impacts by one or more of the following methods: (1) salvage and replant plants at the same location following construction; (2) salvage and relocate the plants to a suitable off-site location with long-term assurance of site protection; (3) collect seeds or other propagules for reintroduction at the site or elsewhere; or (4) payment of fees in lieu of preservation of individual plants, to be used for conservation efforts elsewhere**.** The City shall review and approve the plan.
- The success criterion for any seeded, planted, and/or relocated plants shall be full replacement at a 1:1 ratio after 5 years. Monitoring surveys of the seeded, planted, or transplanted individuals shall be conducted for a minimum of 5 years, to ensure that the success criterion can be achieved at year 5. If it appears the success criterion would not be met after 5 years, contingency measures may be applied. Such measures shall include, but not be limited to: additional seeding and planting, altering or implementing weed management activities, or introducing or altering other management activities.
- Any special-status plant species observed during surveys shall be reported to the CDFW and submitted to the CNDDB and reported to USFWS, if federally-listed.

Impact 3.4-4: The Proposed Project could have a substantial adverse effect, either directly or through habitat modification, on marine species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the CDFW, USFWS, or NOAA. (*Less than Significant with Mitigation*)

Construction Impacts

Implementation of the Proposed Project would require earth-moving construction activities in support of levee creation and improvements, marshplain restoration and creation, beach installation, and revegetation. A subset of the actions would occur within, or adjacent to, the aquatic environment and thus have the potential to impact special-status marine species or protected habitat. The construction of the Project elements listed above would require substantial amounts of work within the intertidal environment. Most of this work would occur in the form of fill placement in support of the conversion of habitat from intertidal and mudflat into restored tidal marsh and coarse beach. Thus, there is the potential for significant impact on aquatic species and habitat in support of these restoration actions. These activities, their potential for impact, and mitigation measures required to reduce the severity of these impacts to less-than-significant levels are discussed below.

Turbidity Impacts

Work within the intertidal environment may result in the temporary suspension of silt, sand, and clay particles within the water column if done within a wetted environment. Increases in turbidity may occur during all construction activities within the intertidal environment construction of the beach, ecotone slope, and tidal marsh, and to a lesser degree during pile installation, tidal channel excavation, and temporary access road construction. Increased suspended solids in the water column have the potential to affect special-status fish species by disrupting normal feeding behavior, reducing growth rates, increasing stress levels, and reducing respiratory functions. Additionally, the suspension of sediment has the potential to release constituents of concern within the water column. Severe turbidity impacts may result in substantially depressed oxygen levels (i.e., below 5.0 mg/l), which may cause respiratory stress to aquatic life and even mortality.

While construction work would proceed across the full tidal cycle, work conducted at low tide or directly on mudflat should result in negligible turbidity impacts. Work that does occur in a wetted environment may result in elevated turbidity levels within adjacent San Rafael Bay. However, due to the Project site's proximity to these deep waters, currents are expected to be strong and function to dissipate turbidity plumes within hours, if not faster. Similarly, oxygen level depression resulting from construction activities is not expected to persist due to rapid tidal flushing and the short duration of releases of anoxic (oxygen-poor) sediment. Additionally, prior to any fill placement in the aquatic environment for the tidal marsh reconstruction, sediment curtains would be installed along the perimeter of the exposed mudflat during low tide (see Chapter 2, *Project Description,* under the heading *Coarse Beach Construction*). These curtains would prevent the spread of localized turbidity impacts and serve as a barrier to any aquatic species attempting to access the Project site.

Water Quality Impacts

Commensurate with any construction activity adjacent to, or within, an aquatic environment is the potential for the accidental discharge of hydrocarbon containing materials (e.g., fuel, lubricating oils, construction materials), construction debris, or other harmful materials. Such construction activities could pose a short-term and temporary risk of exposing resident marine taxa to toxic contaminants and non-edible forage. Prior to construction, the Project would be required to procure an NPDES Construction General Permit (See Section 3.6, *Hydrology and Water Quality,* under the heading '*NPDES Construction General Permit*). This permit requires the development and implementation of a SWPPP that includes specific BMPs designed to prevent sediment and pollutants from impacting the adjacent aquatic environment. The BMPs fall into several categories, including erosion control, sediment control, waste management, and good housekeeping, and are intended to protect surface water quality by preventing the off-site migration of eroded soil and construction-related pollutants from the construction area. For a more detailed description of state and local regulations governing stormwater management during Project construction, refer to Section 3.6, *Hydrology and Water Quality*, Subsection 3.6.2, *Regulatory Setting*.

Temporary Underwater Noise

As described in Chapter 2, *Project Description*, a temporary crane platform would be installed along San Rafael Creek at the northeast corner of the Project site to unload materials and equipment brought in via barge. The platform would be a pile-supported steel and timber deck, approximately 30 square feet in size. The platform would be supported by 12 to 16 steel piles, approximately 18 inches in diameter and driven 60 to 70 feet deep using a vibratory hammer. The platform would remain in place for 1 to 3 years while the coarse beach and eroded marsh area are being constructed. Following construction, the platform would be completely removed and transported off site. Of primary concern with the in-water installation, or removal, of piles is the potential for the generation of underwater noise at a level that is harmful to marine species. The use of an impact hammer during pile driving can produce high-intensity noise, resulting in damage to the soft tissues of fish, such as gas bladders or eyes (barotraumas) and/or result in harassment of fish and marine mammals such that they alter swimming, sleeping, or foraging behavior or temporarily abandon forage habitat.

The striking of a pile by an impact hammer creates a pulse of sound that propagates through the pile, radiating out through the water column, seafloor, and air. Sound pressure pulses, as a function of time are referred to as a waveform. Peak waveform pressure underwater is typically expressed in decibels (dB) referenced to 1 microPascal (μPa).[9] Sound levels are generally reported as peak levels, root-mean-square pressure, and sound exposure levels. The peak pressure is the highest absolute value of the measured waveform. For pile driving pulses, the root-mean-square (RMS) pressure level is determined by analyzing the waveform and computing the average of the squared pressures over time that comprise the portion of the waveform containing the vast majority of sound energy. Sound exposure level (SEL) is a metric that provides an indication of the amount of acoustical energy contained in a sound event. For pile driving, the sound exposure level can be used to describe a single impact hammer pulse or many cumulative pulses when required to drive multiple piles. In addition to the pressure pulse of the waveform, the frequency of the sound, expressed in hertz, is also important to evaluating the potential for sound impacts. Low frequency sounds are typically capable of traveling over greater distances with less reduction in the pressure waveform than high frequency sounds.

Vibratory pile drivers work on a different principle than impact hammers and therein produce a different sound profile. A vibratory driver works by inducting particle motion to the substrate immediately below and around the pile, causing liquefaction of the immediately adjacent soft substrate, allowing the pile to sink downward. Sound levels are typically 10–20 dB lower in intensity relative to the higher, pulse-type noise produced by an impact hammer (Caltrans 2020).

Impacts on Fish

Scientific investigations on the potential effect of noise on fish indicate that sound levels below 183 dB SEL do not appear to result in any acute physical damage or mortality to fish (barotraumas) of any size (Dalen and Knutsen 1986). **Table 3.4-4** provides a summary of known acute and sub-lethal effects of noise on fish. Noise levels that result in startle responses in steelhead and salmon have been documented to occur at sound levels as low as 150 dB RMS (Halvorsen et al. 2012). Any disturbance to listed fish species that results in altered swimming, foraging, movement along a migration corridor, or any other altered normal behavior is considered harassment. It should be noted that the acoustic thresholds for fish only exist for impact hammer pile driving; no vibratory standards exist for fish at this time. In contrast with impact pile driving, vibratory pile installation appears to result in minimal acute damage to fish. As such, hydroacoustic impacts from vibratory pile installation on fish species are likely to be limited to a temporary loss in access to foraging habitat during pile installation and removal activities.

[9] Therefore, 0 dB on the decibel scale would be a measure of sound pressure of 1 μPa.

TABLE 3.4-4
POTENTIAL IMPACTS ON FISH AT VARYING NOISE LEVELS

Taxa	Sound Level (dB)	Effect	Reference
Fish			
All fish > 2 grams in size	206 peak 187 (SEL)	Acute barotraumas	Fisheries Hydroacoustic Working Group, 2008
All fish < 2 grams	186 (SEL)	Acute barotraumas	Fisheries Hydroacoustic Working Group, 2008
Salmon, steelhead	150 (RMS)	Avoidance behavior	Halvorsen et al. 2012

NOTES: SEL = sound exposure level; RMS = root-mean-square pressure level

Impacts on Marine Mammals

Pursuant to the Marine Mammal Protection Act, the National Oceanic and Atmospheric Administration (NOAA) has established two levels of harassment related to marine mammals:

- **Level A:** Any act of pursuit, torment, or annoyance that has the potential to injure a marine mammal or marine mammal stock in the wild.
- **Level B:** Any act of pursuit, torment, or annoyance that has the potential to disturb a marine mammal or marine mammal stock in the wild by causing the disruption of behavioral patterns, including but not limited to migration, breathing, nursing, breeding, feeding, or sheltering.

NOAA has applied sound thresholds to each of these harassment categories depending on the species of marine mammal. To be considered Level A harassment, marine mammals must be exposed to sound levels in exceedance of those listed below in **Table 3.4-5**. As reflected in the table, underwater noise thresholds for marine mammals differ between families and hearing groups. Level B behavioral harassment is considered to occur when any marine mammal is exposed to 120 dB RMS pressure level for vibratory pile driving or removal. Marine mammal hearing thresholds for airborne noise are 90 dB for harbor seals and 100 dB for all other pinnipeds. Since no impact pile driving is proposed, construction work is not expected generate airborne noise in exceedance of these levels.

TABLE 3.4-5
ADOPTED UNDERWATER ACOUSTIC CRITERIA FOR MARINE MAMMALS

	NOAA-Adopted Pile Installation Criteria for Marine Mammals		
Family	Vibratory Pile Removal Disturbance Threshold (Level B Harassment)	Species	SEL Threshold (dB) (Level A Harassment)
Cetacean	120 dB RMS	Harbor porpoise	173 dB
Pinniped		Harbor seal	201 dB
		California sea lion	219 dB

NOTES:
dB = decibel; RMS = root-mean-square pressure level; SEL = sound exposure level.
SOURCE: NOAA 2018.

Given the uncertainties regarding the exact pile configuration and installation methods to be used for proposed in-water construction, there remains a potential that construction of the Project could have an adverse effect on protected fish or marine mammals, a **significant impact**. Thus, **Mitigation Measure 3.4-6**, **Fish and Marine Mammal Protection during Pile Driving** is proposed. This measure requires the development and implementation of a sound monitoring plan to protect fish and marine mammals. Additionally, this measure requires that the Project adhere to the observance of NMFS-approved in-water work windows. Implementation of this measure would ensure that potential impacts from pile installation are ***less than significant***.

Operational Impacts

Habitat Conversion

While the implementation of the Project would result in a conversion in mudflat and open water habitat to tidal marsh, this action would result in the restoration of the historical extent of tidal marsh within the site. Additionally, restored tidal marsh habitat is extremely limited within the San Francisco Bay-Delta compared to open water and mudflat, and long-term implementation of the Proposed Project may provide the following benefits:

- Enhancement of regional food web productivity and export to San Rafael Bay in support of aquatic species; in particular, special-status fish that utilize San Pablo Bay as foraging habitat including green sturgeon and longfin smelt.
- The creation of rearing habitats for out-migrating juvenile salmonids.
- The creation of rearing, breeding, and refuge habitats for a broad range of other aquatic and wetland-dependent species that utilize or depend on the combination of brackish aquatic and tidal marsh habitat, including non-listed native species.
- Enhancement to the ecosystem functions associated with the combination San Rafael Bay waters, tidal marsh, and upland interfaces that these species require.
- The creation of increased topographic variability, and diversity of habitat, to allow for habitat succession and resilience against future climate change and sea level rise.

Overall improvement within the aquatic environment of the San Francisco Bay-Delta is especially important given that populations of pelagic fish within the Delta and Suisun Marsh continue to show a significant decline in abundance, placing the continued viability of many populations in serious jeopardy (La Luz and Baxter 2015). As such, restoration or enhancement projects that create tidal marsh habitat with the potential to benefit special-status species are of paramount importance.

Maintenance and Monitoring Actions

Physical and biological monitoring would be conducted at the completion of Project construction and at 1, 3, 5, and 10 years post-construction (see Section 2.4, *Operations and Maintenance*). The restored wetland habitats would be largely self-maintaining after the initial period of vegetation establishment. Post-construction monitoring for the Project is anticipated to lead only to minor repair and maintenance activities, primarily within the upland environment. Minor maintenance actions may include the following:

- Manual hand removal of any obstructions that may be blocking tidal channels (e.g., sediment and/or debris), if needed.
- Periodic grading, fill placement, and trail resurfacing due to additional settlement/subsidence, or earthquake damage that occurs after initial construction period (anticipated to occur once, or possibly twice, in the first 10 years after construction).
- Grading and filling of any settlement cracks that occur along the new levee, particularly at the connection to the existing trail.
- Minor repair and/or bank protection of any erosion scarps that may threaten the levee.
- Additional manual vegetation management beyond the initial establishment period, including weed control and replanting to be done by hand, and/or extended temporary watering, as needed.

Any in-channel or intertidal maintenance work would result in similar impacts on water quality and benthic habitat to the construction activities described above. Direct contact with a wetted environment may result in the degradation of water quality through temporary increases in turbidity. As described above, increases in suspended sediments can impact aquatic organisms by reducing dissolved oxygen levels and light transmission. Additionally, when sediments resettle, there is the potential to smother aquatic habitats and organisms. This maintenance work is designed to improve the long-term functionality of this habitat to support these protected species, but may result in short-term impacts during in-channel work.

The NPDES Construction General Permit described above would also be applied to any future in-channel maintenance activities. Additionally, to ensure consistency with Mitigation Measure 3.4-6, any maintenance work within tidal, wetted channel would be limited to June 1 through November 30. Observance of this work window would minimize the potential presence of special-status aquatic species within the Project site. Additionally, silt and turbidity curtains would be installed at the tidal-adjacent end of the maintenance location to intercept turbidity plumes generated from earthwork activities. Installation of these curtains prevents the export of any large amount of turbidity beyond the immediate maintenance location. These curtains may also provide the secondary benefit of reducing the likelihood that fish can enter the active work area. As such, impacts from maintenance and monitoring on aquatic species and habitat are expected to be ***less than significant with mitigation***.

Mitigation Measures

Mitigation Measure 3.4-6: Fish and Marine Mammal Protection During Pile Driving

Prior to the start of any in-water construction that would require pile driving, the Project sponsor shall prepare a NOAA-approved sound attenuation monitoring plan to protect fish and marine mammals, and the approved plan shall be implemented during construction. This plan shall provide detail on the sound attenuation system, detail methods used to monitor and verify sound levels during pile driving activities (if required based on projected in-water noise levels), and describe methods to reduce impact pile-driving in the aquatic environment to an intensity level less than 120 dB (RMS) continuous noise level for marine mammals at a distance of 1,640 feet. The plan shall incorporate, but not be limited to, the following elements:

- All in-water construction shall be conducted within the established environmental work window between June 1 and November 30, designed to avoid potential impacts on fish species.
- To the extent feasible, vibratory pile drivers shall be used for the installation of all support piles. Vibratory pile driving shall be conducted following the USACE "Proposed Procedures for Permitting Projects that will Not Adversely Affect Selected Listed Species in California." The USFWS and NMFS completed Section 7 consultation on this document, which establishes general procedures for minimizing impacts on natural resources associated with projects in or adjacent to jurisdictional waters.
- If NOAA sound level criteria for marine mammals are exceeded during vibratory hammer pile installation, a NOAA-approved biological monitor shall be available to conduct surveys before and during pile driving to inspect the work zone and adjacent waters for marine mammals. The monitor shall be present as specified by NMFS during impact pile driving and ensure that:
  - The safety zones established in the sound monitoring plan for the protection of marine mammals are maintained.
  - Work activities are halted when a marine mammal enters a safety zone and resumed only after the animal has left the area or has not been observed for a minimum of 15 minutes.

Significance after Mitigation: Less than Significant.

Impact 3.4-5: The Project could have substantial adverse effects on jurisdictional wetlands, other Waters of the United States, and Waters of the State. (*Less than Significant*)

San Rafael Creek and San Rafael Bay and associated features are Waters of the U.S. and Waters of the State. Elements of the Project would impact these features during both the construction and operation phases. The below discussion analyzes wetlands and waters collectively.

Construction Impacts

Table 3.4-6 provides a summary of anticipated impacts on potentially jurisdictional wetlands and waters during the construction phase of the Project. The potential impacts identified below are based on habitat mapping completed for the Habitat Assessment (ESA 2020) and the preliminary design.

TABLE 3.4-6
PRELIMINARY IMPACTS ON POTENTIALLY JURISDICTIONAL WETLANDS AND WATERS

Water/Wetland Feature	Existing Acres	Temporary Impacts (Acres)	Permanent Impact/ Conversion (Acres)	Post-Project Acres	Post-Project Conversion in Acres
San Rafael Bay (open water /mudflat)	12.75	0.10 (temporary crane platform and barge offloading area, temporary access route)	4.67	8.08	-4.67
Tiscornia Marsh (tidal marsh)	7.59	0.10 (temporary access road)	0	14.17 (Alt 1) 14.24(Alt 2)	+6.58
Diked Marsh	3.95	0	3.95	0.07 (Alt 1) 0 (Alt 2)	-3.88
Non-tidal Pond	0.07	0	0.07	0	-0.07
Beach	0	0	0	1.64	+1.64
TOTAL	**24.36**	**0.20**	**8.69**	**23.96**	**-0.4**

NOTES:

The western levee tie-off has two design options. Under option 1, the non-tidal pond would be converted to diked marsh. Under option 2, the non-tidal pond would be converted to tidal marsh.

The potential impacts identified are based on the habitat mapping completed for the Habitat Assessment (ESA 2020) and the preliminary design. The potential impacts do not show the overall increase in and long-term benefits to ecological function, flood resilience, and future marsh edge erosion protection for the 24 acres of wetlands and waters on site.

Temporary Impacts

Potential wetlands and waters would be temporarily affected by the installation of a temporary access road over a portion of the tidal marsh and open water. A temporary access road would be constructed across Tiscornia Marsh (in an east-west direction) to allow looped construction access. The temporary road would be approximately 20 feet wide and would either be constructed of timber mats or temporary fill built up to a height of 3 feet. The road would be located at two of the narrowest portions of the marsh to reduce the area of disturbance, and would include a culvert over the existing tidal channel to maintain tidal flows to the south portion of the marsh. All access road materials would be completely removed following construction.

A temporary crane platform and a barge off-loading location would be installed along San Rafael Creek as shown on Figure 2-5. These two sites would be used to unload materials and equipment brought in via barge. The platform would remain in place for 1 to 3 years while the coarse beach and eroded marsh area are being constructed. Following construction, the platform would be completely removed and transported off site. The barge location has no fringing marsh and is armored with riprap.

Temporary impacts on wetlands and waters as a result of the temporary access road, crane platform, and barge offloading location would affect a relatively small area (less than 1 percent) of wetland and waters habitat. The temporary impact is essential for constructing the restoration Project. Once construction is complete, these areas can naturally reestablish to their pre-Project condition. The City would require the Project sponsor to implement BMPs, discussed in Section

3.6, *Hydrology and Water Quality*, Impact 3.6-1, avoiding substantial temporary impacts on jurisdictional water quality as a result of potential soil erosion or accidental release of deleterious materials during construction. As such, temporary impacts on potentially jurisdictional wetlands and waters would be **less than significant**.

Permanent Impacts

Permanent impacts on wetlands and waters would be offset by a net gain in wetland and water function and values after Project implementation. The Project would improve wetlands and open water habitats in the both the near and long term. Wetlands and waters in the study area would benefit from improved ecosystem function, flood resilience, and protection from future marsh edge erosion offered by the Project. Overall, there is expected to be an approximate 0.4-acre loss in wetlands and waters due to sea level rise adaptation elements including coarse beach construction, shoreline levee improvements, and ecotone slope development.

The habitat changes proposed by the Project are shown on Figure 2-3. The restoration of the diked marsh would permanently convert a small portion of the diked marsh to open water tidal channels and to ecotone slope or transition zone uplands (Table 3.4-6). The restoration of the diked marsh would convert the remaining diked marsh area to tidal marsh. The conversion of diked marsh to tidal marsh would improve wetland habitat structure and diversity, increase Ridgway's rail and California black rail habitat, and allow the marsh to accrete sediment, which would facilitate the marsh in becoming more resilient to sea level rise.

The restoration of beach and tidal marsh in the Bay would permanently convert a portion of tidal open water to tidal marsh and coarse beach habitat (refer to Figure 2-3, Table 3.4-6). The new beach and tidal marsh are necessary to protect the existing tidal marsh, restore previously eroded tidal marsh, and provide sea level rise resiliency. Although some other waters would be converted to tidal marsh and beach, they would remain as jurisdictional wetlands and other waters. The beach and portions of the tidal marsh would also be planted to enhance habitat conditions for native wildlife. The improved ecosystem resulting from the conversion of open water and mudflat to tidal marsh and beach would provide additional flood protection, erosion control, and habitat for tidal marsh-dependent species. The creation and planting of the new beach would provide habitat and ecosystem services that are not provided under existing conditions, such as flood and erosion protection and habitat for a diversity of marsh-dependent species.

There are currently two design options for tying the west end of the new levee into the shoreline (both represented in Figure 2-3). Under the first option (west levee tie-off option 1), the existing non-tidal marsh and pond would be converted to all non-tidal marsh. The levee placement would prevent this area from becoming tidal, although it would be enhanced by converting the existing pond, which provides poor habitat value and function, to non-tidal marsh that could become salt marsh harvest mouse habitat.

Under the second option (west levee tie-off option 2), the new levee would extend approximately 150 feet directly west to the northwest corner of the site. This option would require that a small stormwater outlet channel be excavated to the north of the new levee through the tidal marsh and into the creek. The non-tidal pond and existing diked marsh in this area would be restored to tidal marsh and would directly connect to the converted tidal marsh to the east, providing additional habitat for tidal marsh-dependent species.

Due to sea level rise, the Project site is expected to gain future benefits to existing habitats due to increased ecological connectivity, improved tidal hydrology, and marsh erosion protection over the next 50 years, which would enhance wetlands, waters, and upland areas in and adjacent to the Project site. Although there would be some conversion of wetland and water types and a nominal loss of approximately 0.40 acre of wetlands and waters, the Project would increase the ecological function and long-term benefits of 24 acres of wetlands and waters on site including an increase in over 6 acres of tidal marsh. Therefore, the Project would result in **less-than-significant impacts** on wetlands and waters.

Operational Impacts

Minor vegetation management and levee maintenance activities, as discussed in Chapter 2, *Project Description*, Section 2.4, *Operations and Maintenance*, are expected after the new levee is constructed and planting of native vegetation is completed. After initial revegetation, the plantings would be monitored to determine the need for additional maintenance or remedial actions, such as replacement plantings, substitute species, watering, weeding, and/or nonnative plant treatment. Minor repairs may be needed, such as manual hand removal of sediment on channels, grading, and fill placement due to levee settlement. Periodic sediment removal would result in temporary disturbance of the restored tidal channels, but there would be no permanent loss of wetlands.

Levee management and maintenance activities would not result in substantial adverse effects because maintenance activities would be beneficial to the resource, infrequent, and would only require brief periods of activity at each location when maintenance is required. Additionally, the overall net gain in the quality of restored habitat would offset any adverse impacts resulting from the Project's vegetation and levee maintenance activities. Overall, operational and maintenance activities in wetlands and waters in the study area would be **less than significant** under the Project as they would result in an enhancement of ecosystem function and continue in a similar nature as they are currently implemented.

Mitigation: None required.

Impact 3.4-6: The Project could interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites. (*Less than Significant with Mitigation*)

Construction and Operational Impacts

Terrestrial Biological Resources

Wildlife movement corridors link together areas of suitable wildlife habitat that are otherwise separated by rugged terrain, changes in vegetation, or by areas of human disturbance or urban development. Topography and other natural factors in combination with urbanization can fragment or separate large open-space areas. The fragmentation of natural habitat can create isolated "islands" of vegetation and habitat that may not provide sufficient area to accommodate sustainable populations and can adversely impact genetic and species diversity. The retention of wildlife movement corridors ameliorates the effects of such fragmentation by allowing animals to move between remaining habitats, which in turn allows depleted populations to be replenished. Such movement may also promote genetic exchange between separated populations.

The study area is not part of major or local wildlife corridor/travel routes according to the CDFW's Essential Habitat Connectivity natural landscape blocks (Spencer et al. 2010). The study area has limited upland connectivity opportunity since the upland areas surrounding the study area are developed neighborhoods. Any terrestrial wildlife movement in the area is likely habituated to high levels of human activity. However, wildlife that can fly or swim is able to move between the study area and other nearby marsh and upland habitats.

The Project would not substantially adversely interfere with the movement of any native terrestrial resident or migratory wildlife species or with an established native resident or migratory wildlife corridor, or impede the use of a native wildlife nursery site, and the impact would be **less than significant**.

Marine Biological Resources

Central San Francisco Bay serves as a migration corridor for special-status anadromous fish between the Pacific Ocean and spawning habitat, primarily within the Sacramento and San Joaquin River watersheds, but also in a handful of tributaries to San Francisco Bay. Those that use the San Francisco Bay as a migration corridor to the Central Valley watersheds may pass by the Project site during the migratory period. Additionally, Central California Coast steelhead may occur seasonally in the waters offshore when moving between spawning streams and the Pacific Ocean. If special-status anadromous fish species were to occur within the vicinity of the Project site, their presence would only be temporary, as they move between spawning habitat and the Pacific Ocean, and would likely occur outside the window in which pile installation or other in-water work would occur. Of all the special-status fish species in the study area, longfin smelt have the greatest potential to occur within the water adjacent to the Project site. However, because longfin smelt distribution within the San Francisco Bay-Delta is driven by fluctuations in salinity, they are unlikely to occur in large numbers near the Project site outside of late summer.

In general, the presence of marine mammals in San Francisco Bay is related to the distribution and presence of prey species and foraging habitat. Harbor seals and sea lions use various intertidal substrates that are exposed at low to medium tide levels for resting and breeding. California sea lions are noted for using anthropogenic structures such as floating docks, piers, and buoys to haul out of the water to rest. Marine mammal haul-out locations do not occur in the Project study area; as such, the presence of marine mammals is likely to be confined to a few rafting or foraging individuals and not the large numbers seen elsewhere within San Francisco Bay.

Given the rarity and transient nature of regionally occurring special-status species, no sustained presence of special-status aquatic species is expected occur. With a low-likelihood of occurrence of special-status marine species, a substantial impact on marine movement corridors unlikely. Nevertheless, the implementation of **Mitigation Measure 3.4-6**, **Fish and Marine Mammal Protection during Pile Driving**, would ensure that any construction-related impacts on marine movement corridors and established native wildlife nursery sites would be ***less than significant with mitigation***.

Mitigation Measure 3.4-6: Fish and Marine Mammal Protection During Pile Driving

Significance after Mitigation: Less than Significant

Impact 3.4-7: Construction and operation of Proposed Project could conflict with local policies or ordinances protecting biological resources; and could conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan. (*Less than Significant*)

No adopted habitat conservation plan or natural community conservation plan covers the Project terrestrial or marine areas, and there are no protected significant or landmark trees on the Project site. Thus, **no impact** related to conflict with policies or plans protecting biological resources is expected to result from Project implementation.

Construction Impacts

The City of San Rafael provides for the protection of street trees along any public street, sidewalk, or walkway in the city, and outlines requirements for removal and replacement of certain street trees in the Municipal Code (Code) Section 11.12 and 14.25.050. The Project would remove approximately one native and seven non-native trees to accommodate Project construction; and construction activities would occur in the vicinity of trees located adjacent to Spinnaker Point Drive. The native tree to be removed would be replaced as part of the Project, as noted in Section 2.3.3, Vegetation Removal. However, if the Project proponent does not implement tree removal and replacement and protection of trees to be retained on site in accordance with the Codes, an impact would occur. With implementation of Mitigation Measure 3.4-7, construction-related impacts would be **less than significant**.

Operational Impacts

The Project would require ongoing maintenance, including vegetation trimming and other vegetation related maintenance. However, weedy species would generally be removed when small, and removal of larger trees subject to the City's tree ordinance is not anticipated under routine Project maintenance. Therefore, the Project would not affect trees protected under City requirements, and **no impact** would occur as part of Project operation.

Mitigation Measure 3.4-7: Tree Ordinance Requirements

- Any tree-related work (removal, planting, or pruning) shall adhere to the City of San Rafael Municipal Code Section 11.12 and 14.25.050. Specifically, written permit must be issued to cut, prune, break, injure, or remove any living tree in, upon, or along any public street, sidewalk, or walkway in the city or cut, disturb, or interfere in any way with the roots of any tree in, upon, or along any street, sidewalk, or walkway, or spray with any chemical or insecticide any tree in, upon, or along any public street, sidewalk, or walkway, or place any sign, poster, or other fixture on any tree or tree guard, or injure, misuse, or remove any device placed to protect any tree in, upon, or along any public street, sidewalk, or walkway in the city.

Whenever any tree shall be cut down or removed in or from any sidewalk area, its butt and roots shall be dug up and removed, or cut level with the ground, as directed by the public works department.

- In the erection or repair of any building or structure, guards shall be placed around all nearby trees in, upon, or along the public streets, sidewalks, and walkways within the city as shall prevent injury to them.
- All trees shall be installed, protected and pruned in accord with accepted arboricultural standards and practices.

Impact 3.4-8: Construction and operation of the Proposed Project could have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the CDFW, USFWS, or NMFS. (*Less than Significant*)

There is no riparian habitat present in the study area, and therefore no impacts would occur to this sensitive natural community. Pickleweed Mat Alliance habitat was documented within the study area and would be subject to losses during construction. Potential impacts on this vegetation community are described in Impact 3.4-5, which considers effects to jurisdictional wetlands, other Waters of the United States, and Waters of the State. Temporary impacts could occur due to disturbance by Project-related equipment, vehicles, the deposition of spoils, or equipment in the reaches listed directly above where the sensitive natural community is present. As described in Impact 3.4-5, restoration of the diked marsh would convert the remaining diked marsh area to tidal marsh, which would improve wetland habitat structure and diversity, increase pickleweed habitat, and allow the marsh to accrete sediment, which would facilitate the marsh in becoming more resilient to sea level rise. Although there would be some conversion of pickleweed and a nominal estimated loss of approximately 0.40 acre of wetlands and waters, which includes Pickleweed Mat Alliance habitat, the Project would ultimately increase the ecological function and long-term benefits of 24 acres of wetlands and waters on site, including pickleweed habitat. Therefore, the Project would result in **less-than-significant impacts** on this sensitive natural community.

Within the San Francisco-Bay Delta region, NMFS has identified eelgrass beds (*Zostera marina*) as a habitat area of particular concern. These habitat areas of particular concern are considered high-priority areas for conservation, management, or research because they are rare, sensitive, stressed by development, or important to ecosystem function. No eelgrass beds exist within the Project site, so there would be no impact on this sensitive natural community and the fish that reside within such habitat from Project construction and operation. Thus, any impact from construction or operation of the Proposed Project on sensitive natural communities would be **less than significant**.

Mitigation: None required.

Cumulative Impacts

Impact 3.4-9: Cumulative loss of sensitive biological resources during construction and operations. (*Less than Significant with Mitigation*)

Terrestrial Biological Resources

The geographic scope of potential biological resources encompasses the jurisdictional waters, and habitats for special-status species within the study area as well as biologically linked areas in the San Rafael Creek Watershed and San Rafael Bay. This regional approach is appropriate because the habitats and wildlife species that could be affected by the Project and by the projects identified in Table 3.1-1 are part of a broader ecosystem, and the potential disturbance of individual areas could have repercussions for a wider region than the immediate Project vicinity.

As discussed above, the Project could adversely affect special-status birds or nesting migratory birds and raptors in the study area, including California Ridgway's rail, California black rail, northern harrier, salt marsh common yellowthroat, San Pablo song sparrow, and other nesting migratory birds and raptors. Implementation of **Mitigation Measures 3.4-1, 3.4-2**, **and 3.4-3** would minimize potential direct impacts. The projects listed in Table 3.1-1 could also have the potential to affect these species, especially those projects that would directly affect nearby tidal waters and wetland areas. These projects may include the San Rafael Creek Operations and Maintenance, the Village at Loch Lomond Marina Project, Schoen Park Conversion of Parking, and Pickleweed Field and Park Project. These could result in similar effects as the Proposed Project. However, each of these projects would be required to complete CEQA analysis similar to that completed for the Project, but it is unknown whether the CEQA process would identify and mitigate potential special-status bird impacts and nesting migratory bird and raptor related impacts associated with those projects. Impacts on nesting birds would be cumulatively considerable pre-mitigation, but less than cumulatively considerable with adherence to Mitigation Measures 3.4-1, 3.4-2, and 3.4-3.

As described above, the Proposed Project could adversely affect salt marsh harvest house and salt marsh wandering shrew. Implementation of **Mitigation Measures 3.4-1 and 3.4-4** would minimize potential direct impacts. Some of the projects listed in Table 3.1-1 could also have the potential to affect this species if they affect salt marsh harvest mouse habitat. Salt marsh harvest mouse habitat is quite limited in the nearby area due to development and very few areas of tidal wetlands. Potential projects that could have the potential to affect this species would include the San Rafael Creek Operations and Maintenance, the Village at Loch Lomond Marina Project, Schoen Park Conversion of Parking, and Pickleweed Field and Park Project. These could result in similar effects as the Proposed Project if they would be disturbing salt marsh harvest mouse habitat. However, each of these projects would be required to complete CEQA analysis similar to that completed for the Project, but it is unknown whether the CEQA process would identify and mitigate potential salt marsh harvest mouse impacts associated with those projects. Impacts on salt marsh harvest mouse would be cumulatively considerable pre-mitigation, but less than cumulatively considerable with adherence to Mitigation Measures 3.4-1 and 3.4-4.

As also described above, the Proposed Project would result in temporary and permanent impacts on potentially jurisdictional wetlands and waters that are located within or along San Rafael Creek and San Rafael Bay. Overall, Project design would replace existing wetlands and waters habitat to higher quality wildlife habitat and better functioning and resilient wetland habitat. While some of the projects listed in Table 3.1-1 could also have the potential to affect these habitats (namely those listed previously that could directly affect tidal or diked wetlands and waters within the San Rafael Creek watershed), the Proposed Project would not meaningfully contribute to a cumulative impact on jurisdictional wetlands and waters. Therefore, this impact would be **less than significant**.

As described above, the Proposed Project could adversely affect special-status plants. Implementation of **Mitigation Measure 3.4-5** would minimize potential direct impacts. Some of the projects listed in Table 3.1-1 could also have the potential to affect special-status plants, although special-status plant populations are limited in the nearby area due to development. Each of these projects would be required to complete CEQA analysis similar to that completed for the Proposed Project, but it is unknown whether the CEQA process would identify and mitigate potential special-status plant impacts associated with those projects. Impacts on special-status plants could be cumulatively considerable pre-mitigation, but less than cumulatively considerable with adherence to **Mitigation Measure 3.4-5.**

As described above, the upland areas around the Project site are generally surrounded by developed neighborhoods that block terrestrial wildlife migration under existing conditions. Any wildlife movement in the area is likely habituated to high levels of human activity. The Proposed Project, however, would enhance and restore habitat connectivity within tidal marsh in the Project site, and therefore would provide a net benefit for tidal marsh-dependent wildlife. Therefore, residual impacts from the Project would not combine with other cumulative scenario Project impacts, and this impact is considered **less than significant**.

As described above, the Proposed Project would remove approximately eight trees to accommodate construction. Adherence to City of San Rafael Code requirements for trees would ensure that tree protection measures would be implemented under the Proposed Project to protect trees and ensure compliance with applicable ordinances and policies. Although the Project's pre-mitigation impacts are cumulatively considerable because other cumulative scenario projects may have similar impacts on trees, post-mitigation, this impact would not be cumulatively considerable. Therefore, this impact is considered **less than significant**.

Fisheries Resources

Construction

The geographic scope of potential fisheries resources encompasses the intertidal and shallow subtidal environments of San Rafael Bay and San Rafael Creek. This regional approach is appropriate because the habitats and wildlife species that could be affected by the Proposed Project and by the cumulative projects identified in herein are part of a broader aquatic ecosystem, and the potential disturbance of individual areas of the watershed could have repercussions for a wider region than the immediate Project vicinity. As discussed above, direct impacts of the Project would include impacts on special-status native fish species and their aquatic habitat during Project construction. Potential categories of impact include direct impacts on fish, water quality and sediment quality impacts, underwater noise impacts, and alteration of benthic habitat.

Cumulative projects that involve in-water construction and that, in combination with the Project, have the potential to result in significant cumulative impacts on marine resources are limited ongoing operations and maintenance actions within San Rafael Creek. Operations and maintenance actions primarily consist of the periodic dredging of the San Rafael Creek channel and adjacent environment of San Rafael Bay to facilitate boat access. Dredging of this magnitude can result in elevated turbidity levels, entrainment of aquatic species, and the temporary alteration of benthic habitats. Having last been partially dredged by the USACE in 2011, dredging is slated to commence summer 2022 within San Rafael Creek. As the commencement of construction for the Proposed Project would not be until 2023, no overlap in timing would occur between these two projects. Further, impacts of the project would be reduced to less than significant with implementation of **Mitigation Measure 3.4-6**, Fish and Marine Mammal Protection during Pile Driving. Thus, any cumulative impacts as a result of Project implementation are expected to be **less than significant with mitigation**.

Operation

The Proposed Project's operational impacts on marine biological resources may result in temporary, localized impacts in turbidity during channel maintenance actions. Of the cumulative projects examined, none would result in impacts that could combine geographically with the Project's operational effects. Therefore, cumulative impacts resulting from in-water work, and the cumulative impact on marine resources associated with operations, would be **less than significant**.

> **Impact Significance after Mitigation:** Less than Significant with Mitigation. The impacts on biological resources from the Project considered together with past, present, and reasonably foreseeable future projects would be reduced to a less than significant level with implementation of Mitigation Measures 3.4-1, 3.4-2, 3.4-3, 3.4-4, 3.4-5, and 3.4-6.

Marine Biological resources

Construction Impacts

The geographic scope of potential fisheries resources encompasses the intertidal and shallow subtidal environments of San Rafael Bay and San Rafael Creek. This regional approach is appropriate because the habitats and wildlife species that could be affected by the Project and by the projects identified in herein are part of a broader aquatic ecosystem, and the potential disturbance of individual areas of the watershed could have repercussions for a wider region than the immediate Project vicinity. As discussed above, direct impacts of the Project would include impacts on special-status native fish species and their aquatic habitat during Project construction. Potential categories of impact include direct impacts to fish, water quality and sediment quality impacts, underwater noise impacts, and alteration of benthic habitat.

Cumulative projects that involve in-water construction and that, in combination with the project, have the potential to result in significant cumulative impacts on marine resources are limited ongoing Operations and Maintenance actions within San Rafael Creek. Operations and Maintenance actions primarily consist of the periodic dredging of the San Rafael Creek channel and adjacent environment of San Rafael Bay to facilitate boat access. Dredging of this magnitude can result in elevated turbidity levels, entrainment of aquatic species, and the temporary alteration of benthic habitats. Having last been partially dredged by the USACE in 2011, dredging is slated to commence summer 2022 within the San Rafael Creek. As the commencement of construction for the proposed project would not occur until 2023, overlap in timing between these two projects is not anticipated. Should the Project construction period be expedited, or the USACE dredge project be delayed, overlap of the project activities could overlap and allow for beneficial reuse of dredge materials at the Project site. The Project would be required to implement BMPs designed to prevent sediment and pollutants from impacting the adjacent aquatic environment. The BMPs fall into several categories, including erosion control, sediment control, waste management, and good housekeeping, and are intended to protect surface water quality by preventing the off-site migration of eroded soil and construction-related pollutants from the construction area. Thus, any cumulative impacts as a result of project implementation are expected to be ***less than significant***.

Operation Impacts

The project's operational impacts on marine biological resources may result in temporary, localized impacts in turbidity during channel maintenance actions. Of the cumulative projects examined, none would result in impacts that could combine geographically with the project's operational effects. Therefore, cumulative impacts resulting from in-water work, and the cumulative impact on marine resources associated with operations, would be ***less than significant***.

Mitigation: None required.

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3.5 Greenhouse Gas Emissions

This section describes the environmental and regulatory setting of the Project site and surrounding area with respect to greenhouse gas (GHG) emissions, and includes an analysis of impacts of the Proposed Project related to GHG emissions. This assessment includes an overview of climate change; a review of the GHGs that have been identified as drivers of climate change; pertinent regulations, including those relevant at the federal, state, and local levels; significance criteria for environmental impacts; and environmental impacts associated with Project construction and operation and appropriate mitigation measures.

Emissions of air pollutants, including criteria air pollutants, are considered in Section 3.3, *Air Quality*. If needed, mitigation measures to avoid or reduce significant impacts are also identified.

3.5.1 Environmental Setting

Climate Change

There is general scientific consensus that climate change is occurring and is almost certainly attributed to human activities. GHG emissions caused by human activity, if not sufficiently curtailed, are likely to contribute further to continued increases in global temperatures. Strong scientific evidence documents that the climate is changing and that its impacts are widespread and occurring now. In California, this evidence includes increases in extreme heat, wildfires, extreme storms, coastal flooding and erosion, and reductions in Sierra Nevada springtime snowpack and threats to continued water availability (ARB 2014).

Globally, climate change has the potential to adversely affect numerous environmental resources through potential, though uncertain, impacts related to future air and water temperatures, precipitation patterns, and an array of other factors. According to the Intergovernmental Panel on Climate Change (IPCC), several indicators of climate change are advancing faster than in previous assessments (IPCC 2014):

- Changing precipitation and snowmelt patterns.
- Negative effects on crop yields.
- Increased heat waves, drought, flood, wildfires, and storm events.
- Reduced renewable water resources in most dry subtropical regions.
- Damage to marine ecosystems from ocean acidification.

Also, many secondary effects are projected to result from global warming, including impacts on agriculture, changes in disease vectors, changes in habitat suitability, and potential for a reduction of biodiversity. The possible outcomes and feedback mechanisms involved are not fully understood, and much research remains to be done; however, the potential for substantial environmental, social, and economic consequences over the long term may be great.

Greenhouse Gases

GHGs emitted as a result of human activities primarily include carbon dioxide (CO_2), with smaller amounts of nitrous oxide, methane (often from unburned natural gas), and less common industrial GHGs such as sulfur hexafluoride from high-voltage power equipment, and hydrofluorocarbons and perfluorocarbons from refrigeration/chiller equipment. These GHGs have different warming potentials (defined as the amount of heat trapped in the atmosphere by a certain mass of the gas), and CO_2 is the most common reference gas for climate change; therefore GHG emissions are often quantified and reported as CO_2-equivalent (CO_2e) emissions. For example, sulfur hexafluoride represents a small fraction of the total annual GHGs emitted worldwide, but this gas is very potent, with 22,800 times the global warming potential (GWP) of CO_2. Therefore, an emission of 1 metric ton of sulfur hexafluoride would be reported as 22,800 metric tons CO_2e. The GWPs of methane and nitrous oxide are 25 times and 298 times that of CO_2, respectively (ARB 2016).

Table 3.5-1 summarizes statewide emissions of GHG from relevant source categories for 2010 through 2016. Specific contributions from individual air basins, such as the San Francisco Bay Area Air Basin, which encompasses the Project area, are included in the emissions inventory but are not itemized by air basin. In 2016, California produced 429.34 million gross metric tons of CO_2e emissions. Transportation was the source of 41 percent of the state's GHG emissions, followed by industrial at 23 percent, electricity generation at 16 percent, commercial and residential sources at 12 percent, and agriculture and forestry composing the remaining 8 percent (ARB 2018).

TABLE 3.5-1
CALIFORNIA GREENHOUSE GAS EMISSIONS (MILLION METRIC TONS CO_2E)

Emission Inventory Category	2011	2012	2013	2014	2015	2016	
Electricity Generation (In State)	41.37	51.18	49.6	51.81	50.21	42.67	10%
Electricity Generation (Imports)	46.94	44.15	40.24	36.56	33.88	26.28	6%
Transportation	166.52	166.16	165.8	167.14	170.89	174.01	41%
Industrial	100.63	100.89	103.75	104.23	102.1	100.37	23%
Commercial	20.73	21.11	21.64	21.37	22.07	23.04	5%
Residential	32.03	30.04	31.19	26.26	27.05	28.34	7%
Agriculture and Forestry	34.89	36.08	34.61	35.95	34.41	33.84	8%
Not Specified (Solvents & Chemicals)	0.79	0.78	0.77	0.78	0.79	0.79	0%
Total Gross Emissions	443.9	450.39	447.6	444.1	441.4	429.34	100%

NOTE: CO_2e = carbon dioxide equivalent

SOURCE: ARB 2018

Greenhouse Gas Sources

There is an important distinction between the two general sources of GHG emissions:

- ***Anthropogenic*** GHG emissions are derived from the combustion of fossil fuels. Energy-related CO_2 emissions, resulting from fossil fuel exploration and use, account for approximately three-quarters of the human-generated GHG emissions in the United States, primarily in the form of CO_2 emissions from burning fossil fuels. More than half of the energy-related emissions come from large stationary sources such as power plants; approximately one-third derive from transportation; and industrial processes, agriculture, forestry, other land uses, and waste management compose a majority of the remaining sources (EPA 2016). Anthropogenic emissions also include byproducts of certain human-managed biological processes, such as anaerobic decomposition of organic waste in landfills, wastewater treatment, and treatment of wastes from confined animal facilities such as dairies.
- ***Biogenic*** GHG emissions are derived from natural sources, including the natural decomposition of biomass[1] and combustion of biomass or biomass-derived fuels.

The distinction between anthropogenic and biogenic sources of GHG emissions is important because these sources have different impacts on the global carbon cycle. Carbon in fossil fuel reservoirs, such as coal seams and oil and gas deposits, was removed from the atmosphere by plants over millions of years. Through geologic processes, this carbon accumulated in deposits and was isolated from the active carbon cycle. Without human intervention, fossil-fuel carbon would remain isolated from the active carbon cycle into the future. Through extraction and combustion of fossil fuels, humans release this carbon, increasing the total amount of carbon in the atmosphere and in the active carbon cycle.

In contrast with fossil-fuel carbon, carbon present in biomass is cycling through the atmosphere and global carbon cycle on a much faster scale. For example, over the course of a year, carbon removed from the atmosphere by growing agricultural crops is released back into the atmosphere through the harvest, and subsequent respiration, decomposition, or combustion of the produced/residual biomass. Over short time scales, the carbon mass released by the decomposition of biomass will generally equal the carbon mass taken up by living organisms. Because biogenic carbon is constantly being released and taken up in the carbon cycle, biogenic CO_2 emissions do not act to increase the total amount of carbon in the atmosphere in the same way as the release of carbon from fossil fuels (EPA 2014).

3.5.2 Regulatory Setting

Federal Regulations

U.S. Environmental Protection Agency

On April 2, 2007, in *Massachusetts v. U.S. EPA*, 549 US 497, the Supreme Court found that GHGs are air pollutants covered by the Clean Air Act. The Court held that the U.S.

1 *Biomass* is non-fossilized organic matter from plants, animals, and microorganisms, including products, byproducts, and wastes from agriculture, forestry, and related industries, as well as the non-fossilized biodegradable fractions of industrial and municipal wastes, including gases and liquids recovered from its decomposition.

Environmental Protection Agency (EPA) must determine whether GHG emissions from new motor vehicles cause or contribute to air pollution, which may reasonably be anticipated to endanger public health or welfare, or whether the science is too uncertain to make a reasoned decision. In making these decisions, EPA is required to follow the language of Section 202(a) of the Clean Air Act, which obligates it to prescribe (and from time to time revise) standards applicable to the emission of any air pollutant from any class or classes of new motor vehicles or new motor vehicle engines. The Supreme Court decision resulted from a petition for rulemaking under Section 202(a) of the Clean Air Act filed by more than a dozen environmental, renewable energy, and other organizations.

On April 17, 2009, the EPA Administrator signed proposed "endangerment" and "cause or contribute" findings for GHGs under Clean Air Act Section 202(a). EPA found that six GHGs, taken in combination, endanger both the public health and the public welfare of current and future generations. EPA also found that the combined emissions of these GHGs from new motor vehicles and new motor vehicle engines contribute to the greenhouse effect as air pollution that endangers public health and welfare under Clean Air Act Section 202(a). Pursuant to Code of Federal Regulations Title 40, Part 52, Proposed Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule, EPA has mandated that Prevention of Significant Deterioration (PSD) and Title V requirements apply to facilities whose stationary-source CO_2e emissions exceed 100,000 tons per year (EPA 2019).

U.S. Supreme Court Decision in Utility Air Regulatory Group v. U.S. EPA

On June 23, 2014, the U.S. Supreme Court held that EPA may not treat GHG emissions as an air pollutant for purposes of determining whether a source is a major source required to obtain a PSD or Title V permit. The Court also held that PSD permits that are otherwise required (based on emissions of other pollutants) may continue to require limitations on GHG emissions based on the application of best available control technology.

In accordance with the Supreme Court decision, on April 10, 2015, the U.S. Court of Appeals for the District of Columbia Circuit issued an amended judgment in *Coalition for Responsible Regulation, Inc. v. U.S. Environmental Protection Agency.* The amended judgment vacated the PSD and Title V regulations under review in that case, to the extent that they require a stationary source to obtain a PSD or Title V permit solely because the source emits or has the potential to emit GHGs above the applicable major source thresholds. The Circuit Court also directed EPA to consider whether any further revisions to its regulations are appropriate, and if so, to undertake to make such revisions.

In response to the Supreme Court decision and the Circuit Court's amended judgment, EPA intends to conduct future rulemaking actions to make appropriate revisions to the PSD and operating permit rules (EPA 2019).

State Regulations

A variety of statewide rules and regulations have been implemented or are in development in California that mandate the quantification or reduction of GHGs. Under CEQA, analysis and mitigation of GHG emissions and climate change in relation to a proposed project is required when the lead agency determines that a project would result in a significant addition of GHGs to the atmosphere.

Executive Order S-3-05

Executive Order S-3-05, issued by Governor Arnold Schwarzenegger in June 2006, established statewide emission reduction targets through the year 2050 as follows:

- By 2010, reduce GHG emissions to 2000 levels.
- By 2020, reduce GHG emissions to 1990 levels.
- By 2050, reduce GHG emissions to 80 percent below 1990 levels.

This executive order does not include any specific requirements that pertain to the Proposed Project; however, future actions taken by the state to implement these goals may affect the Project, depending on the specific implementation measures developed.

Assembly Bill 32

California Assembly Bill (AB) 32, the Global Warming Solutions Act of 2006, required the California Air Resources Board (ARB) to establish a statewide GHG emissions cap for 2020 based on 1990 emissions levels. AB 32 required ARB to adopt regulations that identify and require selected sectors or categories of emitters of GHGs to report and verify their statewide GHG emissions, and authorized ARB to enforce compliance with the program.

Under AB 32, ARB was also required to adopt a statewide GHG emissions limit equivalent to the statewide GHG emissions levels in 1990, which must be achieved by 2020. In December 2007, ARB updated its established limit to 431 million metric tons CO_2e, based on updated GWPs from the IPCC's Fourth Assessment Report. This is approximately 15 percent below forecasted "business-as-usual" emissions of 509 million metric tons CO_2e in 2020 (ARB 2014).

In the interest of achieving the maximum technologically feasible and cost-effective GHG emissions reductions, AB 32 permits the use of market-based compliance mechanisms and requires ARB to monitor compliance with and enforce any rule, regulation, order, emissions limitation, emissions reduction measure, or market-based compliance mechanism that it adopts.

Climate Change Scoping Plan (AB 32 Scoping Plan)

In December 2008, ARB approved the Climate Change Scoping Plan (AB 32 Scoping Plan), outlining the State of California's strategy to achieve the 2020 GHG emissions limit. The AB 32 Scoping Plan estimates a reduction of 174 million metric tons CO_2e (about 191 million tons) from the transportation, energy, agriculture, forestry, and high-climate-change-potential sectors. The plan proposes a comprehensive set of actions designed to reduce overall GHG emissions in California, improve the environment, reduce dependence on oil, diversify California's energy sources, save energy, create new jobs, and enhance public health.

Appendices C and E of the adopted 2008 AB 32 Scoping Plan include a list of 39 recommended action measures to reduce GHG emissions (ARB 2009). Of these measures, none are directly relevant to the Proposed Project.

The AB 32 Scoping Plan must be updated every five years to evaluate the adopted mix of AB 32 policies to ensure that California is on track to achieve the 2020 GHG emissions reduction goal. ARB has released two Scoping Plan Updates, in May 2014 and November 2017 (for additional information about the 2017 Scoping Plan Update, see the *Executive Order B-30-15* section, below). No recommended actions identified in the Scoping Plan Update are directly applicable to the Proposed Project.

Senate Bill 97

In 2007, the California Legislature enacted Senate Bill (SB) 97, which required amendment of the CEQA Guidelines to incorporate analysis of, and mitigation for, GHG emissions from projects subject to CEQA. The amendments took effect March 18, 2010.

The amendments added Section 15064.4 to the CEQA Guidelines, specifically addressing the potential significance of GHG emissions. Section 15064.4 neither requires nor recommends a specific analytical methodology or quantitative criteria for determining the significance of GHG emissions. Rather, the section calls for a “good faith effort” to “describe, calculate, or estimate” GHG emissions and indicates that the analysis of the significance of any GHG impacts should consider the extent to which the project would:

- Increase or reduce GHG emissions.
- Exceed a locally applicable threshold of significance.
- Comply with “regulations or requirements adopted to implement a statewide, regional, or local plan for the reduction or mitigation of greenhouse gas emissions.”

The CEQA Guidelines also state that a project may be found to have a less-than-significant impact related to GHG emissions if it complies with an adopted plan that includes specific measures to sufficiently reduce GHG emissions (Section 15064(h)(3)). Importantly, however, the CEQA Guidelines do not require or recommend a specific analytical methodology or provide quantitative criteria for determining the significance of GHG emissions.

Executive Order B-30-15

In April 2015, Governor Edmund G. Brown Jr. issued an executive order to establish a California GHG emissions reduction target of 40 percent below 1990 levels by 2030. Reaching this target will make it possible for California to reach its ultimate goal of reducing emissions 80 percent under 1990 levels by 2050, as identified in Executive Order S-3-05. Executive Order B-30-15 also specifically addresses the need for climate adaptation and directs state government to do all of the following (Office of Governor Brown 2015):

- Incorporate climate change impacts into the state's Five-Year Infrastructure Plan.

- Update the *Safeguarding California Plan*, the state's climate adaption strategy to identify how climate change will affect California infrastructure and industry and what actions the state can take to reduce the risks posed by climate change.
- Factor climate change into state agencies' planning and investment decisions.
- Implement measures under existing agency and departmental authority to reduce GHG emissions.

Executive Order B-30-15 required ARB to update the AB 32 Scoping Plan to incorporate the 2030 target. ARB adopted the 2017 Scoping Plan for achieving the 2030 target, which takes into account the key programs associated with implementation of the AB 32 Scoping Plan—such as GHG emissions reduction programs for cars, trucks, fuels, industry, and electrical generation—and builds upon, in particular, existing programs related to the Cap-and-Trade Regulation; the Low Carbon Fuel Standard; much cleaner cars, trucks, and freight movement; power generation for the state using cleaner renewable energy; and strategies to reduce methane emissions from agricultural and other wastes by using it to meet the state's energy needs. The 2017 Scoping Plan also addresses, for the first time, GHG emissions from natural and working lands, including the agriculture and forestry sectors (ARB 2017).

Senate Bill 32 and Assembly Bill 197

On August 23, 2016, the California Assembly passed SB 32, legislation that would extend California's landmark climate change legislation to require that California reduce its emissions to 40 percent below 1990 levels by 2030, an extension of AB 32's goal to reduce emissions to 1990 levels. SB 32 became fully enacted the next day when AB 197 was passed, as an amendment to SB 32 stated that it would only become operative if AB 197 was enacted. AB 197's key components are as follows:

- Directs ARB to enact environmental justice and social costs when designing climate change regulations.
- Creates a new entity called the Joint Legislative Committee on Climate Change Policies, authorized to do fact-finding and make recommendations to the Legislature regarding the state's climate change programs.
- Makes substantial changes to how ARB functions, increasing the number of board members and adjusting the terms of service, and strengthens the board member service disqualification process.
- Establishes the intention to decrease ARB's reliance on cap-and-trade to achieve reductions and instead directs ARB to prioritize direct emissions reductions at large stationary sources.

Executive Order B-55-18

On September 10, 2018, Governor Brown signed Executive Order B-55-18, committing California to total, economy-wide carbon neutrality by 2045. Executive Order B-55-18 directs ARB to work with relevant state agencies to develop a framework to implement and accounting that tracks progress toward this goal.

Local Plans and Policies

Bay Area Air Quality Management District

The Bay Area Air Quality Management District (BAAQMD) lays the groundwork for GHG emissions reductions through the 2017 Clean Air Plan. The 2017 Clean Air Plan provides a long-term vision of how the Bay Area could and function in a year 2050 post-carbon economy, and describes a control strategy that BAAQMD will implement over the next three to five years. The 2017 Clean Air Plan also includes measures designed to reduce GHG emissions.

City of San Rafael

The City has several documents that guide the reduction of GHG emissions and endeavor to reduce the impacts of climate change, including the *Climate Change Action Plan 2030*, described below.

San Rafael Climate Change Action Plan 2030

In 2009, the City of San Rafael adopted the Climate Change Action Plan (CCAP) in response to AB 32, the California Global Warming Solutions Act. The CCAP includes strategies for transportation, waste reduction, land use, energy conservation, and sequestration that aim to reduce GHG emissions by 25 percent below 2005 levels by 2020. The intention of these strategies is to set a path toward reducing GHG emissions by 80 percent below 2005 levels by 2050. The CCAP was first updated in 2011 to allow the City to use the CCAP as a quantified GHG reduction strategy and streamline the analysis of future projects under CEQA.

On May 6, 2019, the City adopted the Final Draft Climate Change Action Plan 2030 (CCAP 2030), an update to the 2009 CCAP that establishes a new interim target of reducing GHG emissions by 40 percent below 1990 levels by 2030, and outlines the steps that residents, businesses, and the City can take to reach that goal. The CCAP 2030 has been prepared pursuant to CEQA Guidelines Section 15183.5 and is considered a qualified GHG reduction plan for purposes of streamlining CEQA analysis. The following actions would be applicable to the Proposed Project:

> **Action SA-C4: Prepare for and Adapt to a Rising Sea Level**
>
> **d.** Investigate developing flood control projects and modifying the City's land use regulations for areas subject to increased flooding from sea level rise.
>
> **Action WR-C3: Construction & Demolition Debris and Self-Haul Waste**. Require all loads of construction & demolition debris and self-haul waste to be processed for recovery of materials as feasible. Investigate creation of an ordinance requiring deconstruction of buildings proposed for demolition or remodeling when materials of significant historical, cultural, aesthetic, functional or reuse value can be salvaged.

3.5.3 Impacts and Mitigation Measures

Significance Criteria

The criteria used to determine the significance of impacts related to GHG emissions are based on Appendix G of the CEQA Guidelines. The Proposed Project would have a significant impact if it would:

- Generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment.
- Conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing the emissions of GHGs.

With regard to the first GHG impact criterion, CEQA allows the use of the significance criteria established by the applicable air district to assess the impact of a project relative to GHG emissions. For land use projects with operations that are not stationary sources, BAAQMD's CEQA Guidelines recommend using an operational significance threshold of 1,100 metric tons CO_2e per year; for stationary-source projects, the recommended significance threshold is 10,000 metric tons CO_2e per year (BAAQMD 2017). The former threshold was developed to address achieving GHG reductions for the 2020 GHG reduction target established by Executive Order S-3-05. Because the Proposed Project would be constructed in years beyond 2020, an updated threshold will be necessary. BAAQMD guidance does not identify an applicable significance threshold for construction-related GHG emissions.

Because the Proposed Project would include no new stationary operational sources of GHG emissions, the stationary-source significance threshold of 10,000 metric tons CO_2e per year is not an appropriate threshold to gauge the impact significance of the Project.

GHGs generated during construction are considered temporary, in that they would occur for only a few years during construction; however, for this analysis, construction-related GHG emissions were amortized over the Proposed Project's assumed 30-year lifetime. Consistent with guidance from other air districts (e.g., the South Coast Air Quality Management District), the amortized annual emissions were compared to an adjusted BAAQMD threshold to address Executive Order B-30-15 and the 2017 Scoping Plan emissions reduction goal of lowering GHG emissions to 40 percent below 1990 levels by 2030.

Therefore, even though the Proposed Project is not a typical land use development project, this EIR nonetheless starts with the significance threshold of 1,100 metric tons CO_2e per year to evaluate whether the Project's GHG emissions could have a significant impact on the environment. Using this threshold results in approximately 59 percent of all projects being above the significance threshold and having to implement feasible mitigation measures to meet their CEQA obligations. These projects account for approximately 92 percent of all GHG emissions that were anticipated to occur through 2020 from new land use development in the Bay Area (BAAQMD 2017). If all land use–related project emissions were mitigated to below this threshold, it would represent an overall reduction in new land use project–related emissions of up to 92 percent.

It is acknowledged that this significance threshold was developed to focus on emissions reductions by 2020, and that BAAQMD staff and ARB have not yet provided guidance or recommendations for significance thresholds to evaluate consistency with emissions reduction goals for years beyond 2020. The emissions reductions goal of Executive Order B-30-15 and the 2017 Scoping Plan is to lower GHG emissions to 40 percent below 1990 levels by 2030. This updated goal is roughly equivalent to reducing emissions by 40 percent below current levels, and the Executive Order S-3-05 emissions reductions goal of lowering GHG emissions to 80 percent below 1990 levels by 2050 is roughly equivalent to reducing emissions by 80 percent below current levels.

Again, BAAQMD does not have quantitative thresholds of significance for GHG emissions from a project's construction. Instead, BAAQMD recommends that lead agencies quantify and disclose GHG emissions that would occur during construction and make a determination on the significance of these construction-generated GHG impacts.

In the absence of significance thresholds specifically designed to focus on operational emissions reductions beyond 2020 and construction emissions, the Project's amortized construction-related GHG emissions over its useful life[2] were compared to and adjusted BAAQMD's operational GHG threshold of significance that is 40 percent below the 2020 mass emissions threshold of 1,100 metric tons CO_2e per year, i.e., 660 metric tons CO_2e per year.

With regard to the second GHG impact criterion, the CEQA Guidelines state that a project may be found to have a less-than-significant impact related to GHG emissions if it complies with an adopted plan that includes specific measures to sufficiently reduce GHG emissions (Section 15064(h)(3)).

Approach to Analysis

Construction-related emissions that would be associated with the Proposed Project have been quantified using the methods presented for comparison to a threshold conservatively based on BAAQMD guidance. If the estimated Project GHG emissions exceed the applicable threshold and cannot be mitigated to below it, the Project's impacts related to generation of GHG emissions could result in a significant impact. The Project has also been evaluated for consistency with the City's CCAP and the state's 2017 Scoping Plan Update.

GHG emissions during on-site and off-site Project construction activities were estimated using the California Emissions Estimator Model (CalEEMod), version 2020.4.0. CalEEMod was developed by the South Coast Air Quality Management District and other California air districts to assist lead agencies in determining projects' air quality and GHG emissions impacts. The model, which combines the databases from ARB's EMFAC and OFFROAD models into a single tool, estimated the Project's GHG emissions–producing activities as metric tons CO_2e. A standalone spreadsheet with industry-based marine vessel emissions calculations was used to derive GHG emissions from the operation of the tugboat and workboat.

2 The Project's useful life is estimated to be 30 years.

Project assumptions for the GHG emissions analysis were developed in consultation with the applicant's contractor to reflect each phase of Project construction. These assumptions included a conservative construction scenario with maximum concurrent activities, which would result in an limited construction schedule (generally September through December) over three consecutive years. The information used for the analysis consisted of a customized phased schedule along with a list of required off-road construction equipment, equipment workdays, worker trips, hauling trips, and mileage of trips required to complete the Project. This information was then entered into CalEEMod to estimate the Proposed Project's annual construction-related mass emissions of GHGs. CalEEMod defaults were used for Project components in which there were no Project-specific data, primarily load factors. Appendix C, *Air Quality and Greenhouse Gas Emissions Supporting Documentation*, contains the construction schedule, assumptions, emissions summary tables, and CalEEMod output sheets used to quantify the Project's construction emissions of GHGs.

Impact Summary

Table 3.5-2 provides a summary of Project impacts related to GHG emissions.

TABLE 3.5-2
SUMMARY OF GREENHOUSE GAS EMISSIONS IMPACTS

Impact Statement	Construction	Operation
Impact 3.5-1: The Project could generate GHG emissions that would exceed the Bay Area Air Quality Management District's threshold of significance for GHG emissions.	LTS	LTS
Impact 3.5-2: The Project could conflict with applicable plans, policies, and regulations adopted for the purposes of reducing GHG emissions.	LTS	LTS

NOTES:
LTS = Less than significant

Impact Analysis

Impact 3.5-1: The Project could generate GHG emissions that would exceed the Bay Area Air Quality Management District's threshold of significance for GHG emissions. *(Less than Significant)*

Construction and Operation Emissions

Table 3.5-3 shows the GHG emissions estimated to be generated by Project construction activities. Project construction would begin in September 2023 and finish at the end of 2025. As shown in Table 3.5-3, the Project's construction over the three-year construction period would generate a total of 1,307 metric tons CO_2e. See the *Approach to Analysis* section above for a discussion of the methods used to estimate construction emissions; see Appendix C for details on the calculations and assumptions used to estimate the construction emissions.

TABLE 3.5-3
TOTAL AND AMORTIZED GREENHOUSE GAS CONSTRUCTION EMISSIONS

Source	CO_2e (metric tons)
Phase 1 On-site Construction and Haul Trucks	325
Phase 1 Marine Emissions (tugboat and work boat)	147
Phase 2 On-site Construction and haul trucks	679
Phase 2 Marine Emissions (tugboat and work boat)	136
Phase 3 On-site Construction and Haul Trucks	109
Phase 3 Marine Emissions (tugboat and work boat)	20
Total Construction	1,307
30-year Annual Amortized Construction	44
BAAQMD GHG Annual Mass Emissions Threshold for Non-Stationary Sources	1,100
Adjusted BAAQMD GHG Annual Mass Emissions Threshold for Nonstationary Sources to Address Year 2030 Reduction Targets	660
Threshold Exceeded?	**No**

NOTES:

BAAQMD = Bay Area Air Quality Management District; CO_2e = carbon dioxide equivalent; GHG = greenhouse gas

SOURCE: Data compiled by Environmental Science Associates in 2021 (see Appendix C).

As described in the *Approach to Analysis* section, the Project's amortized annual construction GHG emissions were compared to BAAQMD's operational threshold of significance for nonstationary sources, as adjusted to reflect year 2030 emission reduction targets. **Table 3.5-3** shows that the Project's total amortized construction and operational GHG emissions, based on a 30-year Project life span, would be below the applicable threshold. Therefore, this impact would be **less than significant**.

While it is expected that levee foundation soils removed are sandy soils appropriate for reuse for the tidal marsh reconstruction; it is possible that some portion of the foundation soils would require export and disposal offsite, and additional imported soil would then be required for the tidal marsh reconstruction. However, the emissions in Table 3.5-3 from on-road truck hauling (2,250 trips) only account for six percent of the total project CO2e emissions, which are dominated by on-site construction equipment. Therefore, the potential increase in truck transport to accommodate additional export and import of foundational soil, if required, would only marginally increase project CO2e emissions and the impact would remain less than significant should this additional transport be required.

Mitigation: None required.

Impact 3.5-2: The Project could conflict with applicable plans, policies, and regulations adopted for the purposes of reducing GHG emissions. ***(Less than Significant)***

Applicable plans, policies, and regulations promulgated by the City of San Rafael were discussed earlier in this section. One of two potentially applicable actions of the City's CCAP 2030 for a construction project is WR-C3 (Construction & Demolition Debris and Self-Haul Waste), which requires that all loads of construction and demolition debris and self-haul waste be processed for recovery of materials as feasible. The Proposed Project would not involve waste disposal, as no demolition is proposed. Excavated materials would be reused on-site.

The other potentially applicable action of the City's CCAP 2030 is SA-C4 (Prepare for and Adapt to a Rising Sea Level). As stated in Section 2.1.3, *Goals and Objectives,* in Chapter 2, *Project Description*, one of the primary goals of the proposed Project is to *create sustainable benefits that consider future environmental changes such as sea-level rise and sedimentation.* Therefore, the Proposed Project is consistent with measures in the CCAP 2030. The Project would not conflict with the City's Climate Action Plan.

Because no recommended actions identified in the 2017 Scoping Plan Update are directly applicable to the Proposed Project, Project construction would generally be consistent with applicable provisions of the 2017 Scoping Plan. Additionally, as discussed for Impact 3.5-1, the Project would be in conformance with BAAQMD's GHG emissions thresholds. Therefore, the Proposed Project would comply with the City's applicable plans, policies, and regulations for reducing GHG emissions, and this impact would be **less than significant**.

Mitigation: None required.

Cumulative Impacts

Climate change is the cumulative effect of all natural and anthropogenic sources of GHGs accumulated on a global scale. The GHG emissions from an individual project, even a very large development project, would not individually generate sufficient GHG emissions to measurably influence global climate change, and thus, the assessment of GHG emissions impacts is inherently cumulative.

Consideration of a project's climate change impact, therefore, is essentially an analysis of a project's contribution to a cumulatively significant global impact through its emission of GHGs. Although it is possible to examine the quantity of GHGs that would be emitted from individual project sources, it is not currently possible to link these GHGs emitted from a specific source or location to particular global climate changes.

Both BAAQMD and the California Air Pollution Control Officers Association consider GHG impacts to be exclusively cumulative impacts, in that no single project could, by itself, result in a substantial change in the climate (BAAQMD 2012; CAPCOA 2008). Therefore, the evaluation of cumulative GHG impacts presented above evaluates whether the Proposed Project would make a considerable contribution to cumulative climate change effects.

As such, the analysis in Impact 3.5-1 considers the potential cumulative impacts of the Proposed Project related to GHG emissions. Implementation of the Project would not result in a cumulatively considerable contribution to annual GHG emissions. As such, implementation of the Proposed Project would not result in a cumulatively considerable impact.

Mitigation: None required.

3.5.4 References

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3.6 Hydrology and Water Quality

This section evaluates the potential for the Proposed Project to result in adverse impacts related to hydrology and water quality. The analysis is based on a review of available hydrology and water quality reports and maps of the Project site and vicinity, including site-specific investigations; relevant regulations; and a discussion of the methodology and thresholds used to determine whether the Proposed Project would result in significant impacts. This section relies in part on the following site-specific investigations, which are included in Appendix E:

- *San Rafael Sea-Level Rise Adaptation Technical Guidance Study* (ESA 2020a).
- *Geotechnical Investigation, Restore Eroded and Diked Marsh, Tiscornia Marsh Habitat Restoration, San Rafael, California* (Hultgren-Tillis 2021).
- *Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation Project: Conceptual Design Report* (ESA 2018).
- *Tiscornia Marsh Restoration and Sea Level Rise Adaptation Project – Habitat Assessment* (ESA 2020b; refer to Appendix D).

3.6.1 Environmental Setting

Regional Setting

The current configuration of the greater San Francisco Bay Area, including the Project site, began to form after the last ice age when the sea level rose, flooding the valleys (Hultgren-Tillis 2021). Eroded fine-grained silt and clay particles were carried down streams to the Bay, where they met the relatively quiet Bay waters and settled to form the highly plastic clay and silt estuary deposit known as San Francisco Bay Mud (Bay Mud). The accretion of Bay Mud formed mudflats and marshlands throughout the margins of the Bay Area. Marshlands around much of the Bay were diked and reclaimed in the early- to mid-1900s, with artificial fill placed on top of the former mudflats and marshlands.

In this regional area on the east side of Marin County, runoff reaches the Bay primarily from Las Gallinas Creek (north of the Project site) and San Rafael Creek, which flows along the north side of the Project site (ESA 2020a). Tributaries Irwin Creek and Mahon Creek drain into San Rafael Creek in the downtown area west of the Project site. San Rafael Creek drains a 6.4-square-mile watershed in central and northern San Rafael that is largely urban. The City's stormwater system also conveys runoff to the Bay. Because of the low elevations behind the shoreline, pump stations are located throughout the City to lift stormwater into San Rafael Creek and the Bay.

Local Setting

Surface Water Hydrology

As shown on Figure 2-1, the Project site is located in Tiscornia Marsh, where San Rafael Creek enters San Rafael Bay. As shown on Figure 2-2, the Project site consists of the diked marsh area, eroded tidal marsh area north and east of the diked marsh, and shoreline levees. San Rafael Creek flows eastward along the north side of the Project site into San Rafael Bay on the east side of the Project site. All drainage from the Project site is to the creek to the north and the Bay to the east.

There are no drainage channels or structures within the diked marsh area. Stormwater within the diked marsh area infiltrates into sediments or evaporates. The levees that define the diked marsh area prevent stormwater from flowing directly into the creek or Bay. The tidal marsh area has one north-south tidal channel that drains from the southern portion of the tidal marsh area to the north into the creek. Direct rainfall into the tidal marsh area flows as sheet flow into the Creek to the north or the Bay to the east. Elevations of existing conditions are summarized below (ESA 2018; Hultgren and Tillis 2021):

- Elevations within the soccer field area adjacent to the Project site range from 7 to 8 feet North American Vertical Datum (NAVD88).
- The elevation of the berm along the north side of the soccer field ranges from 8 to 10 feet NAVD88.
- Elevation of the diked marsh area and the tidal marsh area range from about 6 to 7 feet NAVD88.
- The crest of the shoreline levee ranges in elevation from 9 to 12 feet NAVD88.

The local storm drains within the soccer field flow to City storm drains on Canal Street, and ultimately the City's pump station on Kerner Boulevard. The pump station discharges via a 48-inch storm drain that runs north-south along the west side of the soccer field, and discharges into San Rafael Creek. There are no other man-made drainage structures within the Project site, other than the shoreline levee.

Flooding and Sea Level Rise

FEMA

Flood mapping characterizes the extent and depth of flood hazards from coastal and watershed sources. The Federal Emergency Management Agency (FEMA) conducts mapping nationwide to inform flood management and its flood insurance program. FEMA, through its Flood Insurance Rate Mapping (FIRM) program, designates areas where flooding could occur during 100-year and 500-year flood events.[1] FEMA has recently updated the coastal flood maps for the City (FEMA 2016). According to the FEMA FIRM, the Project site and surrounding area adjacent to the Project site are within Zone AE coastal flood hazard area (100-year flood zone) and have a base flood elevation (BFE) of 10 feet NAVD88. As summarized above, elevations at the Project site are below the BFE, which allows for overtopping of the levees and flooding of low-lying areas during storm events and higher tides (ESA 2020a).

Sea Level Rise and Erosion

The accumulation of human-produced greenhouse gases in the Earth's atmosphere is causing and will continue to cause global warming and climate change (ESA 2020a). Along the Bay shoreline,

[1] A 100-year flood event has a 1 percent probability of being exceeded in any given year. A 500-year flood event has a 0.2 percent probability of being exceeded in any given year.

climate change causes sea level rise due to the thermal expansion of the ocean's waters and melting of ice sheets. Over the last century, the tide gauge in San Francisco has recorded sea level rise of about 8 inches.

The tidal marshlands have experienced considerable erosion over the past 30 years, retreating as much as 200 feet, with approximately 3 acres lost (ESA 2020b). Tiscornia Marsh is one of a very few small areas of tidal marsh remaining in Central San Rafael. Historically, tidal marshes extended deep into what today is downtown San Rafael, and historic mapping shows that the location of the current levee along the west side of Tiscornia Marsh was the historic wetland/bay shoreline. Tiscornia Marsh was most likely formed from accretion on the historic mudflats. The marsh is comprised of a thin band of high-marsh habitat, dominated by pickleweed, which transitions abruptly from a 3- to 4-foot escarpment to a wide mudflat extending bayward. This band of marshland is most narrow at its north end, expands to the south along the adjacent levee and soccer field, and becomes very thin as it curves eastward along the shoreline levee bordering the south end of the marsh. As previously noted, a single tidal channel enters the marsh from the northern edge bordering San Rafael Creek and extends southward through most of the length of the marsh.

Prior to the development the shoreline area, Tiscornia Marsh formed the edge of open bay/mudflats immediately adjacent to a larger marsh complex that existed from a little east of today's shoreline deep into downtown San Rafael, with San Rafael Creek bisecting and supporting much of this tidal marsh. By 1943, levees had been constructed along the shoreline and marsh had accreted on the mudflats bayward of what was the historic wetland shoreline. Aside from the larger scale changes that were occurring throughout the Bay Area within the past century, sediment delivery to the site was also altered by development of the City of San Rafael, filling of the Bay, and construction of the Spinnaker neighborhood to the south. More recently, recurrent maintenance dredging of San Rafael Creek for navigation purposes has created a local sediment sink adjacent to the marsh.

Aerial images dating from 1987 indicate that the marsh has been eroding rapidly in the last several decades (ESA 2018). The retreat of the bayward marsh edge has been most rapid at the northern edge of the site, eroding at a rate of 4 to 5 feet per year since 2004, when most aerial images were available. The rate of retreat decreases with distance moving south along the marsh edge, declining to as little as 1 foot per year where the marsh intersects the shoreline.

Tsunami and Seiche

Tsunamis are ocean waves generated by vertical movement of the sea floor, normally associated with earthquakes or volcanic eruptions. The Association of Bay Area Governments (ABAG) provides hazard maps, including coastal areas susceptible to tsunamis. The tidal marsh zone is designated as entirely within the tsunami zone (ABAG 2021). The diked marsh area is not designated as within a tsunami zone. The City of San Rafael General Plan (Safety and Resilience Element) describes the tsunami hazard in San Rafael as an unlikely occurrence with a moderate potential impact on the San Rafael shoreline (City of San Rafael 2021). However, given the low elevations of the Project site, should a tsunami occur, flooding would affect low-lying areas, especially areas that are only a few feet above sea level.

Seiches are water-level oscillations in an enclosed or semi-enclosed body of water such as a lake, reservoir, or harbor that result from seismic events, wind stress, volcanic eruptions, underwater landslides, or local basin reflections of tsunamis. The Project site is adjacent to San Rafael Creek, which could be the source of a seiche caused by a seismic event.

Surface Water Quality

There are no creeks or stormwater drains within the Project site and thus no freshwater flow. Water in the channel within the tidal marsh area is a brackish mix of marine water from the bay and some freshwater from San Rafael Creek. Urban runoff in the region drained by San Rafael Creek would include some pollutants from industrial waste discharges and urban stormwater runoff. Pollutant sources include both point and non-point discharges. A point source is any discernible, confined, and discrete conveyance (e.g., a pipe discharge) of pollutants to a water body from sources such as industrial facilities or wastewater treatment plants. Non-point pollutant sources are those that do not have a single, identifiable discharge point but are rather a combination of many sources. For example, a non-point source can be stormwater runoff from land that contains petroleum from parking lots, pesticides from farming operations, or sediment from soil erosion.

Groundwater

The Project site is located within the San Rafael Valley Groundwater Basin 2-029 (DWR 2021). This location is not within a medium- to high-priority basin (i.e., overdrafted) and is not subject to the Sustainable Groundwater Management Act. Given the location of the Project site adjacent to the Bay, the depth to groundwater is largely controlled by the elevation of the surrounding Bay water and is subject to tidal fluctuations. The Bay Muds that underlie the artificial fill would not provide significant sources of groundwater supply. The water quality of groundwater is expected to be brackish, similar to the surrounding Bay water.

3.6.2 Regulatory Setting

Federal Regulations

Clean Water Act (CWA) and Associated Environmental Compliance

Several sections of the CWA pertain to regulating impacts on waters of the United States. As discussed in Section 3.4, *Biological Resources*, the Project site is likely associated with waters of the U.S. The discharge of dredged or fill material into waters of the U.S. is subject to permitting specified under Title IV (Permits and Licenses) of the CWA. The sections below summarize the CWA sections that are applicable to the Proposed Project.

National Pollutant Discharge Elimination System (NPDES) Permit Program

The NPDES permit program was established in the CWA to regulate municipal and industrial point discharges to surface waters of the U.S. Each NPDES permit for point discharges contains limits on allowable concentrations of pollutants contained in discharges. The CWA was amended in 1987 to require NPDES permits for non-point source (i.e., stormwater) pollutants in discharges. Stormwater sources are diffuse and originate over a wide area rather than from a definable point. The goal of NPDES stormwater regulations is to improve the quality of stormwater discharged to receiving waters to the "maximum extent practicable" through the use of structural and non-structural best management practices (BMPs). BMPs can include the development and implementation of various practices such as educational measures (workshops informing the public of what impacts result when household chemicals are dumped into storm drains), regulatory measures (local authority of drainage facility design), public policy measures, and structural measures (filter strips, grass swales, and detention ponds).

CWA Section 303: Water Quality Standards and Implementation Plans

Water quality objectives for all waters of the U.S. are established under applicable provisions of Section 303 of the federal CWA. The State of California adopts water quality standards to protect beneficial uses of state waters as required by Section 303 of the CWA and the Porter-Cologne Water Quality Control Act of 1969 (Porter-Cologne). Section 303(d) of the CWA established the Total Maximum Daily Load (TMDL) process to guide the application of state water quality standards (see the discussion of state water quality standards below). To identify candidate water bodies for the TMDL analysis, a list of water quality–limited streams and other water bodies was generated. These water bodies are impaired by the presence of pollutants, including sediment, and are more sensitive to disturbance. Section 303(d) listings associated with water bodies are included in the Water Board's Water Quality Control Plan, described further under state regulations. The CWA prohibits the discharge of pollutants to navigable waters from a point source unless authorized by an NPDES permit. Because implementation of these regulations has been delegated to the state, additional information regarding this permit is discussed under the state subheading, below.

CWA Section 401: Water Quality Certification

Section 401 of the CWA (33 USC §1341) requires any applicant for a federal license or permit to conduct any activity that may result in a discharge of a pollutant into navigable waters, including the crossing of rivers or streams during road, pipeline, or transmission line construction, to obtain a water quality certification from the state in which the discharge originates. The water quality certification ensures that the discharge will comply with the applicable effluent limitations and water quality standards. The state agency responsible for implementing Section 401 of the CWA in California is the Regional Water Quality Control Board (RWQCB). Under the CWA, the Water Board must issue or waive Section 401 water quality certification for a project to be permitted under Section 404 (as described further below). Water quality certification requires the evaluation of water quality considerations associated with dredging or the placement of fill materials into waters of the U.S. and imposes project-specific conditions on development. A Section 401 waiver establishes conditions that apply to any project that qualifies for a waiver. Because the Project requires a federal permit, a Section 401 Water Quality Certification would be required.

CWA Section 402: National Pollutant Discharge Elimination System

Section 402 of the CWA regulates construction-related stormwater discharges to surface waters through the NPDES program, administered by the U.S. Environmental Protection Agency (EPA) with implementation authority in California delegated to the State Water Resources Control Board (SWRCB). An NPDES Construction General Permit is required for all projects that disturb 1 acre or more of land. Therefore, the Project would require coverage under the NPDES General Construction Permit.

As part of the permitting effort, the Project would be required to file a public Notice of Intent to discharge stormwater associated with the Project; develop a Stormwater Pollution Prevention Plan (SWPPP), which includes BMPs to be implemented to prevent soil erosion and discharge of other construction-related pollutants that could contaminate nearby surface waters; and conduct periodic monitoring and reporting to ensure that BMPs are correctly implemented and effective in controlling the discharge of stormwater-related pollutants. The SWPPP and all associated BMPs must meet the requirements of the NPDES Construction General Permit for construction stormwater discharge (described further below in the section on state regulations).

CWA Section 404: Discharge of Dredged or Fill Material

Section 404 of the CWA (33 USC §1344) authorizes the Secretary of the Army, acting through the Chief of Engineers, to issue permits for the discharge of dredged or fill material into the waters of the U.S. at specified disposal sites (33 Code of Federal Regulations [CFR] Part 323). The term "waters of the U.S." includes wetlands and non-wetland bodies of water that meet specific criteria as defined in the CFR and applicable U.S. Army Corps of Engineers (USACE) guidance. The selection and use of disposal sites will be in accordance with guidelines developed by the Administrator of the EPA in conjunction with the Secretary of the Army and published in 40 CFR Part 230 (the "guidelines"). 40 CFR Part 230 Subpart C includes water quality aspects of dredge and fill activities. Among other topics, these guidelines address discharges, which alter substrate elevation or contours, suspended particulates, water clarity, nutrients and chemical content, current patterns and water circulation, water fluctuations, and salinity gradients. The Project would discharge dredged or fill material into waters of the U.S. and therefore require a CWA Section 404 Permit (see Section 3.4, *Biological Resources*, for details about fill in waters of the U.S.).

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), 7 USC §136 et seq. (1996)

FIFRA provides for federal regulation of the distribution, sale, and use of pesticides. Pesticides include any herbicide, insecticide, rodenticide, algaecide, fungicide, or any combination of substances intended to prevent, destroy, or repel any pest. All pesticides distributed or sold in the U.S. must be registered (licensed) by the EPA. Before the EPA may register a pesticide under FIFRA, the applicant must show, among other things, that using the pesticide according to specifications "*will not generally cause unreasonable adverse effects on the environment.*" FIFRA defines the term "*unreasonable adverse effects on the environment*" to mean: "*(1) any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide, or (2) a human dietary risk from residues that result from a use of a pesticide in or on any food inconsistent with the standard under section 408 of the Federal Food, Drug, and Cosmetic Act."* Training is required for workers in pesticide-treated areas and certification and training for applicators of restricted use pesticides.

State Regulations

Porter-Cologne Water Quality Control Act Overview

The Porter-Cologne Water Quality Control Act (Water Code §13000 et seq.), passed in 1969, requires the protection of water quality by appropriate design, sizing, and construction of erosion and sediment controls. The Porter-Cologne Act established the SWRCB and divided California into nine regions, each overseen by a RWQCB. The SWRCB is the primary state agency responsible for protecting the quality of the state's surface and groundwater supplies and has delegated primary implementation authority to the nine RWQCBs. The Porter-Cologne Act assigns responsibility for implementing CWA Sections 401 through 402 and 303(d) to the SWRCB and the nine RWQCBs.

Coverage under a Construction Stormwater General Permit (Construction General Permit, discussed further below) requires the preparation and implementation of a SWPPP. The SWPPP includes pollution prevention measures (erosion and sediment control measures and measures to control non-stormwater discharges and hazardous spills), demonstration of compliance with all applicable local and regional erosion and sediment control standards, identification of responsible parties, a detailed construction timeline, and a BMP monitoring and maintenance schedule.

Water Quality Control Plan (Basin Plan)

The preparation and adoption of Basin Plans are required by California Water Code Section 13240. According to Water Code Section 13050, Basin Plans establish the beneficial uses to be protected for the waters within a specified area, water quality objectives to protect those uses, and an implementation program for achieving the objectives. Because beneficial uses, together with their corresponding water quality objectives, can be defined per federal regulations as water quality standards, the Basin Plans are regulatory references for meeting the state and federal requirements for water quality control. In relevant part, Article X, Section 2 of the California Constitution declares:

> "*[B]ecause of the conditions prevailing in this State, the general welfare requires that the water resources of the State be put to beneficial use to the fullest extent of which they are capable, and that the waste or unreasonable use or unreasonable method of use of water be prevented, and that the conservation of such waters is to be exercised with a view to the reasonable and beneficial use thereof in the interest of the people and for the public welfare…*"

The Water Quality Control Plan for the San Francisco Bay Area Region (Basin Plan) is designed to preserve and enhance water quality and protect beneficial uses of all waters (RWQCB 2019). Specifically, it:

1. Designates beneficial uses for surface and groundwaters.
2. Sets narrative and numerical objectives that must be attained or maintained to protect the designated beneficial uses and conform to the state's anti-degradation policy.
3. Describes implementation programs for achieving objectives to protect all waters in the region.

In addition, the Basin Plan incorporates all applicable State and Regional Board plans and policies and other pertinent water quality policies and regulations. The Project would be required to meet water quality objectives and maintain the beneficial uses set out in the Basin Plan. The Basin Plan designates the following beneficial uses for San Rafael Creek:

- **Cold Freshwater Habitat -** Uses of water that support cold water ecosystems, including, but not limited to, the preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates. Cold freshwater habitats generally support trout and may support anadromous salmon and steelhead fisheries as well. Cold water habitats are commonly well-oxygenated. Life within these waters is relatively intolerant to environmental stresses. Often, soft waters feed cold water habitats. These waters render fish more susceptible to toxic metals, such as copper, because of their lower buffering capacity.
- **Warm Freshwater Habitat -** Uses of water that support warm water ecosystems including, but not limited to, the preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates. The warm freshwater habitats supporting bass, bluegill, perch, and other fish are generally lakes and reservoirs, although some minor streams serve this purpose where streamflow is sufficient to sustain the fishery. The habitat is also important to a variety of nonfish species, such as frogs, crayfish, and insects, which provide food for fish and small mammals. This habitat is less sensitive to environmental changes, but more diverse than the cold freshwater habitat, and natural fluctuations in temperature, dissolved oxygen, pH, and turbidity are usually greater.
- **Wildlife Habitat -** Uses of waters that support wildlife habitats, including, but not limited to, the preservation and enhancement of vegetation and prey species used by wildlife, such as waterfowl. The two most important types of wildlife habitat are riparian and wetland habitats. These habitats can be threatened by development, erosion, and sedimentation, as well as by poor water quality. The water quality requirements of wildlife pertain to the water directly ingested, the aquatic habitat itself, and the effect of water quality on the production of food materials. Waterfowl habitat is particularly sensitive to changes in water quality. Dissolved oxygen, pH, alkalinity, salinity, turbidity, settleable matter, oil, toxicants, and specific disease organisms are water quality characteristics particularly important to waterfowl habitat. Dissolved oxygen is needed in waterfowl habitats to suppress the development of botulism organisms; botulism has killed millions of waterfowl. It is particularly important to maintain adequate circulation and aerobic conditions in shallow fringe areas of ponds or reservoirs where botulism has caused problems.
- **Water Contact Recreation -** Uses of water for recreational activities involving body contact with water where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, whitewater activities, fishing, and uses of natural hot springs.
- **Non-contact Water Recreation -** Uses of water for recreational activities involving proximity to water, but not normally involving contact with water where water ingestion is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tide pool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.
- **Navigation -** Uses of water for shipping, travel, or other transportation by private, military, or commercial vessels. Navigation is a designated use where water is used for shipping, travel, or other transportation by private, military, or commercial vessels.

NPDES Construction General Permit

Construction associated with the Project would disturb more than 1 acre of land surface affecting the quality of stormwater discharges into waters of the U.S. The Project would, therefore, be subject to the *NPDES General Permit for Stormwater Discharges Associated with Construction* *and Land Disturbance Activities* (Order 2009-0009-DWQ, NPDES No. CAS000002; as amended by Orders 2010-0014-DWQ and 2012-006-DWQ). The Construction General Permit regulates discharges of pollutants in stormwater associated with construction activity to waters of the U.S. from construction sites that disturb 1 acre or more of land surface, or that are part of a common plan of development or sale that disturbs more than 1 acre of land surface. The permit regulates stormwater discharges associated with construction or demolition activities, such as clearing and excavation; construction of buildings; and linear underground projects, including the installation of water pipelines and other utility lines.

The Construction General Permit requires that construction sites be assigned a risk level of 1 (low), 2 (medium), or 3 (high), based both on the sediment transport risk at the site and the receiving waters' risk during periods of soil exposure (e.g., grading and site stabilization). The sediment risk level reflects the relative amount of sediment that could potentially be discharged to receiving water bodies and is based on the nature of the construction activities and the location of the site relative to receiving water bodies. The receiving waters risk level reflects the risk to the receiving waters from the sediment discharge. Depending on the risk level, construction projects could be subject to the following requirements:

- Effluent standards
- Good site management housekeeping
- Non-stormwater management
- Erosion and sediment controls
- Runon and runoff controls
- Inspection, maintenance, and repair
- Monitoring and reporting requirements

The Construction General Permit requires the development and implementation of a SWPPP that includes specific BMPs designed to prevent sediment and pollutants from contacting stormwater from moving off site into receiving waters. The BMPs fall into several categories, including erosion control, sediment control, waste management, and good housekeeping, and are intended to protect surface water quality by preventing the off-site migration of eroded soil and construction-related pollutants from the construction area. Routine inspection of all BMPs is required under the provisions of the Construction General Permit. In addition, the SWPPP is required to contain a visual monitoring program, a chemical monitoring program for non-visible pollutants, and a sediment monitoring plan if the site discharges directly to a water body listed on the 303(d) list for sediment.

The SWPPP must be prepared before the construction begins. The SWPPP must contain a site map(s) that delineates the construction work area, existing and proposed buildings, parcel boundaries, roadways, stormwater collection and discharge points, general topography both before and after construction, and drainage patterns across the project area. The SWPPP must list BMPs and the placement of those BMPs that the applicant would use to protect stormwater runoff. Examples of typical construction BMPs include scheduling or limiting certain activities to dry periods, installing sediment barriers such as silt fence and fiber rolls, and maintaining equipment and vehicles used for construction. Non-stormwater management measures include installing specific discharge controls during certain activities, such as paving operations, vehicle and equipment washing, and fueling. The Construction General Permit also sets post-construction standards (i.e., implementation of BMPs to reduce pollutants in stormwater discharges from the site following construction).

In the Project vicinity, the Construction General Permit is implemented and enforced by the San Francisco Bay RWQCB, which administers the stormwater permitting program. Dischargers must electronically submit a notice of intent and permit registration documents to obtain coverage under this Construction General Permit. Dischargers are to notify the RWQCB of violations or incidents of non-compliance, and submit annual reports identifying deficiencies in the BMPs and explaining how the deficiencies were corrected. The risk assessment and SWPPP must be prepared by a State Qualified SWPPP Developer, and implementation of the SWPPP must be overseen by a State Qualified SWPPP Practitioner. A legally responsible person, who is legally authorized to sign and certify permit registration documents, is responsible for obtaining coverage under the permit.

San Francisco Bay Conservation and Development Commission

The San Francisco Bay Conservation and Development Commission (BCDC) has regulatory jurisdiction as defined by the McAteer-Petris Act (Public Resources Code [PRC] Section 66610), over the Bay and its shoreline, which generally consists of the area between the Bay shoreline and a line 100 feet landward of and parallel to the shoreline. Sea level rise vulnerability and risk assessments are required when planning shoreline areas or designing larger shoreline projects in BCDC's jurisdiction. Risk assessments must be based on the best available estimates of future sea level rise. New projects on Bay fill, likely to be affected by future sea level rise and storm surge activity during the life of the project, must meet additional requirements, and when feasible, integrate hard shoreline protection structures with natural features that enhance the Bay ecosystem (e.g., including marsh and/or upland vegetation). The report *San Rafael Sea-Level Rise Adaptation Technical Guidance Study* prepared by Environmental Science Associates provides the sea level rise vulnerability and risk assessment for the Project site (ESA 2020a).

California State Lands Commission and AB 691

The California State Lands Commission has jurisdiction over tidelands and submerged lands along the entire coast, and within 3 nautical miles offshore from the ordinary high water mark. The California State Lands Commission requires sea level rise planning by Legislative Trust Grantees (such as the City of San Rafael) and requires grantees with average annual gross public trust revenues over $250,000 to prepare and submit a sea level rise plan to the California State Lands Commission no later than July 1, 2019. The report *San Rafael Sea-Level Rise Adaptation Technical Guidance Study* prepared by Environmental Science Associates provides the sea level rise vulnerability and risk assessment for the Project site (ESA 2020a).

California Department of Pesticide Regulation (CDPR), 3 CCR Food and Agriculture, Division 6. Pesticides and Pest Control Operations

The California Department of Pesticide Regulation (CDPR) is dedicated to protecting human health and the environment by regulating the sale and use of pesticides, and by fostering reduced-risk pest management. Pesticides includes any herbicide, insecticide, rodenticide, algaecide, fungicide, or any combination of substances intended to prevent, destroy, or repel any pest. These regulations provide pesticide registration and licensing procedures, list restricted materials, work and worker safety requirements, and environmental protections for groundwater, surface water, air, and aquatic environments. The entities applying herbicides will be required to comply with CDPR regulations.

Local Plans and Policies

San Rafael General Plan 2040 - Safety Element

The Safety portion of the General Plan addresses the protection of life and property from natural hazards, including earthquakes, landslides, wildfire, and flooding. The General Plan provides policies and standards for the type, location, intensity, and design of development in areas of potential hazards. The intent is not to remove all risks associated with each specific type of hazard, but to reduce risks to life and property and to make informed decisions about land use and development near these hazards.

Goal S-3: Resilience to Flooding and Sea Level Rise Recognize, plan for, and successfully adapt to the anticipated effects of increased flooding and sea level rise.

Policy S-3.7: Shoreline Levees Improve and expand San Rafael’s shoreline levee system. When private properties are developed or redeveloped, require levee upgrading as appropriate, based on anticipated high tide and flood conditions.

Program S-3.7A: Levee Improvement Plans. Assess existing levees, berms, and flood control systems to identify reaches with the greatest vulnerability. Develop improvement plans based on existing conditions and projected needs, as documented in adaptation plans. This should include improvement studies for the Spinnaker Point levee, as recommended by the LHMP, and the Canalways levee along San Rafael Bay.

Program S-3.7B: Financing Levee Improvements. Coordinate with property owners; residents and businesses; federal, state, and regional agencies; utilities; and other stakeholders to evaluate potential methods of improving levees and funding ongoing levee maintenance, including assessment or maintenance districts. The cost and fiscal impacts of levee improvements should be evaluated against potential benefits and costs and consequences of inaction.

Goal S-2: Resilience to Geologic Hazards Minimize potential risks associated with geologic hazards, including earthquake-induced ground shaking and liquefaction, landslides, mudslides, erosion, sedimentation, and settlement.

Policy S-2.5: Erosion Control Require appropriate control measures in areas susceptible to erosion, in conjunction with proposed development. Erosion control measures should incorporate best management practices (BMPs) and should be coordinated with requirements for on-site water retention, water quality improvements, and runoff control.

Program S-2.5A: Erosion and Sediment Control Plans. Require Erosion and Sediment Control Plans (ESCPs) for projects meeting the criteria defined by the

Marin County Stormwater Pollution Prevention Program, including those requiring grading permits and those with the potential for significant erosion and sediment discharges. Projects that disturb more than one acre of soil must prepare a Stormwater Pollution Prevention Plan, pursuant to State law.

Program S-2.5B: Grading During the Wet Season. Avoid grading during the wet season due to soil instability and sedimentation risks, unless the City Engineer determines such risks will not be present. Require that development projects implement erosion and/or sediment control measures and runoff discharge measures based on their potential to impact storm drains, drainageways, and creeks.

Program S-2.5C: Sediment Use. Explore the use of sediment from human activities such as dredging and natural processes such as erosion for wetlands restoration and shoreline resiliency projects.

Marin County Pesticide Enforcement

The Marin County Department of Agriculture/Weights and Measures oversees the use of pesticides in Marin County. As previously noted, this includes the use of herbicides. Employers are required to document their written pesticide handler training program, and pesticide handlers are required to document receiving training in the application of pesticides in accordance with the previously summarized federal and state regulations.

3.6.3 Impacts and Mitigation Measures

Significance Criteria

The criteria used to determine the significance of impacts related to hydrology and water quality are based on Appendix G of the CEQA Guidelines. The Proposed Project would have a significant impact if it would:

- Violate any water quality standards or waste discharge requirements or otherwise substantially degrade surface or groundwater quality.
- Substantially decrease groundwater supplies or interfere substantially with groundwater recharge such that the Project may impede sustainable groundwater management of the basin.
- Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river or through the addition of impervious surfaces, in a manner that would:
  - Result in substantial erosion or siltation on or off site.
  - Substantially increase the rate or amount of surface runoff in a manner that would result in flooding on or off site.
  - Create or contribute runoff water that would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff.
  - Impede or redirect flood flows.
- In flood hazard, tsunami, or seiche zones, risk a release of pollutants due to Project inundation.
- Conflict with or obstruct the implementation of a water quality control plan or sustainable groundwater management plan.

Approach to Analysis

General

This environmental analysis of the potential impacts related to hydrology and water quality is based on a review of the results of the site-specific geotechnical investigation (Appendix E), habitat assessment (Appendix D), and the sea level rise study (Appendix E); a review of published literature; and the City of San Rafael General Plan 2040.

The Proposed Project would be regulated by the various laws, regulations, and policies summarized above in Section 3.6.2. Compliance by the Project with applicable federal, state, and local laws and regulations is assumed in this analysis, and local and state agencies would be expected to continue to enforce applicable requirements to the extent that they do so now. Note that compliance with many of the regulations is a condition of permit approval.

After considering the implementation of the Project described in Chapter 2, *Project Description*, and compliance with the required regulatory requirements, the environmental analysis below identifies if the defined significance thresholds are exceeded and, therefore, a significant impact would occur. For those impacts considered to be significant, mitigation measures are proposed to the extent feasible to reduce the identified impacts.

The structural elements of the Project would undergo appropriate design-level geotechnical evaluations prior to final design and construction. Implementing the regulatory requirements of USACE and City of San Rafael codes and regulations, and ensuring that the Project would be constructed in compliance with the law is the responsibility of the Project engineers and building officials. The geotechnical engineer,[2] as a registered professional with the State of California, is required to comply with federal, state, and local regulations while applying standard engineering practice and the appropriate standard of care for the particular region in California, which, in the case of the Project, is the City of San Rafael. The California Professional Engineers Act (Building and Professions Code Sections 6700-6799), and the Codes of Professional Conduct, as administered by the California Board of Professional Engineers and Land Surveyors, provides the basis for regulating and enforcing engineering practice in California. The local building officials are typically with the local jurisdiction (i.e., City of San Rafael) and are responsible for inspections and ensuring regulatory compliance prior to approval of permits.

A significant impact would occur if, after considering the features described in the Project Description and the required compliance with regulatory requirements, a significant impact would still occur. For those impacts considered to be significant, mitigation measures are proposed to reduce the identified impacts.

[2] A geotechnical engineer (GE) specializes in structural behavior of soil and rocks. GEs conduct soil investigations, determine soil and rock characteristics, provide input to structural engineers, and provide recommendations to address problematic soils.

USACE Levee Construction Guidance

The design and restoration of the levees would be conducted using guidance from the following USACE documents that cover levees:

- **Engineer Manual 1110-2-1913, Design and Construction of Levees** – This Engineer Manual provides USACE basic guidance principles for designing and constructing levees. The geotechnical investigation used guidance from this Engineers Manual in developing the design (Hultgren-Tillis 2021).
- **Engineer Circular 1165-2-212, Sea-Level Change Considerations for Civil Works Programs** – This Engineer Circular provides USACE guidance for incorporating the direct and indirect physical effects of projected future sea level change across the Project life cycle in managing, planning, engineering, designing, constructing, operating, and maintaining USACE projects and systems of projects. The preparation of the Sea Level Rise Adaptation Technical Guidance Study addresses this guidance (ESA 2020a).

As discussed above in Section 3.6.1, *Environmental Setting*, to inform the Project design, a preliminary geotechnical investigation was conducted to investigate site conditions and identify potential geotechnical issues (Hultgren-Tillis 2021, provided in Appendix E). To address potential geotechnical issues, which include issues related to hydrology and water quality, the geotechnical investigation provided the preliminary geotechnical recommendations listed below. Further details are provided in the preliminary geotechnical investigation and would be further developed in the final geotechnical investigation.

- **Levee Design**: The crests of the levees would be designed and maintained at a minimum elevation of +13 feet NAVD88, with a width of at least 12 feet at the crest and side slopes of 3H:1V or flatter. The initial crest elevation should be +14 feet NAVD88 to account for settlement. The existing sand fill beneath the footprint of the levee embankment along the new setback and offset levees should be overexcavated and removed. The new setback ecotone levee should also include a keyway. The levee keyway should be centered on the levee centerline and should be 3 feet deep and 12 feet wide at the base. The existing sand fill and keyway should be replaced with low-permeable material meeting the requirements below for fill. The slopes should extend up the ground surface at 2H:1V. The levee footprint should be cleared and grubbed to remove vegetation.
- **Fill Materials**: The levee would be constructed using low permeability, fine-grained soils. The USACE has fill specifications for levees that require the use of fill that is typically lean clays or plastic clayey sand. Typically, fill materials require at least 20 percent fines (passing the No. 200 sieve), a plasticity index of 8 or more, and a liquid limit of no more than 50.
- **Tidal Marsh and Beach Protection**: The expanded tidal marsh and its shoreline would be protected by through placement of dredge materials to raise site grades, a coarse beach along the eastern marsh edge, and a flexible jetty structure along San Rafael Creek to the north. The purpose of the coarse beach is to protect the expanded tidal marsh from erosion. The purpose of the jetty is to trap and accumulate sediment within the proposed expanded tidal marsh and to reduce erosion of the coarse beach. Both the coarse beach and jetty would stabilize the shoreline.
- **Erosion and Site Drainage**: Drainage off the levee would be by sheet flow. Ground surfaces should slope away from the levee crest and toe. Irregularities that may tend to concentrate

drainage should be corrected to re-establish sheet flow. Ponding of surface water should not be allowed on the levee crest or toe.

Sea Level Rise

To plan for the existing and future hazards from sea level rise, the San Rafael Department of Public Works initiated a sea level rise adaptation study in collaboration with the Department of Community Development, Marin County, and ESA (ESA 2020a). To plan for the estimated sea-level rise, the study developed a sea level rise adaptation plan with the following objectives:

- Assess existing flood risk and flood risk that includes future sea-level rise projections.
- Develop reasonable and feasible sea level rise adaptations appropriate to the City's shoreline.
- Evaluate adaptation measures to characterize the measures' costs and benefits.
- Integrate recommended measures into a phased adaptation plan to guide implementation.

To achieve these objectives, the study conducted flood hazard mapping and vulnerability assessments for the City shoreline, including the shoreline at the Project site, which is designated as Bayfront South, Spinnaker Point Focus Area BF-1.

Because specifics about future greenhouse gas emissions and climate response are not fully known, the exact sea level rise scenario that will occur is not precisely known at this time. However, considering a range of all but the most-extreme scenario, sea level rise by 2100 is projected to be between 2 and nearly 7 feet in San Francisco Bay by 2100. The BFE for the 1 percent annual chance flood event varies along the San Rafael shoreline from elevations 10 to 13 feet NAVD88. The BFEs are derived from the 1 percent-annual-chance total water level (TWL), which includes still water elevation level and wave runup. The 1 percent-annual-chance still water elevation level (SWL) along the San Rafael shoreline is a constant 9.7 feet NAVD88. The variability in BFEs is due to varying wave exposure and shoreline geometry. The BFE at the Project site is estimated at 10 feet NAVD88. The design elevation of the levee crest is 13 feet NAVD88, which includes an additional 3 feet of freeboard to account for uncertainties and to provide some sea level rise resilience. (The previously summarized geotechnical investigation recommended that the levee initially be constructed to elevation 14 feet NAVD88 to allow for settlement.)

Topics Considered and Determined to Have No Impact

The following topics are considered to have no impact based on the characteristics of the Proposed Project, its geographical location, and underlying site conditions. Therefore, these topics are not addressed further in this EIR for the following reasons:

- ***Groundwater Supplies or Recharge:*** The Project does not include the extraction of groundwater or the construction of impervious surfaces. Therefore, relative to groundwater supplies and recharge, the Project would have no impact.

Impact Summary

Table 3.6-1 provides a summary of Project impacts related to hydrology and water quality.

TABLE 3.6-1
SUMMARY OF HYDROLOGY AND WATER QUALITY IMPACTS

Impact Statement	Construction	Operation
Impact 3.6-1: The Project could violate water quality standards or waste discharge requirements or otherwise substantially degrade water quality.	LTS	LTS
Impact 3.6-2: The Project could substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river or through the addition of impervious surfaces, in a manner that would result in substantial erosion or siltation on or off site; substantially increase the rate or amount of surface runoff in a manner that would result in flooding on or off site; create or contribute runoff water that would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff; or impede or redirect flood flows.	LTS	LTS
Impact 3.6-3: The Project could risk the release of pollutants in flood hazard, tsunami, or seiche zones.	LTS	LTS
Impact 3.6-4: The Project could conflict with or obstruct the implementation of a water quality control plan or sustainable groundwater management plan.	LTS	LTS
Impact 3.6-5: The Project, combined with cumulative development in the Project vicinity, would not result in significant cumulative impacts relative to hydrology or water quality.	LTS	LTS

NOTES:
LTS = Less than significant

Impact Analysis

Impact 3.6-1: The Project could violate water quality standards or waste discharge requirements or otherwise substantially degrade water quality. ***(Less than Significant)***

Construction

Construction of the Proposed Project would include earthmoving activities such as excavation; trenching; grading; importation of fill; and construction of levees, a jetty, and a coarse beach. Construction activities have the potential to adversely affect water quality through the release of pollutants associated with construction equipment (e.g., fuel, motor oil) or sediments released due to excavation and fill placement.

Because the overall footprint of construction activities would exceed 1 acre, the Proposed Project would be required to comply with the NPDES General Permit for Discharges of Storm Water Runoff Associated with Construction and Land Disturbance Activities (*Order 2009-0009-DWQ, NPDES No. CAS000002; as amended by Orders 2010-0014-DWQ and 2012-006-DWQ*) (Construction General Permit) and the local stormwater ordinances, as described above in Section 3.6.2. These state and local requirements were developed to ensure that stormwater runoff is controlled on construction sites. The Construction General Permit requires preparation and implementation of a SWPPP, which requires the application of BMPs to control runon and runoff from construction work sites. The BMPs would include, but would not be limited to, physical barriers to prevent erosion and sedimentation (e.g., straw wattles, silt fences, sediment curtains, settling basins), limitations on work periods during storm events, protection of stockpiled materials, and a variety of other measures that would substantially reduce or prevent erosion from occurring during construction. In addition, the SWPPP would list the hazardous materials (including petroleum products) proposed for use during construction; describe spill prevention measures, equipment inspections, equipment and fuel storage; describe protocols for responding immediately to spills; and describe BMPs for controlling site runon and runoff of these materials and on-site exposed soil. With compliance with existing regulations, impacts associated with water quality during construction would be **less than significant**.

Operation

Once constructed, the restored wetland habitat would be largely self-maintaining after the vegetation has been re-established. As described in Section 2.4, *Operations and Maintenance*, maintenance for the tidal marsh, ecotone slope, and coarse beach during the 3- to 5-year establishment period would include the removal of invasive plants using mechanical means, and the temporary irrigation of ecotone slope plantings. While unlikely, use of localized herbicides would be employed, if highly invasive species become present at the site. As summarized in Section 3.6.2, the CDPR regulates the use of herbicides. In addition, the new and improved flood protection levees and trails would require periodic inspection to identify maintenance and adaptive management needs. At a minimum, levees would be inspected annually to identify any localized settlement, rodent holes, or other conditions that could compromise the levee integrity. To ensure that the Project performs as anticipated, performance monitoring activities would include the following:

- Manual removal of any obstructions that may be blocking tidal channels (e.g., sediment and/or debris), if needed.
- Periodic grading, fill placement, and trail resurfacing due to additional settlement/subsidence that occurs after the initial construction period (anticipated to occur once, or possibly twice, in the first 10 years after construction).
- Grading and filling of any settlement cracks that occur along the new levee, particularly at the connection to the existing trail.
- Minor repair and/or bank protection of any erosion scarps that may threaten the levee.
- Additional manual vegetation management beyond the initial establishment period, including weed control and replanting to be done by hand, and/or extended temporary watering, as needed.

Performance monitoring would be conducted as needed for permit compliance and other objectives, including establishing baseline conditions and monitoring Project performance. Physical and biological monitoring would be conducted at the completion of Project construction and at 1, 3, 5, and 10 years post-construction. Monitoring would include levee crest surveys to identify any areas of excessive settlement that need to be addressed. With compliance with existing regulations and implementation of the adaptive management activities, impacts associated with water quality would be **less than significant**.

Mitigation: None required.

Impact 3.6-2: The Project could substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river or through the addition of impervious surfaces, in a manner that would result in substantial erosion or siltation on or off site; substantially increase the rate or amount of surface runoff in a manner that would result in flooding on or off site; create or contribute runoff water that would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff; or impede or redirect flood flows. ***(Less than Significant)***

Construction

The construction of the Project could substantially alter the drainage pattern of the site if not properly constructed, resulting in erosion, siltation, flooding, or exceeding stormwater drainage system, or create an additional source of pollution (including fuel, motor oil, and sediments). In particular, much of the work would be conducted in the marsh or Bay, and the ground disturbance would have the potential to result in substantial erosion or siltation, result in flooding on or off site, provide additional sources of polluted runoff, or impede or redirect flood flows.

Construction of the Proposed Project would include earthmoving activities such as excavation, trenching, grading, and importation of fill. As discussed in above in Impact 3.6-1, construction contractors would be required to obtain coverage under the NPDES Construction General Permit, with specific requirements prior to the issuance of a construction permit for the Project. The Construction General Permit requires the preparation and implementation a SWPPP for construction activities. BMPs described in the SWPPP would control the volume and velocity of runoff, if any. In particular, the Project would include the installation of a sediment curtain outboard of the in-water construction areas to prevent sediment from being discharged to the Bay (see Chapter 2, *Project Description,* under the heading "Coarse Beach Construction"). In addition, construction would be phased so that the coarse beach is installed first to contain the dredged material and provide sediment control during placement. This would reduce the risk of erosion during construction and prevent erosion, siltation, flooding, and pollution. The required compliance with the Construction General Permit would reduce the potential impacts from construction relative to altering the existing drainage pattern to a **less-than-significant** level.

Operational

Upon completion of Project construction, the drainage pattern of the Project site would be substantially changed. If not properly designed and maintained, the Project could result in erosion, siltation, flooding, and exceedance of the stormwater drainage system capacities, or create an additional source of pollution (including sediment).

As discussed in Section 2.1.3, *Goals and Objectives*, the goal of the Proposed Project is to enhance the ecological function of the Tiscornia Marsh and increase flood protection for the Canal neighborhood. The Project would be designed to achieve this goal. To ensure that the

Project achieves this goal and as summarized above in Impact 3.6-1, performance monitoring would be conducted for permit compliance and performance objectives, including the establishment of baseline conditions and monitoring Project performance. Physical monitoring would be conducted at the completion of Project construction and at 1, 3, 5, and 10 years post-construction. Monitoring would include levee crest surveys to identify any areas of excessive settlement or erosion that need to be addressed. Repairs would be implemented, as needed. With compliance with existing regulations and implementation of the performance monitoring activities, impacts associated with altering the existing drainage pattern would be **less than significant**.

Mitigation: None required.

Impact 3.6-3: The Project could risk the release of pollutants in flood hazard, tsunami, or seiche zones. ***(Less than Significant)***

Construction

As discussed in Section 3.6.1, the Project site is located entirely within the 100-year flood zone, partially within the tsunami hazard zone, and partially within a seiche zone due to its proximity to San Rafael Creek. Pollutants associated with the Project during construction (e.g., fuel, motor oil, sediment) could be released in the event of a flood, tsunami, or seiche.

As discussed in Section 2.1.3, *Goals and Objectives*, the goal of the Proposed Project is to enhance the ecological function of the Tiscornia Marsh and increase flood protection for the Canal neighborhood; the Project would be designed to achieve this goal. As described above in Impact 3.6-1 and Section 2.3, *Project Construction*, the required preparation and implementation of the SWPPP would include BMPs to contain chemicals (e.g., fuel, motor oil) from being released during construction. Erosion control structures (e.g., straw wattles, silt fences) would be installed around staging areas to prevent runon and runoff. Sediment curtains would be installed along the perimeter of the exposed mudflat during low tide to prevent sediment from entering the Bay. All of these measures would be in place during the unlikely event of a flood, tsunami, or seiche. With compliance with existing regulations and implementation of BMPs, impacts relative to flooding, tsunamis, and seiches during construction would be **less than significant**.

Operation

As discussed in Section 3.6.1, the Project site is located entirely within the 100-year flood zone, partially within the tsunami hazard zone, and partially within a seiche zone due to its proximity to San Rafael Creek. Pollutants associated with the Project during operation (e.g., sediment) could be released in the event of a flood, tsunami, or seiche.

As discussed in Section 2.1.3, *Goals and Objectives*, the goal of the Proposed Project is to enhance the ecological function of the Tiscornia Marsh and increase flood protection for the Canal neighborhood; the Project would be designed to achieve this goal. Once constructed, the levees would be restored to heights above the BFE, which would reduce the potential for flooding. The restored wetland habitat, jetty, and coarse beach constructed outboard of the levees would provide additional protection from flooding, tsunamis, and seiches by absorbing much of the energy of such events. The Project site would be designed to be largely self-maintaining after the vegetation has been re-established. As described in Section 2.4, *Operations and Maintenance*, maintenance for the tidal marsh, ecotone slope, and coarse beach during the 3- to 5-year establishment period would include the removal of invasive plants using mechanical means, and the temporary irrigation of ecotone slope plantings. While unlikely, use of localized herbicides would be employed, if highly invasive species become present at the site. In addition, the new and improved flood protection levees and trails would require periodic inspection to identify maintenance and adaptive management needs. At a minimum, levees would be inspected annually to identify any localized settlement, rodent holes, or other conditions that could compromise the levee integrity.

Performance monitoring would be performed as needed for permit compliance and other objectives, including establishing of baseline conditions and monitoring Project performance. Physical and biological monitoring is anticipated to be conducted at the completion of Project construction and at 1, 3, 5, and 10 years post-construction. Monitoring would include levee crest surveys to identify any areas of excessive settlement that need to be addressed. With compliance with existing regulations and implementation of the performance monitoring activities, impacts associated with flooding, tsunamis, and seiches would be **less than significant**.

Mitigation: None required.

Impact 3.6-4: The Project could conflict with or obstruct the implementation of a water quality control plan or sustainable groundwater management plan. (*Less than Significant*)

The Proposed Project is not located within a medium or high priority groundwater basin and is therefore not subject to a sustainable groundwater management plan (DWR 2021).

Construction

As discussed in Impact 3.6-1 and Section 2.3, *Project Construction*, the Proposed Project would comply with the requirements stipulated in the Construction General Permit. The required preparation and implementation of the SWPPP would include BMPs to prevent pollutants (e.g., fuel, motor oil, sediment) from being released during construction. Erosion control structures (e.g., straw wattles, silt fences) would be installed around staging areas to prevent runon and runoff. Sediment curtains would be installed along the perimeter of the exposed mudflat during low tide to prevent sediment from entering the Bay during construction. These measures would reduce the potential for construction activities to adversely affect water quality, which would make the Project consistent with the Basin Plan. With compliance with existing regulations and implementation of BMPs, impacts relative to the Basin Plan during construction would be **less than significant**.

Operation

Once constructed, the restored wetland habitat would be largely self-maintaining after the vegetation has been re-established. As described in Section 2.4, *Operations and Maintenance*, maintenance for the tidal marsh, ecotone slope, and coarse beach during the 3- to 5-year establishment period would include the removal of invasive plants using localized herbicides or mechanical means, and the temporary irrigation of ecotone slope plantings. In addition, the new and improved flood protection levees and trails would require periodic inspection to identify maintenance and adaptive management needs. At a minimum, levees would be inspected annually to identify any localized settlement, rodent holes, or other conditions that could compromise the levee integrity.

The performance monitoring activities would be performed as needed for permit compliance and other objectives, including establishing baseline conditions and monitoring Project performance. Physical and biological monitoring is anticipated to be conducted at the completion of Project construction and at 1, 3, 5, and 10 years post-construction. Monitoring would include levee crest surveys to identify any areas of excessive settlement that need to be addressed. As proposed, the Project would function as designed, which would include preventing sediments from being released into the Bay. The Project would be consistent with the Basin Plan during operations, and impacts would be **less than significant**.

Mitigation: None required.

Cumulative Impacts

This section presents an analysis of the cumulative effects of the Project in combination with other past, present, and reasonably foreseeable future projects that could cause cumulatively considerable impacts. Significant cumulative impacts related to hydrology and water quality could occur if the incremental impacts of the Project combined with the incremental impacts of one or more of the cumulative projects identified in Table 3.1-1.

As previously discussed, the Project would have no impact with respect to groundwater supplies or recharge, or conflicting with a sustainable groundwater management plan. Accordingly, the Project could not contribute to cumulative impacts related to these topics, which are not discussed further.

The geographic scope for cumulative impacts on hydrology and water quality is the immediate Project vicinity and boundaries of San Rafael Bay. The timeframe during which Project could contribute to cumulative hydrology and water quality impacts includes the construction and operation phases. For the Project, the operations phase is permanent.

Impact 3.6-5: The Project, combined with cumulative development in the Project vicinity, would not result in significant cumulative impacts relative to hydrology or water quality. *(Less than Significant)*

If the Proposed Project and one or more cumulative projects are constructed at the same time, runoff, erosion, and flooding effects could be cumulatively significant if stormwater runoff from the sites were not controlled. However, the state Construction General Permit would require each project that disturbs 1 or more acres to prepare and implement a SWPPP during construction. The SWPPPs would describe BMPs to control runoff and prevent erosion and flooding for each project. Through compliance with this requirement, runoff and erosion impacts on water quality would be controlled. The Construction General Permit was developed to address cumulative conditions arising from construction throughout the state, and is intended to maintain cumulative effects of projects subject to this requirement below levels that would be considered significant. For example, two adjacent construction sites would be required to implement BMPs to reduce and control the release of sediment and/or other pollutants in any runoff leaving their respective sites. The runoff water from both sites would be required to achieve the same action levels, measured as a maximum amount of sediment or pollutant allowed per unit volume of runoff water. Thus, even if the runoff waters were to combine after leaving the sites, the sediments and/or pollutants in the combined runoff would still be at concentrations (amount of sediment or pollutants per volume of runoff water) below action levels and would not be cumulatively considerable. No significant cumulative impact is identified.

Once constructed, the restored wetland habitat for the Proposed Project would be largely self-maintaining after the vegetation has been re-established. Performance monitoring would ensure that the levees are maintained to prevent erosion and adverse water quality impacts. The cumulative projects listed in Table 3.1-1 all drain into the City's stormwater system. Cumulative projects that do not have properly designed stormwater runoff treatment and controls could cause erosion, and drainage and flooding problems that could adversely affect water quality, including that of San Rafael Creek and ultimately San Rafael Bay, which the Proposed Project and the cumulative projects would all drain into. However, all cumulative projects with stormwater runoff that would drain into the City's stormwater system would be required to comply with the SWRCB Stormwater NPDES Permit for small municipal separate storm sewer systems (also known as MS4s), including Provision E.12, *Post-Construction Stormwater Management Program*. This provision mandates municipalities to require specified features and facilities to control pollutant sources; control runoff volumes, rates, and durations; and to treat runoff before discharge from the site. The provision also requires that these measures be included in development plans as conditions of issuing approvals and permits.

With funding from the North Bay Watershed Association (NBWA) and support from the NBWA Joint Technical Committee, the Bay Area Stormwater Management Agencies Association (BASMAA), through the BASMAA Phase II Committee, created the *BASMAA Post-Construction Manual, Design Guidance for Stormwater Treatment and Control for Projects in Marin, Sonoma, Napa, And Solano Counties: A Low Impact Development Approach to Implementing Provision E.12 of the Phase II Small MS4 General Permit* (BASMAA 2019). The Post-Construction Manual assists project applicants in implementing measures that demonstrate that their project complies with the NPDES permit requirements by providing guidance for applicant stormwater control plans and Low-Impact Development (LID) design. With compliance with MS4 requirements, the operation of the Proposed Project and cumulative projects would not have a cumulatively considerable contribution to the cumulative impact on water quality. **No significant cumulative impacts are identified.**

Mitigation: None required.

3.6.4 References

Association of Bay Area Governments (ABAG). 2021. *Tsunami Zone*.

Bay Area Stormwater Management Agencies Association (BASMAA). 2019. *BASMAA Post-Construction Manual, Design Guidance for Stormwater Treatment and Control for Projects in Marin, Sonoma, Napa, and Solano Counties: A Low Impact Development Approach to Implementing Provision E.12 of the Phase II Small MS4 General Permit*. January.

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CHAPTER 4
Other CEQA Issues

4.1 Growth-Inducing Impacts

Section 15126.2(e) of the California Environmental Quality Act (CEQA) Guidelines requires that an environmental impact report (EIR) discuss:

> [T]he ways in which the proposed project could foster economic or population growth, or the construction of additional housing, either directly or indirectly, in the surrounding environment. Included in this are projects which would remove obstacles to population growth (a major expansion of a wastewater treatment plant might, for example, allow for more construction in service areas)… It must not be assumed that growth in any area is necessarily beneficial, detrimental, or of little significance to the environment.

The Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation Project (Proposed Project or Project) would not directly induce growth because it does not involve the development of new housing or job centers that would attract an additional population. Project construction would not extend roads or include other infrastructure that could indirectly induce growth. Given the relatively small size of the construction workforce (approximately 19 construction workers), construction of the Proposed Project would not be expected to induce demand for housing by attracting workers from outside the area, as workers are expected to be drawn from the local labor pool. Long-term operations and maintenance activities associated with the Proposed Project would be similar to existing activities, and would not increase the number of workers employed by the City of San Rafael.

As described in Chapter 2, *Project Description*, the goal of the Proposed Project is to enhance the ecological function of the Tiscornia Marsh property and increase flood protection for the Canal neighborhood, while maintaining the community value of the Albert J. Boro Community Center and Pickleweed Park. The Proposed Project would use existing water supplies and would not create or expand a water supply source that could remove water supply limitations as a potential obstacle to growth.

Based on this analysis, the Proposed Project would not have a substantial growth-inducing impact, and no mitigation is required. For further analysis, see the Population and Housing section of Appendix B, *Topics Not Requiring Detailed Environmental Analysis*.

4.2 Significant Unavoidable Impacts

In accordance with CEQA Section 21100(b)(2)(A) and Sections 15126(b) and 15126.2(c) of the CEQA Guidelines, the purpose of this section is to identify environmental impacts of the Proposed Project that could not be eliminated or reduced to a less-than-significant level with implementation of the mitigation measures identified in Chapter 3, *Environmental Setting, Impacts, and Mitigation Measures*, or Appendix B, *Topics Not Requiring Detailed Environmental Analysis*. The findings in this chapter are subject to final determination by the City of San Rafael as part of its certification of the Final EIR. No significant unavoidable impacts have been identified in this EIR.

4.3 Significant Irreversible Environmental Changes

CEQA Section 21100(b)(2)(B) and CEQA Guidelines Section 15126.2(d) require that an EIR identify significant irreversible environmental changes caused by implementation of the project. Construction of the Proposed Project would indirectly result in the commitment of nonrenewable natural resources used in the construction process. These may include gravel, soils, petroleum products, construction-related chemicals and paints, steel, and other materials. The Proposed Project would also result in the commitment of slowly renewable materials, such as wood products. This would not, however, be considered a significant adverse irreversible environmental change, given the availability of these products and the Project's relatively small need for these products compared to their overall regional use.

4.4 Mitigation Measures Proposed to Minimize Significant Effects

CEQA Guidelines Section 15126.4 requires that an EIR describe feasible measures that could minimize significant adverse impacts. To this end, mitigation measures have been incorporated into the analysis provided in Chapter 3, *Environmental Setting, Impacts, and Mitigation Measures*, and are summarized in the Executive Summary chapter at the beginning of this EIR. See those sections for additional information.

4.5 References

No references are cited in this chapter.

CHAPTER 5
Alternatives

5.1 Introduction

This chapter presents the CEQA alternatives analysis for the Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation Project (Proposed Project). The CEQA Guidelines, Section 15126.6(a), state that an EIR must describe and evaluate a reasonable range of alternatives to the project that would feasibly attain most of the project's basic objectives and would avoid or substantially lessen any identified significant adverse environmental effects of the project. Specifically, the CEQA Guidelines (Section 15126.6) set forth the following criteria for selecting and evaluating alternatives:

- ***Identifying Alternatives.*** The selection of alternatives is limited to those that would avoid or substantially lessen any of the significant effects of the project, are feasible, and would attain most of the basic objectives of the project. Factors that may be considered when addressing the feasibility of an alternative include site suitability, availability of infrastructure, general plan consistency, other plans or regulatory limitations, jurisdictional boundaries, economic viability, and whether the proponent can reasonably acquire, control, or otherwise have access to an alternative site. An EIR need not consider an alternative whose impacts cannot be reasonably ascertained and whose implementation is remote and speculative. The specific alternative of "no project" must also be evaluated.

- ***Range of Alternatives.*** An EIR need not consider every conceivable alternative, but must consider and discuss a reasonable range of feasible alternatives in a manner that will foster informed decision-making and public participation. The "rule of reason" governs the selection and consideration of EIR alternatives, requiring that an EIR set forth only those alternatives necessary to permit a reasoned choice. The lead agency (the City for the Proposed Project) is responsible for selecting a range of project alternatives to be examined and for disclosing its rationale for choosing the alternatives.

- ***Evaluation of Alternatives.*** EIRs are required to include sufficient information about each alternative to allow a meaningful evaluation, analysis, and comparison with the proposed project. Matrices may be used to display the major characteristics and the environmental effects of each alternative. If an alternative would cause one or more significant effects that would not result from the project as proposed, the significant effects of the alternative must be discussed, but in less detail than the significant effects of the project.

Section 5.2 describes the alternatives selection process and the objectives of the Proposed Project; summarizes the significant impacts of the Proposed Project; describes the alternatives selected for detailed analysis; and compares the environmental impacts of each alternative to those of the Proposed Project. Section 5.3 provides a comparison of the alternatives, and identifies the environmentally superior alternative. Section 5.4 discusses the preliminary alternatives that were considered but rejected from further consideration.

5.2 Proposed Project Alternatives Analysis

This section describes the process of developing a reasonable range of Proposed Project alternatives for analysis in this EIR. Consistent with CEQA, the approach to alternatives selection for this EIR focused on identifying alternatives that: (1) could meet most of the basic objectives of the Project while reducing one or more of its significant impacts, (2) could foster informed decision-making and public participation, and (3) could be feasibly implemented.

The alternatives selection process considered multiple alternatives by the City. Certain alternatives were eliminated from consideration based on their inability to meet most of the basic objectives of the Proposed Project, their infeasibility, or their inability to reduce the Project's environmental impacts. CEQA Guidelines (Section 15364) define "feasible" as "*capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, legal, social, and technological factors*." Section 15126.6(f)(1) states that "*the factors that may be taken into account when addressing the potential feasibility of alternatives include site suitability, economic viability, availability of infrastructure, general plan consistency, other plans or regulatory limitations, jurisdictional boundaries (projects with a regionally significant impact should consider the regional context), and whether the proponent can reasonably acquire, control, or otherwise have access to the alternative site (or the site is already owned by the proponent)*."

5.2.1 Project Objectives

As discussed in Chapter 2, *Project Description*, Section 2.1.3, *Goals and Objectives*, the goal of the Project is to enhance the ecological function of the Tiscornia Marsh property and increase flood protection for the Canal neighborhood, while maintaining the community value of the Albert J. Boro Community Center and Pickleweed Park. This goal would be accomplished through the following objectives:

- Restore tidal marsh on the Project site to improve ecological function and habitat quantity, quality, and connectivity (including upland transition zones) for native marsh species and marsh-upland transition species, including special status species.
- Protect Project site marshlands from future marsh edge erosion.
- Increase the level of flood protection for the Canal neighborhood and other nearby communities of central San Rafael.
- Create sustainable benefits that consider future environmental changes such as sea-level rise and sedimentation.
- Maintain and improve public access to passive recreational and outdoor education opportunities (e.g., hiking, jogging, bird watching).

The Proposed Project includes restoring Tiscornia Marsh to its 1950s-era extent, constructing a coarse beach along the bayside edge of the restored marsh, and restoring tidal action to the City-owned diked marsh at the north end of Pickleweed Park. The Proposed Project would also construct a new approximately 600-foot levee on the south side of the existing diked marsh and improve approximately 1,100 feet of shoreline levee to achieve greater flood protection, public access, and habitat benefits. Absent the Proposed Project, it is anticipated that Tiscornia Marsh would continue to erode and the low-lying Canal neighborhood adjacent to Tiscornia Marsh would be further at risk to coastal flooding.

5.2.2 Significant Environmental Impacts

This section summarizes the significant impacts of the Proposed Project, as analyzed in Chapter 3, *Environmental Setting, Impacts, and Mitigation Measures*, and Appendix B, *Topics Not Requiring Detailed Environmental Analysis*, and that were considered during the alternatives identification process. The significant impacts of the Project are limited to effects occurring during construction of the Project; no long-term significant impacts would occur.

Short-Term Impacts

All short-term construction impacts could be mitigated to a less-than-significant level with the implementation of mitigation measures identified in Chapter 3, *Environmental Setting, Impacts, and Mitigation Measure*s, and Appendix B*, Topics Not Requiring Detailed Environmental Analysis*. Project construction would result in the following significant short-term impacts:

- ***Air Quality.*** Project-related construction activities would result in a cumulatively considerable net increase of a criteria pollutant for which the San Francisco Bay Area Air Basin is in non-attainment under applicable federal and state ambient air quality standards. If these impacts are not mitigated, the Proposed Project would exceed the applicable Bay Area Air Quality Management District (BAAQMD) threshold for nitrogen oxides (NO_x). Additionally, the Proposed Project would expose sensitive receptors to substantial pollutant concentration during construction. (Impacts 3.3-2, and 3.3-3; Less than Significant with Mitigation).

- ***Biological Resources.*** Project construction activities could be disruptive to special-status birds (such as California black rail, Ridgway's rail, northern harrier, salt marsh common yellowthroat, San Pablo song sparrow) and nesting birds protected by the Migratory Bird Treaty Act, as well as salt marsh harvest mouse and salt mouse wandering shrew. Proposed Project construction could also impact the following special-status plan species: Marin knotweed, Suisun marsh aster, congested-headed hayfield tarplant, and Point Reyes bird's-beak. Additionally, in-water construction could have an adverse effect on protected fish or marine mammals. Further, construction effects could conflict with local tree ordinance policies. (Impacts 3.4-1, 3.4-2, 3.4-3, 3.4-4, 3.4-6, 3.4-7; Less than Significant with Mitigation).

- ***Cultural Resources.*** While no known or recorded cultural resources are present in or near the Project site, Project construction could disturb previously unknown archaeological resources or human remains, if present. (Cultural Resources Impacts b and c; Less than Significant with Mitigation).

- ***Transportation.*** Project construction activities could generate pedestrian and bicycle activity in the vicinity of the Project site; the introduction of trucks turning into/out of the construction staging area may result in unsafe conditions for pedestrians using the sidewalk and bicyclists traveling in the roadway. Therefore, construction of the Proposed Project could conflict with adopted policies, plans, or programs related to bicycle and pedestrian facilities, or affect the safety of such services/facilities. (Transportation Impact c; Less than Significant with Mitigation).

- ***Tribal Cultural Resources.*** While the City did not identify any tribal cultural resources listed or eligible for listing in the California Register, nor did they determine any resources to be significant pursuant to criteria set forth in Subdivision (c) of Public Resources Code (PRC) Section 5024.1, should any cultural materials be identified during Project implementation that are determined to be tribal cultural resources, they could be affected by construction activities. (Tribal Cultural Resources Impacts a.i and a.ii; Less than Significant with Mitigation).

Construction of the Project would contribute to cumulative impacts for most of the impact topics listed above. All cumulative impacts would be reduced to a less-than cumulatively considerable level by mitigation measures identified in this EIR.

5.2.3 Approach to Alternatives Selection

The alternatives selection process for the Proposed Project was guided in part by the magnitude and severity of the impacts identified above. Therefore, this analysis focuses on alternatives that could be implemented (i.e., are feasible), meet most of the Proposed Project objectives, and lessen or avoid short-term, construction-phase impacts.

5.2.4 Selected CEQA Alternatives

This section describes the Proposed Project alternatives that were selected and analyzed in accordance with CEQA Guidelines Section 15126.6(a). The three alternatives to the Proposed Project selected for detailed analysis in this EIR are:

- **Alternative 1:** No Project Alternative
- **Alternative 2:** Reduced Project – Reduce Tiscornia Marsh Restoration
- **Alternative 3:** Reduced Project – Eliminate Diked Marsh Restoration

Table 5-1 provides a brief description of these alternatives and highlights how they differ from the Proposed Project. This section also evaluates the impacts of the alternatives relative to those of the Proposed Project. The evaluation is based on the available information and reasonable assumptions about how each alternative would be implemented. For each alternative, this section presents the following:

- A description of the alternative, including the rationale for its selection for analysis, and associated improvements and auxiliary components.
- An evaluation of the alternative's ability to meet Project goals and objectives.
- Analysis of the environmental impacts of each alternative compared to those of the Proposed Project.

TABLE 5-1
CEQA ALTERNATIVES

Alternative	How Does the Alternative Differ from the Project?
Alternative 1: No Project.	• Tiscornia Marsh would not be restored to its 1950s-era extent, and a coarse beach would not be constructed along the bayside edge of the restored marsh. • Tidal action would not be restored within the diked marsh at the north end of Pickleweed Park. • The existing level would not be improved. • The marsh and surrounding area would continue to operate as they currently do. • The No Project Alternative would not meet Project objectives, other than maintenance of existing public access.
Alternative 2: Reduced Project – Reduce Tiscornia Marsh Restoration	• Restore diked and outer marsh, front the new marsh with a beach, but with less fill / created marsh on the south side of the marsh. • Would meet the objectives related to enhanced flood protection of the adjacent areas, and maintaining and improving public access. • Would not meet the objectives related to restoration of tidal marsh and long-term benefits associated with sea level rise to the same extent as the Project.
Alternative 3: Reduced Project – Eliminate Diked Marsh Restoration	• Restore eastern marsh but not diked marsh. • Would meet the objective related to maintaining and improving public access. • Would not meet the objectives related to restoration of tidal marsh, enhanced flood protection of the adjacent areas, and long-term benefits associated with sea level rise to the same extent as the Project.

Table 5-2 summarizes the environmental impacts of the alternatives compared to those of the Proposed Project. Neither of the action alternatives (i.e., Alternatives 2 and 3) would avoid any of the Proposed Project's significant impacts or cumulatively considerable impacts.

TABLE 5-2
COMPARISON OF THE ENVIRONMENTAL IMPACTS OF THE CEQA ALTERNATIVES

Impact	Proposed Project	Alternative 1: No Project	Alternative 2: Reduced Project – Reduce Tiscornia Marsh Restoration	Alternative 3: Eliminate Diked Marsh Restoration
Impact 3.3-2: The Project could result in a cumulatively considerable net increase of a criteria air pollutant for which the SFBAAB is in nonattainment under applicable federal and state ambient air quality standards.	Project-related construction activities would result in a cumulatively considerable net increase of NO_x, resulting in an exceedance of the applicable BAAQMD threshold. (Less than Significant with Mitigation)	**No Impact** There would be no earth-moving activities or other construction activities that would result in a cumulatively considerable net increase of NO_x, resulting in an exceedance of the applicable BAAQMD threshold.	**Reduced** Overall construction activities would be less than the Project, but would likely still result in a cumulatively considerable net increase of NO_x, resulting in an exceedance of the applicable BAAQMD threshold. (Less than Significant with Mitigation)	**Reduced** Overall construction activities would be less than the Project, but would likely still result in a cumulatively considerable net increase of NO_x, resulting in an exceedance of the applicable BAAQMD threshold. (Less than Significant with Mitigation)
Impact 3.3-3: The Project could expose sensitive receptors to substantial pollutant concentrations.	The Proposed Project would expose sensitive receptors to substantial pollutant concentration during construction, resulting in an incremental cancer risk of 12.9 in 1 million, which is above the BAAQMD threshold of 10 in 1 million. (Less than Significant with Mitigation)	**No Impact** There would be no earth-moving activities or other construction activities that would expose sensitive receptors to substantial pollutant concentrations above the BAAQMD threshold of 10 in 1 million.	**Reduced** Overall construction activities would be less than the Project, but would likely still expose sensitive receptors to substantial pollutant concentrations during construction, resulting in an incremental cancer risk above the BAAQMD threshold of 10 in 1 million. (Less than Significant with Mitigation)	**Reduced** Overall construction activities would be less than the Project, but would likely still expose sensitive receptors to substantial pollutant concentrations during construction, resulting in an incremental cancer risk above the BAAQMD threshold of 10 in 1 million. (Less than Significant with Mitigation)
Impact 3.4-1: Construction or operation of the Project could have a substantial effect on special-status birds, common nesting migratory birds, or raptors in the study area. (Less than Significant with Mitigation)	Project construction activities could be disruptive to special-status birds (such as California black rail, Ridgway's rail, northern harrier, salt marsh common yellowthroat, San Pablo song sparrow) and nesting birds protected by the Migratory Bird Treaty Act. (Less than Significant with Mitigation)	**No Impact** There would be no earth-moving activities or other construction activities that would be disruptive to special-status birds, nesting migratory birds, and raptors.	**Decreased** Overall construction activities would be less than the Project, but would likely still be disruptive to special-status birds and nesting birds protected by the Migratory Bird Treaty Act. (Less than Significant with Mitigation)	**Decreased** Overall construction activities would be less than the Project, but would likely still be disruptive to special-status birds and nesting birds protected by the Migratory Bird Treaty Act. (Less than Significant with Mitigation)

TABLE 5-2 (CONT.)
COMPARISON OF THE ENVIRONMENTAL IMPACTS OF THE CEQA ALTERNATIVES

Impact	Proposed Project	Alternative 1: No Project	Alternative 2: Reduced Project – Reduce Tiscornia Marsh Restoration	Alternative 3: Eliminate Diked Marsh Restoration
Impact 3.4-2: The Project could have substantial adverse effects on salt marsh harvest mouse and salt marsh wandering shrew.	Project construction could result in impacts on salt marsh harvest mouse and salt mouse wandering shew. (Less than Significant with Mitigation)	**No Impact** There would be no earth-moving activities, removal of trees, or other construction activities that would be disruptive to salt marsh harvest mouse and salt mouse wandering shew.	**Decreased** Overall construction activities would be less than the Project, but would likely still be disruptive to salt marsh harvest mouse and salt mouse wandering shew. (Less than Significant with Mitigation)	**Decreased** Overall construction activities would be less than the Project, but would likely still be disruptive to salt marsh harvest mouse and salt mouse wandering shew. (Less than Significant with Mitigation)
Impact 3.4-3: Construction or operation of the Project could have a substantial effect on special-status plants.	Project construction could result in impacts on special-status plant species. (Less than Significant with Mitigation)	**No Impact** There would be no earth-moving activities or other construction activities that would result in a substantial effect on special-status plant species.	**Decreased** Overall construction activities would be less than the Project, but would likely still be disruptive to special-status plant species. (Less than Significant with Mitigation)	**Decreased** Overall construction activities would be less than the Project, but would likely still be disruptive to special-status plant species. (Less than Significant with Mitigation)
Impact 3.4-4: The Proposed Project could have a substantial adverse effect, either directly or through habitat modification, on marine species identified as a candidate, sensitive, or special-status species in local or regional plans, policies or regulations, or by the CDFW, USFWS, or NOAA.	Project construction activities and in-channel maintenance activities could have adverse impacts on protected fish or marine mammal species. (Less than Significant with Mitigation)	**No Impact** There would be no earth-moving activities or other construction activities that would result in a substantial effect on protected fish or marine mammal species.	**Decreased** Overall construction activities would be less than the Project, but would likely still be disruptive to protected fish or marine mammal species. (Less than Significant with Mitigation)	**Same** Overall construction activities would be less than the Project, the same amount of in-water work would occur as the Project. Alternative 3 would be similarly disruptive to protected fish or marine mammal species as the Project. (Less than Significant with Mitigation)
Impact 3.4-6: The Project could interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites.	While the occurrence of special-status marine species and an impact on marine movement corridors is unlikely, mitigation would be implemented to ensure that construction-related impacts on marine movement corridors and established native wildlife nursery sites would be reduced. (Less than Significant with Mitigation)	**No Impact** There would be no earth-moving activities or other construction activities that would substantially affect marine movement corridors.	**Decreased** Overall construction activities would be less than the Project, but would likely still be disruptive to marine movement corridors. (Less than Significant with Mitigation)	**Decreased** Overall construction activities would be less than the Project, but would likely still be disruptive to marine movement corridors. (Less than Significant with Mitigation)

TABLE 5-2 (CONT.)
COMPARISON OF THE ENVIRONMENTAL IMPACTS OF THE CEQA ALTERNATIVES

Impact	Proposed Project	Alternative 1: No Project	Alternative 2: Reduced Project – Reduce Tiscornia Marsh Restoration	Alternative 3: Eliminate Diked Marsh Restoration
Impact 3.4-7: The Project could conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance and could conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan.	Project construction could require tree removal or tree pruning activities, which could conflict with the City of San Rafael tree ordinance. (Less than Significant with Mitigation)	**No Impact** There would be no construction-related disruption of trees and thus no conflict with local policies related to tree removal or disturbance.	**Decreased** Overall construction activities would be less than the Project, but would likely still require tree removal and pruning, which could conflict with the City of San Rafael tree ordinance. (Less than Significant with Mitigation)	**Decreased** Overall construction activities would be less than the Project, but would likely still require tree removal and pruning, which could conflict with the City of San Rafael tree ordinance. (Less than Significant with Mitigation)
Cultural Resources Impact b: The Project could cause a substantial adverse change in the significance of an archaeological resource as defined in Section 15064.5?	While no known or recorded cultural resources are present in or near the Project site, Project construction could disturb previously unknown archaeological resources or human remains, if present. (Less than Significant with Mitigation)	**No Impact** There would be no earth-moving activities or other construction activities that would result in a substantial effect on archaeological resources or human remains, if present.	**Decreased** Overall construction activities would be less than the Project, but could disturb previously unknown archaeological resources or human remains, if present. (Less than Significant with Mitigation)	**Decreased** Overall construction activities would be less than the Project, but could disturb previously unknown archaeological resources or human remains, if present. (Less than Significant with Mitigation)
Cultural Resources Impact c: The Project could disturb human remains, including those interred outside of formal cemeteries.	Same as above.	Same as above.	Same as above.	Same as above.
Transportation Impact c: The Project could substantially increase hazards due to a geometric design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment).	Project construction activities could generate pedestrian and bicycle activity in the vicinity of the Project site; the introduction of trucks turning into/out of the construction staging area may result in unsafe conditions for pedestrians using the sidewalk and bicyclists traveling in the roadway. Therefore, construction of the Proposed Project could conflict with adopted policies, plans, or programs related to bicycle and pedestrian facilities, or affect the safety of such services/facilities. (Less than Significant with Mitigation)	**No Impact** There would be no earth-moving activities or other construction activities that would result in unsafe conditions for pedestrians using the sidewalk or bicyclists traveling in the roadway.	**Decreased** Overall construction activities would be less than the Project, but could result in unsafe conditions for pedestrians using the sidewalk or bicyclists traveling in the roadway. (Less than Significant with Mitigation)	**Decreased** Overall construction activities would be less than the Project, but could result in unsafe conditions for pedestrians using the sidewalk or bicyclists traveling in the roadway. (Less than Significant with Mitigation)

TABLE 5-2 (CONT.)
COMPARISON OF THE ENVIRONMENTAL IMPACTS OF THE CEQA ALTERNATIVES

Impact	Proposed Project	Alternative 1: No Project	Alternative 2: Reduced Project – Reduce Tiscornia Marsh Restoration	Alternative 3: Eliminate Diked Marsh Restoration
Tribal Cultural Resources Impact a.i: The Project could cause a substantial adverse change in the significance of a tribal cultural resource, defined in PRC Section 21074 as either a site, feature, place, cultural landscape that is geographically defined in terms of the size and scope of the landscape, sacred place, or object with cultural value to a California Native American tribe, and that is listed or eligible for listing in the California Register of Historical Resources, or in a local register of historical resources as defined in PRC Section 5020.1(k)	While the City did not identify any tribal cultural resources listed or eligible for listing in the California Register, or determine any resources to be significant pursuant to criteria set forth in Subdivision (c) of PRC Section 5024.1, should any cultural materials be identified during Project implementation that are determined to be tribal cultural resources, they could be affected by construction activities. (Less than Significant with Mitigation)	**No Impact** There would be no earth-moving activities or other construction activities that would result in a substantial effect on tribal cultural resources, if present.	**Decreased** Overall construction activities would be less than the Project, but could disturb previously unknown tribal cultural resources, if present. (Less than Significant with Mitigation)	**Decreased** Overall construction activities would be less than the Project, but could disturb previously unknown tribal cultural resources, if present. (Less than Significant with Mitigation)
Tribal Cultural Resources Impact a.ii: The Project could cause a substantial adverse change in the significance of a tribal cultural resource, defined in PRC Section 21074 as either a site, feature, place, cultural landscape that is geographically defined in terms of the size and scope of the landscape, sacred place, or object with cultural value to a California Native American tribe, and that is a resource determined by the lead agency, in its discretion and supported by substantial evidence, to be significant pursuant to criteria set forth in Subdivision (c) of PRC Section 5024.1. In applying the criteria set forth in Subdivision (c) of PRC Section 5024.1, the lead agency shall consider the significance of the resource to a California Native American tribe.	Same as above.	Same as above.	Same as above.	Same as above.

Alternative 1: No Project Alternative

CEQA Guidelines (Section 15126.6(e)) require that EIRs include an evaluation of the No Project Alternative to provide decision-makers the information necessary to compare the relative impacts of approving the Proposed Project and not approving the Proposed Project. The No Project Alternative is defined as a continuation of existing conditions, as well as conditions that are reasonably expected to occur in the event that the Proposed Project is not implemented.

Description of the No Project Alternative

In the event that the City does not approve the Proposed Project, the restoration of Tiscornia Marsh and the City-owned diked marsh would not occur. The eroded area outboard of the existing Tiscornia Marsh would not be reconstructed, and the diked marsh would not be reconnected to tidal activity. The new levee north of the soccer field would not be constructed, and the levees to the west and south of Tiscornia Marsh would not be raised and/or widened. In addition, the coarse beach feature would not be constructed to prevent additional erosion of the marsh. The levee trails would not be resurfaced with asphalt.

Ability to Meet Project Objectives

The No Project Alternative would not meet the Project objectives, which are to: restore tidal marsh on the Project site to improve ecological function and habitat quantity, quality, and connectivity (including upland transition zones) for native marsh species and marsh-upland transition species, including special status species; protect Project site marsh lands from future marsh edge erosion; increase the level of flood protection for the Canal neighborhood and other nearby communities of central San Rafael; create sustainable benefits that consider future environmental changes such as sea level rise and sedimentation; and maintain and improve public access to passive recreational and outdoor education opportunities (e.g., hiking, jogging, bird watching). Further, Tiscornia Marsh would continue to erode, and the low-lying Canal neighborhood adjacent to Tiscornia Marsh would be further at risk to coastal flooding. Under the No Project Alternative, the existing levee trail would be retained, and passive recreation would continue; however, the trail surface would not be replaced and outdoor education opportunities would not be improved.

Environmental Impacts of the No Project Alternative Compared to those of the Project

As summarized in Table 5-2, the No Project Alternative would not result in the direct construction impacts of the Project. However, as noted, Tiscornia Marsh would continue to erode and the low-lying Canal neighborhood adjacent to Tiscornia Marsh would be further at risk to coastal flooding.

Alternative 2: Reduced Project – Reduce Tiscornia Marsh Restoration

Description of Alternative 2

Alternative 2 would include the same Project elements as the Proposed Project; however, the south side of the marsh would be reduced; therefore, reducing the total fill required and the overall amount of construction activities. Specifically, the portion of restored tidal marsh and constructed coarse beach would not be extended to the location of the tidal channel.

Ability to Meet Project Objectives

Alternative 2 would meet the objectives related to enhanced flood protection of the adjacent areas, because new/raised levees would be created and would protect the adjacent areas. The alternative would meet the objective of maintaining and improving public access, as it would include new trail surfacing along the levees, and other passive recreation components (same as under the Proposed Project).

However, the amount of tidal marsh restoration would be reduced as compared to the Project, and without the extension of the marsh to the south to the tidal channel, a portion of the site would be subject to ongoing marsh erosion and would be vulnerable to the ongoing effects of sea level rise. Further, without the protection of the coarse beach at the southern portion of the Project site, ongoing erosion would extend from the southern portion of the site northward, and it is expected that the overall Project efficacy and timeline would be reduced compared to the Project.

Environmental Impacts of Alternative 2

Because the overall construction activities would be reduced, all significant impacts of the Project would be reduced. However, because all construction activities would be required, other than at the southern edge of the marsh, no area of sensitive habitat would be avoided, air emissions would occur in the vicinity of sensitive receptors, potential for conflicts between construction vehicles and pedestrians/bicyclists still would occur, and the potential to unearth cultural and tribal cultural resources would occur. While the overall impact potential would occur, impacts would remain less than significant with mitigation.

Alternative 3: Reduced Project – Eliminate Diked Marsh Restoration

Description of Alternative 3

Alternative 3 would include most of the same Project elements on the eastern side of the site as the Proposed Project and would include the restoration of Tiscornia Marsh, construction of the coarse beach, raised southern and eastern levee, and constructed southern ecotone. However, the diked marsh would not be converted to tidal marsh; the new levee between the diked marsh and Pickleweed Park would not be constructed, and the new tidal channels at the north end of the site would not be constructed. Alternative 3 would require the least amount of construction, other than the No Project Alternative.

Ability to Meet Project Objectives

Alternative 3 would meet the objective related to maintaining and improving public access, as it would include new trail surfacing along the improved levees, and other passive recreation components (same as under the Proposed Project). However, the amount of tidal marsh restoration would be substantially reduced as compared to the Project, because the diked marsh would not be converted to tidal marsh. Further, without restoration, the diked marsh would continue to be isolated from bay sediments, which would help marshes accrete (or build up) to keep pace with sea level rise. Without the new levee and ecotone, and restoring tidal action to the diked marsh, the western portion of the site would be more vulnerable to extreme tidal flooding and sea level rise compared to the Proposed Project.

Environmental Impacts of Alternative 3

As noted above, Alternative 3 would require the least amount of construction, other than the No Project Alternative. Because the overall construction activities would be reduced, all significant impacts of the Project would be reduced. However, because all construction activities would be required, no area of sensitive habitat would be avoided other than in the diked marsh, air emissions would occur in the vicinity of sensitive receptors, potential for conflicts between construction vehicles and pedestrians/bicyclists still would occur, and the potential to unearth cultural and tribal cultural resources would occur. While the overall impact potential would occur, impacts would remain less than significant with mitigation.

5.3 Comparison of Alternatives

The CEQA Guidelines (Section 15126.6(e)) require the identification of an environmentally superior alternative to the Proposed Project. If it is determined that the “no project” alternative would be the environmentally superior alternative, then the EIR shall also identify an environmentally superior alternative among the other project alternatives (Section 15126.6[e][2]). To determine the environmentally superior alternative, the impacts of all the alternatives were compared to determine which alternative would have the least adverse effects.

Alternative 1 would eliminate the short-term construction effects relative to the Proposed Project. However, under Alternative 1, the restoration of Tiscornia Marsh and the City-owned diked marsh would not occur and the existing levees would not be raised and improved; thus, the adjacent areas would continue to be vulnerable to flooding. Alternative 1 would not meet any of the Project objectives.

Alternative 2 would not avoid the significant effects of the Proposed Project; however, the impacts would be lessened with the reduced construction footprint. Alternative 2 would only partially meet Project objectives, by eliminating restoration of the southern portion of the marsh. Thus, Alterative 2 provides a reduced habitat benefit. Further, without improvement of the southern part of the Project, ongoing erosion would extend into the northern portion of the Project site, affecting the efficacy of the Project, and somewhat reducing the expected lifetime of the improved levees from 2070 (under the Proposed Project).

Alternative 3 includes the least amount of construction activity, other than the No Project Alternative. While Alternative 3 would not avoid the significant effects of the Proposed Project, the impacts would be lessened with the reduced construction footprint. Thus, Alternative 3 is the environmentally preferred alternative. However, Alternative 3 would only partially meet Project objectives, by eliminating restoration of the diked marsh to tidal marsh and eliminating the new northern levee and ecotone. Thus, Alterative 3 provides the least habitat benefit and smallest flood protection benefit, other than the No Project Alternative. Further, without improvement of the diked marsh, the northwestern part of the Project area would be more vulnerable to extreme tidal flooding and sea level rise, and the expected lifetime of the improved levees would be less than 2070 (under the Proposed Project).

5.4 Alternatives Considered but Rejected from Further Analysis

The following three alternatives were considered in the planning process but rejected prior to additional alternatives analysis. As summarized in **Table 5-3**, these alternatives either do not meet the Project objectives or do not reduce construction-related impacts as compared to the Proposed Project.

TABLE 5-3
ALTERNATIVES CONSIDERED BUT REJECTED FROM FURTHER CONSIDERATION

Potential Alternative Identified	Description	Ability to Meet Project Objectives and Constraints on Implementation
Option 1. Restore diked marsh only	• Build new levee at north side of soccer field. • Excavate a tidal channel in the currently diked marsh to connect to the creek. • Breach/degrade the outer perimeter levee around the currently diked marsh to reintroduce tidal action.	• Does Not Meet Most Project Objectives: - Minimize short-term, construction-related impacts to biological resources and air quality due to smaller construction footprint, but would reduce habitat value and would not meet flood protection objectives. • Reasons for Rejection: - Would not meet most project objectives [a]
Option 2. Restore marsh without coarse beach feature	• Restore diked marsh as described above. • Raise and/or widen levees on western and southern sides of Tiscornia Marsh. • Place/dry/condition material in eroded marsh area for restoration. • Excavate tidal channels in reconstructed marsh to connect to existing tidal channel.	• Partially Meets Project Objectives: - Slightly minimize short-term, construction-related impacts on biological resources and air quality due to smaller construction footprint, and meet flood protection objectives. Would not meet habitat objectives as the restored marsh would rapidly erode as it is under existing conditions. • Reasons for Rejection: Does not meet key habitat Project objectives.
Option 3. Sheet pile wall instead of coarse beach feature	• Restore diked marsh and Tiscornia Marsh as described above. • Raise and/or widen levees as described above. • Install a sheet pile wall outboard of restored marsh area to contain dredged material placed in the marsh for reconstruction.	• Partially Meets Project Objectives: - Increase some construction effects due to use of pile driver or vibratory hammer. Would meet flood protection objectives and habitat objectives, similar to the Proposed Project. • Reasons for Rejection: - Feasibility issues due to geotechnical concerns. - Does not reduce construction-related impacts.

NOTES:
a. This alternative was initially identified as a potential Alternative as part of the Notice of Preparation process but was rejected after further review as it did not meet the project objectives.

5.4.1 Option 1. Restore Diked Marsh Only

Option 1 would restore the City-owned diked marsh using the same methods as described for the Proposed Project in Chapter 2, *Project Description*; however, the rest of the Project components would not occur. Tiscornia Marsh would not be restored/reconstructed, the coarse beach would not be installed to protect the existing marsh from further erosion, and the levees on the west and south side of Tiscornia Marsh would not be raised and/or widened. Option 1 would minimize short-term, construction-related impacts of the Project by reducing the construction footprint, but this option would not meet the flood protection objectives of the Project nor most of the habitat objectives. Option 1 would not increase the quantity of marsh habitat nor include upland transition zones.

5.4.2 Option 2. Restore Marsh without Coarse Beach Feature

Option 2 would restore Tiscornia Marsh and the City-owned diked marsh in the same manner as described in Chapter 2, *Project Description*, except that the coarse beach feature outboard of the existing mudflat would not be constructed. This option would slightly minimize the short-term, construction-related impacts of the Proposed Project by decreasing the construction footprint (i.e., the area where the coarse beach would be constructed would not be disturbed) and would meet the flood and habitat objectives of the Project in the short term. However, this option would have most of the same construction-related impacts without the long-term habitat benefits provided by the Proposed Project, as without the coarse beach the restored marsh would rapidly erode as it is under existing conditions.

5.4.3 Option 3. Sheet Pile Wall Instead of Coarse Beach Feature

Option 3 would replace the coarse beach feature of the Proposed Project with a sheet pile wall, but all other components of the Project would remain the same as described in Chapter 2, *Project Description*. The sheet pile wall would be narrower than the coarse beach feature, but it would not provide high marsh transition habitat as the coarse beach would, it would not reduce construction-related impacts of the Proposed Project, and it would likely face geotechnical concerns causing feasibility issues.

CHAPTER 6
EIR Preparers

6.1 Lead Agency

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Energy	Chris Sanchez
Geology and Soils	Todd Gordon
Greenhouse Gas Emissions	Chris Sanchez
Hazards and Hazardous Materials	Todd Gordon
Hydrology and Water Quality	Michael Burns
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Recreation	Deja Newton
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Tribal Cultural Resources	Heidi Koenig
Utilities and Service Systems	Deja Newton
Wildfire	Raiyna Villaseñor
Alternatives	Alisa Moore
Other CEQA Requirements	Alena Maudru

Appendix A
Notice of Preparation/Scoping

ESA

SAN RAFAEL
THE CITY WITH A MISSION

Community Development Department – Planning Division

Meeting Date:	February 23, 2021
Agenda Item:	3
Case Numbers:	UP21-001, ED21-002, & IS21-001
Project Planner:	Paul Jensen (415) 485-5064

REPORT TO PLANNING COMMISSION

SUBJECT: Tiscornia Marsh Restoration Project, North of Canal Street – Scoping hearing for the Notice of Preparation of an Environmental Impact Report (EIR) to assess the impacts of the Tiscornia Marsh Restoration Project. The project proposes to restore the tidal marsh/mudflats located north and outboard of Canal Street, as well as the diked marsh located north of the Albert J. Boro Center/Pickleweed Park Playfields. APNs: 009-142-01, 009-032-08 and -09; Park/Open Space-Wetland Overlay (P/OS-WO) District. Applicant: Marin Audubon Society; Property Owners: Marin Audubon Society and City of San Rafael.

EXECUTIVE SUMMARY

Marin Audubon Society (MAS), project applicant has filed Use Permit and Environmental and Design Review Permit applications to pursue a restoration of the Tiscornia Marsh and adjacent diked marsh located north of Canal Street. The City of San Rafael is the lead agency for permitting and completing the required environmental review for this project. The applications and plans have been reviewed and it has been determined that the project has the potential to result in significant, physical environmental effects. Therefore, the preparation of an Environmental Impact Report (EIR) is recommended.

Consistent with the California Environmental Quality Act (CEQA) Guidelines, the issuance of a Notice of Preparation (NOP) is required when the lead agency has determined that an EIR will be prepared. An NOP was issued on January 25, 2021 and mailed to the State Clearinghouse, responsible and trustee agencies and interested parties and groups, to announce the initiation of the EIR process. Further, a notice of the NOP was mailed to property owners and residents within 400 feet of the project site. The purpose of the NOP is to solicit comments regarding the scope of issues to be addressed/studied and project alternatives that should be considered in the EIR. The NOP affords a 30-day review period for comments to be submitted. During this NOP comment period, the Planning Commission is required to conduct a “scoping hearing” to receive comments and provide direction on proceeding with the EIR. The 30-day review period will close on Friday, February 26, 2021.

Please note that, for this project, an Initial Study (environmental checklist) has <u>not</u> been prepared, which would “screen out” certain topic areas from the EIR focus. However, staff has recommended key topic areas to be addressed/studied, which are discussed in this report. Following closure of the NOP comment period, the scope will be confirmed and preparation of the Draft EIR (DEIR) will begin. When completed and released, the DEIR will be subject to a 45-day public review period and a public hearing with the Planning Commission. Lastly, it is important to note that the specific purpose of scoping hearing is to provide comments on the issues to be addressed/studied in the EIR. Therefore, comments on the merits of this project (to support, oppose or modify the project) should be held for future public hearings when the project applications will be considered for action by the Planning Commission.

RECOMMENDATION

It is recommended that the Planning Commission take the following action:
1. Accept public testimony on the Notice of Preparation (NOP) and scope of issues to be addressed in the EIR.
2. Direct staff to prepare a Draft Environmental Impact Report (DEIR), taking into consideration verbal and written comments received during the scoping period.

BACKGROUND

Site Description & Setting:
The Tiscornia Marsh site covers 21 acres of tidal marsh and bay lands and well as 2,000 feet of shoreline levee/trail located north of East Canal Street. The property, which is owned by MAS is bound to the: a) south by a shoreline levee, Schoen Park (small City-owned park/playground) and Canal Street; b) west by the Albert J Boro Community Center and Pickleweed Park; c) east by the San Rafael Bay; and d) north by the San Rafael Creek. The neighboring Albert J Boro Community Center and Pickleweed Park covers approximately 15 acres which includes an active community center, community park and an expansive playfield. Included in the City-owned holdings is an undeveloped, four-acre diked salt marsh, which is located north of the large playfield. Although subject to flooding in the winter months, this diked salt marsh is enclosed by a perimeter level and contains a well-used, informal pedestrian trail, which loops through the area.

The Tiscornia Marsh has experienced considerable erosion along its bayward edge, which is attributed to direct wave action from the bay. Over the last 30 years, approximately three acres of the tidal marsh has been lost to this erosion, which has dramatically impacted habitat for species such as the Ridgway's rail and salt marsh harvest mouse. Under current conditions, it is expected that this erosion will continue and will likely increase as sea level rises. The second critical issue for this general area is flooding. The adjacent Canal neighborhood is low-lying and is currently at risk to coastal flooding (as well as sea level rise).

History:
In June 2016, the voters of the nine Bay Area counties approved Measure AA, a parcel tax measure. The tax measure is a $12.00 per year tax on every parcel in the Bay Area. The purpose of Measure AA is to generate $500 million over a 20-year period for critical tidal marsh restoration projects around the San Francisco Bay. The goal is to improve water quality, restore habitat for wildlife, protect communities from flooding and increase shoreline public access.

Applications for Measure AA funds for local restoration projects are initiated annually by the San Francisco Bay Restoration Authority. In fall 2018, a second call for applications was released and Marin Audubon Society applied for funding. As required by the application process MAS was required to submit an endorsement of the application by the local jurisdiction (City). On October 1, 2018, the City Council reviewed this request and adopted Resolution No. 14592 authorizing the application endorsement. As part of this review, the City Council acknowledged it role as the lead agency on this project for permitting and environmental review. In 2019, the Measure AA funds were awarded to MAS for the planning, environmental review and permitting process.

SOURCE: Aerial Imagery: Esri

160888.01

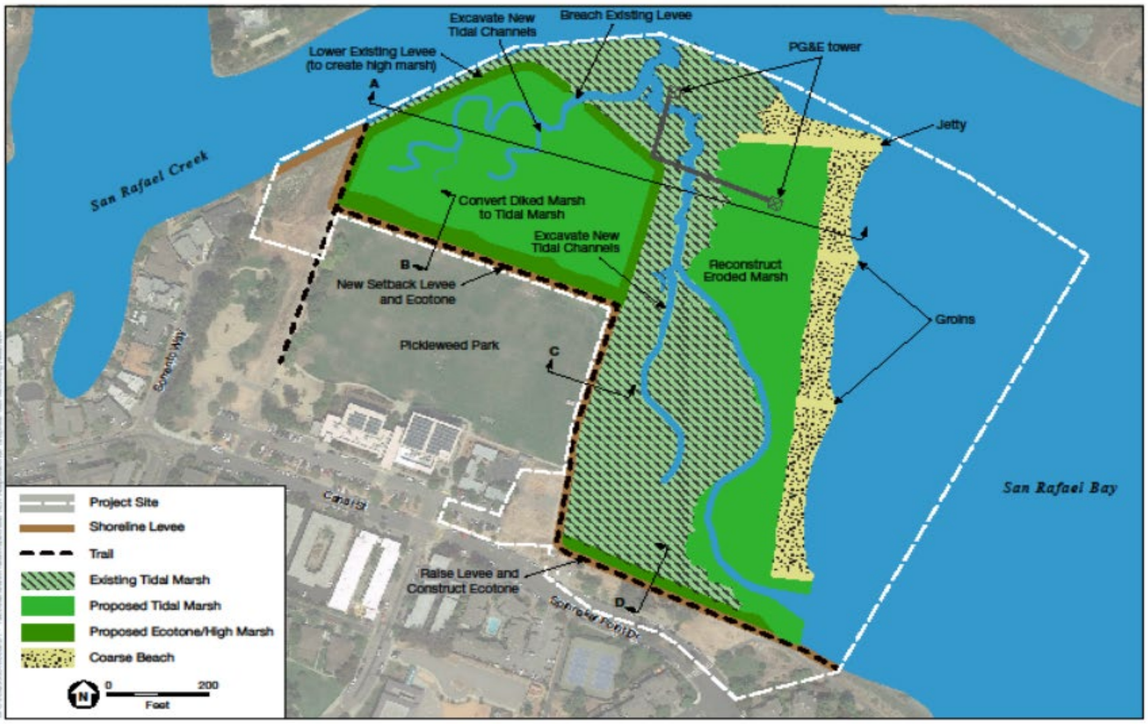
Figure 2
Project Location
Tiscornia Marsh Restoration and Sea level Rise Adaptation

ESA

PROJECT DESCRIPTION

Tiscornia Marsh would be restored to its former extents by beneficially reusing dredged material from local sources. A coarse beach would be constructed along the bay ward edge of the restored marsh to resist future erosion. Tidal action would also be restored to the City-owned diked marsh at the north end of Pickleweed Park. Altogether, the project would reconstruct approximately four acres of eroded tidal marsh, preserve, and protect the approximately eight remaining acres of Tiscornia Marsh, and restore approximately five acres of diked marsh (City-owned area north of the Pickleweed Park playfields) by reconnecting it to tidal inundation. The project also proposes to construct a new 600-foot setback levee and improve approximately 1,100 feet of shoreline levee to achieve greater flood protection, public access, and habitat benefits. In sum, the major project elements include the:

- Development of a course beach;
- Reconstruction of the eroded tidal marsh;
- Restoring the diked marsh to the bay;
- Shoreline levee improvements; and
- Development of an ecotone slope.



SOURCE: ESA, 2020; Base - Google Earth, 2020
NOTE: See Figure 2 for Section A, Figure 3 for Sections B, C, D.

Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation Project

Figure 1
Preliminary Project Overview: Tiscornia Marsh Restoration and Sea-Level Rise Adaptation

ESA

Project plans, project description and technical studies for this project can be found on the project web page at https://www.cityofsanrafael.org/tiscornia-marsh/.

ENVIRONMENTAL ANALYSIS AND REVIEW

Notice of Preparation:
As discussed above, an NOP was published on January 25, 2021 to announce the commencement of the EIR process and to solicit comments concerning the scope of issues to be addressed in the EIR. (Exhibit 2). A 30-day public review period is being observed and public comment will be accepted until Friday, February 26, 2021. The purpose of the scoping hearing is to afford agencies and the public an opportunity to provide verbal comments on the scope of issues to be addressed in the EIR for the proposed project. Following the close of the NOP review period, City staff and the EIR consultant will review comments received for consideration in preparation of the DEIR.

Although scoping hearing is not required under CEQA, it offers another vehicle for public participation in addition to the submittal of written comments. Comments should be limited to the scope of environmental issues to be addressed in the EIR, and not on the merits of the project. There will be subsequent public hearings for the purpose the purpose of reviewing the merits of the project and action on the Planning application.

Probable Environmental Effects:

The primary purpose of the CEQA/environmental review process is to: a) provide full disclosure and information regarding a project's potential physical impacts on the environment, in advance of acting on a project; and b) require feasible mitigation to reduce or eliminate impacts that have been identified. The CEQA review process is not conducted to determine whether a project should be approved or denied (supported or rejected).

Typically, at the start of the CEQA/environmental review process, an Initial Study is prepared to determine if an EIR is required for a project. However, at the onset of this process, the applicant agreed to proceed with the preparation an EIR without the need to prepare an Initial Study. This approach is consistent with CEQA Guidelines Section 15060. Nonetheless, as discussed below, City staff has identified: a) the topic areas for which the project will clearly have no significant effect and could be removed from further study; and b) the topic areas where the project has the potential to significantly impact the environment and, therefore, require analysis in the EIR:

No Impact Determination

Based on the preliminary review of project application materials including the Applicant's Project Description and Project Plans (Exhibit 1), the following environmental Impact factors were determined to clearly not apply to this project and would not warrant further discussion in the EIR:

- *Agriculture and Forestry Resources*
- *Energy*
- *Mineral Resources*
- *Population/Housing*

This determination was based on the fact that there are no agricultural, forestry uses, mapped mineral resources or existing housing on the site. Further, the proposed use and its construction would not wasteful, inefficient, or unnecessary consumption of energy resources, nor conflict for a plan for renewable energy. Should there be evidence presented that any of the above impact categories could result in environmental impacts, the environmental factors would be addressed in the EIR.

Less than Significant or Potentially Significant Impact Determination

The EIR will analyze the extent to which the project design and alternatives would result in "Less than Significant", "Less than Significant with Mitigation Incorporation", and "Potentially Significant" environmental impacts and will identify appropriate project modifications or mitigation measures to reduce or eliminate these impacts. If an impact remains "Potentially Significant" even with mitigation incorporated, the City will have to consider adoption of findings of overriding consideration if it were to approve the project. Preliminary review has determined the following environmental impact categories to be addressed in the EIR:

- *Aesthetics* - The project will result in physical changes in topography and landscape that have potential effects related to scenic vistas (e.g., views of the Bay in the project vicinity), the existing character of the site and its surroundings. It is recommended that the EIR include visual simulations of the project from several vantage points.
- *Air Quality* – It is recommended that the EIR include an analysis of potential construction-related air emissions. The EIR will identify temporary construction-related mitigation measures to reduce potential air quality impacts to less than significant levels.
- *Hazards* - A review of hazardous materials investigation reports and databases for the site and area is recommended. While most of the site consists of mudflats, tidal marsh and diked marsh,

there is the potential for encountering contaminated soils during the dredging and grading process. The presence of contaminated soil material could influence the re-use of this material in the restoration project.

- *Land Use and Planning* – The proposed restoration activity would be consistent with the current property zoning and General Plan 2020. However, there are elements of the project that will require careful review of City land use regulations and policies to ensure consistency, particularly related to wetland protection policies and regulations (WO- Wetland Overlay District). It is recommended that project consistency with the adopted San Rafael Climate Action Plan be addressed. The EIR consistency analysis will focus on policies and regulation related to protection of the environment.
- *Noise* – Project construction has the potential to result in temporary noise impacts. It is recommended that construction-related noise impacts be analyzed in the EIR. The project is surrounded by sensitive noise receptors (residential uses). The EIR will identify temporary construction-related mitigation measures to reduce potential construction-related noise impacts to less than significant levels.
- *Traffic and Transportation* - The project is not expected to increase traffic or result in new traffic impacts. However, project construction (import/export of dredge materials and soil) and staging (construction vehicle trips) will result in a temporary increase in vehicle trips. Depending upon the logistics of the construction management plan, temporary traffic impacts could be significant. Although the City will soon be phasing out of analyzing Level of Service (LOS) for CEQA review,[1] it is recommended that the EIR evaluate construction traffic generation against the Level of Service (LOS) thresholds in the General Plan, as well as Vehicle Miles Travelled (VMT) metrics presented in the Draft General Plan 2040. With this analysis, the EIR will identify mitigation measures for construction-related traffic and staging.
- *Biological Resources* – The project has the potential to result in significant short-term and long-term impacts to biological resources. The *Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation Project Habitat Assessment* (ESA, December 2020) was prepared to assess the natural communities of the site and the environs, extent of wetlands, special-status species, wildlife movement corridors and critical habitat. It is recommended that the information and findings of this assessment be included in the EIR. With inclusion of this analysis, the EIR will identify mitigation measures to reduce potential impacts to biological resource.
- *Cultural/Tribal Resources* – It is recommended that the EIR assess if the project has the potential result in significant impacts to pre-historic or archaeological/tribal resources. As part of the EIR process, the City will be following the tribal consultation protocols set forth in State Resources Code Section 21080.3.1 (AB 52) and CEQA Guidelines Section 15064.5. The City of San Rafael has initiated the tribal consultation process through an initial request with the Federated Indians of Graton Rancheria.
- *Geology and Soils* - The project site contains various forms of geologic conditions and soil types. The predominant, underlying soil type is bay mud, and in some areas, it is overlaid with fill. Consequently, the site is susceptible to seismic ground shaking and risks such as liquefaction. It is recommended that the EIR analyze the geologic and soil conditions of the site, as well as the proposed restoration work, which would change the landscape. The use of imported dredge spoils

[1] Senate Bill 743 mandates a phase of out of analyzing local intersections and arterials utilizing the LOS metric for CEQA review. However, this law permits local jurisdictions to continue to use LOS as a metric for non-CEQA purposes such as monitoring and managing local intersections and roadways. The Draft General Plan 2040 includes policies and programs that support the continued use of LOS for development application review.

and other associated materials will be reviewed under this topic area. With this analysis, the EIR will identify mitigation measures to reduce potential impacts to biological resource.

- *Greenhouse Gas Emissions* – While the completed project is not expected to increase greenhouse gas (GHG) emission, it is recommended that the EIR address this topic area to confirm this finding. This review will also include an assessment of construction-related impacts.
- *Hydrology and Water Quality* - The project will result in a change in the landscape, which will impact the pattern and movement of surface water and runoff. This change is potentially significant. In addition, construction-related activities will occur within tidelands and waterways, which could result in potentially significant water quality impacts. It is recommended that the EIR assess both hydrologic and water quality impacts. With this analysis, the EIR will identify mitigation measures to reduce impacts.

  The project proposes to implement adaptation measures that would ultimately result in a beneficial impact to combating and adapting to projected sea level rise. However, elements of this project design could potentially exacerbate projected sea level rise conditions to adjacent and nearby properties. Therefore, it is recommended that the EIR assess project impacts associated with projected sea level rise.
- *Public Services & Facilities* – It is recommended that the EIR include a discussion to confirm existing City services and infrastructure. This discussion would include police, fire, and public works services, as well as the ability to access the site for services.

  The project has the potential to result in significant impacts the City's park and recreation facilities that border the project site. It is recommended that the EIR will analyze these impacts and identify potential mitigation measures.
- *Utilities and Services Systems* – It is recommended that the EIR assess potential project impacts related to water, wastewater, storm water, and power infrastructure. Utility and service system infrastructure traverse and border the site (e.g., PG & E power lines, San Rafael Sanitation District pipeline and easement, and storm water systems). With this analysis, the EIR will identify mitigation measures to potentially significant impacts to these systems, which may include recommended adjustments to the design and layout of the restoration plan.
- *Wildfire* – While the project is not anticipated to exacerbate the potential for wildfire risk, it may result in indirect environmental effects such as impairment of evacuation routes.
- *Cumulative Impacts* – As required by CEQA, cumulative impacts will be assessed.

Project Alternatives
CEQA requires that an EIR describe a range of reasonable alternatives to a project, which would feasibly attain most of the basic objectives of the project but would avoid or substantially lessen any of the significant effects of the project. One of the intents of the NOP and the Commission's scoping session is to help determine potential alternatives to the project for discussion in the EIR. Staff is recommending that the EIR assess three alternatives including the "No Project" alternative (required by CEQA). The two alternatives to be finalized will consider the following approaches:

- Restore the outer, eastern marsh (Tiscornia Marsh) only with a smaller restoration construction footprint.
- Restore the inner, diked marsh (City-owned land) only with a smaller restoration construction footprint.
- Modify the marsh restoration design that would not include the beach protection feature.

The finalized project alternatives will not include concepts or approaches that would not meet the project objectives, which is to create a restoration project that: benefits biological resources and habitat; provides longer-term protection of the marsh; and combats projected sea level rise.

NEXT STEPS

Draft EIR

Preparation of a Draft EIR (DEIR) will be initiated once the scoping period has been completed. It is expected that completion of the DEIR to the date of release will take approximately three (3) months. Once the DEIR is completed, a Notice of Availability will be released initiating a 45-day public review period for comment on the document. The Planning Commission will hold a public hearing on the DEIR during the public review period and to provide comments on the adequacy of the document.

Final EIR and Project Merits

Following the completion of the DEIR and hearing, the environmental consultant will respond to the comments raised at the DEIR hearing and prepare a Final EIR (FEIR). The FEIR, along with the project merits, will be considered by the Planning Commission at a public hearing. This project involves quasi-judicial permit actions, so the Planning Commission will have final decision-making authority. However, the Planning Commission's action can be appealed to the City Council.

CORRESPONDENCE

As of the date and publication of this staff report, the City has received no correspondence on the NOP. Correspondence received before the Planning Commission meeting will be forwarded to Commission members under separate cover.

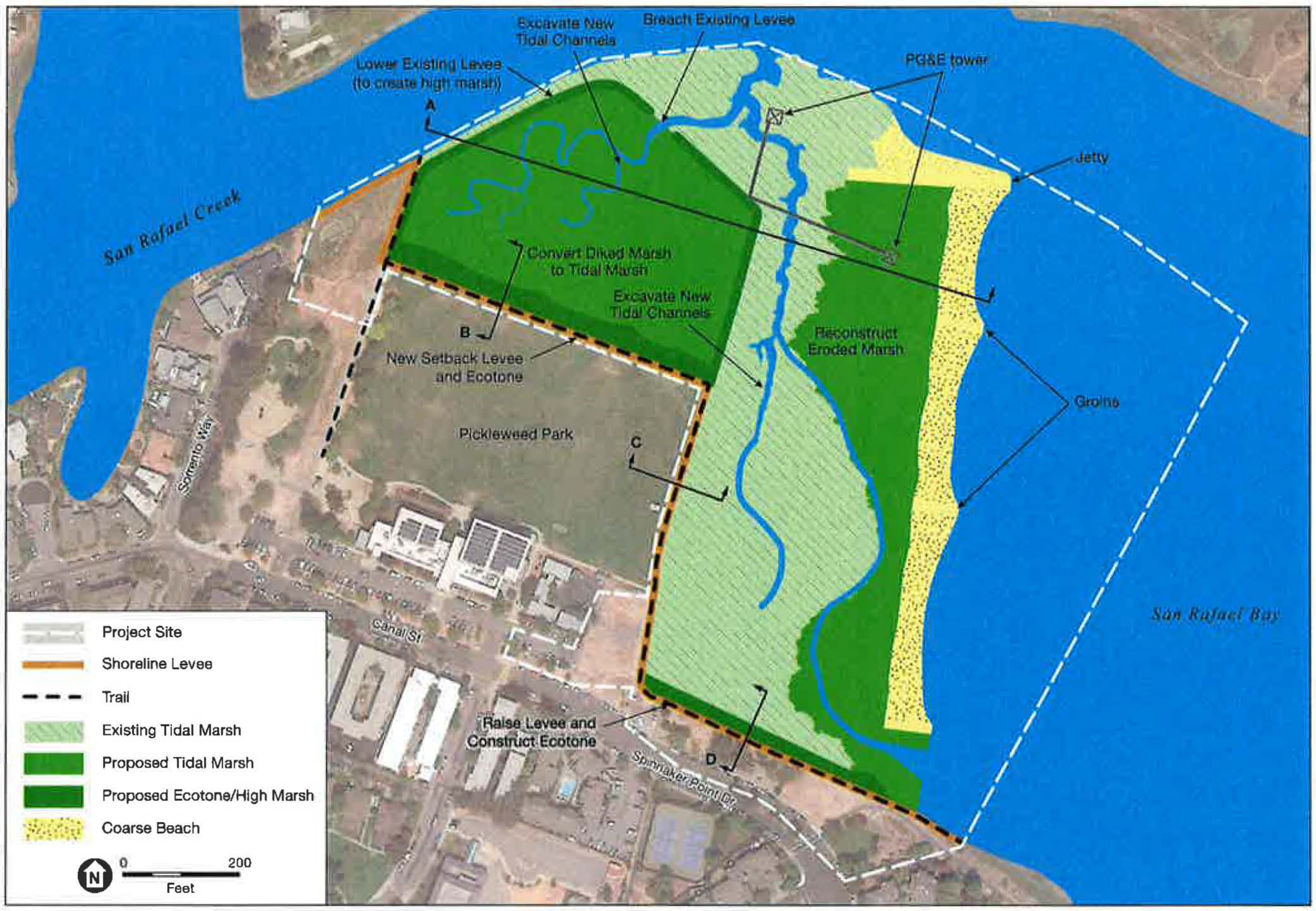
EXHIBITS

1. Tiscornia Marsh Project Description and Plans
2. Notice of Preparation, January 25, 2021

Plans/Documents and supportive studies provided on web site (www.cityofsanrafael.org/tiscornia-marsh/)

EXHIBIT A

TISCORNIA MARSH RESTORATION & SEA LEVEL RISE ADAPTATION PRELIMINARY PLANS



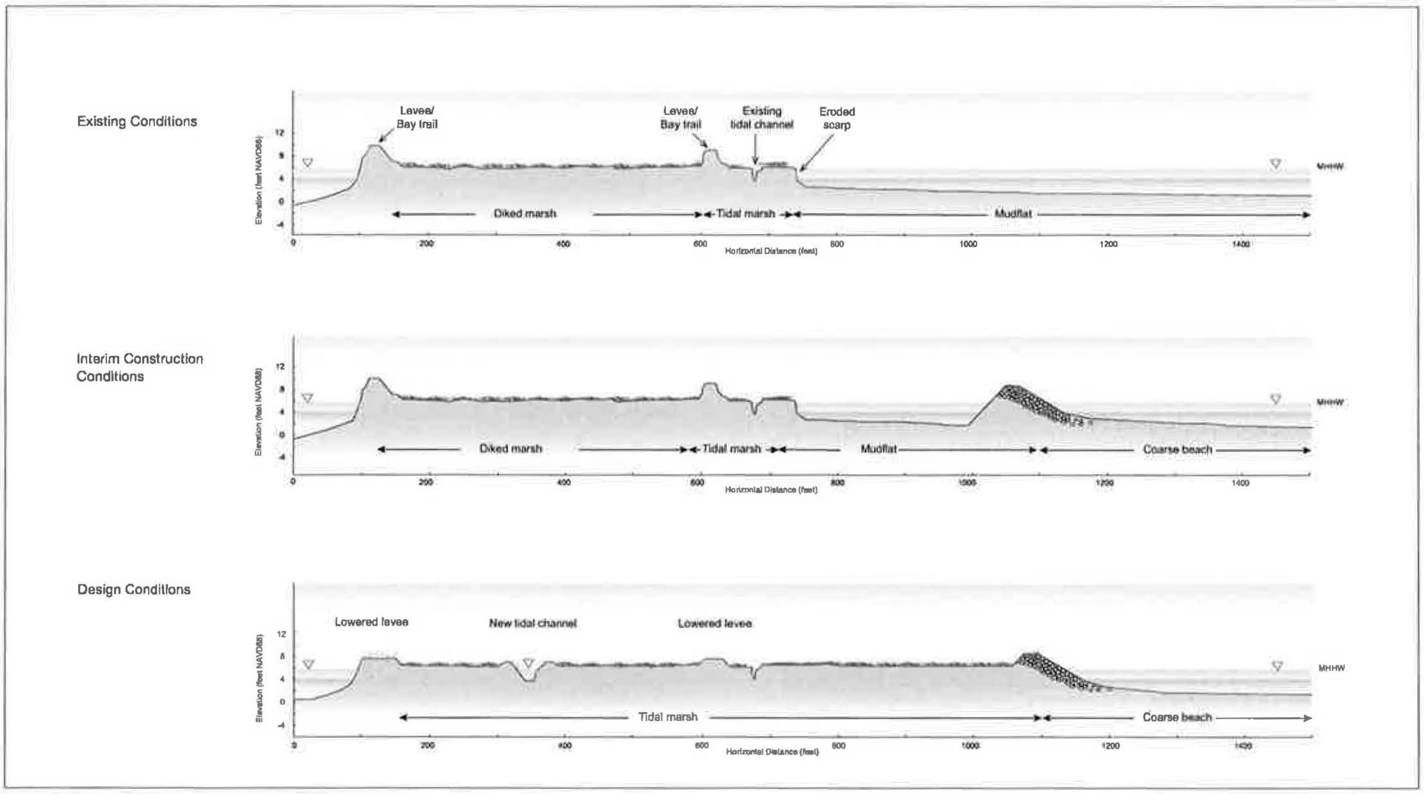
SOURCE: ESA, 2020; Base - Google Earth, 2020

NOTE: See Figure 2 for Section A, Figure 3 for Sections B, C, D.

Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation Project

Figure 1
Preliminary Project Overview: Tiscornia Marsh Restoration and Sea-Level Rise Adaptation

ESA

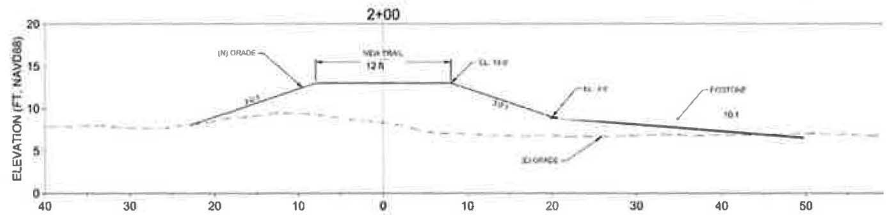


SOURCE: ESA 2020

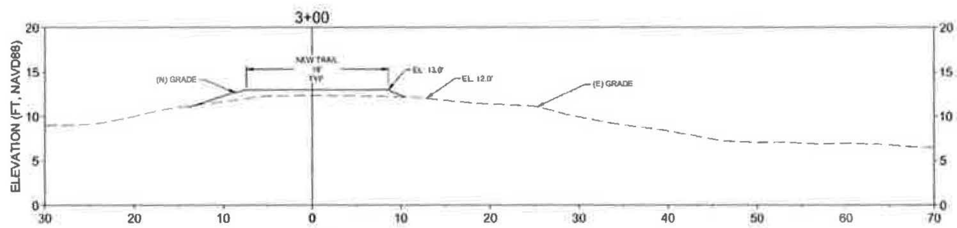
Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation Project

Figure 2
Section A – Preliminary Schematic Marsh Cross-section

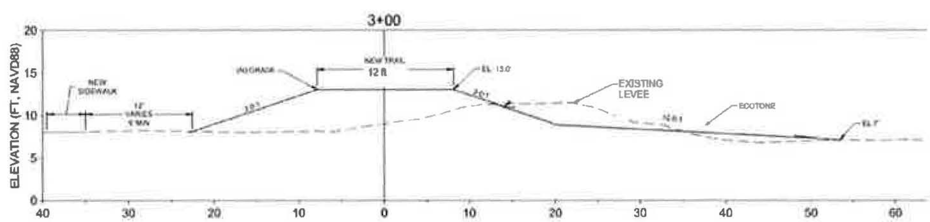
ESA



Section B - New Setback Levee on South Side of Diked Marsh



Section C - Raised Levee on West Side of Tiscornia Marsh



Section D - Raised Levee on South Side of Tiscornia Marsh

SOURCE: ESA, 2020

Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation Project

Figure 3
Sections B, C, and D - Preliminary Levee Cross-sections

EXHIBIT B

NOTICE OF PREPARATION

SAN RAFAEL

THE CITY WITH A MISSION

NOTICE OF PREPARATION

Date of Mailing: January 25, 2021

TO:	Office of Planning and Research State Clearinghouse 1400 Tenth Street, Room 212 Sacramento, CA 95814	**FROM:**	City of San Rafael Community Development Department Attn: Paul Jensen, Community Development Director 1400 Fifth Ave San Rafael, CA 94901
	Responsible and Trustee Agencies, Utility Providers, Organizations, Neighboring Property Owners, Neighboring Occupants, and Interested Parties		

NOTICE OF PREPARATION OF AN ENVIRONMENTAL IMPACT REPORT AND SCHEDULED SCOPING MEETING FOR THE TISCORNIA MARSH RESTORATION PROJECT EIR

The City of San Rafael (City) is preparing an Environmental Impact Report (EIR) for the Tiscornia Marsh Restoration Project. The project proposes to restore the tidal marsh/mudflats located north and outboard of Canal Street and the diked marsh located north of the Albert J. Boro Community Center/Pickleweed Park playfields. Pursuant to the California Environmental Quality Act (CEQA) Guidelines, this project is subject to environmental review. It has been determined that the project has the potential to result in environmental impacts and the preparation of an EIR is recommended to assess these impacts. The City is the "Lead Agency" for the project and is the public agency with the principal responsibility for approving and carrying out the project.

The City is issuing this Notice of Preparation (NOP) to invite comments on the scope and content of study for the EIR. This NOP is being sent to local agencies, nearby residents, and other interested parties. When the draft EIR is published, it will be sent to all parties who respond to this NOP or who otherwise indicate that they would like to receive a copy of the draft EIR.

RESPONDING TO THIS NOP: Responses to this NOP and any related questions or comments regarding the scope or content of the Draft EIR must be directed in writing to: **Paul Jensen, Community Development Director, City of San Rafael, 1400 Fifth Avenue, San Rafael, CA 94901 or by e-mail to paul.jensen@cityofsanrafael.org.**

Comments on the NOP must be received at the above mailing or e-mail address within 30 days of receipt of this notice, or **before Friday, February 26, 2021 at 5:00 PM**. Please reference the project title of "Tiscornia Marsh Restoration Project" in all correspondence.

Responses to this NOP should focus, specific to this project, on the potentially significant environmental effects that the project may have on the physical environment, ways in which those effects might be minimized, and potential alternatives to the project that should be addressed in the EIR. This focus aligns with the purpose of the EIR to inform the public about these aspects of the project.

EXISTING CONDITIONS AND PROJECT LOCATION: The Tiscornia Marsh site covers 20 acres of tidal marsh and bay lands located north and outboard of East Canal Street (APN 009-142-01). The property, which is owned by Marin Audubon Society, is bound to the: a) south by a shoreline levee, Schoen Park (small City-owned park/playground) and Canal Street; b) west by the Albert J Boro Community Center and Pickleweed Park; c) east by the San Rafael Bay; and d) north by the San Rafael Creek. The neighboring Albert J Boro Community Center and Pickleweed Park covers approximately 15 acres which includes an active community center, community park and an expansive playfield (APNs 009-032-06, 08 and 09). Included in the City-owned holdings is an undeveloped, four-acre diked salt marsh, which is located north of the large playfield. Although subject to flooding in the winter months, this diked salt marsh is enclosed by a perimeter level and contains a well-used, informal pedestrian trail, which loops through the area. The Tiscornia Marsh and environs are presented in the attached Site Area Map (Attachment 1).

The Tiscornia Marsh has experienced considerable erosion along its bay ward edge, which is attributed to direct wave action from the bay. Over the last 30 years, approximately three acres of the tidal marsh has been lost to this erosion, which has dramatically impacted habitat for species such as the Ridgway's rail and salt marsh harvest mouse. Under current conditions, it is expected that this erosion will continue and will likely increase as sea level rises. The second critical issue for this general area is flooding. The adjacent Canal neighborhood is low-lying and is currently at risk to coastal flooding (as well as sea level rise).

PROJECT DESCRIPTION: Tiscornia Marsh would be restored to its former extents by beneficially reusing dredged material from local sources. A coarse beach would be constructed along the bay ward edge of the restored marsh to resist future erosion. Tidal action would also be restored to the City-owned diked marsh at the north end of Pickleweed Park. Altogether, the project would reconstruct approximately four acres of eroded tidal marsh, preserve, and protect the approximately eight remaining acres of Tiscornia Marsh, and restore approximately five acres of diked marsh by reconnecting it to tidal inundation. The Project would also construct a new 600-foot setback levee and improve approximately 1,100 feet of shoreline levee to achieve greater flood protection, public access, and habitat benefits. Major project elements include the: a) development of a course beach; b) reconstruction of the eroded tidal marsh; c) restoring the diked marsh to the bay; d) shoreline levee improvements; and e) development of an ecotone slope.

Project plans, project description and technical studies for this project can be found on the project web page at https://www.cityofsanrafael.org/tiscornia-marsh/.

POTENTIAL ENVIRONMENTAL EFFECTS: An Initial Study Checklist has NOT been prepared to accompany this NOP. The scoping of the topic areas to be studied in the EIR will be determined and confirmed as part of this NOP process. However, as part of the initial scoping review, City staff will be recommending that the following the EIR address the following potential environmental effects: Aesthetics, Air Quality, Biological Resources, Cultural Resources, Geology/Soils, Hazards/Hazardous Materials, Noise, Public Services, Recreation, Greenhouse Gas Emissions, Hydrology and Water Quality, Transportation/Traffic, and Utilities/Service Systems. The EIR will examine project and cumulative effects and a reasonable range of alternatives to the project that may be capable or reducing or avoiding potential environmental effects that may be identified for the project. The topics of Agricultural and Forestry Resources, Mineral Resources, and Population/Housing will not be addressed in the EIR as these do not apply to the project or project site.

SCOPING MEETING: A scoping meeting will be held before the City of San Rafael Planning Commission on **Tuesday, February 23, 2021 at 7 PM**. COVID-19 ADVISORY NOTICE: Consistent with Executive Orders No.-25-20 and No. N-29-20 from the State of California Shelter in Place Order, the San Rafael Planning Commission hearing listed above WILL NOT be physically open to the public and the meeting will be streamed live to YouTube at www.youtube.com/sanrafael. Instructions on how to participate online, will be available on the YouTube channel. This virtual meeting will include a brief overview of the EIR process and allow time for comments on the scope of the EIR.

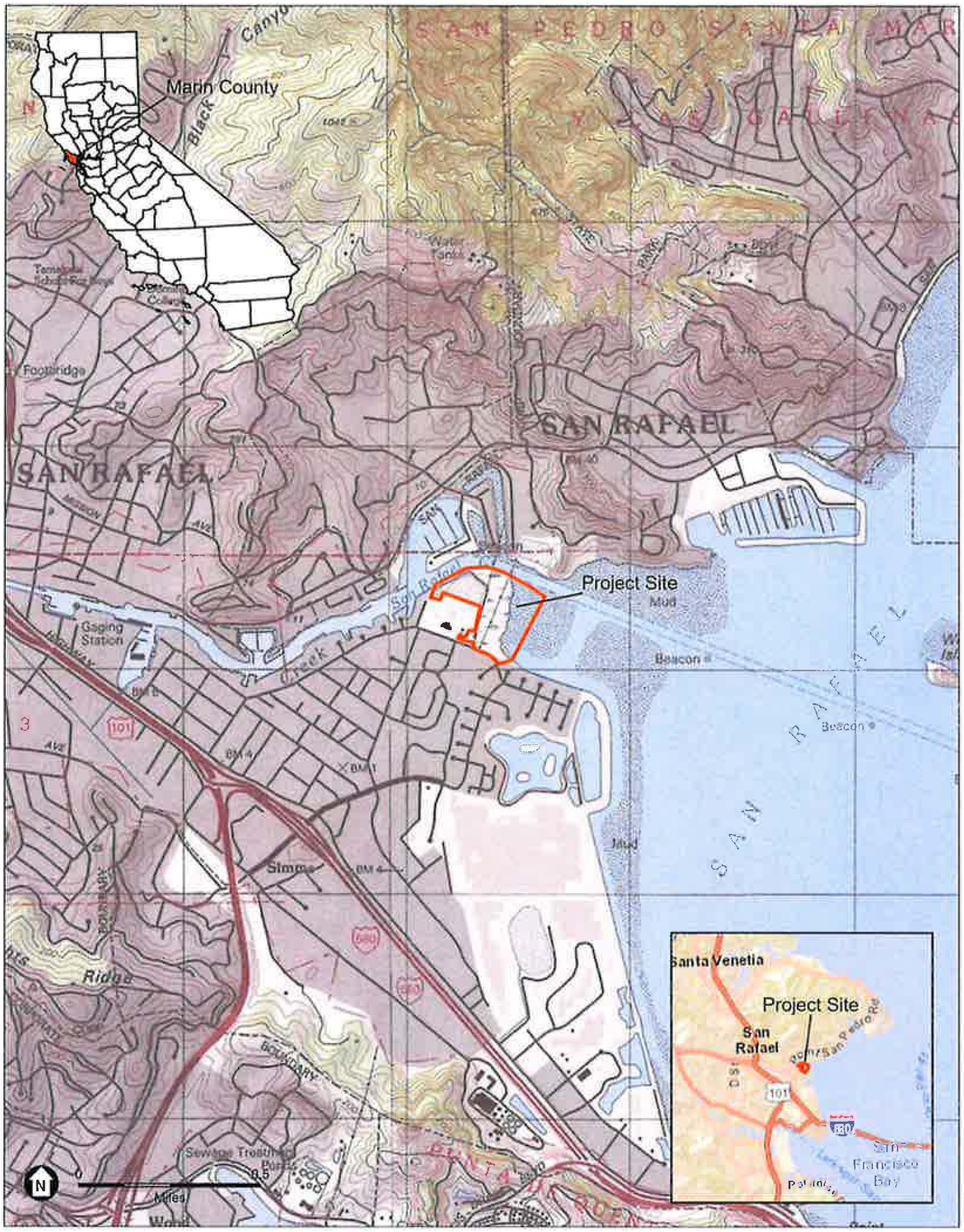
For More Information: For additional information on the project or if you wish to be placed on a mailing list to receive further information as the project progresses, please contact Paul Jensen at (415) 485-5064, paul.jensen@cityofsanrafael.org or the mailing address above.

Date: January 25, 2021

Signature: Paul A. Jensen

Name/Title: Paul A. Jensen, Community Development Director

Reference: California Code of Regulations, Title 14, (State CEQA Guidelines) Sections 15082(A), 15103, 15375



SOURCE: USGS, Esri

Project Name

Figure 1
Regional Setting
Tiscornia Marsh Restoration and Sea level Rise Adaptation

ESA

SOURCE: Aerial Imagery: Esri

160888.01

Figure 2
Project Location
Tiscornia Marsh Restoration and Sea level Rise Adaptation

ESA

San Francisco Bay Conservation and Development Commission
375 Beale Street, Suite 510, San Francisco, California 94105 tel 415 352 3600 fax 888 348 5190
State of California | Gavin Newsom – Governor | info@bcdc.ca.gov | www.bcdc.ca.gov

Transmitted Via Electronic Mail

March 22, 2021

Paul Jensen
City of San Rafael
1400 Fifth Avenue
San Rafael, California 94901

SUBJECT: Notice of Preparation of a Draft Environmental Impact Report for the Tiscornia Marsh Restoration Project; SCH# 2021020362

Dear Mr. Jensen:

Thank you for the opportunity to comment on the Notice of Preparation (NOP) of a Draft Environmental Impact Report (DEIR) for the Tiscornia Marsh Restoration Project, which our office received on January 27, 2021. The proposed project is located on a 28-acre site that will restore and create tidal marsh habitat located north and outboard of Canal Street and restore the diked marsh located north of the Albert J. Boro Community Center/Pickleweed Park playfields. The NOP states that the project would involve reconstruction of approximately 4 acres of eroded tidal marsh on the mudflats, protection of the approximately 8 acres of remaining Tiscornia Marsh, and restoration of 5 acres of diked marsh to tidal marsh. The project would also include construction of a new 600-foot setback levee and improving approximately 1,100 feet of shoreline levee for flood protection, public access, and habitat benefits. The project elements include construction of a coarse beach outboard of the reconstructed marsh, beneficial reuse of sediment to reconstruct the eroded marsh, restoring the diked marsh to tidal connection, shoreline levee improvements, and an ecotone slope.

The Commission is a responsible agency for this project and will rely on the DEIR when it considers the project. The project is not specific enough at this time for us to comment on every issue raised with respect to the Commission's laws and policies. However, we have prepared comments outlining specific Commission issues that should be addressed either in the DEIR or through the Commission permitting process. Once we receive more details on the project, we will be able to provide more detailed responses and can work closely with the project sponsors to ensure the project is consistent with the Commission's laws and policies.

Although the Commission itself has not reviewed the NOP and associated materials, the staff comments are based on the McAteer-Petris Act, the Commission's San Francisco Bay Plan (Bay Plan), the Commission's federally approved management program for the San Francisco Bay, and the federal Coastal Zone Management Act (CZMA). The staff comments are based on the preliminary project details presented in the NOP. As more details become available, the staff will provide additional comments of greater specificity and direction.

Commission Jurisdiction

From the NOP, it appears that a portion of the project would be located within the Commission's jurisdiction. The Commission's jurisdiction includes both the Bay itself and the "shoreline band." The shoreline band extends 100 feet inland from and parallel to the Bay shoreline. The Bay is defined as all tidal areas of the Bay up to the line of mean high tide, or in areas of tidal marsh includes all areas up to five feet above mean sea level. The Commission's jurisdiction also includes all areas formerly subject to tidal action that have been filled since September 17, 1965. Additionally, the Commission's Bay jurisdiction on San Rafael Creek was previously determined by Commission Staff to end at the westernmost powerline at the mouth of San Rafael Creek. Within this jurisdiction, Commission permits are required for activities including the placement of fill, substantial changes in use, and dredging. Permits are issued if the Commission finds the activities are consistent with the McAteer-Petris Act and the policies of the Bay Plan. Please note that the McAteer-Petris Act is a State Law and is administered by the Commission, which is a State agency. The Commission has not yet reviewed the details of the project quantities and impacts in the Commission's jurisdiction to make a determination as to whether this project qualifies as an administrative permit, as noted on page 5 of the project description, or as a major permit that requires a public hearing and vote before the Commission. The DEIR should mention both potential types of Commission permits.

Pursuant to the CZMA, the Commission is also required to review federal projects for effects on the coastal zone, whether or not the projects are located within the Commission's coastal zone as defined by state law, and to concur with or object to the federal agency's determination or federal permit applicant's certification that a project is consistent with the Commission's laws and policies. The "Anticipated Regulatory Requirements" section of the NOP project description mentions that a number of federal approvals would be required for the project. These federal actions are also subject to the Commission's regulatory authority under the CZMA. Where a project is subject to both the Commission's state law and federal jurisdictions, the Commission's Coastal Management Plan provides that issuance of a permit under the McAteer-Petris Act will be deemed to be a concurrence with a consistency certification under the CZMA.

The DEIR should provide a detailed and complete project description, clarify where the project would occur within both the Commission's Bay and 100-foot shoreline band jurisdictions, and identify the Commission's permitting role and the federal government's permitting role. The DEIR should also identify the anticipated life of the project.

Commission Law and Bay Plan Policies Relevant to the Project

Bay Fill

Section 66605 of the McAteer-Petris Act sets forth the criteria necessary to authorize placing fill in the Bay and certain waterways. It states, among other things, that further filling of the Bay should only be authorized if it is the minimum necessary to achieve the purpose of the fill and if harmful effects associated with its placement are minimized. According to the Act, fill is limited to water-oriented uses or minor fill for improving shoreline appearance or public access and should be authorized only when no alternative upland location is available for such purpose. The DEIR should indicate the amount of fill that would be removed, if any, and the amount of new fill for the project, as well as the uses associated with the proposed new fill for each area. Depending on the amount of net total fill proposed and the uses proposed on fill, the Commission may require that fill be removed elsewhere in the Bay or on the shoreline to mitigate the amount of new fill proposed. Based on the project description in the NOP, it appears that much of the proposed fill would be for habitat purposes, which is consistent with the water-oriented uses allowable in the McAteer-Petris Act.

Public Access and Recreation

Section 66602 of the McAteer-Petris Act states, in part, "that maximum feasible public access, consistent with a proposed project, should be provided." The construction of the restored habitat and improved levee trails will impact the existing public access spaces by reducing the public access area and changing the experience of the existing required public access along the perimeter levee around the diked area and Schoen Park. In addition to minimizing adverse impacts on usability and offsetting losses of existing public access areas, maximum feasible public access consistent with the proposed project must also be provided.

The project includes a new 600-foot setback levee and 1,100 feet of improved levee that will provide flood protection, habitat, and public access. In order to fully evaluate the public access and recreation proposed with the project, the DEIR should include more detailed information regarding existing and proposed public access incorporated in this and other currently proposed City projects within the site area, including the City of San Rafael's proposed placement of parking at the former Schoen Park. The design of the new and improved public access areas should be fully described in the DEIR to allow the Commission to fully evaluate the public access proposed with the project. The DEIR should also consider the possible impacts, including views to the water, that the project may have on the usability and accessibility at other nearby public spaces.

The Bay Plan Public Access policies also provide that "[p]ublic access to some natural areas should be provided to permit study and enjoyment of these areas," recognizing that "some wildlife are sensitive to human intrusion… [and, f]or this reason, projects in such areas should be carefully evaluated in consultation with appropriate agencies to determine the appropriate location and type of access to be provided." The Habitat Assessment references existing sensitive habitats, including tidal marsh, mudflats, native vegetation, and open water area present on the site as well as proposed creation of new habitat such as, tidal marsh, beach area, transition zone, and wetlands and ponds. The DEIR should discuss how the project will consult with appropriate agencies, including but not limited to California Department of Fish and Wildlife (CDFW), U.S. Department of Fish and Wildlife (USFWS), National Marine Fisheries Service (NMFS), on the question of the compatibility of the proposed public access with aquatic life, wildlife, and plant communities presently at the site, as well as with the habitat creation and enhancement components of the proposed project. To allow the Commission to understand the potential effects of public access on wildlife, the DEIR should also provide information on the species and habitats at the project site, the likely human use of the access, and the potential for significant adverse effects (such as impacts on endangered species, impacts on breeding and foraging areas, or fragmentation of wildlife corridors). Please provide this information both in the site-specific context and within a regional context, identifying any siting, design, or management strategies that could be employed to avoid or minimize adverse effects on wildlife, and how the effects of public access on wildlife may be monitored over time to determine whether revisions of management strategies are needed.

The DEIR should discuss in detail the proposed shoreline trail network, its connections to the Bay Trail, the adjacent community, and its links to other shoreline parks and nearby public access areas. Please indicate whether the public access areas permit barrier-free access for persons with disabilities. Please also provide detail on anticipated public transit use and connections to the project site and the shoreline, as well as the siting and availability of parking for those arriving by car to visit the shoreline. Please also detail the proposed maintenance program for public areas. The project may necessitate review by the Commission's Design Review Board to advise on the adequacy of the proposed public access. This determination will be based upon the size and complexity of the project and the anticipated impacts to existing public access on the site.

Fish, Other Aquatic Organisms and Wildlife

The Bay Plan policies on Fish, Other Aquatic Organisms and Wildlife address the benefits of fish, other aquatic organisms and wildlife in the Bay, and the importance of protecting the native species, including candidates for listing, threatened, and endangered species, and the Bay's habitats (tidal marshes, tidal flats, and subtidal habitats). Policy No. 1 requires that the Bay's tidal marshes, tidal flats and subtidal habitat are to be conserved, restored, and increased "to the greatest extent feasible." Additionally, Policy No. 4 states that, "[i]n reviewing or approving habitat restoration projects or programs the Commission should be guided by the best available science, including regional goals, and should, where appropriate, provide for a diversity of habitats for associated native aquatic and terrestrial plant and animal species." Additionally, Policy No. 5 allows "fill or a minimum amount of dredging… to enhance or restore fish, other aquatic organisms and wildlife habitat…" And, Policy No. 6 provides conditions for the evaluation of the allowable fill, such as minimizing near term impacts, providing substantial net benefits for Bay habitats and native species, and being appropriately scaled for the project and sea level rise adaptation measures in accordance with the best available science.

The DEIR should address how the construction and use of the proposed project would meet these policies and avoid or minimize impacts to species and habitat in the Bay. The DEIR should include an analysis of the potential impacts of converting mudflat habitat in the project area to tidal marsh and beach habitat, and include impacts to native species (fish, shorebirds, etc.) and special status species that currently utilize this portion of the Bay. The analysis should evaluate these impacts on the project scale and larger regional scale, and evaluate whether the project would achieve regional goals. The DEIR should include information on how these impacts will be avoided, minimized, and/or mitigated.

Tidal Marshes and Tidal Flats, and Subtidal Areas

The Bay Plan policies for these sections limit filling, diking and dredging projects that would substantially harm tidal marshes, tidal flats, and subtidal areas. Tidal Marshes and Tidal Flats Policy No. 1 requires that a project "be allowed only for purposes that provide substantial public benefits and only if there is no feasible alternative." Policy No. 2 requires that "[a]ny proposed filling, diking, or dredging project should be thoroughly evaluated to determine the effect of the project on tidal marshes and tidal flats, and designed to minimize, and if feasible, avoid any harmful effects." Policy No. 3 establishes the same test for the transition zone present between tidal and upland habitats, and that "[w]here a transition zone does not exist and it is feasible and ecologically appropriate, shoreline projects should be designed to provide a transition zone between tidal and upland habitats." The DEIR should discuss the project's potential impacts to tidal marsh and tidal flat habitats. The DEIR should also include information on how these impacts will be avoided, minimized, and/or mitigated.

Tidal Marshes and Tidal Flats Policy No. 6 states that "[a]ny habitat projects should include clear and long-term and short-term biological and physical goals, success criteria, a monitoring program, and as appropriate, an adaptive management plan." The DEIR should include an evaluation of: the adaptive capacity of the project so that it is resilient to sea level rise and climate change; the project impacts on the Bay and local sediment transport and budget; localized sediment erosion and accretion; the role of tidal flows; potential spread of invasive species; rates of vegetation colonization; expected use of the project by wildlife and other aquatic organisms; appropriate buffer between shoreline development and wildlife habitats on site, and the inclusion of migration space as sea level rises; how the project meets regional restoration goals; whether the project would be sustained by natural processes; and how the project restores, enhances, and creates connectivity across Bay habitats at a local, sub-regional, and/or regional scale. The DEIR should evaluate the design of the proposed tidal channels interior to the site and whether the design allows for sediment accretion on the site to help the marsh keep pace with sea level rise. Additionally, the details of tidal marsh creation and restoration, such as channel sizes and breach locations, should be informed by the best available science and evaluated in the DEIR.

Additionally, Subtidal Areas Policy No. 1 establishes the method of evaluating proposed filling or dredging of subtidal areas, and establishes that "[p]rojects in subtidal areas should be designed to minimize and, if feasible, avoid any harmful effects." However, there are stricter standards for projects in scarce subtidal areas, and subtidal areas with an abundance and diversity of fish, other aquatic organisms and wildlife, including eelgrass beds. Policy No. 2 states in part that "[f]illing, changes in use, and dredging in these areas should therefore be allowed only if: (a) there is no feasible alternative; and (b) the project provides substantial public benefits." The DEIR should evaluate whether any scarce subtidal areas occur in the project area, and include information on how impacts to subtidal areas will be avoided, minimized, and/or mitigated. If scarce subtidal areas will be impacted, the DEIR should discuss the public benefits that would accrue from the proposed Bay fill or dredging, and evaluate these benefits against the public detriment from the loss of important habitat values.

The DEIR should quantify all habitat impacts and benefits associated with the project. Habitat monitoring is likely to be required following the completion of the project to ensure success criteria are being met and this monitoring would be consistent with the purpose, size, impact, level of uncertainty, and/or expected life of the project. The DEIR should also include any proposed adaptive management actions or operations that may be necessary. Any proposed mitigation should be included and evaluated in the DEIR.

Water Quality

The Water Quality policies in the Bay Plan address water quality and require Bay water pollution to be prevented to the greatest extent feasible. New projects are required to be sited, designed, constructed, and maintained to prevent or minimize the discharge of pollutants in the Bay by controlling pollutant sources at the project site, using appropriate construction materials, and applying best management practices. The DEIR should address how the construction and land use of the proposed project would be designed to control pollution to the Bay, including litter management. The DEIR should identify whether any portions of the project site are polluted with toxic or hazardous substances, any anticipated effects associated with such pollution, and the role other agencies will take in the review. The DEIR should include an evaluation of the potential water quality impacts associated with the containment methods used for the dredged sediment, construction methods for of the project, and any potential discharges that may be necessary during the construction of the project. The analysis should include avoidance and minimization measures to reduce impacts to water quality.

Water Quality Policy No. 7 requires that, whenever practicable, native vegetation buffer areas should be used in place of hard shoreline and bank erosion control methods (e.g., rock riprap) where appropriate and practicable. The DEIR should identify the approach the project will take in terms of shoreline armoring at the site, and discuss where the use of vegetation in favor of hard shoreline protection would be appropriate and feasible. The DEIR should also discuss the anticipated performance of the softer shoreline protection measures that are proposed for the project site.

Climate Change

Climate Change Policy No. 7 states that, "[u]ntil a regional sea level rise adaptation strategy can be completed, the Commission should evaluate each project proposed in vulnerable areas on a case-by-case basis to determine the project's public benefits, resilience to flooding, and capacity to adapt to climate change impacts. The following specific types of projects have regional benefits, advance regional goals, and should be encouraged, if their regional benefits and their advancement of regional goals outweigh the risk from flooding…(d) a natural resource restoration or environmental enhancement project." Additionally, the Tidal Marshes and Tidal Flats Policy No. 6 says that habitat projects should include clear and specific long-term and short-term biological and physical goals and that the "[d]esign and evaluation of the project should include an analysis of: (a) how the project's adaptive capacity can be enhanced so that it is resilient to sea level rise and climate change…" amongst other criteria used to evaluate the project. If the project is determined to be a larger shoreline project, Climate Change Policy 2 states that, "a risk assessment[s] should be prepared…based on the estimated 100-year flood elevation that takes into account the best estimates of future sea level rise and current flood protection and planned flood protection…for the proposed project or shoreline area. A range of sea level rise projections for mid-century and end of century based on the best scientific data available should be used in the risk assessment." Policy No. 3 states that where such assessments show vulnerability to public safety, projects "should be designed to be resilient to a mid-century sea level rise projection" and an "adaptive management plan should be developed to address long-term impacts" of sea level rise at the end of century.

The project includes both habitat features and shoreline protection. For the project site, the DEIR should identify the Mean Higher High Water, the 100-year-flood elevation, mid- and end-of-century rise in sea level projections, anticipated site-specific storm surge effects, and a preliminary assessment of the project's vulnerability to future flooding and sea level rise. The Commission currently uses the OPC 2018 State Guidance on Sea Level Rise, which the Commission considers the best available science on sea level rise. Please use this document when evaluating the project design and potential future flooding and sea level rise impacts. The DEIR should also describe how the project has been designed for adapting to, tolerating, and managing sea level rise and shoreline flooding at the site to ensure the project is resilient to mid-century sea level rise projections, and how it may adapt to end of the century projections. The DEIR should indicate whether any proposed long-term adaptation strategies would adversely affect or reduce in size public access areas, and possible ways to minimize these effects.

The low-lying Canal neighborhood adjacent to the project site is currently below the FEMA 100-year flood and may be increasingly susceptible to sea level rise, as stated in the project description. The existing berm around the project site is an un-accredited berm and is below the 100-year base flood elevation plus the required two feet of free board. There is a mention that the current Tiscornia Marsh and Pickleweed Park shoreline levee segments are currently at risk of overtopping during an extreme coastal flood event, and resulting in flooding in some portions of the Canal neighborhood. The DEIR should include more detail on how the new shoreline protection will meet the flood protection goals of the project and protect the upland land uses from future flooding and sea level rise.

Shoreline Protection

The Bay Plan establishes criteria by which new shoreline protection projects may be authorized and by which existing shoreline protection may be maintained or reconstructed. Shoreline Protection Policy No. 1 requires that shoreline protection be authorized if it is necessary to provide flood or erosion protection for an existing development, use, or infrastructure, or for a proposed development, use, or infrastructure. Further, the policy requires that the shoreline protection be appropriate for the project site, uses to be protected, and the causes or conditions of erosion and flooding at the site. And, that the project is properly engineered to "provide erosion control and flood protection for the expected life of the project based on a 100-year flood event that takes future sea level rise into account." Additionally, Shoreline Protection Policy No. 4 requires that "shoreline protection projects should include provisions for nonstructural methods such as marsh vegetation and integrate shoreline protection and Bay ecosystem enhancement, using adaptive management," whenever feasible and appropriate. New shoreline protection projects are also required to avoid adverse impacts to natural resources and public access, and provide mitigation or alternative public access when avoidance is not possible.

The DEIR should catalog the existing shoreline protection structures at the project site and identify where maintenance or reconstruction is required. The DEIR should also discuss in detail the proposed methods for new shoreline protection, including an analysis of the potential to adversely impact natural resources or public access, and an evaluation of the appropriateness of the protection for the project site, including shoreline orientation, wave climate, geotechnical stability, etc. The proposed project includes some traditional methods of shoreline protection, such as levees and the jetty, and softer shoreline protection methods in some areas, such as the beach, marsh, and transitional zone habitats. If there are areas of shoreline protection where softer methods are not proposed, please consider if they would be feasible in those locations. Please also address the stability of the "flexible jetty structure" and the beach in the DEIR. These features would occur near the navigation channel used by boats and the DEIR should analyze the stability of this feature and appropriateness for the site. The DEIR should evaluate the appropriateness of the shoreline protection design for the existing physical and biological conditions at the site and future sea level rise conditions based upon the life of the project.

The project description mentions that construction may occur over a three to four-year period and that the diked marsh area would be restored prior to the construction of the beach and tidal marsh habitat out into the Bay, to the extent feasible. The DEIR should evaluate the timing of this construction with receiving dredged sediment and the construction of the beach, which seems to need to be constructed in phases. The DEIR should clarify the beach construction timing/duration and update the construction timing if necessary.

Beneficial Reuse

The Bay Plan Dredging Policy No. 11(a) requires that a site meet a number of criteria to be approved for beneficial reuse of dredged sediment to create, restore, or enhance natural resources of the Bay. The project needs to: (1) include detailed site specific studies appropriate to the size and potential impact of the project that include, but are not limited to site morphology and physical conditions, biological considerations, the potential for fostering invasive species, dredged sediment stability, and engineering aspects of the project, (2) include adequate monitoring and a management plan to help ensure the success and permanence of the project and that an agency or organization with fish and wildlife expertise will manage and operate the site for the life of the project, (3) use only clean sediment suitable for aquatic disposal and after the input from the Regional Water Quality Control Board, Dredged Material Management Office and other appropriate agencies on sediment suitability has occurred, (4) not place dredged sediment in areas with high or rare existing natural resource values, such as eelgrass beds and tidal marsh and mudflats, unless the material would be needed to protect or enhance habitat, and would not significantly decrease the overall amount of any particular habitat within the embayments of San Francisco Estuary, (5) have at least one of the agencies (CDFW, NMFS, and USFWS) that supports the proposed project, and (6) include designs and goals that incorporate the best available science on the use of dredged sediment for habitat projects. Additionally, if the project is considered a research or pilot project, there are criteria laid out in Policy No. 11(c) to evaluate whether the site should be approved for beneficial reuse.

The DEIR should address the appropriateness of the project design and construction methods to the particular site, and the address the criteria mentioned above in order for the site to be approved for accepting and using dredged sediment to create tidal marsh habitat. The DEIR should also address the site specific and regional context of the habitat conversion from mudflats to tidal marsh that would occur and analyze whether this project alone or cumulatively with other projects would decrease the overall amount of tidal marsh habitat near the site and within the larger regional context. Regarding sediment containment, please include additional detail on how the sediment would be contained in areas where the beach is not being constructed. If other methods of placement may be used, including hydraulic placement of dredged sediment, this method should also be evaluated in the DEIR.

Navigational Safety

The DEIR should include an analysis of the placement of the crane platform and offloading area for barges delivering dredged sediment or equipment and their potential location near the navigation channel within San Rafael Creek and how impacts to navigation can be reduced during the project construction.

Environmental Justice

The Commission adopted policies on Environmental Justice and Social Equity in late 2019, those policies are now in effect. The project site is located adjacent to the Al Boro Community, Pickleweed Park, and the nearby Canal neighborhood in the City of San Rafael. The Canal neighborhood is low-lying in elevation and is adjacent to Tiscornia Marsh. The project appears to be located in an area that the Commission's Community Vulnerability Mapping Tool indicates has the highest social vulnerability and high contamination vulnerability. The Bay Plan Environmental Justice and Social Equity Policy No. 4 requires that projects occurring in identified vulnerable communities include the impacted community in discussions of potential disproportionate impacts, and that the project include measures to mitigate for any disproportionate adverse impacts on the vulnerable community that may be identified. The DEIR should provide detail on how the planning process for the project includes environmental justice and social equity considerations in the project designs. This information on the planning process should include details on how the project has included and/or will include equitable, culturally-relevant community outreach and engagement to potentially impacted communities in underrepresented, vulnerable, or disadvantaged communities near the project site. This information should also include how community concerns were addressed.

Public Trust

The public trust doctrine holds that navigable waters and tidal lands are the property of the state and must be protected for public use and enjoyment. The Bay Plan policies on public trust lands state, in part, that when taking actions on such land, the Commission "should assure that the action is consistent with the public trust needs for the area and, in the case of lands subject to legislative grants, would also assure that the terms of the grant are satisfied and the project is in furtherance of statewide purposes." Public trust uses cited in the Bay Plan include commerce, navigation, fisheries, wildlife habitat, recreation, and open space. The DEIR should indicate where the State's public trust requirements apply to the proposed project, discuss how the project affects the public trust, and indicate that the Commission's determination regarding a project's consistency with the public trust doctrine is done independently and in consultation with the State Lands Commission.

Thank you for providing the staff with an opportunity to review the NOP and associated documents for the Tiscornia Marsh Restoration Project. We recognize the importance and scope of this project and hope these comments aid you in preparation of the DEIR. We look forward to working with you and the project sponsors as the project is developed and through the permitting stage. If you have any questions regarding this letter or the Commission's policies and permitting process, please do not hesitate to contact me at 415/352-3624 or anniken.lydon@bcdc.ca.gov.

Sincerely,

DocuSigned by:
Anniken Lydon
CA403961512F409...

ANNIKEN LYDON
Senior Environmental Scientist (Specialist)

AL/ra

cc: State Clearinghouse
Ms. Barbara Salzman, Marin Audubon

State of California – Natural Resources Agency
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GAVIN NEWSOM, Governor
CHARLTON H. BONHAM, Director

March 22, 2021

Mr. Paul Jensen, Development Director
City of San Rafael, Community Development Department
1400 Fifth Avenue
San Rafael, CA 94901
Paul.Jensen@cityofsanrafael.org

Subject: Tiscornia Marsh Restoration Project, Notice of Preparation of a Draft Environmental Impact Report, SCH No. 2021020362, City of San Rafael, Marin County

Dear Mr. Jensen:

The California Department of Fish and Wildlife (CDFW) has reviewed the Notice of Preparation (NOP) of a draft Environmental Impact Report (EIR) for the Tiscornia Marsh Restoration Project (Project) pursuant to the California Environmental Quality Act (CEQA) (Pub. Resources Code, §21000 et seq.; hereafter CEQA; Cal. Code Regs., §15000 et seq.; hereafter CEQA Guidelines).

Thank you for the opportunity to provide comments and recommendations regarding those activities involved in the Project that are within CDFW's area of expertise and relevant to its statutory responsibilities (Fish and Game Code, §1802), and/or which are required to be approved by CDFW (CEQA Guidelines, §§15086, 15096 and 15204).

CDFW ROLE

CDFW is a Trustee Agency with responsibility under the California Environmental Quality Act (CEQA; Pub. Resources Code, §21000 et seq.) pursuant to CEQA Guidelines §15386 for commenting on projects that could impact fish, plant, and wildlife resources (e.g., biological resources). CDFW is also considered a Responsible Agency if a project would require discretionary approval, such as permits issued under the California Endangered Species Act (CESA), the Native Plant Protection Act, the Lake and Streambed Alteration (LSA) Program, and other provisions of the Fish and Game Code that afford protection to the state's fish and wildlife trust resources.

REGULATORY REQUIREMENTS

California Endangered Species Act

Please be advised that a CESA Incidental Take Permit (ITP) should be obtained pursuant to Fish and Game Code §2081(b) if the Project has the potential to result in take of plants or animals listed under CESA, either during construction or over the life of the Project. Take, as defined by Fish and Game Code §86 is to "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill". Issuance of a CESA ITP is subject to CEQA documentation. The CEQA document must specify impacts, mitigation measures, and a mitigation monitoring and reporting program. If the Project will impact CESA listed species, early consultation is encouraged, as significant modification to the Project and mitigation measures may be required in order to obtain a CESA ITP.

CEQA requires a Mandatory Finding of Significance if a project is likely to substantially impact threatened or endangered species (CEQA §§21001(c), 21083, and CEQA Guidelines §§15380, 15064, 15065). Impacts must be avoided or mitigated to less-than-significant levels unless the CEQA Lead Agency makes and supports Findings of Overriding Consideration (FOC). The CEQA Lead Agency's FOC does not eliminate the Project proponent's obligation to comply with Fish and Game Code §2080.

Lake and Streambed Alteration Agreement

CDFW requires an LSA Notification, pursuant to Fish and Game Code §1600 et. seq., for Project activities affecting lakes or streams. Notification is required for any activity that may substantially divert or obstruct the natural flow; change or use material from the bed, channel, or bank including associated riparian or wetland resources; or deposit or dispose of material where it may pass into a river, lake, or stream. Work within ephemeral streams, washes, watercourses with a subsurface flow, and floodplains are subject to notification requirements. CDFW will consider the CEQA document for the Project and may issue an LSA Agreement. CDFW may not execute the final LSA Agreement until it has complied with CEQA as a Responsible Agency.

Migratory Birds and Raptors

CDFW also has authority over actions that may disturb or destroy active nest sites or take birds without authorization. Fish and Game Code §§3503, 3503.5, and 3513 protect birds, their eggs, and nests. Fully protected bird species may not be taken or possessed at any time, except for necessary scientific research, including efforts for recovery (Fish and Game Code, §3511). Migratory birds are also protected under the federal Migratory Bird Treaty Act.

PROJECT LOCATION

The Project is an approximately 20-acre site consisting of tidal marsh and bay lands located north and outboard of East Canal Street (APN 009-142-01). The marsh/bay lands property is owned by the Marin Audubon Society and is surrounded on the south by a shoreline levee, Schoen Park (small, city-owned park and playground), and Canal

Street; on the west by the city-owned Albert J. Boro Community Center and Pickleweed Park; on the east by San Rafael Bay; and on the north by San Rafael Creek.

PROJECT DESCRIPTION

The Project includes restoration of tidal marsh and mudflats north and outboard of Canal Street, as well as restoration of the city-owned diked marsh north of the Community Center and Pickleweed Park playfields. Major elements of the Project include restoring the Tiscornia Marsh site to its former extent by beneficially reusing dredged material from local sources, restoring tidal action to the diked marsh, constructing a coarse beach along the bayward edge of the restored marsh to resist future erosion, constructing a new 600-foot setback levee, development of an ecotone slope, and improving approximately 1,100 feet of shoreline levee to achieve flood protection, public access, and habitat benefits. The overall Project will reconstruct approximately four acres of eroded tidal marsh, preserve and protect approximately eight acres of Tiscornia Marsh, and restore approximately five acres of diked marsh by reconnecting it to tidal inundation.

The CEQA Guidelines (§§15124 and 15378) require that the draft EIR incorporate a full project description, including reasonably foreseeable future phases of the Project, and that contains sufficient information to evaluate and review the Project's environmental impact. Please include a complete description of the following Project components in the Project description: footprint of permanent Project features and temporarily impacted areas, including staging areas and access routes; quantification of any habitat type conversion, such as conversion of tidal mudflat to tidal marsh; encroachment into wetland habitat, mudflat habitat, San Rafael Creek, eelgrass beds, or other sensitive areas; description of dredging methodology (i.e., mechanical dredging versus hydraulic dredging); potential sources of dredged material, including use of material dredged from San Rafael Creek; methods of importing, offloading, and placement of any dredged material; public access elements including trails or overlooks and anticipated level of human presence; phasing/timing of Project; any short-term or long-term use of artificial lighting; and construction schedule, activities, equipment, and crew sizes.

ENVIRONMENTAL SETTING

Marine Biological Significance

The San Francisco Bay-Delta is the second largest estuary in the United States and supports numerous aquatic habitats and biological communities. It encompasses 479 square miles, including shallow mudflats. This ecologically significant ecosystem supports both state and federally threatened and endangered species and sustains important commercial and recreational fisheries.

CDFW therefore offers the comments and recommendations below to assist the City of San Rafael in adequately identifying and/or mitigating the Project's significant, or potentially significant, direct and indirect impacts on special-status species and their habitats.

Special-Status Species

Sufficient information regarding the environmental setting is necessary to understand the Project's and its alternatives' significant impacts on the environment (CEQA Guidelines, §§15125 & 15360). CDFW recommends that the draft EIR provide baseline habitat assessments for special-status plant, fish, and wildlife species located and potentially located within the Project area and surrounding lands, including all rare, threatened, or endangered species (CEQA Guidelines, §15380).

Fully protected, threatened or endangered, candidate, and other special-status and sensitive species that are known to occur, or have the potential to occur in or near the Project site, include, but are not limited to:

- California Ridgway's rail (*Rallus obsoletus obsoletus*), federally and State endangered and State fully protected,
- California black rail (*Laterallus jamaicensis coturniculus*), State threatened and State fully protected,
- Brown Pelican (*Pelecanus occidentalis californicus*), State fully protected,
- Salt-marsh harvest mouse (*Reithrodontomys raviventris*), federally and State endangered and State fully protected,
- Longfin smelt (*Spirinchus thaleichthys*), federal candidate and State threatened,
- Chinook salmon (*Oncorhynchus tshawytscha*), federally and State threatened (Spring-run), federal and State endangered (Winter-run),
- Steelhead (*O. mykiss*), federally threatened (Central California Coast and Central Valley Evolutionarily Significant Units),
- Green sturgeon (*Acipenser medirostris*), federally threatened and State species of special concern (southern Distinct Population Segment),
- White sturgeon (*A. transmontanus*), State species of special concern,
- Western snowy plover (*Charadrius nivosus nivosus*), federally threatened and State species of special concern,
- Burrowing owl (*Athene cunicularia*), State species of special concern,
- Saltmarsh common yellowthroat (*Geothlypis trichas sinuosa*), State species of special concern,

- San Pablo song sparrow (*Melospiza melodia samuelis*), State species of special concern,
- Yellow rail (*Coturnicops noveboracensis*), State species of special concern,
- Western pond turtle (*Emys marmorata*), State species of special concern,
- Nesting and foraging migratory birds.

Several species with important commercial and recreational fisheries value that could potentially be impacted by Project activities include:

- Dungeness crab (*Cancer magister*),
- Pacific herring (*Clupea pallasii*),
- Rockfish (*Sebastes* spp.),
- California halibut (*Paralichthys californicus*),
- Surfperches (*Embiotocidae*).

Habitat descriptions and species profiles should include information from multiple sources such as aerial imagery, available historical and recent survey data, field reconnaissance, scientific literature and reports, and findings from “positive occurrence” databases such as California Natural Diversity Database (CNDDB). Based on the data and information from the habitat assessment, the CEQA document can then adequately assess which special-status species are likely to occur in the Project vicinity.

CDFW recommends that during Project planning and prior to Project implementation, surveys be conducted for special-status species with potential to occur, following recommended survey protocols if available. Survey and monitoring protocols and guidelines for some species are available at: https://wildlife.ca.gov/Conservation/Survey-Protocols.

Botanical surveys for special-status plant species, including those listed by the California Native Plant Society (http://www.cnps.org/cnps/rareplants/inventory/), should be conducted during the appropriate blooming period for all sensitive plant species potentially occurring within the Project area and require the identification of reference populations. Please refer to CDFW protocols for surveying and evaluating impacts to rare plants available at: https://www.wildlife.ca.gov/Conservation/Plants.

IMPACT ANALYSIS AND MITIGATION MEASURES

The CEQA Guidelines (§15126.2) necessitate that the draft EIR discuss all direct and indirect impacts (temporary and permanent) that may occur with implementation of the Project. This includes evaluating and describing impacts such as:

- Potential for "take" of special-status species;
- Loss or modification of breeding, nesting, dispersal, and foraging habitat, due to Project activities including, but not limited to, vegetation removal, alteration of soils and hydrology, and removal of habitat structural features;
- Permanent and temporary habitat disturbances associated with ground disturbance, noise, lighting, reflection, air pollution, traffic, or human presence; and
- Obstruction of movement corridors, fish passage, or access to water sources and other core habitat features.

The CEQA document also should identify reasonably foreseeable future projects in the Project vicinity, disclose any cumulative impacts associated with these projects, determine the significance of each cumulative impact, and assess the significance of the Project's contribution to the impact (CEQA Guidelines, §15355). Although a project's impacts may be insignificant individually, its contributions to a cumulative impact may be considerable. Contribution to a significant cumulative impact (e.g., reduction of available habitat for a listed species) should be considered cumulatively considerable without mitigation to minimize or avoid the impact.

Based on the comprehensive analysis of the direct, indirect, and cumulative impacts of the Project, the CEQA Guidelines (§§15021, 15063, 15071, 15126.2, 15126.4 and 15370) direct the Lead Agency to consider and describe all feasible mitigation measures to avoid potentially significant impacts in the draft EIR, and/or mitigate significant impacts of the Project on the environment. This includes a discussion of take avoidance and minimization measures for special-status species, which are recommended to be developed in early consultation with the U.S. Fish and Wildlife Service (USFWS), the National Marine Fisheries Service and CDFW. These measures can then be incorporated as enforceable Project conditions to reduce potential impacts to biological resources to less-than-significant levels.

Measures recommended by CDFW to avoid and minimize impacts to special-status species include, but are not limited to, clearly marking suitable habitat for the species; minimizing ground disturbance and the removal of vegetation suitable for the species; utilizing seasonal work windows; and having a CDFW-approved qualified biologist present during Project activities.

Impacts to State Fully Protected Species

State fully protected species such as California Ridgway's rail, California black rail, brown pelican, and salt-marsh harvest mouse may occur within the Project area. State fully protected species may not be taken or possessed at any time except for necessary scientific research, including efforts for recovery (Fish and Game Code §§3511 and

4700). Therefore, the draft EIR should include measures to ensure complete take avoidance of these fully protected species.

Measures to avoid impacts to rails may include, but are not limited to, having a CDFW-approved qualified biologist conduct surveys for both California Ridgway's rail and California black rail using protocols in coordination with staff from CDFW and the USFWS; avoiding Project activities during the rail breeding season (extends from February 1 to August 31); implementing a no-work buffer within a minimum 700 feet of breeding rail call centers; and utilization of portable acoustic and/or visual barriers between Project activities and rails.

Measures to avoid impacts to salt-marsh harvest mouse may include, but are not limited to, conducting removal of vegetation suitable for the species with non-motorized hand tools; limiting the number of workers conducting vegetation removal per qualified biologist on-site; conducting vegetation removal in the direction of large, contiguous suitable habitat that will remain undisturbed; placing stockpiled vegetation outside of areas where they may be recolonized by the species; and staging equipment and materials away from suitable habitat for the species.

Impacts to Other State Special-Status Species and Commercially/Recreationally Important Species

State threatened or endangered fish and wildlife species, State species of special concern, and commercially/recreationally important species may occur within the Project area. Depending on the proposed methods and time of year work is conducted, and without appropriate mitigation measures, the Project could potentially have a significant impact on these species. Potential impacts to special-status and commercially/ recreationally important species include, but are not limited to, hydroacoustic impacts caused from impact pile driving during crane platform construction; potential for entrainment and/or impingement of fish and invertebrates from suction dredging and placement of dredged material via slurry pumping; impacts to Pacific herring spawning habitat; injury to aquatic species due to decreased dissolved oxygen; inability of aquatic species to forage due to increased turbidity; reduced reproductive success; nest abandonment; loss of nesting and foraging habitat; impacts to wetland and tidal mudflat habitat; loss of habitat due to habitat type conversion; and direct mortality. Unauthorized take of species listed as threatened or endangered pursuant to CESA is a violation of Fish and Game Code.

If State species of special concern are found within or adjacent to the Project site, a qualified biologist should establish a no-disturbance buffer appropriate for the species and conduct on-site monitoring during all Project-related activities. The draft EIR should include additional minimization and mitigation measures for each State species of special concern that could be potentially impacted by Project activities.

Impacts to Nesting Birds

CDFW recommends that Project implementation occur during the bird non-nesting season. However, if ground-disturbing or vegetation-disturbing activities must occur during the breeding season [February through early-September (see above under State Fully Protected Species regarding the rail breeding season)], the Project applicant is responsible for ensuring that implementation of the Project does not result in violation of the Migratory Bird Treaty Act or Fish and Game Code.

To evaluate and avoid potential impacts to nesting bird species, CDFW recommends that a qualified avian biologist conduct surveys for active nests no more than seven (7) days prior to the start of Project activities involving ground or vegetation disturbance and every fourteen (14) days during Project activities to maximize the probability that active nests within the construction area are detected. CDFW also recommends that surveys cover a sufficient area around the Project site to identify nests and determine their status. A sufficient area means any area potentially affected by the Project. Prior to initiation of ground or vegetation disturbance, CDFW recommends that a qualified biologist conduct surveys to establish a behavioral baseline of all identified nests. Once Project activities begins, CDFW recommends having the qualified biologist continuously monitor nests to detect behavioral changes resulting from the Project. If behavioral changes (e.g., alertness, sitting up from brooding position, flying off the nest, alarm calling, etc.) occur, CDFW recommends halting the work causing that change and consulting with CDFW for additional avoidance and minimization measures.

If continuous monitoring of identified nests by a qualified avian biologist is not feasible, CDFW recommends implementing appropriate buffers around active nests based on species, behavior of birds, ambient noise levels, type of construction activities, topography, and other site-specific factors that may affect nesting bird disturbance levels (see above under State Fully Protected Species regarding buffers for rails). Buffers are advised to remain in place until the breeding season has ended or until a qualified biologist has determined that the birds have fledged and are no longer reliant upon the nest or on-site parental care for survival. Variance from these buffers is possible when there is compelling biological or ecological reason to do so, such as when the Project site would be concealed from a nest site by topography. CDFW recommends that a qualified avian biologist advise and support any variance from these buffers.

Impacts to Special-Status Plant Species

State threatened, endangered or rare plant species may occur within the Project location. Without appropriate mitigation measures, the Project could potentially have a significant impact on these species. Potential impacts to special-status plants include inability to reproduce and direct mortality. Unauthorized take of plant species listed as threatened, endangered, or rare pursuant to CESA or the Native Plant Protection Act is a violation of Fish and Game Code.

Special-status plants are typically narrowly distributed endemic species. These species are susceptible to habitat loss and habitat fragmentation resulting from construction activities, vehicle and foot traffic, and introduction of non-native plant species.

Special-status plant species should be avoided through delineation and establishment of appropriate buffers from the outer edge of the plant population or specific habitat type required by special-status plant species. Buffers may be determined based on factors including, but not limited to, plant species, type of construction activities, and topography.

Dredged Material as Marsh Fill

CDFW supports the beneficial reuse of dredged material within San Francisco Bay. However, the type of sediment used and the analysis of whether the material is free of potentially harmful substances will determine whether it is suitable at this location to create marsh habitat. Additionally, CDFW has concerns about how the material is dredged and subsequently placed at the site. CDFW recommends that the material be dredged and placed using mechanical methods such as a clamshell dredge or excavator to avoid and minimize potential impacts to sensitive species.

Habitat Conversion

The Project proposes to convert mudflat habitat to a functioning marsh and cobble beach. CDFW has concerns about the loss of mudflat habitat which is utilized by a number of listed and commercially/recreation important species including longfin smelt, chinook salmon, green sturgeon, Dungeness crab, and California halibut. The draft EIR should provide sufficient discussion and analysis on the potential impacts to these species by the loss of habitat. Additionally, the alternatives analysis should contain a range of options, including a reduced marsh and beach size, and whether the Project could still achieve the necessary flood protection by balancing the construction of new marsh/beach habitat and limiting the loss of existing mudflat.

In-Water Work Window

The marine in-water work window is June 1 through November 30. All in-water work should occur within this timeframe. The draft EIR should discuss the proposed Project timeline in detail and highlight whether any conflicts could arise with this work window. CDFW recommends reaching out to CDFW staff with any questions on work windows prior to the release of the draft EIR.

Construction of Overwater Structures

There may be potential impacts from the construction of any overwater structure related to the Project such as the crane platform. CDFW recommends that materials and methods used to construct any overwater structures be discussed in the draft EIR. Fish and Game Code states that it is unlawful to deposit into, permit to pass into, or place where it can pass into waters of the state any substance or material deleterious to fish, plant life, or bird life [Fish and Game Code Section §5650(6)]. CDFW recommends avoiding the use of treated wood materials in or above the waters of San Francisco Bay. CDFW also recommends that overwater structures use materials that will light penetration to the waters of the bay. This can be achieved by spacing deck boards one-inch apart or using slated/grated decking made of metal or composite materials. The draft EIR should discuss the preferred alternatives for pile and decking materials as well as the ability to include decking which allows light penetration.

Sea Level Rise

The State of California Sea-Level Rise Guidance/2018 Update (California Natural Resources Agency 2018) provides a science-based methodology for state and local governments to analyze and assess the risks associated with sea-level rise and incorporate sea-level rise into their planning, permitting, and investment decisions. The Marin Shoreline Sea Level Rise Vulnerability Assessment/Bay Waterfront Adaptation & Vulnerability Evaluation (BayWAVE) (Marin County 2017) provides context and estimates of the physical and fiscal impacts across Marin County's bayside shoreline over the coming decades. It includes sea level rise scenarios ranging from 10 inches in the near-term (15 years) to 20 inches in the medium-term (mid-century) and to 60 inches in the long-term (end of century). Since the Project intends to restore tidal marsh and mudflats that have been lost to erosion over the last 30 years, and that under current conditions, erosion is expected to continue and increase due to sea level rise, CDFW recommends incorporating the long-term (end of century) scenarios for sea level rise to fully evaluate Project impacts.

FILING FEES

CDFW anticipates that the Project will have an impact on fish and/or wildlife, and assessment of filing fees is necessary (Fish and Game Code, §711.4; Pub. Resources Code, §21089). Fees are payable upon filing of the Notice of Determination by the Lead Agency and serve to help defray the cost of environmental review by CDFW.

If you have any questions for staff in the Bay Delta Region, please contact Ms. Tami Schane, Senior Environmental Scientist (Specialist), at (415) 831-4640 or Tami.Schane@wildlife.ca.gov; or Ms. Brenda Blinn, Senior Environmental Scientist (Supervisory), at (707) 944-5541 or Brenda.Blinn@wildlife.ca.gov. For questions for staff in Marine Region, please contact Mr. Arn Aarreberg, Environmental Scientist, at (707) 576-2889 or Arn.Aarreberg@wildlife.ca.gov; or Mr. Eric Wilkins, Senior Environmental Scientist (Supervisory), at (805) 594-6172 or Eric.Wilkins@wildlife.ca.gov.

Sincerely,

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REFERENCES

California Natural Resources Agency. 2018. State of California Sea-level Rise Guidance. https://opc.ca.gov/webmaster/ftp/pdf/agenda_items/20180314/Item3_Exhibit-A_OPC_SLR_Guidance-rd3.pdf

Marin County. 2017. Marin Shoreline Sea Level Rise Vulnerability Assessment/Bay Waterfront Adaptation & Vulnerability Evaluation. Prepared by BVB Consulting LLC for Marin County Department of Public Works, June 2017. https://www.marincounty.org/-/media/files/departments/cd/planning/slr/baywave/vulnerability-assessment-final/final_allpages_bvbconsulting_reduced.pdf?la=en

NATIVE AMERICAN HERITAGE COMMISSION

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February 22, 2021

Paul Jensen
City of San Rafael
1400 5th Avenue
San Rafael, CA 94901

Re: 2021020362, Tiscornia Marsh Restoration Project, Marin County

Dear Mr. Jensen:

The Native American Heritage Commission (NAHC) has received the Notice of Preparation (NOP), Draft Environmental Impact Report (DEIR) or Early Consultation for the project referenced above. The California Environmental Quality Act (CEQA) (Pub. Resources Code §21000 et seq.), specifically Public Resources Code §21084.1, states that a project that may cause a substantial adverse change in the significance of a historical resource, is a project that may have a significant effect on the environment. (Pub. Resources Code § 21084.1; Cal. Code Regs., tit.14, §15064.5 (b) (CEQA Guidelines §15064.5 (b)). If there is substantial evidence, in light of the whole record before a lead agency, that a project may have a significant effect on the environment, an Environmental Impact Report (EIR) shall be prepared. (Pub. Resources Code §21080 (d); Cal. Code Regs., tit. 14, § 5064 subd.(a)(1) (CEQA Guidelines §15064 (a)(1)). In order to determine whether a project will cause a substantial adverse change in the significance of a historical resource, a lead agency will need to determine whether there are historical resources within the area of potential effect (APE).

CEQA was amended significantly in 2014. Assembly Bill 52 (Gatto, Chapter 532, Statutes of 2014) (AB 52) amended CEQA to create a separate category of cultural resources, "tribal cultural resources" (Pub. Resources Code §21074) and provides that a project with an effect that may cause a substantial adverse change in the significance of a tribal cultural resource is a project that may have a significant effect on the environment. (Pub. Resources Code §21084.2). Public agencies shall, when feasible, avoid damaging effects to any tribal cultural resource. (Pub. Resources Code §21084.3 (a)). **AB 52 applies to any project for which a notice of preparation, a notice of negative declaration, or a mitigated negative declaration is filed on or after July 1, 2015.** If your project involves the adoption of or amendment to a general plan or a specific plan, or the designation or proposed designation of open space, on or after March 1, 2005, it may also be subject to Senate Bill 18 (Burton, Chapter 905, Statutes of 2004) (SB 18). **Both SB 18 and AB 52 have tribal consultation requirements.** If your project is also subject to the federal National Environmental Policy Act (42 U.S.C. § 4321 et seq.) (NEPA), the tribal consultation requirements of Section 106 of the National Historic Preservation Act of 1966 (154 U.S.C. 300101, 36 C.F.R. §800 et seq.) may also apply.

The NAHC recommends consultation with California Native American tribes that are traditionally and culturally affiliated with the geographic area of your proposed project as early as possible in order to avoid inadvertent discoveries of Native American human remains and best protect tribal cultural resources. Below is a brief summary of portions of AB 52 and SB 18 as well as the NAHC's recommendations for conducting cultural resources assessments.

Consult your legal counsel about compliance with AB 52 and SB 18 as well as compliance with any other applicable laws.

AB 52

AB 52 has added to CEQA the additional requirements listed below, along with many other requirements:

1. Fourteen Day Period to Provide Notice of Completion of an Application/Decision to Undertake a Project: Within fourteen (14) days of determining that an application for a project is complete or of a decision by a public agency to undertake a project, a lead agency shall provide formal notification to a designated contact of, or tribal representative of, traditionally and culturally affiliated California Native American tribes that have requested notice, to be accomplished by at least one written notice that includes:

a. A brief description of the project.
b. The lead agency contact information.
c. Notification that the California Native American tribe has 30 days to request consultation. (Pub. Resources Code §21080.3.1 (d)).
d. A "California Native American tribe" is defined as a Native American tribe located in California that is on the contact list maintained by the NAHC for the purposes of Chapter 905 of Statutes of 2004 (SB 18). (Pub. Resources Code §21073).

2. Begin Consultation Within 30 Days of Receiving a Tribe's Request for Consultation and Before Releasing a Negative Declaration, Mitigated Negative Declaration, or Environmental Impact Report: A lead agency shall begin the consultation process within 30 days of receiving a request for consultation from a California Native American tribe that is traditionally and culturally affiliated with the geographic area of the proposed project. (Pub. Resources Code §21080.3.1, subds. (d) and (e)) and prior to the release of a negative declaration, mitigated negative declaration or Environmental Impact Report. (Pub. Resources Code §21080.3.1(b)).

a. For purposes of AB 52, "consultation shall have the same meaning as provided in Gov. Code §65352.4 (SB 18). (Pub. Resources Code §21080.3.1 (b)).

3. Mandatory Topics of Consultation If Requested by a Tribe: The following topics of consultation, if a tribe requests to discuss them, are mandatory topics of consultation:

a. Alternatives to the project.
b. Recommended mitigation measures.
c. Significant effects. (Pub. Resources Code §21080.3.2 (a)).

4. Discretionary Topics of Consultation: The following topics are discretionary topics of consultation:

a. Type of environmental review necessary.
b. Significance of the tribal cultural resources.
c. Significance of the project's impacts on tribal cultural resources.
d. If necessary, project alternatives or appropriate measures for preservation or mitigation that the tribe may recommend to the lead agency. (Pub. Resources Code §21080.3.2 (a)).

5. Confidentiality of Information Submitted by a Tribe During the Environmental Review Process: With some exceptions, any information, including but not limited to, the location, description, and use of tribal cultural resources submitted by a California Native American tribe during the environmental review process shall not be included in the environmental document or otherwise disclosed by the lead agency or any other public agency to the public, consistent with Government Code §6254 (r) and §6254.10. Any information submitted by a California Native American tribe during the consultation or environmental review process shall be published in a confidential appendix to the environmental document unless the tribe that provided the information consents, in writing, to the disclosure of some or all of the information to the public. (Pub. Resources Code §21082.3 (c)(1)).

6. Discussion of Impacts to Tribal Cultural Resources in the Environmental Document: If a project may have a significant impact on a tribal cultural resource, the lead agency's environmental document shall discuss both of the following:

a. Whether the proposed project has a significant impact on an identified tribal cultural resource.
b. Whether feasible alternatives or mitigation measures, including those measures that may be agreed to pursuant to Public Resources Code §21082.3, subdivision (a), avoid or substantially lessen the impact on the identified tribal cultural resource. (Pub. Resources Code §21082.3 (b)).

7. Conclusion of Consultation: Consultation with a tribe shall be considered concluded when either of the following occurs:

a. The parties agree to measures to mitigate or avoid a significant effect, if a significant effect exists, on a tribal cultural resource; or

b. A party, acting in good faith and after reasonable effort, concludes that mutual agreement cannot be reached. (Pub. Resources Code §21080.3.2 (b)).

8. Recommending Mitigation Measures Agreed Upon in Consultation in the Environmental Document: Any mitigation measures agreed upon in the consultation conducted pursuant to Public Resources Code §21080.3.2 shall be recommended for inclusion in the environmental document and in an adopted mitigation monitoring and reporting program, if determined to avoid or lessen the impact pursuant to Public Resources Code §21082.3, subdivision (b), paragraph 2, and shall be fully enforceable. (Pub. Resources Code §21082.3 (a)).

9. Required Consideration of Feasible Mitigation: If mitigation measures recommended by the staff of the lead agency as a result of the consultation process are not included in the environmental document or if there are no agreed upon mitigation measures at the conclusion of consultation, or if consultation does not occur, and if substantial evidence demonstrates that a project will cause a significant effect to a tribal cultural resource, the lead agency shall consider feasible mitigation pursuant to Public Resources Code §21084.3 (b). (Pub. Resources Code §21082.3 (e)).

10. Examples of Mitigation Measures That, If Feasible, May Be Considered to Avoid or Minimize Significant Adverse Impacts to Tribal Cultural Resources:

a. Avoidance and preservation of the resources in place, including, but not limited to:

i. Planning and construction to avoid the resources and protect the cultural and natural context.

ii. Planning greenspace, parks, or other open space, to incorporate the resources with culturally appropriate protection and management criteria.

b. Treating the resource with culturally appropriate dignity, taking into account the tribal cultural values and meaning of the resource, including, but not limited to, the following:

i. Protecting the cultural character and integrity of the resource.

ii. Protecting the traditional use of the resource.

iii. Protecting the confidentiality of the resource.

c. 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.

d. Protecting the resource. (Pub. Resource Code §21084.3 (b)).

e. Please note that a federally recognized California Native American tribe or a non-federally recognized California Native American tribe that is on the contact list maintained by the NAHC to protect a California prehistoric, archaeological, cultural, spiritual, or ceremonial place may acquire and hold conservation easements if the conservation easement is voluntarily conveyed. (Civ. Code §815.3 (c)).

f. Please note that it is the policy of the state that Native American remains and associated grave artifacts shall be repatriated. (Pub. Resources Code §5097.991).

11. Prerequisites for Certifying an Environmental Impact Report or Adopting a Mitigated Negative Declaration or Negative Declaration with a Significant Impact on an Identified Tribal Cultural Resource: An Environmental Impact Report may not be certified, nor may a mitigated negative declaration or a negative declaration be adopted unless one of the following occurs:

a. The consultation process between the tribes and the lead agency has occurred as provided in Public Resources Code §21080.3.1 and §21080.3.2 and concluded pursuant to Public Resources Code §21080.3.2.

b. The tribe that requested consultation failed to provide comments to the lead agency or otherwise failed to engage in the consultation process.

c. The lead agency provided notice of the project to the tribe in compliance with Public Resources Code §21080.3.1 (d) and the tribe failed to request consultation within 30 days. (Pub. Resources Code §21082.3 (d)).

The NAHC's PowerPoint presentation titled, "Tribal Consultation Under AB 52: Requirements and Best Practices" may be found online at: http://nahc.ca.gov/wp-content/uploads/2015/10/AB52TribalConsultation_CalEPAPDF.pdf

SB 18

SB 18 applies to local governments and requires local governments to contact, provide notice to, refer plans to, and consult with tribes prior to the adoption or amendment of a general plan or a specific plan, or the designation of open space. (Gov. Code §65352.3). Local governments should consult the Governor's Office of Planning and Research's "Tribal Consultation Guidelines," which can be found online at: https://www.opr.ca.gov/docs/09_14_05_Updated_Guidelines_922.pdf.

Some of SB 18's provisions include:

1. Tribal Consultation: If a local government considers a proposal to adopt or amend a general plan or a specific plan, or to designate open space it is required to contact the appropriate tribes identified by the NAHC by requesting a "Tribal Consultation List." If a tribe, once contacted, requests consultation the local government must consult with the tribe on the plan proposal. **A tribe has 90 days from the date of receipt of notification to request consultation unless a shorter timeframe has been agreed to by the tribe.** (Gov. Code §65352.3 (a)(2)).
2. No Statutory Time Limit on SB 18 Tribal Consultation. There is no statutory time limit on SB 18 tribal consultation.
3. Confidentiality: Consistent with the guidelines developed and adopted by the Office of Planning and Research pursuant to Gov. Code §65040.2, the city or county shall protect the confidentiality of the information concerning the specific identity, location, character, and use of places, features and objects described in Public Resources Code §5097.9 and §5097.993 that are within the city's or county's jurisdiction. (Gov. Code §65352.3 (b)).
4. Conclusion of SB 18 Tribal Consultation: Consultation should be concluded at the point in which:
    - **a.** The parties to the consultation come to a mutual agreement concerning the appropriate measures for preservation or mitigation; or
    - **b.** Either the local government or the tribe, acting in good faith and after reasonable effort, concludes that mutual agreement cannot be reached concerning the appropriate measures of preservation or mitigation. (Tribal Consultation Guidelines, Governor's Office of Planning and Research (2005) at p. 18).

Agencies should be aware that neither AB 52 nor SB 18 precludes agencies from initiating tribal consultation with tribes that are traditionally and culturally affiliated with their jurisdictions before the timeframes provided in AB 52 and SB 18. For that reason, we urge you to continue to request Native American Tribal Contact Lists and "Sacred Lands File" searches from the NAHC. The request forms can be found online at: http://nahc.ca.gov/resources/forms/.

NAHC Recommendations for Cultural Resources Assessments

To adequately assess the existence and significance of tribal cultural resources and plan for avoidance, preservation in place, or barring both, mitigation of project-related impacts to tribal cultural resources, the NAHC recommends the following actions:

1. Contact the appropriate regional California Historical Research Information System (CHRIS) Center (http://ohp.parks.ca.gov/?page_id=1068) for an archaeological records search. The records search will determine:
    - **a.** If part or all of the APE has been previously surveyed for cultural resources.
    - **b.** If any known cultural resources have already been recorded on or adjacent to the APE.
    - **c.** If the probability is low, moderate, or high that cultural resources are located in the APE.
    - **d.** If a survey is required to determine whether previously unrecorded cultural resources are present.

2. If an archaeological inventory survey is required, the final stage is the preparation of a professional report detailing the findings and recommendations of the records search and field survey.
    - **a.** The final report containing site forms, site significance, and mitigation measures should be submitted immediately to the planning department. 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.
    - **b.** The final written report should be submitted within 3 months after work has been completed to the appropriate regional CHRIS center.

3. Contact the NAHC for:

a. A Sacred Lands File search. Remember that tribes do not always record their sacred sites in the Sacred Lands File, nor are they required to do so. A Sacred Lands File search is not a substitute for consultation with tribes that are traditionally and culturally affiliated with the geographic area of the project's APE.

b. A Native American Tribal Consultation List of appropriate tribes for consultation concerning the project site and to assist in planning for avoidance, preservation in place, or, failing both, mitigation measures.

4. Remember that the lack of surface evidence of archaeological resources (including tribal cultural resources) does not preclude their subsurface existence.

a. Lead agencies should include in their mitigation and monitoring reporting program plan provisions for the identification and evaluation of inadvertently discovered archaeological resources per Cal. Code Regs., tit. 14, §15064.5(f) (CEQA Guidelines §15064.5(f)). In areas of identified archaeological sensitivity, a certified archaeologist and a culturally affiliated Native American with knowledge of cultural resources should monitor all ground-disturbing activities.

b. Lead agencies should include in their mitigation and monitoring reporting program plans provisions for the disposition of recovered cultural items that are not burial associated in consultation with culturally affiliated Native Americans.

c. Lead agencies should include in their mitigation and monitoring reporting program plans provisions for the treatment and disposition of inadvertently discovered Native American human remains. Health and Safety Code §7050.5, Public Resources Code §5097.98, and Cal. Code Regs., tit. 14, §15064.5, subdivisions (d) and (e) (CEQA Guidelines §15064.5, subds. (d) and (e)) address the processes to be followed in the event of an inadvertent discovery of any Native American human remains and associated grave goods in a location other than a dedicated cemetery.

If you have any questions or need additional information, please contact me at my email address: Nancy.Gonzalez-Lopez@nahc.ca.gov.

Sincerely,

Nancy Gonzalez

Nancy Gonzalez-Lopez
Cultural Resources Analyst

cc: State Clearinghouse

Appendix B

Topics Not Requiring Detailed Environmental Analysis

ESA

APPENDIX B

Topics Not Requiring Detailed Environmental Analysis

B.1 Introduction

The environmental impact report (EIR) for the Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation Project (Proposed Project, or Project) evaluates the environmental effects of the restoration of former tidal marshlands and improvement of a shoreline levee on a 28-acre site at the confluence of San Rafael Creek and San Rafael Bay. Sections 3.2 through 3.6 of the EIR address topics for which the Project components could have a significant impact, and that require detailed environmental analysis. This appendix addresses topics for which it was found that the Project components would not have a significant impact, or where project components could have a significant impact but where a detailed environmental analysis is not required to understand the potential significant impact. The topics considered in this appendix include:

- Agriculture & Forestry Resources
- Cultural Resources
- Energy
- Geology & Soils
- Hazards & Hazardous Materials
- Land Use & Planning
- Mineral Resources
- Noise & Vibration
- Population & Housing
- Public Services
- Recreation
- Transportation
- Tribal Cultural Resources
- Utilities & Service Systems
- Wildfire

B.2 Agriculture & Forestry Resources

Issues (and Supporting Information Sources):	*Potentially Significant Impact*	*Less-than-Significant Impact with Mitigation*	*Less-than-Significant Impact*	*No Impact*
AGRICULTURE & FORESTRY RESOURCES — In determining whether impacts on agricultural resources are significant environmental effects, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (1997) prepared by the California Department of Conservation as an optional model to use in assessing impacts on agriculture and farmland. In determining whether impacts on forest resources (including timberland) are significant environmental effects, lead agencies may refer to information compiled by the California Department of Forestry and Fire Protection regarding the state's inventory of forest land, including the Forest and Range Assessment Project and the Forest Legacy Assessment project; and forest carbon measurement methodology provided in Forest Protocols adopted by the California Air Resources Board. Would the Project:				
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	☐	☐	☐	☒
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?	☐	☐	☐	☒
c) Conflict with existing zoning for, or cause rezoning of, forest land (as defined in Public Resources Code Section 12220(g)), timberland (as defined by Public Resources Code Section 4526), or timberland zoned Timberland Production (as defined by Government Code Section 51104(g))?	☐	☐	☐	☒
d) Result in the loss of forest land or conversion of forest land to non-forest use?	☐	☐	☐	☒
e) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland to non-agricultural use or conversion of forest land to non-forest use?	☐	☐	☐	☒

Environmental Setting

The California Department of Conservation (DOC) administers the Farmland Mapping and Monitoring Program (FMMP), California's statewide agricultural land inventory. Through this mapping effort, the DOC classifies farmland into four categories: Prime Farmland, Farmland of Statewide Importance, Unique Farmland, and Farmland of Local Importance. The Project site is designated as other land, with Urban and Built-Up Land located immediately adjacent to the Project site, as indicated by the DOC (DOC 2016).

The Williamson Act, also known as the California Land Conservation Act of 1965, enables local governments to enter into contracts with private landowners for the purpose of restricting specific parcels of land to agricultural or related open-space use. There are no active Williamson Act contracts within the Project site (DOC 2019).

Forest land is defined as native tree cover greater than 10 percent. Timberland is forest land available for harvest and has the capacity to be harvested over a long period of time. No forest lands or timberlands are located within the Project site.

Discussion

a) through e) Would the Project convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use? Would the Project conflict with existing zoning for agricultural use, or a Williamson Act contract? Would the project conflict with existing zoning for, or cause rezoning of, forest land (as defined in Public Resources Code Section 12220(g)), timberland (as defined by Public Resources Code Section 4526), or timberland zoned Timberland Production (as defined by Government Code Section 51104(g))? Would the Project result in the loss of forest land or conversion of forest land to non-forest use? Would the Project involve other changes in the existing environment that, due to their location or nature, could result in conversion of Farmland, to non-agricultural use or conversion of forest land to non-forest use? (*No Impact*)

The Proposed Project is not zoned for agriculture (it is zoned Parks/Open Space, Planned Development, and Water Zoning Districts with a Wetlands Overlay and a Canalfront Review Overlay); further, it is not located in an area that contains any Prime Farmland, Unique Farmland, Farmland of Statewide Importance, or Williamson Act contracts. The nearest farmland includes Farmland of Local Importance, approximately 4 miles north and 3.5 miles south of the Project site. Similarly, the Project site does not include any existing forest land, timberland, or timberland zoned Timberland Production; nor do any exist near the Project site. For these reasons, construction and operation of the Proposed Project would not involve the conversion of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to non-agricultural use, nor would it conflict with an active Williamson Act contract. Further, the Proposed Project would not result in the conversion of existing forest or timberland, or conflict with existing agricultural or forestry land policies or zoning. Therefore, there would be **no impact** on farmland and forestry resources.

Cumulative Impacts

f) Would the Project in combination with reasonably foreseeable future projects, result in significant cumulative impacts on farmland and forestry resources? (*No Impact*)

The geographic scope for cumulative impacts on farmland and forestry resources consists of the Project site and immediate vicinity.

As discussed above for issues a) through e), there are no known farmland or forestry resources in or near the Project site. There are reasonably foreseeable future projects, specifically the Pickleweed Field and Park Project and the Schoen Park Conversion to Parking, in the Project vicinity. However, there are no known cumulative projects that would affect farmland or forestry resources, given the lack of such resources in the Project vicinity. Therefore, the Proposed Project, in combination with other reasonably foreseeable future projects, would not result in significant cumulative impacts on farmland and forestry resources.

References

California Department of Conservation (DOC). 2016. California Important Farmland Finder. Available: https://maps.conservation.ca.gov/DLRP/CIFF/. Accessed May 21, 2021.

California Department of Conservation (DOC). 2019. Williamson Act Program. Available: https://www.conservation.ca.gov/dlrp/wa. Accessed November 18, 2020.

B.3 Cultural Resources

Issues (and Supporting Information Sources):	Potentially Significant Impact	Less-than-Significant Impact with Mitigation	Less-than-significant Impact	No Impact
CULTURAL RESOURCES — Would the Project:				
a) Cause a substantial adverse change in the significance of a historical resource pursuant to Section 15064.5?	☐	☐	☒	☐
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to Section 15064.5?	☐	☒	☐	☐
c) Disturb any human remains, including those interred outside of dedicated cemeteries?	☐	☒	☐	☐

Environmental Setting

Cultural resources staff with Environmental Science Associates (ESA) conducted a records search at the Northwest Information Center (NWIC) of the California Historical Resources Information System (CHRIS) on March 17, 2020 (File No. 19-1643) (NWIC 2020). The records search included a review of cultural resources and studies in the Project vicinity. The purpose of the records search was to: (1) determine whether known architectural or archaeological resources have been recorded within the Project site or a 0.5-mile radius; (2) assess the likelihood of unrecorded cultural resources based on historical references and the distribution of nearby sites; and (3) develop a context for the identification of historical themes.

ESA also reviewed the Built Environment Resources Directory (BERD) for Marin County, which contains information on resources of recognized historical significance—including those evaluated for listing in the National Register of Historic Places (National Register), the California Register of Historical Resources (California Register), the California Inventory of Historical Resources, California Historical Landmarks, and California Points of Historical Interest. Historic maps and aerial imagery were also examined.

Based on the NWIC records search, there are no previously recorded archaeological resources within the Project site. The nearest pre-contact indigenous archaeological resources are a series of four shellmounds recorded on the north side of San Rafael Creek on a promontory between two low-lying valleys. These sites (CA-MRN-81, -82, -88, and -91) are all shellmounds recorded by N.C. Nelson during his intensive survey of the San Francisco Bay in the early 20th century (Nelson 1909). Five recent cultural resources studies have been completed within and adjacent to the Project site; no cultural resources have been identified within the Project site.

ESA completed a surface survey of the Project site in May 2020. All areas of proposed ground disturbance were walked in narrow transects to provide an overall assessment of existing conditions. The Project site is entirely disturbed and developed fill adjacent to the existing Tiscornia Marsh. The levee segments provided access to the outer perimeter of the reclaimed land. As anticipated from the environmental context, no pre-contact indigenous cultural materials or other evidence of past human use or occupation was identified within the Project site.

The Tiscornia Marsh shoreline levee was documented on a Department of Parks and Recreation 523 form. The earthen levee includes two segments: a northern portion adjacent to San Rafael Creek (documented as Marin County Levee 42 in the National Levee Database [NLD][1]), and a portion east of Pickleweed Park (documented as Marin County Levee 12 in the NLD). There are no discerning features associated with the levees. Currently, the levee segments are used as trails along the creek and bay. The levee appears to have been constructed in several phases, with the initial construction of a levee along San Rafael Creek, looping the point in the north, and extending to the south. Additional levee construction occurred in the 1940s, 1970s, and 1980s.

The Tiscornia Marsh shoreline levee was evaluated according to the criteria for listing in the National and California Registers and has been recommended Not Eligible for listing (ESA 2020). Archival review of the levee did not indicate any significant association between the levee and significant events or individuals in history. The levee is a product of flood control and land reclamation and appears to be a part of the levee construction around San Rafael Creek and the Bay implemented by the City of San Rafael (City). The levee was instrumental in the establishment of the useable reclaimed land that currently constitutes the Canal District of the City; however, the levee is not a recognizable feature that promotes association with the development of the neighborhood (Criterion A/1). Research did not indicate any important persons associated with the design or construction of the levee (Criterion B/2). The levee is a typical standard utilitarian structure that has been modified and maintained, and does not represent the work of a master engineer or embody unique architectural characteristics (Criterion C/3). Finally, there are no known features associated with the levee, and the levee would not yield information important to history (Criterion D/4). The levee is not considered a historic property or a historical resource, and no additional consideration of this resource is recommended for the Proposed Project.

Discussion

a) Would the Project cause a substantial adverse change in the significance of a historical resource as defined in Section 15064.5? (*Less-than-Significant Impact*)

CEQA Guidelines Section 15064.5 requires the lead agency to consider the effects of a project on historical resources. A historical resource is defined as any building, structure, site, or object listed in or determined to be eligible for listing in the California Register, or determined by a lead agency to be significant in the architectural, engineering, scientific, economic, agricultural, educational, social, political, or cultural annals of California. The following discussion focuses on architectural and structural resources. Archaeological resources, including those that are potentially historical resources according to CEQA Guidelines Section 15064.5, are addressed below under issue b).

As a result of the records search, background research, and a site survey, it was determined that no historical resources are present within the Proposed Project site. The Tiscornia Marsh shoreline levee has been evaluated and is not considered a historical resource for the purposes of CEQA. As such, there are no architectural or structural resources on the Proposed Project site that

[1] The National Levee Database is an online map maintained by the U.S. Army Corps of Engineers (USACE) and the Federal Emergency Management Agency (FEMA). The map is available at https://levees.sec.usace.army.mil/#/.

qualify as historical resources, as defined in CEQA Guidelines Section 15064.5, and impacts would be **less than significant**.

b) Would the Project cause a substantial adverse change in the significance of an archaeological resource as defined in Section 15064.5? (*Less-than-Significant Impact with Mitigation*)

CEQA Guidelines Section 15064.5 requires the lead agency to consider the effects of a project on archaeological resources. A significant impact would occur if a project would cause a substantial adverse change to an archaeological resource through physical demolition, destruction, relocation, or alteration of the resource.

As a result of the records search, background research, and a site survey, it was determined that no known archaeological resources are present within the Project site. Based on the survey results and environmental context, there is a low potential that unknown archaeological resources could be discovered during Project implementation.

In the unlikely event that a previously unrecorded archaeological resource were identified during Project ground-disturbing activities and found to qualify as a historical resource or a unique archaeological resource, any impacts on the resource resulting from the Project could be **potentially significant**.

Based on the analysis presented above, implementation of **Mitigation Measure CUL-1: Cultural Resources Awareness Training and Inadvertent Discovery of Archaeological Resources or Tribal Cultural Resources** would reduce potentially significant impacts to **less than significant with mitigation incorporated**. In the event of an inadvertent discovery of an archaeological or tribal cultural resource, this mitigation would ensure that work is halted in the vicinity until a qualified archaeologist can make an assessment and provide additional recommendations if necessary, including contacting Native American tribes.

Mitigation Measure CUL-1: Cultural Resources Awareness Training and Inadvertent Discovery of Archaeological Resources or Tribal Cultural Resources

Prior to authorization to proceed, a qualified archaeologist, defined as an archaeologist meeting the U.S. Secretary of the Interior's Professional Qualification Standards for Archeology, shall conduct a training program for all construction and field workers involved in site disturbance. On-site personnel shall attend a mandatory pre-Project training that shall outline the general archaeological sensitivity of the area and the procedures to follow in the event an archaeological resource and/or human remains are inadvertently discovered.

If pre-contact or historic-era archaeological resources are encountered during Project implementation, all construction activities within 100 feet shall halt, and a qualified archaeologist shall inspect the find within 24 hours of discovery and notify the City of the initial assessment. Pre-contact archaeological materials might include obsidian and chert flaked-stone tools (e.g., projectile points, knives, scrapers) or toolmaking debris; culturally darkened soil ("midden") containing heat-affected rocks, artifacts, or shellfish remains; stone milling equipment (e.g., mortars, pestles, handstones, or milling slabs); and battered stone tools, such as hammerstones and pitted stones. Historic-era materials might include building or structure footings and walls, and deposits of metal, glass, and/or ceramic refuse.

If the City determines, based on recommendations from a qualified archaeologist and a Native American representative (if the resource is pre-contact indigenous related), that the resource may qualify as a historical resource or unique archaeological resource (as defined in CEQA Guidelines Section 15064.5) or a tribal cultural resource (as defined in Public Resources Code [PRC] Section 21080.3), the resource shall be avoided if feasible. Consistent with Section 15126.4(b)(3), this may be accomplished through planning construction to avoid the resource, incorporating the resource within open space, capping and covering the resource, or deeding the site into a permanent conservation easement.

If avoidance is not feasible, the City shall consult with appropriate Native American tribes (if the resource is pre-contact indigenous related), and other appropriate interested parties to determine treatment measures to avoid, minimize, or mitigate any potential impacts to the resource pursuant to PRC Section 21083.2, and CEQA Guidelines Section 15126.4. This shall include documentation of the resource and may include data recovery (according to PRC Section 21083.2), if deemed appropriate, or other actions such as treating the resource with culturally appropriate dignity and protecting the cultural character and integrity of the resource (according to PRC Section 21084.3).

c) Would the Project disturb any human remains, including those interred outside of formal cemeteries? (*Less-than-Significant Impact with Mitigation*)

The records search and background research determined that no human remains are known to exist within the Project site. Therefore, the Proposed Project is not anticipated to impact human remains, including those interred outside of formal cemeteries.

However, while unlikely, if any previously unknown human remains were encountered during ground-disturbing activities, any impacts on the human remains resulting from the Proposed Project could be **potentially significant**.

Based on the analysis presented above, implementation of **Mitigation Measure CUL-2: Inadvertent Discovery of Human Remains** would reduce potentially significant impacts to **less than significant with mitigation**. This measure shall comply with applicable state laws, including Section 7050.5 of the Health and Safety Code. This would require work to halt in the vicinity of a find and the immediate notification of the County coroner. If the coroner determines that the human remains are Native American, they would notify the California Native American Heritage Commission (NAHC), who shall appoint a Most Likely Descendant (PRC Section 5097.98).

Mitigation Measure CUL-2: Inadvertent Discovery of Human Remains

If potential human remains are encountered, all work shall halt within 100 feet of the find and the City shall be contacted by on-site construction crews. The City shall contact the Marin County coroner in accordance with PRC Section 5097.98 and Health and Safety Code Section 7050.5. If the coroner determines that the remains are Native American, the coroner shall contact the NAHC. As provided in PRC Section 5097.98, the NAHC shall identify the person or persons believed to be the Most Likely Descendant (MLD). The MLD shall make recommendations for the means of treating, with appropriate dignity, the human remains and any associated grave goods, as provided in PRC Section 5097.98.

Cumulative Impacts

d) Would the Project, in combination with reasonably foreseeable future projects, result in significant cumulative impacts on archeological resources or human remains? (*Less-than-Significant Impact with Mitigation*)

The geographic scope for cumulative effects on archeological resources and human remains consists of the Project site and immediate vicinity. Federal and state laws protect cultural resources in most cases, either through project redesign to ensure the preservation of the resource, or by requiring archaeological recovery of a sample of the significant data represented by an archaeological resource.

As discussed above, there are no known archaeological resources within the Project site. While there is the potential for the Project to encounter archaeological resources, which could include prehistoric archeological features or deposits, the Project is not expected to result in significant impacts even if archaeological resources are found. There are reasonably foreseeable future projects, specifically the Pickleweed Field and Park Project and the Schoen Park Conversion to Parking, that could impact the same archaeological resources as the Proposed Project, if any such resource is identified. However, these projects would involve the implementation of similar types of mitigation measures described above, which would reduce potential for impacts on these resources and any other as-yet undiscovered resources to a less-than-significant level. Therefore, the Proposed Project, in combination with other reasonably foreseeable future projects, would result in a **less-than-significant cumulative impact** on archeological resources and human remains.

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B.4 Energy

Issues (and Supporting Information Sources):	*Potentially Significant Impact*	*Less-than-Significant Impact with Mitigation*	*Less-than-Significant Impact*	*No Impact*
ENERGY — Would the Project:				
a) Result in potentially significant environmental impact due to wasteful, inefficient, or unnecessary consumption of energy resources, during Project construction or operation?	☐	☐	☒	☐
b) Conflict with or obstruct a state or local plan for renewable energy or energy efficiency?	☐	☐	☒	☐

Environmental Setting

Consistent with PRC Section 21100(b)(3), this impact analysis evaluates the potential for the Proposed Project to result in a substantial increase in energy demand and wasteful use of energy during Project construction and operation and maintenance. The impact analysis is informed by Appendix G of the CEQA Guidelines. The potential impacts are analyzed based on an evaluation of whether construction energy use estimates for the Proposed Project would be considered excessive, wasteful, or inefficient. Operational energy use would be negligible once the Proposed Project is complete because of the limited use of energy for the public access and recreation facilities, as well as maintenance activities.

Discussion

a) Would the Project result in potentially significant environmental impact due to wasteful, inefficient, or unnecessary consumption of energy resources, during project construction or operation? (*Less than Significant*)

The analysis in this section utilizes the energy input assumptions used to complete the analyses in Section 3.3, *Air Quality*, and Section 3.5, *Greenhouse Gas Emissions* of the EIR. Because the California Emissions Estimator Model (CalEEMod) program used for those analyses does not quantify the fuel volume or type for construction-related sources, additional calculations were completed and are summarized below.

Construction of the Proposed Project would result in fuel consumption from the use of construction tools and equipment, truck and barge trips to haul material, and vehicle trips generated from construction workers commuting to and from the site. Project construction is expected to consume a total of approximately 135,657 gallons of diesel fuel from construction equipment and vendors, hauling, water truck trips, and marine engines and 387 gallons of gasoline fuel from commuting construction workers.

Construction activities and corresponding fuel energy consumption would be temporary and localized, as the use of diesel fuel and heavy-duty equipment would not be a long-term condition of the Proposed Project. The total fuel use during the construction period would be equivalent to less than 3.4 percent of the total diesel fuel sold in Marin County in 2019, and approximately 0.0004 percent of the gasoline fuel sold in Marin County (CEC 2020). In addition, there are no unusual Project characteristics that would require the use of construction equipment or haul vehicles that are less energy efficient necessary for similar construction efforts in other parts of the state. In conclusion, construction-related fuel consumption by the Proposed Project would not result in inefficient, wasteful, or unnecessary energy use that would be expected of other construction efforts in the region. The impact on energy resources during the construction phase of the Proposed Project would be **less than significant**.

b) Would the Project conflict with or obstruct a state or local plan for renewable energy or energy efficiency? (*Less than Significant*)

The transportation sector is a major end-user of energy in California, accounting for approximately 39 percent of total statewide energy consumption in 2019 (U.S. Energy Information Administration 2019). In addition, energy is consumed in connection with the construction and maintenance of transportation infrastructure, such as streets, highways, freeways, rail lines, and airport runways. California's 30 million vehicles consume more than 16 billion gallons of gasoline and more than 3 billion gallons of diesel each year, making California the second largest consumer of gasoline in the world (CEC 2014).

With respect to transportation energy, existing energy standards are promulgated through the regulation of fuel refineries and products, such as the Low Carbon Fuel Standard (LCFS), which mandates a 10 percent reduction in the non-biogenic carbon content of vehicle fuels by 2020. All on-road vehicles used for hauling and worker trips would operate subject to these regulations. Additionally, there are other regulatory programs with emissions and fuel efficiency standards established by the U.S. Environmental Protection Agency (EPA) and California Air Resources Board (CARB), such as Pavley II/LEV III from California's Advanced Clean Cars Program and the Heavy-Duty (Tractor-Trailer) Greenhouse Gas (GHG) Regulation. CARB has set a goal of 4.2 million Zero Emissions Vehicles (ZEV) on the road by the year 2030 (CARB 2016). Further, construction sites, including the Proposed Project, need to comply with state requirements designed to minimize idling and associated emissions, which also minimizes use of fuel. Specifically, idling of commercial vehicles and off-road equipment would be limited to 5 minutes in accordance with the Commercial Motor Vehicle Idling Regulation and the Off-Road Regulation (California Code of Regulations, 2005. Title 13, Chapter 10, 2485, updated through 2014).

The City of San Rafael adopted the Final Draft Climate Change Action Plan 2030 (CCAP 2030), which establishes a new interim target of reducing GHG emissions by 40 percent below 1990 levels by 2030, and outlines the steps that residents, businesses, and the City can take to reach that goal. Potentially applicable actions of the CCAP 2030 for a construction project would be WR-C3 (Construction & Demolition Debris and Self-Haul Waste), which requires all loads of construction & demolition debris and self-haul waste to be processed for recovery of materials as feasible. The Proposed Project would not involve waste disposal as no demolition is proposed. Excavated materials would be reused on-site. Therefore, the Proposed Project would be consistent with energy-related measures of the CCAP 2030. In conclusion, the Proposed Project would not conflict with or obstruct a state or local plan for renewable energy or energy efficiency, and impacts would be **less than significant**.

Cumulative Impacts

c) Would the Project, in combination with reasonably foreseeable future projects, result in significant energy impacts? (*Less than Significant*)

The geographic scope of potential cumulative effects with respect to energy resources includes the Pacific Gas & Electric Company's (PG&E's) electric grid and natural gas transmission system that would serve the Project, areas from which transportation fuels would be provided, and the cumulative projects discussed in Section 3.0 of the EIR. Eight foreseeable cumulative projects have been identified within the City of San Rafael.

There is no significant cumulative condition to which the Project could contribute related to the use of large amounts of fuel or energy in a wasteful or inefficient manner. Given that the Proposed Project would have no measureable electrical demand during or after construction and the relatively small percentage of the Project's fuel and energy use compared to existing fuel and energy use in the region, the Project's less-than-significant incremental impacts related to the use of fuel or energy in a wasteful or inefficient manner are not expected to combine with the incremental impacts of other projects to cause an adverse cumulative impact. There would be no operational electricity or natural gas requirements of the Project. Energy demand during Project construction would be temporary.

The eight cumulative projects could require increased construction and, in some cases, operational energy demand. Peak and base energy demands, therefore, could cause or contribute to adverse cumulative conditions. However, the cumulative projects would be subject to the same applicable federal, state, and local energy efficiency requirements (e.g., the state's Title 24 requirements) that would be required of the Project, which would result in efficient energy use during their construction and operation. Adverse Project-related impacts on electricity demand would be negligible, and would not significantly impact peak or base power demands during construction, operation, or maintenance. Accordingly, the Project's less-than-significant incremental contribution to cumulative peak and base demands would not be cumulatively considerable.

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B.5 Geology & Soils

Issues (and Supporting Information Sources):	*Potentially Significant Impact*	*Less-than-Significant Impact with Mitigation*	*Less-than-Significant Impact*	*No Impact*
GEOLOGY & SOILS — Would the Project:				
a) Directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving:				
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.	☐	☐	☐	☒
ii) Strong seismic ground shaking?	☐	☐	☒	☐
iii) Seismic-related ground failure, including liquefaction?	☐	☐	☒	☐
iv) Landslides?	☐	☐	☒	☐
b) Result in substantial soil erosion or the loss of topsoil?	☐	☐	☒	☐
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the Project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?	☐	☐	☒	☐
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial direct or indirect risks to life or property?	☐	☐	☒	☐
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?	☐	☐	☐	☒
f) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	☐	☐	☐	☒

Environmental Setting

The greater San Francisco Bay Area is located in an area of high seismic activity due to its tectonic setting. Surface rupture can occur when the ground surface is displaced due to fault movement at the earth’s surface during seismic events. Such hazards are generally assumed to occur in the vicinity of an active fault trace as they represent an existing plane of weakness. Active faults in the region include the San Andreas Fault, 10 miles to the west of the Project site, and the Hayward Fault, 7 miles east of the Project site. While fault rupture has not occurred in the vicinity of the Project site, the above-noted San Andreas and Hayward Fault Zones pose a risk of surface rupturing (DOC 2021).

The Working Group on California Earthquake Probabilities (WGCEP), comprised of the U.S. Geological Survey (USGS), the California Geological Survey (CGS), and the Southern California Earthquake Center, evaluates the probability of one or more earthquakes of Mw 6.7 or higher (on the Moment Magnitude Scale) occurring in the State of California over the next 30 years. As a whole, the San Francisco Bay Area has an estimated 72 percent chance of experiencing an earthquake of Mw 6.7 or higher over the next 30 years; among the various active faults in the region, the Hayward and Calaveras Faults are the most likely to cause such an event (WGCEP 2015a). The Proposed Project is located in an area with high earthquake shaking potential, rated as "Severe" shaking severity on the Modified Mercalli Intensity scale for both the San Andreas and Hayward faults (MTC and ABAG 2006).

The Hayward Fault Zone extends northwest approximately 55 miles from San Jose to Point Pinole. It is a right-lateral, strike-slip fault and is designated as an Alquist-Priolo Earthquake Fault Zone. The fault is active, producing large historic earthquakes, fault creep, and abundant geomorphic evidence of fault rupture. The Hayward Fault Zone has a 13.71 percent probability of generating an earthquake with a magnitude equal to or greater than 6.7 Mw over the next 30 years (WGCEP 2015b).

The San Andreas Fault is a major northwest-trending, right-lateral, strike-slip fault zone. The fault zone extends for about 600 miles from the Gulf of California in the south to Cape Mendocino in the north. The San Andreas is not a single fault trace but rather a system of active faults that diverges from the main fault south of the City of San Jose, California. The San Andreas Fault Zone has produced numerous large earthquakes, including the 1906 San Francisco earthquake. The San Andreas Fault Zone has a 5.5 percent probability of generating an earthquake in the Bolinas segment with a magnitude equal to or greater than 6.7 Mw over the next 30 years (WGCEP 2015b).

The State of California, through the Alquist-Priolo Earthquake Fault Zoning Act (Alquist-Priolo Act), prohibits the development of structures for human occupancy across active fault traces without an adequate geotechnical study to demonstrate that the hazard is not present (Hart 1997).[2] Under the Alquist-Priolo Act, the CGS (formerly the California Division of Mines and Geology) establishes zones on either side of an active fault that delineate areas considered most susceptible to surface fault rupture. These zones are referred to as fault rupture hazard zones and are shown on official maps published by the CGS. The closest active fault to the Project site mapped under the Alquist-Priolo Act is the Hayward fault, which is oriented northwest-southeast and is located approximately 7 miles east of the Project site, well outside of the respective fault rupture hazard zone for the Hayward Fault (DOC 2021). The San Andreas Fault is also mapped under the Alquist-Priolo Act in the area of Bolinas. This segment of the San Andreas fault is approximately 10.5 miles west of the Project site.

2 The Alquist-Priolo Act designates zones that are most likely to experience fault rupture, although surface fault rupture is not necessarily restricted to those specifically zoned areas. The zones are defined by the CGS. An active fault is defined by the State of California as a fault that has had surface displacement within Holocene time (approximately the last 11,000 years). A potentially active fault is defined as a fault that has shown evidence of surface displacement during the Quaternary (last 1.6 million years), unless direct geologic evidence demonstrates inactivity for all of the Holocene or longer. This definition does not, of course, mean that faults lacking evidence of surface displacement are necessarily inactive. Sufficiently active is also used to describe a fault if there is some evidence that Holocene displacement occurred on one or more of its segments or branches. A structure for human occupancy is one that is intended for supporting or sheltering any use or occupancy, which is expected to have a human occupancy rate of more than 2,000 person hours per year (Hart, 1997).

Liquefaction is a phenomenon where saturated subsurface soils lose strength because of increased pore pressure and exhibit properties of a liquid rather than those of a solid. In general, the soils most susceptible to liquefaction are clean, loose, uniformly graded, saturated and fine-grained, and occur close to the ground surface, usually at depths of less than 50 feet. Liquefaction risk maps show that soils in the Project site have a moderate risk for liquefaction, with a very small amount of very high susceptibility soils on the southwest edges of the Project site, primarily where the ecotone slope would be (MTC and ABAG 2006).

Discussion

a.i) Would the Project directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? (Refer to Division of Mines and Geology Special Publication 42.) (*No Impact*)

The Project site is not located within an Alquist-Priolo fault zone. Therefore, **no impact** related to the rupture of a known earthquake fault would occur during Project construction or operations.

a.ii) Would the Project directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving strong seismic ground shaking? (*Less than Significant*)

As discussed previously, the region will likely experience a large regional earthquake within the operational life of the Proposed Project. There is a potential for strong to very strong intensity groundshaking at the Project site that would be associated with such an earthquake. The intensity of such an event would depend on the causative fault and the distance to the epicenter, the magnitude, and the duration of shaking. Intense groundshaking and high ground accelerations would affect the entire area around the Project site. However, the restoration and enhancement of marsh habitats would not require protection from seismic shaking because no structures would be constructed. The Proposed Project would not be expected to substantially increase visitation to the site due to shoreline levee/trail improvements, as compared to existing conditions. In addition, the use of trails would not expose people to significant risk associated with strong seismic groundshaking because the Proposed Project would not include structures on the trail that could increase risk or injury. Therefore, impacts relative to seismic shaking during Project construction and operation would be **less than significant**.

a.iii) Would the Project directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving seismic-related ground failure, including liquefaction? (*Less than Significant*)

Seismic shaking can also trigger seismic-induced ground failures caused by liquefaction, and soils at the Project site are known to have a moderate risk for liquefaction. While seismic-induced liquefaction may damage trails and restored habitat areas, the damage would not result in risks to people, and the damaged trails and habitat could be easily repaired. As discussed in Chapter 2, *Project Description*, the Proposed Project would be constructed in stages to limit stress on the Bay Mud (Hultgren-Tillis Engineers 2021). In addition, any access roads and/or crane pads required on the existing mudflat would be constructed in stages in accordance with geotechnical recommendations to avoid soil failures (e.g., creating mud waves). During the operational phase, the Project would not change the risk of liquefaction or ground failure from existing conditions, which include the same structure types. Therefore, impacts relative to seismic-induced ground failure such as liquefaction would be **less than significant**.

a.iv) Would the Project directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving landslides? (*Less than Significant*)

Landslides generally consist of any type of ground movement that occurs primarily due to gravity acting on an over-steepened slope and can occur due to excessive precipitation, man-made activities, or induced by seismic activity. Areas that are more prone to landslides include old landslides, the bases or tops of steep or filled slopes, and drainage hollows. The Project site is in an alluvial plain, formed where San Rafael Creek meets San Rafael Bay. The relatively flat topography of this area makes landslides unlikely in the Project site; landslide risk maps show no risk areas in the Project site (MTC and ABAG 2006). In addition, the Project's wetland restoration activities would not create slopes susceptible to landsliding. Therefore, the Proposed Project would not increase the exposure of people or associated structures to an increased risk of loss, injury, or death at the Project site, during construction or operations, due to seismically induced landslides, and impacts would be **less than significant**.

b) Would the Project result in substantial soil erosion or the loss of topsoil? (*Less than Significant*)

Construction

Construction of the Proposed Project would have the potential to result in soil erosion during excavation; trenching; grading; or construction of levees, a rock jetty, and a coarse beach. Because the overall footprint of construction activities would exceed 1 acre, the Proposed Project would be required to comply with the National Pollutant Discharge Elimination System (NPDES) General Permit for Discharges of Storm Water Runoff Associated with Construction and Land Disturbance Activities (*Order 2009-0009-DWQ, NPDES No. CAS000002; as amended by Orders 2010-0014-DWQ and 2012-006-DWQ*) (Construction General Permit) and the local stormwater ordinances. For more details about the Construction General Permit and Stormwater Pollution Prevention Plan (SWPPP), please refer to Impact 3.6-1 in EIR Section 3.6, *Hydrology and Water Quality*. These state and local requirements were developed to ensure that stormwater is managed and erosion is controlled on construction sites.

The Construction General Permit requires preparation and implementation of a Stormwater Pollution Prevention Plan (SWPPP), which requires applications of Best Management Practices (BMPs) to control runon and runoff from construction work sites. The BMPs would include, but would not be limited to, physical barriers to prevent erosion and sedimentation, construction of sedimentation basins, limitations on work periods during storm events, use of infiltration swales, protection of stockpiled materials, and a variety of other measures that would substantially reduce or prevent erosion from occurring during construction. Compliance with existing regulations would result in **less-than-significant impacts** associated with soil erosion during construction.

Operation

Once constructed, the restored wetland habitats would be largely self-maintaining after the initial period of vegetation establishment. As described in EIR Section 2.4, *Operations and Maintenance*, maintenance for the tidal marsh, ecotone slope, and coarse beach during the 3- to 5-year establishment period would include the removal of invasive plants using localized herbicides or mechanical means, and temporary irrigation of ecotone slope plantings. In addition, the new and improved flood protection levees and trails would require periodic inspection to identify maintenance and adaptive management needs. Physical and biological monitoring would be conducted at Project completion and at 1, 3, 5, and 10 years post-construction. At a minimum, levees would be inspected annually to identify any localized settlement, rodent holes, or other conditions that could compromise the levee integrity. With compliance with existing regulations and implementation of the adaptive management activities, impacts associated with erosion would be **less than significant.**

c) Would the Project be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the Project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse? (*Less than Significant*)

As described above for issues a.iii and a.iv, impacts relative to liquefaction, lateral spreading (a ground failure associated with liquefaction), and landslides would be less than significant. Subsidence and collapse are ground failures that can occur as a result of groundwater or oil extraction. Neither construction nor operation of the Proposed Project includes the extraction of groundwater or oil and would not otherwise create soil that is unstable. Therefore, impacts would be **less than significant**.

d) Would the Project be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial direct or indirect risks to life or property? (Less than Significant)

Soils within the Project site primarily include xerorthents, fill with a small amount of urban land – xerorthents complex, 0 to 9 percent slopes. Typically, xerorthents are loamy, are well drained, and have a low potential to expand. Permeability and available water capacity vary. Surface runoff is very rapid, and the hazard of erosion is moderate. The soils are also subject to subsidence. Geotechnical Investigation (Hultgren-Tillis Engineers 2021; included in Draft EIR Appendix E) indicated that the site is underlain by Bay Mud, which has expansive properties. The presence of expansive soils would not prevent the restoration of tidal habitat. While expansive soils may cause cracks in trails, the cracks would be a minor nuisance that would be easily repaired with minor maintenance, assuming the cracks were large enough to become an issue. In addition, soils used for levee improvements would be imported from an upland source, which would further minimize the expansive properties of the soils at the Project site. Therefore, impacts relative to expansive soils would be **less than significant**.

e) Would the Project have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water? (*No Impact*)

The Proposed Project does not include the construction or operation of septic or wastewater disposal systems; therefore, there would be **no impact**.

f) Would the Project directly or indirectly destroy a unique paleontological resource or site or unique geologic feature? (*No Impact)*

Paleontological resources are the fossilized evidence of past life found in the geologic record. Despite the tremendous volume of sedimentary rock deposits preserved worldwide, and the enormous number of organisms that have lived through time, the preservation of plant or animal remains as fossils is an extremely rare occurrence. Because of the infrequency of fossil preservation, fossils—particularly vertebrate fossils—are considered to be nonrenewable resources. Because of their rarity and the scientific information, they can provide, fossils are highly significant records of ancient life.

Rock formations that are considered of paleontological sensitivity are those rock units that have yielded significant vertebrate or invertebrate fossil remains (SVP 2010). These include, but are not limited to, sedimentary rock units that contain significant paleontological resources anywhere within its geographic extent. The Project site is underlain by artificial fill over Late Holocene-age Bay Mud (NRCS 2021). These types of geologic deposits are too young (i.e., less than 5,000 years old) to have fossilized the remains of organisms, or to have preserved vertebrate fossils. While the Bay Mud may contain a variety of marine invertebrate remains and organic matter (mollusks, clams, fomanifera, microorganisms, etc.), such remains would not have been buried long enough to become fossilized, are likely to commonly exist in other Bay Mud deposits around the Bay Area, and would not be considered significant or unique. For these reasons, in accordance with Society of Vertebrate Paleontology standards, the younger Holocene deposits that would be disturbed for construction and operation of the Project would have no paleontological sensitivity. Therefore, the Proposed Project would have **no impact** on unique paleontological resources.

Cumulative Impacts

g) Would the Project, in combination with reasonably foreseeable future projects, result in significant cumulative impacts related to geology, soils, or paleontological resources? (*Less than Significant*)

For geology and soils, the geographic scope consists of the area that could be affected by Proposed Project activities and the areas affected by other projects whose activities could directly or indirectly affect the geology and soils of the Project site. The analysis above indicated no rare or special geological features or soil types on the Project site that would be affected by Project activities and no other known activities or projects with activities that affect the geology and soils of this site. In addition, the Proposed Project, as with all foreseeable projects, would be required to comply with the applicable state and local requirements. such as the Construction General Permit. Therefore, the Proposed Project's contribution to cumulative geotechnical and soil impacts is **less than significant**.

For paleontological resources, the cumulative study area is the geographical area of the City of San Rafael, which is the geographical area covered by the City's General Plan, including all goals and policies included therein. Future development in the City could include excavation and grading that could potentially affect paleontological resources. However, as noted above, the Project would not result in an impact on paleontological resources. Therefore, the Proposed Project's contribution to the cumulative destruction of known and unknown paleontological resources throughout the City would not be cumulatively considerable.

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B.6 Hazards & Hazardous Material

Issues (and Supporting Information Sources):	*Potentially Significant Impact*	*Less-than-Significant Impact with Mitigation*	*Less-than-Significant Impact*	*No Impact*
HAZARDS & HAZARDOUS MATERIALS — Would the Project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	☐	☐	☒	☐
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	☐	☐	☒	☐
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	☐	☐	☒	☐
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?	☐	☐	☐	☒
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within 2 miles of a public airport or public use airport, would the project result in a safety hazard or excessive noise for people residing or working in the project area?	☐	☐	☐	☒
f) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?	☐	☐	☒	☐
g) Expose people or structures, either directly or indirectly, to a significant risk of loss, injury, or death involving wildland fires?	☐	☐	☒	☐

Environmental Setting

The study area for the impact analysis of hazards and hazardous materials includes the Project site, which itself includes the construction storage area and construction staging area. The Project site is immediately south of San Rafael Creek, and to the east is San Rafael Bay. The Project site includes the Tiscornia Marsh property, with approximately 500 feet of shoreline levee/trail, as well as the currently diked salt marsh within Pickleweed Park, with approximately 1,800 feet of shoreline levee/trail, and a portion of former Schoen Park (now a vacant lot). The Project site also includes two existing PG&E towers and boardwalk, as well as a City stormwater drain and sanitary sewer line to the west of Pickleweed Park and the diked marsh (see Chapter 2, *Project Description*, Figure 2-2). The stormwater drain runs adjacent to the Bay Trail on the west side of Pickleweed Park, while the sanitary sewer line generally runs parallel to it before dog-legging into the soccer field and heading back toward the shoreline, where both utilities outfall into the creek. The Project site is generally characterized by flat marsh areas adjacent to earthen levees.

Hazardous Materials

Materials and waste may be considered hazardous if they are poisonous (toxic); can be ignited by open flame (ignitable); corrode other materials (corrosive); or react violently, explode, or generate vapors when mixed with water (reactive). The term *hazardous material* is defined in law as any material that, because of its quantity, concentration, or physical or chemical characteristics, poses a significant present or potential hazard to human health and safety or to the environment (California Health and Safety Code, Section 25501[o]). In some cases, past uses can result in spills or leaks of hazardous materials to the ground, resulting in soil and groundwater contamination. The use, storage, transportation, and disposal of hazardous materials are subject to numerous federal, state, and local laws and regulations.

Information about hazardous materials sites on the Project site was collected by reviewing the California Environmental Protection Agency's Cortese List data resources and the State Water Resources Control Board's GeoTracker list. The Cortese List data resources provide information regarding facilities or sites identified as meeting the requirements for inclusion on the Cortese List. The Cortese List is updated at least annually, in compliance with California regulations (California Government Code Section 65962.5), and includes federal Superfund sites, state response sites, non-operating hazardous waste sites, voluntary cleanup sites, and school cleanup sites. The GeoTracker list shows underground storage tanks. Based on a review of the Cortese List conducted in June 2021, no active listed sites are located within 0.25 mile of the Project site (DTSC 2021). One site, the Bahia Vista Elementary School (21880002), is a School Investigation site with no action required as of August 12, 2004 (DTSC 2021).

Soil Contamination and Naturally Occurring Asbestos

Marin is among the identified counties where ultramafic bedrock materials are present. These bedrock materials contain naturally occurring asbestos particles or fibers, which could be disturbed during excavation activities. However, no serpentine soils are present on the Project site, which indicates that the site is not underlain by materials that contain naturally occurring asbestos.

Proximity to Wildfire Hazards Zones

The Project site is located within a Local Responsibility Area, which are lands on which neither the state nor the federal government has any legal responsibility for providing fire protection. The California Department of Forestry and Fire Protection (CAL FIRE) has designated the land within the Project site as Non-Very High Fire Hazard Severity Zone (Non-VHFHSZ) (CAL FIRE 2008).

Proximity to Airports and Schools

The Project site is located 3 miles southeast of the San Rafael Airport. The San Rafael Airport is a private airport primarily located within the City of San Rafael, but also has a small portion within unincorporated Marin County.

The Project site is adjacent to the Pickleweed Children's Center, a pre-school. Bahia Vista Elementary School is located approximately 300 feet south of the Project site.

Discussion

a, b) Would the Project create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials or through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment? (*Less than Significant*)

Construction

During the construction phase, equipment would use fuels, oils, and lubricants, which are all commonly used in construction. The routine use or an accidental spill of hazardous materials could result in inadvertent releases, which could adversely affect construction workers and the environment.

Construction activities would be required to comply with numerous hazardous materials regulations designed to ensure that hazardous materials are transported, used, stored, and disposed of in a safe manner to protect worker safety, and to reduce the potential for a release of construction-related fuels or other hazardous materials into the environment, including stormwater and downstream receiving water bodies. Contractors would be required to prepare and implement Hazardous Materials Business Plans (HMBPs) as per the California Hazardous Materials Release Response Plan and Inventory Law of 1985, which requires that hazardous materials used for construction be used properly and stored in appropriate containers with secondary containment to contain a potential release. The California Fire Code also requires measures for the safe storage and handling of hazardous materials.

Construction associated with the Project would disturb more than 1 acre of land surface, affecting the quality of stormwater discharges into waters of the U.S. The Project would, therefore, be subject to the *NPDES General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities* (Order 2009-0009-DWQ, NPDES No. CAS000002; as amended by Orders 2010-0014-DWQ and 2012-006-DWQ). The Construction General Permit requires the development and implementation of a SWPPP that includes specific BMPs designed to prevent sediment and pollutants from contacting stormwater and from moving off site into receiving waters. The SWPPP would list the hazardous materials (including petroleum products) proposed for use during construction; describe spill prevention measures, equipment inspections, equipment, and fuel storage; identify protocols for responding immediately to spills; and describe BMPs for controlling site runoff. Additionally, the SWPPP must contain a visual monitoring program, a chemical monitoring program for “non-visible” pollutants to be implemented if there is a failure of BMPs. For more details about the Construction General Permit and SWPPP, please refer to Impact 3.6-1 in EIR Section 3.6, *Hydrology and Water Quality*.

In addition, the transportation of hazardous materials would be regulated by the United States Department of Transportation (USDOT), California Department of Transportation (Caltrans), and the California Highway Patrol (CHP). Together, federal and state agencies determine driver training requirements, load labeling procedures, and container specifications designed to minimize the risk of accidental release.

Finally, in the event of a spill that releases hazardous materials at the Project site, a coordinated response would occur at the federal, state, and local levels. The Marin County Hazardous Materials Response Team (HMRT) is a joint-powers authority team that responds to significant hazardous materials incidents, isolates and denies entry to non-equipped personnel, evacuates injured parties, identifies the materials, and assists with the removal of the materials.

The required compliance with the numerous laws and regulations discussed above that govern the transportation, use, handling, and disposal of hazardous materials would limit the potential for creation of hazardous conditions due to the use or accidental release of hazardous materials, and, therefore, the impact would be **less than significant**.

Operation

Once constructed, the restored wetland habitats are expected to be largely self-maintaining after the initial period of vegetation establishment. As described in EIR Section 2.4, *Operations and Maintenance*, maintenance for the tidal marsh, ecotone slope, and coarse beach during the 3- to 5-year establishment period would include the removal of invasive plants using localized herbicides or mechanical means, and temporary irrigation of ecotone slope plantings. The California Department of Pesticide Regulation (DPR), California Code of Regulations (Title 3. Food and Agriculture) Division 6. Pesticides and Pest Control Operations (Sections 6000 – 6960) regulates the use of herbicides. In addition, the new and improved flood protection levees and trails would require periodic inspection to identify maintenance and adaptive management needs. At a minimum, levees would be inspected annually to identify any localized settlement, rodent holes, or other conditions that could compromise the levee integrity. The required compliance with the numerous laws and regulations discussed above that govern the transportation, use, handling, and disposal of hazardous materials would limit the potential for the creation of hazardous conditions due to the use or accidental release of hazardous materials, and, therefore, the impact would be **less than significant**.

c) Would the Project emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school? (*Less than Significant*)

Construction

During the construction phase, construction equipment and vehicles would use low toxicity materials including gasoline, diesel fuel, oil, and lubricants, which are all commonly used in construction. These low toxicity materials would be used throughout the Project site. While two schools are located within 0.25 mile of the Proposed Project, the low toxicity of the materials associated with the Proposed Project and required compliance with the laws and regulations discussed above that govern the transportation, use, handling, and disposal of hazardous materials would reduce impacts on area schools to a **less-than-significant** level.

Operation

Once constructed, the restored wetland habitats are expected to be largely self-maintaining after the initial period of vegetation establishment. However, maintenance for the tidal marsh, ecotone slope, and coarse beach during the 3- to 5-year establishment period would include the removal of invasive plants using localized herbicides or mechanical means, and temporary irrigation of ecotone slope plantings. The required compliance with the laws and regulations discussed above that govern the transportation, use, handling, and disposal of hazardous materials would limit the potential for the creation of hazardous conditions due to the use or accidental release of hazardous materials, and, therefore, the impact would be **less than significant**.

d) Would the Project be located on a site that is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment? (*No Impact*)

There are no hazardous materials sites that are listed on the Cortese List within the Project site. Therefore, there would be **no impact** related to construction or operation of the Proposed Project.

e) For a project located within an airport land use plan or, where such a plan has not been adopted, within 2 miles of a public airport or public use airport, would the project result in a safety hazard or excessive noise for people residing or working in the project area? (*No Impact*)

The Project site is located approximately 3 miles southeast of the closest airport, the San Rafael Airport. The Project site is therefore not located within an airport land use plan or within 2 miles of a public or private airport. In addition, no structures would be constructed as a part of the Proposed Project that could interfere with height restrictions on structures near airports. Therefore, there would be **no impact** related to the construction or operation of the Proposed Project.

f) Would the Project impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan? (*Less than Significant*)

Construction

There is no emergency response plan or evacuation plan actions specific to the Project site or immediate vicinity; the nearest designated evacuation route is Point San Pedro Road (on the north side of San Rafael Creek from the Project site), which serves as a primary wildfire evacuation route (Marin County 2016). Construction activities would occur within the habitat area to be restored and not on public roads. Spinnaker Point Drive, Canal Street, and other nearby City streets may be used for access but would not require closure or restriction of any lanes. Thus, Project construction would not impair implementation of an adopted emergency response plan or emergency evacuation plan. Further, while not required to reduce a hazards impact, as described in greater detail under issue c) of Section B.13, *Transportation*, Mitigation Measure TRAN-1 would be implemented to minimize potentially hazardous conditions associated with construction trucks accessing the proposed construction staging area. The Traffic Control Plan would require temporary signing, lighting, and traffic control devices to indicate the presence of heavy vehicles and construction traffic, which would support implementation of an adopted Emergency Response Plan or Emergency Evacuation Plan.

Materials and equipment would be transported to and from the site via barge. In addition to the use of a barge, in-water work would occur in an area with existing boating and personal boat docks. As such, water traffic would occur near the Project site, including the barge and in-water work. Boat traffic may be temporarily reduced during construction for safety reasons, but boaters would be able to pass around the Project site. Because of the temporary nature of the Proposed

Project, the limited size of the Proposed Project, and San Rafael Creek and San Rafael Bay near the Project site remaining passable to boaters during Project construction, the Project would not impair implementation of an adopted emergency response plan or emergency evacuation plan. Thus, the impact would be **less than significant**.

Operation

Once constructed, the restored wetland habitats are expected to be largely self-maintaining after the initial period of vegetation establishment. Maintenance for the tidal marsh, ecotone slope, and coarse beach during the 3- to 5-year establishment period would include the removal of invasive plants using localized herbicides or mechanical means, and temporary irrigation of ecotone slope plantings. In addition, the new and improved flood protection levees and trails would require periodic inspection to identify maintenance and adaptive management needs. Access for maintenance and inspections would occur via Spinnaker Point Drive and Canal Street, but would not require the closure or restriction of any lanes. Therefore, the impact would be **less than significant.**

g) Would the Project expose people or structures, either directly or indirectly, to a significant risk of loss, injury or death involving wildland fires? (*Less than Significant*)

Construction

As discussed in the *Environmental Setting*, the Project site is located within a Local Responsibility Area and is designated by CAL FIRE as Non-VHFHSZ. The use of mechanized equipment during construction could cause a wildfire if spark-arresting equipment is not installed on hot surfaces such as mufflers. However, the California Vehicle Code, Section 38366, requires spark-arresting equipment on vehicles that travel off-road. This code applies to the Proposed Project, and vehicles that work in off-road areas would be required to have spark-arresting equipment to reduce the risk of wildfires. Therefore, the impact would be **less than significant**.

Operation

Once constructed, the Proposed Project would involve the removal of invasive plants using localized herbicides or mechanical means, and temporary irrigation of ecotone slope plantings. In addition, the new and improved flood protection levees and trails would require periodic inspection to identify maintenance and adaptive management needs. As discussed previously, vehicles that work in off-road areas would be required to have spark-arresting equipment to reduce the risk of wildfires. Therefore, the impact would be **less than significant**.

Cumulative Impacts

h) Would the Project, in combination with reasonably foreseeable future projects, result in significant cumulative impacts related to hazards and hazardous materials? (*Less than Significant*)

The cumulative impact area for hazardous materials consists of the area that could be affected by Proposed Project activities, such as the release of hazardous materials, and the areas affected by other projects whose activities could directly or indirectly affect the presence or fate of hazardous materials on the Project site. Typically, only projects adjacent to or abutting the Project site are considered because of the limited potential impact area associated with the release of hazardous materials into the environment.

The contribution of hazardous materials use and hazardous waste disposal with implementation of the Proposed Project is minimal, and combined hazardous materials effects from past, present, and reasonably foreseeable projects within the City and immediate area would not be significant. As previously stated, Project construction and operation would involve the use of potentially hazardous materials (e.g., localized herbicides, solvents, and diesel and petroleum fuels), that when used correctly and in compliance with existing laws and regulations, would not result in a significant hazard to visitors or workers in the vicinity of the Project site. Impacts associated with the potential to encounter unknown hazardous debris and waste that may exist on site during construction would be reduced to a less-than-significant level through environmental review pursuant to CEQA. Furthermore, the Proposed Project and all other projects in the cumulative area are required to comply with the existing regulations related to hazards and hazardous materials. Consistency with federal, state, and local regulations would prevent the Proposed Project, as well as other projects, from creating cumulative impacts in terms of hazards and hazardous materials.

Impacts associated with hazardous soils, hazardous groundwater, and the use of hazardous materials on site would be controlled through application of regulatory compliance measures. For the reasons outlined above, implementation of the Proposed Project would not result in an incremental contribution to cumulative impacts related to hazards and hazardous materials that are cumulatively considerable; therefore, cumulative hazards and hazardous materials impacts are considered **less than significant.**

References

California Department of Forestry and Fire Protection (CAL FIRE). 2008. Recommended Very High Fire Hazard Severity Zones in LRA. October 16, 2008.

California Department of Toxic Substances Control (DTSC). 2021. DTSC's Hazardous Waste and Substances Site List—Site Cleanup (Cortese List). Available: https://calepa.ca.gov/sitecleanup/corteselist/. Accessed June 8, 2021.

Marin County. 2016. Wildfire Evacuation Zones. Available: https://www.marincounty.org/-/media/files/departments/fr/wildfire-evacuation-zones/mtz_san-rafael.pdf. Accessed July 9, 2021.

B.7 Land Use & Planning

Issues (and Supporting Information Sources):	Potentially Significant Impact	Less-than-Significant Impact with Mitigation	Less-than-Significant Impact	No Impact
LAND USE & PLANNING — Would the Project:				
a) Physically divide an established community?	☐	☐	☐	☒
b) Cause a significant environmental impact due to a conflict with any land use plan, policy, or regulation adopted for the purpose of avoiding or mitigating an environmental effect?	☐	☐	☐	☒

Environmental Setting

As discussed in EIR Chapter 2, *Project Description*, the Proposed Project would restore former tidal marshlands and improve a shoreline levee at the confluence of San Rafael Creek and San Rafael Bay. The Project site is along the north boundary of the Canal neighborhood in Central San Rafael. Tiscornia Marsh is bounded on the west by the Al Boro Community Center and Pickleweed Park. To the north is the mouth of San Rafael Creek, and to the east is San Rafael Bay (Bay). The location of former Schoen Park (removed by the City in 2019) lies south of the Tiscornia Marsh shoreline levee, on the southeastern portion of the Project site, bordered by Spinnaker Point Drive (refer to Figure 2-2).

The Project site is designated in the San Rafael General Plan 2040 (General Plan) as Parks, Recreation, and Open Space and as Conservation (City of San Rafael 2021) and is zoned as Parks/Open Space, Planned Development, and Water Zoning Districts with a Wetlands Overlay and a Canalfront Review Overlay (City of San Rafael 2021).

Discussion

a) Would the Project physically divide an established community? *(No Impact)*

As indicated above, the Project site is along the north boundary of the Canal neighborhood in Central San Rafael. While the Proposed Project would set back a levee to restore and enhance wetlands, this is contained within the Project site and would not divide or otherwise go through any neighborhoods or communities. Therefore, neither construction nor operation of the Proposed Project would physically divide an established community, and there would be ***no impact***.

b) Would the Project cause a significant environmental impact due to a conflict with any land use plan, policy, or regulation adopted for the purpose of avoiding or mitigating an environmental effect? *(No Impact)*

The General Plan and zoning designations within San Rafael are identified above. Implementation of the Proposed Project would restore former tidal marshlands and improve a shoreline levee and would not conflict with the current designations of Parks, Recreation, and Open Space; Conservation; or Parks/Open Space. As part of this analysis, the General Plan Land Use Element's goals and policies, as well as the San Rafael Shoreline Park Master Plan (1989)were reviewed for any potential conflict that the Proposed Project could have with specific policies whose purpose it is to avoid or mitigate environmental effects. Goal 1 of the Land Use Element is related to "Well-Managed Growth and Change," with a focus on growing in a way that balances community needs, the environment, fiscal stability, and quality of life. Goal 2 is related to "A Complete Community," focused on balanced and diverse land uses (City of San Rafael 2021). Neither construction nor operation of the Proposed Project would induce growth or alter San Rafael's balance and diversity. Further, the Land Use Element makes clear that the City's Zoning Ordinance establishes regulations and standards to ensure that the policies, goals, and objectives of the General Plan are carried out. For the Parks/Open Space District (with Wetland Overlay and Canalfront Review Overlay), the Zoning Ordinance provides that public improvements (such as levees) and public recreation facilities and trails are permitted by right, and that wildlife preserves or sanctuaries are conditionally permitted (City of San Rafael Municipal Code, Title 14, Chapters 14.07, 14.10, 14.11, 14.13, and 14.15). Neither the Water District, Planned Development District, or Canalfront Review Overlay District regulations conflict with these allowable uses. Because the Proposed Project would not conflict with the General Plan's goals or the regulations set forth by the Zoning Ordinance, there would be ***no impact***.

Cumulative Impacts

c) Would the Project, in combination with reasonably foreseeable future projects, result in significant cumulative impacts on land use? (*No Impact*)

The geographic scope of potential cumulative land use impacts encompasses the Project site and its vicinity. Cumulative scenario projects include the Pickleweed Field and Park Project and the Schoen Park Conversion to Parking. However, the Project and cumulative projects would replace existing land uses, or result in a new land use that is compatible with existing zoning and land use plans, and would not physically divide an established community. Therefore, there would be no cumulative impact, and the Project's contribution to cumulative land use impacts would not be cumulatively considerable.

References

City of San Rafael. 2004. City of San Rafael General Plan 2020, Land Use Map, November 15, 2004.

City of San Rafael. 2021. City of San Rafael General Plan 2040, Land Use Element. Adopted August 2021.

City of San Rafael. 2021. City of San Rafael Zoning Map. Available: https://www.arcgis.com/apps/View/index.html?appid=f9a6eba03a8d44f5919bfef783f056c2. Accessed on May 26, 2021.

B.8 Mineral Resources

Issues (and Supporting Information Sources):	*Potentially Significant Impact*	*Less-than-Significant Impact with Mitigation*	*Less-than-Significant Impact*	*No Impact*
MINERAL RESOURCES — Would the Project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	☐	☐	☐	☒
b) Result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plan?	☐	☐	☐	☒

Environmental Setting

The City of San Rafael General Plan identifies the San Rafael Rock Quarry and McNear Brick and Block properties as the only locally important mineral resource located within the City of San Rafael (City of San Rafael 2021). These properties are located at Point San Pedro, approximately 2.5 miles northeast of the Project site, and mineral resources have not been identified within the Proposed Project site. No active mines or mineral plants have been identified within the Proposed Project site (USGS 2003).

Discussion

a, b) Would the Project result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state? Would the Project result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plan? (*No Impact*)

There are no known mineral resources and no active mines or mineral plants located within the Proposed Project site. The closest mineral resource is the San Rafael Rock Quarry and McNeary Brick and Block properties, located approximately 2.5 miles to the northeast of the Proposed Project site, at the north end of San Rafael Bay. Project construction and operation would not directly affect this resource, nor would Project construction activities affect the operation of that quarry given the distance between the Project site and the quarry. Therefore, the Proposed Project would not result in the loss of availability of a known mineral resource that would be of value to the region, and would not result in the loss of availability of a locally important mineral resource recovery site. **No impact** would occur.

Cumulative Impacts

c) Would the Project, in combination with reasonably foreseeable future projects, result in significant cumulative impacts on mineral resources? (*No Impact*)

For mineral resources, the geographic scope consists of the area that could be affected by Proposed Project activities and the areas affected by other projects whose activities could directly or indirectly affect the mineral resources of the region. The analysis above indicates no mineral resources on the Project site. Therefore, the Proposed Project would not contribute to cumulative mineral resource impacts and there would be **no impact**.

References

City of San Rafael. 2021. City of San Rafael General Plan 2040. Adopted August 2021.

U.S. Geological Survey (USGS). 2003. Active Mines and Mineral Plants in the U.S. Available: https://mrdata.usgs.gov/mineplant/. Accessed July 7, 2021.

B.9 Noise & Vibration

Issues (and Supporting Information Sources):	Potentially Significant Impact	Less-than-Significant Impact with Mitigation	Less-than-Significant Impact	No Impact
NOISE & VIBRATION— Would the Project:				
a) Result in generation of a substantial temporary or permanent increase in ambient noise levels in the vicinity of the Project in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?	☐	☐	☒	☐
b) Result in generation of excessive ground-borne vibration or ground-borne noise levels?	☐	☐	☒	☐
c) For a project located within the vicinity of a private airstrip or an airport land use plan or, where such a plan has not been adopted, within 2 miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒

Environmental Setting

Noise Terminology

Noise is generally defined as unwanted sound. Sound, traveling in the form of waves from a source, exerts a sound pressure level (referred to as sound level), which is measured in decibels (dB), with 0 dB corresponding roughly to the threshold of human hearing and 120 dB to 140 dB corresponding to the threshold of pain.

Sound pressure fluctuations can be measured in units of hertz (Hz), which correspond to the frequency of a particular sound. Typically, sound does not consist of a single frequency, but rather a broad band of frequencies varying in levels of magnitude (sound power). The sound pressure level, therefore, constitutes the additive force exerted by a sound corresponding to the frequency/sound power level spectrum.

The typical human ear is not equally sensitive to all frequencies of the audible sound spectrum. As a consequence, when assessing potential noise impacts, sound is measured using an electronic filter that de-emphasizes the frequencies below 1,000 Hz and above 5,000 Hz in a manner corresponding to the human ear's decreased sensitivity to low and extremely high frequencies instead of the frequency mid-range. This method of frequency weighting is referred to as A-weighting and is expressed in units of A-weighted decibels (dBA). Frequency A-weighting follows an international standard methodology of frequency de-emphasis and is typically applied to community noise measurements.

When a new noise is introduced to an environment, the human reaction can be predicted by comparing the new noise to the ambient noise level, which is the existing noise level comprised of all sources of noise in a given location. In general, the more a new noise exceeds the ambient noise level, the less acceptable the new noise will be judged by those hearing it. With regard to increases in A-weighted noise level, the following relationships occur (Caltrans 2013).

- Except in carefully controlled laboratory experiments, a change of 1-dB cannot be perceived.

- Outside of the laboratory, a 3-dB change is considered a just-perceivable difference.
- A change in level of at least 5-dB is required before any noticeable change in human response would be expected.
- A 10-dB change is subjectively heard as approximately a doubling in loudness, and can cause an adverse response.

The perceived increases in noise levels described above are applicable to both mobile and stationary noise sources. These relationships occur in part because of the logarithmic nature of sound and the decibel system. The human ear perceives sound in a non-linear fashion; hence, the decibel scale was developed. Because the decibel scale is based on logarithms, two noise sources do not combine in a simple additive fashion, rather logarithmically. For example, if two identical noise sources produce noise levels of 50 dBA, the combined sound level would be 53 dBA, not 100 dBA.

Noise exposure is a measure of noise over a period of time. Noise level is a measure of noise at a given instant in time. Community noise varies continuously over a period of time with respect to the contributing sound sources of the community noise environment. Community noise is primarily the product of many distant noise sources, which constitute a relatively stable background noise exposure, with the individual contributors unidentifiable. The background noise level changes throughout a typical day, but does so gradually, corresponding with the addition and subtraction of distant noise sources such as traffic and atmospheric conditions. What makes community noise constantly variable throughout a day, besides the slowly changing background noise, is the addition of short duration single-event noise sources (e.g., aircraft flyovers, motor vehicles, sirens), which are readily identifiable to the individual receptor. These successive additions of sound to the community noise environment vary the community noise level from instant to instant, requiring the measurement of noise exposure over a period of time to legitimately characterize a community noise environment and evaluate cumulative noise impacts.

This time-varying characteristic of environmental noise is described using statistical noise descriptors. The most frequently used noise descriptors are summarized below:

L_{dn}: A 24-hour day and night A-weighted noise exposure level, which accounts for the greater sensitivity of most people to nighttime noise by weighting noise levels at night ("penalizing" nighttime noises). Noise between 10:00 p.m. and 7:00 a.m. is weighted (penalized) by adding 10 dB to take into account the greater annoyance of nighttime noises.

CNEL: The Community Noise Equivalent Level (CNEL); similar to L_{dn}, the CNEL adds a 5-dB "penalty" for the evening hours between 7:00 p.m. and 10:00 p.m. in addition to a 10-dB penalty between the hours of 10:00 p.m. and 7:00 a.m.

L_{eq}: The energy-equivalent sound level is used to describe noise over a specified period of time, typically one hour, in terms of a single numerical value. The L_{eq} is the constant sound level, which would contain the same acoustic energy as the varying sound level, during the same time period (i.e., the average noise exposure level for the given time period).

L_{max}: The instantaneous maximum noise level for a specified period of time.

Vibration Terminology

As described in the Federal Transit Administration's (FTA) Transit Noise and Vibration Impact Manual, ground-borne vibration can be a serious concern for nearby neighbors, causing buildings to shake and rumbling sounds to be heard (FTA 2018). In contrast to airborne noise, ground-borne vibration is not a common environmental problem. It is unusual for vibration from sources such as buses and trucks to be perceptible, even in locations close to major roads. Some common sources of ground-borne vibration are trains; buses and heavy trucks on rough roads; and construction activities such as blasting, sheet pile-driving, and operating heavy earth-moving equipment.

Several different methods are used to quantify vibration. The peak particle velocity (PPV) is defined as the maximum instantaneous peak of the vibration signal, which is measured in inches per second. The PPV is most frequently used to describe vibration impacts on buildings. The root mean square (RMS) amplitude is most frequently used to describe the effect of vibration on the human body. The RMS amplitude is defined as the average of the squared amplitude of the signal. Decibel notation (VdB) is commonly used to express RMS. The decibel notation acts to compress the range of numbers required to describe vibration. Typically, ground-borne vibration generated by man-made activities attenuates rapidly with distance from the source of the vibration. Sensitive receptors for vibration assessment include structures (especially older masonry structures), people who spend a lot of time indoors (especially residents, students, the elderly and sick), and vibration-sensitive equipment such as hospital analytical equipment and equipment used in computer chip manufacturing.

The effects of ground-borne vibration include the movement of the building floors, rattling of windows, shaking of items on shelves or hanging on walls, and rumbling sounds. In extreme cases, the vibration can cause damage to buildings. Building damage is not a factor for most projects, with the occasional exception of blasting and pile-driving during construction, which would not occur under the Proposed Project. Annoyance from vibration often occurs when the vibration exceeds the threshold of perception by only a small margin.

Sensitive Receptors

Human response to noise varies considerably from one individual to another. Effects of noise at various levels can include interference with sleep, concentration, and communication, and can cause physiological and psychological stress and hearing loss. Given these effects, some land uses are considered more sensitive to ambient noise levels than others. In general, residences, schools, hospitals, and nursing homes are considered to be the most sensitive to noise. Places such as churches, libraries, and cemeteries (where people tend to pray, study, and/or contemplate) are also sensitive to noise. Commercial and industrial uses are considered the least noise-sensitive.

The Proposed Project is located within the City of San Rafael, with existing residences on the south side of Spinnaker Point Drive as close as 150 feet from proposed setback levee and ecotone construction. Additionally, existing residences along the terminus of Sorrento Way would be adjacent to a proposed staging area and approximately 200 feet from the proposed new levee for the diked marsh. The nearest sensitive receptors to the proposed temporary crane platform, which would be installed via vibratory hammer, are residences at the terminus of Sea Way, approximately 470 feet across the creek to the northwest.

Existing Noise Setting

The noise environment surrounding the Project site is influenced by vehicular traffic along U.S. 101/I-580, approximately 1.3 miles to the southwest and Point San Pedro Road, approximately 800 feet to the northwest. According to the Draft update to the San Rafael General Plan Noise Element, the Project environs are located outside of (lower than) the 60 dBA L_{dn} noise contour from roadway sources (City of San Rafael 2021).

Regulatory Framework

City of San Rafael General Plan 2040

The Noise Element of City of San Rafael's General Plan 2040 contains the following policies and programs addressing noise and vibration relevant to the Proposed Project:

> ***Policy N-1.9: Maintaining Peace and Quiet.*** Minimize noise conflicts resulting from everyday activities such as construction, sirens, yard equipment, business operations, night-time sporting events, and domestic activities.
>
>> *Program N-1.9A:* Noise Ordinance. Maintain and enforce the noise ordinance, which addresses common noise sources such as amplified music, mechanical equipment use, and construction. Updates to the ordinance should be periodically considered in response to new issues (for example, allowing portable generators during power outages).
>>
>> *Program N-1.9B: Construction Noise.* Establish a list of construction best management practices (BMPs) for future projects and incorporate the list into San Rafael Municipal Code Chapter 8.13 (Noise) The City Building Division shall verify that appropriate BMPs are included on demolition, grading, and construction plans prior to the issuance of associated permits.

City of San Rafael Municipal Code

Chapter 8.13 of the San Rafael Municipal Code establishes general noise limits within the city. These noise standards are not to be exceeded at the property plane of the receiving property types or zones, with some exceptions. Standard exceptions to general noise limits are identified for construction and would therefore be applicable to the Proposed Project. Per Section 8.13.050(A), for any construction project on property within the city, the construction, alteration, demolition, maintenance of construction equipment, deliveries of materials or equipment, or repair activities otherwise allowed under applicable law shall be allowed between the hours of 7:00 a.m. and 6:00 p.m., Monday through Friday, and 9:00 a.m. and 6:00 p.m. on Saturdays, provided that the noise level at any point outside of the property plane of the project shall not exceed 90 dBA. All such activities shall be precluded on Sundays and holidays.

Discussion

a) Would the Project result in the generation of a substantial temporary or permanent increase in ambient noise levels in the vicinity of the Project in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies? (*Less than Significant*)

The Proposed Project is located within the jurisdiction of the City of San Rafael.

Construction Impacts

As discussed above, the City of San Rafael has established allowable construction hours within its municipal code. Project construction activities are proposed to occur from approximately 8:00 a.m. to 5:00 p.m., Monday through Friday. Section 8.13.050(A) of the San Rafael Municipal Code restricts construction activities to between 7:00 a.m. and 6:00 p.m., Monday through Friday, and 9:00 a.m. and 6:00 p.m. on Saturdays. The proposed construction activities would be consistent with the time restrictions of the City ordinance, provided that the noise level at any point outside of the property plane of the Project shall not exceed 90 dBA.

Although there would be no long-term operational noise sources following construction, the construction of the Proposed Project could result in a substantial temporary increase in ambient noise levels in the Project vicinity above levels existing without the Proposed Project.

Construction noise levels at and near the Project site would fluctuate depending on the type, number, and duration of use of various pieces of construction equipment. Given the low level of construction-related vehicle trips associated with hauling (approximately one truck trip per hour during the levee improvement phase) and commuting workers, these trips would not be expected to raise ambient noise levels along haul routes. **TableB-1** shows typical noise levels produced by various types of construction equipment that would operate during the construction of the Proposed Project.

The operation of each piece of equipment throughout the Project site would not be constant throughout each phase or workday, as equipment would be turned off when not in use. Over a typical workday, the equipment would operate at different locations, and all of the equipment would not operate concurrently at the same location within the Project site. To quantify construction-related noise exposure that would occur at the nearest sensitive receptors, it was assumed that the two loudest pieces of construction equipment would operate at the same time at the closest location of the Project site to the nearest off-site sensitive receptors. **Table B-2** presents the highest L_{eq} noise levels that sensitive receptors could be exposed to at each of the construction sites.

TABLE B-1
REFERENCE CONSTRUCTION EQUIPMENT NOISE LEVELS – (50 FEET FROM SOURCE)

Type of Equipment	L_{max}, dBA	Hourly L_{eq}, dBA/Percent Used[a]
Bulldozer	85	81/40
Front Loader	80	76/40
Excavator	85	81/40
Dump Truck	84	80/40
Water Truck	84	80/40
Compactor	80	73/20
Tug Boat	87	87/NA
Work Boat	NA	72/NA
Dragline	NA	85/NA
Crane	85	77/16
Pile Driver (vibratory)	101	88/20

NOTE:
a. "Percent used" were obtained from the FHWA Roadway Construction Noise Model User's Guide.

SOURCE: FHWA 2006.

TABLE B-2
ESTIMATED NOISE LEVELS AT SENSITIVE RECEPTORS DURING PROPOSED PROJECT CONSTRUCTION

Receptor	Distance to Nearest Sensitive Receptor (feet)	Two Loudest Pieces of Construction Equipment	Combined Noise level from 50 feet (dBA L_{eq})[a]	Attenuated Noise Level (dBA L_{eq})[b]	Exceed 90 dBA Leq (yes or no)?
Phase 1A: Site Preparation					
Sorrento Way	1,390	Pile Driver, Crane	93.9	65.0	No
Community Center	1,000	Pile Driver, Crane	93.9	67.8	No
Sea Way	470	Pile Driver, Crane	93.9	74.4	No
Phase 1B: Initial Beach Construction					
Sorrento Way	1,200	Dozer, Excavator	80.2	52.6	No
Community Center	530	Dozer, Excavator	80.2	59.7	No
Sea Way	400	Dozer, Excavator	80.2	62.2	No
Spinnaker Point Drive	300	Dozer, Excavator	80.2	64.7	No
Phase 2A: Levee Improvements and Marsh Reconstruction					
Sorrento Way	150	Dozer, Excavator	80.2	70.7	No
Community Center	330	Dozer, Excavator	80.2	63.9	No
Sea Way	440	Dozer, Excavator	80.2	61.4	No
Spinnaker Point Drive	300	Dozer, Excavator	80.2	64.7	No
Phase 2B: Drying and Shaping					
Sorrento Way	150	Dozer, Excavator	80.2	70.7	No
Community Center	330	Dozer, Excavator	80.2	63.9	No
Sea Way	440	Dozer, Excavator	80.2	61.4	No
Spinnaker Point Drive	610	Dozer, Excavator	80.2	58.5	No

TABLE B-2 (CONT.)
ESTIMATED NOISE LEVELS AT SENSITIVE RECEPTORS DURING PROPOSED PROJECT CONSTRUCTION

Receptor	Distance to Nearest Sensitive Receptor (feet)	Two Loudest Pieces of Construction Equipment	Combined Noise level from 50 feet (dBA L_{eq})[a]	Attenuated Noise Level (dBA L_{eq})[b]	Exceed 90 dBA Leq (yes or no)?
Phase 3A: Levee Lift and Diked Marsh Restoration					
Sorrento Way	150	Dozer, Excavator	80.2	70.7	No
Community Center	330	Dozer, Excavator	80.2	63.9	No
Sea Way	440	Dozer, Excavator	80.2	61.4	No
Spinnaker Point Drive	610	Dozer, Excavator	80.2	58.5	No
Phase 3B: Site Restoration					
Sorrento Way	150	Dozer, Excavator	80.2	70.7	No
Community Center	330	Dozer, Excavator	80.2	63.9	No
Sea Way	440	Dozer, Excavator	80.2	61.4	No
Spinnaker Point Drive	300	Dozer, Excavator	80.2	64.7	No

NOTES:
a. Reference construction equipment noise levels were obtained from Caltrans' Roadway Construction Noise Level (RCNM).
b. Assumed an attenuation rate of 7.5 dB per doubling of distance (i.e., soft site), to account for interning terrain and structures.

SOURCE: FHWA 2006.

As shown in Table B-2, construction activities of all phases of the Proposed Project would generate noise levels at the nearest sensitive receptors below the 90 dBA criterion of Section 8.13.050(A) of the San Rafael Municipal Code. The temporary increase in ambient noise levels would cause a **less-than-significant impact**.

Operation Impacts

Once all construction activities are completed, the Proposed Project would not create any new permanent noise sources (e.g., pumps, generators). Periodic maintenance of the levee and restoration areas would be similar to existing conditions. Therefore, operation and maintenance of the Proposed Project would not generate a substantial increase in noise levels in excess of standards established in the local general plan or noise ordinance. This would result in **no impact** from project operations and maintenance.

b) Would the Project result in the generation of excessive ground-borne vibration or ground-borne noise levels? (*Less than Significant*)

The construction of the Proposed Project would include compaction and pile driving, which can generate significant levels of vibration. Therefore, vibration impacts from these onsite construction activities have been evaluated.

For adverse human reaction, the analysis applies the "strongly perceptible" threshold of 0.9 inch/second PPV for transient sources (Caltrans 2020). A threshold of 0.3 inch/second PPV is used to assess damage risk for all other buildings (Caltrans 2020). There are no historic structures in the vicinity of the Project site that could be adversely affected by Project construction-related vibration.

The potential use of a pile driver and compactor during construction of the Proposed Project would be expected to generate the highest vibration levels during construction. According to the Caltrans *Transportation and Construction Vibration Manual*, both impact pile driving and vibratory pile driving typically generate vibration levels of 0.65 inch/second PPV at a distance of 25 feet (Caltrans 2020). There are single-family residences located 470 feet north of the proposed temporary crane platform where driving of piles would occur. These single-family residences would be exposed to a vibration level of less than 0.026 inch/second PPV, well below the applied human annoyance and building damage threshold. Compaction activities for the new levee would occur as close as 150 feet east of existing residences at the terminus of Sorrento Way. These single-family residences would be exposed to a vibration level of less than 0.029 inch/second PPV, also well below the applied human annoyance and building damage threshold. Consequently, existing sensitive receptors and structures near the Project site would not be affected by substantial ground-borne vibration during Project construction, and there would be no activities during Project operations that involve compaction, pile driving, or other vibratory equipment. Therefore, the impact with respect to the generation of excessive vibration would be considered **less than significant**.

c) For a project located within the vicinity of a private airstrip or an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels? (*No Impact*)

The Proposed Project is located over 3 miles southeast of where the City of San Rafael operates a general aviation airport. Given this distance from the nearest operating airport and the fact that the Proposed Project would not locate new noise-sensitive land uses within 3 miles of a private or public airport, Proposed Project construction and operation would not expose people residing or working in the Proposed Project area to excessive noise levels. **No impact** would occur.

Cumulative Impacts

d) Would the Project, in combination with reasonably foreseeable future projects, result in significant noise or vibration impacts? (*Less than Significant*)

The geographic scope of analysis for cumulative noise and vibration construction impacts encompasses sensitive receptors within approximately 1,000 feet of the Project site.[3] Beyond 1,000 feet, the contributions of noise from other projects would be greatly attenuated through both distance and intervening structures, and their contribution would be expected to be minimal.

3 This screening threshold distance was developed based on stationary source noise attenuation equations (Caltrans, 2013) and the combined noise level generated by typical construction phases for a given project (assuming multiple pieces of equipment) at a distance of 50 feet. Using the attenuation equations, the maximum noise level of 89 dBA for both excavation and finishing would diminish to below 65 dBA at 1,000 feet. A receptor experiencing noise levels of 89 dBA from two adjacent construction sites would experience a cumulative noise level of 91 dBA (the acoustical sum of 89 dBA plus 89 dBA), which would still be below 65 dBA at 1,000 feet, which, hence, is used as the geographic scope.

There are eight foreseeable cumulative projects within the City of San Rafael. All but three of the listed cumulative projects are sufficiently distant to not meaningfully contribute to construction noise impacts.

Of the three cumulative projects within 1,000 feet of the Project site, one is the adjacent Pickleweed Field and Park Project to be constructed between 2021 and 2025. This project would convert the field at Pickleweed to synthetic turf for year-round access and install several other recreation features; it would likely involve the limited use of off-road construction equipment, and would not be expected to require the use of vibration-generating construction equipment.

Another project is San Rafael Creek Operations and Maintenance, which would involve dredging of the creek to a depth of the -8 feet mean lower low water line to the mouth of San Rafael Creek, adjacent to Tiscornia Marsh. This project has no established timeline for dredging activity. This project would likely involve the limited use of dredging equipment and possibly trucks or barges to transport dredged materials, and would not be expected to require the use of vibration-generating construction equipment.

The third is construction of improvements to Schoen Park. The modifications would create approximately 20 new parking spaces in the previous footprint of Schoen Park. This project is scheduled to begin in 2021 and would likely be completed prior to the 2023 commencement of construction of the proposed Project

The Proposed Project's construction is assumed to occur over a period of approximately 275 work days, commencing in September 2023 and finishing in December 2025, so it could coincide with the construction schedule for the nearest two cumulative projects identified above.

As shown in Table B-2, the construction activities of the Proposed Project would generate noise levels of up to 74.4 dBA at the nearest receptors, which is below the 90 dBA criterion of Section 8.13.050(A) of the San Rafael Municipal Code. It is unlikely that either of the two other projects, individually, would result in an equivalent intensity of construction activity as that of the Proposed Project. However, if it were conservatively assumed that each of these two projects would generate the same noise levels as those of the Proposed Project, the resultant noise level would be up to 79.2 dBA, which would still be below the 90 dBA criterion of Section 8.13.050(A) of the San Rafael Municipal Code. Consequently, the cumulative noise impact would be less than significant. As stated above, neither of the two cumulative projects would be expected to involve the use of vibration-generating construction equipment. Therefore, because the Proposed Project would have a less-than-significant construction impact with respect to vibration, as discussed above, the cumulative vibration impact would also be **less than significant.**

References

California Department of Transportation (Caltrans). 2013. Technical Noise Supplement to the Traffic Noise Analysis Protocol. September 2013.

California Department of Transportation (Caltrans). 2020. Transportation and Construction Vibration Guidance Manual. April 2020.

City of San Rafael. 2021. San Rafael 2040 General Plan. August 2021.

Federal Highway Administration (FHWA). 2006. FHWA Roadway Construction Noise Model User's Guide. January 2006.

Federal Transit Administration (FTA). 2018. Transit Noise and Vibration Impact Manual. September 2018.

B.10 Population & Housing

Issues (and Supporting Information Sources):	*Potentially Significant Impact*	*Less-than-Significant Impact with Mitigation*	*Less-than-Significant Impact*	*No Impact*
POPULATION & HOUSING — Would the Project:				
a) Induce substantial unplanned population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?	☐	☐	☐	☒
b) Displace substantial numbers of existing people or housing, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒

Environmental Setting

As of July 1, 2019, there were approximately 258,826 and 58,440 people in Marin County and the City of San Rafael, respectively (United States Census Bureau 2020).

Discussion

a) Would the Project induce substantial unplanned population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)? (*No Impact*)

The Proposed Project would restore and reconstruct former tidal marshlands and improve a shoreline levee along the north boundary of the Canal neighborhood in Central San Rafael. Project activities would not include changes in land uses that would result in new residences or business, nor would the Project extend roads or other infrastructure that could result in new areas that could be developed. It is anticipated the Proposed Project would occur in three phases, over at least 3 years, and that 19 construction workers would be employed. However, given the location of the Project site and its proximity to several population centers, the regional labor pool could likely meet the construction workforce requirements. Therefore, the Proposed Project would not result in substantial unplanned population growth in the area, and there would be **no impact.**

b) Would the Project displace substantial numbers of existing people or housing, necessitating the construction of replacement housing elsewhere? (*No Impact*)

The Proposed Project would restore and reconstruct former tidal marshlands on parcels currently owned by the Marin Audubon Society and the City of San Rafael. Land use on the Project site is mainly comprised of tidal marsh and diked pickleweed marsh, neither of which contain residences or housing of any kind. The Project would therefore not displace existing people or housing, necessitating the construction of replacement housing elsewhere. There would be **no impact.**

Cumulative Impacts

c) Would the Project, in combination with reasonably foreseeable future projects, result in significant cumulative impacts on population and housing? (*No Impact*)

The geographic scope of potential cumulative population and housing use impacts encompasses the Project site and its vicinity. Cumulative scenario projects include the Pickleweed Field and Park Project and the Schoen Park Conversion to Parking. However, the Project and cumulative projects would replace existing land uses, or result in a new land use that is compatible with existing zoning and land use plans. None of the projects would require or draw new populations to the area, remove existing housing, or require the addition of new housing. Therefore, there would not be a cumulative impact, and the Project's contribution to cumulative population and housing impacts would not be cumulatively considerable.

References

United States Census Bureau. 2020. Quick Facts: Marin County and San Rafael city, California. Accessible: https://www.census.gov/quickfacts/fact/table/marincountycalifornia,sanrafaelcitycalifornia/PST045219. Accessed on May 24, 2021.

B.11 Public Services

Issues (and Supporting Information Sources):	*Potentially Significant Impact*	*Less-than-Significant Impact with Mitigation*	*Less-than-Significant Impact*	*No Impact*
PUBLIC SERVICES — Would the Project:				
a) Result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times, or other performance objectives for any of the following public services:				
i) Fire protection?	☐	☐	☒	☐
ii) Police protection?	☐	☐	☒	☐
iii) Schools?	☐	☐	☐	☒
iv) Parks?	☐	☐	☒	☐
v) Other public facilities?	☐	☐	☒	☐

Environmental Setting

Emergency fire and medical services and disaster response within the City of San Rafael are provided by the San Rafael Fire Department. The Fire Department administers seven neighborhood fire stations with 90 personnel to provide these services within City limits and other areas as defined through contracts and mutual aid agreements with bordering areas. The City of San Rafael Police Department is responsible for areas within the City limits. The Police Department has an Operational Division providing uniformed police services 24 hours per day and an Administrative Division providing criminal investigations, training, and dispatch. The Police Department has 60 full-time sworn personnel and 22 full-time non-sworn personnel. In the event of an emergency at the Project site, the City of San Rafael Police Department and San Rafael Fire Department would respond.

San Rafael City Schools (SRCS) include the San Rafael Elementary School District and the San Rafael High School District. There are nine elementary schools, two comprehensive 9–12 high schools, and one continuation high school. SRCS serves more than 7,200 students. Both districts are governed by a school board and district office administration.

Exclusive of open space lands, there are 40 classified parks in San Rafael's Park System. These parks include regional, community, neighborhood, pocket, and special use parks. The City has 4.17 acres of parkland per 1,000 residents. The parkland serves over 73,300 residents from the City and surrounding unincorporated areas (City of San Rafael 2021).

Discussion

a.i (Fire Protection) Would the Project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered government facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times, or other performance objectives for fire protection? (*Less than Significant*)

Construction for the Project would be intermittent and temporary, requiring an approximate 6-month construction window over the course of 3 to 4 years and involving approximately 19 construction workers on any given day. These workers would likely be sourced from the local workforce, but either way they would not relocate to communities nearby the Project site for this short-term work. Therefore, Project construction would not significantly increase the demand for fire protection services throughout the Project vicinity due to population growth and would not change any uses on the site. For these reasons, the Project would not be expected to substantially affect the San Rafael Fire Department's ability to maintain service ratios, response times, or other performance objectives or require new or physically altered facilities. For this reason, and because Project operations would be consistent with existing conditions, the Project's impact with respect to fire services would be **less than significant.**

a.ii (Police Protection) Would the Project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered government facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times, or other performance objectives for police protection? (*Less than Significant*)

As referenced in a.i, construction for the Project would be intermittent, with only 19 construction workers on site at a given time. The Project would therefore not be expected to substantially affect the City of San Rafael Police Department's ability to maintain service ratios, response times, or other performance objectives or require new or physically altered facilities. The Project's impact with respect to the provision of police protection during construction and operations would be **less than significant.**

a.iii (Schools) Would the Project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered government facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times, or other performance objectives for schools? *(No Impact)*

The Proposed Project would result in a small temporary increase of construction worker employees at the Project site. Construction workers would most likely be from the region, and the Project would not require an increase of permanent construction employees such that new or expanded school facilities would be required. For these reasons, and because Project operations would be consistent with existing conditions, the Project would have **no impact** with respect to schools.

a.iv (Parks) Would the Project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered government facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times, or other performance objectives for parks? (*Less than Significant*)

The Project site includes unpaved segments of the Bay Trail at the existing levee crest. The Proposed Project would improve and pave these trail segments upon the final lift of the improved levee and setback levee segments and would add educational signage. For the reasons described for issue a.i above, the Project would not result in increased population such that there would be additional demand for park facilities during or after construction, and the completed Project would actually expand accessibility to the trail segments within the Project site. Impacts related to increased or expanded public access are addressed in Section B.12, *Recreation*. The Project's impacts related to new or expanded park facilities to maintain acceptable service ratios would be **less than significant.**

a.v (Other Public Facilities) Would the Project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered government facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times, or other performance objectives for other public facilities? (*Less than Significant*)

The Proposed Project would not involve the employment of new permanent employees or residents, and Project operations would be consistent with existing conditions; therefore, it is not expected to increase the use of other public facilities (such as libraries or hospitals), and the impact with respect to other public facilities would be **less than significant.**

Cumulative Impacts

b) Would the Project, in combination with reasonably foreseeable future projects, result in significant cumulative impacts on public services? (*Less than Significant*)

The geographic scope of potential cumulative public services impacts encompasses the Project site and its vicinity. Cumulative scenario projects include the Pickleweed Field and Park Project and the Schoen Park Conversion to Parking. However, the Project and cumulative projects would replace existing land uses, or result in a new land use that is compatible with land use, and would not result in an increase in population or visitation that would require the construction of new public service facilities. Therefore, a cumulative public services impact would not occur, and the Project's contribution to cumulative public services impacts would not be cumulatively considerable.

References

City of San Rafael. 2021. City of San Rafael General Plan 2040. August 2021.

B.12 Recreation

Issues (and Supporting Information Sources):	Potentially Significant Impact	Less-than-Significant Impact with Mitigation	Less Than Significant Impact	No Impact
RECREATION —				
a) Would the Project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	☐	☐	☒	☐
b) Does the Project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?	☐	☐	☒	☐

Environmental Setting

There are 19 City parks within the City of San Rafael (City of San Rafael 2021). These parks help make up the City's existing 3,455 acres of parks and open space that vary in size and amenities.

The Project site contains existing facilities such as recreational trails along the shoreline levee and a City-owned pond. Located adjacent to the Project site is the Al Boro Community Center and adjoining Pickleweed Park soccer field.

Discussion

a, b) Would the Project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated? Does the Project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment? (*Less than Significant with Mitigation*)

The Project includes the construction and operation of a recreational resource, the implementation of which could cause adverse physical effects on the environment. The impacts that could result from Project construction and operation are addressed in the corresponding topical sections of the EIR. However, as described below, construction and operation of the Project is not expected to have substantial adverse effects related to increased use of nearby parks or facilities such that deterioration or degradation would occur. The Proposed Project would include changes to the existing shoreline levee that traverses the Project site, which is currently used as a recreational trail. Project activities for the shoreline levee improvements would result in the shoreline levee/ trail around the diked marsh being lowered and breached to restore tidal inundation. This portion of the shoreline trail would be replaced with a new levee and trail along the north side of the soccer field, approximately 200 to 400 feet behind the location of the existing perimeter levee. During Project construction, the levee trail would be closed to access; however, use of the soccer field and Pickleweed Park play areas and community facility would not be affected. Trail users would be able to continue along the Bay Trail by utilizing the pedestrian sidewalk along Spinnaker Point Drive during construction of the new levee trail. While Project construction activities would interrupt the use of the levee trail, with the availability of trail detour options and the overall availability of recreation opportunities in the Project vicinity, recreation use during construction would continue in the Project vicinity, and it is not anticipated that existing recreation users would instead use other recreation resources at a level that would result in the deterioration of or damage to other nearby recreation facilities.

Following completion of construction of the new levee, the new levee, the raised levee on the east side of the existing soccer field, and the setback levee on the south side of Tiscornia Marsh would all include asphalt-paved trails at the levee crest (whereas the existing trail segments are unpaved), and new signage and seating would be added that do not currently exist. Given that the existing recreational trail within the Project site would be replaced by a similar but slightly shorter trail following completion of Project construction, implementation of the Proposed Project would not result in the increased use of existing neighborhood and regional parks or other recreational facilities that would result in substantial physical deterioration of the facilities. Additionally, the Proposed Project would not result in an increase in use of existing recreational facilities or require the construction or expansion of recreational facilities because construction activities along the shoreline levee would be temporary and would not permanently disrupt or displace recreational activities on the trail. Therefore, impacts would be **less than significant.**

Cumulative Impacts

c) Would the Project, in combination with reasonably foreseeable future projects, result in significant cumulative impacts on recreation resources? (*Less than Significant*)

The geographic scope of potential cumulative recreation impacts encompasses the Project site and its vicinity, as well as park and recreational facilities, including parks, trails, and other public recreation facilities, within the vicinity of the Project site.

As described above, the Project would result in the temporary closure of access to the levee trail during construction of the new levee and levee trail. During the construction period, it is anticipated that local users would detour along the pedestrian sidewalk along Spinnaker Point Drive to continue along the Bay Trail. Cumulative scenario projects that could result in a restriction of access to recreational opportunities include the Pickleweed Field and Park Project and the Schoen Park Conversion to Parking. The potential for active construction on elements of these projects that would affect access to recreational facilities during the same period as the Project is expected to be limited. Even if closures to recreational facilities were to co-occur with the Project, several other parks and recreational facilities in the vicinity would remain open and unaffected by construction of the Project or of the cumulative scenario projects. Therefore, the Project’s contribution to a cumulative loss of recreational opportunities, or to cumulative increases in the use of parks or recreational facilities, would not be cumulatively considerable and would be **less than significant.**

References

City of San Rafael. 2021. Visitors – Parks & Outdoor Activities. Available: https://www.cityofsanrafael.org/parks-outdoor-activities/. Accessed June 7, 2021.

B.13 Transportation

Issues (and Supporting Information Sources):	Potentially Significant Impact	Less-than-Significant Impacts with Mitigation	Less-than-Significant Impact	No Impact
TRANSPORTATION — Would the Project:				
a) Conflict with a program, plan, ordinance, or policy addressing the circulation system, including transit, roadway, bicycle, and pedestrian facilities?	☐	☐	☒	☐
b) Conflict or be inconsistent with CEQA Guidelines Section 15064.3, Subdivision (b)?	☐	☐	☒	☐
c) Substantially increase hazards due to a geometric design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?	☐	☒	☐	☐
d) Result in inadequate emergency access?	☐	☐	☒	☐

Environmental Setting

The Project site is located along the north boundary of the Canal neighborhood in Central San Rafael (see Figures 2-1 and 2-2 in the EIR). Regional access to the Project site is provided from the U.S. 101/I-580 Interchange approximately two-thirds of a mile to the southwest at the Bellam Boulevard on- and off-ramps. Bellam Boulevard, Kerner Boulevard, and Canal Street/Spinnaker Point Drive is used for local access between the freeway on- and off-ramps and the Project site.

Regional Access

U.S. 101 is an eight-lane (three general-purpose and one high-occupancy vehicle lane in each travel direction) interstate highway in the Project vicinity, running north and south through Marin County all the way to Washington State to the north and Los Angeles to the south. It carries an average annual daily traffic (AADT) volume of approximately 202,000 vehicles in the Project vicinity (Caltrans 2020). I-580 is a four-lane interstate highway (two general-purpose lanes in each travel direction) in the Project vicinity, running east and west between U.S. 101 in San Rafael and I-5 in the Central Valley. It carries an AADT volume of approximately 66,200 vehicles in the Project vicinity (Caltrans 2020). U.S. 101 provides access to the Project site via a full-access interchange at Bellam Boulevard.

Local Access

Bellam Boulevard is identified in the City's General Plan as a major arterial, and has five lanes (three westbound and two eastbound travel lanes) in the Project vicinity (City of San Rafael 2021). It is approximately 0.7-mile long, with a terminus to the west at Auburn Street where it continues as Woodland Avenue, and to the east at Catalina Boulevard where it continues as Baypoint Village Drive. Kerner Boulevard is a two-lane, north-south local roadway (i.e., no General Plan classification) that is approximately 1-mile long and terminates at Canal Street to the north and dead-ends approximately 1,500 feet south of Irene Street to the south. It only operates one-way, in the northbound travel direction, south of Bellam Boulevard. Canal Street is a two-lane, east-west local roadway (i.e., no General Plan classification) that is approximately 1-mile long and dead-ends approximately 250 feet west of Harbor Street to the west and at Bahia Way to the east, where it continues as Spinnaker Point Drive. Access to the Proposed Project's construction staging area would be provided off of Spinnaker Point Drive.

Transit, Bicycle, and Pedestrian Facilities

Marin Transit, the public transit service provider in San Rafael, operates the following six bus routes in the Project vicinity, with bus stops located on Kerner Boulevard approximately 200 feet south of Canal Street (Marin Transit 2020):

- Route 23 Canal – Downtown Fairfax
- Route 23X Canal – Fairfax Manor
- Route 29 Canal – Marin Health
- Route 35 Canal – Novato
- Route 36 Canal – Marin City
- Route 135 Canal – Downtown San Rafael

There are sidewalks on both sides of Canal Street/Spinnaker Point Drive, the road that would be used to access to the Proposed Project construction staging area, as well as crosswalks across Canal Street at Kerner Boulevard, Bahia Way, and Portsmouth Cove. Near the Project site, the City's Bicycle & Pedestrian Master Plan identifies Class I multi-use paths (off-street facilities exclusively dedicated to the use by bicyclists, pedestrians, and other non-motorized travel such as roller skaters and skateboarders) connecting Bellam Boulevard with Canal Street/Spinnaker Drive and along the San Rafael Bay connecting Pickleweed Park to the San Francisco Bay Trail (City of San Rafael 2018). There are also existing Class III bike routes (travel lanes shared between people bicycling and driving that are usually low speed and have little traffic) on Canal Street west of Kerner Boulevard and on Bellam Boulevard between U.S. 101 and Playa Del Rey.

Discussion

a) Would the Project conflict with a program, plan, ordinance, or policy addressing the circulation system, including transit, roadway, bicycle, and pedestrian facilities? (*Less than Significant*)

Construction Impacts

Traffic Operating Conditions

As described in EIR Chapter 2, *Project Description*, the Proposed Project would restore former tidal marshlands and improve a shoreline levee on a 28-acre site at the confluence of San Rafael Creek and San Rafael Bay. Construction activities would involve coarse beach construction, eroded tidal marsh reconstruction, diked marsh restoration, shoreline levee improvements, and ecotone slope development. Direct traffic impacts from construction of the Proposed Project would be short term and temporary. The duration of impacts related to short-term disruption of traffic flow and potential increased congestion generated by construction vehicles would be limited to the period of time needed to complete construction of the Proposed Project components.

Construction activities that would generate off-site traffic would include the daily arrival and departure of construction workers, and the import or export of materials (i.e., soil, coarse beach material) throughout the construction period. Although there are no designated truck routes in the vicinity of the Project site, it was assumed that workers and haul trucks would travel to/from the Project site via U.S. 101, Bellam Boulevard, Kerner Boulevard, and Canal Street/Spinnaker Point Drive (City of San Rafael 2021). This routing assumption takes into consideration the fact that the origins and destinations of workers and haul trucks would mostly be outside of the local area and would; therefore, use U.S. 101 and the Bellam Boulevard ramps; the overall distance of possible routes, and the and suitability of local roadways to accommodate Project-generated vehicle trips. Exact truck haul routes would be defined by the construction contractor and approved by the City of San Rafael Public Works Department as part of the Construction Traffic Control Plan (see Impact discussion c).

As stated in EIR Chapter 2, *Project Description*, construction of the Proposed Project would occur in three phases, over at least 3 years, beginning in 2023. For the purposes of the transportation analysis, the overlap of phases requiring the highest number of on-road truck haul trips and construction workers was evaluated using detailed construction scheduling and phasing information used to model emissions for Air Quality (see EIR Appendix C). Estimated maximum daily truck and worker trips for the Proposed Project by construction component are listed below in **Table B-3** for the 3-month construction period (63 work days) during Phase 2 when construction activities generating truck trips would overlap, which represents a worst-case scenario for potential traffic impacts. Please note that this table represents a subset of the total estimated earthwork volumes shown in Table 2-4 of EIR Chapter 2, *Project Description*, as it includes only those excavation and fill project elements that would generate truck trips during the 3-month overlap. Construction activities during the remainder of the approximately 3-year construction period would generate fewer vehicle trips than described below.

TABLE B-3
MAXIMUM DAILY CONSTRUCTION VEHICLE TRIPS

<table>
<tr><th>Project Element</th><th>Total Volume of Material (CY)</th><th>Truck Trips[a]</th><th>Worker Trips</th></tr>
<tr><td>Levee Improvements: Imported soil for levee construction</td><td>18,000</td><td>16</td><td>9</td></tr>
<tr><td>Eroded Tidal Marsh Reconstruction: On-site excavation of levee foundation and placement in the eroded marsh</td><td>6,000</td><td>0[b]</td><td rowspan="2">10</td></tr>
<tr><td>Eroded Tidal Marsh Reconstruction: Imported dredged material</td><td>25,000</td><td>0[c]</td></tr>
<tr><td colspan="2">Total</td><td>16</td><td>19</td></tr>
</table>

NOTES:

CY = cubic yards.

a. Assumes truck hauling capacity of 18 CYs.
b. All activity would be constructed by trucks operating on site and, therefore, would not generate any truck trips to or from the Project site.
c. Dredged material would be transported by barge and, therefore, would not generate any truck trips to or from the Project site.

SOURCE: ESA 2021.

As shown in Table B-3, the maximum number of truck trips generated by construction activity at the Project site would be 16 daily round trips, or 32 one-way trips (16 inbound, 16 outbound). Truck trips would be spread over the course of an approximately 8-hour work day rather than occurring all at once. The maximum number of construction workers on site at any given time would be 19, which would generate 38 daily one-way trips, conservatively assuming that all workers would drive-alone and would not carpool. Construction workers would commute to and from the worksite primarily before or after peak traffic hours; parking for worker vehicles and construction vehicles would be available in the designated on-site staging area within the Project site.

While other phases of Proposed Project construction would also generate vehicle trips for construction workers commuting and trucks hauling material to and from the Project site, the total number of daily vehicle trips would be lower than the numbers listed above in Table B-3. For instance, approximately 23,200 cubic yards (CY) of the 26,000 CY of material needed to construct the coarse beach would be transported to the Project site during Phase 1. Although it is expected that this construction activity would be completed using water-borne transport (i.e., barge), an assumption was made that it could be transported by truck to allow the construction contractor flexibility with respect to transport method, and to provide a worst-case scenario for the evaluation of on-road traffic impacts in case trucks are used. Coarse beach materials would be imported to the Project site over the course of 77 work days; assuming a truck hauling capacity of 18 CY (same assumption used for imported soil for levee improvements in Table B-3), then approximately 17 daily round trips, or 34 one-way trips (17 inbound, 17 outbound) could be required in the unlikely scenario that all coarse beach material were to be transported via truck. Although this number is marginally higher than the number of truck trips described above for Phase 2, the maximum number of construction workers on site at any given time during Phase 1 when coarse beach material is being imported to the Project site would be lower (12), resulting in a lower overall number of vehicle trips than described above for Phase 2.

It should be noted that all 9,500 CY of excavated material is expected to be reused on site; however, if timing, soil quality, or other currently unknown considerations limit the ability for the construction contractor to reuse all of the soil on site, then some excavated material may need to be exported from the Project site by truck. Any such removal by truck would not, however, generate any new truck trips because, once emptied, trucks used to import material (either soil or coarse beach material) would be used to export any excavated materials that cannot be balanced on site.

Construction-generated traffic would be temporary and, therefore, would not result in any long-term degradation in operating conditions on any locally used roadways for the Proposed Project. The impact of construction-related traffic would be temporary and result in intermittent reduction of the capacities of streets in the Project vicinity because of the slower movements and larger turning radii of construction trucks compared to passenger vehicles. Drivers could experience delays if they were traveling behind a heavy truck; however, as noted above, only 32 trucks per day (16 inbound, 16 outbound) are expected to travel to/from the Project site during the peak of construction activities, and those truck trips would occur over the course of the 8-hour work day. In the context of the AADT described above in the *Environmental Setting* section, construction-related traffic from the Proposed Project would not be substantial in relation to traffic flow conditions on U.S. 101, I-580, or local access roadways. The Proposed Project trips would fall within the daily fluctuations of traffic volumes on U.S. 101 and I-580 (not perceptible to the average motorist), and so while the traffic generated by construction activities would be noticeable (i.e., would represent a higher percent increase in traffic volumes) on the local-serving roadways serving the construction site, the effect on traffic flow would be **less than significant**.

Pedestrian, Bicycle, and Transit Facilities

Access to the construction staging area, which would be located in the empty lots adjacent to the Community Center and east of former Schoen Park as shown in Figure 2-5 of the EIR (Chapter 2, *Project Description*) would be provided via an existing gated driveway located on Spinnaker Point Drive. There are no designated bicycle facilities or transit stops adjacent to the construction staging area, but there is a sidewalk.

Construction of the Proposed Project would neither directly nor indirectly eliminate existing or planned alternative transportation corridors or facilities (i.e., bike paths, lanes, etc.), including changes in policies or programs that support alternative transportation, nor construct facilities in locations where future alternative transportation facilities may be planned. The Proposed Project would not conflict with adopted policies, plans, and programs supporting alternative transportation.

As described above for traffic operating conditions, construction activities associated with the Proposed Project would not generate traffic volume increases that would significantly affect traffic flow on area roadways. The performance of public transit, in-street bicycle, and pedestrian facilities in the area likewise would not be adversely affected (see Section B.12, *Recreation,* related to Project effects on the recreational trail on the shoreline levee that traverses the Project site and the San Francisco Bay Trail), and the impact would be **less than significant**.

Operational Impacts

The primary source of vehicle trips generated by Proposed Project operations would be for monitoring and maintenance, and for adaptive management, which may be conducted if the Proposed Project is not performing as anticipated. The types of activities associated with Proposed Project operations and maintenance are described in detail in EIR Chapter 2, *Project Description*, and would include maintenance of the tidal marsh, ecotone slope, and course beach during the 3- to 5-year establishment period, annual levee inspections, and performance monitoring. The number of workers and equipment required to perform operations and maintenance activities would be lower than the number evaluated above for Proposed Project construction, and would generate no more than 20 one-way daily vehicle trips, which would include trips generated by both maintenance crews and equipment. Therefore, operation of the Proposed Project would not conflict with any adopted policies, plans, or programs related to public transit or bicycle and pedestrian facilities, nor would it affect the safety of such services/ facilities, and impacts would be **less than significant**.

b) Would the Project conflict or be inconsistent with CEQA Guidelines Section 15064.3, Subdivision (b)? (*Less than Significant*)

In accordance with Senate Bill (SB) 743, the new CEQA Guidelines Section 15064.3, subdivision (b) was adopted in December 2018 by the California Natural Resources Agency. These revisions to the CEQA Guidelines criteria for determining the significance of transportation impacts are primarily focused on projects within transit priority areas, and shifts the focus from driver delay to a reduction of greenhouse gas emissions, creation of multimodal networks, and promotion of a mix of land uses. Vehicle miles traveled, or VMT, is a measure of the total number of miles driven to or from a development and is sometimes expressed as an average per trip or per person.

The City Council adopted VMT screening criteria and thresholds in July 2020 (City of San Rafael 2021). According to this guidance, a detailed transportation VMT analysis is required for all land development projects, except those that meet one of seven designated screening criteria. A project that meets at least one of the screening criteria would be presumed to result in a less-than-significant VMT impact due to the project characteristics and/or location. The Proposed Project would meet the Small Developments criterion, which states that projects that generate fewer than 110 trips per day would result in a less-than-significant VMT impact. As stated above in the discussion of issue a), the Proposed Project would generate a maximum of 70 daily vehicle trips (32 one-way truck trips and 38 one-way construction worker trips) during Proposed Project construction and no more than 20 daily vehicle trips during Proposed Project operation/ maintenance. Since the Proposed Project meets screening the Small Developments criterion, the Proposed Project would result in a **less-than-significant** impact related to CEQA Guidelines Section 15064.3.

c) Would the Project substantially increase hazards due to a geometric design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)? (*Less than Significant with Mitigation*)

The Proposed Project would not make any changes to public roadways. The land uses adjacent to and included in the Project vicinity include single- and multi-family residential, community uses (i.e., community center, library, park), and an elementary school. Due to the proximity of these uses to the Project site, this area is frequented by residents and visitors on a regular basis. As such, the temporary introduction of construction equipment required to construct the Proposed Project on roadways in and around the Project site would not be compatible with existing uses and would pose a potential safety hazard.

Although the number of trucks generated by Proposed Project construction would occur relatively infrequently, they would need to cross a sidewalk to access the construction staging area. Due to the presence of Bahia Vista Elementary School, the San Francisco Bay Trail, and other public/ community facilities that could generate pedestrian and bicycle activity in the vicinity of the Project Site, the introduction of trucks turning into/out of the construction staging area may result in unsafe conditions for pedestrians using the sidewalk and bicyclists traveling in the roadway. Therefore, construction of the Proposed Project could conflict with adopted policies, plans, or programs related to bicycle and pedestrian facilities, or affect the safety of such services/facilities, and impacts would be **potentially significant**.

Mitigation Measure TRAN-1: Construction Traffic Control Plan. Prior to the issuance of construction permits, the construction contractor shall prepare and submit a Construction Traffic Control Plan to the City of San Rafael Public Works Department for approval. The Construction Traffic Control Plan must be prepared in accordance with the California Department of Transportation Manual on Uniform Traffic Control Devices and must address, at a minimum, the following issues:

1) Defining truck haul routes to/from the Project that avoid residential streets, to the extent feasible.
2) Placing temporary signing, lighting, and traffic control devices if required, including, but not limited to, appropriate signage along access routes to indicate the presence of heavy vehicles and construction traffic.
3) Provision of construction personnel at driveway on Spinnaker Point Drive leading to the construction staging area to direct traffic, pedestrians, and bicyclists while trucks are turning into and out of the driveway.
4) Notification of all construction activities with San Rafael City Schools at least 2 months in advance, so that it may make proper accommodations for any possible limitations to access at Bahia Vista Elementary School. San Rafael City Schools shall be notified of the timing, location, and duration of construction activities. The construction contractor shall be required to ensure that construction of the Proposed Project does not inhibit vehicle, bicycle, pedestrian, and/or school bus service through the inclusion of such provisions in the construction contract.

With implementation of Mitigation Measure TRAN-1, potentially hazardous conditions associated with construction trucks accessing the proposed construction staging area would be minimized. Therefore, the impact would be reduced to a **less-than-significant** level.

d) Would the Project result in inadequate emergency access? (*Less than Significant*)

The Proposed Project is located in an area with multiple access roads allowing adequate egress/ ingress to the Project site in the event of an emergency. Additionally, as part of the Proposed Project, internal access roadway improvements would be implemented. Therefore, the Proposed Project would allow for adequate emergency access.

As described above for issue a), Project-related operational traffic would not cause a significant increase in congestion and would not significantly affect roadway operations. Furthermore, the Proposed Project would not require the closures of public roads, which could inhibit access by emergency vehicles. During construction of the Proposed Project, heavy construction-related vehicles could interfere with emergency response to the site or emergency evacuation procedures in the event of an emergency (e.g., slowing vehicles traveling behind the truck). However, construction-related traffic from the Proposed Project would not be substantial in relation to traffic flow conditions on U.S. 101, I-580, or local access roadways. As such, the impact would be **less than significant**.

Cumulative Impacts

e) Would the Project, in combination with reasonably foreseeable future projects, result in significant cumulative impacts on transportation? (*Less than Significant with Mitigation*)

The geographic scope for this analysis is the roadway network in the vicinity of the Project site that would be affected by the Proposed Project.

Construction Impacts

Impacts on traffic associated with construction (e.g., an intermittent reduction in street and intersection operating capacity, potential conflicts with pedestrians/ bicyclists, overlap with construction of nearby related projects) are typically considered as potential short-term impacts. As noted above, the Project would result in a potentially significant traffic impact during construction activities. However, with implementation of Mitigation Measure TRAN-1, construction impacts on transportation facilities would be reduced to a less-than-significant level. Each of the identified cumulative projects listed in Table 3.1-1 (see EIR Section 3.1.4, *Approach to Cumulative Impact Analysis*) would be required to comply with jurisdictional requirements regarding haul routes and would implement mitigation measures and/or include project characteristics, such as traffic controls and scheduling, notification, and safety procedures, to reduce potential traffic impacts during construction. Accordingly, Proposed Project-related contributions to cumulative construction traffic conditions during construction would be **less than significant with mitigation.**

Operational Impacts

As described above in the impact discussion of the Proposed Project, operation and maintenance associated with the Proposed Project would result in a minimal amount of daily vehicle trips. This is due to the fact that the Proposed Project, once constructed, would require infrequent and minor maintenance, which would not result in any discernable effect on study area roadway operations. Additionally, operation of the Proposed Project would not alter the permanent configuration (alignment) of area roadways or introduce any barriers to travel. For these reasons, the Proposed Project would not result in any operational impacts and would not cause or contribute to any cumulative effects related to these transportation issues. Accordingly, Proposed Project-related contributions to cumulative construction traffic conditions during operation would be **less than significant.**

> **Mitigation Measure TRAN-1: Construction Traffic Control Plan (refer to Project Impact Issue c)**

References

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B.14 Tribal Cultural Resources

Issues (and Supporting Information Sources):	*Potentially Significant Impact*	*Less-than-Significant Impact with Mitigation*	*Less-than-Significant Impact*	*No Impact*
TRIBAL CULTURAL RESOURCES —				
a) Would the Project cause a substantial adverse change in the significance of a tribal cultural resource, defined in PRC Section 21074 as either a site, feature, place, cultural landscape that is geographically defined in terms of the size and scope of the landscape, sacred place, or object with cultural value to a California Native American tribe, and that is:				
i) Listed or eligible for listing in the California Register of Historical Resources, or in a local register of historical resources as defined in PRC Section 5020.1(k), or	☐	☒	☐	☐
ii) A resource determined by the lead agency, in its discretion and supported by substantial evidence, to be significant pursuant to criteria set forth in subdivision (c) of PRC Section 5024.1. In applying the criteria set forth in subdivision (c) of PRC Section 5024.1, the lead agency shall consider the significance of the resource to a California Native American tribe.	☐	☒	☐	☐

Environmental Setting

The description of existing cultural, archaeological, and historical resources is included above in Section B.3, *Cultural Resources*.

Discussion

a.i) Would the Project cause a substantial adverse change in the significance of a tribal cultural resource, defined in PRC Section 21074 as either a site, feature, place, cultural landscape that is geographically defined in terms of the size and scope of the landscape, sacred place, or object with cultural value to a California Native American tribe, and that is listed or eligible for listing in the California Register of Historical Resources, or in a local register of historical resources as defined in PRC Section 5020.1(k) (*Less than Significant with Mitigation*)

Tribal cultural resources are: (1) sites, features, places, cultural landscapes, sacred places, and objects with cultural value to a California Native American tribe that are listed, or determined to be eligible for listing, in the California Register of Historical Resources (California Register), or local register of historical resources, as defined in PRC Section 5020.1(k); or (2) a resource determined by the CEQA lead agency, in its discretion and supported by substantial evidence, to be significant pursuant to criteria set forth in PRC Section 5024.1(c). For a cultural landscape to be considered a tribal cultural resource, it must be geographically defined in terms of the size and scope of the landscape (PRC Section 21074[b]). A historical resource, as defined in PRC Section 21084.1, unique archaeological resource, as defined in PRC Section 21083.2(g), or non-unique archaeological resource, as defined in PRC Section 21083.2(h), may also be a tribal cultural resource.

Through background research at the Northwest Information Center of the California Historical Resources Information System, no known archaeological resources that could be considered tribal cultural resources, listed or determined eligible for listing in the California Register, or included in a local register of historical resources as defined in PRC Section 5020.1(k), pursuant to PRC Section 21074(a)(1), would be impacted by the Proposed Project.

According to the requirements of PRC Section 21080.3.1(b), one tribe, the Federated Indians of Graton Rancheria, requested consultation regarding the Proposed Project. The City had a meeting with tribal representatives in March 2020. The City provided to the tribe a description of the Project and the results of a cultural resources inventory and evaluation report completed for the Project (ESA 2020). No additional comments were received.

Based on the analysis presented above, the City did not identify any tribal cultural resources listed or eligible for listing in the California Register, nor did they determine any resources to be significant pursuant to criteria set forth in Subdivision (c) of PRC Section 5024.1. In the event that cultural materials are identified during Project implementation that are determined to be tribal cultural resources, implementation of **Mitigation Measure CUL-1: Cultural Resources Awareness Training and Inadvertent Discovery of Archaeological Resources or Tribal Cultural Resources**, outlined above in Section B.3, *Cultural Resources*, would reduce potentially significant impacts to less than significant with mitigation incorporated. This mitigation would ensure that work is halted in the vicinity of a find until a qualified archaeologist and a Native American tribal representative can make an assessment and provide additional recommendations.

a.ii) Would the Project cause a substantial adverse change in the significance of a tribal cultural resource, defined in PRC Section 21074 as either a site, feature, place, cultural landscape that is geographically defined in terms of the size and scope of the landscape, sacred place, or object with cultural value to a California Native American tribe, and that is a resource determined by the lead agency, in its discretion and supported by substantial evidence, to be significant pursuant to criteria set forth in Subdivision (c) of PRC Section 5024.1. In applying the criteria set forth in Subdivision (c) of PRC Section 5024.1, the lead agency shall consider the significance of the resource to a California Native American tribe. (*Less than Significant with Mitigation*)

For the same reasons stated in the analysis of potential impacts on tribal cultural resources above for issue a.i, impacts would be potentially significant, but implementation of **Mitigation Measure CUL-1** would reduce impacts to **less than significant with mitigation incorporated**.

Cumulative Impacts

b) Would the Project, in combination with reasonably foreseeable future projects, result in significant cumulative impacts on tribal cultural resources? (*Less than Significant with Mitigation*)

The geographic scope for cumulative effects on tribal cultural resources consists of the Project site and immediate vicinity. Federal and state laws protect tribal cultural resources in most cases, either through project redesign to ensure the preservation of the resource, or by requiring consultation with Native American tribes regarding the treatment of resources.

As described above for issue a.i, there are no known tribal cultural resources within the Project site. While there is the potential for the Project to encounter archaeological resources, which could include prehistoric archeological features or deposits considered tribal cultural resources, the Project would not be expected to result in significant impacts even if such resources are found. There are reasonably foreseeable future projects, specifically the Pickleweed Field and Park Project and the Schoen Park Conversion to Parking, that could impact the same tribal cultural resources as the Proposed Project, if any such resource is identified. However, these projects would involve the implementation of similar types of mitigation measures described above, which would reduce the potential for impacts on these resources and any other as-yet undiscovered resources to a less-than-significant level. Therefore, the Proposed Project, in combination with other reasonably foreseeable future projects, would result in a **less-than-significant cumulative impact** on tribal cultural resources.

References

Environmental Science Associates (ESA). 2020. *Tiscornia Marsh Restoration and Sea Level Rise Adaptation Project, Cultural Resources Inventory and Evaluation Report.* Prepared for Marin Audubon Society. August 2020.

B.15 Utilities & Service Systems

Issues (and Supporting Information Sources):	Potentially Significant Impact	Less-than-Significant Impact with Mitigation	Less-than-Significant Impact	No Impact
UTILITIES & SERVICE SYSTEMS — Would the Project:				
a) Require or result in the relocation or construction of new or expanded, water, wastewater treatment, or stormwater drainage, electric power, natural gas, or telecommunications facilities, the construction or relocation of which could cause significant environmental effects?	☐	☐	☒	☐
b) Have sufficient water supplies available to serve the Project and reasonably foreseeable future development during normal, dry, and multiple dry years?	☐	☐	☒	☐
c) Result in a determination by the wastewater treatment provider which serves or may serve the Project that it has inadequate capacity to serve the Project's projected demand in addition to the provider's existing commitments?	☐	☐	☐	☒
d) Generate solid waste in excess of state or local standards, or in excess of the capacity of local infrastructure, or otherwise impair the attainment of solid waste reduction goals?	☐	☐	☒	☐
e) Comply with federal, state, and local management and reduction statutes and regulations related to solid waste?	☐	☐	☒	☐

Environmental Setting

Existing utilities at the Project site include two Pacific Gas & Electric Company (PG&E) transmission line towers in the northeastern portion of the site, as well as a City stormwater drain and sanitary sewer line to the west of Pickleweed Park and the diked marsh. The stormwater drain runs adjacent to the Bay Trail on the west side of Pickleweed Park, while the sanitary sewer line runs generally parallel to it before dog-legging into the soccer field and heading back toward the shoreline, where both utilities outfall into the creek.

Potable water in the City of San Rafael is managed by the Marin Municipal Water District (MMWD), with 75 percent of water coming from the Mt. Tamalpais watershed west of Marin and the rest from the Russian River System in Sonoma County, managed by Sonoma County Water Agency (SWCA). The City of San Rafael utilizes the Las Gallinas Sanitary District, Central Marin Sanitation Agency, and San Rafael Sanitation District to manage wastewater.

The Marin Hazardous and Solid Waste Joint Powers Authority, known as Zero Waste Marin, is comprised of representatives from all over Marin County, including the City Manager of San Rafael. Zero Waste Marin administers waste diversion initiatives in support of meeting the County's goal of reducing landfilled waste to zero by 2025 and ensures the County's compliance with the California Integrated Waste Management Act and its recycling and waste reduction mandates.

Discussion

a) Would the Project require the relocation or construction of new or expanded water, wastewater treatment, stormwater drainage, electric power, natural gas, or telecommunications facilities, the construction or relocation of which could cause significant environmental effects? *(Less than Significant)*

As stated in the Environmental Setting section above, the Project site currently supports two PG&E towers, a stormwater drain, and a sanitary sewer. The Project does not include any modifications to the PG&E towers or sanitary sewer line. These utilities would be maintained in place in their existing condition throughout Project construction and post-construction, and would not require relocation, construction, or expansion due to the Project.

While construction work would not require the relocation of any power lines, construction would have the potential to damage power lines and expose construction workers to hazardous conditions, particularly through the use of vertical construction equipment such as cranes. To avoid this potential damage, construction workers would follow the Power Line Safety standards from the Department of Industrial Relations.[4] These include:

- Identifying the work zone.
- Determine if any part of the equipment, load line, or load (including rigging and lifting accessories), if operated up to the equipment's maximum working radius in the work zone, could get closer than 20 feet to a power line.
- Preventing encroachment/electrocution.
- Providing training to operators and crew members.

There are two design options for tying the west end of the new levee into the shoreline that may involve some modification of the stormwater drain. The west levee tie-in option 1 includes extending the new levee directly west to the shoreline, cutting off the stormwater drain where it intersects with the levee and installing the trash capture device within the new levee, at the storm drain's new terminus. This would require that a small stormwater outlet channel be excavated to the north of the new levee through the tidal marsh and into the creek. The second option (west levee tie-in option 2) includes constructing the new levee along the existing path and shoreline, leaving the stormwater drain as is, and installing the trash capture device at the current drain terminus at the shoreline. Neither of these options would require a change in capacity or service of the stormwater line, nor would result in its relocation or construction of new or expanded water, wastewater treatment, or stormwater drainage facilities.

No other utilities or telecommunication facilities would be affected in the course of the construction or operation of the Proposed Project. Project operations would include levee maintenance and repair, invasive species control, and biological monitoring. For the reasons

4 Subchapter 4. Construction Safety Orders, Article 15. Cranes and Derricks in Construction. § 1612.1. Power Line Safety (Up to 350 kV) - Equipment Operations. Available: https://www.dir.ca.gov/title8/1612_1.html.

presented, Project construction and operation would have a **less-than-significant impact** related to the expansion or relocation of utility services that could result in environmental effects.

b) Would the Project have sufficient water supplies available to serve the Project and reasonably foreseeable future development during normal, dry, and multiple dry years? *(Less than Significant)*

Project construction would require the intermittent use of potable water for drinking use and sanitary needs at the construction site over the course of an approximately 6-month construction window for 3 to 4 years. Project construction would also require water for dust control, which the construction contractor would obtain from available water sources near the Project site and/or would store on the Project site, as needed, for dust suppression.

At the completion of Phase 1 of the Project, new plants would be planted on the new levee, lowered levee, and ecotone slopes. Irrigation water would be required for the new plants in upland and transition zones. The water used would be delivered by temporary drip irrigation, used only from April through October for the first 3 years, or until plants have matured. Water supplies to serve the irrigation would be purchased by the landscaping contractor from local sources of water and stored on site in tanks to be pumped through the irrigation system, or through temporary connections to the adjacent Pickleweed Park landscape irrigation system.

Post-construction operations would not require water use beyond the temporary irrigation of upland and transitional vegetation plantings, which would be limited to efficient drip irrigation of any areas requiring additional plantings. Given that the Project has relatively minimal demands for water supply during construction and no long-term water use requirements, there would be a **less-than-significant impact** on water supplies available to serve the Project.

c) Would the Project result in a determination by the wastewater treatment provider which serves the Project that it has inadequate capacity to serve the Project's projected demand in addition to the provider's existing commitments? (Less than Significant)

Neither construction nor operation of the Proposed Project would generate wastewater or disrupt wastewater services. As described for issue a) above, the sanitary sewer line on the west side of the Project site would be maintained in place in its existing condition throughout Project construction and post-construction, and would not require relocation, construction, or expansion, or experience any disruption in service. The Project would restore tidal wetland habitat and modify and improve the existing levee and trail system, but no element of the Project would install a system with wastewater requirements or increase the residential or employment population of the area, as described in Section B.10, *Population & Housing*. As such, new sources of wastewater discharge would not be created, and an increase in capacity to serve short- or long-term Project demands would not be necessary. The Project would have **no impact** on wastewater treatments systems or capacity.

d) Would the Project be served by a landfill with sufficient permitted capacity to accommodate the Project's solid waste disposal needs and would not impair the attainment of solid waste reduction goals? *(Less than Significant)*

The Project would generate approximately 9,500 CY of excavated material from earthwork involved with developing the new tidal channel during diked marsh restoration and removal of foundation soils for levee improvements. The intent is to store excavated material on site for reuse in the marsh reconstruction phase, but any contaminated or otherwise unusable soils would be off-hauled and properly disposed of at an approved industrial and/or hazardous waste landfill in the area. However, even if all excavated material were removed from the site, the amount of off-hauled materials would be negligible and would not contribute substantially to landfill capacity reduction.

Project operations would support passive recreation activities on the site's trail system, including running, walking, hiking, and bird watching. These recreational uses may generate solid waste, but the intensity of recreational usage is expected to be consistent with existing conditions and would not be substantial compared to City-wide solid waste generation. Local landfill usage for the City of San Rafael is limited to the Potrero Hills Landfill and Redwoods Landfill. The Redwood Landfill is planned for closure in 2024, but the Potrero Hills Landfill has operational capacity through 2048, and the City also works with landfills across the state as needed. The Project would also comply with Zero Waste Marin's waste reduction goals, which support the solid waste reduction mandates of the state.

Due to the reasons presented, the Project would have a **less-than-significant impact** on the sufficiency of landfill capacity and solid waste reduction goals.

e) Would the Project comply with federal, state, and local management and reduction statues and regulations related to solid waste? *(Less than Significant)*

As stated for issue d) above, during Project construction, excavated soil would be used on site to the extent practicable. However, in the event that some soil was discovered to be contaminated or could otherwise not be used for the Project, this soil would be disposed of at the nearest landfill capable of accepting the excavated materials. The potential disposal need would be negligible and would not contribute substantially to landfill capacity reduction. Project operations would generate solid waste from visitors recreating along the Bay Trail system and would be limited to the number of visitors and hours of operation, which would be similar to current conditions. Therefore, solid waste generation would not be substantial compared to City-wide solid waste generation, nor would it vary significantly from existing conditions.

The Project would also comply with applicable local, state, and federal regulations concerning solid waste management, including the solid waste diversion initiatives administered by Zero Waste Marin. Impacts would be **less than significant.**

Cumulative Impacts

f) Would the Project, in combination with reasonably foreseeable future projects, result in significant cumulative impacts related to disruption of utility service or relocation of utilities? (*Less than Significant*)

The geographic scope of potential impacts on utilities and service systems is limited to the immediate Project vicinity where services could be disrupted and/or where utilities could require relocation. For landfill capacity, the geographic scope includes the service areas where disposal of construction-related waste could occur. As described above, the Project would not require additional facilities to serve the Project and reasonably foreseeable future development during normal, dry, and multiple dry years. It would not combine with impacts from other cumulative scenario impacts and, therefore, would not result in a cumulatively considerable impact related to water supply and utilities. This impact would be **less than significant.**

With respect to solid waste, the Project could require disposal of excavated materials. However, none of the other projects identified in EIR Table 3.1-1 is anticipated to require disposal of large volumes of waste in landfills. Therefore, the waste disposal impacts of the Project would not combine with waste disposal impacts from other cumulative scenario projects, and would not result in a cumulatively considerable impact on solid waste.

B.16 Wildfire

Issues (and Supporting Information Sources):	*Potentially Significant Impact*	*Less-than-Significant Impact with Mitigation*	*Less-than-Significant Impact*	*No Impact*
WILDFIRE — If located in or near state responsibility areas or lands classified as very high fire hazard severity zones, would the Project:				
a) Substantially impair an adopted emergency response plan or emergency evacuation plan?	☐	☐	☒	☐
b) Due to slope, prevailing winds, and other factors, exacerbate wildfire risks, and thereby expose Project occupants to pollutant concentrations from a wildfire or the uncontrolled spread of a wildfire?	☐	☐	☒	☐
c) Require the installation or maintenance of associated infrastructure (such as roads, fuel breaks, emergency water sources, power lines, or other utilities) that may exacerbate fire risk or that may result in temporary or ongoing impacts to the environment?	☐	☐	☒	☐
d) Expose people or structures to significant risks, including downslope or downstream flooding or landslides, as a result of runoff, post-fire slope instability, or drainage changes?	☐	☐	☒	☐

Environmental Setting

Wildfire is the outcome of several variables, primarily weather (temperature, humidity, and wind), vegetation, topography, and human influences, which combine to produce regional and local severity zones. The California Department of Forestry and Fire Protection (CAL FIRE) developed a fire hazards severity scale that considers vegetation, climate, and slope to evaluate the level of wildfire hazards, and identifies three levels of fire hazards severity (moderate, high, and very high) to indicate the severity of fire hazards in a particular geographic area.

The Proposed Project is located in a designated Local Responsibility Area (LRA) and falls within an Unzoned Federal Responsibility Area Fire Hazard Severity Zone (CAL FIRE 2021).

Discussion

a) Would the Project substantially impair an adopted emergency response plan or emergency evacuation plan? (*Less than Significant*)

As described in Section B.13, *Transportation*, the Proposed Project could result in an increase of construction phase, Project-related traffic. However, as described, the increased Project-related traffic would not cause a significant increase in congestion and would not significantly affect roadway operations. Additionally, the Proposed Project would not require the closures of public roads or block access along local roadways. For these reasons, the Proposed Project would not impair an adopted emergency response plan or emergency evacuation plan. This impact would be **less than significant.**

b) Due to slope, prevailing winds, and other factors, exacerbate wildfire risks, and thereby expose Project occupants to, pollutant concentrations from a wildfire or the uncontrolled spread of a wildfire? (*Less than Significant*)

The Proposed Project is not located within or near state responsibility areas or lands classified as very high fire hazard severity zones. Construction activities would require the use of heavy equipment, vehicles, and temporary storage areas that could lead to an increased risk of ignition, which could ignite a fire in an area with flammable vegetation or material. However, the risk of igniting a wildfire would be low because the Project site consists of highly eroded marshlands, a shoreline levee, and recreational trails, with relatively flat topography. Additionally, as described in Section B.6, *Hazards & Hazardous Materials*, contractors would be required to comply with hazardous materials storage and fire protection regulations, which would reduce the potential for wildfire. This impact would be **less than significant.**

c) Would the Project require the installation or maintenance of associated infrastructure (such as roads, fuel breaks, emergency water sources, power lines, or other utilities) that may exacerbate fire risk or that may result in temporary or ongoing impacts on the environment? (*Less than Significant*)

The Proposed Project would result in the construction of approximately 600 feet of new levee on the south side of the existing diked marsh and restore approximately 1,100 feet of the shoreline levee. No new roads or other infrastructure would be installed as part of the Proposed Project. As mentioned in Section B.10, *Population and Housing*, the Proposed Project would not induce a need for housing or otherwise result in population growth in the area necessitating the installation of fuel breaks, water sources, power lines, or other utilities that may exacerbate fire risk, and the impact would be **less than significant.**

d) Would the Project expose people or structures to significant risks, including downslope or downstream flooding or landslides, as a result of runoff, post-fire slope instability, or drainage changes? (*Less than Significant*)

The Project site consists of highly eroded marshland and has relatively flat topography. Under existing conditions, portions of the Project site (i.e., shoreline segments on the Tiscornia and Pickleweed Park properties) are currently at risk of overtopping during extreme coastal flood events, which would result in flooding of low-lying portions of the adjacent Canal neighborhood. Implementation of the Proposed Project would result in beneficial impacts on flooding by increasing the level of flood protection for the Canal neighborhood and other nearby communities of central San Rafael. While the restored wetland habitats would be largely self-maintaining, it is anticipated that operation and maintenance activities (i.e., removal of invasive plants and temporary irrigation of ecotone slope plantings) would be needed during the 3- to 5-year establishment period. Additional physical and biological monitoring would be conducted after construction of the Proposed Project and would occur at 1, 3, 5, and 10 years post-construction. However, these activities would not expose people or structures to significant risks, including flooding or landslide as a result of runoff, post-fire slope instability, or drainage changes. In addition, as stated above, the Project site contains flat topography and moist soils that would not exacerbate fire risk or create post-fire conditions involving slope instability, landslides, downslope or downstream flooding, or changes in drainage. Therefore, the Proposed Project would not expose people or structures to significant post-fire changes, and this impact would be **less than significant.**

Cumulative Impacts

e) Would the Project, in combination with reasonably foreseeable future projects, result in significant cumulative impacts associated with wildfire? (*No Impact*)

The geographic scope of potential cumulative wildfire impacts encompasses the Project site and its vicinity. Cumulative scenario projects include the Pickleweed Field and Park Project and the Schoen Park Conversion to Parking. However, the Project and cumulative projects would replace existing land uses, or result in new land use that is compatible with existing land uses. The Project site and vicinity contain flat topography and moist soils that would not exacerbate fire risk or create post-fire conditions, and none of the cumulative project types would be associated with a high potential for wildfire ignition. Therefore, there would not be a cumulative impact, and the Project's contribution to cumulative wildfire impacts would not be cumulatively considerable.

References

California Department of Forestry and Fire Protection (CAL FIRE). 2021. California Fire Hazard Severity Zone Viewer. Available: https://gis.data.ca.gov/datasets/789d5286736248f69c4515c04f58f414. Accessed May 28, 2021.

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Appendix C

Air Quality and Greenhouse Gas Emissions Supporting Documentation

ESA

Criteria Pollutant Summary

Tiscornia Marsh Restoration Criteria Pollutant Summary

Parameter	Tons			
	ROG	**NO_x**	**Exhaust PM_{10}**	**Exhaust $PM_{2.5}$**
Phase 1 On-site Construction and haul trucks	0.18	1.5	0.067	0.062
Phase 1 Marine Emisions (tug and work boat)	0.17	1.97	0.11	0.1
Phase 2 On-site Construction and haul trucks	0.25	2.55	0.096	0.089
Phase 2 Marine Emisions (tug and work boat)	0.02	0.22	0.01	0.01
Phase 3 On-site Construction and haul trucks	0.055	0.43	0.019	0.017
Phase 3 Marine Emisions (tug and work boat)	0.04	0.53	0.03	0.03
Total Tons	0.66	6.77	0.313	0.291
Total Work Days	275	275	275	275
Avereage pounds per day	4.80	49.24	2.28	2.12
BAAQMD Construction Threshold	54	54	82	54
Significant Impact?	No	No	No	No

GHG Emission Summary

Summary of project GHG Emissions - Tiscornia Marsh Restoration

Parameter	GHG (MT)
Phase 1 On-site Construction and haul trucks	325
Phase 1 Marine Emisions (tug and work boat)	147
Phase 2 On-site Construction and haul trucks	679
Phase 2 Marine Emisions (tug and work boat)	136
Phase 3 On-site Construction and haul trucks	109
Phase 3 Marine Emisions (tug and work boat)	20
Total Metric Tons Tons	1307
Amortized over 30 year life of project	44

Marine Emission Calculations

Construction Marine Emissions

Year = **2023 Site Preperation and new beach construction**

Duration = 81 days
Total Phase 1 Work Days = 100 days

Source **Work Boat**

Use = 8 hours/day

Total Useage during phase = 648 hours

Emission Rate Source: SMAQMD Harborcraft, Dredge and Barge Emission Factor Model

	ROG	NOx	PM10	PM2.5	CO2
Running					
lb/hr	0.510592	6.072689	0.349288	0.311031	429.51

Running Emissions =	ROG	NOx	PM10	PM2.5	CO2
pounds =	330.86	3935.10	226.3386	201.5482	278325.5
Tons =	0.17	1.97	0.11	0.10	139.16

Duration = 9 days

Source **Tug with Barge**

Year = 2025

Useage = 8 hour/ day

Total Useage phase = 72 hours

Emission Factors

	ROG	NOx	PM10	PM2.5	CO2
Running					
lbs/hour	0.738299	8.780906	0.505059	0.449741	621.06

Source: SMAQMD Harborcraft, Dredge and Barge Emission Factor Model

Running Emissions =	ROG	NOx	PM10	PM2.5	CO2
Total Pounds =	53.16	632.23	36.36	32.38	4.47E+04
Total Tons =	0.03	0.32	0.02	0.02	22.36
Total Year 2023 Tons (Work Boat and Barge) =	**0.19**	**2.28**	**0.13**	**0.12**	**161.52**
Total MT CO2e =					**146.53**

Year = **2024 Marsh Reconstruction**

Duration = 87 days

Source	**Work Boat**				
Use =	8 hours/day				
Total Useage during phase =	696 hours				
Emission Rate	Source: SMAQMD Harborcraft, Dredge and Barge Emission Factor Model				
Running	ROG	NOx	PM10	PM2.5	CO2
lb/hr	0.510592	6.072689	0.349288	0.311031	429.51
Running Emissions =	ROG	NOx	PM10	PM2.5	CO2
pounds =	355.37	4226.59	243.1044	216.4777	298942.2
Total Year 2024 Tons (Work Boat) =	0.18	2.11	0.12	0.11	149.47
Total MT CO2e =					**135.60**

Year = **2025 Beach Construction**

Duration = **9 days**

Source **Work Boat**

Use = 8 hours/day

Total Useage during phase = 72 hours

Emission Rate Source: SMAQMD Harborcraft, Dredge and Barge Emission Factor Model

Running	ROG	NOx	PM10	PM2.5	CO2
lb/hr	0.510592	6.072689	0.349288	0.311031	429.51

Running Emissions =	ROG	NOx	PM10	PM2.5	CO2
pounds =	36.76	437.23	25.14873	22.39424	30925.06

Duration = 9 days

Source **Tug with Barge**

Year = 2025

Useage = 8 hour/ day

Total Useage phase = 72 hours

Emission Factors

Running	ROG	NOx	PM10	PM2.5	CO2	Source: SMAQMD Harborcraft, Dredge and Barge Emission Factor Model
lbs/hour	0.738299	8.780906	0.505059	0.449741	621.06	

Running Emissions =	ROG	NOx	PM10	PM2.5	CO2
Total Pounds =	53.16	632.23	36.36	32.38	44716.60
Total Tons =	0.03	0.32	0.02	0.02	22.36
Total Year 2025 Tons (Work Boat and Barge) =	**0.03**	**0.32**	**0.02**	**0.02**	**22.36**
Total MT CO2e =					**20.28**

Metric ton conversion 1 ton = 0.907185 Metric ton

CalEEmod Output

Tiscroria Marsh Adaptation Project - Marin County, Annual

EMFAC Off-Model Adjustment Factors for Gasoline Light Duty Vehicle to Account for the SAFE Vehicle Rule Not Applied

Tiscroria Marsh Adaptation Project

Marin County, Annual

1.0 Project Characteristics

1.1 Land Usage

Land Uses	Size	Metric	Lot Acreage	Floor Surface Area	Population
City Park	28.00	Acre	28.00	1,219,680.00	0

1.2 Other Project Characteristics

Urbanization	Urban	**Wind Speed (m/s)**	2.2	**Precipitation Freq (Days)**	69
Climate Zone	5			**Operational Year**	2027
Utility Company	Pacific Gas and Electric Company				
CO2 Intensity (lb/MWhr)	203.98	**CH4 Intensity (lb/MWhr)**	0.033	**N2O Intensity (lb/MWhr)**	0.004

1.3 User Entered Comments & Non-Default Data

Project Characteristics - wind speed is default value

Land Use -

Construction Phase - Phasing adjusted to match RFI response

Off-road Equipment - Amphibious excavator and low pressure dozer.

Off-road Equipment - Other construcion equipment is sheepsfoot compactor.

Off-road Equipment - Other handling equipment is a dragline.

Off-road Equipment - Other handling equipment is dragline.

Off-road Equipment - Other construction equipment is sheepsfoot compactor. Other handling equipment is dragline.

Off-road Equipment - Equipment hours calculated from equipment days. HP provided by contractor. Other equip is sheepsfoot compactor. Crane is pile driver.

Off-road Equipment - Other construction equipment is sheepsfoot compactor.

Date: 6/7/2021 1:58 PM

Tiscroria Marsh Adaptation Project - Marin County, Annual

EMFAC Off-Model Adjustment Factors for Gasoline Light Duty Vehicle to Account for the SAFE Vehicle Rule Not Applied

Grading - Excavation only no grading.

Vehicle Trips - No operational emissions

Landscape Equipment - No operational emissions

Water And Wastewater - No ooperational emissions.

Solid Waste - No operational emissions.

Construction Off-road Equipment Mitigation - Tier 4 equipment as potential mitigation, if necessary.

Table Name	Column Name	Default Value	New Value
tblConstEquipMitigation	NumberOfEquipmentMitigated	0.00	2.00
tblConstEquipMitigation	NumberOfEquipmentMitigated	0.00	13.00
tblConstEquipMitigation	NumberOfEquipmentMitigated	0.00	16.00
tblConstEquipMitigation	NumberOfEquipmentMitigated	0.00	4.00
tblConstEquipMitigation	NumberOfEquipmentMitigated	0.00	5.00
tblConstEquipMitigation	NumberOfEquipmentMitigated	0.00	13.00
tblConstEquipMitigation	NumberOfEquipmentMitigated	0.00	6.00
tblConstEquipMitigation	Tier	No Change	Tier 4 Final
tblConstEquipMitigation	Tier	No Change	Tier 4 Final
tblConstEquipMitigation	Tier	No Change	Tier 4 Final
tblConstEquipMitigation	Tier	No Change	Tier 4 Final
tblConstEquipMitigation	Tier	No Change	Tier 4 Final
tblConstEquipMitigation	Tier	No Change	Tier 4 Final
tblConstEquipMitigation	Tier	No Change	Tier 4 Final
tblConstructionPhase	NumDays	45.00	77.00
tblConstructionPhase	NumDays	45.00	87.00
tblConstructionPhase	NumDays	45.00	60.00
tblConstructionPhase	NumDays	45.00	25.00
tblConstructionPhase	NumDays	45.00	9.00
tblConstructionPhase	NumDays	45.00	8.00

Tiscroria Marsh Adaptation Project - Marin County, Annual

EMFAC Off-Model Adjustment Factors for Gasoline Light Duty Vehicle to Account for the SAFE Vehicle Rule Not Applied

tblConstructionPhase	NumDays	20.00	23.00
tblFleetMix	HHD	0.00	3.7270e-003
tblFleetMix	LDA	0.00	0.54
tblFleetMix	LDT1	0.00	0.06
tblFleetMix	LDT2	0.00	0.20
tblFleetMix	LHD1	0.00	0.02
tblFleetMix	LHD2	0.00	5.6320e-003
tblFleetMix	MCY	0.00	0.03
tblFleetMix	MDV	0.00	0.12
tblFleetMix	MH	0.00	2.7160e-003
tblFleetMix	MHD	0.00	6.9200e-003
tblFleetMix	OBUS	0.00	6.5600e-004
tblFleetMix	SBUS	0.00	7.2500e-004
tblFleetMix	UBUS	0.00	3.9000e-004
tblGrading	MaterialImported	0.00	18,000.00
tblOffRoadEquipment	HorsePower	231.00	1,311.00
tblOffRoadEquipment	HorsePower	158.00	275.00
tblOffRoadEquipment	HorsePower	402.00	350.00
tblOffRoadEquipment	HorsePower	402.00	475.00
tblOffRoadEquipment	HorsePower	172.00	157.00
tblOffRoadEquipment	HorsePower	247.00	165.00
tblOffRoadEquipment	HorsePower	97.00	241.00
tblOffRoadEquipment	HorsePower	158.00	275.00
tblOffRoadEquipment	HorsePower	158.00	275.00
tblOffRoadEquipment	HorsePower	402.00	320.00
tblOffRoadEquipment	HorsePower	402.00	350.00
tblOffRoadEquipment	HorsePower	402.00	300.00

Tiscroria Marsh Adaptation Project - Marin County, Annual

EMFAC Off-Model Adjustment Factors for Gasoline Light Duty Vehicle to Account for the SAFE Vehicle Rule Not Applied

tblOffRoadEquipment	HorsePower	172.00	157.00
tblOffRoadEquipment	HorsePower	168.00	400.00
tblOffRoadEquipment	HorsePower	247.00	165.00
tblOffRoadEquipment	HorsePower	247.00	165.00
tblOffRoadEquipment	HorsePower	97.00	241.00
tblOffRoadEquipment	HorsePower	158.00	275.00
tblOffRoadEquipment	HorsePower	247.00	165.00
tblOffRoadEquipment	HorsePower	158.00	275.00
tblOffRoadEquipment	HorsePower	158.00	275.00
tblOffRoadEquipment	HorsePower	402.00	320.00
tblOffRoadEquipment	HorsePower	402.00	350.00
tblOffRoadEquipment	HorsePower	402.00	300.00
tblOffRoadEquipment	HorsePower	172.00	157.00
tblOffRoadEquipment	HorsePower	247.00	165.00
tblOffRoadEquipment	HorsePower	247.00	165.00
tblOffRoadEquipment	HorsePower	158.00	275.00
tblOffRoadEquipment	HorsePower	402.00	300.00
tblOffRoadEquipment	HorsePower	168.00	400.00
tblOffRoadEquipment	HorsePower	247.00	165.00
tblOffRoadEquipment	HorsePower	231.00	1,311.00
tblOffRoadEquipment	HorsePower	402.00	350.00
tblOffRoadEquipment	HorsePower	402.00	300.00
tblOffRoadEquipment	HorsePower	172.00	157.00
tblOffRoadEquipment	HorsePower	247.00	165.00
tblOffRoadEquipment	HorsePower	158.00	275.00
tblOffRoadEquipment	HorsePower	402.00	300.00
tblOffRoadEquipment	HorsePower	168.00	400.00

Tiscroria Marsh Adaptation Project - Marin County, Annual

EMFAC Off-Model Adjustment Factors for Gasoline Light Duty Vehicle to Account for the SAFE Vehicle Rule Not Applied

tblOffRoadEquipment	HorsePower	247.00	165.00
tblOffRoadEquipment	LoadFactor	0.42	0.40
tblProjectCharacteristics	PrecipitationFrequency	0	69
tblProjectCharacteristics	WindSpeed	0	2.2
tblSolidWaste	SolidWasteGenerationRate	2.41	0.00
tblVehicleTrips	ST_TR	1.96	0.00
tblVehicleTrips	SU_TR	2.19	0.00
tblVehicleTrips	WD_TR	0.78	0.00
tblWater	OutdoorWaterUseRate	33,361,477.79	0.00

2.0 Emissions Summary

2.1 Overall Construction

Unmitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	tons/yr										MT/yr					
2023	0.1789	1.4992	1.1877	3.6700e-003	0.5295	0.0673	0.5967	0.2888	0.0619	0.3507	0.0000	322.5299	322.5299	0.1025	1.7000e-004	325.1443
2024	0.2499	2.5503	1.9230	7.2200e-003	0.9839	0.0964	1.0803	0.5169	0.0889	0.6057	0.0000	664.3454	664.3454	0.1431	0.0366	678.8223
2025	0.0554	0.4296	0.4858	1.2300e-003	0.1874	0.0190	0.2063	0.1018	0.0174	0.1192	0.0000	108.3546	108.3546	0.0341	8.0000e-005	109.2320
Maximum	**0.2499**	**2.5503**	**1.9230**	**7.2200e-003**	**0.9839**	**0.0964**	**1.0803**	**0.5169**	**0.0889**	**0.6057**	**0.0000**	**664.3454**	**664.3454**	**0.1431**	**0.0366**	**678.8223**

Mitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	tons/yr										MT/yr					
2023	0.0471	0.2249	1.8121	3.6700e-003	0.5295	6.0700e-003	0.5355	0.2888	6.0700e-003	0.2949	0.0000	322.5295	322.5295	0.1025	1.7000e-004	325.1439
2024	0.0751	0.8259	2.6890	7.2200e-003	0.9839	0.0112	0.9951	0.5169	0.0110	0.5279	0.0000	664.3449	664.3449	0.1431	0.0366	678.8219
2025	0.0161	0.0893	0.6813	1.2300e-003	0.1874	2.0800e-003	0.1895	0.1018	2.0800e-003	0.1038	0.0000	108.3545	108.3545	0.0341	8.0000e-005	109.2319
Maximum	**0.0751**	**0.8259**	**2.6890**	**7.2200e-003**	**0.9839**	**0.0112**	**0.9951**	**0.5169**	**0.0110**	**0.5279**	**0.0000**	**664.3449**	**664.3449**	**0.1431**	**0.0366**	**678.8219**

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N20	CO2e
Percent Reduction	**71.46**	**74.55**	**-44.09**	**0.00**	**0.00**	**89.43**	**8.67**	**0.00**	**88.61**	**13.85**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Quarter	Start Date	End Date	Maximum Unmitigated ROG + NOX (tons/quarter)	Maximum Mitigated ROG + NOX (tons/quarter)
1	**9-1-2023**	**11-30-2023**	1.3036	0.2206
2	**12-1-2023**	**2-29-2024**	0.4012	0.0567
5	**9-1-2024**	**11-30-2024**	2.0639	0.6702
6	**12-1-2024**	**2-28-2025**	0.7439	0.2356
9	**9-1-2025**	**9-30-2025**	0.2209	0.0361
		Highest	2.0639	0.6702

2.2 Overall Operational

Unmitigated Operational

Tiscroria Marsh Adaptation Project - Marin County, Annual

EMFAC Off-Model Adjustment Factors for Gasoline Light Duty Vehicle to Account for the SAFE Vehicle Rule Not Applied

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Area	0.0115	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Energy	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Mobile	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Waste						0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Water						0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	**0.0115**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**

Mitigated Operational

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Area	0.0115	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Energy	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Mobile	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Waste						0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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Water						0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	**0.0115**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N20	CO2e
Percent Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

3.0 Construction Detail

Construction Phase

Phase Number	Phase Name	Phase Type	Start Date	End Date	Num Days Week	Num Days	Phase Description
1	Site Preparation	Site Preparation	9/1/2023	10/2/2023	5	23	Phase 1A activities
2	Initial Beach Construction	Grading	9/14/2023	12/31/2023	5	77	
3	Levee excavation, placement and compaction	Grading	9/1/2024	12/31/2024	5	87	Phase 2 activities
4	Drying and Shaping	Grading	10/9/2024	12/31/2024	5	60	Phase 2B activities
5	Final Levee Lift and Diked Marsh Work	Grading	9/1/2025	10/3/2025	5	25	Phase 3A activities
6	Final Lift and Shape of Beach	Grading	10/4/2025	10/16/2025	5	9	Phase 3B activities
7	Site Restoration	Grading	10/17/2025	10/30/2025	5	8	Phase 3C activities

Acres of Grading (Site Preparation Phase): 0

Acres of Grading (Grading Phase): 0

Acres of Paving: 0

Residential Indoor: 0; Residential Outdoor: 0; Non-Residential Indoor: 0; Non-Residential Outdoor: 0; Striped Parking Area: 0 (Architectural Coating –

OffRoad Equipment

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Phase Name	Offroad Equipment Type	Amount	Usage Hours	Horse Power	Load Factor
Site Preparation	Cranes	1	1.70	1311	0.29
Site Preparation	Excavators	1	2.80	275	0.38
Site Preparation	Off-Highway Trucks	1	2.80	350	0.38
Site Preparation	Off-Highway Trucks	2	8.30	475	0.38
Site Preparation	Other Construction Equipment	1	3.50	157	0.42
Site Preparation	Rubber Tired Dozers	1	7.00	165	0.40
Site Preparation	Tractors/Loaders/Backhoes	1	6.30	241	0.37
Levee excavation, placement and compaction	Cranes	0	7.00	231	0.29
Levee excavation, placement and compaction	Excavators	1	1.80	275	0.38
Levee excavation, placement and compaction	Excavators	2	8.00	275	0.38
Levee excavation, placement and compaction	Off-Highway Trucks	1	3.70	320	0.38
Levee excavation, placement and compaction	Off-Highway Trucks	1	7.60	350	0.38
Levee excavation, placement and compaction	Off-Highway Trucks	1	1.80	300	0.38
Levee excavation, placement and compaction	Other Construction Equipment	1	11.60	157	0.42
Levee excavation, placement and compaction	Other Material Handling Equipment	2	8.00	400	0.40
Levee excavation, placement and compaction	Rubber Tired Dozers	1	5.80	165	0.40
Levee excavation, placement and compaction	Rubber Tired Dozers	2	8.00	165	0.40
Levee excavation, placement and compaction	Tractors/Loaders/Backhoes	1	7.60	241	0.37
Drying and Shaping	Excavators	1	8.00	275	0.38
Drying and Shaping	Graders	0	8.00	187	0.41
Drying and Shaping	Pavers	0	8.00	130	0.42
Drying and Shaping	Paving Equipment	0	8.00	132	0.36
Drying and Shaping	Rollers	0	8.00	80	0.38
Drying and Shaping	Rubber Tired Dozers	1	8.00	165	0.40
Drying and Shaping	Scrapers	0	8.00	367	0.48
Drying and Shaping	Tractors/Loaders/Backhoes	0	8.00	97	0.37

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Final Levee Lift and Diked Marsh Work	Air Compressors	0	6.00	78	0.48
Final Levee Lift and Diked Marsh Work	Excavators	1	2.20	275	0.38
Final Levee Lift and Diked Marsh Work	Excavators	1	2.20	275	0.38
Final Levee Lift and Diked Marsh Work	Graders	0	8.00	187	0.41
Final Levee Lift and Diked Marsh Work	Off-Highway Trucks	1	4.50	320	0.38
Final Levee Lift and Diked Marsh Work	Off-Highway Trucks	1	8.00	350	0.38
Final Levee Lift and Diked Marsh Work	Off-Highway Trucks	1	6.70	300	0.38
Final Levee Lift and Diked Marsh Work	Other Construction Equipment	1	7.00	157	0.42
Final Levee Lift and Diked Marsh Work	Rubber Tired Dozers	2	4.60	165	0.40
Final Levee Lift and Diked Marsh Work	Rubber Tired Dozers	1	2.20	165	0.40
Final Levee Lift and Diked Marsh Work	Scrapers	0	8.00	367	0.48
Final Levee Lift and Diked Marsh Work	Tractors/Loaders/Backhoes	2	8.00	97	0.37
Final Lift and Shape of Beach	Excavators	2	8.40	275	0.38
Final Lift and Shape of Beach	Graders	0	8.00	187	0.41
Final Lift and Shape of Beach	Off-Highway Trucks	2	8.40	300	0.38
Final Lift and Shape of Beach	Other Material Handling Equipment	1	8.00	400	0.40
Final Lift and Shape of Beach	Rubber Tired Dozers	2	8.40	165	0.40
Final Lift and Shape of Beach	Scrapers	0	8.00	367	0.48
Final Lift and Shape of Beach	Tractors/Loaders/Backhoes	0	8.00	97	0.37
Site Restoration	Cranes	1	3.00	1311	0.29
Site Restoration	Excavators	2	8.00	158	0.38
Site Restoration	Graders	0	8.00	187	0.41
Site Restoration	Off-Highway Trucks	1	5.00	350	0.38
Site Restoration	Off-Highway Trucks	2	5.00	300	0.38
Site Restoration	Other Construction Equipment	1	6.00	157	0.40
Site Restoration	Rubber Tired Dozers	1	5.00	165	0.40
Site Restoration	Scrapers	0	8.00	367	0.48

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Site Restoration	Tractors/Loaders/Backhoes	2	8.00	97	0.37
Initial Beach Construction	Excavators	2	8.00	275	0.38
Initial Beach Construction	Graders	0	8.00	187	0.41
Initial Beach Construction	Off-Highway Trucks	2	8.00	300	0.38
Initial Beach Construction	Other Material Handling Equipment	2	8.00	400	0.40
Initial Beach Construction	Rubber Tired Dozers	2	8.00	165	0.40
Initial Beach Construction	Scrapers	0	8.00	367	0.48
Initial Beach Construction	Tractors/Loaders/Backhoes	0	8.00	97	0.37

Trips and VMT

Phase Name	Offroad Equipment Count	Worker Trip Number	Vendor Trip Number	Hauling Trip Number	Worker Trip Length	Vendor Trip Length	Hauling Trip Length	Worker Vehicle Class	Vendor Vehicle Class	Hauling Vehicle Class
Site Preparation	8	20.00	0.00	0.00	10.80	7.30	20.00	LD_Mix	HDT_Mix	HHDT
Levee excavation, placement and	13	33.00	200.00	2,250.00	10.80	7.30	20.00	LD_Mix	HDT_Mix	HHDT
Drying and Shaping	2	5.00	0.00	0.00	10.80	7.30	20.00	LD_Mix	HDT_Mix	HHDT
Final Levee Lift and Diked Marsh Work	11	28.00	0.00	0.00	10.80	7.30	20.00	LD_Mix	HDT_Mix	HHDT
Final Lift and Shape of Beach	7	18.00	0.00	0.00	10.80	7.30	20.00	LD_Mix	HDT_Mix	HHDT
Site Restoration	10	25.00	0.00	0.00	10.80	7.30	20.00	LD_Mix	HDT_Mix	HHDT
Initial Beach Construction	8	20.00	0.00	0.00	10.80	7.30	20.00	LD_Mix	HDT_Mix	HHDT

3.1 Mitigation Measures Construction

Use Cleaner Engines for Construction Equipment

3.2 Site Preparation - 2023

Unmitigated Construction On-Site

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	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.0580	0.0000	0.0580	0.0319	0.0000	0.0319	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Off-Road	0.0299	0.2522	0.1986	6.6000e-004		0.0102	0.0102		9.4100e-003	9.4100e-003	0.0000	57.9500	57.9500	0.0187	0.0000	58.4186
Total	**0.0299**	**0.2522**	**0.1986**	**6.6000e-004**	**0.0580**	**0.0102**	**0.0682**	**0.0319**	**9.4100e-003**	**0.0413**	**0.0000**	**57.9500**	**57.9500**	**0.0187**	**0.0000**	**58.4186**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Worker	6.1000e-004	4.0000e-004	4.7500e-003	1.0000e-005	1.7300e-003	1.0000e-005	1.7400e-003	4.6000e-004	1.0000e-005	4.7000e-004	0.0000	1.3613	1.3613	4.0000e-005	4.0000e-005	1.3738
Total	**6.1000e-004**	**4.0000e-004**	**4.7500e-003**	**1.0000e-005**	**1.7300e-003**	**1.0000e-005**	**1.7400e-003**	**4.6000e-004**	**1.0000e-005**	**4.7000e-004**	**0.0000**	**1.3613**	**1.3613**	**4.0000e-005**	**4.0000e-005**	**1.3738**

Mitigated Construction On-Site

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EMFAC Off-Model Adjustment Factors for Gasoline Light Duty Vehicle to Account for the SAFE Vehicle Rule Not Applied

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.0580	0.0000	0.0580	0.0319	0.0000	0.0319	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Off-Road	8.0900e-003	0.0661	0.3282	6.6000e-004		1.2000e-003	1.2000e-003		1.2000e-003	1.2000e-003	0.0000	57.9499	57.9499	0.0187	0.0000	58.4185
Total	**8.0900e-003**	**0.0661**	**0.3282**	**6.6000e-004**	**0.0580**	**1.2000e-003**	**0.0592**	**0.0319**	**1.2000e-003**	**0.0331**	**0.0000**	**57.9499**	**57.9499**	**0.0187**	**0.0000**	**58.4185**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Worker	6.1000e-004	4.0000e-004	4.7500e-003	1.0000e-005	1.7300e-003	1.0000e-005	1.7400e-003	4.6000e-004	1.0000e-005	4.7000e-004	0.0000	1.3613	1.3613	4.0000e-005	4.0000e-005	1.3738
Total	**6.1000e-004**	**4.0000e-004**	**4.7500e-003**	**1.0000e-005**	**1.7300e-003**	**1.0000e-005**	**1.7400e-003**	**4.6000e-004**	**1.0000e-005**	**4.7000e-004**	**0.0000**	**1.3613**	**1.3613**	**4.0000e-005**	**4.0000e-005**	**1.3738**

3.3 Initial Beach Construction - 2023

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EMFAC Off-Model Adjustment Factors for Gasoline Light Duty Vehicle to Account for the SAFE Vehicle Rule Not Applied

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.4637	0.0000	0.4637	0.2549	0.0000	0.2549	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Off-Road	0.1463	1.2451	0.9677	2.9400e-003		0.0570	0.0570		0.0524	0.0524	0.0000	258.4539	258.4539	0.0836	0.0000	260.5436
Total	**0.1463**	**1.2451**	**0.9677**	**2.9400e-003**	**0.4637**	**0.0570**	**0.5207**	**0.2549**	**0.0524**	**0.3073**	**0.0000**	**258.4539**	**258.4539**	**0.0836**	**0.0000**	**260.5436**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Worker	2.1500e-003	1.4100e-003	0.0166	5.0000e-005	6.0700e-003	3.0000e-005	6.1000e-003	1.6100e-003	3.0000e-005	1.6400e-003	0.0000	4.7646	4.7646	1.4000e-004	1.3000e-004	4.8083
Total	**2.1500e-003**	**1.4100e-003**	**0.0166**	**5.0000e-005**	**6.0700e-003**	**3.0000e-005**	**6.1000e-003**	**1.6100e-003**	**3.0000e-005**	**1.6400e-003**	**0.0000**	**4.7646**	**4.7646**	**1.4000e-004**	**1.3000e-004**	**4.8083**

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EMFAC Off-Model Adjustment Factors for Gasoline Light Duty Vehicle to Account for the SAFE Vehicle Rule Not Applied

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.4637	0.0000	0.4637	0.2549	0.0000	0.2549	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Off-Road	0.0362	0.1570	1.4625	2.9400e-003		4.8300e-003	4.8300e-003		4.8300e-003	4.8300e-003	0.0000	258.4536	258.4536	0.0836	0.0000	260.5433
Total	**0.0362**	**0.1570**	**1.4625**	**2.9400e-003**	**0.4637**	**4.8300e-003**	**0.4685**	**0.2549**	**4.8300e-003**	**0.2597**	**0.0000**	**258.4536**	**258.4536**	**0.0836**	**0.0000**	**260.5433**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Worker	2.1500e-003	1.4100e-003	0.0166	5.0000e-005	6.0700e-003	3.0000e-005	6.1000e-003	1.6100e-003	3.0000e-005	1.6400e-003	0.0000	4.7646	4.7646	1.4000e-004	1.3000e-004	4.8083
Total	**2.1500e-003**	**1.4100e-003**	**0.0166**	**5.0000e-005**	**6.0700e-003**	**3.0000e-005**	**6.1000e-003**	**1.6100e-003**	**3.0000e-005**	**1.6400e-003**	**0.0000**	**4.7646**	**4.7646**	**1.4000e-004**	**1.3000e-004**	**4.8083**

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EMFAC Off-Model Adjustment Factors for Gasoline Light Duty Vehicle to Account for the SAFE Vehicle Rule Not Applied

3.4 Levee excavation, placement and compaction - 2024

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.7149	0.0000	0.7149	0.3925	0.0000	0.3925	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Off-Road	0.2066	1.7504	1.5065	4.1900e-003		0.0815	0.0815		0.0750	0.0750	0.0000	367.8582	367.8582	0.1190	0.0000	370.8326
Total	**0.2066**	**1.7504**	**1.5065**	**4.1900e-003**	**0.7149**	**0.0815**	**0.7964**	**0.3925**	**0.0750**	**0.4676**	**0.0000**	**367.8582**	**367.8582**	**0.1190**	**0.0000**	**370.8326**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	2.5000e-003	0.1671	0.0473	6.8000e-004	0.0190	1.2300e-003	0.0202	5.2200e-003	1.1800e-003	6.3900e-003	0.0000	69.4141	69.4141	4.4900e-003	0.0111	72.8257
Vendor	0.0114	0.4092	0.1500	1.8100e-003	0.0569	2.2700e-003	0.0592	0.0165	2.1700e-003	0.0186	0.0000	179.0156	179.0156	6.8900e-003	0.0253	186.7114
Worker	3.7500e-003	2.3400e-003	0.0289	9.0000e-005	0.0113	6.0000e-005	0.0114	3.0100e-003	5.0000e-005	3.0600e-003	0.0000	8.5974	8.5974	2.4000e-004	2.3000e-004	8.6730
Total	**0.0177**	**0.5786**	**0.2262**	**2.5800e-003**	**0.0872**	**3.5600e-003**	**0.0907**	**0.0247**	**3.4000e-003**	**0.0281**	**0.0000**	**257.0271**	**257.0271**	**0.0116**	**0.0366**	**268.2101**

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EMFAC Off-Model Adjustment Factors for Gasoline Light Duty Vehicle to Account for the SAFE Vehicle Rule Not Applied

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.7149	0.0000	0.7149	0.3925	0.0000	0.3925	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Off-Road	0.0516	0.2236	2.2090	4.1900e-003		6.8800e-003	6.8800e-003		6.8800e-003	6.8800e-003	0.0000	367.8578	367.8578	0.1190	0.0000	370.8321
Total	**0.0516**	**0.2236**	**2.2090**	**4.1900e-003**	**0.7149**	**6.8800e-003**	**0.7217**	**0.3925**	**6.8800e-003**	**0.3994**	**0.0000**	**367.8578**	**367.8578**	**0.1190**	**0.0000**	**370.8321**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	2.5000e-003	0.1671	0.0473	6.8000e-004	0.0190	1.2300e-003	0.0202	5.2200e-003	1.1800e-003	6.3900e-003	0.0000	69.4141	69.4141	4.4900e-003	0.0111	72.8257
Vendor	0.0114	0.4092	0.1500	1.8100e-003	0.0569	2.2700e-003	0.0592	0.0165	2.1700e-003	0.0186	0.0000	179.0156	179.0156	6.8900e-003	0.0253	186.7114
Worker	3.7500e-003	2.3400e-003	0.0289	9.0000e-005	0.0113	6.0000e-005	0.0114	3.0100e-003	5.0000e-005	3.0600e-003	0.0000	8.5974	8.5974	2.4000e-004	2.3000e-004	8.6730

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EMFAC Off-Model Adjustment Factors for Gasoline Light Duty Vehicle to Account for the SAFE Vehicle Rule Not Applied

Total	**0.0177**	**0.5786**	**0.2262**	**2.5800e-003**	**0.0872**	**3.5600e-003**	**0.0907**	**0.0247**	**3.4000e-003**	**0.0281**	**0.0000**	**257.0271**	**257.0271**	**0.0116**	**0.0366**	**268.2101**

3.5 Drying and Shaping - 2024

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.1807	0.0000	0.1807	0.0993	0.0000	0.0993	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Off-Road	0.0253	0.2211	0.1873	4.4000e-004		0.0113	0.0113		0.0104	0.0104	0.0000	38.5616	38.5616	0.0125	0.0000	38.8734
Total	**0.0253**	**0.2211**	**0.1873**	**4.4000e-004**	**0.1807**	**0.0113**	**0.1920**	**0.0993**	**0.0104**	**0.1098**	**0.0000**	**38.5616**	**38.5616**	**0.0125**	**0.0000**	**38.8734**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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EMFAC Off-Model Adjustment Factors for Gasoline Light Duty Vehicle to Account for the SAFE Vehicle Rule Not Applied

Worker	3.9000e-004	2.4000e-004	3.0200e-003	1.0000e-005	1.1800e-003	1.0000e-005	1.1900e-003	3.1000e-004	1.0000e-005	3.2000e-004	0.0000	0.8984	0.8984	2.0000e-005	2.0000e-005	0.9063
Total	**3.9000e-004**	**2.4000e-004**	**3.0200e-003**	**1.0000e-005**	**1.1800e-003**	**1.0000e-005**	**1.1900e-003**	**3.1000e-004**	**1.0000e-005**	**3.2000e-004**	**0.0000**	**0.8984**	**0.8984**	**2.0000e-005**	**2.0000e-005**	**0.9063**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.1807	0.0000	0.1807	0.0993	0.0000	0.0993	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Off-Road	5.4100e-003	0.0235	0.2509	4.4000e-004		7.2000e-004	7.2000e-004		7.2000e-004	7.2000e-004	0.0000	38.5616	38.5616	0.0125	0.0000	38.8734
Total	**5.4100e-003**	**0.0235**	**0.2509**	**4.4000e-004**	**0.1807**	**7.2000e-004**	**0.1814**	**0.0993**	**7.2000e-004**	**0.1000**	**0.0000**	**38.5616**	**38.5616**	**0.0125**	**0.0000**	**38.8734**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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EMFAC Off-Model Adjustment Factors for Gasoline Light Duty Vehicle to Account for the SAFE Vehicle Rule Not Applied

Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Worker	3.9000e-004	2.4000e-004	3.0200e-003	1.0000e-005	1.1800e-003	1.0000e-005	1.1900e-003	3.1000e-004	1.0000e-005	3.2000e-004	0.0000	0.8984	0.8984	2.0000e-005	2.0000e-005	0.9063
Total	**3.9000e-004**	**2.4000e-004**	**3.0200e-003**	**1.0000e-005**	**1.1800e-003**	**1.0000e-005**	**1.1900e-003**	**3.1000e-004**	**1.0000e-005**	**3.2000e-004**	**0.0000**	**0.8984**	**0.8984**	**2.0000e-005**	**2.0000e-005**	**0.9063**

3.6 Final Levee Lift and Diked Marsh Work - 2025

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.1073	0.0000	0.1073	0.0590	0.0000	0.0590	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Off-Road	0.0289	0.2275	0.2612	6.2000e-004		0.0104	0.0104		9.5400e-003	9.5400e-003	0.0000	54.7975	54.7975	0.0177	0.0000	55.2405
Total	**0.0289**	**0.2275**	**0.2612**	**6.2000e-004**	**0.1073**	**0.0104**	**0.1176**	**0.0590**	**9.5400e-003**	**0.0685**	**0.0000**	**54.7975**	**54.7975**	**0.0177**	**0.0000**	**55.2405**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					

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EMFAC Off-Model Adjustment Factors for Gasoline Light Duty Vehicle to Account for the SAFE Vehicle Rule Not Applied

Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Worker	8.6000e-004	5.1000e-004	6.5900e-003	2.0000e-005	2.7600e-003	1.0000e-005	2.7700e-003	7.3000e-004	1.0000e-005	7.5000e-004	0.0000	2.0264	2.0264	5.0000e-005	5.0000e-005	2.0436
Total	**8.6000e-004**	**5.1000e-004**	**6.5900e-003**	**2.0000e-005**	**2.7600e-003**	**1.0000e-005**	**2.7700e-003**	**7.3000e-004**	**1.0000e-005**	**7.5000e-004**	**0.0000**	**2.0264**	**2.0264**	**5.0000e-005**	**5.0000e-005**	**2.0436**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.1073	0.0000	0.1073	0.0590	0.0000	0.0590	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Off-Road	7.6400e-003	0.0331	0.3542	6.2000e-004		1.0200e-003	1.0200e-003		1.0200e-003	1.0200e-003	0.0000	54.7974	54.7974	0.0177	0.0000	55.2405
Total	**7.6400e-003**	**0.0331**	**0.3542**	**6.2000e-004**	**0.1073**	**1.0200e-003**	**0.1083**	**0.0590**	**1.0200e-003**	**0.0600**	**0.0000**	**54.7974**	**54.7974**	**0.0177**	**0.0000**	**55.2405**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e

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EMFAC Off-Model Adjustment Factors for Gasoline Light Duty Vehicle to Account for the SAFE Vehicle Rule Not Applied

Category	tons/yr										MT/yr					
Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Worker	8.6000e-004	5.1000e-004	6.5900e-003	2.0000e-005	2.7600e-003	1.0000e-005	2.7700e-003	7.3000e-004	1.0000e-005	7.5000e-004	0.0000	2.0264	2.0264	5.0000e-005	5.0000e-005	2.0436
Total	**8.6000e-004**	**5.1000e-004**	**6.5900e-003**	**2.0000e-005**	**2.7600e-003**	**1.0000e-005**	**2.7700e-003**	**7.3000e-004**	**1.0000e-005**	**7.5000e-004**	**0.0000**	**2.0264**	**2.0264**	**5.0000e-005**	**5.0000e-005**	**2.0436**

3.7 Final Lift and Shape of Beach - 2025

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.0569	0.0000	0.0569	0.0313	0.0000	0.0313	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Off-Road	0.0130	0.0997	0.0965	2.9000e-004		4.5500e-003	4.5500e-003		4.1900e-003	4.1900e-003	0.0000	25.7667	25.7667	8.3300e-003	0.0000	25.9751
Total	**0.0130**	**0.0997**	**0.0965**	**2.9000e-004**	**0.0569**	**4.5500e-003**	**0.0615**	**0.0313**	**4.1900e-003**	**0.0355**	**0.0000**	**25.7667**	**25.7667**	**8.3300e-003**	**0.0000**	**25.9751**

Unmitigated Construction Off-Site

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EMFAC Off-Model Adjustment Factors for Gasoline Light Duty Vehicle to Account for the SAFE Vehicle Rule Not Applied

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Worker	2.0000e-004	1.2000e-004	1.5300e-003	1.0000e-005	6.4000e-004	0.0000	6.4000e-004	1.7000e-004	0.0000	1.7000e-004	0.0000	0.4690	0.4690	1.0000e-005	1.0000e-005	0.4729
Total	**2.0000e-004**	**1.2000e-004**	**1.5300e-003**	**1.0000e-005**	**6.4000e-004**	**0.0000**	**6.4000e-004**	**1.7000e-004**	**0.0000**	**1.7000e-004**	**0.0000**	**0.4690**	**0.4690**	**1.0000e-005**	**1.0000e-005**	**0.4729**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.0569	0.0000	0.0569	0.0313	0.0000	0.0313	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Off-Road	3.6100e-003	0.0156	0.1488	2.9000e-004		4.8000e-004	4.8000e-004		4.8000e-004	4.8000e-004	0.0000	25.7667	25.7667	8.3300e-003	0.0000	25.9751
Total	**3.6100e-003**	**0.0156**	**0.1488**	**2.9000e-004**	**0.0569**	**4.8000e-004**	**0.0574**	**0.0313**	**4.8000e-004**	**0.0318**	**0.0000**	**25.7667**	**25.7667**	**8.3300e-003**	**0.0000**	**25.9751**

Mitigated Construction Off-Site

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EMFAC Off-Model Adjustment Factors for Gasoline Light Duty Vehicle to Account for the SAFE Vehicle Rule Not Applied

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Worker	2.0000e-004	1.2000e-004	1.5300e-003	1.0000e-005	6.4000e-004	0.0000	6.4000e-004	1.7000e-004	0.0000	1.7000e-004	0.0000	0.4690	0.4690	1.0000e-005	1.0000e-005	0.4729
Total	**2.0000e-004**	**1.2000e-004**	**1.5300e-003**	**1.0000e-005**	**6.4000e-004**	**0.0000**	**6.4000e-004**	**1.7000e-004**	**0.0000**	**1.7000e-004**	**0.0000**	**0.4690**	**0.4690**	**1.0000e-005**	**1.0000e-005**	**0.4729**

3.8 Site Restoration - 2025

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.0188	0.0000	0.0188	0.0103	0.0000	0.0103	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Off-Road	0.0121	0.1016	0.1176	2.8000e-004		4.0200e-003	4.0200e-003		3.7000e-003	3.7000e-003	0.0000	24.5714	24.5714	7.9500e-003	0.0000	24.7701
Total	**0.0121**	**0.1016**	**0.1176**	**2.8000e-004**	**0.0188**	**4.0200e-003**	**0.0228**	**0.0103**	**3.7000e-003**	**0.0140**	**0.0000**	**24.5714**	**24.5714**	**7.9500e-003**	**0.0000**	**24.7701**

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EMFAC Off-Model Adjustment Factors for Gasoline Light Duty Vehicle to Account for the SAFE Vehicle Rule Not Applied

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Worker	3.1000e-004	1.8000e-004	2.3500e-003	1.0000e-005	9.8000e-004	0.0000	9.9000e-004	2.6000e-004	0.0000	2.7000e-004	0.0000	0.7237	0.7237	2.0000e-005	2.0000e-005	0.7298
Total	**3.1000e-004**	**1.8000e-004**	**2.3500e-003**	**1.0000e-005**	**9.8000e-004**	**0.0000**	**9.9000e-004**	**2.6000e-004**	**0.0000**	**2.7000e-004**	**0.0000**	**0.7237**	**0.7237**	**2.0000e-005**	**2.0000e-005**	**0.7298**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.0188	0.0000	0.0188	0.0103	0.0000	0.0103	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Off-Road	3.4300e-003	0.0398	0.1679	2.8000e-004		5.6000e-004	5.6000e-004		5.6000e-004	5.6000e-004	0.0000	24.5714	24.5714	7.9500e-003	0.0000	24.7701
Total	**3.4300e-003**	**0.0398**	**0.1679**	**2.8000e-004**	**0.0188**	**5.6000e-004**	**0.0194**	**0.0103**	**5.6000e-004**	**0.0109**	**0.0000**	**24.5714**	**24.5714**	**7.9500e-003**	**0.0000**	**24.7701**

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EMFAC Off-Model Adjustment Factors for Gasoline Light Duty Vehicle to Account for the SAFE Vehicle Rule Not Applied

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Worker	3.1000e-004	1.8000e-004	2.3500e-003	1.0000e-005	9.8000e-004	0.0000	9.9000e-004	2.6000e-004	0.0000	2.7000e-004	0.0000	0.7237	0.7237	2.0000e-005	2.0000e-005	0.7298
Total	**3.1000e-004**	**1.8000e-004**	**2.3500e-003**	**1.0000e-005**	**9.8000e-004**	**0.0000**	**9.9000e-004**	**2.6000e-004**	**0.0000**	**2.7000e-004**	**0.0000**	**0.7237**	**0.7237**	**2.0000e-005**	**2.0000e-005**	**0.7298**

4.0 Operational Detail - Mobile

4.1 Mitigation Measures Mobile

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Mitigated	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

EMFAC Off-Model Adjustment Factors for Gasoline Light Duty Vehicle to Account for the SAFE Vehicle Rule Not Applied

Unmitigated	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

4.2 Trip Summary Information

	Average Daily Trip Rate			Unmitigated	Mitigated
Land Use	Weekday	Saturday	Sunday	Annual VMT	Annual VMT
City Park	0.00	0.00	0.00		
Total	0.00	0.00	0.00		

4.3 Trip Type Information

	Miles			Trip %			Trip Purpose %		
Land Use	H-W or C-W	H-S or C-C	H-O or C-NW	H-W or C-W	H-S or C-C	H-O or C-NW	Primary	Diverted	Pass-by
City Park	9.50	7.30	7.30	33.00	48.00	19.00	66	28	6

4.4 Fleet Mix

Land Use	LDA	LDT1	LDT2	MDV	LHD1	LHD2	MHD	HHD	OBUS	UBUS	MCY	SBUS	MH
City Park	0.544281	0.061644	0.199793	0.122945	0.023341	0.005632	0.006920	0.003727	0.000656	0.000390	0.027229	0.000725	0.0027

5.0 Energy Detail

Historical Energy Use: N

5.1 Mitigation Measures Energy

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e

Tiscroria Marsh Adaptation Project - Marin County, Annual

EMFAC Off-Model Adjustment Factors for Gasoline Light Duty Vehicle to Account for the SAFE Vehicle Rule Not Applied

Category	tons/yr										MT/yr					
Electricity Mitigated						0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Electricity Unmitigated						0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NaturalGas Mitigated	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NaturalGas Unmitigated	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

5.2 Energy by Land Use - NaturalGas

Unmitigated

	NaturalGas Use	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Land Use	kBTU/yr	tons/yr										MT/yr					
City Park	0	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total		**0.0000**	**0.0000**	**0.0000**	**0.0000**		**0.0000**	**0.0000**		**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**

Mitigated

	NaturalGas Use	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e

Tiscroria Marsh Adaptation Project - Marin County, Annual

EMFAC Off-Model Adjustment Factors for Gasoline Light Duty Vehicle to Account for the SAFE Vehicle Rule Not Applied

Land Use	kBTU/yr	tons/yr										MT/yr					
City Park	0	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total		**0.0000**	**0.0000**	**0.0000**	**0.0000**		**0.0000**	**0.0000**		**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**

5.3 Energy by Land Use - Electricity

Unmitigated

	Electricity Use	Total CO2	CH4	N2O	CO2e
Land Use	kWh/yr	MT/yr			
City Park	0	0.0000	0.0000	0.0000	0.0000
Total		**0.0000**	**0.0000**	**0.0000**	**0.0000**

Mitigated

	Electricity Use	Total CO2	CH4	N2O	CO2e
Land Use	kWh/yr	MT/yr			
City Park	0	0.0000	0.0000	0.0000	0.0000

Tiscroria Marsh Adaptation Project - Marin County, Annual

EMFAC Off-Model Adjustment Factors for Gasoline Light Duty Vehicle to Account for the SAFE Vehicle Rule Not Applied

Total		**0.0000**	**0.0000**	**0.0000**	**0.0000**

6.0 Area Detail

6.1 Mitigation Measures Area

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Mitigated	0.0115	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Unmitigated	0.0115	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

6.2 Area by SubCategory

Unmitigated

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
SubCategory	tons/yr										MT/yr					
Architectural Coating	0.0000					0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Consumer Products	0.0115					0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Landscaping	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	**0.0115**	**0.0000**	**0.0000**	**0.0000**		**0.0000**	**0.0000**		**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**

Mitigated

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
SubCategory	tons/yr										MT/yr					
Architectural Coating	0.0000					0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Consumer Products	0.0115					0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Landscaping	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	**0.0115**	**0.0000**	**0.0000**	**0.0000**		**0.0000**	**0.0000**		**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**

7.0 Water Detail

7.1 Mitigation Measures Water

Tiscroria Marsh Adaptation Project - Marin County, Annual

EMFAC Off-Model Adjustment Factors for Gasoline Light Duty Vehicle to Account for the SAFE Vehicle Rule Not Applied

	Total CO2	CH4	N2O	CO2e
Category	MT/yr			
Mitigated	0.0000	0.0000	0.0000	0.0000
Unmitigated	0.0000	0.0000	0.0000	0.0000

7.2 Water by Land Use

Unmitigated

	Indoor/Outdoor Use	Total CO2	CH4	N2O	CO2e
Land Use	Mgal	MT/yr			
City Park	0 / 0	0.0000	0.0000	0.0000	0.0000
Total		**0.0000**	**0.0000**	**0.0000**	**0.0000**

Mitigated

Tiscroria Marsh Adaptation Project - Marin County, Annual

EMFAC Off-Model Adjustment Factors for Gasoline Light Duty Vehicle to Account for the SAFE Vehicle Rule Not Applied

	Indoor/Outdoor Use	Total CO2	CH4	N2O	CO2e
Land Use	Mgal	MT/yr			
City Park	0 / 0	0.0000	0.0000	0.0000	0.0000
Total		**0.0000**	**0.0000**	**0.0000**	**0.0000**

8.0 Waste Detail

8.1 Mitigation Measures Waste

Category/Year

	Total CO2	CH4	N2O	CO2e
	MT/yr			
Mitigated	0.0000	0.0000	0.0000	0.0000
Unmitigated	0.0000	0.0000	0.0000	0.0000

8.2 Waste by Land Use

Unmitigated

Tiscroria Marsh Adaptation Project - Marin County, Annual

EMFAC Off-Model Adjustment Factors for Gasoline Light Duty Vehicle to Account for the SAFE Vehicle Rule Not Applied

	Waste Disposed	Total CO2	CH4	N2O	CO2e
Land Use	tons	MT/yr			
City Park	0	0.0000	0.0000	0.0000	0.0000
Total		**0.0000**	**0.0000**	**0.0000**	**0.0000**

Mitigated

	Waste Disposed	Total CO2	CH4	N2O	CO2e
Land Use	tons	MT/yr			
City Park	0	0.0000	0.0000	0.0000	0.0000
Total		**0.0000**	**0.0000**	**0.0000**	**0.0000**

9.0 Operational Offroad

Equipment Type	Number	Hours/Day	Days/Year	Horse Power	Load Factor	Fuel Type

10.0 Stationary Equipment

Tiscroria Marsh Adaptation Project - Marin County, Annual

EMFAC Off-Model Adjustment Factors for Gasoline Light Duty Vehicle to Account for the SAFE Vehicle Rule Not Applied

Fire Pumps and Emergency Generators

Equipment Type	Number	Hours/Day	Hours/Year	Horse Power	Load Factor	Fuel Type

Boilers

Equipment Type	Number	Heat Input/Day	Heat Input/Year	Boiler Rating	Fuel Type

User Defined Equipment

Equipment Type	Number

11.0 Vegetation

Appendix D
Habitat Assessment

TISCORNIA MARSH HABITAT RESTORATION AND SEA LEVEL RISE ADAPTATION PROJECT

Habitat Assessment

Prepared for
Marin Audubon Society

December 2020

TISCORNIA MARSH HABITAT RESTORATION AND SEA LEVEL RISE ADAPTATION PROJECT

Habitat Assessment

Prepared for
Marin Audubon Society

December 2020

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160888.01

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Tiscornia Marsh Restoration and Sea Level Rise Adaptation Project – Habitat Assessment

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SUMMARY

Environmental Science Associates (ESA) conducted biological reconnaissance surveys within the approximately 38-acre Tiscornia Restoration and Sea Level Rise Adaptation Project (Project) site, located in the City of San Rafael, California. The Project plans to create a nature based buffer against sea level rise, preserve and restore critical wildlife habitat, and provide access to the Bay Trail. The purpose of this report is to describe site conditions and assess the suitability of the Study Area to support special status species and sensitive habitat types. This report may be used in support of regulatory permitting and California Environmental Quality Act (CEQA) compliance.

The following upland habitat types occur in the Study Area: ruderal/nonnative grassland, turf, coastal scrub, landscaped, and developed. Aquatic habitat types in the Study Area include tidal salt marsh, diked marsh, tidal waters/mudflat, and pond.

The Study Area provides suitable habitat for special status plants, including Point Reyes bird's-beak, Marin knotweed, Suisun Marsh aster, and Congested-headed hayfield tarplant.

The Study Area provides suitable habitat for special-status fish and wildlife species including California Central Valley and Central California Coast steelhead DPSs, Sacramento River winter-run, Central Valley spring-run, and Central Valley fall/late fall-run Chinook Salmon ESUs, longfin smelt, Southern DPS of North American green sturgeon, California black rail, California Ridgway's (California clapper) rail, northern harrier, salt-marsh common yellowthroat, San Pablo song sparrow, and salt marsh harvest mouse.

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CHAPTER 1
Introduction

This report includes a description of habitat types, sensitive natural communities, and the potential presence and distribution of common and special-status plant and wildlife species at the proposed Tiscornia Marsh Restoration and Sea Level Rise Adaptation Project site and surrounding area (Study Area).

1.1 Background and Purpose for the Habitat Assessment

The intent of this document is to characterize the existing biological resources of the Study Area to support environmental permitting, CEQA analysis, and restoration design.

Information used in the preparation of this report was obtained from regional biological studies, reports from the California Natural Diversity Database (CDFW, 2020), California Native Plant Society Electronic Inventory (CNPS, 2020), U.S. Fish and Wildlife species list (USFWS, 2020), reconnaissance-level field surveys, and other biological literature.

Habitat types and associated wildlife were identified using records, field observations, and aerial imagery. Environmental Science Associates (ESA) conducted two reconnaissance-level surveys of the Study Area on December 19, 2019 and May 13, 2020 to gather information and verify existing data on habitat types, sensitive natural communities, and potential habitat use of wildlife on and surrounding the site.

1.2 Project Description

The Tiscornia Restoration and Sea Level Rise Adaptation Project (Project), led by the Marin Audubon Society (MAS), proposes to address potential flooding and habitat degradation along San Rafael's Canal Area shoreline. The Project plans to create a nature based buffer against sea level rise, preserve and restore critical wildlife habitat, and provide access to the Bay Trail. MAS acquired Tiscornia Marsh, located at the mouth of the San Rafael Canal, in 2008. The 20-acre Tiscornia Marsh property, which was donated by Mary Tiscornia, consists of vegetated marsh, mudflats, shoreline levee, and a 500-foot reach of public trail that connects segments of the Bay Trail (Figure 1). There are currently two main concerns for the Tiscornia Marsh property. First, the tidal marshlands have experienced considerable erosion over the past 30 years, retreating as much as 200 feet, with approximately 3 acres lost. This erosion has resulted in significant loss of habitat for the endangered California Ridgway's rail and salt marsh harvest mouse, migratory shorebirds, and other important marsh wildlife. Second, the levee segment on the Tiscornia property is relatively low, and therefore at risk of overtopping during an extreme coastal flood events. Both of these conditions are expected to worsen in the coming decades as sea level rises.

The Project's preliminary design concept was developed with three overarching goals:

1. Enhance ecological function of the Project site,
2. Increase flood protection, and
3. Foster healthy public engagement.

1.3 Description of Study Area

The Project site is located in the City of San Rafael at the mouth of the San Rafael Canal and along the San Pablo Bay shoreline. Tiscornia Marsh, the tidal marsh portion of the Project site, is bounded to the west by the Al Boro Community Center and Pickleweed Park, a soccer field, and diked salt marsh, all of which are enclosed by a combined perimeter levee and trail. The Study Area for this Habitat Assessment is shown in **Figure 1**.

Tiscornia Marsh is one of a very few small areas of tidal marsh remaining in Central San Rafael. Historically, tidal marshes extended deep into what today is downtown San Rafael, and historic mapping shows that the location of the current levee along the west side of Tiscornia Marsh was the historic wetland/bay shoreline. Tiscornia Marsh thus most likely formed from accretion on the historic mudflats. The marsh is comprised of a thin band of high marsh habitat, dominated by pickleweed (*Salicornia pacifica*), which transitions abruptly from a 3- to 4-foot escarpment to a wide mudflat extending bayward. This band of marshland is most narrow at its north end, expands to the south, along the adjacent levee and soccer field, and becomes very thin as it curves eastward along the shoreline levee bordering the south end of the marsh. A single tidal channel enters the marsh from the northern edge bordering the San Rafael Canal and extends southward through most of the length of the marsh.

There are two Pacific Gas and Electric (PG&E) power line towers located within the marsh, which can be accessed by two wooden service walkways. One walkway runs generally northeast to southwest to a tower within the northern portion of the marsh, and the second runs in west-east to a tower adjacent to the bayward edge of the marsh. This tower was formerly surrounded by pickleweed marsh, which has since eroded as described below.

1.3.1 Regional Setting

The Study Area is located in Marin County along San Pablo Bay. Marin County has a diverse topography and microclimate, and has an associated high diversity of vegetation and wildlife, although development in the region, has resulted in a substantial reduction in land available for native flora and fauna. San Francisco Bay has lost 80% of its historic tidal wetlands. The Study Area is within the City of San Rafael which is a small valley confined by headlands with urban development along the San Rafael Canal.

SOURCE: aerial (ESRI)

Tiscornia Marsh Restoration and Sea level Rise Adaptation . 160888.01

Figure 1
Study Area

ESA

1.3.2 Ecological Site History and Ongoing Erosion

Prior to the development the San Rafael Regional Shoreline, Tiscornia Marsh formed the edge of open bay/mudflats immediately adjacent to a larger marsh complex that existed from a little east of today's shoreline deep into downtown San Rafael, with San Rafael Creek bisecting and supporting much of this tidal marsh. By 1943, the shoreline had been leveed and marsh had accreted on the mudflats bayward of what was the historic wetland shoreline. The general site location is illustrated in **Figure 2** on the 1853 U.S. Coast and Geodetic Survey T-Sheet for the area. Aside from the larger scale changes that were occurring throughout the Bay Area within the past century, sediment delivery to the site was also altered by development of the City of San Rafael, filling of the Bay, and construction of the Spinnaker neighborhood to the south. More recently, recurrent maintenance dredging of San Rafael Creek for navigation purposes has created a local sediment sink adjacent to the marsh.

Aerial images dating from 1987 indicate that the marsh has been eroding rapidly in the last several decades. The retreat of the bayward marsh edge has been most rapid at the northern edge of the site, eroding at a rate of 4-5 feet per year since 2004, when most aerial images were available. The rate of retreat decreases with distance moving south along the marsh edge, declining to as little as 1 foot per year where the marsh intersects the shoreline (ESA 2018).

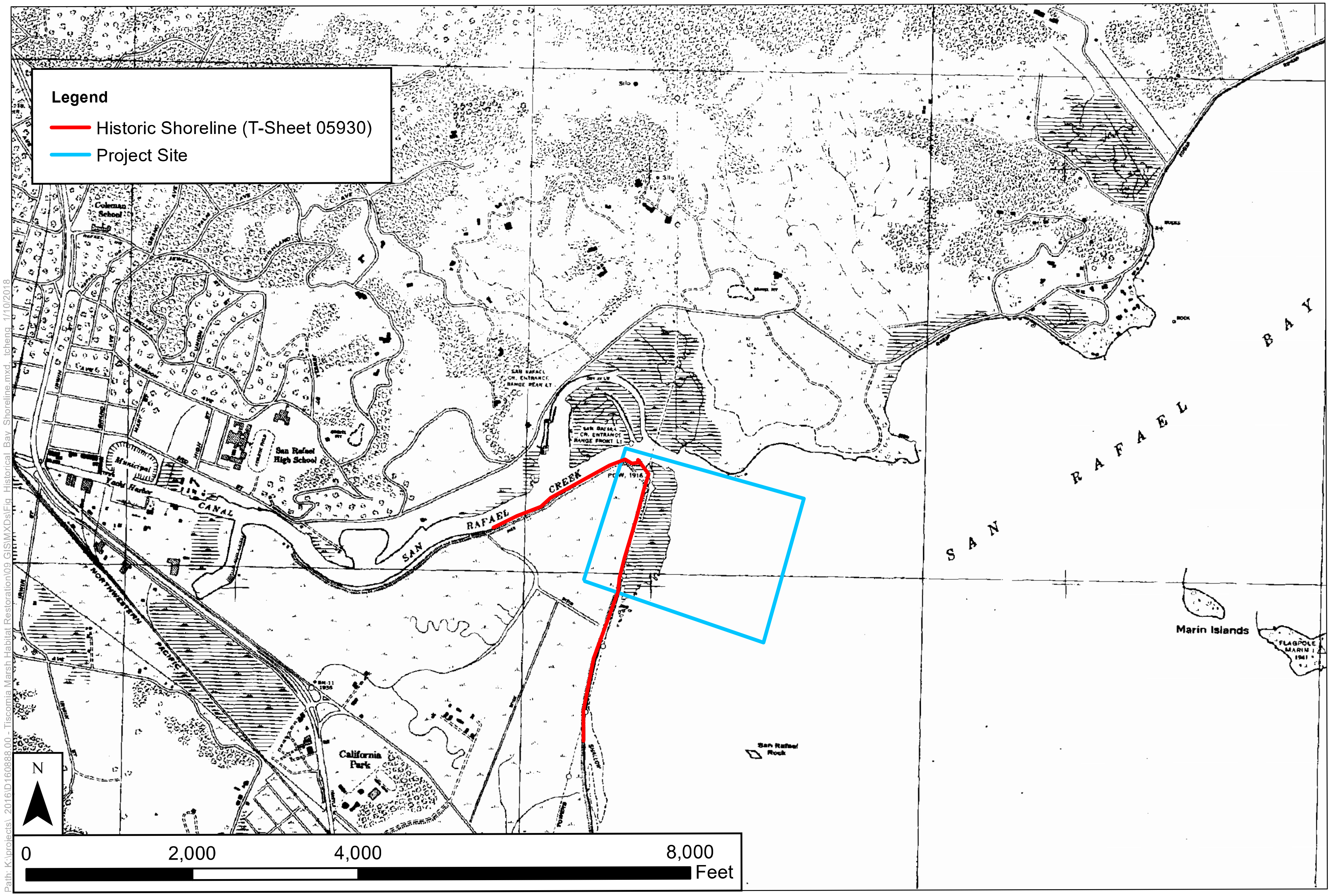
1.4 Regulatory Context

Biological resources in the Study Area, including special-status species, wetlands, and sensitive natural communities, may fall under the jurisdiction of various regulatory agencies and be subject to their regulations and permit requirements. Biological resources observed within the Study Area, or with potential to occur in the Study Area, as described in *Section 3: Environmental Setting*, may be subject to the regulations described below. Additionally, some sensitive biological resources described in this report may occur outside of, but adjacent to the Study Area. If affected by Project activities, these resources also could be subject to regulatory considerations.

1.4.1 Federal Regulations

1.4.1.1 Federal Endangered Species Act

Under the Federal Endangered Species Act (FESA), the Secretary of the Interior and the Secretary of Commerce have joint authority to list a species as threatened or endangered. Two federal agencies oversee the FESA: the United States Fish and Wildlife Service (USFWS) has jurisdiction over plants, wildlife, and resident fish, while the National Marine Fisheries Service (NMFS) has jurisdiction over anadromous fish, marine fish, and marine mammals.



SOURCE: NOAA (T-Sheet)

D160888.00 Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation

Figure 2
Historical Marsh Shoreline
NOAA T-Sheet 05930 (1943)

ESA

Section 7 of FESA requires a federal agency reviewing a project within its jurisdiction to determine whether any federally listed threatened or endangered species may be present in the Study Area and whether the proposed action will have a potentially significant impact on such species. In addition, the agency is required to determine whether the proposed action is likely to jeopardize the continued existence of any species proposed to be listed under FESA or result in the destruction or adverse modification of critical habitat proposed to be designated for such species. The USFWS designates critical habitat for threatened or endangered species under FESA. Critical habitat designations are specific areas within the geographic region that are occupied by a listed species that are determined to be critical to its survival and recovery in accordance with FESA. Federal entities issuing permits or acting as a federal agency must show that their actions do not negatively affect the critical habitat to the extent that it impedes the recovery of the species.

1.4.1.2 Migratory Bird Treaty Act

The federal Migratory Bird Treaty Act (MBTA), administered by the USFWS, is the domestic law that affirms, or implements, a commitment by the United States to four international conventions (with Canada, Mexico, Japan, and Russia) for the protection of a shared migratory bird resource. It generally prohibits the killing, possessing, or trading of migratory birds, bird parts, eggs, and nests, except as provided by the statute. The federal MBTA definition of "take" does not prohibit or penalize the incidental take of migratory birds that results from actions that are conducted without motivation to harm birds.

1.4.1.3 Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act, enforced by the USFWS, makes it illegal to import, export, take (which includes molest or disturb), sell, purchase, or barter any bald eagle (*Haliaeetus leucocephalus*) or golden eagle (*Aquila chrysaetos*) or parts thereof.

1.4.1.4 The Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended (16 USC 1801), requires that Essential Fish Habitat (EFH) be identified and described in Federal fishery management plans (FMP). Federal agencies must consult with NMFS on any activity which they fund, permit, or carry out that may adversely affect EFH.

1.4.1.5 Waters of the U.S.

The USACE has primary federal responsibility for administering regulations that concern waters of the U.S. In this regard, the USACE acts under two statutory authorities: the Rivers and Harbors Act, which governs specified activities in "navigable waters,"[1] and the Clean Water Act, which governs specified activities in waters of the U.S., including wetlands.

1 Navigable waters are defined as those waters that are subject to the ebb and flow of the tide or that are presently used, have been used in the past, or may be susceptible for use to transport interstate or foreign commerce.

Rivers and Harbors Act of 1899

Section 10 of the Rivers and Harbors Act (RHA) (33 U.S.C. § 403) requires authorization from the Corps for work or structures in or affecting navigable waters of the U.S. The term “navigable waters of the U. S.” generally includes those waters that are subject to the ebb and flow of the tide and/or are presently used, or have been used in the past, or may be susceptible to use to transport interstate or foreign commerce. A determination of navigability, once made, applies laterally over the entire surface of the waterbody, and is not extinguished by later actions or events which impede or destroy navigable capacity (33 C.F.R. §329.4).

Section 14 of the RHA of 1899 (33 U.S.C. § 408), commonly referred to as “Section 408,” authorizes the Corps to grant permission to alter, occupy, or use a Corps civil works project if the Secretary determines that the activity will not be injurious to the public interest and will not impair the usefulness of the project.

Clean Water Act

The Clean Water Act (CWA) establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. The basis of the CWA was enacted in 1948 and was called the Federal Water Pollution Control Act, but the Act was significantly reorganized and expanded in 1972. "Clean Water Act" became the Act's common name with amendments in 1972.

In 1986, the term “waters of the United States” was defined as follows (33 CFR 328.3[a]):

(1) All waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide;

(2) All interstate waters including interstate wetlands;

(3) All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sand flats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation or destruction of which could affect interstate or foreign commerce including any such waters:

   (i) Which are or could be used by interstate or foreign travelers for recreational or other purposes; or

   (ii) From which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or

   (iii) Which are used or could be used for industrial purpose by industries in interstate commerce;

(4) All impoundments of waters otherwise defined as waters of the United States under the definition;

(5) Tributaries of waters identified in paragraphs (a)(1) through (4) of this section;

(6) The territorial seas; and

(7) Wetlands adjacent to waters (other than waters that are themselves wetlands) identified in paragraphs (a)(1) through (6) of this section.

(8) Waters of the United States do not include prior converted cropland. Notwithstanding the determination of an area's status as prior converted cropland by any other Federal agency, for the purposes of the Clean Water Act, the final authority regarding Clean Water Act jurisdiction remains with EPA.

Waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of CWA (other than cooling ponds as defined in 40 CFR 423.11(m) which also meet the criteria of this definition) are not waters of the United States.

Wetlands (including swamps, bogs, seasonal wetlands, seeps, marshes, and similar areas) are also considered waters of the U.S. (subject to the significant nexus test), and are defined by USACE as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (33 CFR 328.3[b]; 40 CFR 230.3[t]). Indicators of three wetland parameters (i.e., hydric soils, hydrophytic vegetation, and wetlands hydrology), as determined by field investigation, must be present for a site to be classified as a wetland by USACE (Environmental Laboratory 1987).

Section 401 of the CWA gives the state authority to grant, deny, or waive certification of proposed federally licensed or permitted activities resulting in discharge to waters of the U.S. The State Water Resources Control Board (State Water Board) directly regulates multi-regional projects and supports the Section 401 certification and wetlands program statewide. The Regional Water Quality Control Board (RWQCB) regulates activities pursuant to Section 401(a)(1) of the federal CWA, which specifies that certification from the State is required for any applicant requesting a federal license or permit to conduct any activity including but not limited to the construction or operation of facilities that may result in any discharge into navigable waters. The certification shall originate from the State or appropriate interstate water pollution control agency in/where the discharge originates or will originate. Any such discharge will comply with the applicable provisions of Sections 301, 302, 303, 306, and 307 of the CWA.

The USACE requires a permit if a project proposes placement of structures within navigable waters and/or alteration of waters of the U.S. Some classes of fill activities may be authorized under Regional General or Nationwide permits if specific conditions are met. Nationwide permits do not authorize activities that are likely to jeopardize the existence of a threatened or endangered species (listed or proposed for listing under FESA). The Nationwide permit outlines general conditions and may specify project-specific conditions as required by the USACE during the Section 404 permitting process. When a project's activities do not meet the conditions for a Nationwide Permit, an Individual Permit may be issued by the USACE.

1.4.2 State Regulations

1.4.2.1 Waters of the State

Most projects involving water bodies or drainages are regulated by the RWQCB, the principal State agency overseeing water quality of the State at the local/regional level. The survey area is located within the jurisdiction of the San Francisco Bay RWQCB. Where waters of the State overlap with waters of the U.S., pending verification from the USACE, those waters would be regulated under Section 401 of the CWA which is described in the Regulatory Framework in Section 3.1.

In the absence of waters of the U.S., waters may be regulated under the Porter-Cologne Water Quality Control Act if project activities, discharges, or proposed activities or discharges could affect California's surface, coastal, or ground waters. The permit submitted by the applicant and issued by RWQCB is either a Water Quality Certification in the presence of waters of the U.S. or a Waste Discharge Requirement (WDR) in the absence of waters of the U.S.

1.4.2.2 Rivers, Streams, and Lakes

Pursuant to Division 2, Chapter 6, Section 1600 et seq. of the FGC, California Department of Fish and Wildlife (CDFW) regulates all diversions, obstructions, or changes to the natural flow or bed, channel or bank of any river, stream, or lake which supports fish or wildlife. A notification of a Lake or Streambed Alteration Agreement must be submitted to CDFW for “any activity that may substantially change the bed, channel, or bank of any river, stream, or lake.” In addition, CDFW has authority under FGC over wetland and riparian habitats associated with lakes and streams. The CDFW reviews proposed actions, and if necessary, submits to the applicant a proposal that includes measures to protect affected fish and wildlife resources. The final proposal that is mutually agreed upon by CDFW and the applicant is the Lake or Streambed Alteration Agreement (LSAA).

1.4.2.3 Section 3503 California Fish and Game Code

Under Section 3503 of the California Fish and Game Code, it is unlawful to take, possess, or needlessly destroy the nest or eggs of any bird, except as otherwise provided by this code or any regulation made pursuant thereto. Section 3503.5 of the California Fish and Game Code prohibits take, possession, or destruction of any birds in the orders Falconiformes or Strigiformes (birds of prey), or of their nests and eggs.

1.4.2.4 California Fully Protected Species

California law (Fish and Game Code Sections 3511 birds, 4700 mammals, 5050 reptiles and amphibians and 5515 fish) allows the designation of a species as fully protected. This is a greater level of protection than is afforded by the California Endangered Species Act, since such a designation means the listed species cannot be taken at any time. Salt marsh harvest mouse (*Reithrodontomys raviventris*), California Ridgway’s rail (*Rallus obsoletus obsoletus*), and California black rail (*Laterallus jamaicensis coturniculus*) are California fully protected species.

1.4.2.5 CEQA Guidelines Section 15380

Although threatened and endangered species are protected by specific federal and state statutes, CEQA Guidelines section 15380(b) provides that a species not listed on the federal or state list of protected species may be considered rare or endangered if the species can be shown to meet certain specified criteria. These criteria have been modeled after the definition in the FESA and the section of the California Fish and Game Code dealing with rare or endangered plants or animals. This section was included in the Guidelines primarily to deal with situations in which a public agency is reviewing a project that may have a significant effect on, for example, a "candidate species" that has not yet been listed by either the USFWS or CDFW.

CEQA also specifies the protection of other locally or regionally significant resources, including natural communities or habitats. Although natural communities do not presently have legal protection, CEQA requires an assessment of such communities and potential project impacts. Natural communities that are identified as sensitive in the CNDDB are considered by CDFW to be significant resources and fall under the CEQA Guidelines for addressing impacts. Local planning documents, such as general and area plans, also often identify sensitive natural communities.

1.4.3 Local Regulations

1.4.3.1 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 Bay shoreline and a line 100 feet landward of and parallel to the shoreline. These areas are defined in the McAteer-Petris Act (PRC Section 66610) as:

- San Francisco Bay, being 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, extended 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 laying between mean high tide and mean low tide); and submerged lands (land lying below mean low tide).
- A shoreline band consisting of 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.

CHAPTER 2
Methods

2.1 Study Area

The use of the term “Study Area” refers to the area generally defined by the potential Project boundary (Figure 1). The Study area includes parcels owned by Marin Audubon Society, the City of San Rafael, the federal government, and the State of California.

Note that although this footprint is generally the starting point to define a biological survey area, in practical terms, biological resources have varied sensitivity to disturbance and a slightly larger Study Area is typically needed in order to identify habitat values for many species including nesting raptors, passerine birds, and many terrestrial species that may be located in an adjacent area or may move between the Project site and an adjacent area.

2.2 Survey Dates and Surveying Personnel

Environmental Science Associates (ESA) wetland restoration ecologist Stephanie Bishop and wildlife biologist Leonard Liu conducted a reconnaissance-level plant and wildlife survey of the Study Area on December 19, 2019; and Stephanie Bishop and ESA biologist Michelle Giolli conducted a reconnaissance-level plant and wildlife survey on May 13, 2020. The surveys were conducted to observe and characterize vegetation communities in the Study Area, to assess habitat quality and potential for common and special-status wildlife species, and to verify conditions described in site specific studies. Data collected in the reconnaissance surveys were intended to identify the presence or absence of suitable habitat for each special-status species known to occur in the vicinity in order to determine its potential to occur in the Study Area. The site visits did not constitute protocol-level surveys and were not intended to determine the actual presence or absence of such species.

2.3 Review of Background Information

Some site specific biological studies and surveys have been performed in the Study Area over the years. These, along with publicly available data and subscription-based biological resource data, were evaluated to provide a foundation of existing biological conditions in this report.

Data sources that assisted in this analysis include:

- Topographic maps
- Historic and current aerial imagery

- USFWS Information for Planning and Conservation (IPaC), USFWS, 2020
- The CDFW California Natural Diversity Database (CNDDB), CDFW, 2020
- The California Native Plant Society (CNPS) online database, CNPS, 2020
- California Ridgway's Rail Survey Reports (Olofson Environmental, Inc. 2011-2016, 2018a, 2018b, 2020)
- eBird Hotspot for Pickleweed Park, Marin County, eBird, 2020

CHAPTER 3
Environmental Setting

This chapter provides the environmental baseline for vegetation communities and habitats and special-status plant and wildlife species in the Study Area. Habitat types occurring within the Study Area are briefly described below. **Figure 3** shows the distribution of these habitats in the Study Area and **Appendix A** shows representative photos of these habitats within the Study Area.

3.1 Habitat Types

The description of habitat types presented herein is based on field observations, review of previous biological studies and the standard *Preliminary Descriptions of the Terrestrial Natural Communities of California* (Holland, 1986). Plant communities generally correlate with wildlife habitat types; wildlife habitats were classified and evaluated using the *A Guide to Wildlife Habitats of California* (Mayer and Laudenslayer, 1988). The following upland habitat types occur in the Study Area: ruderal/nonnative grassland, turf, coastal scrub, landscaped, and developed. Aquatic habitat types in the Study Area include tidal salt marsh, diked marsh, tidal waters/mudflat, and pond. Habitat types within the Study Area are presented in **Figure 3**. **Table 1** provides a summary of the habitat types by acreages. Dominant vegetation and wildlife observed during the reconnaissance surveys are provided under each of the habitat types described below.

TABLE 1
HABITAT TYPES BY ACREAGES

Habitat Type	Acreage[1]
Upland Habitat Types	
Ruderal/Non-Native Grassland	1.43
Turf	4.72
Coastal Scrub	0.32
Landscaped	3.32
Developed	3.90
Aquatic Habitat Types	
Tidal Salt Marsh	7.59
Diked Marsh	3.95
Tidal Waters/Mudflat	12.75
Pond	0.07
	38.05

NOTES:
1 GIS calculations may not reflect exact acreage of Study Area due to rounding.

SOURCE: aerial (ESRI)

Tiscornia Marsh Restoration and Sea level Rise Adaptation . 160888.01

Figure 3
Habitat Types

ESA

3.1.1 Upland Habitat Types

3.1.1.1 Ruderal/Non-native Grassland/Turf

The upland areas of the Study Area are dominated by ruderal vegetation and non-native grassland. Ruderal and non-native grassland habitats are most prevalent in areas subject to frequent vegetation and soil disturbances including disked or fallow fields, construction sites, levees or trails, and railroad or other public utility rights of way. This habitat occurs mostly along the trail within the Study Area (see Photos 1, 2, and 3 in Appendix A). It is characterized by a dense growth of non-native grasses and forbs. Non-native invasive grasses common within the Study Area include wild oat (*Avena* sp.), Italian ryegrass (*Festuca perennis*), ripgut brome (*Bromus diandrus*), soft chess (*Bromus hordeaceus*), seaside barley (*Hordeum marinum*), and foxtail barley (*Hordeum murinum*). Non-native invasive forbs common within this habitat in the Study Area include fennel (*Foeniculum vulgare*), bristly oxtongue (*Helminthotheca echioides*), and wild radish (*Raphanus sativus*). Some native grasses and herbs occurred intermittently throughout the ruderal vegetation and non-native grassland including pineapple weed (*Matricaria discoidea*) and meadow barley (*Hordeum brachyantherum*). Several native and non-native trees occur within the ruderal/non-native grassland along the trails including coast live oak (*Quercus agrifolia*), Canary island date palm (*Phoenix canariensis*) and acacia (*Acacia* sp.). Turf occurs at the soccer field in the Study Area (see Photo 4 in Appendix A). This field appears regularly mowed and contains non-native grasses and forbs including annual blue grass (*Poa annua*) and clover (*Trifolium* sp.).

In areas adjacent to trails and parks that are utilized by humans, wildlife use is likely limited. Canada geese (*Branta canadensis*) were seen foraging in the turf during the reconnaissance survey. Some other common wildlife that may use non-native grassland and ruderal habitats include western fence lizard (*Sceloporus occidentalis*), black-tailed jackrabbit (*Lepus californicus*) and other small mammals, and western meadowlark (*Sturnella neglecta*). The non-native grassland and ruderal habitat in areas directly adjacent to tidal and non-tidal wetlands is important as refugia habitat for marsh wildlife during high tides, storms, and flood events. Scattered trees next to the trail likely provide minimal wildlife habitat, but may provide foraging and nesting habitat for a wide variety of birds.

3.1.1.2 Coastal Scrub

A small strip of uplands between the tidal marsh and trail is comprised of coastal scrub habitat, dominated by shrubs such as California sagebrush (*Artemisia californica*) and coyote brush (*Baccharis pilularis*) (see Photo 5 in Appendix A). This area was planted several years ago by STRAW (Students and Teachers Restoring a Watershed) and Point Blue Conservation Science. The area contains several non-native and invasive species including pride of madeira (*Echium candicans*), dwarf mallow (*Malva neglecta*), and Canarian sea lavender (*Limonium perezii*), as well as non-native grasses and herbs found in the non-native grassland/ruderal habitat. Some native grasses and herbs also occur throughout the scrub habitat including creeping wildrye (*Elymus triticoides*) and California mugwort (*Artemesia douglasiana*).

The coastal scrub habitat in the Study Area provides wildlife refugia habitat for marsh wildlife during high tide, storm, and flood events. Many birds may utilize this coastal scrub habitat for foraging including San Pablo song sparrow (*Melospiza melodia samuelis*), white-crowned sparrow (*Zonotrichia leucophrys*), and red-winged blackbird (*Agelaius phoeniceus*).

3.1.1.3 Landscaped

Several different landscaped areas exist within the Study Area surrounding the Al Boro Community Center, Pickleweed Park, and nearby trails (see Photo 4 in Appendix A). Several trees are found throughout these landscaped areas including non-native sweet gum (*Liquidambar styraciflua*) and native black oak (*Quercus kelloggii*). Mowed grassy areas and wood-chipped areas exist under the tree canopy. The mowed grassy areas include mostly non-native grasses and herbs also found in the soccer field turf.

Trees can generally provide nesting, roosting, and foraging habitat for many species of birds. However, because these trees are near a parking area of a City park and near Waterfront Road, they may only provide nesting opportunities to birds willing to nest near areas of frequent human disturbance, such as California scrub jay (*Aphelocoma californica*), Northern mockingbird (*Mimus polyglottos*), and house finch (*Haemorhous mexicanus*). Predators to birds and other wildlife may also inhabitat these areas include raccoon (*Procyon lotor*) and Virginia opossum (*Didelphis virginiana*).

3.1.1.4 Developed

Developed areas include the community center buildings, a parking lot, and paved and unpaved trails (see Photos 1, 4, and 5 in Appendix A). The unpaved trail around the Study Area bisects the tidal marsh from the diked marsh, soccer field, and other landscaped and developed areas. Trees and shrubs are found scattered throughout the developed areas surrounding the parking lot and buildings and include non–native species such as golden rain tree (*Koelreuteria paniculata*), Marina strawberry tree (*Arbutus* x ‘Marina’), and Crimson bottlebrush (*Callistemon citrinus*).

These trees can provide habitat to birds and other wildlife, but the buildings and paved areas themselves support few biological resources. The unpaved trail is likely used by wildlife to move between other wetland and upland habitats. Developed areas provide limited wildlife habitat and usually support only generalist, and sometimes non-native wildlife species that are tolerant of human presence and activities, such as house sparrow (*Passer domesticus*) and Virginia opossum.

3.1.1.5 Transition Zone

The transition zone within the Study Area encompasses upland habitat types adjacent to the tidal marsh. In the Study Area, a very narrow band, typically 5 to 30 feet wide, of ruderal/non-native grassland or coastal scrub exists before it abuts against the pedestrian trail. If necessary, wildlife could cross the pedestrian trail to other upland and wetland habitat during periods of high water levels due to high tides and storm events. However, for the purposes of this report, the transition zone is considered the narrow band of upland habitat between the tidal marsh and the trail. The transition zone is important refugia habitat for marsh wildlife during high tides, storms, and flood events. However, because the transition zone is so narrow and close to developed areas, wildlife utilizing this transition zone may be exposed to excessive predation.

3.1.2 Aquatic Habitat Types

3.1.2.1 Tidal Salt Marsh

Tidal salt marsh, found along the edge of San Pablo Bay and San Rafael Creek in the Study Area, is typical of tidal salt marsh in San Pablo Bay and contains low and mid-high marsh zones (See Photos 2, 3, and 6 in Appendix A). Due to the small size of the tidal salt marsh and the mix of the mid and high marsh plants at this site, the latter two zones are lumped below into the mid-high marsh zone. Vegetation communities in tidal wetlands are defined by tidal hydroperiod, salinity, soils, drainage, and species competition.

Low Marsh Zone

The low marsh zone consists of the marsh directly adjacent to San Pablo Bay, San Rafael Canal, and adjacent to small channels within the interior of the marsh. Low marsh generally occurs between elevations 3.3 and 5.5 ft. NAVD, or approximately mean tide level (MTL) to mean high water (MHW) (ESA 2018). The dominant plant species within the low marsh zone is California cordgrass (*Spartina foliosa*).

Mid-High Marsh Zone

The mid-high marsh zone occurs in the band between the uplands and trail and the narrow strip of low marsh along the San Pablo Bay shoreline. Mid - high marsh habitat generally occurs between 5.5 and 7.3 ft. NAVD, or between MHW and the highest tide (ESA 2018).

Vegetation within this zone is dominated by pickleweed (*Salicornia pacifica*). Jaumea (*Jaumea carnosa*) is also present in the lower elevations of the mid-high marsh zone. Many other species are found at the upper elevations of the high marsh and at the edge between high marsh and uplands including native salt grass (*Distichlis spicata*), alkali heath (*Frankenia salina*), and gumplant (*Grindelia stricta*). Both the size in area and the amount of plant diversity is greater in the mid-high marsh than in the low marsh zone within the Study Area. Some other native species encountered intermittently within the mid-high marsh habitat include marsh rosemary (*Limonium californicum*) and fat hen (*Atriplex prostrata*).

Tidal salt marsh vegetation throughout the Study Area provides nesting and foraging opportunities and cover for marsh bird species, including mallard (*Anas platyrhynchos*), great blue heron (*Ardea herodias*), great egret (*Ardea alba*), marsh wren (*Cistothorus palustris*), San Pablo song sparrow (*Melospiza melodia samuelis*), red-winged blackbird (*Agelaius phoeniceus*), salt marsh common yellowthroat (*Geothlypis trichas sinuosa*), and small mammals such as raccoon (*Procyon lotor*), and California vole (*Microtus californicus*).

Raptors that are typical of marsh habitats include northern harrier (*Circus hudsonius*), red-tailed hawk (*Buteo jamaicensis*), white-tailed kite (*Elanus leucurus*), and American kestrel (*Falco sparverius*). During high tides, ducks that may be found in tidal marsh environments include northern shoveler (*Anas clypeata*), American wigeon (*Anas americana*), northern pintail (*Anas acuta*), gadwall (*Anas strepera*), and canvasback (*Aythya valisineria*).

Special-status wildlife that may occur within tidal marsh habitats includes salt marsh harvest mouse, California Ridgway's rail, and California black rail.

3.1.2.2 Diked Marsh

Diked marsh habitat in the Study Area is dominated by pickleweed and contains varying densities of this plant (see Photo 7 in Appendix A). With a slight increase in elevation, pickleweed intergrades into areas composed of an assortment of hydrophytic species including, natives salt grass, alkali heath, and non-natives fat hen, and rabbitsfoot grass (*Polypogon monspeliensis*). Most of the diked marsh in the Study Area occurs west of the tidal salt marsh, behind the levee/trail. However, two other smaller areas of diked marsh occur in the northwest area of the Study Area around a pond and in an area of lower elevation (Figure 3).

Similar to tidal salt marsh, diked marsh can provide nesting, foraging, and refugia habitat for wildlife associated with tidal marsh vegetation. The lower water levels and sparse vegetation can attract foraging and nesting shorebirds such as sandpiper (*Calidris* spp.), black-necked stilt (*Himantopus mexicanus*), American avocet (*Recurvirostra americana*), short-billed dowitcher (*Limnodromus griseus*), and killdeer (*Charadrius vociferous*). Northern harrier commonly hunts over open marshes. Diked marshes also provide habitat for small rodents that occur in the tidal marshes in the region including saltmarsh harvest mouse.

3.1.2.3 Tidal Waters

San Pablo Bay, San Rafael Creek, and small channels within the tidal marsh consist of open water, bordered by stands of cordgrass. The tidal waters within the Study Area occur within intertidal elevations and thus are mudflat at low tide (see Photos 3 and 6 in Appendix A). Subtidal habitat occurs in San Rafael Creek and in San Pablo Bay adjacent to the Study Area where elevations are below the tide range and the substrate is, as a result, continuously submerged. Intertidal mudflat occurs upslope of the subtidal areas and in a few smaller tidal channels within the Study Area and is generally devoid of vegetation.

Mudflat within San Pablo Bay provides foraging opportunities for shorebirds. Migratory shorebirds that may forage in the mudflats along San Pablo Bay and San Rafael Creek during low tide, as well as the channel banks, include dunlin (*Calidris alpina*), willet (*Tringa semipalmata*), black-necked stilt, American avocet, marbled godwit (*Limosa fedoa*), and several sandpiper species.

During high tide the shallow waters may provide habitat for dabbling ducks such as mallard, northern shoveler, and gadwall; and the deeper waters may provide foraging and resting habitat for grebes, cormorants, and diving ducks.

San Rafael Creek (also referred to as San Rafael Canal) and the nearshore waters of San Rafael Bay provide shallow subtidal and intertidal benthic estuarine habitat for a wide variety of fish, wildlife and invertebrate species. Riprap and other shoreline structures, such as piles, provide some solid substrates. A twelve-month aquatic habitat survey of the Canal and nearshore waters adjacent to Tiscornia Marsh was conducted for the Corps of Engineers by the U.S. Fish and Wildlife Service in 1989 (Weinrich 1990). Benthic samples at the mouth of the Canal yielded numerous polychaete worms, as well as clams and snails. Three species of crabs were found: Dungeness (*Metacarcinus magister*), red rock (*Cancer productus*), and yellow shore crabs (*Hemigrapsus oregonensis*). Twenty-two species of fish were captured in the Canal and in San Rafael Bay during the yearlong survey. The most common species (accounting for 91 percent of the total fish captured) were northern anchovy (*Engraulis mordax*), shiner perch *(Cymatogaster aggregata),* yellowfin goby *(Acanthogobius flavimanus)*, threadfin shad *(Dorosoma petenense)*, and butter sole *(Isopetta isolepis)*. Seventeen species captured are endemic to California waters. Five introduced species were captured: Mississippi silverside (*Menidia audens*), threadfin shad, striped bass (*Morone saxatilis*), yellowfin goby and chameleon goby (*Tridentiger trigonocephalos*). Other aquatic species found included jellyfish, comb jellies, and two species of bay shrimp (Weinrich 1990).

In 2017 Environmental Science Associates (ESA) conducted fish sampling in the (restored) Hamilton Wetlands Preserve, approximately 6 miles north of Tiscornia Marsh. This effort resulted in capture and identification of 1841 individual fish, representing 12 species including native species: northern anchovy, Pacific herring (*Clupea pallasii*), Pacific staghorn sculpin (*Leptocottus armatus*), three-spined stickleback (*Gasterosteus aculeatus*), topsmelt (*Atherinops affinis*), California halibut (*Paralichthys californicus*), and Chinook salmon (*Oncorhynchus tshawytscha*); as well as non-native species: chameleon goby, yellowfin goby, rainwater killifish (*Lucania parva*), Shokihaze goby (*Tridentiger barbatus*), and striped bass (HDR et al. 2017).

3.1.2.4 Pond

One small pond, that appears man-made, occurs in the northwest corner of the Study Area near the San Rafael Canal (see Photo 8 in Appendix A). The open water pond may provide foraging and resting habitat for waterfowl and migrating birds. The pond edges are steep and provide limited cover for wildlife.

3.2 Sensitive Natural Communities

Natural Communities are assemblages of plant species that occur together in the same area and are defined by species composition and relative abundance. Sensitive natural communities are designated by various resource agencies, such as CDFW, or in local policies and regulations, and are generally considered to have important functions or values for wildlife and/or are recognized as declining in extent or distribution, and are considered threatened enough to warrant some level of protection. CDFW tracks communities it believes to be of conservation concern through its

California Sensitive Natural Community List (CDFW 2019, Sawyer et al. 2009). Only those Natural Communities with a rarity ranking of 1 to 3, as well as communities considered sensitive as marked with a 'Y' on the *California Sensitive Natural Community List*, are considered sensitive.

The diked marsh and tidal marsh habitat types, described in Section 3.1.2 above and shown on Figure 3, both contain sensitive natural communities. The diked marsh and mid-high tidal marsh zones are both sensitive natural communities because they are dominated by pickleweed which equates to the Pickleweed Mat Alliance in the California Sensitive Natural Community List (CDFW 2019, Sawyer et al. 2009). The low tidal marsh zone is dominated by California cordgrass which corresponds to the California Cordgrass Marsh Alliance. Both the Pickleweed Mat Alliance and California Cordgrass Marsh Alliance have a State Rarity Ranking of S3.

Eelgrass (*Zostera marina*) is a native marine vascular plant indigenous to the softbottom bays and estuaries and occurs within San Pablo Bay. It has been afforded special management considerations by CDFW, USFWS, NMFS, and BCDC and can be considered a sensitive natural community. This eelgrass species is found from middle Baja California and the Sea of Cortez to northern Alaska along the west coast of North America, and is common in healthy, shallow bays and estuaries. The depth to which this species can grow is a function of light penetration, but it generally occurs within shallow subtidal elevations (Merkel 2014). Small patches of eelgrass have been documented offshore more than 2,500 feet from the Study Area (Merkel 2014). Eelgrass has not been found within the Study Area during past eelgrass surveys and is also not expected to occur within the Study Area due to the tidal waters within the Study Area occurring at intertidal mudflat elevations and not shallow subtidal elevations.

3.3 Potential Waters of the U.S and State

Aquatic resources within the study area that have potential to be considered federally or state jurisdictional include all the aquatic habitat types described above in Section 3.1. However, the exact area and acreage of potentially jurisdictional waters will not be known until an aquatic resources delineation has been completed for the project. These aquatic habitat types (tidal marsh, diked marsh, tidal waters, and pond) are also shown in Figure 3.

3.4 Special-Status Species

A comprehensive list of special-status fish, wildlife and plant species that could occur in the Study Area was compiled to assess the likelihood of species occurrence (see **Appendix B**). Some of these receive specific protection defined in federal or state endangered species legislation. Others have been designated as "sensitive" on the basis of adopted policies and expertise of state resource agencies or organizations with acknowledged expertise, or policies adopted by local governmental agencies such as counties, cities, and special districts to meet local conservation objectives. These species are referred to collectively as "special-status species" in this report. Species with a moderate or high potential to occur in the Study Area are described below in greater detail.

3.4.1 Special-Status Plants

Database information indicates that many special-status plants have been documented in the vicinity of the Study Area, four of which were determined to have moderate likelihood to occur within the Study Area. Summaries of each of these four species is provided below. The remaining species were determined unlikely to occur based on lack of suitable specific habitat conditions (i.e., vernal pools), associated habitat communities are not present (i.e., chaparral), lack of suitable soil conditions, or because the Study Area is below the elevation range of the species.

Point Reyes bird's-beak (*Chloropyron maritimum* ssp. *palustre*) is a California Rare Plant Rank (CRPR) 1B.2 species. Point Reyes bird’s-beak is found in the heavy clay soils of coastal salt marshes of northern San Francisco Bay and occurs at the upper end of tidal zones. It is associated with pickleweed, salt grass, fat hen, and jaumea and is rarely found in non-tidal conditions. Point Reyes bird’s-beak is an annual herb in the broomrape family (Orobanchaceae) that blooms from May to October. It typically occurs in low growing marsh vegetation in coastal salt marshes at elevations ranging from 0 to 30 feet. Point Reyes bird's-beak is known to occur 1.8 miles to the South and 3.2 miles to the north from the Study Area within historic tidal marshes. Potentially suitable tidal marsh habitat exists in the Study Area, however the tidal marsh in the Study Area was recently formed (within the last 50 to 150 years) and therefore likely less biologically diverse than most historic tidal marshes in the area that were formed between 2,000 and 5,000 years ago and potentially less likely to contain rare plants such as Point Reyes bird’s-beak then historic tidal marshes.

Marin knotweed (*Polygonum marinense*), a CRPR 3.1 species, is an annual forb in the knotweed family (Polygonaceae) that blooms from May to August. It typically occurs in salt and brackish marshes between 0 to 30 feet. This species has been documented along the Marin County shoreline 2.7 miles from the Study Area to the north and 1.9 miles to the south in historic tidal marshes. Potentially suitable tidal marsh habitat exists in the Study Area, however the tidal marsh in the Study Area was recently formed and therefore likely less biologically diverse than most historic tidal marshes and potentially less likely to contain rare plants such as Marin knotweed then historic tidal marshes.

Suisun Marsh aster (*Symphyotrichum lentum*), a CRPR 1B.2 species, is a perennial forb in the sunflower family (Asteraceae) that blooms from May to November. It typically occurs along sloughs and channels in dense marsh vegetation in freshwater and coastal brackish marsh habitat at elevations ranging from 0 to 10 feet. The plant is a tall (3 to 6 feet) perennial with fairly large violet heads having ray flowers 10 to 12 mm (half inch) long. Historic occurrences exist along the San Pablo Bay shoreline in Marin, although the most recent observation occurs 4.2 miles from the Study Area across San Pablo Bay. Potentially suitable tidal marsh habitat exists in the Study Area.

Congested-headed hayfield tarplant (*Hemizonia congesta* subsp. *congesta*), a CRPR 1B.2 species, is an annual forb in the sunflower family (Asteraceae) that can have a wide blooming period between April to November. It typically occurs in grassy sites and marsh edges at elevations below 330 feet. Three occurrences exist between 4 and 5 miles to the west and north of the Study Area. Non-native grassland between the trail and diked and tidal marsh provide suitable habitat for this species within the Study Area.

3.4.2 Special-Status Fish and Wildlife

Wildlife species that have a moderate to high likelihood to occur within the Study Area are described below.

3.4.2.1 Fish

California Central Valley and Central California Coast steelhead DPSs. The California Central Valley (CCV) and Central California Coast (CCC) steelhead Distinct Population Segments (DPS) are listed as threatened under FESA. Steelhead possess the ability to spawn repeatedly, maintaining the mechanisms to return to the Pacific Ocean after spawning in freshwater. Juvenile steelhead may spend up to four years residing in freshwater prior to migrating to the ocean as smolts. CCC and CCV steelhead migrate through San Pablo Bay waters in transit between freshwater spawning areas and the Pacific Ocean, and may therefore occur seasonally in the waters of the Study Area.

Sacramento River winter-run, Central Valley spring-run, and Central Valley fall/late fall-run Chinook Salmon ESUs. The population of Chinook salmon in the San Francisco Bay-Delta is comprised of three distinct races: winter-run, spring-run, and fall/late fall-run. These races or evolutionary significant units (ESUs) are distinguished by the seasonal differences in adult upstream migration, spawning, and juvenile downstream migration. Chinook salmon are anadromous fish, spending three to five years at sea before returning to freshwater to spawn. These fish pass through the San Francisco Bay-Delta waters to reach their upstream spawning grounds. In addition, juvenile salmon migrate through San Pablo Bay en route to the Pacific Ocean.

Sacramento River winter-run Chinook salmon, listed as both state and federally endangered, migrate through San Francisco Bay from December through July with a peak in March (Moyle 2002). Spawning is confined to the mainstem Sacramento River and occurs from mid-April through August (Moyle, 2002). Juveniles emerge between July and October, and are resident in their natal stream 5-10 months followed by an indeterminate residency period in estuarine habitats (Moyle, 2002).

The state- and federal-listed threatened Central Valley spring-run Chinook salmon migrate to the Sacramento River from March to September with a peak spawning period between late August and October (Moyle, 2002). Juvenile salmon emerge between November and March, and are resident in streams for a period of 3 to 15 months before migrating to downstream habitats (Moyle, 2002).

The Central Valley fall/late fall-run Chinook salmon is a California species of special concern. These salmon enter the Sacramento and San Joaquin Rivers from June through December and spawn from October through December, with a peak in November. The Central Valley fall/late fall run ESU is generally more common in San Pablo Bay than the Central Valley spring-run and Sacramento River winter-run ESUs.

Adult and juvenile (smolts) winter-run, spring-run, and fall-run Chinook salmon are known to occur in San Pablo Bay and the waters adjacent to the Study Area during migrations to upstream freshwater spawning habitat.

Longfin smelt, a federal candidate for listing, state-listed threatened species, is a small schooling fish that inhabits the freshwater section of the lower Delta and has been observed from south San Francisco Bay to the Delta, with the bulk of the San Francisco Bay population occupying the region between the Carquinez Straight and the Delta. In the fall, adults from San Francisco and San Pablo Bays migrate to fresher water in the Delta to spawn. The larvae are pelagic and found in the upper layers of the water column. Longfin smelt are harvested commercially and sold in local markets. Longfin smelt are known to be present in San Pablo Bay.

Southern DPS of North American green sturgeon is a federal-listed threatened species. This anadromous fish is the most widely distributed member of the sturgeon family and the most marine-oriented of the sturgeon species. Green sturgeons range in the nearshore waters from Mexico to the Bering Sea and are common occupants of bays and estuaries along the western coast of the United States (Moyle et al., 1995). Adult green sturgeons migrate into freshwater beginning in late February with spawning occurring in March through July, with peak activity in April and June. After spawning, juveniles remain in fresh and estuarine waters for 1-4 years and then begin to migrate out to the sea (Moyle et al., 1995). The upper Sacramento River has been identified as the only known spawning habitat for the green sturgeon southern DPS. Green Sturgeon is not expected to use the Study Area as spawning ground; however, they do travel through San Pablo Bay waters and may utilize the Study Area for feeding.

3.4.2.2 Birds

California Ridgway's rail. The California Ridgway's rail (formerly known as the California clapper rail and hereafter RIRA) is a federally endangered, state endangered, and California fully protected species. RIRA is the resident rail subspecies of northern and central California, and is currently restricted to the San Francisco Bay Estuary, with the largest populations occurring in remnant salt marshes of south San Francisco Bay. The RIRA occurs only within salt and brackish marshes. In south and central San Francisco Bay, RIRA typically inhabits salt marshes dominated by pickleweed and cordgrass. Breeding occurs from mid-March through July, with peak activity in late April to late May.

The California Ridgway's rail is a secretive, hen-like waterbird, that lives in salt and brackish tidal marshes in the San Francisco Bay. This species once occupied coastal California tidal marshes from Humboldt Bay southward to Morro Bay, and estuarine marshes of San Francisco Bay and San Pablo Bay to the Carquinez Strait (Raabe et al. 2010). Resident populations are currently limited to San Francisco Bay, San Pablo Bay, Suisun Bay, and associated tidal marshes.

RIRA occur almost exclusively in tidal salt and brackish marshes with unrestricted daily tidal flows, adequate invertebrate prey food supply, well developed tidal channel networks, and suitable nesting and escape cover during extreme high tides (Raabe et al. 2010). RIRA depend on mudflats or very shallow water within a network of tidal channels where there are both abundant invertebrate populations and taller plant material to provide cover, refuge during high tides, nesting opportunities above high tides and wave action, and protection from predators. RIRA rely on marsh plants such as Pacific cordgrass (*Spartina foliosa*), bulrush (*Bolboschoenus maritimus*), and pickleweed for breeding and feeding.

As part of the San Francisco Estuary Invasive Spartina Project, Olafson Environmental Inc (OEI) has conducted annual monitoring of RIRA at treatment sites since 2010. RIRA were detected in Tiscornia Marsh in 2010, 2011, 2012, 2016, 2017, and 2018. Monitoring recorded a highest minimum count of six (6) RIRA in 2016, eleven (11) in 2017, and five (5) in 2018 (OEI 2016, OEI 2018a, OEI 2018b). However, RIRA were not detected during surveys in 2019 (OEI 2020). In its report on the 2017 RIRA monitoring, OEI notes about the Tiscornia Marsh site:

"Surprisingly, this small marsh fragment had one of the highest density rail populations of all sites surveyed by OEI in 2017. The site is small, relatively isolated, and does not support exceptional rail habitat, however it has supported an intermittent population of Ridgway's rails. … It is likely a pair has been successfully breeding at the site since [2016]." (OEI 2018a)

California black rail. Potential breeding habitat for California black rail (state threatened species and California fully protected species) exists in the tidal marsh habitat in the Study Area. This species lives in coastal salt and brackish marshes. Year-round residents, these species stay mainly in the upper to lower zones of coastal marshes that are dominated by pickleweed. Threats to this species include lost and degradation of salt marsh habitat, encroachment of human activities, genetic isolation due to habitat fragmentation, and predation from coyotes, red fox, raptors, possibly river otter, raccoons, and feral cats. California black rail has not been detected during rail surveys within Tiscornia marsh (OEI 2011-2020). Several occurrences are documented within five miles of the Study Area (CDFW 2020). The nearest species occurrence is documented on the north side of the mouth of San Rafael Creek, in 2012 (CDFW 2020).

Northern harrier. This species, like other raptors and birds in general, is protected under California Code 3503 and 3503.5, which prohibits the taking or destroying of any bird or nest in the order of Falconiformes (falcons, kites, and hawks) and Strigiformes (owls). It is also a California species of special concern. Northern harrier nest and forage along wet meadows, slough, savanna, prairie, and marshes, feeding on small mammals, such as California vole and mice. The territory for this species is often a minimum of 10-20 acres of foraging area. Destruction of marsh habitat is the primary reason for the decline of this species. Suitable foraging or nesting habitat for the Northern harrier may occur within or nearby the Study Area.

Saltmarsh common yellowthroat. The common yellowthroat is a small warbler with a complex of subspecies. The salt marsh subspecies is recognized as a distinct breeding population, with geographic distribution, habitats, and subtle differences in morphological traits that distinguish it from other subspecies. It inhabits tidal salt and brackish marshes in winter, but breeds in freshwater to brackish marshes and riparian woodlands during spring to early summer. Nests are placed on or near the ground in dense emergent vegetation or shrubs. The subspecies is a

California species of special concern due to major decline of both habitat and populations in the past decade, but is not currently listed as endangered or threatened. The common yellowthroat is also protected under the Migratory Bird Treaty Act and is a California species of special concern. Suitable habitat for this species may occur within the Study Area.

San Pablo song sparrow is one of three morphologically distinct song sparrow subspecies that occur in the San Francisco Bay region. This particular subspecies is endemic to the marshes fringing San Pablo Bay and is a California species of special concern. San Pablo song sparrow are primarily associated with high marsh, particularly pickleweed, and their territories are densest in areas where tidal channels are lined with gumplant (Shuford et al. 2008). This species was observed foraging and singing within the diked marsh during the reconnaissance-level surveys.

3.4.2.3 Mammals

Salt marsh harvest mouse are small, native rodents that are endemic to the salt marshes and adjacent diked wetlands of San Francisco Bay. Salt marsh harvest mice are listed as federally and state endangered species. This species is considered a California fully protected species. Suitable habitat for salt marsh harvest mouse is present in the tidal and diked marshes in the Study Area. It is anticipated salt marsh harvest mouse will occupy suitable pickleweed and marsh habitats within the Study Area.

The salt marsh harvest mouse (SMHM) is endemic to the marshes which border San Francisco, San Pablo, and Suisun Bays. There are two subspecies of SMHM: the northern subspecies (*Reithrodontomys raviventris halicoetes*) is found in the Marin Peninsula and San Pablo and Suisun Bays (Shellhammer 2000). The southern (*R. r. raviventris*) lives in the marshes of Corte Madera, Richmond and South San Francisco Bay (Shellhammer 2000). Occurrence of both subspecies within this small range is highly fragmented.

The primary habitat of the SMHM is the middle to upper zone of salt and brackish marshes. The SMHM is dependent on dense vegetation cover, usually in the form of pickleweed (*Salicornia pacifica*, the dominant salt marsh vegetation in the Bay) and other salt dependent or salt tolerant vegetation. Optimal SMHM habitat has dense vegetative cover, with a high percentage cover of pickleweed, and has contiguous dense and tall cover in which the mice can escape extreme water levels without excessive exposure to predation. SMHM may also move into grasslands adjacent to marshes during extreme high tides if dense cover is present. The mouse is largely herbivorous with pickleweed known to be its primary food source. Loss of habitat due to the diking and filling of wetlands has been the major factor contributing to the decline of the SMHM.

Trapping studies conducted in 1990 for the US Army Corps of Engineers resulted in capture of fourteen SMHM in Tiscornia Marsh and fifteen in the adjacent diked wetland in Pickleweed Park (Flannery and Bias 1990 as reported in USACE 1992). No other records of recent captures or trapping efforts in the area have been found, however based upon habitat suitability, resource agencies would likely assume presence of this species for the purposes of Project environmental compliance.

3.5 Wildlife Movement Corridors

Wildlife movement corridors link together areas of suitable wildlife habitat that are otherwise separated by rugged terrain, changes in vegetation, or by areas of human disturbance or urban development. Topography and other natural factors in combination with urbanization can fragment or separate large open-space areas. The fragmentation of natural habitat can create isolated "islands" of vegetation and habitat that may not provide sufficient area to accommodate sustainable populations and can adversely impact genetic and species diversity. The retention of wildlife movement corridors ameliorates the effects of such fragmentation by allowing animals to move between remaining habitats, which in turn allows depleted populations to be replenished. Such movement may also promote genetic exchange between separated populations.

The study area is not part of major or local wildlife corridor/travel routes according to the CDFW's Essential Habitat Connectivity natural landscape blocks. The Study Area has limited connectivity opportunity since the upland areas surrounding the Study Area are developed neighborhoods. The Study Area is located over a mile to the south of China Camp State Park, which is the closest natural landscape block to the Study Area (CDFW 2017).

3.6 Critical Habitat for Listed Fish and Wildlife Species

Critical habitat is a term defined in the FESA as a specific geographic area that contains features essential for the conservation of a threatened or endangered species and that may require special management and protection. The FESA 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 FESA 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.

The National Marine Fisheries Services (NMFS) designated critical habitat for Sacramento winter-run Chinook salmon on June 16, 1993 (NMFS 1993), Central Valley spring-run Chinook salmon, central California coast steelhead and California Central Valley steelhead, on September 2, 2005 (NMFS, 2005) and for green sturgeon on October 9, 2009 (NMFS 2009). Open water habitat of San Pablo Bay is designated as critical habitat for winter-run Chinook salmon, spring-run Chinook salmon, central California coast steelhead, Central Valley steelhead, and green sturgeon.

3.6.1 Federal Essential Fish Habitat

The Sustainable Fisheries Act of 1996 (Public Law 104-297), amended the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) to establish new requirements for Essential Fish Habitat (EFH) descriptions in federal Fisheries Management Plans (FMPs) and to require federal agencies to consult with the NMFS on activities that may adversely affect EFH. The Magnuson-Stevens Act requires all fishery management councils to amend their FMPs to describe and identify EFH for each managed fishery. The Act also requires consultation for all federal agency actions that may adversely affect EFH (i.e., direct versus indirect effects); it does not distinguish between actions in EFH and actions outside EFH. Any reasonable attempt to encourage the conservation of EFH must take into account actions that occur outside of EFH, such as upstream and upslope activities that may have an adverse effect on EFH. Therefore, EFH consultation with NMFS is required by federal agencies undertaking, permitting, or funding activities that may adversely affect EFH, regardless of the activity's location. Under section 305(b)(4) of the Magnuson-Stevens Act, NMFS is required to provide EFH conservation and enhancement recommendations to federal and state agencies for actions that adversely affect EFH. However, state agencies and private parties are not required to consult with NMFS unless state or private actions require a federal permit or receive federal funding. Although the concept of EFH is similar to that of critical habitat under the FESA, measures recommended to protect EFH by NMFS are advisory, not proscriptive.

The bay waters adjacent to the Study Area fall within EFH for multiple species of commercially important fish managed under three federal fisheries management plans (FMPs):

Coastal Pelagic EFH: The Coastal Pelagic FMP is designed to protect habitat for a variety of fish species that are associated with open coastal waters. Fish managed under this plan include planktivores and their predators. Those commonly found in San Pablo and Suisun Bay include Northern anchovy and Pacific sardine.

Pacific Groundfish EFH: The Pacific Groundfish FMP is designed to protect habitat for more than 90 species of fish, including rockfish, flatfish, roundfish, some sharks and skates, and other species that associate with the underwater substrate. Multiple species are reported in recent years as present in San Pablo and Suisun Bay waters, including English sole and starry flounder.

Pacific Salmon EFH: The Pacific Salmon FMP is designed to protect habitat for commercially important salmonid species. Sacramento Chinook salmon is the only one of these species that may be seasonally present in the Study Area, although historically Coho salmon were once common in San Francisco Bay.

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CHAPTER 4
Regulatory Considerations

Based on the Project Description (Section 1.3), Regulatory Context (Section 1.4), and Environmental Setting (Chapter 3), the anticipated regulatory permits and consultations that will be needed for the Project related to biological resources are shown in **Table 2** below. This list of potential permitting requirements is preliminary and may change based upon pre-application coordination with the regulatory agencies through the San Francisco Bay Restoration Regulatory Integration Team (BRRIT) and/or on the project design development.

TABLE 2
ANTICIPATED REGULATORY REQUIREMENTS RELATED TO BIOLOGICAL RESOURCES

Agency	Governing Regulation	Key Permit Triggers	Potential Requirement*
Federal			
U.S. Army Corps of Engineers	Clean Water Act Section 404, Rivers and Harbors Act Section 10	Section 404: Activities that take place in Waters of the United States (WOTUS), including the placement of dredged or fill materials. Section 10: Structures and work beneath, in, or over navigable waters.	Nationwide or Individual Permit
U.S. Fish and Wildlife Service	Endangered Species Act, Fish & Wildlife Coordination Act (FWCA), Migratory Bird Treaty Act (MBTA)	Consultation is triggered when there is federal agency approval (CWA Section 404, RHA Section 10) or funding and project would result in potential adverse effects on federally-listed wildlife species and critical habitat. California Ridgway's rail and salt marsh harvest mouse habitat present at the site.	FESA Section 7 Consultation
National Marine Fisheries Service	Endangered Species Act and Magnuson-Stevens Fishery Conservation and Management Act	Consultation is triggered when there is federal agency approval (CWA Section 404, RHA Section 10) or funding, and project would result in potential adverse effects on federally-listed fish or Critical Habitat or Essential Fish Habitats. California central valley and central California coast steelhead, Sacramento River winter-run and central valley spring-run Chinook salmon, longfin smelt, and green sturgeon habitat present at site. Site is within critical habitat for winter-run Chinook salmon, spring-run Chinook salmon, central California coast steelhead, Central Valley steelhead, and green sturgeon. Site is within coastal pelagic, pacific groundfish, and pacific salmon EFH.	FESA Section 7 and Magnuson-Stevens Fishery Conservation and Management Act Consultation
State			
Bay Conservation and Development Commission (BCDC)	McAteer-Petris Act	Filling, dredging, dredged sediment disposal, shoreline development, other work in the Bay or within 100 feet of the shoreline requires a BCDC permit.	Administrative or Major Permit
San Francisco Bay Regional Water Quality Control Board	Clean Water Act Section 401; Porter-Cologne Water Quality Act	CWA Section 401 certification required when a CWA Section 404 or RHA Section 10 permit required.	Water Quality Certification/Waste Discharge Requirements

* Potential permitting requirements are preliminary and may change during pre-application coordination with the regulatory agencies or as the project design develops.

CHAPTER 5
References and Report Preparation

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5.2 Document Preparation

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Appendix A
Representative Photographs

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Tiscornia Marsh Restoration and Sea Level Rise Adaptation . 160888.1

Photo 1

Developed trail with annual grassland/ruderal vegetation looking north from central part of the Study Area.

Tiscornia Marsh Restoration and Sea Level Rise Adaptation . 160888.1

Photo 2

Annual nonnative grassland just upland of tidal marsh with San Pablo Bay in the background. Photo taken from trail edge in the central part of the Study Area looking southeast.

Tiscornia Marsh Restoration and Sea Level Rise Adaptation . 160888.1

Photo 3

San Rafael Creek tidal waters, mudflat, and tidal marsh and adjacent non-native grassland in the northern section of the Study Area looking north.

Tiscornia Marsh Restoration and Sea Level Rise Adaptation . 160888.1

Photo 4

Developed trail on west side of the Study Area looking southeast at the soccer field (turf), landscaped trees (landscaped), and Al Boro Community Center buildings (developed).

Tiscornia Marsh Restoration and Sea Level Rise Adaptation . 160888.1

Photo 5

Small strip of coastal scrub habitat in the Study Area adjacent to the trail.

Tiscornia Marsh Restoration and Sea Level Rise Adaptation . 160888.1

Photo 6

Tidal marsh and adjacent mudflat along San Pablo Bay in the Study Area.

Tiscornia Marsh Restoration and Sea Level Rise Adaptation . 160888.1

Photo 7

Diked marsh in the Study Area dominated by pickleweed.

Tiscornia Marsh Restoration and Sea Level Rise Adaptation . 160888.1

Photo 8

Small pond within the northwest corner of the Study Area

Appendix B

Special Status Fish, Wildlife, and Plant Species with Potential to Occur in the Tiscornia Marsh Restoration Project

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TABLE 1
SPECIAL-STATUS SPECIES WITH POTENTIAL TO OCCUR IN THE PROJECT AREA

Name	Listing Status	General Habitat Requirements	Potential for Species Occurrence Within the Project Area
Invertebrates			
Western bumble bee (*Bombus occidentalis*)	-/CT	Found in any area with sufficient flowers for nutrition, and underground burrows for nest for the queen.	**Low.** Limited flowering plants present in the developed area surrounding the diked marsh.
San Bruno elfin butterfly (*Callophrys mossii bayensis*)	FE/--	Coastal, mountainous areas with grassy ground cover, mainly in the vicinity of San Bruno Mountain, San Mateo County. Colonies are on steep, north-facing slopes within the fog belt. Larval host plant is *Sedum spathulifolium*.	**Absent.** Project area outside species' known distribution.
Callippe silverspot butterfly (*Speyeria callippe callippe*)	FE/--	Host plant is *Viola pedunculata*. Most adults found on East-facing slopes; males congregate on hilltops in search of females.	**Absent.** Suitable habitat not found in Project area.
California freshwater shrimp (*Syncaris pacifica*)	FE/SE	Shallow pools away from main streamflow. Winter: undercut banks with exposed roots. Summer: leafy branches touching water.	**Absent.** Suitable habitat not found in Project area.
Amphibians			
California giant salamander (*Dicamptodon ensatus*)	--/SSC	Vernal or temporary pools in annual grasslands, or open stages of woodlands. Typically adults use mammal burrows.	**Low**. Project area is isolated and surrounded by development; aquatic conditions are too saline for this species.
California red-legged frog (*Rana draytonii*)	FT/SSC	Streams, freshwater pools, and ponds with overhanging vegetation. Also found in woods adjacent to streams. Requires permanent or ephemeral water sources such as reservoirs and slow moving streams and needs pools of >0.5 m depth for breeding.	**Low**. Project area is isolated and surrounded by development; aquatic conditions are too saline for this species.
Foothill yellow-legged frog (*Rana boylii*)	--/SSC	Partly-shaded, shallow streams & riffles with a rocky substrate in a variety of habitats; requires at least some cobble-sized substrate for egg-laying.	**Low.** Suitable habitat lacking in the Project area.
Fish			
North American green sturgeon southern DPS (*Acipenser medirostris*)	FT/SSC	Spawns in Sacramento River. Known to rear and forage in the San Francisco Bay-Delta.	**Moderate.** Migrates within San Pablo Bay, so may occasionally stray into Study Area.
Tidewater goby (*Eucyclogobius newberryi*)	FE/SSC	Found in shallow lagoons and lower stream reaches, they need fairly still but not stagnant water & high oxygen levels	**Absent.** Presumed extirpated from San Francisco Bay.
Chinook salmon – fall/late fall-run ESU (*Oncorhynchus tshawytscha*)	--/SSC	Migrate through San Pablo Bay from spawning grounds in Central Valley rivers. Require beds of loose, silt-free, coarse gravel for spawning. Also need cover, cool water & sufficient dissolved oxygen.	**Moderate.** Migrates within San Pablo Bay, so may occasionally stray into Study Area.
Chinook salmon -Sacramento River winter-run ESU *(Oncorhynchus tshawytscha*)	FE/CE	Spawns and rears in Sacramento River and tributaries where gravelly substrate and shaded riparian habitat occurs.	**Low.** Migrates within San Pablo Bay, so may occasionally stray into Study Area.

Name	Listing Status	General Habitat Requirements	Potential for Species Occurrence Within the Project Area
Chinook salmon - Central Valley spring-run ESU (*Oncorhynchus tshawytscha*)	FT/CT	Spawns and rears in Sacramento River and tributaries where gravelly substrate and shaded riparian habitat occurs.	**Low.** Migrates within San Pablo Bay, so may occasionally stray into Study Area.
Steelhead – central California Coast DPS (*Oncorhynchus mykiss*)	FT/--	Requires cold, freshwater streams with suitable gravel for spawning. Rears in rivers and tributaries to the San Francisco Bay.	**Moderate.** Occasional steelhead from Corte Madera Creek run or other migrating steelhead may be present in the project area.
Longfin smelt (*Spirinchus thaleichthys*)	FC/ST	Occur in the middle or bottom of water column in salt or brackish water portions of the San Francisco Bay-Delta. Concentrated in Suisun, San Pablo, and North San Francisco Bays.	**Moderate.** Present in San Pablo Bay and may occasionally occur in the project area.
Sacramento splittail (*Pogonichthys macrolepidotus*)	--/SSC	Splittail are adjusted to a wide range of salinities and temperatures and depend on both brackish water for rearing habitat and floodplain/river-edge habitat for spawning.	**Low.** Once abundant throughout the San Francisco Estuary, splittail are now confined to Suisun Bay, Suisun Marsh, and the Napa, Petaluma, and Sacramento River systems.
Reptiles			
Western pond turtle (*Actinemys marmorata*)	--/SSC	Ponds, marshes, rivers, streams, and irrigation ditches with aquatic vegetation <6,000' in elevation. Require basking area and upland habitat for egg laying (sandy banks and open, grassy fields)	**Low.** While adult turtles may use brackish or estuarine water as non-breeding aquatic habitat, the project area is surrounded by development and turtles have not been observed in the watershed.
Birds			
Short-eared owl (*Asio flammeus*)	--/SSC	Found in swamp lands, both fresh and salt; lowland meadows; irrigated alfalfa fields. Tule patches/tall grass needed for nesting/daytime seclusion. Nests on dry ground in depression concealed in vegetation.	**Low.** Suitable open habitat is limited in the Project area due to surrounding development.
Northern spotted owl (*Strix occidentalis caurina*)	FT/ST	In California, the northern spotted owl inhabits a mix of old and younger forests, featuring dense canopy closure of mature trees, abundant logs, standing snags, and live trees with broken tops.	**Absent.** Northern spotted owl activity centers present on the slope of Mt. Tamalpais but suitable forest habitat is not present in the Project area.
Burrowing owl (*Athene cunicularia*)	--/SSC	Nests and forages in low-growing grasslands with burrowing mammals.	**Low**. Project area grasslands are too disturbed to provide suitable habitat. Species occurrences are documented 2.5 miles north of the Project area in Gallinas.
Western snowy plover (*Charadrius alexandrines nivosus*)	FT/SSC	Sandy beaches, salt pond levees & shores of large alkali lakes. Needs sandy, gravelly or friable soils for nesting.	**Low.** Suitable sandy, gravelly soil habitat not found in the project area.
Northern harrier (*Circus cyaneus*)	--/SSC	Nests on ground in shrubby vegetation, usually at marsh edge; nest built of a large mound of sticks in wet areas.	**Moderate.** May forage over Tiscornia marsh. Likely breeds in marshes along San Pablo Bay.
Yellow rail (*Coturnicops noveboracensis*)	-/SSC	Winters in small numbers in brackish and tidal marshes of San Francisco Bay.	**Low.** Species is extremely rare but may winter in coastal marshes of San Pablo Bay.
White-tailed kite (*Elanus leucurus*)	--/CFP	Nests in shrubs and trees adjacent to grasslands, forages over grasslands and agricultural lands	**Present.** Observed foraging over project area marsh.
American peregrine falcon (*Falco peregrinus anatum*)	BCC/CFP	Nest consists of a scrape or a depression on rock, cliff or building ledge over an open site.	**Low.** Suitable foraging habitat in the Project area, but nesting habitat is not present.

Name	Listing Status	General Habitat Requirements	Potential for Species Occurrence Within the Project Area
Salt-marsh common yellowthroat (*Geothylpis thrichas sinuosa*)	--/SSC	In brackish and saline tidal marsh habitat around San Francisco Bay, associated with a high percent cover of rushes (*Scirpus* spp.), Peppergrass (*Leipidium latifolium*), and *Juncus*	**Moderate.** Tidal marsh in project area provides marginal habitat for this species though it is not dense enough for preferred habitat.
California black rail (*Laterallus jamaicensis*)	BCC/ST/ CFP	Found in salt, brackish and freshwater marsh with dense vegetation for nesting habitat.	**Moderate.** Tidal marsh in project area provides marginal habitat for this species, but it has not been detected during rail surveys. One species occurrence is documented nearby (less than 0.5 mile north of the Project area) in 2012. Multiple other occurrences are documented within 5 miles of the Project area.
Bank swallow (*Riparia riparia*)	--/ST	Requires vertical banks/cliffs with fine-textured/sandy soils near streams, rivers, lakes, ocean to dig nesting hole.	**Low.** Suitable habitat not found in the Project area.
Salt-marsh common yellowthroat (*Geothlypis trichas sinuosa*)	BCC/SSC	Requires thick, continuous cover down to water surface for foraging; tall grasses, tule patches, willows for nesting.	**Moderate.** Tidal marsh in project area provides marginal habitat for this species though it is not tall or dense enough for preferred habitat.
Alameda song sparrow (*Melospiza melodia pusillula*)	BCC/SSC	Salt marshes. Inhabits *Salicornia* marshes; nests low in *Grindelia* bushes (high enough to escape high tides) and in *Salicornia*.	**Absent.** Project area outside subspecies' range.
San Pablo song sparrow (*Melospiza melodia samuelis*)	BCC/SSC	Inhabits tidal sloughs in *Salicornia* marshes; nests in *Grindelia* bordering slough channels.	**Present.** Observed foraging and singing within the diked marsh.
Ridgway's rail [California clapper rail] (*Rallus obsoletus*)	FE/SE/CF P	Found in salt and brackish marsh with well-defined tidal channels and dense growth of pickleweed; feeds on invertebrates in mud-bottomed sloughs.	**High.** Known to breed in Pickleweed Park though 2019 surveys were negative. .
California least tern (*Sternula antillarum browni*)	FE/SE	Nest on beaches, mudflats, and sand dunes, usually near shallow estuaries and lagoons with access to open ocean.	**Low.** Suitable beach and dune habitat is not present in the project area.
Mammals			
Pallid bat (*Antrozous pallidus*)	--/SSC	Grasslands, shrublands, woodlands, and forests. Common in arid regions with rocky outcroppings, particularly near water. Roosts in rock crevices, buildings, and under bridges. Very sensitive to disturbance.	**Low.** Although suitable habitat is present in Project area, high levels of disturbance may preclude presence.
Hoary bat (*Lasiurus cinereus*)	--/--/ WBWG Medium	Prefers open habitats or habitat mosaics, with access to trees for cover & open areas or habitat edges for feeding. Roosts in dense foliage of medium to large trees. Feeds primarily on moths. Requires water.	**Low**. Suitable dense foliage for roosting is not present within the Project area, but species may forage there.
Western red bat (*Lasiurus blossevillii*)	WBWG High	Roosts primarily in trees, 2-40 ft aboveground, from sea level up through mixed conifer forests. Prefers habitat edges & mosaics with trees that are protected from above & open below with open areas for foraging.	**Low**. Suitable roost trees are not present within the Project area.
Townsend's big-eared bat (*Corynorhinus townsendii*)	--/SSC	Herbaceous, shrub, and open stages of most habitats with dry, friable soils.	**Low.** Suitable shrub and open habitat is not present within the Project area.

Name	Listing Status	General Habitat Requirements	Potential for Species Occurrence Within the Project Area
San Pablo vole (*Microtus californicus sanpabloensis*)	--/SSC	Constructs burrow in soft soil. Feeds on grasses, sedges and herbs. Forms a network of runways leading from the burrow	**Absent.** Project area outside of species' known range.
Big free-tailed bat (*Nyctinomops macrotis*)	--/SSC	Roost mainly in crevices and rocks in cliffs, but occasionally roosts in buildings, caves, and tree cavities in rugged, rocky habitats in arid landscapes.	**Low.** Suitable arid rocky habitat is not present within the Project area.
Salt-marsh harvest mouse (*Reithrodontomys raviventris*)	FE/SE/ CFP	Pickleweed is primary habitat, but may occur in other marsh vegetation types and in adjacent upland areas. Does not burrow, builds loosely organized nests. Requires higher areas for flood escape.	**High.** Suitable pickleweed marsh habitat within the Project area.
Salt-marsh wandering shrew (*Sorex vagrans halicoetes*)	--/SSC	Medium high marsh 6-8 ft above sea level where abundant driftwood is scattered among *Salicornia*.	**Moderate.** Diked pickleweed marsh habitat within the Project area provides low quality habitat.
American badger (*Taxidea taxus*)	--/SSC	Herbaceous, shrub, and open stages of most habitats with dry, friable soils.	**Low.** No suitable open, dry habitat in the Project area.
Point Reyes jumping mouse (*Zapus trinotatus orarius*)	--/SSC	Primarily in bunch grass marshes on the uplands of Point Reyes. Also present in coastal scrub, grassland, and meadows.	**Absent.** Project area outside of species' known range.
Plants			
Napa false indigo (*Amorpha californica* var. *napensis*)	--/--/1B.2	Broadleafed upland forest, chaparral, or cismontane woodland. Blooms April - July. Elevation up to 2000 meters.	**Low.** No nearby recent occurrences. Landscaped trees within the Project area only provide marginal suitable habitat.
Bent-flowered fiddleneck (*Amsinckia lunaris*)	--/--/1B.2	Cismontane woodland, valley and foothill grassland, and coastal bluff scrub. Blooms March – June. Elevation up to 500 meters.	**Not expected.** Project area is outside species' known distribution.
Franciscan manzanita (*Arctostaphylos franciscana*)	FE/-- /1B.1	Serpentine chaparral. Blooms February - April. Elevation up to 300 meters.	**Not expected.** Project area is outside species' known distribution. No suitable habitat present in the Project area. Only one plant in the wild; others are from cultivation.
Mt. Tamalpais manzanita (*Arctostaphylos montana* subsp. *montana*)	--/--/1B.3	Serpentine chaparral. Blooms February - April. Elevation ranges from 250 – 800 meters.	**Not expected.** No suitable habitat present in the Project area. Project area not within elevation range.
Presidio manzanita (*Arctostaphylos montana* subsp. *ravenii*)	FE/SE/1B .1	Serpentine chaparral. Blooms February - April. Elevation ranges from 60 – 95 meters.	**Not expected.** No suitable habitat present in the Project area. Project area not within elevation range.
Marin manzanita (*Arctostaphylos virgata*)	--/--/1B.2	Sandstone, granite outcrops in chaparral, and conifer forests. Blooms December - March. Elevation up to 500 meters.	**Not expected.** Local occurrences documented in western portion of Ross Valley, but suitable habitat is lacking in the Project area.
Coastal marsh milk-vetch (*Astragalus pycnostachyus* var. *pycnostachyus*)	--/--/1B.2	Coastal marshes, seeps, and adjacent sand. Blooms June – September. Elevation up to 150 meters.	**Low.** Project area outside species' known distribution.
Alkali-milk vetch (*Astragalus tener* var. *tener*)	--/--/1B.2	Alkaline flats, vernally moist meadows. Blooms March – June. Elevation up to 60 meters.	**Not expected.** Project area outside species' known distribution.
Thurber's reed grass (*Calamagrostis crassiglumis*)	--/--/2B.1	Mesic coastal scrub, freshwater marshes and swamps. Blooms May - August. Elevation ranges from 10 – 60 meters.	**Low.** No nearby recent occurrences. Project area not within elevation range.

Name	Listing Status	General Habitat Requirements	Potential for Species Occurrence Within the Project Area
Tiburon mariposa –lily (*Calochortus tiburonensis*)	--/--/1B.1	Open, rocky, slopes in serpentine grassland. Blooms March – June. Elevation up to 150 meters.	**Not Expected.** Endemic to Ring Mtn. Preserve on the Tiburon Peninsula. No suitable habitat within the Project area.
Bristly sedge (*Carex comosa*)	--/--/2B.1	Wet places. Blooms June – September. Elevation ranges from -5-1620 meters.	**Low.** No nearby recent occurrences.
Northern meadow sedge (*Carex praticola*)	--/--/2B.2	Moist to wet meadows, riparian edges, and open forest. Blooms May – July. Elevation up to 3200 meters.	**Low.** Only nearby occurrence is from 1967 on Angel island.
Tiburon paintbrush (*Castilleja affinis* var. *neglecta*)	FE/ST/1B .2	Open serpentine grassland slopes. Blooms April – June. Elevation ranges from 60 – 400 meters.	**Not Expected.** No suitable habitat present in the Project area. Project area not within elevation range.
Johnny-nip (*Castilleja ambigua* ssp. *ambigua*)	--/--/4.2	Coastal bluffs and grasslands. Blooms May – August. Elevation ranges from 0 – 435 meters.	**Low.** Marginal suitable habitat present. Recently documented 6 miles from the Project area.
Nicasio ceanothus (*Ceanothus decornutus*)	--/--/1B.2	Open, rocky serpentine slopes and ridges Blooms March – May. Elevation ranges from 235 - 290 meters.	**Not expected.** No suitable habitat present in the Project area. Project area not within elevation range.
Point Reyes bird's-beak (*Chloropyron maritimum* subsp. *palustre*)	--/--/1B.2	Coastal salt marsh. Blooms May – October. Elevation up to 10 meters.	**Moderate.** Tidal and diked salt marsh provide suitable habitat. Recent occurrence (CNDDB Occurrence #60) is 1.8 miles away from Project area.
Soft salty bird's-beak (*Chloropyron molle* subsp. *molle*)	FE/SR/--	Coastal salt marsh. Blooms July – November. Elevation up to 10 meters.	**Low.** Believed to be extirpated from Marin County. However, the surrounding counties do have recent occurrences and the tidal and diked salt marshes within the Project area provide suitable habitat.
San Francisco Bay spineflower (*Chorizanthe cuspidata* var. *cuspidata*)	--/--/1B.2	Sand. Blooms April – July. Elevation up to 300 meters.	**Low.** Small sandy areas present within the Project area provide marginal suitable habitat. No nearby recent occurrences.
Robust spineflower (*Chorizanthe robusta* var. *robusta*)	FE/-- /1B.1	Sand or gravel. Blooms May – September. Elevation ranges from 10 to 300 meters.	**Low.** Small sandy and gravely areas present within the Project area provide marginal suitable habitat. No nearby recent occurrences.
Franciscan thistle (*Cirsium andrewsii*)	--/--/1B.2	Bluffs, ravines, seeps, and occasionally on serpentine. Blooms May – September. Elevation up to 100 meters.	**Not expected.** No suitable habitat present within Project area. Project area not within elevation range.
Mt. Tamalpais thistle (*Cirsium hydrophilum* var. *vaseyi*)	--/--/1B.2	Serpentine seeps. Blooms June – September. Elevation ranges from 300 – 450 meters.	**Not expected.** No suitable habitat present within Project area. Project area not within elevation range.
Presidio clarkia (*Clarkia franciscana*)	FE/SE/1B .1	Serpentine. Blooms May – June. Elevation ranges from 25 – 335 meters.	**Not expected.** No suitable habitat present within Project area. Project area not within elevation range.
Round-headed Chinese houses (*Collinsia corymbosa*)	--/--/1B.2	Coastal sand dunes. Blooms April – June. Elevation up to 20 meters.	**Not expected.** No suitable habitat present within Project area.
San Francisco collinsia (*Collinsia multicolor*)	--/--/1B.2	Moist, shady scrub and forest. Blooms March – May. Elevation up to 300 meters.	**Not expected.** Project area outside species' known distribution.

Name	Listing Status	General Habitat Requirements	Potential for Species Occurrence Within the Project Area
Western leatherwood (*Dirca occidentalis*)	--/--/1B.2	North or north eastern facing slopes, mixed-evergreen forest to chaparral, generally in fog belt. Blooms November to March. Elevation ranges from 50 – 400 meters.	**Not expected.** Project area not within elevation range. Wooded areas in Project area only provide marginal suitable habitat. No nearby recent occurrences.
Tiburon buckwheat (*Eriogonum luteolum* var. *caninum*)	--/--/1B.2	Serpentine. Blooms May - September. Elevation up to 700 meters.	**Not expected.** No suitable habitat present within Project area.
San Francisco wallflower (*Erysimum franciscanum* var. *crassifolium*)	--/--/4.2	Often serpentinite or granitic, sometimes roadsides. Blooms March to June. Elevation ranges 0-550 meters.	**Not expected.** Most documented occurrences in Marin occur on cliffs or rocky slopes. Along trail in Project area may provide marginal suitable habitat, but preferred substrate not present and no nearby recent occurrences.
Minute pocket moss (*Fissidens pauperculus*)	--/--/1B.2	Damp coastal soil within conifer forests. Elevation ranges from 10 -1024 meters.	**Low.** No suitable habitat present within Project area. Project area not within elevation range.
Fragrant fritillary (*Fritillaria liliacea*)	--/--/1B.2	Heavy soils on open hills and fields near the coast. Blooms from February - April. Elevation up to 400 meters.	**Low.** Non-native grassland only provides marginal suitable habitat. No nearby recent occurrences.
Marin checker lily (*Fritillaria lanceolata* var. *tristulis*)	--/--/1B.1	Coastal scrub, prairie and woodland. Blooms February – May. Elevation ranges from 15-150 meters.	**Low.** Project area not within elevation range. Wooded areas and non-native grassland within Project area only provide marginal suitable habitat.
Blue coast gilia (*Gilia capitata* subsp. *chamissonis*)	--/--/1B.1	Coastal sand hills. Blooms April – June. Elevation up to 185 meters.	**Low.** Small sandy areas present within the Project area provide marginal suitable habitat. No nearby recent occurrences.
Dark-eyed gilia (*Gilia millefoliata*)	--/--/1B.2	Stabilized coastal dunes. Blooms March – July. Elevation up to 10 meters.	**Not expected.** No suitable habitat present within Project area.
San Francisco gumplant (*Grindelia hirsutula* var. *maritima*)	--/--/3.2	Sandy or serpentine slopes and seas bluffs. Blooms June – September. Not recognized by the Jepson Manual. Elevation ranges from 15 – 400 meters.	**Low.** Small sandy areas present within the Project area provide marginal suitable habitat. Project area not within elevation range.
Diablo helianthella (*Helianthella castanea*)	--/--/1B.2	Open, grassy areas. Blooms April – June. Elevation ranges from 60 – 1,300 meters.	**Low.** Project area not within elevation range. Non-native grassland within Project area provides marginal suitable habitat.
Congested-headed hayfield tarplant (*Hemizonia congesta* subsp. *congesta*)	--/--/1B.2	Grassy sites and marsh edges. Blooms April – November. Elevation up to 100 meters.	**Moderate.** Non-native grassland along diked and tidal marsh provide suitable habitat. Recent occurrences (CNDDB occurrence #'s 3, 6 and 49) are within 5 miles or Project area.
Marin western flax (*Hesperolinon congestum*)	FT/ST/1B.1	Serpentine grassland. Blooms April – August. Elevation up to 200 meters.	**Not expected.** No suitable habitat present within Project area.
Santa Cruz tarplant (*Holocarpha macradenia*)	FT/SE/1B.1	Clay soils in grassy areas. Blooms June – November. Elevation up to 200 meters.	**Low.** Non-native grassland in Project area provides suitable habitat, but soils have not yet been studied. Two occurrences (CNDDB occurrence #s 24 and 25) approximately 5 miles away from the Project area; however, one is presumed to be extirpated, and the other has not been visited since 2002.
Kellogg's horkelia (*Horkelia cuneata* var. *sericea*)	--/--/1B.1	Old dunes and coastal sand hills. Blooms April – August. Elevation up to 200 meters.	**Low.** Sandy areas in Project area provide marginal suitable habitat. No nearby recent occurrences.

Name	Listing Status	General Habitat Requirements	Potential for Species Occurrence Within the Project Area
Thin-lobed horkelia (*Horkelia tenuiloba*)	--/--/1B.2	Sandy soils within open chaparral. Blooms April – July. Elvation ranges from 50 – 500 meters.	**Low.** Project area not within elevation range. Sandy areas in Project area provide marginal suitable habitat. Nearest recent occurrence (CNDDB occurrence # 4) is approximately 5 miles awat
Small groundcone (*Kopsiopsis hookeri*)	--/--/2B.3	Open woodland, mixed conifer fores, generally on *Gaultheria shallon*, and occationally on either *Arbutus menziesii* or *Arctostaphylos uva-ursi*. Blooms April – August. Elevation ranges from 120 – 1,435 meters.	**Not expected.** No suitable habitat present within Project area. Project area not within elevation range.
Delta tule pea (*Lathyrus jepsonii* var. *jepsonii*)	--/--/1B.2	Coastal estuarine marshes. Blooms April – August. Elevation up to 30 meters.	**Low.** Tidal marsh provides suitable habitat. However, no occurrences within Marin county.
Beach layia (*Layia carnosa*)	FE/SE/1B.1	Coastal dunes. Blooms April – July. Elevation up to 70 meters.	**Not expected.** No suitable habitat present within Project area.
Rose leptosiphon (*Leptosiphon rosaceus*)	--/--/1B.1	Open, grassy slopes and coast bluffs. Blooms April – June. Elevation up to 100 meters.	**Low.** No nearby recent occurrences. Non-native grassland in Project area provides marginal suitable habitat
San Francisco lessingia (*Lessingia germanorum*)	FE/SE/1B.1	Sandy soils, coastal scrub and remnant dunes. Blooms June – November. Elevation from 25 – 110 meters.	**Not expected.** No nearby recent occurrences. Sandy areas in Project area provides marginal suitable habitat, but Project area not within elevation range.
Woolly headed lessingia (*Lessingia hololeuca*)	--/--/3	Clay, sepentinite soils, coastal scrub, grassland, roadsides. Blooms June – October. Elevation from 15-305 meters.	**Low.** Two recent occurrences within 3 miles of the Project area. Project area provides marginal suitable habitat, but Project area not within elevation range.
Tamalpais lessingia (*Lessingia micradenia* var. *micradenia*)	--/--/1B.2	Thin, gravelly soils of serpentine outcrops and roadcuts. Blooms July – October. Elevation from 60 – 305 meters.	**Low.** No suitable habitat present within Project area.
Mason's lilaeopsis (*Lilaeopsis masonii*)	--/SR/1B.1	Intertidal marshes and streambanks. Blooms June – August. Elevation up to 36 meters.	**Low.** Tidal salt marsh provides suitable habitat, but no nearby recent occurrences. Project area is outside of presumed extent.
Marsh microseris (*Microseris paludosa*)	--/--/1B.2	Moist grassland and open woodland. Blooms April – June. Elevation up to 300 meters.	**Low.** Non-native grassland provides marginal suitable habitat.
Marin County navarretia (*Navarretia rosulata*)	--/--/1B.2	Rocky serpentine areas. Blooms May – July. Elevation from 200 – 600 meters. May – July. 200-635m	**Not expected.** No suitable habitat present within Project area. Project area not within elevation range.
White-rayed pentachaeta (*Pentachaeta bellidiflora*)	FE/SE/1B.1	Grassy or rocky areas. Blooms March – May. Elevation up to 620 meters.	**Low.** Non-native grassland provides marginal suitable habitat. Several extirpated populations nearby. One occurrence (CNDDB occurrence # 14) approximately 3 miles away that was revisited in 2007.
Choris' popcorn-flower (*Plagiobothrys chorisianus* var. *chorisianus*)	--/--/1B.2	Grassy, moist places within ephemeral drainages, coastal scrub or chaparral. Blooms March – June. Elevation up to 650 meters.	**Low.** No nearby recent occurrences. Non-native grassland along margins of marsh provides marginal suitable habitat.
Hairless popcornflower (*Plagiobothrys glaber*)	--/--/1A	Wet, saline to alkaline soils in valleys and coastal marshes. Blooms March – May. Elevation up to 100 meters.	**Not expected.** Presumed extinct in California.

Name	Listing Status	General Habitat Requirements	Potential for Species Occurrence Within the Project Area
North Coast semaphore grass (*Pleuropogon hooverianus*)	--/ST/1B.1	Wet grassy areas. Blooms March – June. Elevation up to 1,300 meters.	**Low.** No nearby recent occurrences. Non-native grassland along margins of marsh provides marginal suitable habitat.
Oregon polemonium (*Polemonium carneum*)	--/--/2B.2	Moist to dry, open areas. Blooms April – June. Elevation up to 1,800 meters.	**Low.** No nearby recent occurrences. Non-native grassland along margins of marsh provides marginal suitable habitat.
Marin knotweed (*Polygonum marinense*)	--/--/3.1	Coastal salt and brackish marshes, swamps. Blooms April – August. Elevation up to 10 meters.	**Moderate.** Tidal salt marsh provides suitable habitat. Three nearby recent occurrences (CNDDB occurrence #s 4, 6 and 20) within 3 miles of Project area.
Tamalpais oak (*Quercus parvula* var. *tamalpaisensis*)	--/--/1B.3	Understory of conifer woodlands. Blooms March – April. Elevation from 100 – 750 meters.	**Not expected.** Project area not within elevation range. No suitable habitat within Project area.
Lobb's aquatic buttercup (Runuculus lobbii)	--/--/4.2	Mesic, ponds, grasslands, vernal pools, woodlands. Blooms February – May. Elevation from 15 – 470 meters.	**Not expected.** No suitable habitat within Project area, mesic areas in Project areas are saline or brackish. Project area not within elevation range.
Abode sanicle (*Sanicula maritima*)	--/--/1B.1	Coastal, grassy, open wet meadows, ravines. Blooms February – May. Elevation from 30 -240 meters.	**Not expected.** Project area not within species' distribution.
Point Reyes checkerbloom (*Sidalcea calycosa* subsp. *rhizomata*)	--/--/1B.2	Freshwater marshes. Blooms May – July. Elevation up to 30 meters.	**Not expected.** No suitable habitat within Project area.
Marin checkerbloom (*Sidalcea hickmanii* subsp. *viridis*)	--/--/1B.1	Dry ridges near coast in serpentine areas. Blooms May – June. Elevation ranges from 50 – 430 meters.	**Not expected.** No suitable habitat within Project area.
Scouler's catchfly (*Silene scouleri* subsp. *scouleri*)	--/--/2B.2	Rocky slopes and coastal bluffs. Blooms March – September. Elevation up to 600 meters.	**Not expected.** No suitable habitat within Project area.
San Francisco campion (*Silene verecunda* subsp. *verecunda*)	--/--/1B.2	Sandy habitats in coastal bluff scrub, chaparral, coastal prairie, coastal scrub, and grassland. Blooms February – August. Elevation ranges from 30 – 645 meters	**Not expected.** Project area outside of species' distribution.
Santa Cruz microseris (*Stebbinsoseris decipiens*)	--/--/1B.2	Open, sandy, shale, or serpentine areas. Blooms April – May. Elevation ranges from 10 – 500 meters.	**Low.** No nearby recent occurrences. Possible marginal suitable sandy areas within non-native grassland.
Mt. Tamalpais jewelflower (*Streptanthus batrachopus*)	--/--/1B.3	Serpentine barrens and chaparral. Blooms April – July. Elevation ranges from 335 – 670 meters.	**Not expected.** No suitable habitat present within Project area. Project area not within elevation range.
Tiburon jewelflower (*Streptanthus glandulosus* ssp. *niger*)	FE/SE/1B.1	Shallow, rocky serpentine slopes in grassland. Blooms May – June. Elevation ranges from 30 – 150 meters.	**Not expected.** No suitable habitat present within Project area. Project area not within elevation range.
Mt. Tamalpais bristly jewelflower (*Streptanthus glandulosus ssp. pulchellus*)	--/--/1B.2	Dry, open grassland, chaparral, open conifer/oak woodland; occasionally on serpentine. Blooms May – August. Elevation ranges from 125 – 670 meters.	**Not expected.** Project area not within elevation range.
Suisun marsh aster (*Symphyotrichum lentum*)	--/--/1B.1	Marshes. Blooms May – November. Elevation ranges up to 300 meters.	**Moderate.** Tidal salt marsh within Project area provides suitable habitat. Recent occurrence (CNDDB occurrence # 147) is approximately 4 miles away from Project area.

Name	Listing Status	General Habitat Requirements	Potential for Species Occurrence Within the Project Area
Two-fork clover (*Trifolium amoenum*)	FE/--/1B.1	Moist, heavy soils in disturbed areas, coastal bluff scrub, and grassland. Blooms April – June. Elevation ranges from 5 – 415 meters.	**Low.** Non-native grassland in Project area provides marginal suitable habitat. Most nearby occurrences have been extirpated.
Saline clover (*Trifolium hydrophilum*)	--/--/1B.2	Salt marshes, open areas in alkaline soils. Blooms April-June. Elevation up to 335 meters.	**Low.** No known occurrences in Marin county. Tidal and diked salt marshes provide suitable habitat.
San Francisco owl's-clover (*Triphysaria floribunda*)	--/--/1B.2	Coastal grassland and serpentine slopes. April-June. 10-160 m.	**Low.** No nearby recent occurrences. Non-native grassland provides marginal suitable habitat.
Coastal triquetrella (*Triquetrella californica*)	--/--/1B.2	Moss. Within 10 miles of the coast. Shaded soil, rocks, sand, or gravel in dry or moist areas. Reported from trails, roadsides, picknick areas, playgrounds, and rock outcrops. Elevation up to 100 meters.	**Low.** Some of the shaded developed recreation areas provide marginal suitable habitat. Recent occurrence (CNDDB occurrence #9) is approximately 3.5 miles away from Project area.

Status Codes:

USFWS (U.S. Fish and Wildlife Service)
- FE = Listed as Endangered by the Federal Government
- FT = Listed as Threatened by the Federal Government.
- FC = Listed as Candidate
- BBC = USFWS Bird of Conservation Concern

CDFW (California Department of Fish and Wildlife)
- SE = Listed as Endangered by the State of California
- ST = Listed as Threatened by the State of California
- CaT = Candidate Threatened by the State of California
- CFP = California Fully Protected species
- SSC = Species of Special Concern
- WBWG = Western Bat Working Group

California Native Plant Society:

List 1A=Plants presumed extinct in California
List 1B=Plants rare, Threatened, or Endangered in California and elsewhere
List 2= Plants rare, Threatened, or Endangered in California but more common elsewhere
List 3= Plants about which more information is needed
List 4= Plants of limited distribution
An extension reflecting the level of threat to each species is appended to each rarity category as follows:
- .1 – Seriously endangered in California
- .2 – Fairly endangered in California
- .3 – Not very endangered in California

Potential to Occur Categories:

Absent/Not Expected = The Project and/or immediate vicinity does not support suitable habitat for a particular species. Project area may be outside of the species' known range.
Low Potential = The Project and/or immediate vicinity only provides limited habitat. In addition, the species' known range may be outside of the Project area.
Moderate Potential = The Project and/or immediate vicinity provides suitable habitat.
High Potential = The Project and/or immediate vicinity provides ideal habitat conditions or the species has been observed.
Present = Species has been recorded within the Project Area or immediate vicinity.

SOURCES: California Department of Fish and Wildlife (CDFW), California Natural Diversity Data Base, 2020. Available online at http://dfg.ca.gov/biogeodata/cnddb/mapsanddata.asp; California Native Plant Society, Inventory or Rare, Threatened and Endangered Plants of California, 2020. Available online at http://www.rareplants.cnps.org/; U.S. Fish and Wildlife Service (USFWS), iPac Information for Planning and Conservation. Online database powered by ECOS Environmental Conservation Online System, 2020. Available online at https://ecos.fws.gov/ipac/.

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Appendix E

Sea-Level Rise Adaptation Technical Guidance Study, Geotechnical Investigation, and Conceptual Design Report

ESA

San Rafael Sea-Level Rise Adaptation Technical Guidance Study

SAN RAFAEL SEA-LEVEL RISE ADAPTATION TECHNICAL GUIDANCE STUDY

Prepared for
City of San Rafael

June 19, 2020

SAN RAFAEL SEA-LEVEL RISE ADAPTATION TECHNICAL GUIDANCE STUDY

Prepared for
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June 19, 2020

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San Rafael Sea-Level Rise Adaptation Technical Guidance Study

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1 STUDY PURPOSE

The City of San Rafael's vibrancy emanates, in part, from the City's ten miles of shoreline along San Francisco Bay. However, when Bay water levels surge above their typical elevations, this shoreline is currently susceptible to overtopping, threatening substantial portions of the City with flooding. In addition, much of the City's stormwater drains through low-lying areas near the shoreline and out to the Bay. This drainage can be impeded by elevated Bay water levels and cause flooding.

These flood hazards will be exacerbated by future sea-level rise. Sea-level rise is a consequence of climate change caused by global increases in greenhouse gas emissions. These gases have and will continue to increase Earth's temperatures. The increased temperatures then cause sea-level rise through thermal expansion of the oceans and melting of ice sheets. Sea-level rise of about eight inches has already occurred in the last century and several feet or more of sea-level rise is projected by the end of this century. By elevating Bay water levels, sea-level rise will increase the frequency and severity of flooding along the City's shoreline.

To plan for these existing and future hazards, the City's Department of Public Works initiated this study, and has collaborated with the City's Department of Community Development and Marin County. The study's goal is to develop a sea-level rise adaptation plan that can be implemented for the benefit of the City and its residents. To meet this goal, this study's objectives are:

- Assess existing flood risk and flood risk that includes future sea-level rise projections
- Develop reasonable and feasible sea-level rise adaptations appropriate to the City's shoreline
- Evaluate adaptation measures to characterize the measures' costs and benefits
- Integrate recommended measures into phased adaptation plan to guide implementation

To achieve these objectives, this study conducted flood hazard mapping and vulnerability assessments for the City shoreline. Based on this assessment, the study recommends adaptation measures for each shoreline region. Adaptation measures that address sea-level rise for the City shoreline will need to be integrated with a larger, regional strategy of flood management and adaptation. Planning for this regional strategy is beyond the scope of this study, but being addressed by other City, County, and Bay area planning efforts.

This study builds on prior countywide and City efforts that identified areas vulnerable to sea-level rise. In particular, the City developed a white paper in 2014 (City of San Rafael, 2014) that identified the need to incorporate sea-level rise into long-term planning efforts and listed opportunity areas for addressing vulnerabilities. The County's BayWAVE study (BVB, 2017) combined flood mapping with public asset data to identify flood hazards throughout the County. This present study advances the BayWAVE mapping by providing vulnerability information at a more granular City scale and City-specific adaptation measures to address these hazards.

2 FLOOD SOURCES, HAZARDS, AND VULNERABILITIES

The foundations for managing for and adapting to flooding are descriptions of how and where flooding occurs and what assets flooding is likely to affect. This section summarizes these factors for the City's shoreline, starting with the flood sources which threaten the City shoreline. San Francisco Bay is the primary flood source of concern, with additional concern from watersheds that drain through the shoreline. These sources can generate flood hazards, which need to be characterized in terms of the area which they can inundate and the depth of inundation. Vulnerability takes another step by considering what assets fall within flood hazard areas and how these assets may be damaged.

2.1 Flooding from San Francisco Bay

2.1.1 Astronomic Tides

Pacific Ocean water levels propagate through the Golden Gate and largely determine water levels in San Francisco Bay. Under typical conditions, ocean water level fluctuations are caused by astronomic tides. As indicated by their name, astronomic tides are generated in the ocean by forces between the earth, the sun, and the moon. These tidal fluctuations are well-understood and can be predicted with high accuracy. The highest astronomic tides of each year are commonly referred to as 'king tides'.

Tidal water level fluctuations are commonly extracted at distinctive phases of the tide and then averaged, to provide representative elevations known as tidal datums. Three common tidal datums are mean higher-high water (MHHW), mean sea level (MSL), and mean lower-low water (MLLW). Tidal datums, measured relative to North American Vertical Datum of 1988[1] (NAVD88), are available from a number of NOAA stations near the San Rafael shoreline, as shown in Table 1. ESA (2018) collected tidal data at Tiscornia Marsh (immediately south of the mouth of San Rafael Creek) in September and October of 2017 and calculated tidal datums based on comparison with the NOAA Richmond gauge and the NOAA (2003) methodology.

This comparison of City tidal datums with NOAA tidal datums confirms that the longer NOAA records and tidal datums can be applied along the City's shoreline.

[1] This study uses the North American Vertical Datum of 1988 (NAVD88) as a reference point for measuring and comparing elevations of water levels, flood management measures, and development subject to flooding.

TABLE 1
TIDAL DATUMS IN VICINITY OF PROJECT SITE

	Nearby NOAA Tidal Datum Elevations (1983-2001 Tidal Epoch) ft NAVD88			Estimated Tiscornia Tidal Datums[4] ft NAVD88
	Richmond[1]	Point San Pedro[2]	Point San Quentin[3]	
Mean Higher High Water (MHHW)	6.06	6.04	5.95	6.06
Mean Sea Level (MSL)	3.26	3.24	3.24	3.24
Mean Lower Low Water (MLLW)	0.00	0.17	0.17	0.17

1 NOAA Station 9414863
2 NOAA Station 9415009
3 NOAA Station 9414873
4 Based on data collected in September and October 2017 by ESA (2018), and methodology of NOAA (2003)

2.1.2 Coastal Flood Events

Flood conditions above the typical astronomic tides are caused by atmospheric and oceanic processes. The processes that raise ocean water levels are mostly associated with winter storm events, so the resulting water level increase is often termed 'storm surge'. Storm-related processes that cause surge are lower atmospheric pressure and wind. In addition, changes in large-scale oceanic circulation, particularly during winters with El Niño conditions, can cause higher-than-normal water levels for several months at a time. Depending on the intensity of each of these processes, as well as their coincident occurrence relative to astronomic tides, storm surge can result in water levels up to three feet higher than just astronomic tides. Winter storm winds can also generate waves that may pose an additional flood hazard, particularly when the waves ride on storm-surge-elevated water surface.

Historical flood events in San Francisco Bay from the last several decades are listed in Table 2, along with the estimated 99%, 10%, and 1% annual chance[2] still water levels. These extreme statistical water levels are based on the hydraulic analysis used by FEMA (2017) for its revised coastal flood mapping and are tabulated in AECOM (2016). As still water levels, they do not include the additional effects of wave runup.

Flood events in February 2017 resulted from high rainfall combined with elevated Bay water levels, leading to peak water levels at the NOAA Richmond (Chevron Pier) gauge reaching 7.9 feet NAVD88 on February 7th and 14th. These events fell between the 99% and 10% annual chance flood level at the site. While water level observations aren't available along the San Rafael shoreline for most time periods, ESA (2018) found that water levels at the NOAA Richmond gauge are similar and are useful as a proxy for water levels along the San Rafael shoreline.

[2] 'Annual chance' refers to the probability of a flood event being equaled or exceeded each year. An alternate naming convention is based on the return interval concept, where the return interval is the inverse of the annual chance. For example, the 99% annual chance may also be called the 1-year event and the 1% annual chance may also be called the 100-year event.

Flood water levels exceeding the 2017 events were recorded in 1998, 2001, 2003, 2005, 2011, and 2014 (Figure 2). The events in 2005 and 1998 fell between the 10% and 1% annual chance water level. Although the Richmond gauge does not have data before 1995, the largest recorded water level at the Presidio gauge in San Francisco occurred during the winter 1982-83 El Niño event, when water levels around the Bay were estimated (USACE, 1984) and thought to yield levels similar to the 1% annual chance water levels throughout the Bay.

TABLE 2
FLOOD WATER LEVELS SINCE 1998 IN SAN FRANCISCO BAY

Annual Chance (Return interval) OR Event	Richmond[4]	San Francisco[5]
Daily (MHHW) [1]	6.1	6.1
99% annual chance (1-year, approx. king tide)[1]	7.3	7.2
February 7, 2017[2]	7.9	7.4
February 14, 2019[3]	7.9	7.5
December 3, 2014	8.0	7.8
January 10, 2001	8.1	8.1
March 20, 2011	8.1	7.7
December 24, 2003	8.3	8.2
10% annual chance (10-year)[1]	8.3	8.3
January 8, 2005	8.5	8.2
February 6, 1998	8.7	8.4
1% annual chance (100-year)[1]	9.5	9.5

[1] Based on AECOM (2016)
[2] Coincident with ~1" precipitation
[3] Coincident with ~ 5" precipitation
[4] NOAA Station 9414863
[5] NOAA Station 9414290

2.2 Flooding from Watersheds

While this study mainly focuses on vulnerability of San Rafael to coastal flooding from the Bay, large rainfall events can occur simultaneously with high tides and storm surge. Elevated Bay water levels may then impede the drainage of creeks and stormwater systems to the Bay, resulting in watershed-sourced flooding more severe than flooding due to watershed or storm surge events on their own.

Runoff reaches the Bay primarily from Las Gallinas Creek and San Rafael Creek (whose lower end is also referred to as the San Rafael Canal). Tributaries Irwin Creek and Mahon Creek drain into San Rafael Creek in downtown, near the Irwin Street crossing. The City's stormwater system also conveys runoff across and from the low-lying land just behind the shoreline, to discharge to the Bay. Because of the low elevations behind the shoreline, pump stations are located throughout the City to lift stormwater into the San Rafael Canal and the Bay.

2.2.1 San Rafael Creek

San Rafael Creek drains a 6.4-square-mile watershed in central and northern San Rafael that is largely urban. The creek drains to the Bay near the Al Boro Community Center and the Marin Yacht Club.

Peak flows are reported by FEMA (2017) and shown in Table 3. The portion of the creek located east of Main Street is oversized for the freshwater runoff conveyed through the creek (Appendix B in ESA, 2018). East of the Highway 101 crossing, the creek is periodically dredged to maintain depths for an active boating community. Flood water levels in the dredged reach nearly match Bay water levels and are relatively unaffected by riverine flood events, indicating that Bay storm surge is the principal flooding source in this reach.

TABLE 3
PEAK RIVERINE DISCHARGE IN LAS GALLINAS AND SAN RAFAEL CREEKS, CUBIC FEET PER SECOND (CFS)

Annual Chance	Las Gallinas Creek North Fork[1]	Las Gallinas Creek South Fork[1]	San Rafael Creek at Grand St[2]	San Rafael Creek at B St[2,3]
1% (100-year event)	1,563	1,596	1,995	1,090
2% (50-year event)	1,377	1,401	1,865	905
10% (10-year event)	923	920	1,430	750
50% (2-year event)	353	340	--	--

1 USACE (2011), ESA (2019)
2 FEMA (2017)
3 Note that this tributary portion of San Rafael Creek is also referred to as Mahon Creek

2.2.2 Lower San Rafael Creek Tributaries

Downtown San Rafael includes two tributary channels that feed into the lower portion of San Rafael Creek. Due to their confluence to San Rafael Creek, both tributaries experience some extent of tidal influence and have segments within the FEMA 100-year flood zone.

Irwin Creek is a small flood control channel contained within earthen embankments and riprap, running north-south underneath of Highway 101. The creek has steep banks and is laterally constrained (approximate width of 30 feet). The creek experiences tidal action from its confluence with San Rafael Creek to approximately as far north as Mission Avenue. The creek's connection with San Rafael Creek is south of 3rd Street, and this portion could be widened in the future, as well as the portion north of the 2nd Street crossing.

Mahon Creek is a tributary to San Rafael Creek with a confluence near the Highway 101 crossing in downtown San Rafael. West of Highway 101, the creek turns south at the City's Old Corporation Yard pump station, and passes under Lincoln Avenue before turning west near the Lindaro pump station. This portion of the creek is tidally-influenced, relatively wide (approximately 100 feet), and has a vegetated slope on both sides, flanked by earthen embankments and a bike path. Upstream from the Lindaro pump station and Anderson Drive crossing, the creek becomes more constrained by development (approximate width of 25 feet) and continues to have tidal influence at least as far as the B Street crossing. The creek is not differentiated from San Rafael Creek by FEMA (2017), which lists flood flows and flood stages from the tidally influenced areas up to the upper watershed (Table 3). Potential widening of a portion of the creek is being considered.

2.2.3 Las Gallinas Creek

Las Gallinas Creek drains a 7.5-square-mile watershed bounded by Lucas Valley Ridge and Sleep Hollow Ridge to the west, the Gallinas Hills to the north, and San Rafael Hill and San Pedro Ridge to the south. The creek has north and south forks which join near the east end of the San Rafael Airport and continue for about 7,000 feet before draining into the Bay. The creek's flood hydrology was studied by USACE (2011) and more recently in conjunction with marsh restoration planning for McInnis Park (ESA 2019). Table 3 lists the peak flow rates for the north and south forks of the creek.

ESA (2019) modeled creek water levels under a range of scenarios including high flows (10- and 100- year fluvial flood events) coincident with Bay storm surge (10- and 100-year coastal water level). This modeling indicates that Bay water levels propagating up the channels are the principal determinant of peak flood water levels along the lower reaches of the creek.

2.3 Sea-Level Rise Projections

The accumulation of human-produced greenhouse gases in the Earth's atmosphere is causing and will continue to cause global warming and climate change. Along the Bay shoreline, climate change will cause sea-level rise due to thermal expansion of the ocean's waters and melting of ice sheets. Over the last century, the tide gauge in San Francisco has recorded sea-level rise of eight inches over the last century (Figure 32). In addition to these observed sea-level rise trends, the best available science, as reviewed specifically for California (Griggs et al., 2017; OPC, 2018), predicts that sea-level rise will continue and accelerate throughout this century and into the next century. Because specifics about future greenhouse gas emissions and climate response are not fully known, the exact sea-level rise scenario that will occur is not precisely known at this time. However, considering a range of all but the most extreme scenario, sea-level rise by 2100 is projected to be between two and nearly seven feet in San Francisco Bay by 2100 (OPC, 2018).

Table 4 lists sea-level rise projections for 2030, 2050, 2070, and 2100 relative to sea level in 2000. The 'likely range' for low risk aversion is estimated to have a 66% chance of occurrence, whereas the medium-high risk aversion range is estimated to have a 0.5% chance of exceedance.

TABLE 4
SEA-LEVEL RISE PROJECTIONS FOR SAN FRANCISCO, IN FEET

Scenario	2030	2050	2070	2100
66% Likely Occurrence: Low Risk Aversion	0.5	1.1	1.5 - 1.9	2.4 – 3.4
0.5% Chance of Exceedance: Medium-High Risk Aversion	0.8	1.9	3.1 – 3.5	5.7 – 6.9

Source: OPC (2018)

Table 5 shows how extreme water levels near San Rafael would change with different amounts of sea-level rise. The table's cells are shaded to indicate correspondence between existing conditions with zero sea-level rise and future conditions. For example, the existing 10-year water level of 8.3 ft NAVD88 will occur with a 1-year return interval with one foot of sea-level rise and with a daily return interval with two feet of sea-level rise. These intervals were chosen to best illustrate the concept with conventional intervals. The County BayWave study (BVB 2017) were based on a intervals based on the metric system (e.g. 50 cm, 100 cm).

TABLE 5
FUTURE WATER LEVELS WITH SEA-LEVEL RISE AT SAN RAFAEL, IN FEET NAVD88

Annual Chance (Return Interval)	0 ft SLR	1 ft SLR	2 ft SLR	3 ft SLR	5 ft SLR
(Daily MHHW)	6.1	7.1	8.1	9.1	11.1
99% annual chance (1-year)	7.3	8.3	9.3	10.3	12.3
10% annual chance (10-year)	8.3	9.3	10.3	11.3	13.3
1% annual chance (100-year)	9.5	10.5	11.5	12.5	14.5

Source: NOAA Station 9414863 and OPC (2018)

In addition to climate change causing sea-level rise, future conditions are also projected to increase precipitation intensity (Swain et al. 2018). This change would likely increase flood hazards from stormwater and creek discharge. However, this aspect of climate change was not characterized for this study.

2.4 Flood Mapping

Flood mapping characterizes the extent and depth of flood hazards from coastal and watershed sources. FEMA conducts mapping nationwide to inform flood management and its flood insurance program. Coastal flood maps for the City were recently updated by FEMA. However, FEMA only considers existing conditions and does not account for sea-level rise in its mapping. To provide an assessment of future conditions, the County's BayWAVE study evaluated flood mapping that includes sea-level rise. This effort also considered vulnerability by tabulating what assets are within areas mapped flood hazard areas.

2.4.1 FEMA

FEMA performed detailed coastal engineering analyses (DHI, 2011) of water levels and waves in San Francisco Bay for the nine San Francisco Bay Area counties. These analyses were then used to revise the Marin County Flood Insurance Study (FIS) and Flood Insurance Rate Map (FIRM) panels along the San Francisco Bay shoreline. For San Rafael, the revised FIRM became effective on March 16, 2016.

Special Flood Hazard Areas (SFHA) mapped on the revised FIRM are shown on Figure 4. None of the City's shoreline levees are accredited as meeting FEMA crest elevation and geotechnical standards. Therefore, FEMA assumes the levees do not protect inland areas from inundation, but do block inland wave propagation. The Base Flood Elevation (BFE), for the 1% annual chance flood event varies along the San Rafael shoreline from elevations 10 to 13 feet NAVD88. The BFEs are derived from the 1-percent-annual-chance Total Water Level (TWL), which includes still water elevation level (SWL) and wave runup. The 1-percent-annual-chance SWL along the San Rafael shoreline is a constant 9.7 feet NAVD88. Therefore, the variability in BFEs is due to varying wave exposure and shoreline geometry. Table 6 lists BFEs along the regions of the San Rafael shoreline considered in this study.

TABLE 6
FEMA COASTAL FLOOD ZONE INFORMATION

Region	FEMA Coastal Transect	BFE (ft NAVD88)
Bayfront South	B69 – B76	10 - 12
Canal South	N/A	10
Canal North	B65 – B67	10 - 13
Loch Lomond	B64	12
Point San Pedro Road	B58 – B61	10 - 12
Las Gallinas	B17 – B20	10 - 12

Source: FEMA (2016)

2.4.2 BayWAVE

2.4.2.1 Flood Hazards

The Marin BayWAVE study provided vulnerability assessments for cities throughout Marin County, including San Rafael (BVB, 2017). This study's vulnerability assessment was based on modeling results from the Coastal Storm Modeling System (CoSMoS), developed by USGS. CoSMoS provides predictions of coastal flood hazards with future sea level rise, whereas FEMA only considers existing conditions. CoSMoS predictions are accessible via the website for the Our Coast, Our Future program.

As described in more detail in Appendix B, the BayWAVE study used the coastal flood hazard mapping predicted by the USGS to map which assets are vulnerable to flooding under a range of future scenarios. The modeled inundation extents and depths are from a two-dimensional numerical model (Ballard et al. 2016). The numerical model's Bay water level predictions have not been fully validated, nor has the model's representation of the City's shoreline elevations been confirmed. These factors probably explain why the BayWAVE mapping for lower water levels (e.g. Scenarios 1 and 3) predict extensive inundated areas that do not correspond to little or no inundation observed during recent events with similar water levels. However, in spite of these sources of uncertainty, the study provides useful screening level assessment, particularly for more extreme conditions anticipated to occur with sea-level rise.

2.4.2.2 Flood Vulnerability

Table 7 lists built assets that were identified as vulnerable by the BayWAVE study for a scenario of peak water level three feet above current MHHW. This is roughly equivalent to the 1% annual chance coastal flood event occurring now or the daily water levels that would occur with three feet of sea-level rise. As part of this project, the vulnerability of these areas to flooding was also compared with other sources, including FEMA's mapping, a site visit with City staff, and a targeted topographic survey of parts of the shoreline. Sections 3.2.1 through 3.2.6 describe vulnerabilities targeted for each of the City's shoreline regions.

TABLE 7
ASSETS VULNERABLE TO FLOODING FOR WATER LEVEL THREE FEET ABOVE CURRENT MHHW

Region	Roads		Example Built Assets Impacted
Bayfront South	Bahia Pl. [L] Bahia Wy. [L]	Bahia Cir. [L] Kerner Blvd. [L]	Businesses adjacent to Francisco and Kerner Blvds
Canal South	Alto St. [L] Amalfi Pl. [L] Bellam Blvd [L] Belvedere St. [L] Canal St. [L] Capri Ct. [L] Castro Ave. [L] Charlotte Dr. [L] Elaine Wy. [L] Fairfax St. [L] Francisco Blvd E [L] Front St. [L] Grand Ave [L] Hwy 101 [C] Hwy 580 [C] Irene St. [L,P]	Larkspur St. [L] Lido Ln. [L] Lisbon St. [L] Louise St. [L] Market St. [L] Medway Rd. [L] Mill St. [L] Novato St. [L] Portofino Rd. [L] Shoreline Path Sonoma St. [L] Sorrento Wy. [L] Tiburon St. [L] Verdi St. [L] Vivian St. [L]	Beach Park Canal Neighborhood Pickleweed Park facilities
Canal North (East of Hwy 101)	Grand Ave [L] Irwin St. [L]	Mooring Rd [L] Sea Wy [L] Summit Ave [L]	Marin Community Clinic Montecito Plaza San Rafael High School San Rafael Yacht Club
Canal North (West of Hwy 101)	Hetherton St. [M] 2nd St. [M] 3rd St. [M] 4th St. [L]	Tamalpais Ave. [L] Francisco Blvd W. [L] Lincoln Ave. [L]	San Rafael Transit Center SMART Rail Station San Rafael Corporate Center Businesses along Francisco Blvd W and South Irwin St.
Loch Lomond	Point San Pedro Rd [L,C]		Loch Lomond Marina
Point San Pedro Rd	Point San Pedro Rd [L,C]		Peacock Gap Park
Las Gallinas	Smith Ranch Airport Rd. [L]		Smith Ranch Airport SMART Rail Marin Lagoon

M = Marin County; C = State; L = Local; P = Private.

Source: MarinMap, CoSMoS

3 FLOOD HAZARD AND VULNERABILITY

As identified by the City of San Rafael (2014), FEMA (2016), and the BayWAVE study (BVB, 2017), parts of San Rafael are already vulnerable to flooding, particularly due to combined high water levels and wave runup in the Bay threatening the shoreline, and watershed runoff that occurs during elevated Bay water levels. Information on existing flood vulnerability was gathered from several sources for this study:

- **FEMA:** The FIRM (effective March 2016) maps flood hazard zones for the 1% and 0.2% annual chance coastal flood events and the FIS (effective August 2017) provides additional details about base flood elevations.
- **BayWAVE Study:** maps of predicted flooding from the USGS CoSMoS model overlaid with publicly available asset data from MarinMap and other sources. This study looked at a range of future sea-level rise scenarios.
- **Coordination with City of San Rafael staff:** ESA met with City staff from the Public Works and Community Planning departments. Public Works staff provided locations of known flood vulnerabilities and met ESA staff on May 2nd, 2019 to tour the sites. Community Planning staff provided information on shoreline developments, sea-level rise planning, and the City's General Plan.
- **Site topographic survey:** ESA performed a targeted RTK GPS topographic survey on May 2nd, 2019. Site photos and elevation data were collected in areas where flooding is known to already occur, and along outboard levees adjacent to the Bay (Appendix A).
- **San Francisco Bay Tidal Datums and Extreme Tides Study:** This study by AECOM (2016) aggregates hydraulic modeling that was conducted for FEMA (DHI, 2011). The modeling hindcasted multiple decades of Bay water levels and was analyzed to estimate tidal datums and extreme water levels along the Bay shoreline.
- **Concurrent planning and restoration efforts:** Ongoing studies provided valuable information on local hydrology and flooding, including the McInnis Marsh Restoration Project Hydraulic Modeling Report (ESA, 2019) and the Tiscornia Marsh Conceptual Design Report (ESA, 2018).

3.1 Shoreline Delineation

The City consists of low-lying areas vulnerable to coastal flooding within the City of San Rafael. Much of the vulnerable areas were built on former tidal marshes (USCS, 1853), which were raised with earthen fill and/or protected by levees to make more suitable for development. However, none of the City's shoreline levees are accredited as meeting FEMA crest elevation and geotechnical standards.

Based on San Rafael's topographic layout, existing shoreline flood protection, flood hazard exposure, and land use, this study defines the six shoreline regions shown in Figure 1. The characteristics used to designate each of these regions are described in the sections below. From south to north, these regions are:

- Bayfront South
- Canal South
- Canal North
- Loch Lomond
- Point San Pedro Road
- Las Gallinas

Other portions of the City border the Bay besides these six areas. However, in these other areas, the land rises steeply from the shoreline and structures are typically several feet or more above the current and future flood hazard elevations. As such, these areas are not considered in this study. However, the vulnerability of these shoreline segments and structures to flooding and erosion should be assessed on a case-by-case basis.

While these six areas do not include all land within the City, many public resources are within these areas that serve portions of the City and region outside of these six areas. For instance, many roads that serve as key transportation corridors, pump stations that convey stormwater from uplands, businesses, and City services are located within the six vulnerable areas.

3.2 Hazard Assessments

3.2.1 Bayfront South

This region comprises the southern shoreline of San Rafael from the mouth of San Rafael Creek to the high ground near Point San Quentin (Figure 5). Except for Tiscornia Marsh on the north end and the interior of the Canalways property, most of this region was built on Bay fill to elevations above high tide elevations, but below the 1% annual chance Bay water level. Its levees were constructed sometime between 1950 and 1968 (Siegel Environmental, 2016). This region's shoreline faces the Bay and is exposed to waves as well as high Bay water levels. The City owns much of this region's shoreline. Low-lying areas on the west side of this region are hydraulically connected to low-lying areas in the next region, Canal South.

The Bayfront South region is protected by levees along the edge of the Spinnaker and Baypoint neighborhoods, Canalways, and other properties to the City's southern boundary (Figure 6). The northern half of this region is shown in more detail in Figure 7, and the southern half in Figure 8.

Based on hazards and vulnerabilities in this area, focus areas for adaptation in this region are:

- **Focus Area BF-1:** The approximately 2,200-foot levee and walkway fronting the Al Boro Community Center, City-owned diked pickleweed marsh, and Schoen Park varies in elevation from about 9 to 13 feet NAVD88. The levee has not qualified for FEMA accreditation criteria for crest elevation and geotechnical specifications. The outboard

FEMA BFE is 10 feet NAVD88. The adjacent marsh provides some protection from wind wave runup and erosion, but the marsh's outboard edge has been eroding at a rate of 1-5 feet per year and will continue to erode without restoration (ESA, 2018).

- **Focus Area BF-2:** The northern shoreline of Spinnaker Point is protected by an unaccredited levee that varies in elevation from about 11 to 12 feet NAVD88 (Figure 6). The local FEMA BFE is 12 feet NAVD88, higher than just Bay water levels alone, indicating that waves contribute to the flood hazard.

- **Focus Area BF-3:** The eastern shoreline of the Spinnaker Point neighborhood is protected by an unaccredited levee with an average elevation of about 12 feet NAVD88, similar to the local BFE, and therefore not providing enough freeboard for accreditation and flood hazards with future sea-level rise. The levee's performance relative to geotechnical accreditation criteria is unknown.

- **Focus Area BF-4:** The unaccredited levee fronting the undeveloped Canalways property has a relatively low crest elevation (between 9 and 10 feet NAVD88) and is vulnerable to overtopping from high Bay water levels and waves. The site also receives runoff from surrounding areas. Canalways is privately-owned property, with much of the site below tidal water levels. Development and a possible extension of Kerner Boulevard has been proposed near the southwest portion of the site.

- **Focus Area BF-5:** East of Kerner Way, between Shoreline Parkway and Grange Avenue, City-owned land along the shoreline includes unaccredited levees and managed wetlands. The levees vary in height, with lower portions vulnerable to wave overtopping for present conditions. The wetlands are connected to the Bay via culverts with hydraulic structures to only allow muted tides within the tidal marshes. The southern wetland is drained by the Piombo pump station. Developed areas behind the levee ranges in height from lower than current high tide to higher than the 100-year still water level even with several feet of sea-level rise.

3.2.2 Canal South

This region includes the area bordered by the southern shoreline of San Rafael Canal and Kerner Boulevard. Due to subsidence, much of this region lies at elevations from 4-7 ft NAVD. These elevations are below high tide elevations and would be inundated daily were it not for the high ground along the canal's south shoreline. Its primary flood hazard stems from coastal Bay flood events, which may be supplemented by high creek and stormwater discharge. Because this area is below typical tidal water levels in the canal, this region depends on pump stations to remove storm water. Most of this shoreline consists of residential private property. Low-lying areas within this region are hydraulically connected to low-lying areas in the prior region, Bayfront South.

The Canal South region (Figure 9) has the greatest number of vulnerable roadways and building assets within the FEMA 1% SFHA (Figure 4). As noted elsewhere (City of San Rafael, 2014;

ESA, 2018), this region also has a high density of low-income and low English-proficiency households.

All along the southern shoreline of San Rafael Creek, this region is vulnerable to flooding from the current 1% annual chance Bay water levels. The eastern portion of the creek shoreline is particularly vulnerable as the area starting from right behind the shoreline, at Canal Street, is lower than the daily high tide and susceptible to substantial inundation depths. Most parcels along the shoreline are privately-owned. Many have building encroaching on the shoreline edge, which obscures the elevation of the shoreline and would complicate flood barrier improvements.

In addition to this overall vulnerability, a focus area for adaption in Canal South is:

- **Focus Area CS-1:** A low-lying portion of the shoreline adjacent to 15 Harbor Street (Figures 10 and 11) has experienced overtopping in recent years (pers. comm. DPW), causing flooding on streets and within adjacent buildings. The shoreline elevations are as low as 7.8 feet NAVD88, lower than multiple observed water levels in the last decade.

3.2.3 Canal North

This region is located along the northern shoreline of San Rafael Creek, from Downtown San Rafael on the west to the Marin Yacht Club and the neighborhoods on Summit Drive and Sea Way to the east (Figure 12). Most of the developed land in this region is above high tide elevations, although some portions at either end are still lower than the 1% annual chance water levels (Figure 13). Its primary flood hazard stems from coastal Bay flood events, which may be supplemented by high creek and stormwater discharge. Like Canal South shoreline, much of this shoreline is at or below the 1% annual chance Bay water level and will face substantially increased flood hazard with future sea-level rise. Vulnerable portions of this region are a mix of publicly and privately owned land and are clustered into two locations: near the Highway 101 crossing over San Rafael Creek (Figure 14) and near the Marin Yacht Club (Figure 15). Based on hazards and vulnerabilities in this area, focus areas for adaptation in this region are:

- **Focus Area CN-1:** The Mahon Creek channel includes a focus area from its connection with San Rafael Creek at Highway 101 to as far upstream as 2nd Street. This segment of the creek is within the FEMA 1% annual chance SFHA. Tidal influence is experienced at least as far upstream as the B Street crossing. Pending coordination with private land owners, this focus area could include private parcels bounded by Mahon Creek to the west, Francisco Blvd W to the east, and the shopping center to the south.

- **Focus Area CN-2:** The Irwin Creek channel includes a focus area spanning from its connection to San Rafael Creek near 3rd street, to as far north as Mission Avenue. This segment was identified by the City as a region experiencing tidal inundation, and could become a pathway for flooding in the future with sea-level rise. Currently, the segment from 2nd Street to San Rafael Creek is mapped within the FEMA 1% annual chance SFHA.

- **Focus Area CN-3:** Mooring Road is a focus area as both a portion of the road and all of the private residences on its southern end are mapped within the FEMA 1% annual chance SFHA. The road forms a narrow peninsula which is bordered on the south by San Rafael Creek and on the north by a yacht harbor. The source of potential flooding is from encroachment by elevated water levels in the creek. Given its location, private residences are at risk from both direct flooding and from flooding of their evacuation route to Point San Pedro Road.

- **Focus Area CN-4:** Near where Highway 101 crosses the canal (Figure 14), flooding is already reported at the intersection of 2nd and Irwin Streets. Based on information from City DPW staff, elevations of the stormwater system, and the known high tide levels, flooding at the intersection can occur due to high Bay water levels that propagate through the storm drain system and are exacerbated with high Bay water levels occur at the same time as precipitation.

- **Focus Area CN-5:** Point San Pedro Road along the Marin Yacht Club harbor (Figure 15) is known to flood every few years due to elevated Bay water levels, with the last documented event in January 2017. The vulnerable area includes a low-lying portion of the road and a drainage system which drains the homes immediately north of the roadway via a culvert under the road.

- **Focus Area CN-6:** Summit Drive experiences flooding near the intersection with Somers Peterson Lane, where a small drainage ditch along the eastern edge of Summit Drive discharges to a dredged arm of San Francisco Bay. The low shoreline elevations here suggest flooding is a result of high tides overtopping the roadway and limiting the conveyance capacity of the drainage ditch (Figure 13).

- **Focus Area CN-7:** The bayward portions of Summit Drive and Sea Way are grouped together into Focus Area CN-7. Flooding likely occurs on Summit Drive from the western shoreline (freeboard deficient) and from high tides backing up a culvert outlet that drains the stormwater network on the roadway. Both Summit Drive and Sea Way contain a number private properties with varying amounts of privately funded flood protection walls (City of San Rafael 2014). A small drainage ditch running along the east side of Sea Way is connected to the Bay via a small tide gate, and the roadway adjacent to the ditch is low (6-7 feet NAVD88), meaning that the homes here would be vulnerable to flooding during high tides if the tide gate were to fail.

3.2.4 Loch Lomond

This region comprises a marina and an adjacent neighborhood between two small headlands (Figure 16). The region's lower portions are above high tides but vulnerable to the 1% annual chance Bay water level and impeded stormwater drainage (Figure 17). Nearby stretches of shoreline are mapped within the FEMA 'VE' zone, signifying additional flood hazard due to wind waves. However, because of the marina's breakwater, the Village at Loch Lomond Marina is designated an 'AE' zone, indicating FEMA considers this area to face limited additional hazard due to wind waves. A portion of the City's storm drain network is vulnerable, and the rest of the vulnerable areas are privately owned.

Based on hazards and vulnerabilities in this area, focus areas for adaptation in this region are:

- **Focus Area LL-1:** The intersection of Point San Pedro Road and Lochinvar Road (Figure 16) experiences occasional flooding, beginning with water first ponding at the intersection's southeast stormwater grate. This flooding could be exacerbated by stormwater drainage being impeded by high Bay water levels. The stormwater drainage network within the Village includes subgrade storage to manage drainage for the 1% annual chance precipitation, even when Bay water levels are elevated too (San Rafael, 2007).

- **Focus Area LL-2:** Much of the Village area is mapped within the FEMA 1% annual chance SFHA, but this mapping appears to be based on older ground surface elevation data, prior to construction of the Village. As part of the development of the Village, the existing grade was raised with fill and the breakwater around the marina was improved. These improvements enabled the new Village structures to apply for and receive a Letter of Map Change indicating their lowest floor elevations are above the BFE. However, these structures will become exposed to 1% annual chance flooding with sea-level rise. In addition, while the new Village structures benefit from being above the current BFE, this section of shoreline does not have a contiguous flood barrier to block coastal flooding from inundating Point San Pedro Road and other adjacent areas which have not been raised.

- **Focus Area LL-3:** This managed wetland is separated from the Bay with low embankments that could be overtopped by king tides. The embankment would be vulnerable to more frequent overtopping and erosion with future sea-level rise. Continued separation of the wetland from the Bay reduces the wetland's capacity to naturally adapt to sea-level rise.

3.2.5 Point San Pedro Road

All of this region is fronted by Point San Pedro Road where it runs through the Glenwood and Peacock Gap neighborhoods (Figure 18.). The roadway is protected by an armored levee that is occasionally overtopped by waves during high Bay water level events, and thereby designated a FEMA 'VE' zone with a BFE of 12 ft NAVD88 (Figure 19). Wave overtopping was documented in 2017 (Appendix A). The road is jointly maintained by the City and County.

Based on hazards and vulnerabilities in this area, focus areas for adaptation in this region are:

- **Focus Area SP-1:** The existing levee along Point San Pedro Road is vulnerable to flooding from combined high tides and wave runup. Wave overtopping has been observed during recent kind tide events, and this will become more common with sea-level rise, threatening to cut off access to the Peacock Gap neighborhood and Point San

Pedro. Between Main Drive and Riviera Drive, the elevation of the unaccredited levee varies from about 9 to 11 feet NAVD88.

- **Focus Area SP-2:** A box culvert under Point San Pedro Road serves as an outlet to the Bay for a drainage channel from the Glenwood neighborhood. Although there is mounting hardware suggesting that a tide gate used to cover the outboard end of this culvert, the culvert currently allows Bay water levels to propagate into the drainage channel unimpeded. This culvert serves as a pathway for coastal flooding to reach the Glenwood neighborhood.

3.2.6 Las Gallinas

This region includes low-lying areas adjacent to the south and north forks of Las Gallinas Creek (Figure 20). Properties in this region are protected by levees that are typically just above the 1% annual chance water level (Figure 21). Flooding along the creek was recently studied by USACE (2013) and ESA (2019). These studies indicate that the highest flood water levels occur during coastal storm surge from the Bay propagating upstream. High riverine discharge events can also raise flood levels, but not to the levels of coastal storm surge. Residences behind the levees are at a range of elevations both below and above the 1% annual chance water level. This area also includes a stretch of the SMART railroad tracks and a small private airport. The levees are on privately-owned land.

Based on hazards and vulnerabilities in this area, focus areas for adaptation in this region are:

- **Focus Area LG-1:** The Contempo Marin mobile home community is mapped within the FEMA 1% SFHA since its surrounding levee is unaccredited. LiDAR data indicates that this levee's crest elevations are typically between 10 to 11 feet NAVD88 and may include some lower portions. These elevations are just above the 1% annual chance water level and would become vulnerable to more frequent events with sea-level rise.

- **Focus Area LG-2:** The SMART rail segment crossing Las Gallinas Creek dips below the 1% annual chance water level for most of its length and its lowest portion may even be below the 99% annual chance king tide event. This vulnerability is mitigated on the west by the levee fronting Contempo Marin and on the east by the levee surrounding the San Rafael Airport. Without these levees on adjacent properties, the lowest portion of the tracks could be inundated annually.

- **Focus Area LG-3:** The Marin Lagoon development is protected by an unaccredited levee along three sides of its perimeter and high ground to the south. While most of the levee's crest appears to be a foot or more above the 1% annual chance water level, the LiDAR data suggest that a short section may dip below this water level. The levee is not high enough to meet FEMA freeboard requirements and its geotechnical properties may also not be sufficient.

4 ADAPTATION MEASURES

This section presents a series of potential adaptation approaches for reducing flood vulnerability along San Rafael's shoreline. In keeping with the format of Section 4, approaches are targeted by region, to account for variability in causes of flooding and regional constraints. Adaptation strategies presented here fall within several categories:

- Raising low-lying portions of the shoreline,
- Installing backflow-prevention devices on culverts that discharge stormwater to the Bay
- Increasing pump station capacity
- Conducting additional targeted local flood studies of combined stormwater runoff and high tides
- Considering marsh restoration combined with construction of setback of levees where opportunities exist
- Incorporate nature-based approaches to complement flood protection measures

The following subsections list the main considerations, outline the proposed strategies, and discuss potential funding sources.

4.1 Considerations

The following considerations were used to develop and initially screen adaptation measures for their suitability along the City shoreline.

4.1.1 Area Affected

The broad and interconnected extent of flooding predicted both by FEMA (2017) for existing conditions and by the BayWAVE Study (BVB 2017) for sea-level rise makes it difficult to precisely rank sites by the area affected. This is because many of the focus sites are affected by the same local cause of flooding (e.g. overtopping of a particular shoreline levee) and have overlapping impact zones. However, in some cases, local topography limits the area of impact, and in other cases, potential blockage of emergency access routes by flooding has the potential for wider impacts. To account for these differences, sites are classified as small-, medium-, or large-impact area based on the area exposed to flood hazard for the 1% annual chance event:

- **Small:** Areas where flooding is limited to fewer than 25 properties
- **Medium:** Areas where flooding could impact 25-100 properties

- **Large:** Areas with larger than 100 properties affected, or where access to an emergency evacuation route would be impacted

4.1.2 Time Frame

While most of the areas discussed in this report are within the 100-year FEMA floodplain, the level of vulnerability varies markedly from region to region. As described in Section 4, some areas are already exposed to flooding from the 99% annual chance event, whereas others face flood hazards from 10% to 1% annual chance events. As discussed in Section 2.3, each foot of sea-level rise will increase the frequency, such that a location exposed to the 1% annual chance today will be exposed to the 10% annual chance with one foot of sea-level rise. For the purpose of this study, we note whether the focus areas are vulnerable in the 'short-term', 'medium-term', or 'long-term':

- **Short-term:** Areas with documented flooding in recent years' high water events, or where the shoreline levels indicate flooding could occur for less than a 10% annual chance flood event.

- **Medium-term:** Areas vulnerable to the 10% to 1% annual chance flood event, or for 99% annual chance events with one foot of sea-level rise.

- **Long-term:** Areas where flooding would be expected to occur for the 1% annual chance flood event with one or more feet of sea-level rise.

None of the focus areas of this study are in the 'long-term' category, since a large number of sites require attention in the near future. However, since this study is likely to be extended in the future, we have included it here at this time. Appendix B discusses potential extents and impacts of flooding for the 1% annual chance flood event for escalating amounts of sea-level rise.

4.1.3 Land Ownership

Much of the low-lying and shorefront areas of the City are privately-owned. While these areas will require coordination with the City and County to address flooding, one of the goals of this initial study is to identify areas that the City can address first to mitigate flood risks under current conditions. Publically-owned parcels allow the City to implement projects in a shorter time frame. In the long-term, a comprehensive strategy for the City's shoreline will require outreach and partnerships with private landowners. Property owners can assist in long-term planning through actions such as development clustering and transfer of development rights. These actions are not explored in this study.

4.1.4 Cost Estimate

While flood management measures can provide definite public benefits, the cost to achieve these benefits is an important consideration. For this study, rough order of magnitude implementation costs ("cost estimate") were developed for the measures which would likely be led by the City. These estimates are based on their conceptual-level descriptions, as described below.

In addition to construction itself, the cost estimates also include related soft costs for engineering, design, and permitting. To account for uncertainties surrounding these costs, the estimates assumes a 30% contingency. The estimates include design and environmental compliance allotments, but do not include environmental mitigation or right-of-way costs. The cost estimates made for this study are rough order of magnitude estimates in 2019 dollars and have an anticipated accuracy range of +50%/-30%. Further design efforts are needed to reduce uncertainties and improve the accuracy of the cost estimate. Appendix C provides additional information about the cost estimates.

4.1.5 Flood Hazard Reduction

The fundamental criteria for flood management is the capacity of a measure or plan to reduce flood hazard to assets in the project area. Many of the areas in San Rafael that are predicted to flood during extreme events are interconnected, making it difficult to say with certainty whether or how much a flood protection measure in one area would be effective, when flooding from adjacent areas could overlap. The City will need to collectively decide what level of protection to build to, and this study does not provide a recommendation for that level of protection. However, to help understand the potential benefit of certain measures, what level of flood protection might be achieved is identified while also noting where the need for more widespread protection is necessary.

4.2 Potential Adaptation Measures

Adaptation measures are summarized in Table 8 and described in more detail in the subsections below.

Table 8
Adaptation Strategies by Region and Focus Area

Focus Area #	Location	Likely/Potential Cause of Flooding	Potential Adaptation Strategy	Area affected[1]	Time-frame[2]	Land Owner-ship	Affects Primary or Secondary Evac. Route?	Cost[3]	Flood Hazard Reduction[4]
City-Wide Measures									
CW-1	Canal Feasibility Study	Much of Canal shoreline currently exposed to 1% annual chance Bay water levels	• Flood barriers (levees, floodwalls) OR • Hydraulic structure & pump station	Large	Short	Private	Yes	$200,000	Protect from 1% annual chance event[4]
CW-2	Sea-level rise zoning overlay	Varies from 99% to 1% annual chance Bay water levels	Guidance on structure elevations, shoreline setback, and/or disclosure	Large	Short	City + Private	Yes	--	Depends on guidance assigned to layer
CW-3	Shoreline pump stations assessment	tbd	Develop and apply protocol for assessing pump station inflows, discharge capacity, and resilience with climate change	Large	Short	City	Yes	$25,000-$150,000	Maintain existing stormwater design criteria
Bayfront South									
BF-1	Al Boro Community Center	Mapped 1% annual chance floodplain. Future flooding potential from wave runup during high tides	Currently being addressed with Measure AA-funded planned restoration of Tiscornia Marsh	Large	Short	City	No	--	Protect from 1% annual chance event[4]
BF-2	Northern shoreline along Spinnaker Point	Mapped 1% annual chance floodplain. Future flooding potential from wave runup during high tides	Raise levee to FEMA-accredited level, to map Spinnaker neighborhood out of floodplain and provide longer-term protection from sea-level rise	Medium/ Large	Medium	City + Private (HOA common areas)	No	$2,200,000-$4,800,000	Protect from 1% annual chance event[4]

Focus Area #	Location	Likely/Potential Cause of Flooding	Potential Adaptation Strategy	Area affected[1]	Time-frame[2]	Land Owner-ship	Affects Primary or Secondary Evac. Route?	Cost[3]	Flood Hazard Reduction[4]
BF-3	Eastern shoreline along Spinnaker Point, in front of Spinnaker Lagoon	Mapped 1% annual chance floodplain. Future flooding potential from wave runup during high tides	• Raise levee to FEMA-accredited level, to map Spinnaker neighborhood out of floodplain and provide longer-term protection from sea-level rise • Restore diked marsh and build setback levee in front of Spinnaker Lagoon	Medium/ Large	Medium	City + Private (diked marsh)	No	$2,200,000-$4,800,000 + marsh restoration	Protect from 1% annual chance event[4]
BF-4	Canalways property	Levee crest below 1% annual chance wave runup elevation and mapped 1% annual chance floodplain. Future flooding potential from wave runup during high tides	Consider long-term restoration plan for Canalways and consider raising levee protecting properties along its western edge as part of Kerner Blvd connection and development (as per General Plan)	Large	Medium	Private (levee and diked marsh) + City (drainage pond)	No	--	Design-dependent
BF-5	East of south Kerner Way	Mapped 1% annual chance floodplain. Future flooding potential from wave runup during high tides	Raise shoreline levee, either along existing alignment or setback levee to also restore portions of tidal wetlands	Large	Medium	City	No	$5,600,000-$12,000,000	Protect from 1% annual chance event[4]
Canal South									
CS-1	Shoreline adjacent to 15 Harbor St	Tidal overtopping of shoreline	Raise low-lying portion of shoreline	Large	Short	Private + City	No	$70,000-$150,000	Protect from 1% annual chance event[4]
Canal North									
CN-1	Mahon Creek	Mapped 1% annual chance floodplain.	Raise shoreline with levee and/or flood wall	Medium/ Large	Medium	Private + City	No	$18,500,000-$39,600,000	Protect from 1% annual chance event[4]
CN-2	Irwin Creek	Mapped 1% annual chance floodplain.	Raise shoreline with flood wall	Medium/ Large	Medium	Private + City	Yes	$7,800,000-$16,800,000	Protect from 1% annual chance event[4]

Focus Area #	Location	Likely/Potential Cause of Flooding	Potential Adaptation Strategy	Area affected[1]	Time-frame[2]	Land Owner-ship	Affects Primary or Secondary Evac. Route?	Cost[3]	Flood Hazard Reduction[4]
CN-3	Mooring Rd	Mapped 1% annual chance floodplain.	Raise roadway to maintain local evacuation route. Coordinate with homeowners on shoreline protection	Small	Medium	Private	No	--	Protect from 1% annual chance event[4]
CN-4	Intersection at 2nd and Irwin St	Tidal flooding through culvert outlet under Hwy 101 (Node HW195)	Install one-way flow valve on Node HW195	Small	Short	City	No	• $15,000-$20,000	Mitigate annual king tide flooding
CN-5	San Pedro Rd at Marin Yacht Club basin	Tidal flooding through culvert outlet (N477). Tidal overtopping at shoreline	• Install one-way flow valve on Node N477. • Raise low-lying portion of shoreline	Medium/ Large	Short	City	Primary	• $15,000-$20,000 • $1,000,000-$2,100,000	• Mitigate annual king tide flooding • Protect from 1% annual chance event[4]
CN-6	Summit Dr near intersection with Sommers Peterson Ln	Tidal flooding onto Summit Dr, possibly exacerbated by stormwater flooding from watershed north of San Pedro Rd and local culverts	• Raise low-lying portion of shoreline • Install one-way flow valve on Node N909	Medium	Short	City	No	• $1,100,000-$2,400,000 • $15,000-$20,000	• Protect from 1% annual chance event[4] • Mitigate annual king tide flooding
CN-7	Sea Way & Summit Neighborhood	SLR exacerbating flooding of low-lying areas	Adaptation strategy that combines engineered solutions for the Summit & Sea Dr communities and restoration of adjacent wetland parcel to the east	Medium	Medium	Private	No	--	• Variable
Loch Lomond									
LL-1	Intersection of San Pedro Rd	Tidal flooding through culvert outlets. Possible combined tidal and	Recommend further study of the cause of flooding at the	Medium	Short	City	Primary	• $30,000-$60,000	tbd

Focus Area #	Location	Likely/Potential Cause of Flooding	Potential Adaptation Strategy	Area affected[1]	Time-frame[2]	Land Owner-ship	Affects Primary or Secondary Evac. Route?	Cost[3]	Flood Hazard Reduction[4]
	and Lochinvar Rd	watershed runoff flooding	intersection to determine phasing of adaptation measures						
LL-2	Loch Lomond shoreline	Mapped 1% annual chance floodplain includes Point San Pedro Road and beyond, and increases with sea-level rise.	Identify alignment for future coastal flood levee that ties off to high ground before development encroaches on open space	Medium	Short	Private	No	--	Protect from 1% annual chance event[4]
LL-3	Loch Lomond eastern managed wetland	Levee erosion and flood overtopping causing unplanned breaching and marsh drowning	Develop wetlands resilience management plan for eastern wetland	Medium	Medium	Private	No	--	Provide 'living shoreline' to complement flood protection
Point San Pedro Road									
SP-1	Shoreline along Point San Pedro Rd from Main Dr to Riviera Dr	Wave overtopping already occurs during high Bay water levels and strong wind	Raise crest elevation via • levee widening (coordinated w/raising path and possible road re-alignment, OR • Floodwall	Large	Medium	City	Primary	• $12,000,000-$27,000,000 • $9,000,000-$20,000,000	Protect from 1% annual chance event[4]
SP-2	Tide gate at Glenwood	None documented. Potential for future flooding during high tides	• Install tide gate at culvert passing under Point San Pedro Rd (Node HW542)	Small	Medium	City	No	• $100,000-$210,000	Protect from 1% annual chance event[4]
Las Gallinas									
LG-1	Contempo Marin	Mapped 1% annual chance coastal floodplain.	• Conduct survey of levee crest and compare to flood water levels to refine flood hazard assessment • Consider (1) raising crest elevation with sheet pile wall or (2) set back mobile homes and raise earthen levee	Medium	Medium	Private	No	--	• n/a • Protect from 1% annual chance event[4]

Focus Area #	Location	Likely/Potential Cause of Flooding	Potential Adaptation Strategy	Area affected[1]	Time-frame[2]	Land Owner-ship	Affects Primary or Secondary Evac. Route?	Cost[3]	Flood Hazard Reduction[4]
LG-2	SMART rail	Mapped 1% annual chance coastal floodplain.	Coordinate with SMART on long-term resilience plan for exposed segment of rail	Large	Medium	Marin & Sonoma Counties	No	--	tbd
LG-3	Marin Lagoon Neighborhood levee	Mapped 1% annual chance coastal floodplain.	• Conduct survey of path crest and compare to flood water levels to refine flood hazard assessment • Consider raising crest elevation with (1) sheet pile wall and/or (2) earthen levee	Medium	Medium	Private	No	--	• n/a • Protect from 1% annual chance event[4]

1 Defined in Section 4.1.1
2 Defined in Section 4.1.2
3 See Appendix C
4 Flooding may still impact the focus area from other adjacent areas. More comprehensive protection needed to mitigate flood risk.

4.2.1 City-wide Measures

Several adaptation focus areas occur in more than one region and have implications across the City, as compared to local benefits to reducing flooding in one region. These city-wide measures include:

Focus Area CW-1: The San Rafael Canal runs through much of the City's low-lying area, and overtopping of the Canal's shoreline can cause inundation in three of the six shoreline regions: Bayfront, Canal North, and Canal South. These regions include substantial City and regional infrastructure, businesses, residences, and City services. In addition, stormwater from the hillside watersheds around the low-lying Canal area flows through the area to pump stations to reach the Bay. Particularly on the south side of the Canal, where there is a large area lower than daily high tides, inundations could be several feet or more during a flood. Substantial portions of the shoreline along the Canal are below the current 1% annual chance water level and will be below the 10% annual chance water level with only one foot of sea-level rise and below the 99% annual chance water level with two feet of sea-level rise. For these reasons, this measure is considered a city-wide measure even though some areas of the City would not be inundated by flooding from the Canal.

To address this flood exposure, there are two potential approaches, which are substantially different and costly. Therefore, the City should invest in a feasibility planning effort to evaluate and select a preferred approach for implementation.

Constructing flood barriers, such as levees and flood walls, is one approach. These barriers would be aligned along the existing shoreline, to raise the shoreline elevation and block overtopping. Many sections of the existing shoreline have encroaching buildings, which would complicate the completion of a continuous flood barrier crest. By keeping the footprint to the existing shoreline, this approach would be less disruptive to the hydraulic connectivity of the Canal, thereby preserving the existing conveyance for creek discharge, boat navigation access, and aquatic ecosystems.

The second approach consists of constructing a large hydraulic structure at the mouth of the Canal. This structure would have large gates which can be opened to allow water exchange when water levels do not threaten flooding and can be closed to block Bay water from entering when floods threaten. Because high Bay water levels and creek discharge are both associated with winter storms and may occur simultaneously, this approach would also require the construction of a very large pump station to convey creek discharge past the structure when it is closed. This approach was evaluated by the US Army Corps of Engineers in the early 1990s (USACE 1992), and while that study did not consider sea-level rise, the study could still be informative for a present-day feasibility study. This hydraulic structure would need to increase its frequency and duration of closure in response to sea-level rise. For example, a structure designed to close for the current 10% annual chance event would need to close nearly every day with two feet of sea-level rise. Other considerations for this approach would include disruptions to boat navigation and aquatic ecosystems.

Focus Area CW-2: As part of its General Plan update, the City's Community Development Department is considering a sea-level rise overlay for the City's zoning map. This overlay would identify properties along the City's shoreline which are vulnerable to sea-level rise and provide additional guidance for development which falls within this overlay. Guidance associated with the overlay zone may include elevation benchmarks for structures, setback from levees, and hazard disclosure. Elevation requirements for structures could be raised several feet higher than the minimum FEMA lowest floor elevation, to account for expected sea-level rise by 2050. Components of this overlay may be applied toward lowering FEMA flood insurance rates in the City via FEMA's Community Rating System program.

Focus Area CW-3: Many of the City's pump stations are located in and pump water from low-lying areas along the shoreline that face greater flood hazard due to sea-level rise. Some of these pump stations also manage runoff from portions of the City at higher elevations. The City should develop a protocol for assessing a pump station's capacity to meet its performance criteria in the face of climate change. Three key assessments are:

- What is the potential for increased inflow to the pump station due to more frequent levee overtopping due to sea-level rise, elevated groundwater levels caused by sea-level rise, and/or increased precipitation due to higher rainfall intensity and frequency?

- Can the pump station provide its design discharge capacity when pumping to Bay or Canal water levels elevated by sea-level rise?

- Is the pump station itself and its supporting infrastructure (e.g. power supply, maintenance access) vulnerable to inundation from greater flood hazards due to sea-level rise?

Once the assessment protocol is developed, the protocol can either be applied across the City's entire stormwater system at once or on a case-by-case basis as individual pump stations are slated for substantial repair and upgrade.

Nature-Based Approaches: Nature-based, or 'living shorelines' approaches include habitats (e.g. coarse beaches, ecotone or 'horizontal' levees, offshore oyster reefs) that complement shoreline flood protection measures by preserving or enhancing existing habitats, recreation, and/or public access. These measures may provide limited flood hazard reduction in the form of wave attenuation and scour protection. However, since nature-based approaches seldom provide enough flood hazard reduction on their own, these approaches are usually combined with structural flood protection such levees and floodwalls.

Since the focus of this study is adapting to flood hazards exacerbated by sea-level rise, these nature-based approaches, whose benefits are focused on habitat, are not detailed for all the focus areas. However, the City should continue to consider incorporating these approaches as flood protection planning advances. Ultimately, their feasibility will have to consider a range of factors including cost, constructability, effect on flooding, geomorphic sustainability, and regulatory considerations.

These approaches have been explored at a conceptual level for the San Rafael shoreline as part of the Resilient by Design Bay Area Challenge (Bionic 2018), by the San Francisco Bay Adaptation Atlas (SFEI and SPUR 2019), by non-profit groups such as Resilient Shore, and as part of City planning efforts (City of San Rafael 2014) and county-wide planning efforts (Point Blue, SFEI, and County of Marin 2019). At Tiscornia Marsh (near the Al Boro Community Center), a planned restoration of the eroding offshore marsh is being considered using beneficially re-used dredge material (ESA 2018). Recent conceptual designs have proposed ecotone levees fronting the Bayfront South area, restoration of the Canalways and Spinnaker marsh areas, and coarse beaches fronting raised levees in front of the Bayfront South and Point San Pedro Road and Loch Lomond areas. A living shorelines test site including native oyster reefs and eelgrass beds near Spinnaker Point is also currently being monitored (Latta and Boyer 2015).

Managed Retreat: In its 2014 climate change white paper (City of San Rafael 2014), the City identified managed retreat as a potential approach for sea-level rise adaptation to be explored further. Retreat entails removing a portion of outboard Bay-fronting levees to allow tidal action in formerly diked areas that were separated from the Bay. Areas of diked wetlands where this could be explored further include the Canalways property (in the Bayfront South region) and the San Rafael Airport (in the Las Gallinas region). Managed retreat has been described by SFEI and SPUR (2019) and envisioned by Bionic (2018) and typically involves building setback levees and other measures to protect built assets situated behind the areas of retreat. This report does not consider managed retreat in detail, given its focus on the large numbers of City-owned areas that are vulnerable to sea-level rise in the short and medium term. Managed retreat should be considered as part of a long-term strategy to adapt to higher amount of sea-level rise anticipated for the end of this century and into the next century.

4.2.2 Bayfront South

The Bayfront South region includes a large portion of the City's Bay-fronting shoreline. Adaptations focus on improving flood protection from the unaccredited levee protecting the interior neighborhoods and businesses from elevated water levels and waves in the Bay. A number of conceptual nature-based approaches (e.g. ecotone levees, coarse beach fronting raised levee) have been proposed to complement flood protection measures for this shoreline and for the diked or muted tidal marshes immediately west of the shoreline trail. The feasibility of including these nature-based approaches should be considered as planning for flood protection advances.

Focus Area BF-1: The City should continue to coordinate with the Marin Audubon Society and the California State Coastal Conservancy on the restoration of Tiscornia Marsh, which includes improvements to about 1,600 feet of the adjacent levee. The conceptual design was funded by the Marin Community Foundation and the current phase, preliminary design and CEQA, is funded by a Measure AA grant. The Al Boro Community Center was also identified by Bionic (2019) as a site for protection and restoration of adjacent marsh areas, as part of its long-term vision for the Resilient by Design Challenge.

Focus Area BF-2: The northern shoreline from the Al Boro Community Center to Spinnaker point has a mix of City (pathway) and private ownership. The current shoreline levee is not

FEMA-accredited, and the City may consider improving this to meet FEMA accreditation standards and sea-level rise. Flooding along this portion of the shoreline would affect a relatively large area, but may be considered as a medium-term priority given the current crest elevation. It would cost approximately $2,200,000 to $4,800,000.

Focus Area BF-3: The eastern shoreline of the Spinnaker neighborhood has a City-owned, unaccredited levee protecting a large number of homes. The managed wetland just inboard of the levee presents an opportunity for a combined project improving both flood protection and wetland habitat. Long-term options include raising the existing outboard levee ($2,200,000 to $4,800,000) or consider pursuing Measure AA funding to set back the levee and improve wetland habitat via increased connectivity between the wetland and the Bay.

Focus Area BF-4: The Canalways property may present a long-term opportunity for protecting the shoreline and improving habitat. The City could collaborate with the landowner and other stakeholders to study the feasibility of alternatives that combine improved flood protection with development and wetlands restoration. Alternatives could consider different alignments for an improved levee, ranging from its present location to landward re-location that enables tidal restoration bayward of the levee. Implementation would be a longer-term effort.

Focus Area BF-5: The southern shoreline east of Kerner Way, between Shoreline Parkway and Grange Avenue, is primarily City-owned land. The existing shoreline levee is not FEMA-accredited, and the City may consider improving this to meet FEMA accreditation standards and sea-level rise. Flooding along this portion of the shoreline would affect commercial development and Interstate 580, but may be considered as a longer-term improvement item as it would have a high cost (at least $8,000,000) and other areas of the shoreline nearby are more vulnerable. Feasibility of setting back one or more sections of the levees that fronts the wetlands should be considered, as this approach offers the potential for restoring full tidal connectivity to the wetlands. This could offset wetlands impacts of levee improvements and also increase the resilience of the wetlands to sea-level rise by increasing sediment delivery to the wetlands.

4.2.3 Canal South

The Canal South region includes the highest density of private and public assets vulnerable to flooding due to the current 1% annual chance event. Developing an approach to this overall vulnerability is addressed in the City-wide measure CW-1 described above. The region may also be susceptible to flooding from the Bayfront South region. In addition, this region has a shoreline low spot which warrants its own adaptation measure:

Focus Area CS-1: The shoreline adjacent to 15 Harbor Street should be raised, in coordination with the local business owners who have already been taking measures in recent years to protect their structures from flood damage. Since this location was identified as one of the major pathways of flooding into the Canal District during high tides, this should be a high priority in the short-term. The length of the low-lying portion of the shoreline is limited, and the expected cost of raising the shoreline would be $70,000 to $150,000.

4.2.4 Canal North

Much of the shoreline in the Canal North region is currently vulnerable to the 1% annual chance event. Developing an approach to this overall vulnerability is addressed in the City-wide measure CW-1 described above. In addition, this region has several low spots which warrants their own adaptation measures:

Focus Area CN-1: Flooding along Mahon Creek should be mitigated by raising its banks. Since a significant portion of its length is laterally constrained, this may require vertical flood walls, although there may be room in some reaches for levees incorporated with the public trails and open space . The cost of improvement would be roughly $18,500,000 to $39,600,000. This assumes flood walls are erected from the Highway 101 crossing to B Street. There may also be restoration opportunities within this reach, although an assessment of restoration potential was not conducted for this study, nor included in the cost estimate.

Focus Area CN-2: Flooding along Irwin Creek should be mitigated by raising its banks. The entire length of the creek within the FEMA 1% SFHA is laterally constrained. Erecting flood walls would cost roughly $7,800,000 to $16,800,000, if placed between 3rd Street and Mission Avenue and minimal interference with the highway and its associated structures. There may also be restoration opportunities within this reach, although an assessment of restoration potential was not conducted for this study, nor included in the cost estimate.

Focus Area CN-3: Mooring Road should be an area for improvements to mitigate flood risk in the medium term. While the shoreline is privately-owned, actions can be taken by the City to preserve the evacuation route to Point San Pedro Road. The City may consider raising the portion of the roadway where possible to protect this evacuation route.

Focus Area CN-4: Flooding at the intersection of 2nd and Irwin streets should be mitigated by installing a one-way flow valve to the outlet that drains stormwater from the intersection to San Rafael Creek. The cost of the improvement would be roughly $15,000 to $20,000. This should be a high priority item, since flooding is already documented during events with high Bay water levels and/or heavy precipitation, and the intersection carries a high volume of traffic.

Focus Area CN-5: Flooding at Point San Pedro Road near the Marin Yacht Club should be mitigated by (1) installing a one-way flow valve on the culvert that drains the homes north of the road, and (2) considering raising low-lying portions of the road. These adaptations would cost $15,000 to 20,000 and $1,000,000-$2,100,000, respectively. Flooding of Point San Pedro Road blocks an emergency evacuation route. It should be considered a high priority for improvement by the City.

Focus Area CN-6: The portion of Summit Drive near its connection to Somers Peterson Lane should be an area of high priority for improvements to mitigate flood risk in the short term, since flooding of this area risks isolating homeowners from evacuation via Point San Pedro Road. We recommend that the City consider: (1) Raising either the roadway or the lowest-lying portion of the shoreline adjacent to the tidal channel, (2) Investigating flooding from the watershed north of Point San Pedro Road into the small drainage ditch on the eastern side of Summit Drive, and/or

(3) Installing a one-way flow valve at Node N909, which could eventually lead to flooding of Summit Drive through the existing stormwater system. The cost of these items is listed in Table 8.

Focus Area CN-7: Since both Summit Dr. and Sea Way are fronted by private homes with varying degrees of flood protection, we advise that the City coordinate with homeowners on a longer-term approach that could potentially tie into a larger project including the adjacent wetlands to the east and west. Given the setting, this could tie together engineering solutions (coordinated shoreline improvements of private properties, investigating feasibility of tide gate in front of the tidal channel), with habitat improvement of the wetland parcels immediately to the west and east (horizontal levees or other nature-based approaches), which could provide opportunities for additional funding mechanisms that would help the planning process (Measure AA grant or others listed in Section 5.3).

4.2.5 Loch Lomond

Much of the shoreline in the Loch Lomond region is currently vulnerable to the 1% annual chance event. Since the site is also the intersection of tides and stormwater drainage from neighborhoods north of Point San Pedro Road, potential measures may need additional study of the site's hydrology. The focus in this region is on a range of stormwater and shoreline protection measures.

Focus Area LL-1: The City should consider a stormwater study to identify the causes of flooding at the intersection of Point San Pedro and Lochinvar Roads and to assess the feasibility of potential flood mitigation measures. The stormwater network in this area collects runoff from neighborhoods north of Point San Pedro Road, includes drainage from the Village development south of Point San Pedro Road that is detained by subsurface storage, and ultimately discharged to the Bay. However, the details of the stormdrain network, the relative importance of watershed runoff versus Bay water levels, and causes of flooding, is not fully understood for present conditions. The gravity-dependent drainage will be further impeded by sea-level rise. Given the potential of the flooding at this location to disrupt emergency evacuation on Point San Pedro Road for nearby residents, this study is recommended as a short-term priority for the City. The cost of the study would be expected to range from $50,000 to $75,000.

Focus Area LL-2: Although recent development in the Village has been raised above the current BFE, these structures will become vulnerable to flooding with sea-level rise. In addition, there is no contiguous flood barrier to protect areas outside of the immediate footprint of the structures, such as Point San Pedro Road. Before development encroaches on the open space along the shoreline, the City should coordinate with the private landowners to determine an alignment for a contiguous flood barrier to address future coastal flood hazards. The ends of this barrier should tie off to high ground. The tradeoffs of aligning the levee landward or bayward of each area, such as the park to the west of the marina, should be considered. Since the breakwater fronting the Loch Lomond Marina provides protection from wind waves for the Village development, its ongoing maintenance and potential improvement to adapt to sea-level rise should be integrated into planning for this flood barrier.

Focus Area LL-3: In its current state, with levees blocking it off from daily tides, the wetland east of the marina and owned by the marina association will be limited in its capacity to naturally adapt to sea-level rise. Wetlands with continuous tidal connectivity can gradually sequester sediment and organic matter to naturally pace sea-level rise. The existing levees limit connectivity to only coastal flood events, which do not promote natural adaptation. With sea-level rise, the levees will face growing threat from erosion and flood overtopping until they eventually fail. An abrupt levee failure, particularly after some sea-level rise that leaves the wetland further lagging in its elevation relative to the tides, could result in excess inundation and marsh plant demise. A wetland adaptation plan should be developed for this wetland. With a planned increase in tidal connectivity, the marsh could more readily pace sea-level rise via its own natural adaptation processes. Enhancing this marsh with increased tidal connectivity could be used to offset wetland impacts from other nearby flood protection measures.

4.2.6 Point San Pedro Road

Adaptations for the Point San Pedro Road region (Figure 18) focus on improving flood protection from the unaccredited levee protecting the roadway and interior neighborhoods from elevated water levels and waves in the Bay. Table 8 summarizes the adaptation measures and rough costs for the region. Although the existing Dutra Quarry at Point San Pedro is not within the City boundaries, it may eventually become an opportunity area for shoreline enhancement and increased resiliency, as it includes an adjacent diked tidal marsh and a small beach.

Focus Area SP-1: Since the shoreline along Point San Pedro Road affects an emergency evacuation corridor and is already subject to wave overtopping when king tides coincide with high winds, improving the shoreline protection should be a near-term priority. The City should conduct further study of the feasibility of two measures: (1) raising the crest elevation via landward levee widening and potential realignment of the road, or (2) installing a flood wall on top of the existing levee. The first measure would likely be costlier and more difficult to plan, but would provide the City more flexibility in the long-term, as flood walls have limited long-term adaptability (i.e. a flood wall can only be raised to a point before they become structurally unsound and can no longer be accredited by FEMA).

Improving the existing shoreline levee to achieve FEMA accreditation would require raising the levee by several feet, increasing the lateral footprint of the shoreline protection, and re-aligning the roadway for a significant portion between Main Drive and Rivera Drive. The roadway appears to have some re-alignment capacity since it is four lanes wide with shoulders and a central median. Re-alignment could also include moving the sidewalk onto the levee crest, preserving some of the shoreline access that would be more impaired by a floodwall. Implementing the flood wall option may be complicated by the extent of removal needed for existing grouted riprap and the reduced visibility from the sidewalk. A rough order of magnitude cost for this effort would be $9,000,000 to $27,000,000. Also, this segment of the City's shoreline was identified by SFEI and SPUR (2019) as a potential area for including complementary nature-based approaches, such as a coarse beach fronting a raised shoreline. These options were not included in the cost estimate.

Focus Area SP-2: The portion of the Glenwood neighborhood that is mapped within the FEMA 1% annual chance floodplain could be better protected by installing a tide gate on the culvert that passes under Point San Pedro Road just west of Knight Drive. Installing a tide gate could limit the propagation of high Bay water levels into the neighborhood, and would be expected to cost $100,000 to $210,000.

4.2.7 Las Gallinas

Adapting to sea-level rise in the Las Gallinas region will require working with private owners of the assets at risk. Ownership of existing flood barriers are predominantly private landowners, and will require coordination between the City, landowners, the SMART Rail district, and the County. Although not analyzed in detail here, the San Rafael airport is surrounded by unaccredited levees and may present an opportunity for long-term adaptation in the future. In particular, less developed portions of the site may provide opportunities for managed retreat and marsh restoration.

Focus Area LG-1: The unaccredited levee protecting the western and northern sides of the Contempo Marin mobile home community has uncertain elevations, and should be surveyed to better understand the vulnerability of the community. Given the proximity of the levee to homes and to the wetlands immediately to the west, opportunities may be limited to raise the levee without encroaching on either space. The owner of the land could consider setting back homes to accommodate a larger levee, adding a flood wall to the existing levee, or a hybrid approach of enlarging the levee and adding a flood wall in more constrained areas. The eastern side of the community is protected by the SMART rail embankment and the levees surrounding the San Rafael Airport, so the community should coordinate both with the SMART Rail authority and the airport on management of these levees.

Focus Area LG-2: The SMART Rail tracks, managed by a joint Sonoma County and Marin County district, are raised on a low embankment. However, since much of this embankment is lower than flood water levels, the tracks also rely upon the Contempo Marin levee and the levee protecting the airport. The City should coordinate with SMART on the long-term resilience plan for this area.

Focus Area LG-3: The raised trail and bike path surrounding the Marin Lagoon neighborhood at the end of McInnis Parkway should be surveyed to better understand the level of flood vulnerability. Similar to the Contempo Marin community, space constraints between the homes and the wetlands along Las Gallinas Creek may limit the potential to raise the levee with additional earth fill. Floodwalls or a hybrid approach of levees and floodwalls may be preferred to protect the path and homes.

4.3 Potential Funding Sources

Implementing adaptation measures will require funding and will likely need to come from supplemental sources besides the City's general fund or local assessments. Collaboration with other stakeholders, such as the ongoing collaboration at Tiscornia Marsh with the Marin Audubon Society and the California State Coastal Conservancy, can support funding efforts. Other funding options to explore are summarized in Table 9 along with web links to the relevant resources.

TABLE 9
POTENTIAL FUNDING SOURCES

Potential Funding Source	Purpose	Additional Information
Flood Mitigation Assistance (FMA)	Reduce or eliminate claims against the NFIP by reducing long-term risk of flood damage to buildings insurable under NFIP	Cal OES http://www.caloes.ca.gov/cal-oes-divisions/hazard-mitigation/pre-disaster-flood-mitigation FEMA https://www.fema.gov/flood-mitigation-assistance-program
Pre-Disaster Mitigation (PDM)	National competitive program focused on mitigation project and planning activities that address multiple natural hazards	Cal OES http://www.caloes.ca.gov/cal-oes-divisions/hazard-mitigation/pre-disaster-flood-mitigation FEMA https://www.fema.gov/pre-disaster-mitigation-grant-program
Repetitive Flood Claims (RFC)	Reduce flood claims against the NFIP through flood mitigation; properties must be currently NFIP insured and have had at least one NFIP claim	FEMA https://www.fema.gov/media-library-data/20130726-1621-20490-8359/rfc_08_guidance_final_10_30_07.pdf
Severe Repetitive Loss (SRL)	Reduce or eliminate the long-term risk of flood damage to SRL residential structures currently insured under the NFIP	FEMA https://www.fema.gov/pdf/nfip/manual201205/content/20_srl.pdf
Hazard Mitigation Grant Program (HMGP)	Activated after a presidential disaster declaration; provides funds on a sliding scale formula based on a percentage of the total federal assistance for a disaster for long-term mitigation measures to reduce vulnerability to natural hazards	Cal OES http://www.caloes.ca.gov/cal-oes-divisions/recovery/disaster-mitigation-technical-support/404-hazard-mitigation-grant-program FEMA https://www.fema.gov/hazard-mitigation-grant-program
Proposition 1 Climate Ready Grants	Climate Ready Grants are focused on supporting planning, project implementation and multi-agency coordination to advance actions that will increase the resilience of coastal communities and ecosystems	Coastal Conservancy http://scc.ca.gov/climate-change/climate-ready-program/
Measure AA	San Francisco Bay-specific program for restoring habitat, protecting communities from floods, and increasing shoreline public access	San Francisco Bay Restoration Authority http://sfbayrestore.org/sf-bay-restoration-authority-grants.php

Potential Funding Source	Purpose	Additional Information
Continuing Authorities Program (CAP)	CAP is to plan, design, and construct flood damage reduction projects. CAP projects do not require project-specific authorization from Congress.	U.S. Army Corps of Engineers, San Francisco District https://www.spn.usace.army.mil/Missions/Projects-and-Programs/Continuing-Authorities-Program/
City of San Rafael Capital Improvement Plan (CIP)	Multi-year planning tool used to identify and implement the City's capital needs over the upcoming 3-year period	City of San Rafael: https://www.cityofsanrafael.org/capital-improvement-program/
Assessment District	An assessment district is a geographic area in which a governing body may apply a charge to real estate parcels to fund public projects that provide a direct benefit to the area.	City of San Rafael: https://www.cityofsanrafael.org/assessment-districts/
Potential Mitigation Fee	Fees that may be collected by the City for new development projects	City of San Rafael: https://www.cityofsanrafael.org/development-impact-fees-information/
Potential Tax Measures	Local tax measures that raise funds for specific public projects	Local; Example, Measure A – Transportation Sales Tax: https://www.cityofsanrafael.org/measure-a-transportation-sales-tax/
Geologic Hazard Abatement District (GHAD)	Independent, state-level public entity to oversee geologic hazard prevention, mitigation, abatement, and control. Typically funded through supplemental property assessments included within a property tax bill	Local; Example for Bay Area use of GHADs from BCDC: https://bcdc.ca.gov/fwg/20170601GeologicHazardAbatement.pdf

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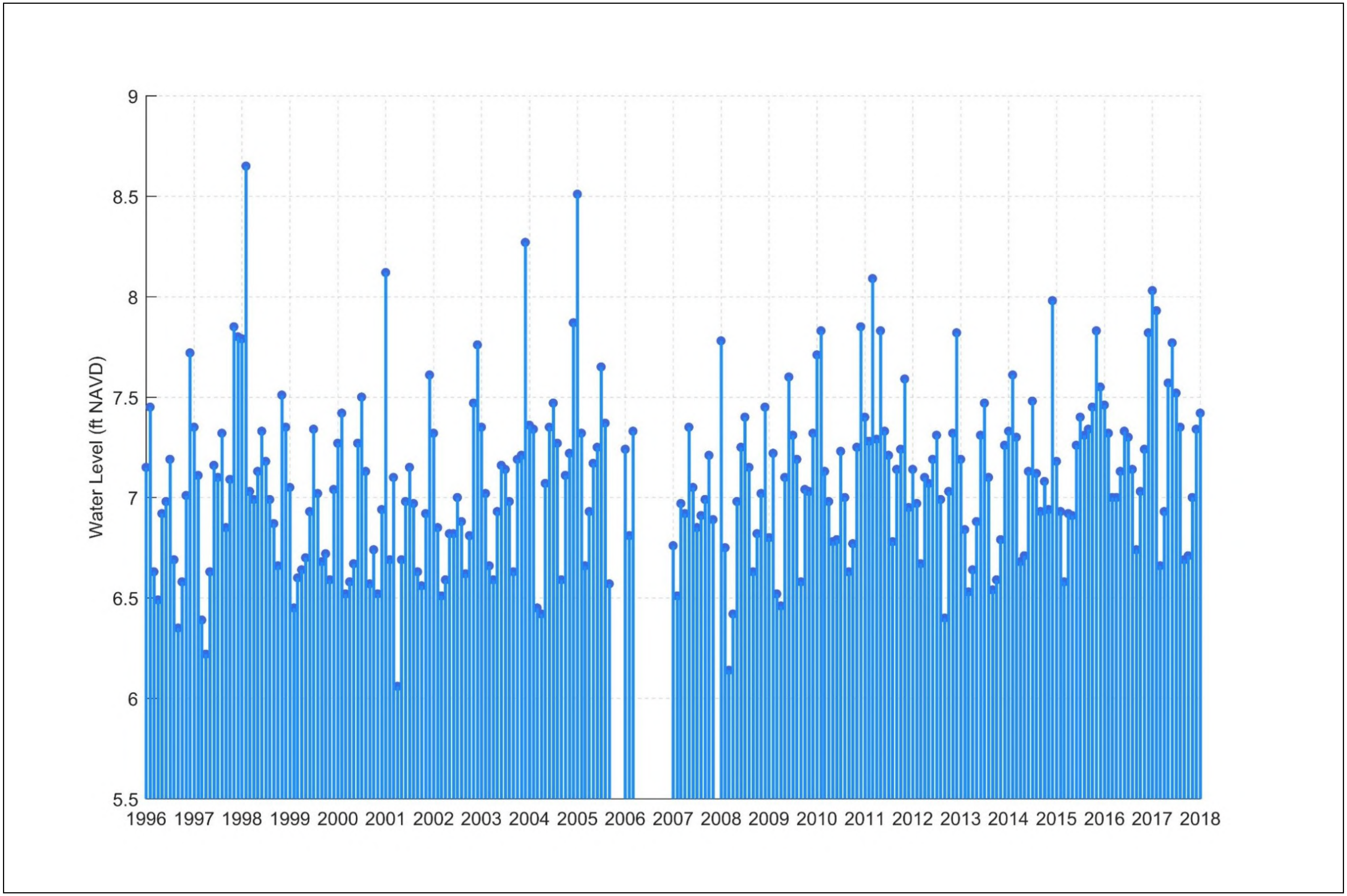
7 FIGURES

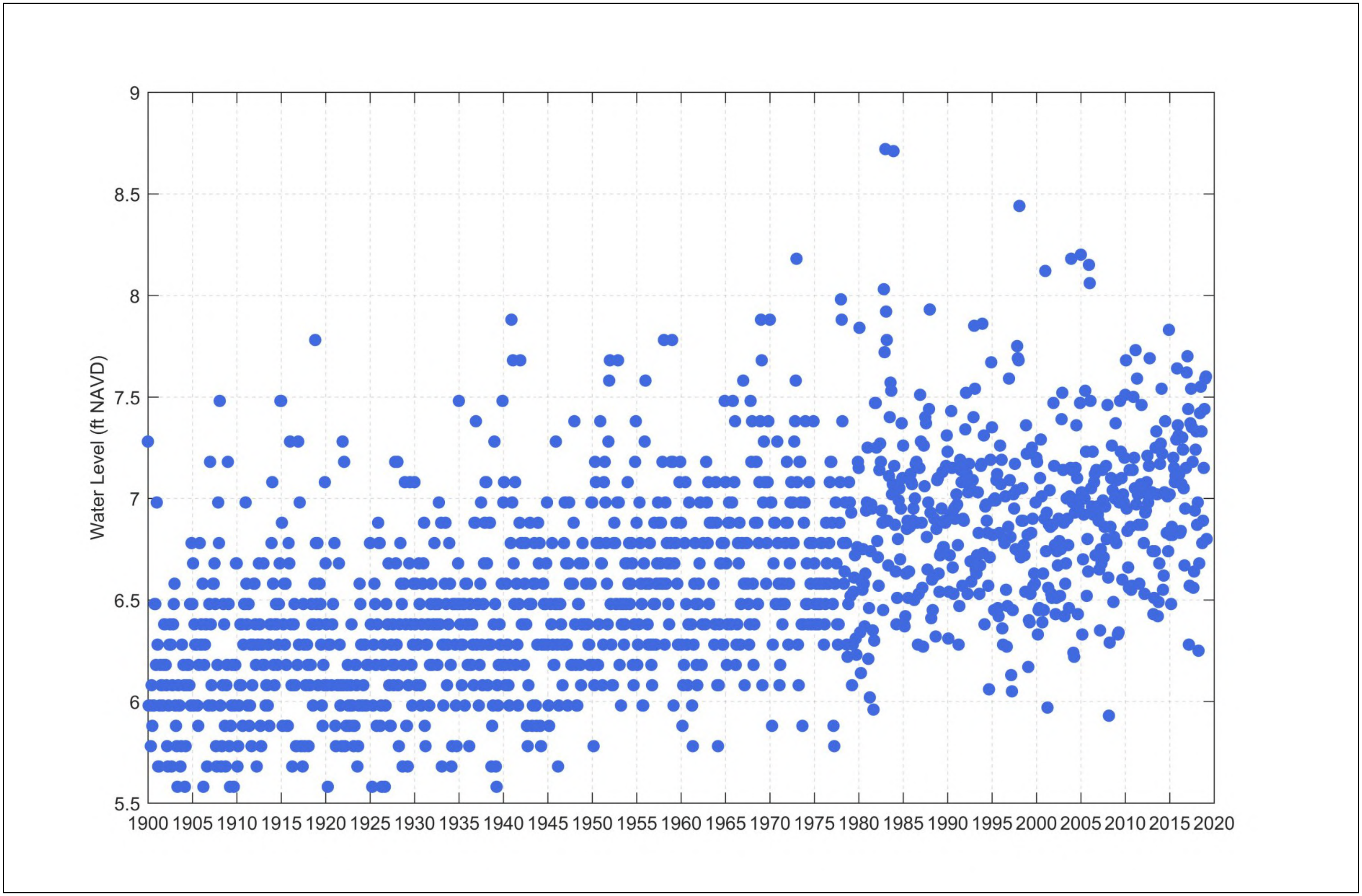


SOURCE: NOAA Station 9414863

San Rafael Sea Level Rise Adaptation Study . D180140.00

Figure 1

Monthly peak water levels measured at NOAA Richmond tide station, 1996-2018

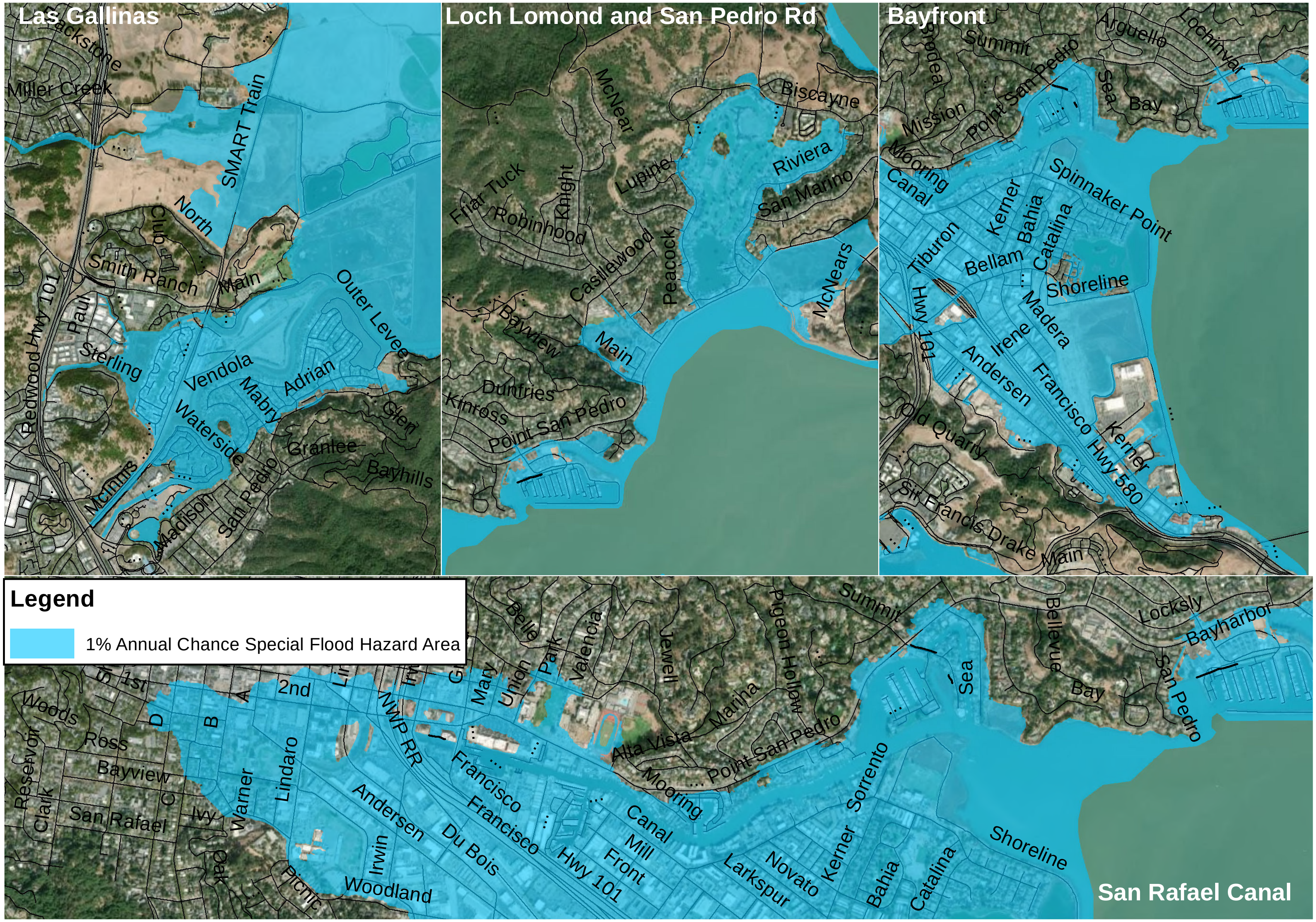


SOURCE: NOAA Station 9414290

San Rafael Sea Level Rise Adaptation Study . D180140.00

Figure 3

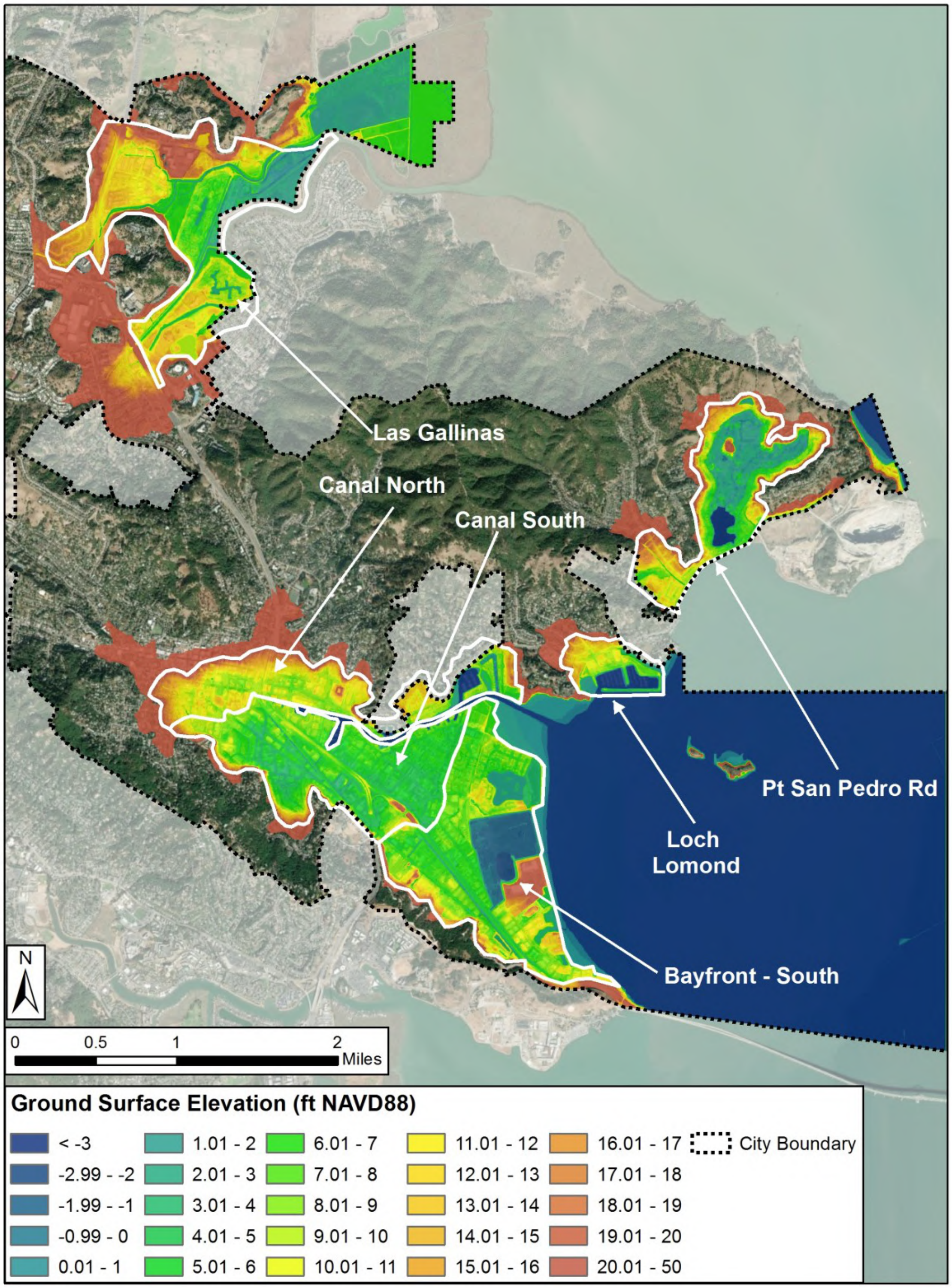
Monthly peak water levels at NOAA San Francisco tide station, 1900-2019



SOURCE: FEMA (Effective March 2016)

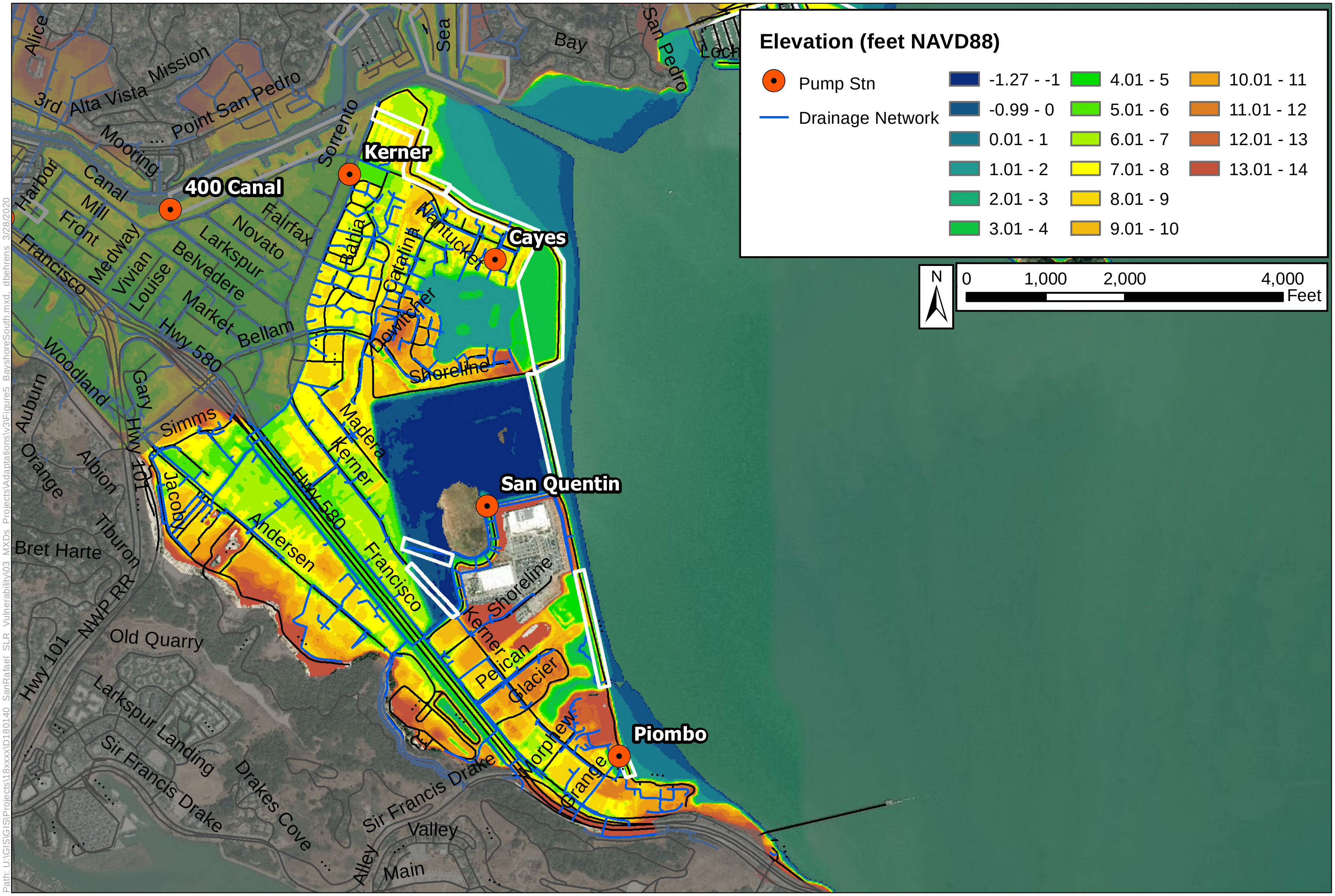
San Rafael Sea Level Rise Adaptation Study . D180140.00

Figure 3
FEMA 1% Annual Chance Special Flood Hazard Area



SOURCE: NOAA SLR Viewer Topography (2010)

Figure 4
Site map and flood vulnerability regions



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SOURCE: NOAA SLR Viewer Topography (2010)

San Rafael SLR Adaptation Study . D180140.00

Figure 5
Site Map: Bayfront South Region

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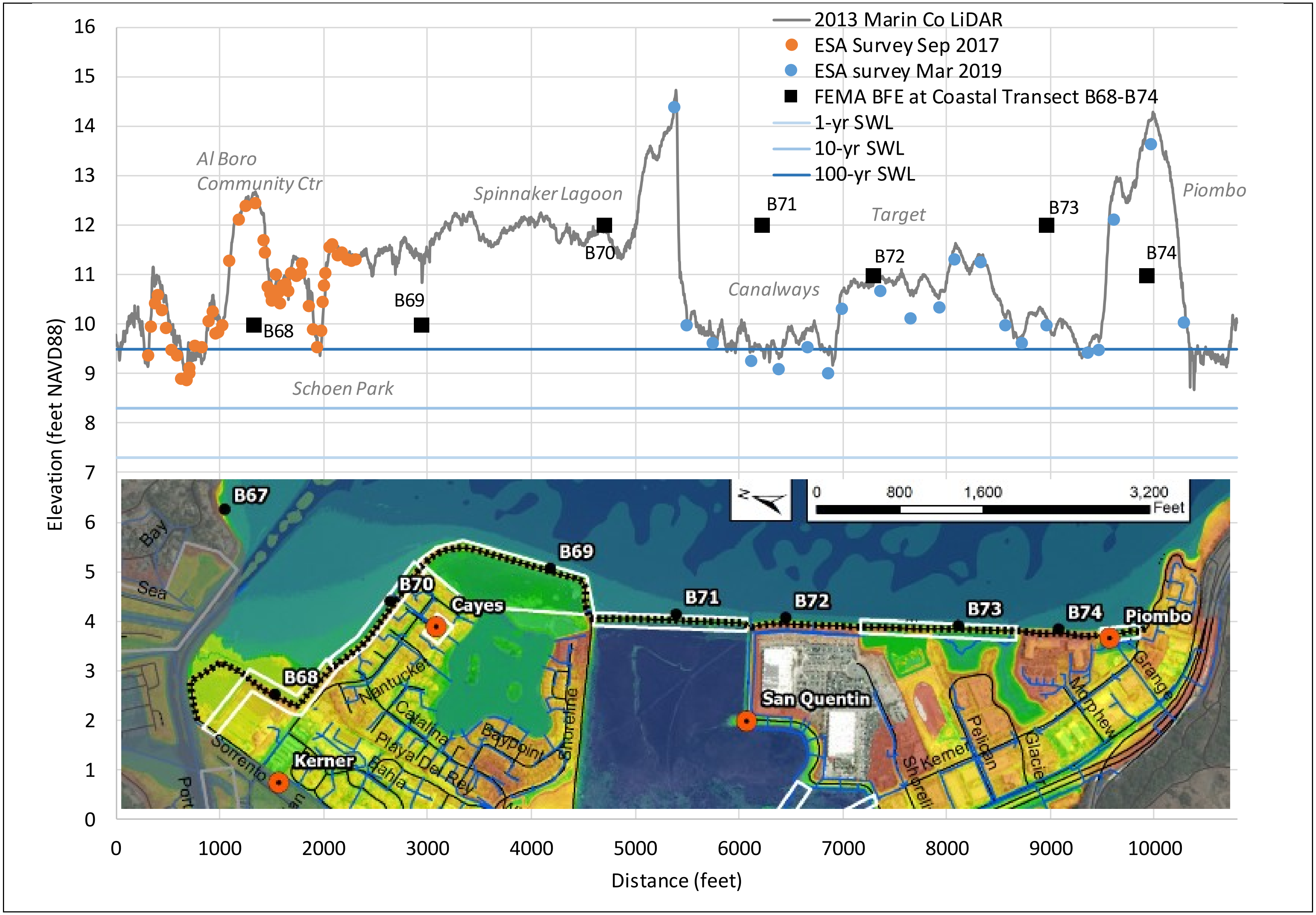
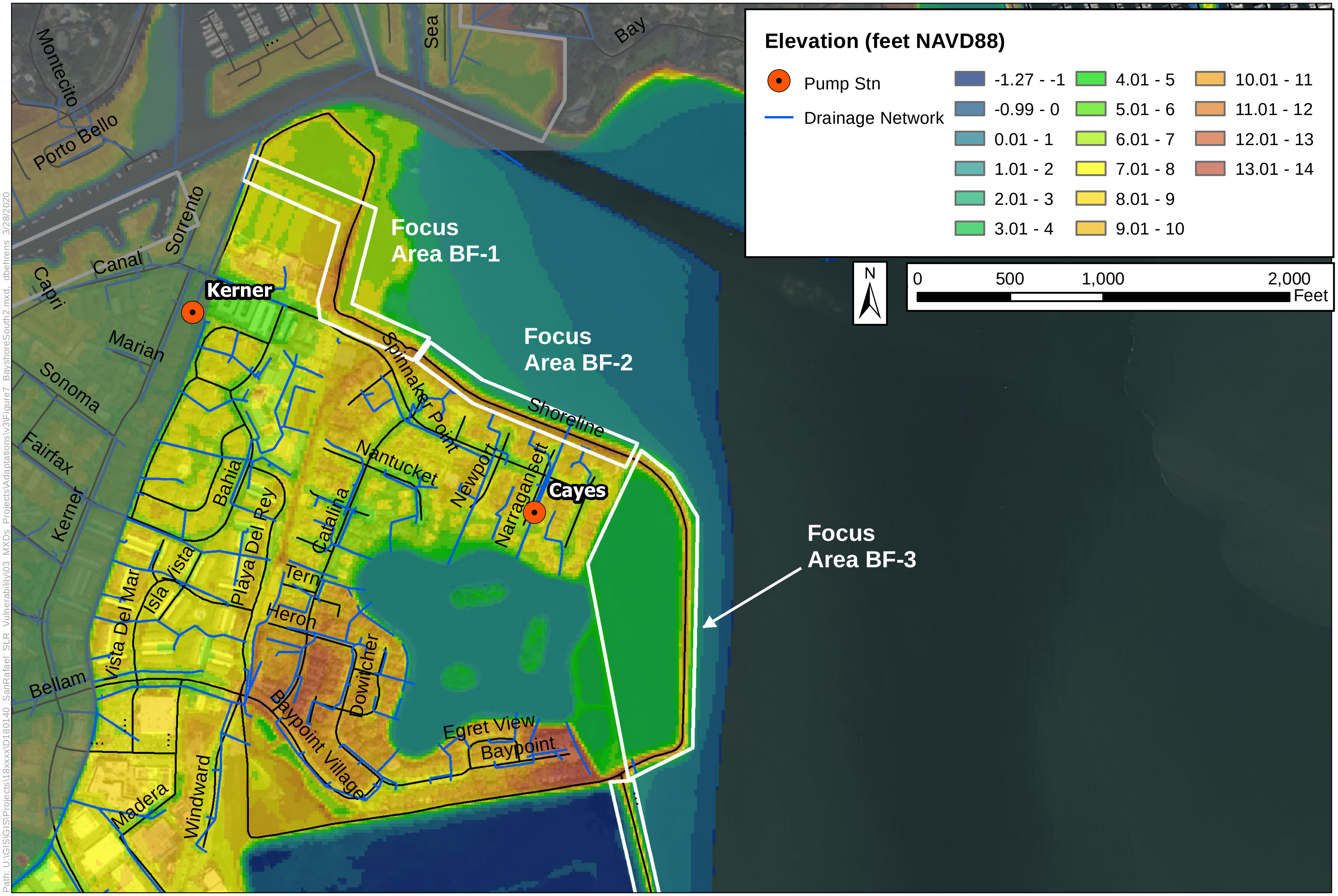


SOURCE: Marin County (2013) LiDAR and 2017 and 2019 ESA RTK GPS surveys

San Rafael Sea Level Rise Adaptation Study . D180140.00

Figure 6

Shoreline elevations and extreme flood elevations: Bayfront South Region



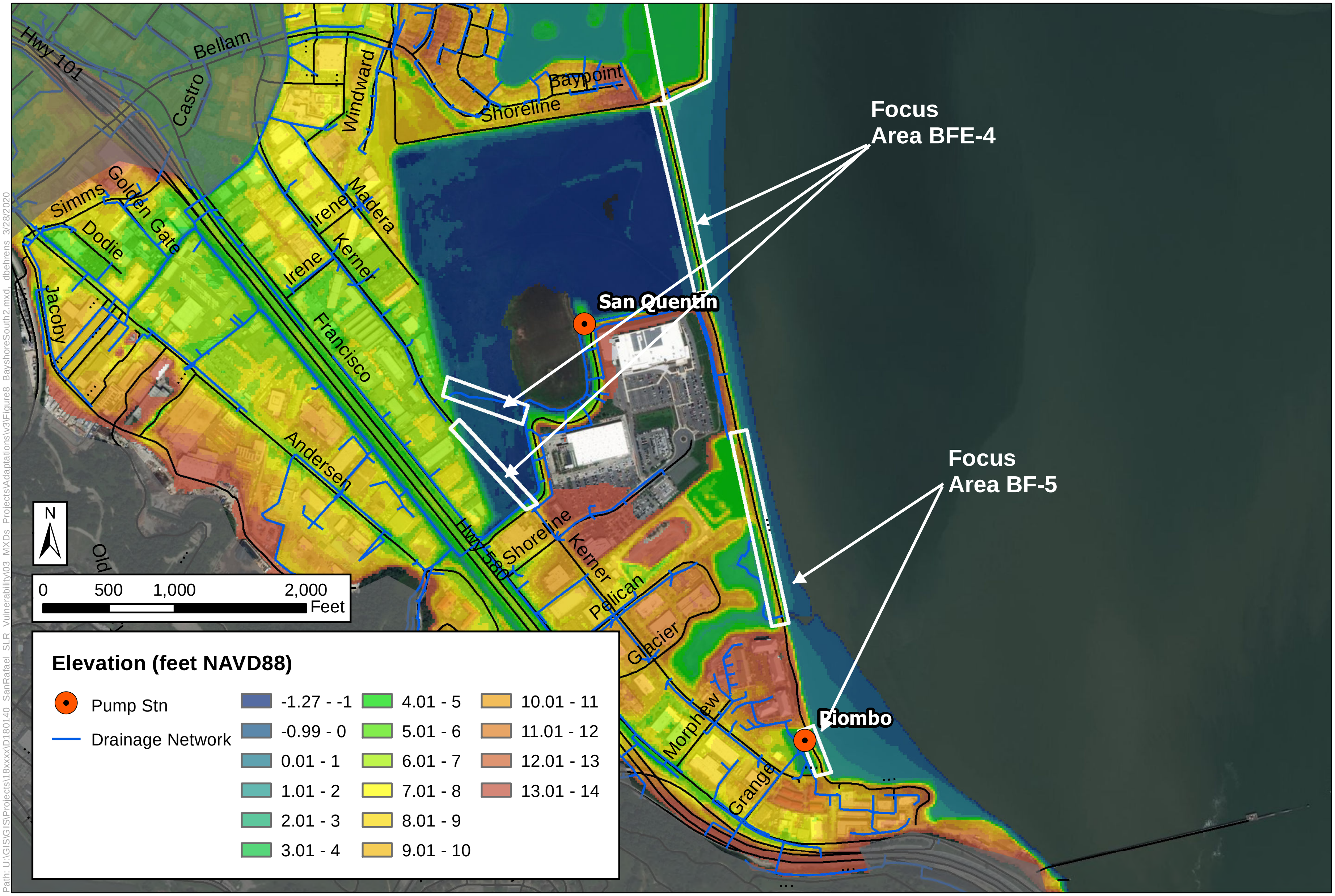
SOURCE: NOAA SLR Viewer Topography (2010)

San Rafael SLR Adaptation Study . D180140.00

Figure 7

Site Map: Bayfront South Region: near Spinnaker Point

ESA



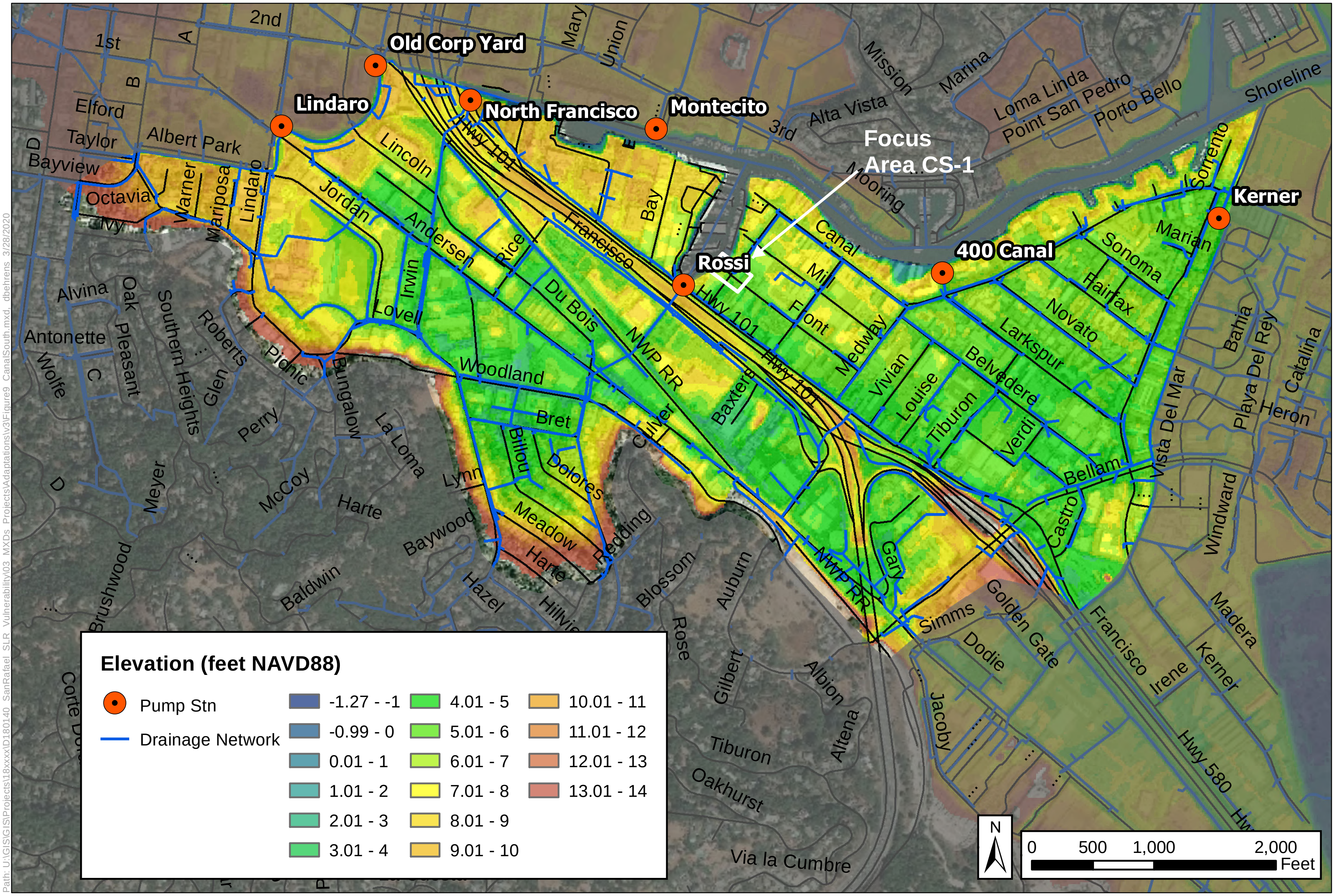
SOURCE: NOAA SLR Viewer Topography (2010)

San Rafael SLR Adaptation Study . D190002.00

Figure 8

Site Map: Baysfront South Region: near Morphew Street

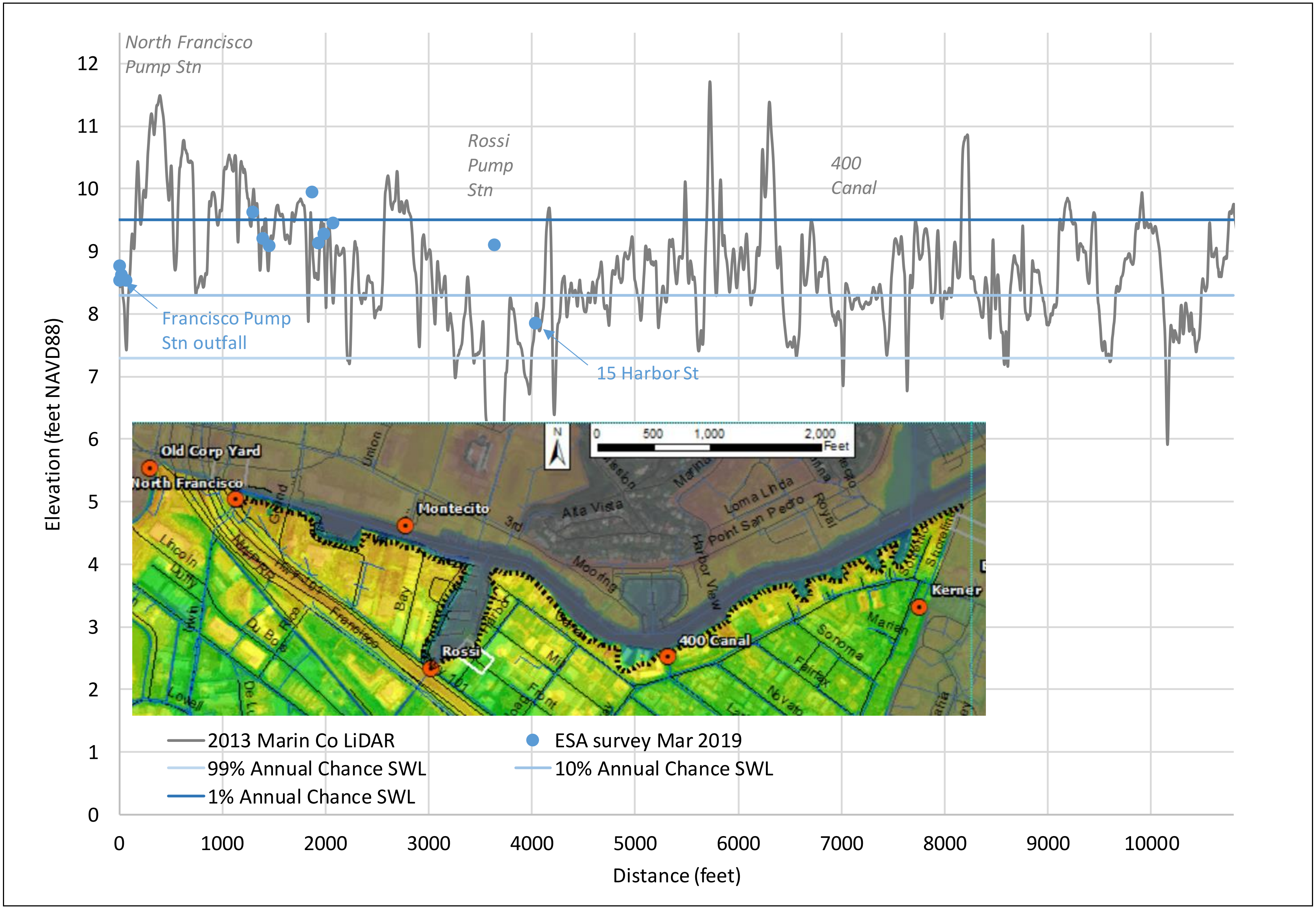
ESA



SOURCE: NOAA SLR Viewer Topography (2010)

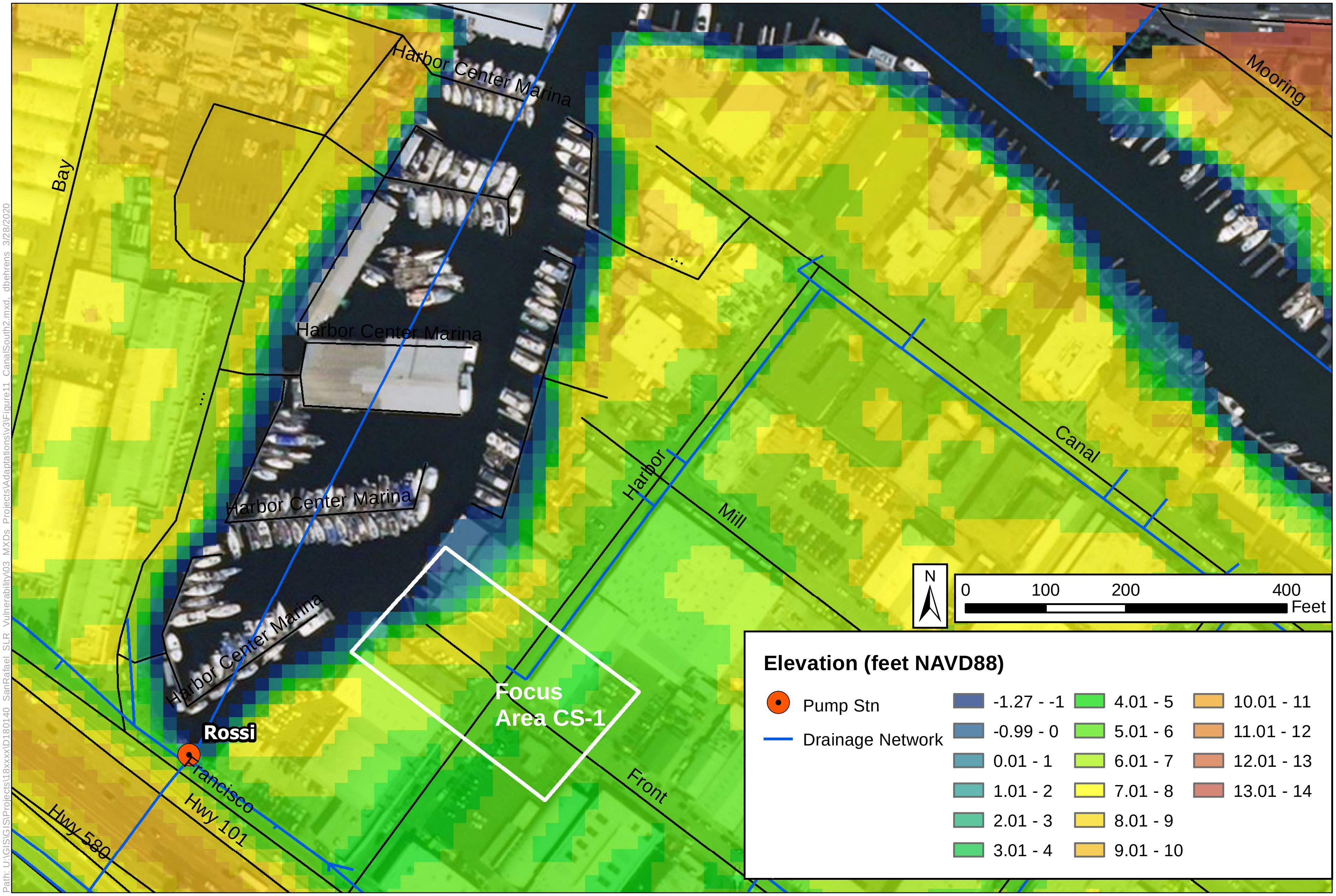
San Rafael SLR Adaptation Study. D180140.00

Figure 9
Site Map: Canal South Region



SOURCE: Marin County (2013) LiDAR and 2017 and 2019 ESA RTK GPS surveys

Figure 10
Shoreline elevations and extreme flood elevations: Canal South Region

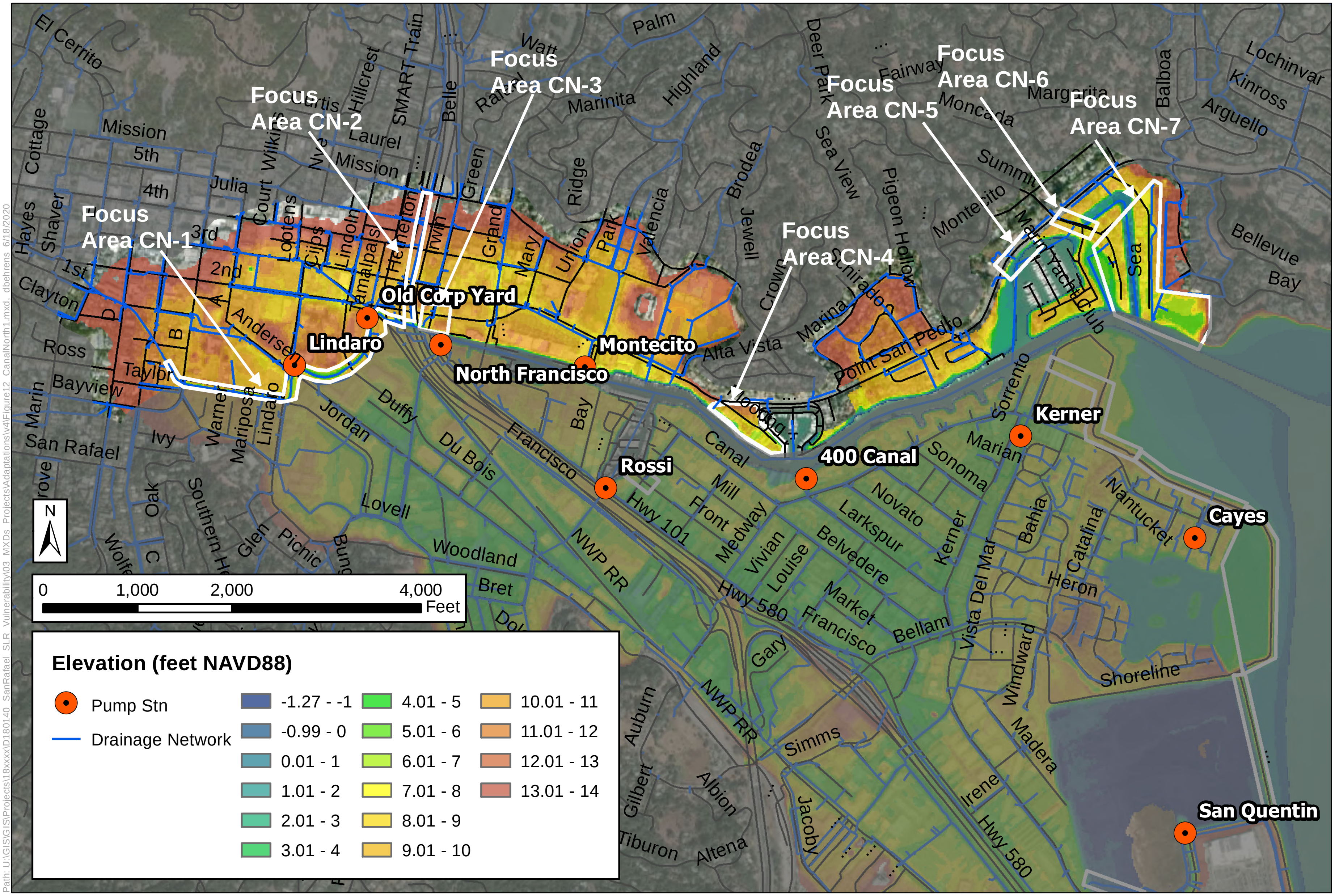


SOURCE: NOAA SLR Viewer Topography (2010)

San Rafael SLR Adaptation Study . D180140.00

Figure 11
Site Map: Canal South Region: near Harbor Street

ESA

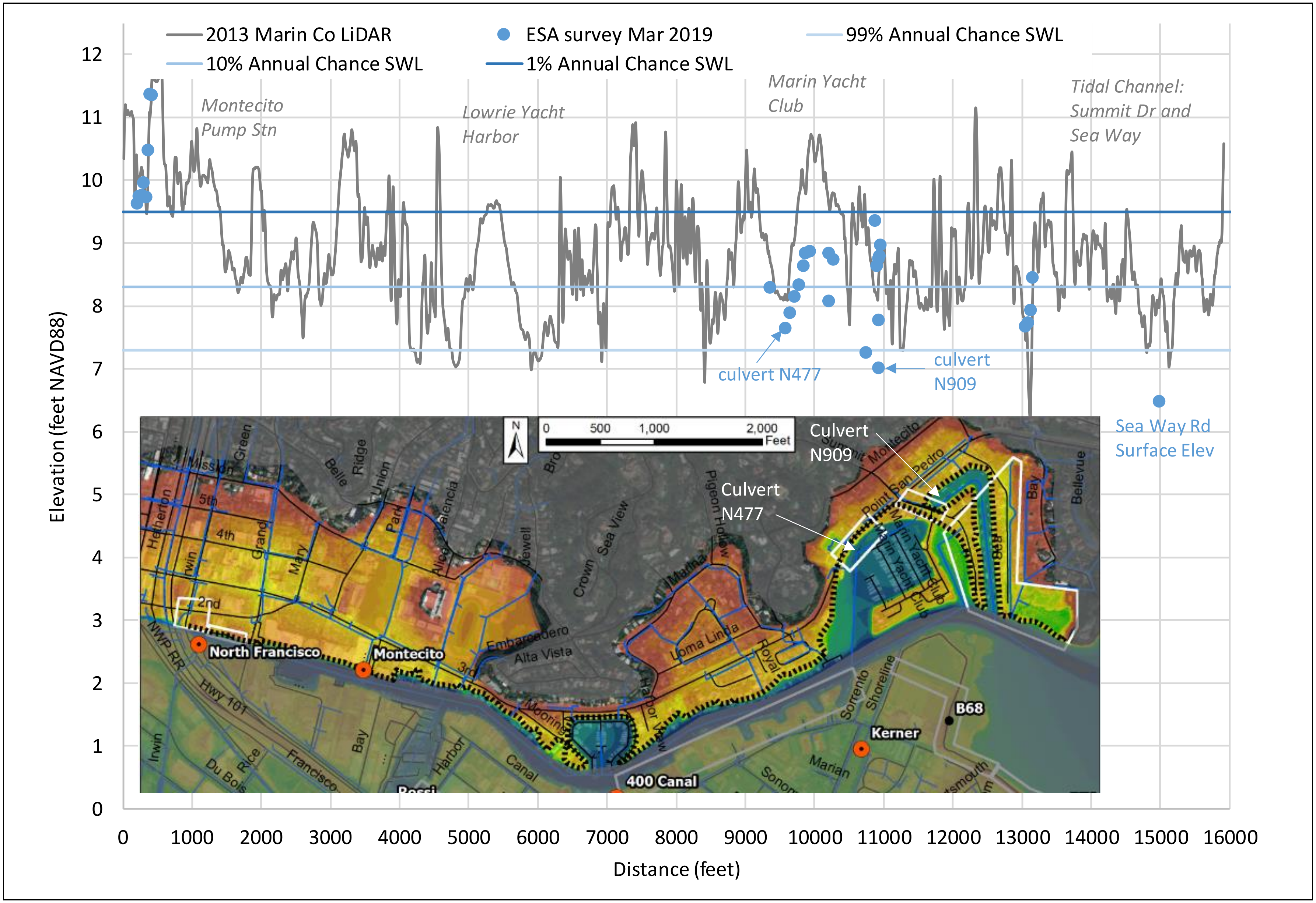


SOURCE: NOAA SLR Viewer Topography (2010)

San Rafael SLR Adaptation Study . D180140.00

Figure 12
Site Map: Canal North Region

ESA

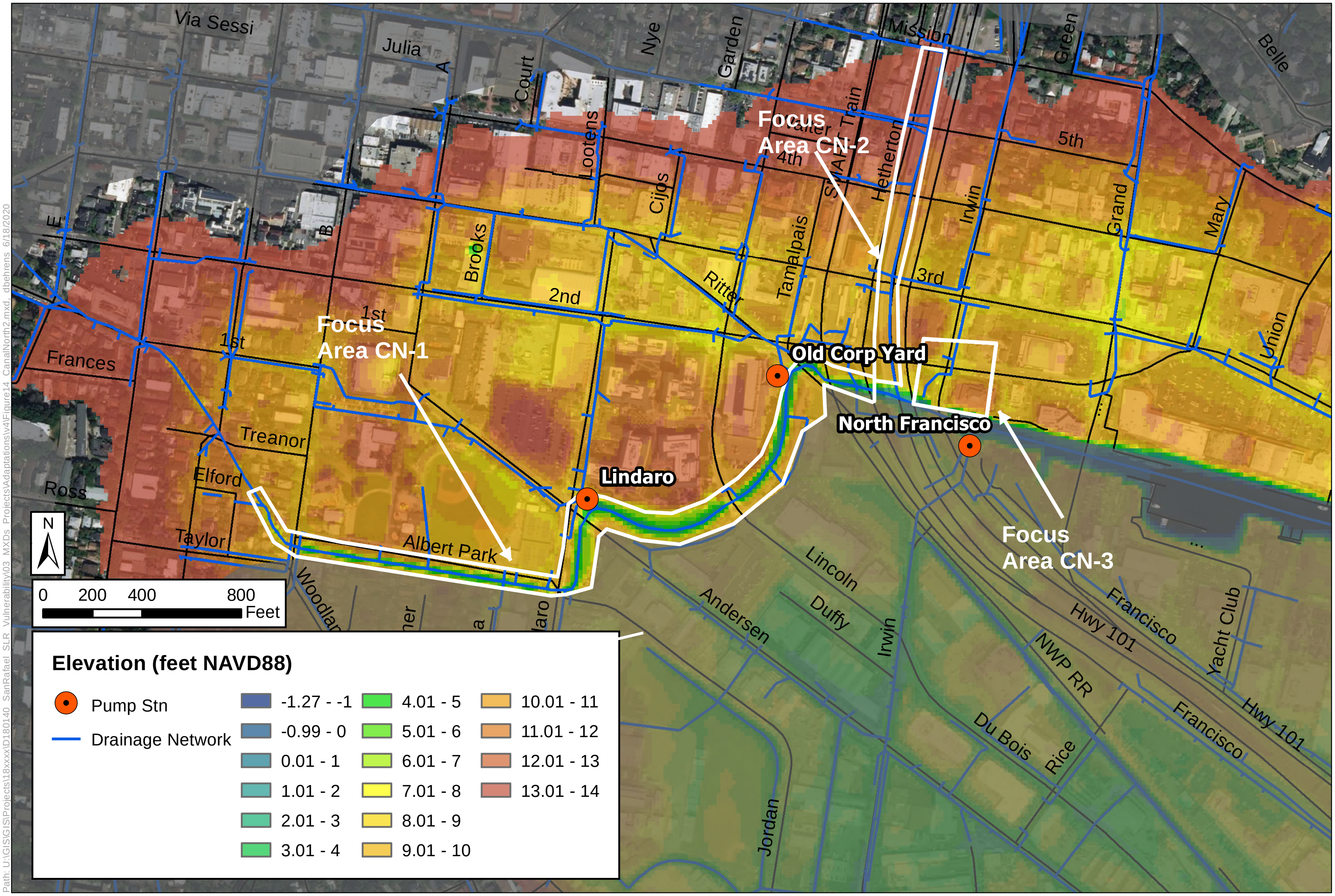


SOURCE: Marin County (2013) LiDAR and 2017 and 2019 ESA RTK GPS surveys

San Rafael Sea Level Rise Adaptation Study . D180140.00

Figure 13

Shoreline elevations and extreme flood elevations: Canal North Region



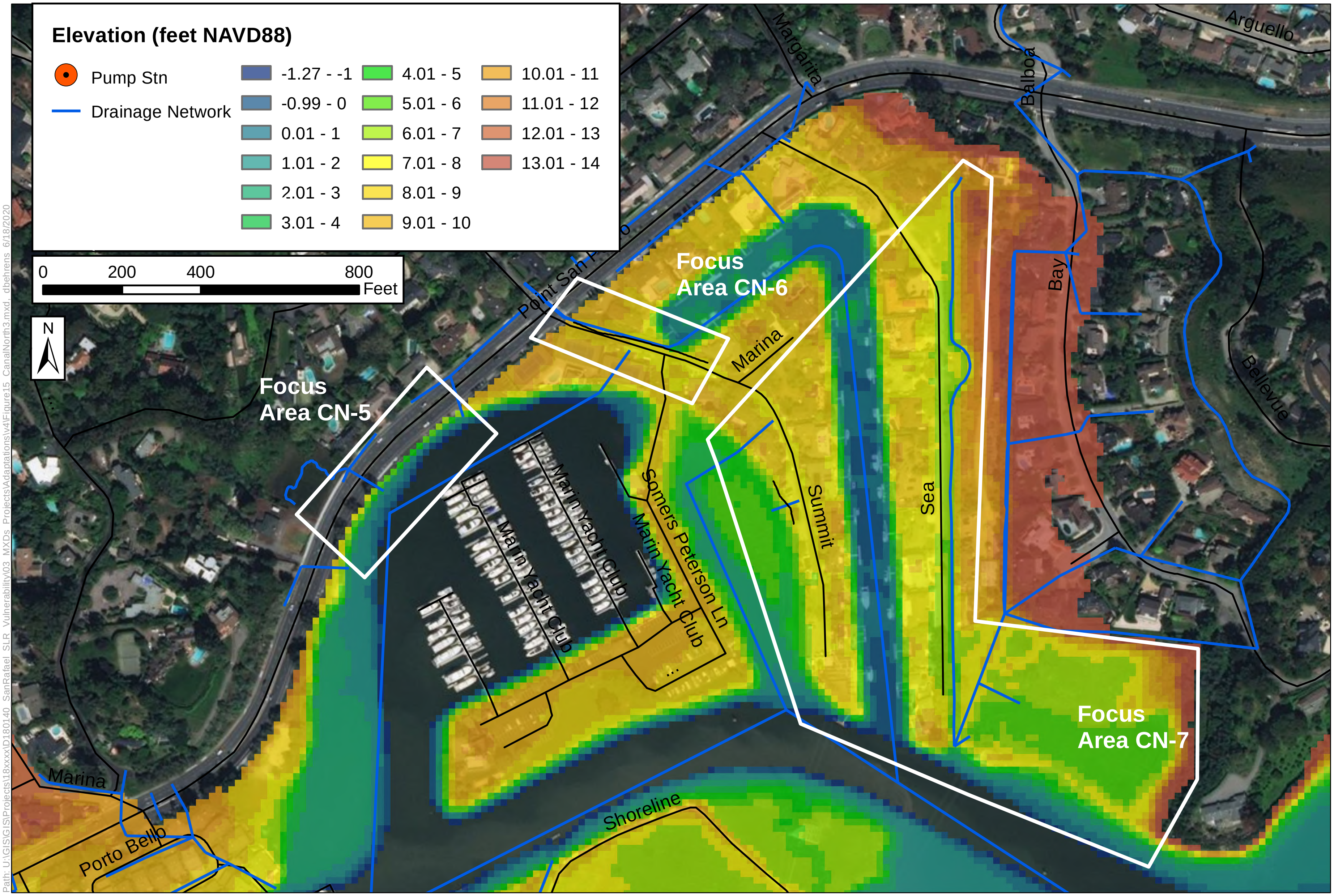
SOURCE: NOAA SLR Viewer Topography (2010)

San Rafael SLR Adaptation Study . D180140.00

Figure 14

Site Map: Canal North Region: near Highway 101

ESA



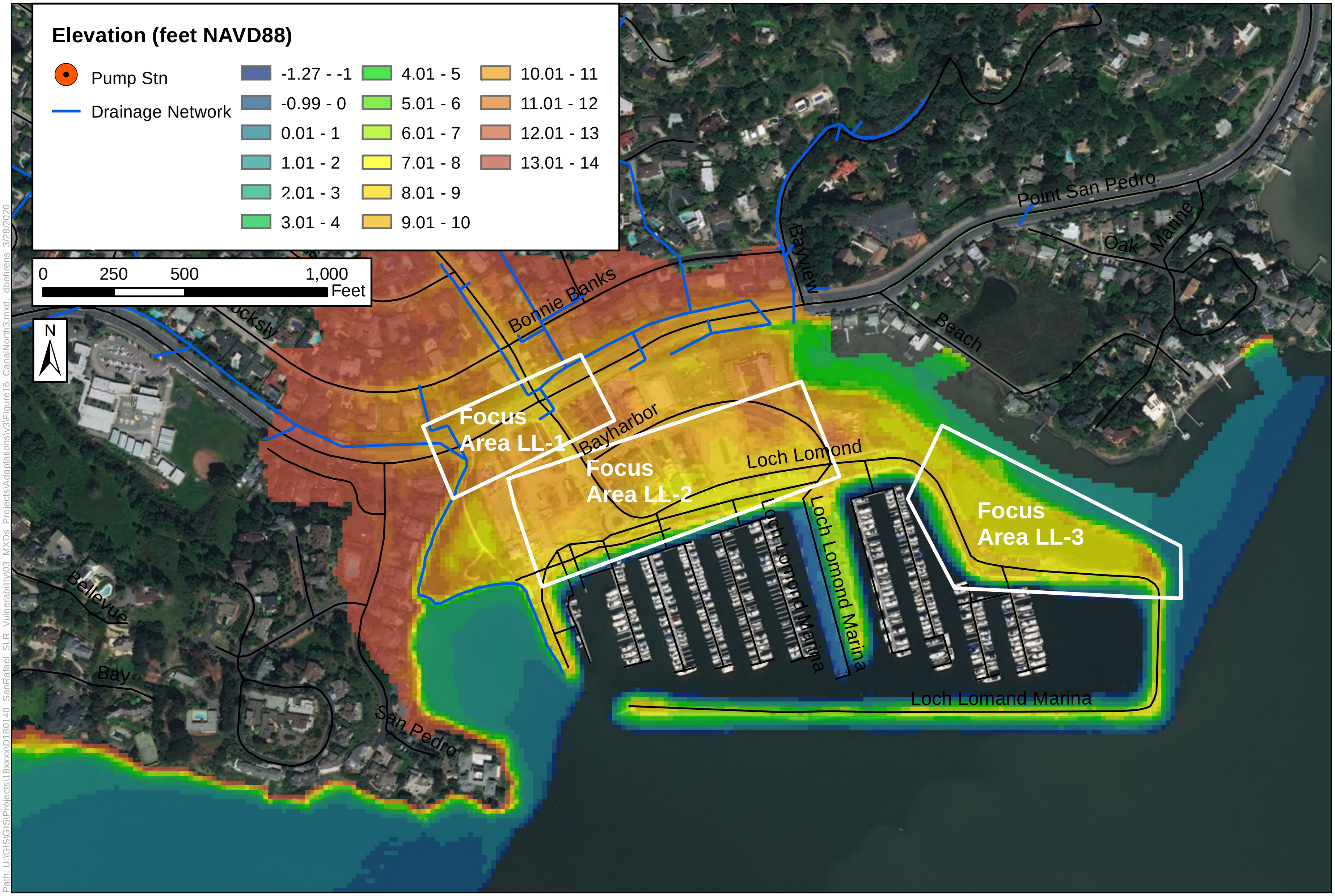
SOURCE: NOAA SLR Viewer Topography (2010)

San Rafael SLR Adaptation Study . D180140.00

Figure 15

Site Map: Canal North Region: near Marin Yacht Club

ESA

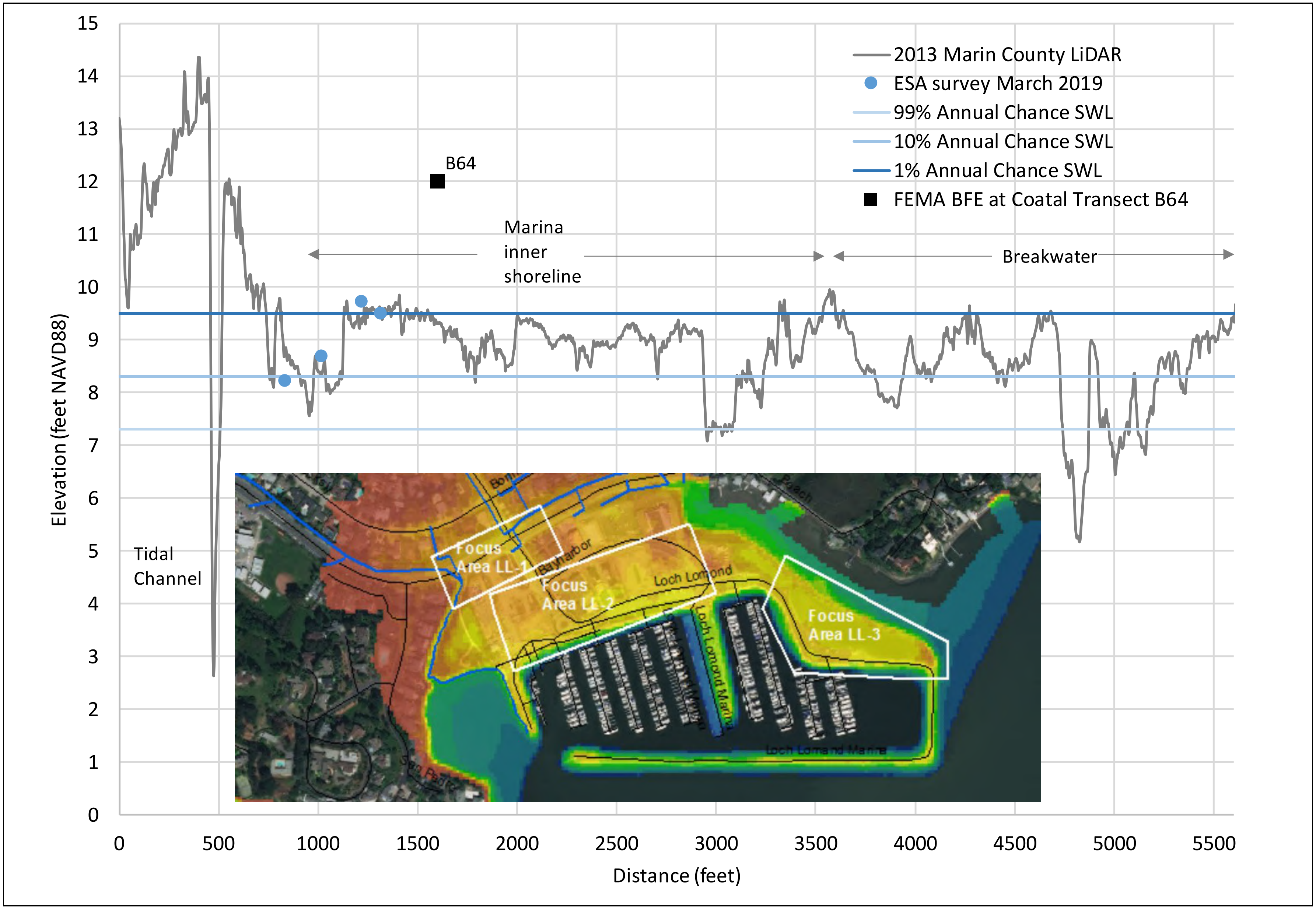


SOURCE: NOAA SLR Viewer Topography (2010)

San Rafael SLR Adaptation Study . D180140.00

Figure 16
Site Map: Loch Lomond Region

ESA

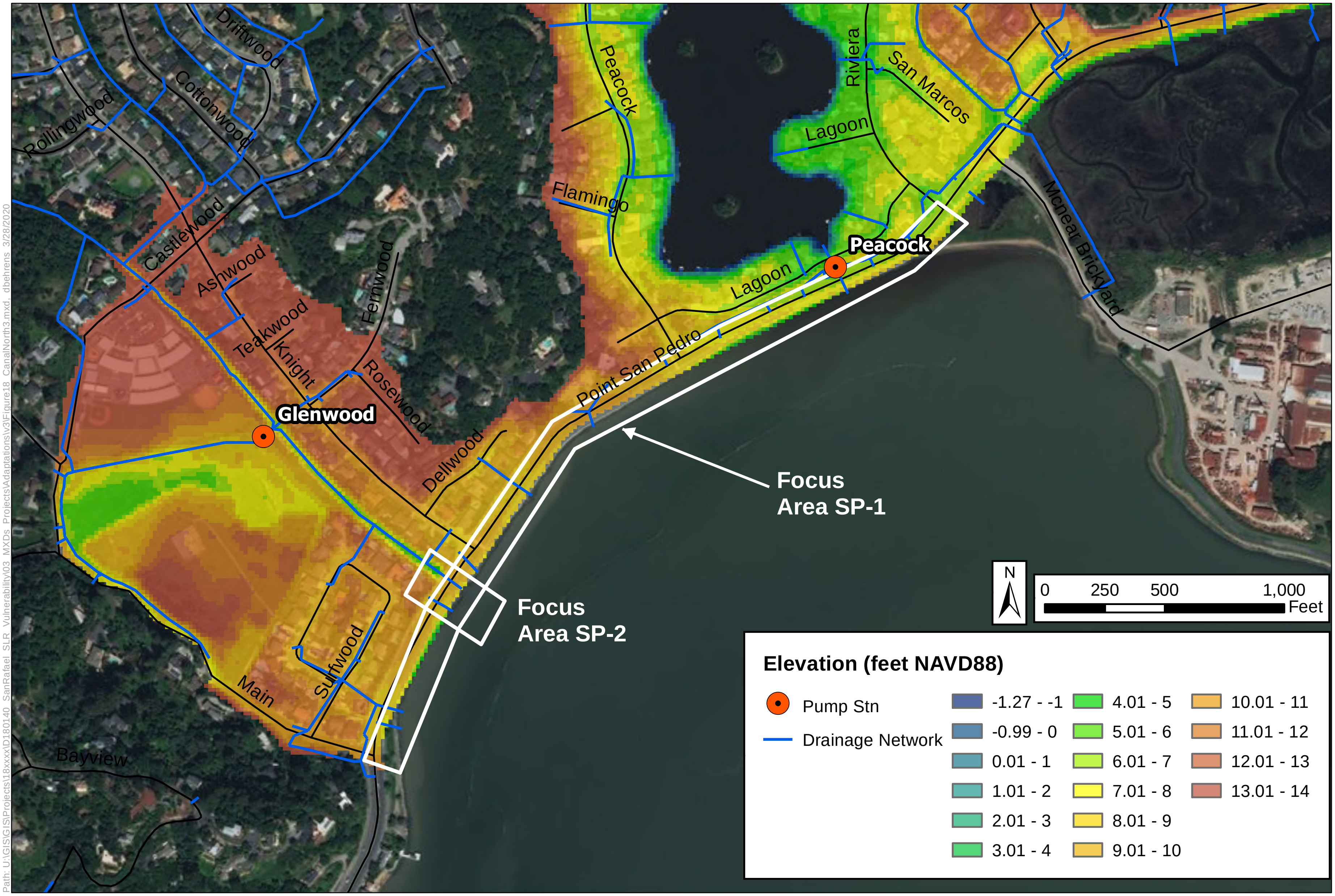


SOURCE: Marin County (2013) LiDAR and 2019 ESA RTK GPS surveys

San Rafael Sea Level Rise Adaptation Study . D180140.00

Figure 17

Shoreline elevations and extreme flood elevations: Loch Lomond Region

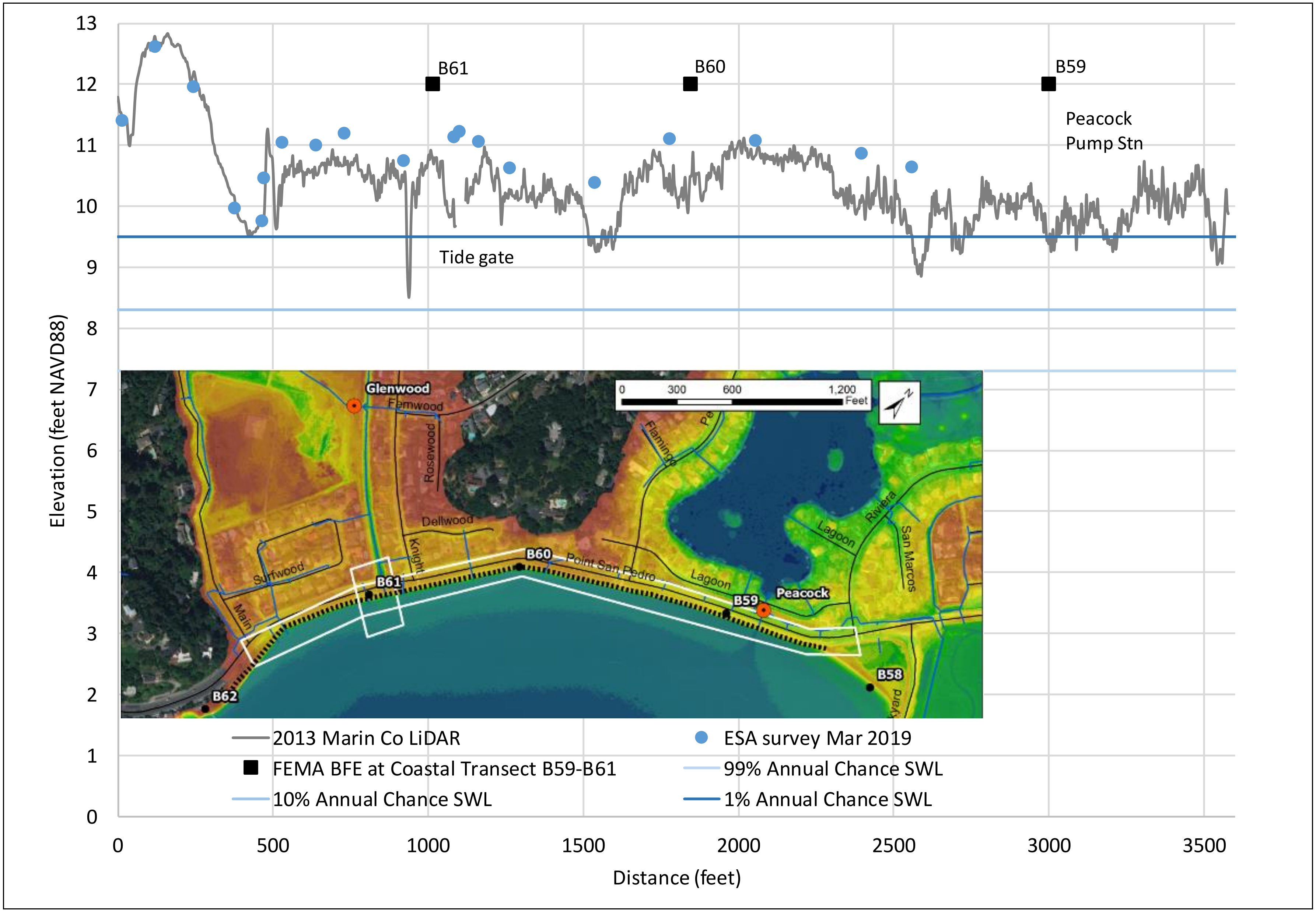


SOURCE: NOAA SLR Viewer Topography (2010)

San Rafael SLR Adaptation Study . D180140.00

Figure 18
Site Map: Point San Pedro Rd Region

ESA

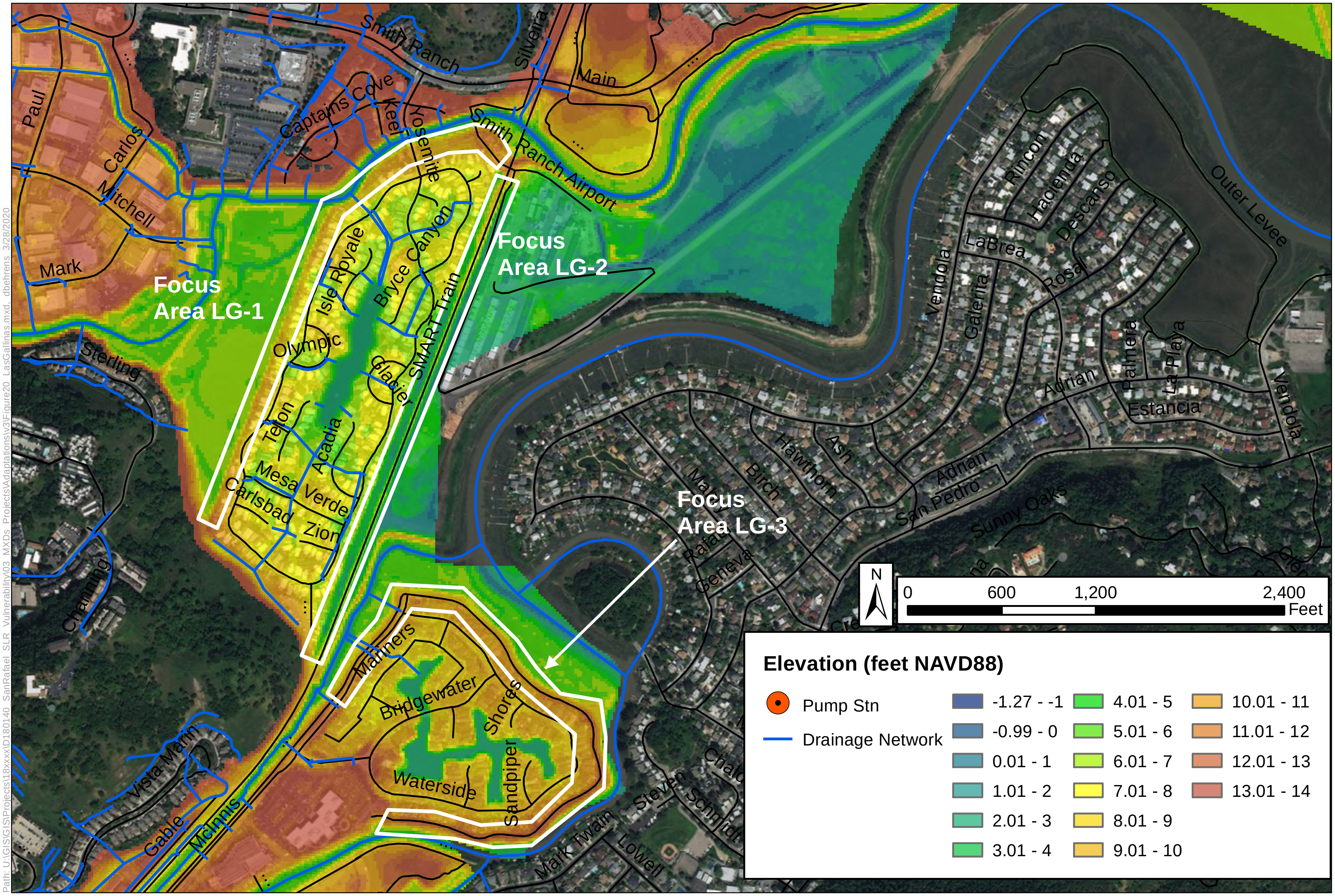


SOURCE: Marin County (2013) LiDAR and 2019 ESA RTK GPS survey

San Rafael Sea Level Rise Adaptation Study . D180140.00

Figure 19

Shoreline elevations and extreme flood elevations: Point San Pedro Rd Region

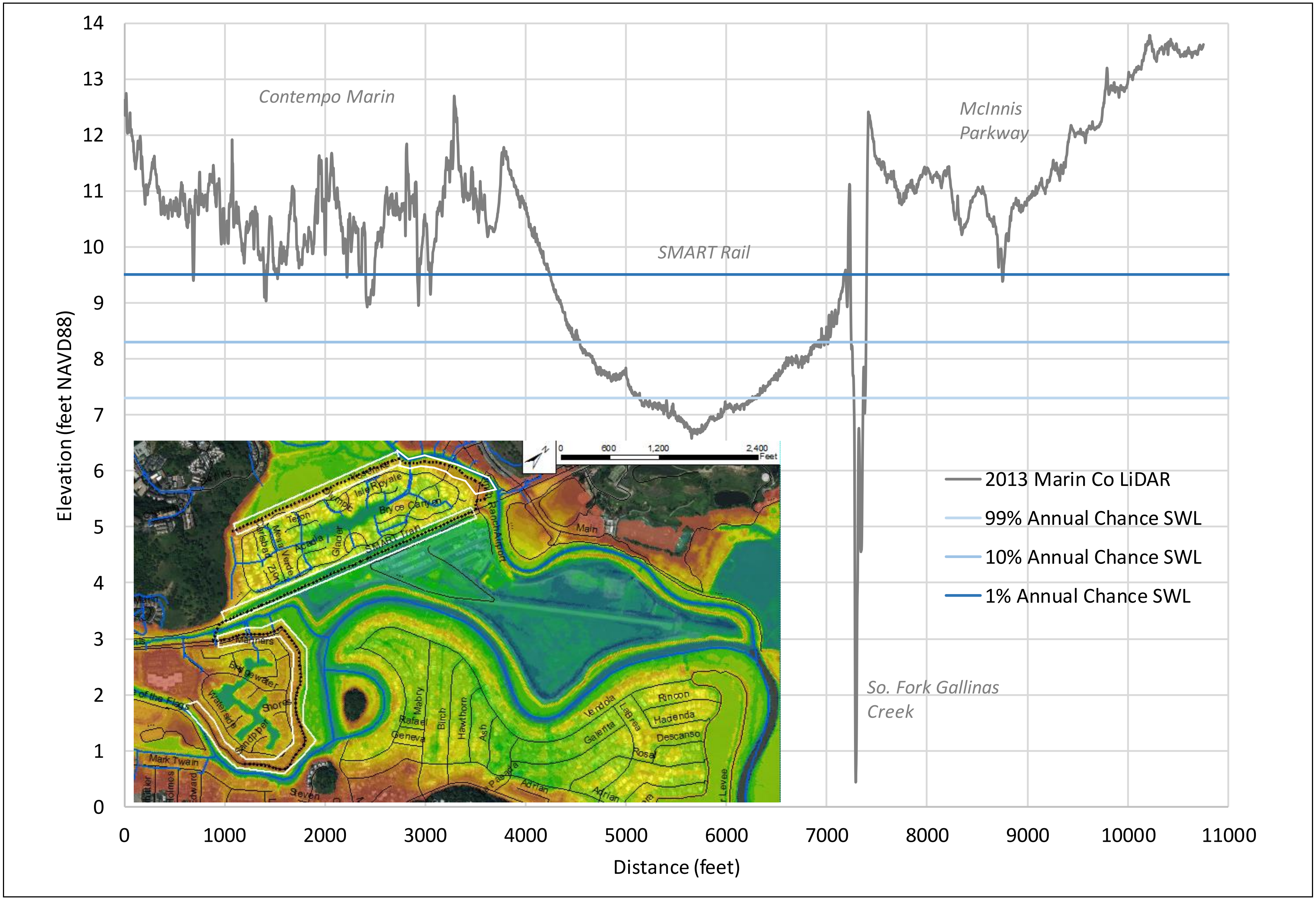


SOURCE: NOAA SLR Viewer Topography (2010)

San Rafael SLR Adaptation Study . D180140.00

Figure 20
Site Map: Las Gallinas Region

ESA



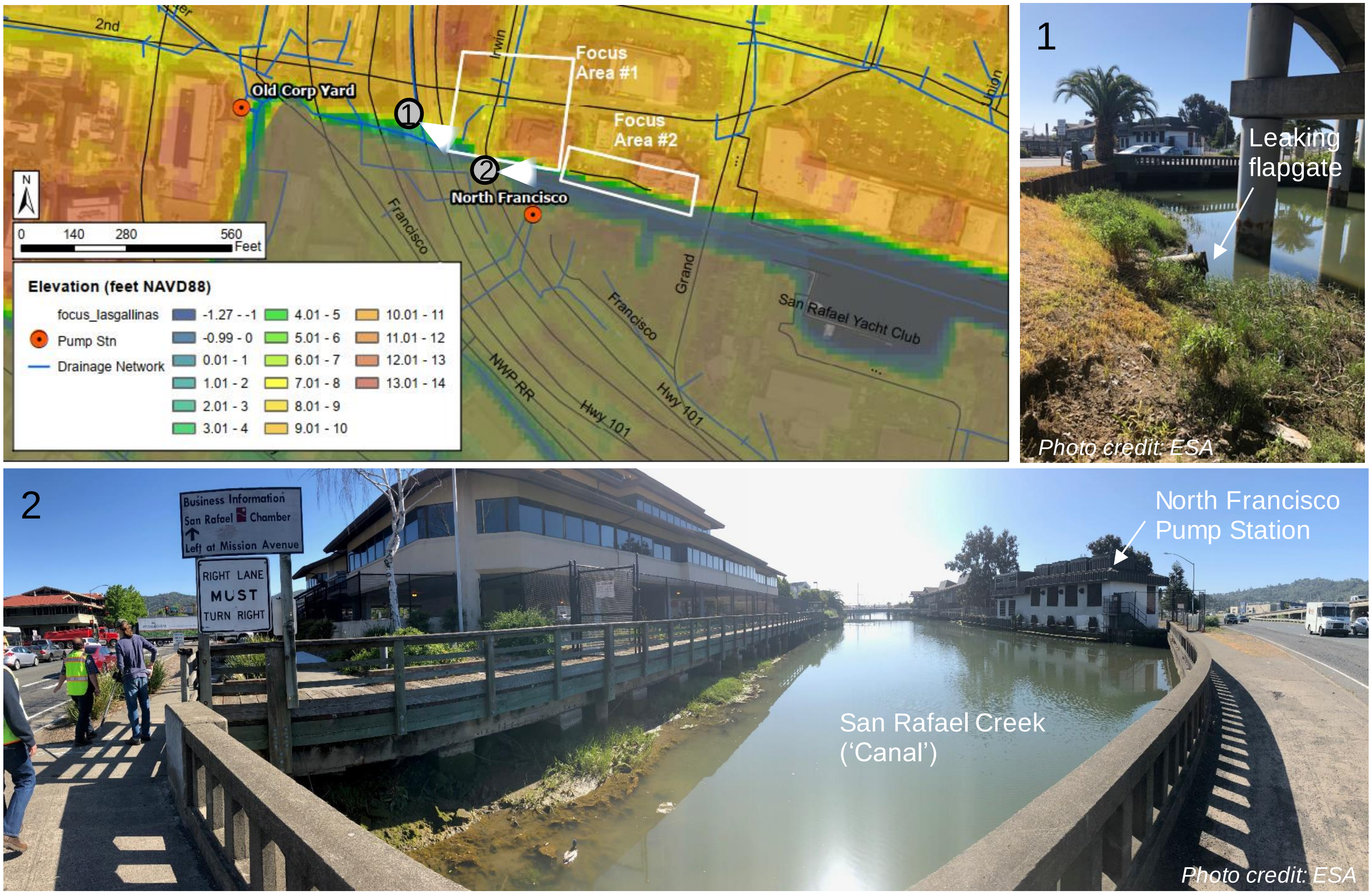
SOURCE: Marin County (2013) LiDAR and 2019 ESA RTK GPS surveys

San Rafael Sea Level Rise Adaptation Study . D180140.00

Figure 21
Shoreline elevations and extreme flood elevations: Las Gallinas Region

Appendix A
Site Photographs

ESA

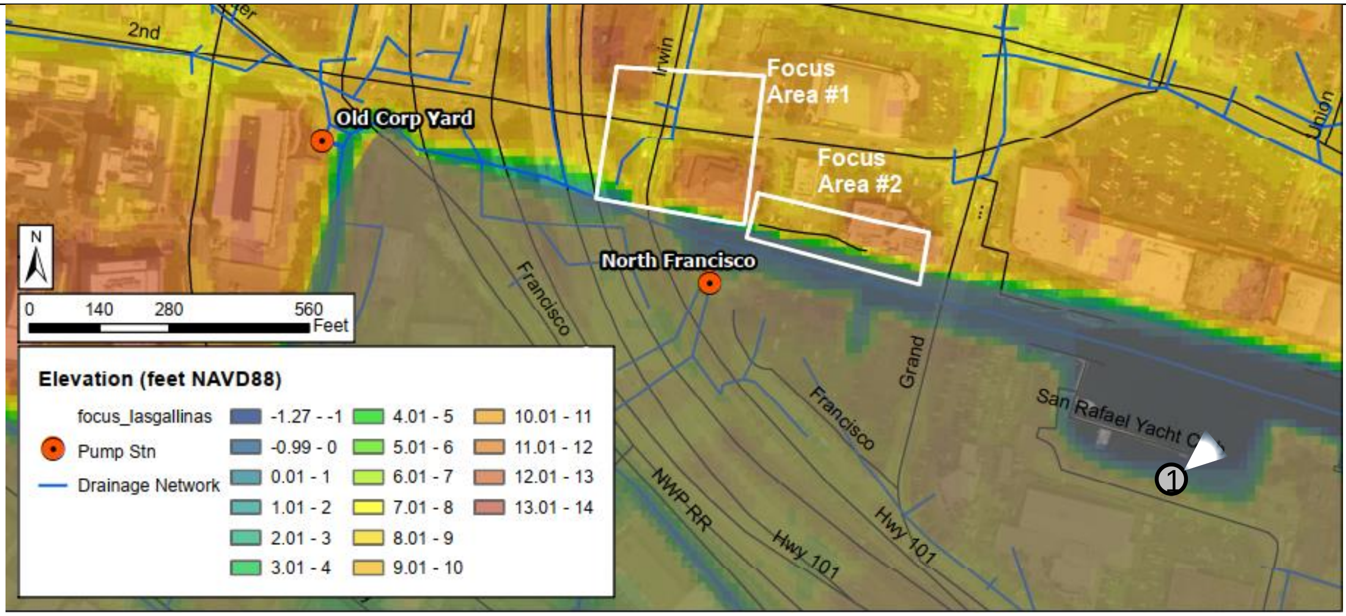


SOURCE: ESA

San Rafael SLR Vulnerability Study . D180140.00

Figure A1

Focus areas near Highway 101 overpass of San Rafael Creek



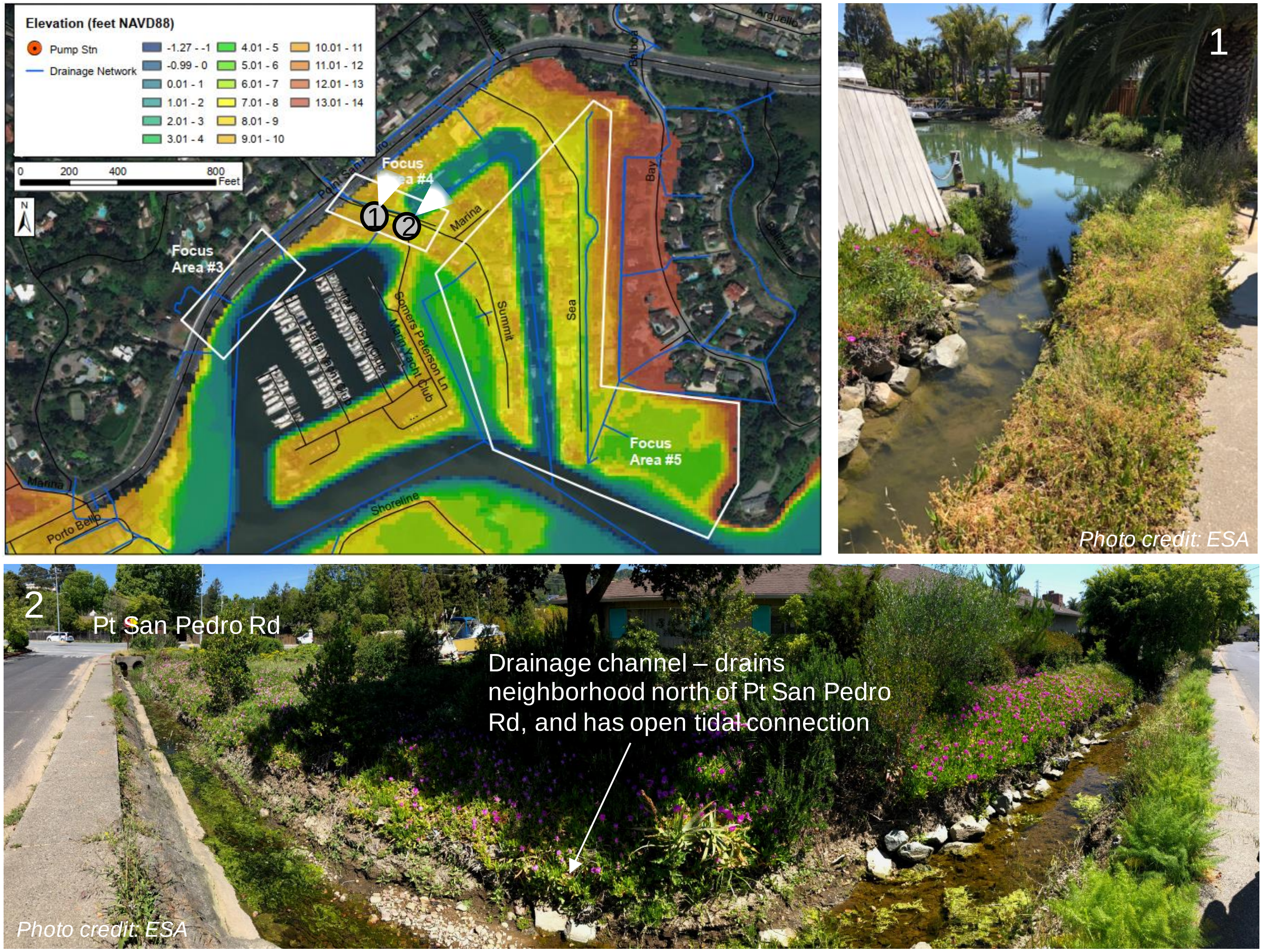
SOURCE: ESA

Figure A2
Shoreline walkway along the northern shoreline of San Rafael Creek (adjacent to Montecito Plaza)

SOURCE: ESA

San Rafael SLR Vulnerability Study . D180140.00

Figure A3
Focus area within Marin Yacht Club



SOURCE: ESA

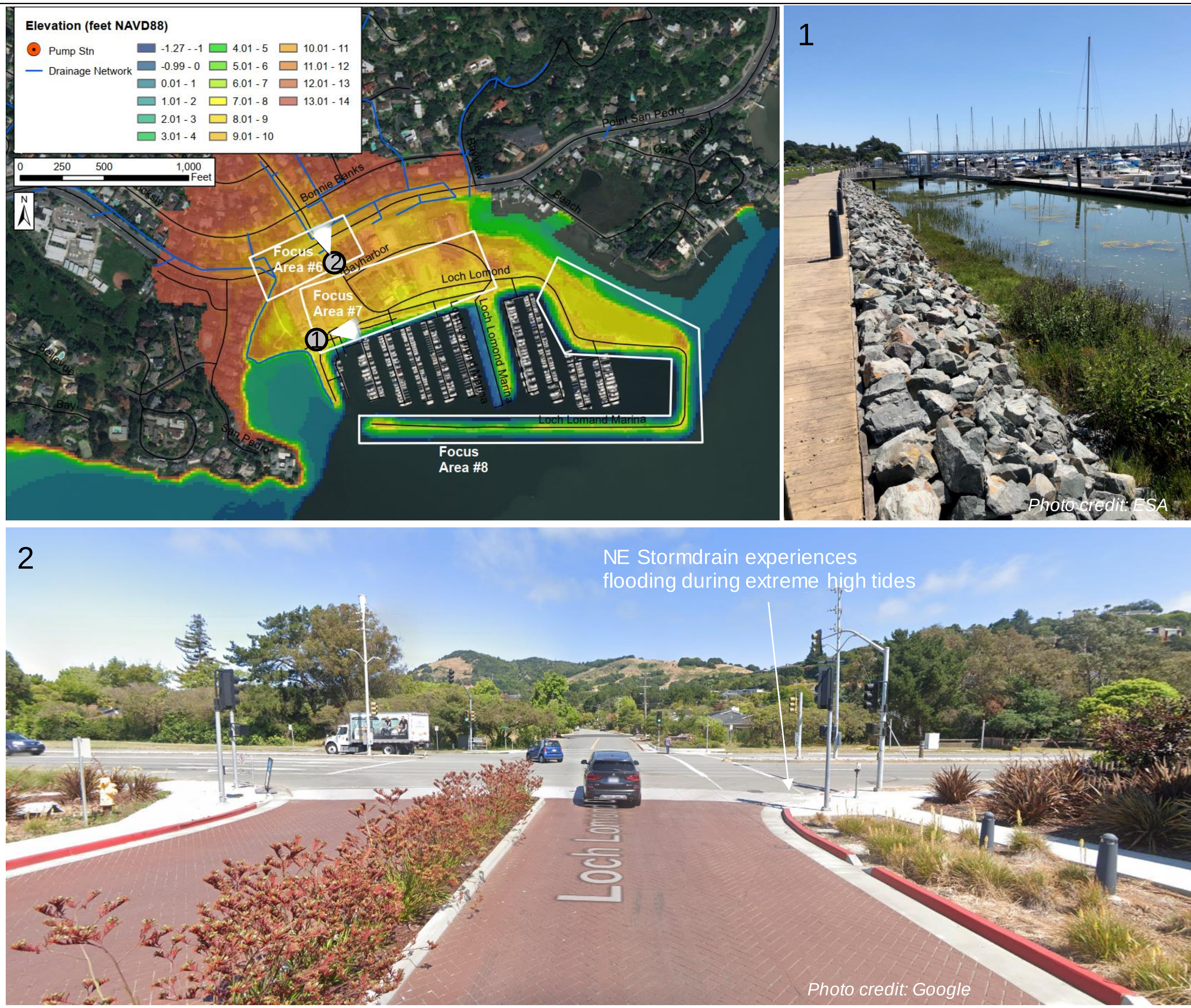
Figure A4
Drainage channel with open connection to the Bay along Summit Drive

SOURCE: ESA

San Rafael SLR Vulnerability Study . D180140.00

Figure A5

Photos of Focus Area 5, adjacent to Sea Way and Summit Drive

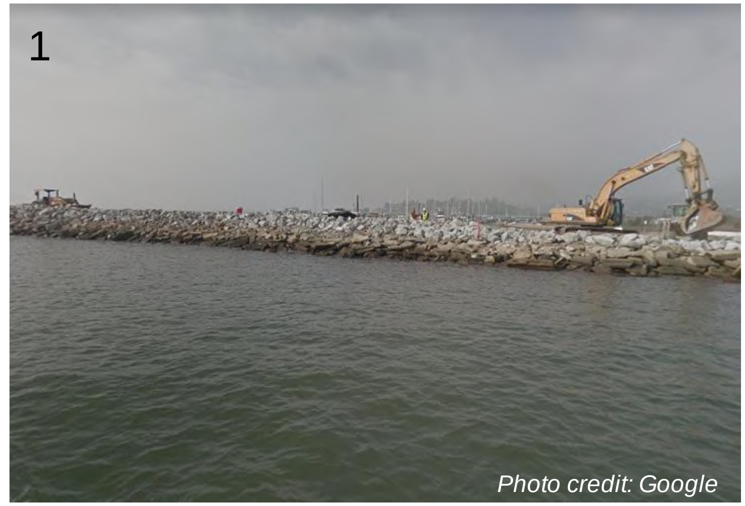


SOURCE: ESA

San Rafael SLR Vulnerability Study . D180140.00

Figure A6

Photos of focus areas within Loch Lomond region



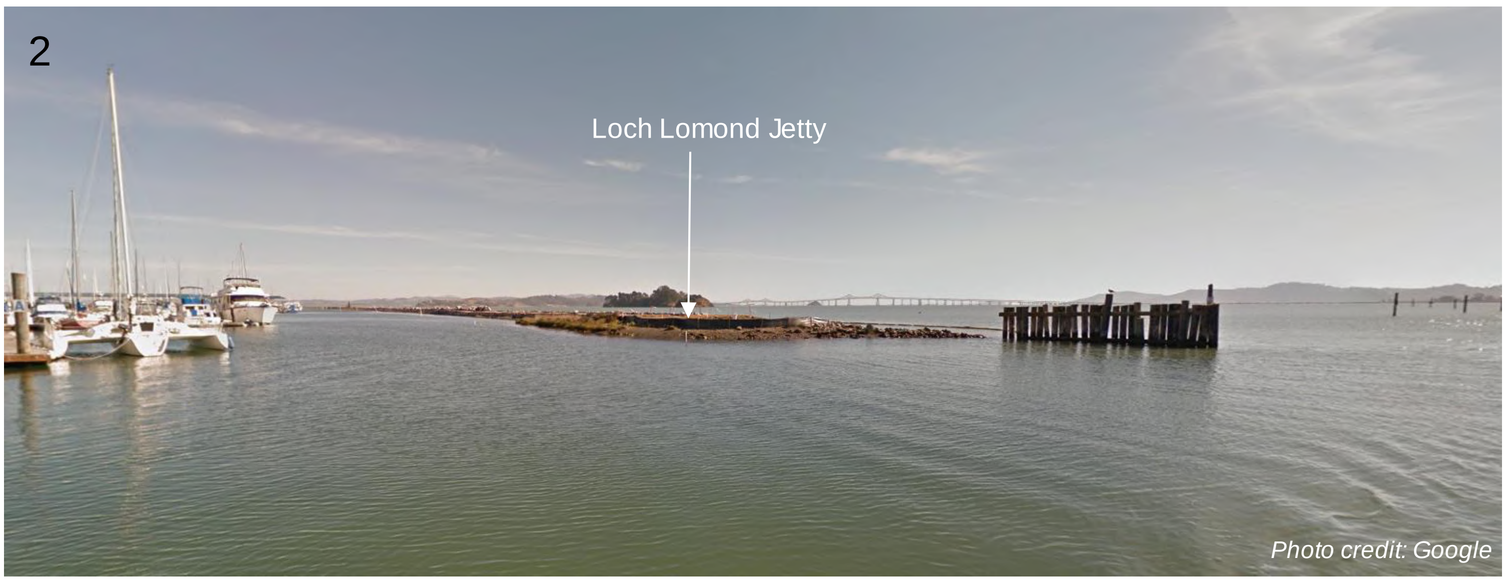
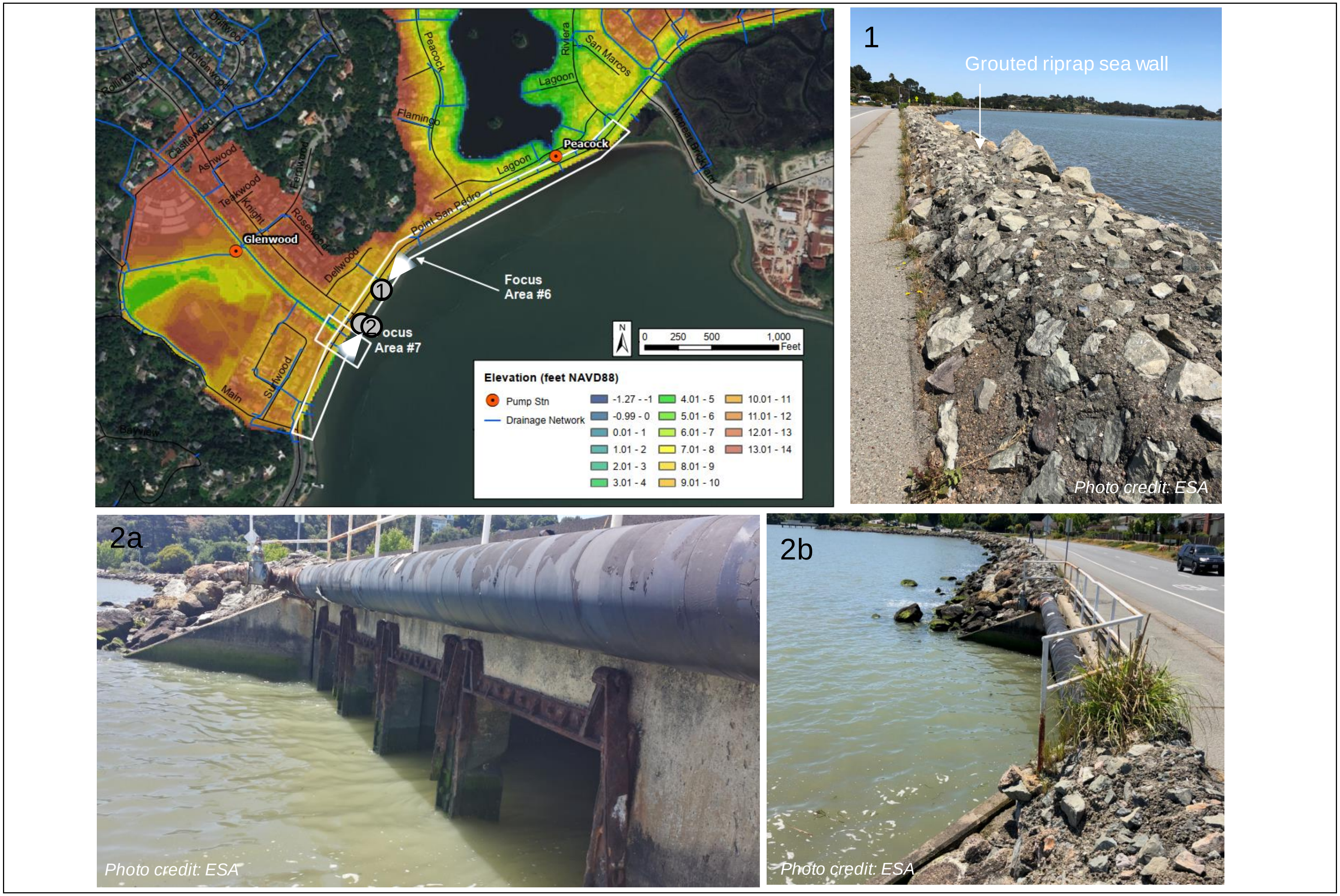


Figure A7
Loch Lomond Jetty



SOURCE: ESA

San Rafael SLR Vulnerability Study . D180140.00

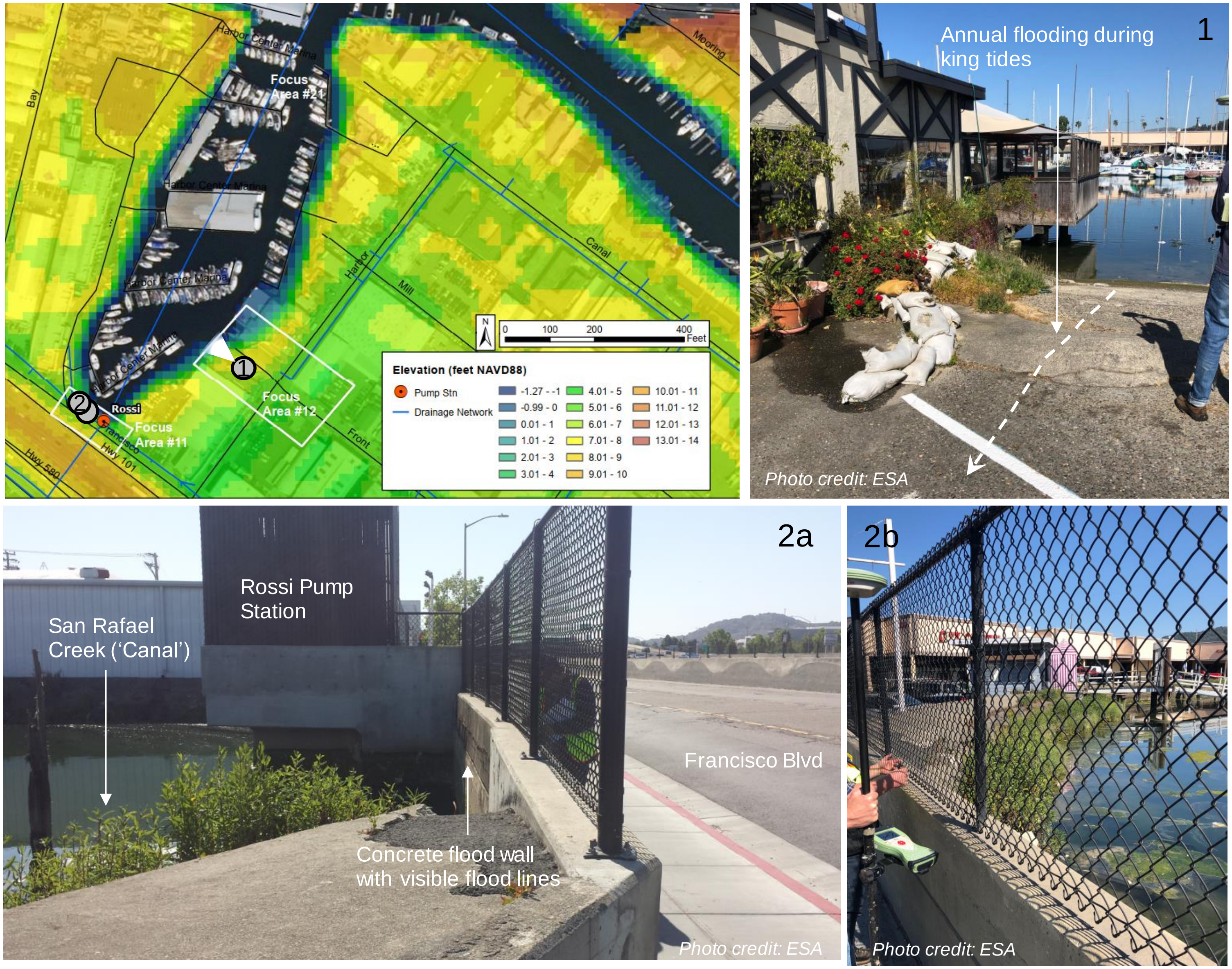
Figure A8

Focus areas along Pt San Pedro Road

SOURCE: Stephen Sarhad

San Rafael SLR Vulnerability Study . D180140.00

Figure A9
Flooding observed from combined high tides and wave runup at Pt San Pedro Road

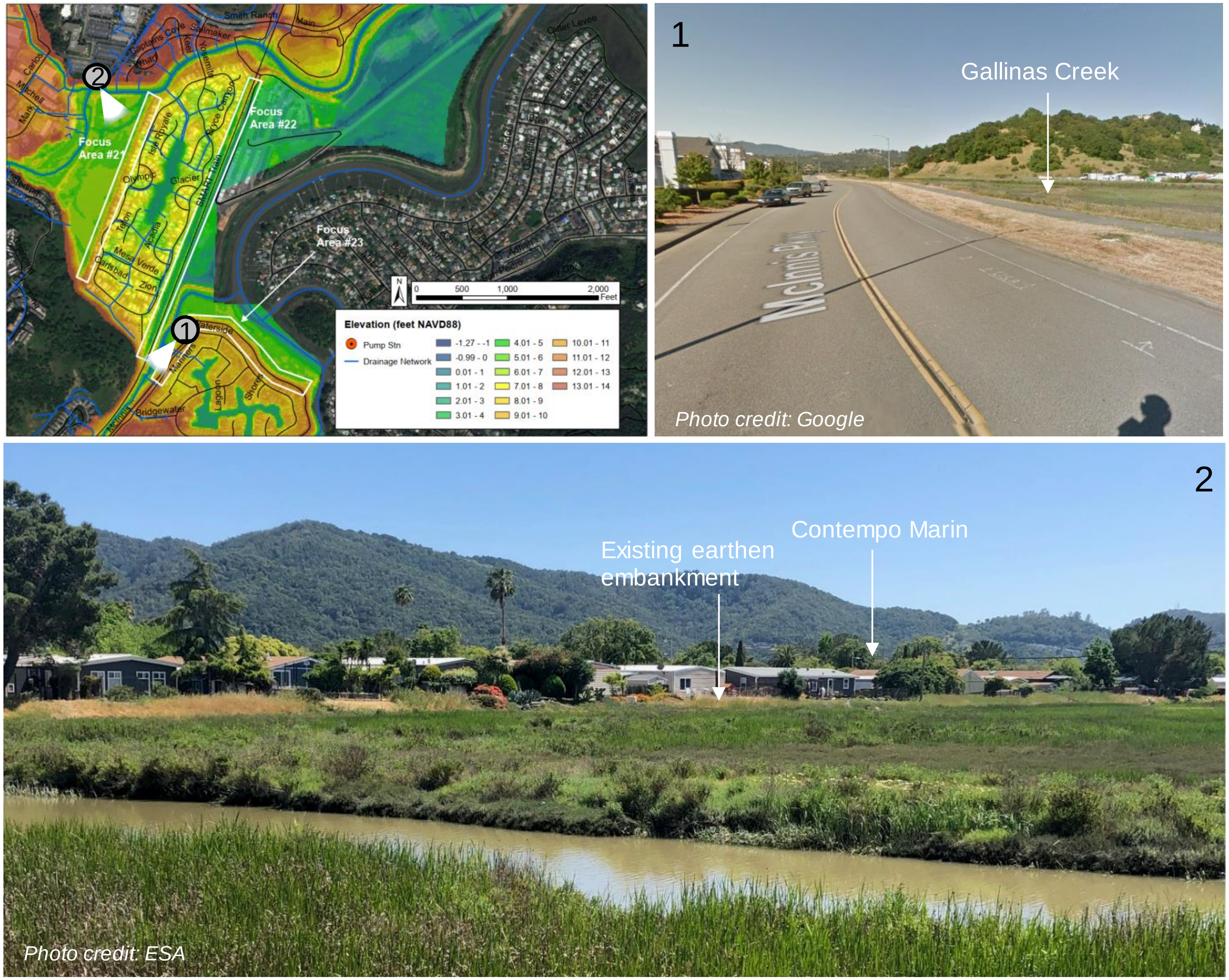


SOURCE: ESA

San Rafael SLR Vulnerability Study . D180140.00

Figure A10

Focus areas along the southern shore of San Rafael Creek



SOURCE: ESA

Figure A11
Focus areas within the Las Gallinas region

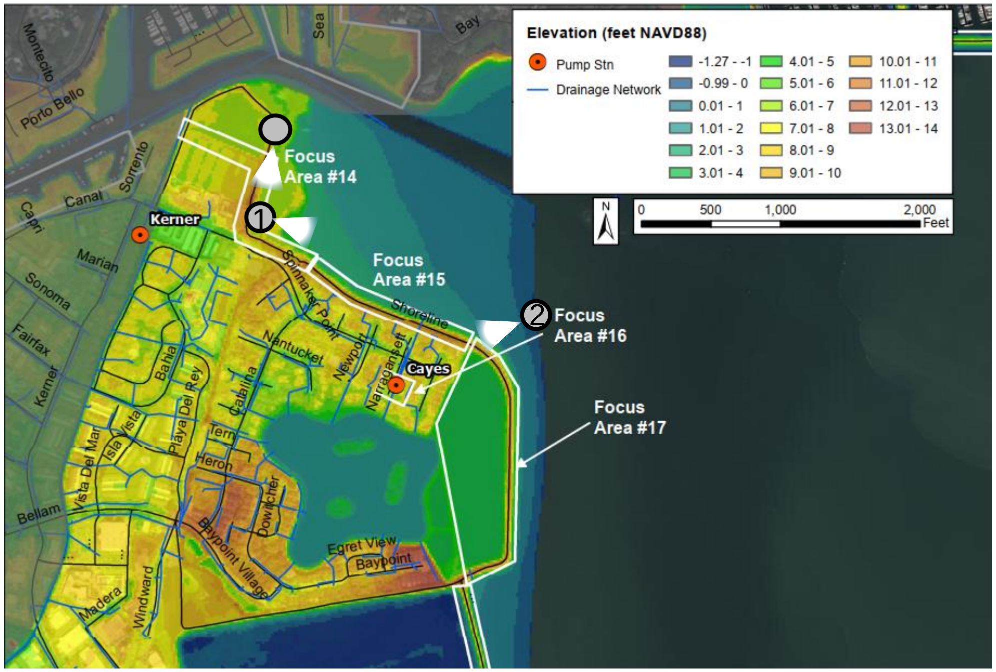


Photo credit: ESA

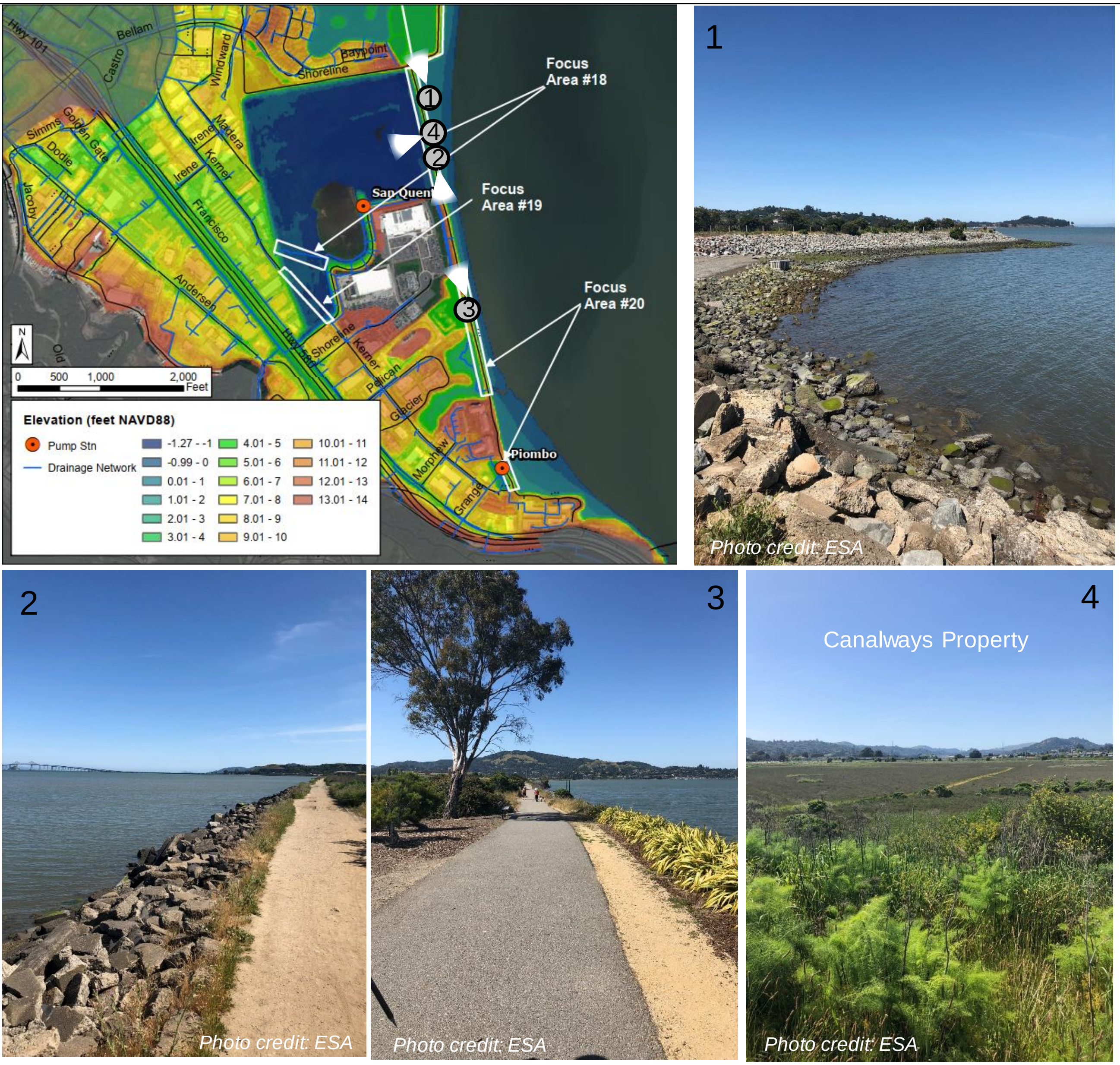
Photo credit: Google

Photo credit: ESA

SOURCE: ESA

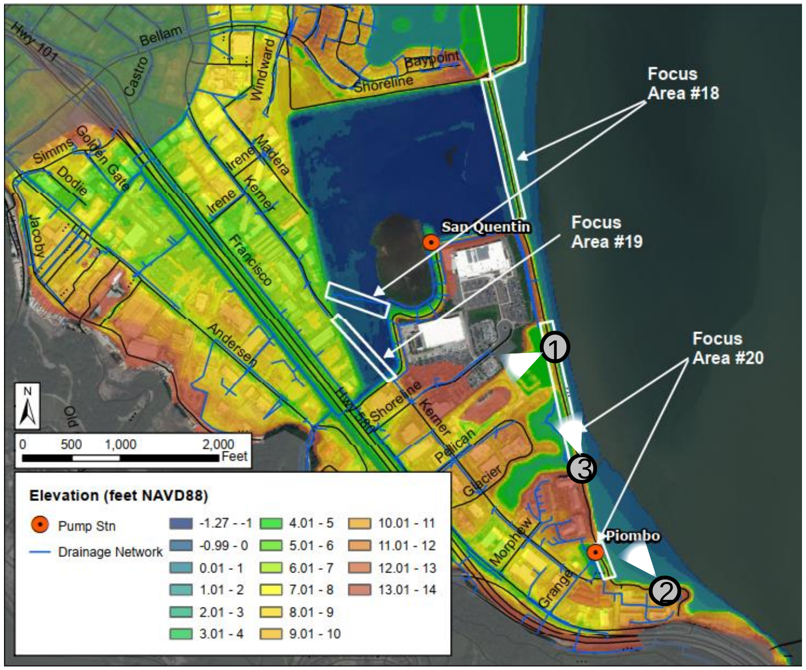
San Rafael SLR Vulnerability Study . D180140.00

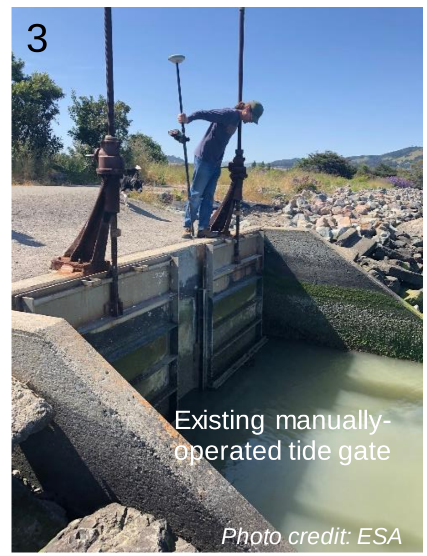
Figure A12
Focus areas near Tiscornia Marsh



SOURCE: ESA

Figure A13
Focus areas near Canalways





SOURCE: ESA

Figure A14
Focus areas near Piombo Marsh

Appendix B
Vulnerability Assessment

BVB Consulting LLC

San Rafael, CA Sea Level Rise Vulnerability Assessment

A Scenario-based analysis sea level rise and 100-year storm surge flooding along the shoreline

BRIDGIT VAN BELLEGHEM

Introduction

Climate change is affecting natural and built systems around the world. In the past century, the average global temperature has increased about 1.4°F, and average global sea level has increased 7 to 8 inches.[1] Locally, sea level at the San Francisco tide gauge has risen 8 inches over the past century. The two major causes of sea level rise are expanding warming oceans and land-based glacial and polar ice cap melt.[2]

According to the Marin County BayWAVE Vulnerability Assessment addressing sea level rise, the City of San Rafael is one of the most vulnerable jurisdictions in Marin County. Sea level rise will exacerbate the erosion, flooding, and storm impacts that already disrupt and damage San Rafael, leading to significant social, environmental, and economic impacts.

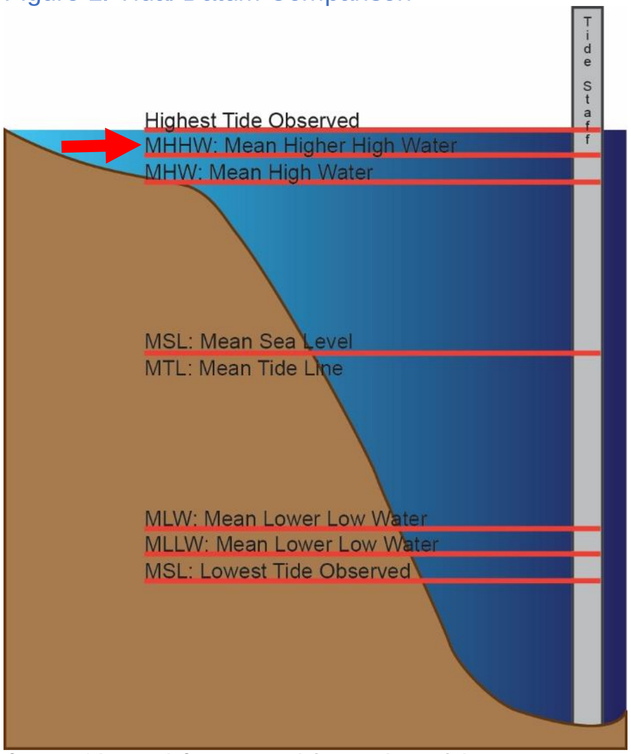
This assessment follows the BayWAVE assessment approach to refine potential flooding impacts from sea level rise on the City of San Rafael. This San Rafael Vulnerability Assessment seeks to provide context and estimates of the physical and fiscal impacts to shoreline over the coming decades. The data presented can be used to prioritize efforts, seek funding, and inform policy and development decisions. This Vulnerability Assessment is advisory and not a regulatory document or legal standard of review for action of San Rafael or other involved special government may take. Such actions are subject to the applicable local and state regulations.

Methods

Projecting and Mapping Sea Level Rise

Predicted Bay water levels used in this analysis are from the USGS Coastal Storm Modeling Systems (CoSMoS). CoSMoS scales down global and regional climate and wave models[3] and applies it to a 2010 digital elevation model (DEM) with 2-meter horizontal grid resolution elevations (North American Vertical Datum of 1988, NAVD88). CoSMoS references flood levels to mean higher high water (MHHW) tidal elevation. Mean higher high water is the average of the higher high-water level of each tidal day observed over the National Tidal Datum Epoch.[4,5] CoSMoS also provides the option to add higher water levels due to storm surges and sea level rise of different magnitudes, yielding up to 40 different possible scenarios.

Figure 1. Tidal Datum Comparison



Source: National Oceanic and Atmospheric Administration. Credit: BVB Consulting LLC

CoSMoS does not incorporate flooding from upstream or draining from pump stations. The DEM does not account for shoreline improvements made after 2010. For example, portions of the Strand and Loch Lomond Marina were elevated to meet 2015

[1] Heberger, M., Cooley, H., Moore, E. and Herrera, P. 2012 The Pacific Institute. *The Impacts of Sea Level Rise on the San Francisco Bay.* California Energy Commission. Publication number: CEC-500-2012-014.

[2] Heberger, M., Cooley, H., Moore, E. and Herrera, P. 2012 The Pacific Institute. *The Impacts of Sea Level Rise on the San Francisco Bay.* California Energy Commission. Publication number: CEC-500-2012-014.

[3] Ballard, G., Barnard, P.L., Erikson, L., Fitzgibbon, M., Higgason, K., Psaros, M., Veloz, S., Wood, J. 2014. Our Coast Our Future (OCOF). [web application]. Petaluma, California. www.pointblue.org/ocof. (Accessed: Date August 2014]).

[4] National Tidal Datum Epoch is the specific 19-year period adopted by the National Ocean Service as the official time segment over which tide observations are taken to obtain mean values (e.g., mean lower low water) for tidal data.

[5] NOAA/National Ocean Service. *Tidal Datums*. Access Oct. 19, 2015. Last updated: 10/15/2013. Center for Operational Oceanographic Products and Services. https://tidesandcurrents.noaa.gov/datum_options.html.

FEMA standards, thus, the model and maps overestimate flood vulnerabilities in these areas. Finally, the model does not incorporate planned projects and assumes no action taken to prepare or adapt for sea level rise.

Selecting the Sea Level Rise Scenarios

Because of uncertainty in the magnitude and timing of future sea level rise[6], this analysis uses a scenario approach to assess a range of tidal, storm surge, and sea level rise exposures. Both typical tidal water levels (MHHW) and the 1% annual chance storm surge were considered. The sea level rise projected for the six scenarios in Table 1 align with the upper end of the ranges from the National Research Council (2012) for San Francisco and the medium-high risk aversion scenarios from OPC (2018). San Francisco region sea level estimates as follows:

- Scenarios 1 and 2 represent the near-term projection, 10 inches, projected to occur between 2030-2040
- Scenarios 3 and 4 represent the medium-term projection, 20 inches, projected to occur between 2050-2070
- Scenarios 5 and 6 represent the long-term projection, 60 inches, projected to occur between 2090-2140

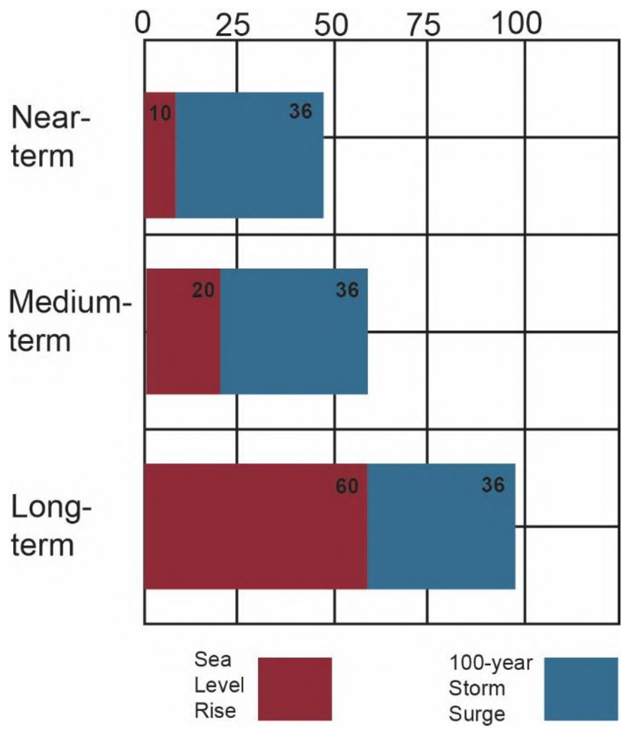
Table 1. Sea Level Rise & Storms Scenarios

Sea Level Rise Scenario		Term
1	MHHW + 10 inches SLR	Near 2030-2040
2	100-year storm + 10 inches SLR	
3	MHHW + 20 inches SLR	Medium 2050-2070
4	100-year storm + 20 inches SLR	
5	MHHW + 60 inches SRL	Long 2090-2140
6	100-year storm + 60 inches SLR	

Source: BayWAVE Vulnerability Assessment, 2017

Error! Not a valid bookmark self-reference. presents another view of the scenarios where the red lengths represent tidal MHHW flooding in sea level rise scenarios 1, 3, and 5, and the blue lengths represent the additional storm surge water level associated with a 100-year storm in scenarios 2, 4, and 6.

Figure 2. Scenarios' Associated Water Levels, in Inches



Source: BayWAVE Vulnerability Assessment, 2017

The 100-year storm surge was selected because it is a standard scenario typically used in Federal Emergency Management Agency (FEMA) mapping. A 100-year storm surge has one percent chance of being exceeded in a given year. Within the time frame of a 30-year mortgage, a 100-year storm has a nearly 30 percent chance of occurring.

Assessing Asset Flooding Vulnerability

As described in CalAdapt, sea level rise vulnerability is based on an asset's exposure, sensitivity, and adaptive capacity to higher high tides and bay surge threats. The assets identified as vulnerable for San Rafael in the BayWAVE process are represented here. The methods used in the BayWAVE Vulnerability Assessment (2017) are summarized as:

6 San Francisco Bay Conservation and Development Commission. Revised September 2008. *A Sea Level Rise Strategy for the San Francisco Bay Region*

Available digitized assets were identified using MarinMap geographic data layers for roads, trails, parks, public facilities, utility districts, buildings, and parcels. Department of Fish and Wildlife provided fishing piers, marinas, and ports. Local utility data was provided by government agencies and the California Energy Commission. The absence of an asset does not imply that an asset is not vulnerable, as the lists here in are not exhaustive. Asset data layers were generated over several years and changes to the built environment may have occurred since the asset data was updated. Thus asset counts, and associated calculations, may be off.

To determine what could be exposed to sea level rise at MHHW and/or a 100-year storm surge, CoSMoS flood hazard layers and asset data points were overlaid in a geographic computer program. Asset data points within the geographic extent of the CoSMoS layers were marked as exposed.[7] BVB Consulting LLC compiled interviews with professional managers to determine if exposed assets would be sensitive and/or adaptable to:

- Flooding during annual highest tides and/or storm surges that cause nuisance flooding,
- Inundation at one high tide a day, several days a month, that causes chronic flooding,
- Erosion and other physical changes from higher high tides and storms,
- Saltwater intrusion, and/or
- Rising water table

without human intervention. [8, 9,10, 11]

Additionally, CoSMoS flood depth at 10 inch, three feet, and five feet MHHW layers were spatially joined with assets to determine average flood depths for scenarios 1, 3, and 5 respectively. Flood depth was calculated by converting GIS vector data to raster cells, each with a flood level. For buildings, all cells underlying its footprint are averaged. Where buildings are presented as a neighborhood, a maximum building flood depth is listed. Where data is available, additional analysis summarizes how many buildings could flood in one-foot flood depth intervals ranging from 0-6 feet for scenarios 1, 3, and 5. For roads, a high and low value was calculated on the flooded line segment. Exposed road mileage is road miles. Note that flood depth data is not available for all areas and may not match exposure figures.

Additional calculations were completed using the FEMA HAZUS parameters to determine the potential monetary losses from storm damages. Losses from minor damage range from $5,000-17,000, moderate damage are assessed at $17,001+, and finally, complete loss of value if a building is destroyed.[12, 13]

Understanding full physical vulnerability requires, at a minimum, onsite inspections of utilities and base floor elevations for each building as the CoSMoS data does not account for raised floor elevations. Recording building base floor elevations is beyond the scope of this report. The city may consider doing such an assessment to determine how deep of flood waters each structure could withstand and to inform individual property elevations and the regulations that guide them.

Coastal Flood Vulnerabilities in San Rafael

Map 1 shows the furthest inland extent of the six sea level rise scenarios. Most built assets within these areas are vulnerable to 100-year storm surge and/or tidal flooding before 2100. San Rafael is the most vulnerable city in Marin County to sea level rise with respect to both land area and population affected.

The vulnerable places and assets reported in this assessment are divided into near-, medium-, and long-term time frames, each presenting potential tidal flooding impacts and storm surge impacts. Each

[7] Guidance for Incorporating Sea Level Rise into Capital Planning in San Francisco. 2014. Appen 5. OneSF Checklist

[8] Center for Science in the Earth System (CSES), University of Washington, *Conduct a Climate Resiliency Study*, Chapter 8. Conduct a Climate Change Vulnerability Assessment. http://cses.washington.edu/db/pdf/snoveretalgb574ch8.pdf

[9] Department of Transportation, Federal Highway Administration, Office of Environment and Planning, Mike Culp, IFC International, *Literature Review: Climate Change Vulnerability Assessment, Risk Assessment, and Adaptation Approaches.* http://www.fhwa.dot.gov/environment/climate_change/adaptation/publications_and_tools/vulnerability_assessment/index.cfm#Toc236233837

[10] California Energy Commission Public Interest Environmental Research Program. Adapting to Sea Level Rise: A Guide for California's Coastal Communities. 2012.

[11] Bay Conservation & Development Commission: Adapting to Rising Tides. Hayward Resilience Study. 2014.

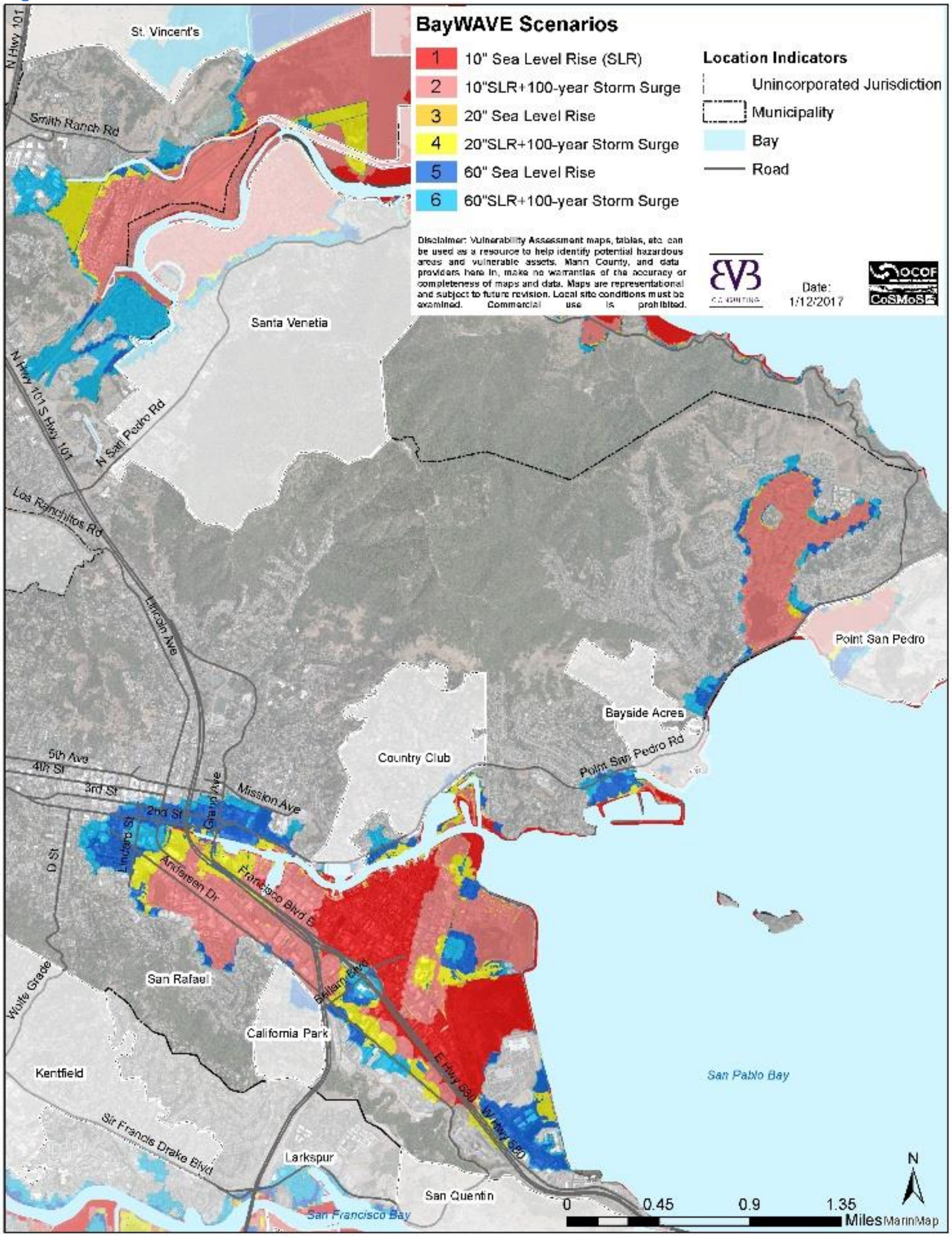
[12] Federal Emergency management Agency (FEMA) Website. Hazus. Last updated July 8, 2015. http://www.fema.gov/hazus.

[13] 2016 dollars

scenario is cumulative with the previous with the exception scenarios 2 and 3, where the extent of storm surge flooding by 2030 exceeds the extent tidal flooding could reach by 2050 in most locations. Areas flooded by 2030 experience more frequent and more severe flooding as sea levels rise to five feet.

Within each time frame, vulnerable areas are divided into sub-areas. In central San Rafael these are the Canal, Kerner, San Pedro (include Montecito and Happy Valley neighborhoods), Shoreline, Anderson/Francisco West (includes Picnic Valley and Bret Harte neighborhoods), and Downtown (includes Gerstle Park neighborhood). Near Point San Pedro is the Peacock Gap neighborhood, and in northern San Rafael the Las Gallinas area.

Map 1. San Rafael Sea Level Rise and 100-year Storm Surge Scenarios



Source: CoSMoS, Marin Map

Near-term Vulnerable Assets

In the near-term, sea level rise and storm surge impacts are concentrated in the low-lying areas in central and northern San Rafael. Several models predict flooding well beyond the shoreline into the Canal and Kerner areas, compromising multi-family housing, commercial, industrial, and recreational lands. A 100-year storm surge could also impact portions of the Anderson and Las Gallinas areas.

Tidal Flooding (MHHW) + 10 inches SLR

Tidally flooded lands at ten inches MHHW account for 449 acres, or three percent of San Rafael's land area. Affected areas are either next to the bay, estuaries, and/or surrounded by marshes bayside of Interstate 580 and US Highway 101 in central San Rafael Canal, Kerner, and San Pedro areas.

On the southern banks of the San Rafael Canal, water could reach land on both sides of the Harbor Center Marina and Harbor 555. Traveling towards the bay, tidal flooding can affect properties between San Rafael Creek and Canal Street starting at Hoag Street. These buildings include commercial and residential uses, including several apartment buildings. About midway through the block between Hoag Street and Medway Road. Kerner Boulevard marks the limit of tidal flooding north of Irene Street in the Canal area. However, at Irene Street, flooding originating from the shoreline marsh south of Spinnaker Point merges with flooding from the Canal area, impacting the area between Francisco Boulevard East and the bay to the Shoreline Path access off Francisco Boulevard East to the south at the border of the Shoreline area.

The Canal area population is about 70 percent Central and South American origin. Residents are young with larger families, lower incomes, and primarily renters compared to the rest of the city.[14] Almost one-half of residents are housing cost burdened,[15] are less likely to own cars, and more likely to ride transit.[16] These residents are not only disproportionately vulnerable to sea level rise, they will also be the first to experience the destructive forces of storm surges and higher high tides. Tidal flooding also jaunts inland beyond Francisco Boulevard East, over State Route 580 and into the rear portions of development facing Anderson Drive in the Anderson area.

As shown in Table 2, the impacted land in the Canal, Kerner, San Pedro, and Anderson a reas is broken up into 492 residential, 132 commercial, and 42 industrial parcels. These parcels contain 410 buildings, or two percent of all buildings in San Rafael. Many of these parcels contain large numbers of low-income renter households. In fact, 78 parcels covering 34 acres provide apartment homes in the Canal area. Bahia Vista Elementary School, San Rafael Fire Station 54, the Marin County Health Innovation Campus, San Rafael Municipal Marina are some of the public facilities that could flood.

Table 2. Vulnerable Parcels, Scenario 1: MHHW + 10" SLR

Land Use	#	Acres	%
Commercial	**132**	**187**	**11**
Improved	116	98	-
Unimproved	16	89	
Industrial	**48**	**22**	**17**
Residential	**492**	**46**	**3**
Multi-Family Improved	78	34	-
Multi-Family Unimproved	2	0.2	
Single Family Attached	382	5	
Single Family Improved	20	4	
Single Family Unimproved	8	3	
Tax Exempt	35	59	-

Source: MarinMap, CoSMoS

Table 3. Building Flood Depth Estimates, Scenario 1: MHHW + 10" SLR

Flood Depth (feet)	# of Buildings
0.1-1	90
1.1-2	140
2.1-3	180
3.1-4	250
4.1-5	3
5.1-6	1

[14] Census 2010
[15] Human Impact Partners. 2013. Community Health Needs Assessment Sub-County Health Indicators.
[16] Census 2010

Flood Depth (feet)	# of Buildings

Source: MarinMap, CoSMoS

The analysis presented in Table 3 divides vulnerable buildings into one-foot flood depth intervals. Most vulnerable buildings could experience flood depths less than or equal to three feet.

As see in Table 4, major roads potentially impacted by 0.8 ft sea level rise and tidal flooding if there were no levees are Bellam Boulevard, Francisco Boulevard East, Kerner Boulevard, Grand Avenue and Irwin Street. In the San Pedro area, roads bayside of Pt. San Pedro Road, such as Mooring Road, could also flood at MHHW. In total, eight road miles could experience tidal flooding, becoming impassable at least once, if not twice, a day for several hours. Drivers that venture through the salt water could damage their vehicle's mechanical and electronic systems.

US Highway 101 on- and off-ramps could flood along most of its course through the city center and at low spots of US Highway 101 where it connects with State Route 580 south of San Rafael Harbor. Preliminary conversations indicate that Caltrans is aware of the existing and arising concerns in San Rafael.17

The San Rafael Airport could experience flooding in low-lying areas. Several miles of trails, including the Bay Trail and Shoreline Path, McNear's Beach, Gallinas Creek, Pickleweed Park, and Starkweather Shoreline Park could anticipate impacts at the shoreline edges.

Utility assets, such as transmission lines, wires above and below ground, and pipelines below ground in the affected areas are vulnerable in the following ways:

- Poles and pipes could sink due to subsidence,
- Underground pipes can bend from compounding pressure forces between the water and road, or get damaged if roads erode or collapse,
- Saltwater inflow and infiltration can cause inefficiencies in wastewater treatment,
- Flood waters could prevent employees from reaching work sites.

[17] Sea Level Rise Vulnerability Assessment Interview. Caltrans. April 30, 2015. J. Peterson. D. Fahey. Marin County Development Agency. BVB Consulting LLC.

Table 4. Roads Flooded, Scenario 1: MHHW + 10” SLR

Scenario 1: Tidal Flooding 8 road miles	
Canal	**San Pedro**
Hwy 101 [C]	Bay Harbor Wy [P]
Hwy 580 [C]	Mooring Rd [L]
Bellam Blvd [L]	Sea Wy [L]
Francisco Blvd E [L]	Summit Ave [L]
Grand Ave [L]	**Kerner**
Irwin St. [L]	Hwy. 580 [C]
Canal St. [L]	Bellam Blvd. [L]
Alto St. [L]	Francisco Blvd. E [L]
Amalfi Pl. [L]	Kerner Blvd. [L]
Belvedere St. [L]	Bahia Pl. [L]
Capri Ct. [L]	Bahia Wy. [L]
Castro Ave. [L]	Bahia Cir. [L]
Charlotte Dr. [L]	Irene St. [L,P]
Elaine Wy. [L]	Market St. [L]
Fairfax St. [L]	
Front St. [L]	**Las Gallinas**
Larkspur St. [L]	Smith Ranch Airport Rd. [L]
Lido Ln. [L]	
Lisbon St. [L]	
Louise St. [L]	
Medway Rd. [L]	
Mill St. [L]	
Novato St. [L]	
Portofino Rd. [L]	
Shoreline Path	**Anderson**
Sonoma St. [L]	Golden Gate Dr. [L]
Sorrento Wy. [L]	
Tiburon St. [L]	
Verdi St. [L]	
Vivian St. [L]	

M = Marin County; C = State; L = Local; P = Private.
Source: MarinMap, CoSMoS

Table 5 lists the flooding potential for several critical assets mentioned across all sectors of daily life from deepest to shallowest levels of MHHW flood waters measured at that asset. These assets could flood at least once a day several days a month.

Table 5. Flood Inundation Depths for Representative Assets Vulnerable, Scenario 1: MHHW + 10” SLR

Asset	Scenarios		
	Near-term	Medium-term	Long-term
	1	3	5
Canal area Bay Trail & open space	10’3”	11’1”	25’4”
McInnis Park	7’6”	8’6”	10’6”
Starkweather Shoreline Park	5’4”	6’	16’3”
Pickleweed Park	5’	5’8”	8’9”
Hwy. 580 East	0-4’	0-4’10”	4”-7’8”
Kerner Blvd.	0-4’	0-4’7”	8”-7’5”
Francisco Blvd. E	0-3’10”	0-4’7”	1’-7’5”
Bellam Blvd.	0-3’5”	0-4’	0-7’3”
Canal St.	0-3’4”	1’2”-4’2”	2’-7’11”
Bahia Way	2’-3’3”	2’4”-3’11”	5’2”-6’10”
Hwy. 580 West	1”-2’10”	1”-3’7”	1”-6’5”
Bay Trail	0-2’3”	0-3’	0-10’3”
Fire Station 54	1'6"	2'7"	6'7"
San Rafael Yacht Harbor	1’2”	4’	10’4”
Municipal Harbor	1’	2’	6’
Lowrie Yacht Harbor	9”	3’7”	8’5”
Bahia Vista Elem. School/ Trinity Preschool	8”	2’3”	4’8”
Hi-Tide Boat	6”	3’4”	8’5”
Marin Yacht Club	1”	1’6”	3’9”
Health Innovation Campus/Clinics	1”	1’3”	3’
~~San Rafael Canal~~	~~Water resource~~		
Marin Lagoon	Water resource		

Source: MarinMap, CoSMoS

100-year Storm Surge + 10 inches SLR

A 100-year storm surge combined with ten inches of sea level rise, scenario 2, could flood, either in addition to or temporarily, three times as many acres than just tidal flooding alone. Roughly 1,300 acres, 1,940(10%) buildings, and 22 road miles could experience 100-year storm surge flooding. Storm surges can cause up to 3 feet of flooding. In addition to areas tidally flooded at 10 inches of sea level rise, areas flooded under 100-year storm surge conditions are:

- All areas that experience 100-year storm surge flooding in scenario 2
- Canal south to Shoreline area- Lands from Grand Avenue to Shoreline Parkway (about 2 miles south) could flood leaving a few temporary islands including Grand Ave to Bay Street, Spinnaker Point west of Baypoint Lagoon and near Shoen Park, Marin County Health Clinics, Mi Pueblo Food Center, and Target and Home Depot properties,
- San Pedro area- Along the San Rafael Canal at the Marin Yacht Club on Summit Avenue and Marina Way, and ends of Sea Way, Porto Bello Drive, and Harbor View Court, Mooring Road, and 3rd Street just before Embarcadero Way,
- Anderson area- a greater extent over and under State Route 580, US Highway 101, all of Francisco Boulevard West shopping and industrial areas into the Bret Harte neighborhood, Woodland Avenue up to Davidson Middle School, and development from State Route 580 to Anderson Drive, leaving only Simms Island dry,
- Peacock Gap area- Homes adjacent to San Pedro Lagoon and Peacock Gap golf course holes 5, 12, 14, 15, 16, and
- Las Gallinas area- Contempo Marin neighborhood and San Rafael Airport.

Of note, the Golden Gate Transit and Marin Airporter facilities and several Francisco Boulevard West shopping centers could flood. In addition, two of San Rafael's historic resources, the Litchfield Sign and French Quarter could be experience flooding.

If all the buildings exposed under this scenario are damaged, a minimum of $9.2 million in damages could occur. Damages could exceed $31.4 million if damages are more severe. Finally, assuming an average assessed value of $460,750/building, over $850 million (2016 dollars) in property could be lost.

Table 6. Roads Flooded in Near-Term Scenario 2

Scenario 2: 22 road miles	
Kerner	**Canal**
Roads in scenario 1	Roads in scenario 1
Bahia Ln. [L]	Hoag St. [L]
Bedford Cv. [L]	
Catalina Blvd. [L]	**Las Gallinas**
Duxbury Cv. [L]	Roads in scenario 1
Falmouth Cv. [L]	Acadia Ln. [L]
Gloucester Cv. [L]	Bryce Canyon Rd. [L]
Hingham Cv. [L]	Carlsbad Ct. [L]
Isla Vista Ln. [L]	Crater Lake Wy. [L]
Loma Vista Pl. [L]	Glacier Wy. [L]
Nantucket Cv. [L]	Isle Royale Ct. [L]
Narragansett Cv. [L]	McNear Dr. [L]
Newport Wy. [L]	Mesa Verde Wy. [L]
Playa Del Rey [L]	Olympic Wy. [L]
Plymouth Cv. [L]	Shenandoah Pl. [L]
Rockport Cv. [L]	Tahoe Pl. [L]
Salem Cv. [L]	Teton Ct. [L]
Spinnaker Point Dr. [L]	Yellowstone Ct. [L]
Vista Del Mar [L]	Zion Ct. [L]
Windward Wy. [L]	
San Pedro	**Anderson**
Roads in scenario 1	Roads in scenario 1
Marina Wy. [L]	Baxters Ct. [P]
Porto Bello Dr. [L]	Billou St. [L]
Pt. San Pedro Rd. [L, C]	Bret Ave. [L]
	De Luca Pl. [L]
Peacock Gap	Dolores St. [L]
Peacock Dr. [L]	Du Bois St. [L]
Lagoon Pl. [L]	Duffy Pl. [L]
Lagoon Rd. [L]	Gary Pl. [L]
Riviera Dr. [L]	Jordon St. [L]
San Marcos Pl. [L]	Lincoln Ave. [L]
Shoreline	Lovell Ave. [L]
Shoreline Pkwy. [L]	Rice Dr. [L]
	Woodland Ave. [L]

M = Marin County; C = State; L = Local; P = Private.
Source: Marin Map, COSMOS

Table 6 lists the roads that could suffer temporary storm surge flooding. Recent precedent indicates that temporary could mean days at a time, especially if coinciding with king tides. Roads that are named below would only flooding under storm conditions. San Rafael Municipal Marina and several private marinas could experience flooded facilities if barrier walls are not adequately elevated or if pier and dock pilings are not tall enough for the highest water level boats could become dislodged and damaged.

Utility assets in the affected areas would now also be vulnerable to storm damages to roads. Above ground utilities are especially vulnerable during storms due to high water and wind forces. floating debris, high winds, and falling and/or uprooting trees. In addition, several of these areas depend on storm water pump stations to remove stormwater flowing down from the uplands. Stormwater combined with higher tides and storm surges would require the pumps to work harder, increasing wear and the potential to fail.

Medium-term Vulnerable Assets

In the medium-term, impacts to the areas and assets affected by high tides in the near-term worsen. Water levels are higher, and flooding reaches properties more often. Additionally, most areas that previously flooding under 100-year storm surge conditions under scenario 2 could experience tidal flooding at MHHW.

Tidal Flooding (MHHW) + 20 inches SLR

At this level of flooding, nearly 900 acres could be wet at MHHW. These tidally flooded lands contain 883 residential, 234 commercial, and 104 industrial parcels with 1,088 (16%) buildings. These figures indicate 20 percent of commercial parcels and an alarming 40 percent of industrial parcels in central San Rafael areas would be vulnerable to tidal flooding. Most vulnerable buildings could experience inundation depths up to three feet, though some buildings could experience up to six feet of tidal flooding.

In addition to the areas that experienced tidal flooding in scenario 1 and 100-year storm surge flooding in scenario 2, the following could now experience flooding at MHHW:

- Canal area- Pickleweed Park up to the Albert J. Boro Community Center,
- Shoreline area- Starkweather Shoreline Park,
- San Pedro area- Montecito buildings on Irwin, 2nd, and 3rd Streets including gas stations, grocery stores, offices, and several businesses; east of the Montecito Shopping Plaza and over San Pedro Road fronting San Rafael High School,
- Downtown area- Up to Albert Park at the edges of Gerstle Park neighborhood
- Peacock Gap area- Point San Pedro Road at Peacock Drive extending over the lower portion of Peacock Gap Golf Course and more of the homes adjacent to it, and
- Las Gallinas area- Contempo Marin.

Table 7. Scenario 3: Vulnerable Parcels

Land Use	#	Ac.	%
Commercial	**224**	**375**	**19**
Improved	213	267	-
Unimproved	21	108	
Industrial	**104**	**51**	**37**
Improved	**97**	**50**	-
Unimproved	**7**	**1**	
Residential	**883**	**88**	**6**
Multi-Family Improved	104	44	-
Multi-Family Unimproved	3	0.6	
Single Family Attached	634	10	
Single Family Improved	127	31	
Single Family Unimproved	12	3	
Tax Exempt	75	203	

Source: MarinMap, CoSMoS

Table 8. Flood Depth Estimates at MHHW + 3 ft SLR

Flood Depth (feet)	# of Buildings
0.1-1	212
1.1-2	251
2.1-3	206
3.1-4	102
4.1-5	9
5.1-6	1
6.1-7	212

Source: MarinMap, CoSMoS

Table 9. Scenario 3: Vulnerable Roads

Scenario 3: 15 road miles
Roads in scenario 1 Francisco Blvd W [L]

L = Local
Source: MarinMap, CoSMoS

Francisco Boulevard West is the only new addition to roads vulnerable to tidal flooding in this scenario. The roads identified under scenario 1 would become impassable for longer periods with deeper waters. Emergency services will continue to face challenges accessing those in need in vulnerable areas, especially service from Fire Stations 54, 52 and 55.

Table 10 provides flood depths at MHHW for example vulnerable assets in scenario 3.

Table 10. Scenario 3: Example Vulnerable Assets

Asset	Scenarios		
	Near-term 1	Medium-term 3	Long-term 5
Beach Park		8’11”	11’10”
Peacock Gap Park		6’3”	9’
Grand Ave.		0-6’	7”-9’
Andersen Dr.		0-5’	3”-8”
Francisco Blvd. W		0-4’9”	1’8”-9’5”
Peacock Dr.		0-4’	9”-6’8”
SMART Rail		1’8”-3’9”	1’2”-6’8”
Loch Lomond Marina		3’7”	9’7”
Peacock Gap homes		1”-3’6”	2”-8’9”
San Rafael Airport		3’5”	8’10”
Canal Neighborhood		1”-3’	2”-7’8”
Marin Lagoon		5“-2’5”	1’-6’
US 101 North		0-2’5”	6”-5’3”
Davidson Middle School		2’3”	5’9”
Pt. San Pedro Rd.		0-2’2”	4”-5’10”
San Rafael Yacht Club		2’2”	5’7”
US 101S off ramp		0-2’	1’4”-5’
GGBHTD Depot/ Headquarters		1’8”-2’	4’2”-5’
Downtown		1”-1’3”	3”-3’3”
PG&E Office/ Yard		1’2”	3’
Pickleweed Park facilities		1’2”	3’
Montecito Plaza		1’	2’3”
Transit Center		11”	2’5”
Marin Community Clinic		10”	3’8”
San Rafael High School		10”	2’
3rd Street		5”	10”-3’10”

Source: Marin Map, COSMOS

100-year Storm Surge + 20 inches SLR
Roughly 1,500 acres, 2,100 (11%) buildings, and 27 road miles could be vulnerable at three feet of sea level rise and a 100-year storm surge is the already vulnerable areas. Recovering from these storm damages would be costly. According to the

FEMA Hazus model, minor damage to buildings could reach almost $11 million, while moderate damage could exceed $35 million. Destruction would cost nearly $1 billion. Storm surge flooding would flood all previously identified areas and reach:

- Downtown area- Further downtown to C Street and in to the Gerstle Park neighborhood,
- San Pedro area- Further into Montecito to nearly 4th Street, including the Montecito Shopping Plaza, along San Pedro Road after Country Club (unincorporated), north of Marin Yatch Club, and just after Bayside Acres (unincorporated) in Glenwood, and
- Peacock Gap area- Larger segment of San Pedro Road, golf course, and adjacent homes.

Table 11 lists the roads that could suffer in scenario 4. Roads identified by name would only experience flooding in combination with storm surges, avoiding tidal flooding at this water level.

Table 11. Scenario 4: Vulnerable Roads

Scenario 4: 27 road miles	
Canal	**San Pedro**
Roads in scenarios 1-3 Yacht Club Dr [P]	Roads in scenarios 1-3 3rd St [L] Aqua Vista Dr [L] Loch Lomond Dr [L] Royal Ct [L]
Kerner	
Roads in scenarios 1-3 Baypoint Dr [L] Baypoint Village Dr [L] Egret View [L] Pelican Wy [L]	**Peacock Gap**
Anderson	Roads in scenarios 1-3 Biscayne Dr [L]
Simms St [L] Dodie St [L] Lindaro St [L]	**Las Gallinas**
	Roads in scenarios 1-3
	Downtown
	2nd St [L] 3rd St [L]

M = Marin County; C = State; L = Local; P = Private.
Source: Marin Map, COSMOS

Long-term Vulnerable Assets

By 2100, significant portions of San Rafael could experience tidal flooding, and an even larger area could experience 100-year storm surge flooding. The areas closest to the shoreline could become undevelopable without intervention, and in some cases relocation may be warranted.

During a storm-surge, these areas experience significantly more flooding, and could reach further inland, especially in the Gerstle Park and Marin Lagoon neighborhoods.

Tidal Flooding (MHHW) + 60 inches SLR
At five feet of sea level rise, 1,856 acres, roughly 13 percent of San Rafael's land area, could be exposed to tidal flooding. At this level of flooding, 40 percent of commercial and 60 percent of industrial parcels in the city could experience tidal flooding and potentially become unusable. Nearly 15 percent of residential parcels could flood, affecting thousands of homes, many of them the most affordable neighborhoods. For instance, 136 parcels on 54 acres of multi-family housing could experience tidal flooding.

Table 12. Parcels Vulnerable to Tidal Flooding At 5 feet of Sea Level Rise

Land Use	#	Ac.	%
Commercial	**473**	**676**	**40**
Improved	419	527	
Unimproved	54	149	
Industrial	**170**	**88**	**61**
Improved	153	83	
Unimproved	17	5	
Residential	**1,798**	**196**	**12**
Mobile Home	154	1	
Multi-Family Improved	136	54	
Multi-Family Unimproved	4	1	
Single Family Attached	1,084	38	
Single Family Improved	390	76	
Single Family Unimproved	27	26	
Tax Exempt	182	65.5	

Source: MarinMap, CoSMoS

Table 13. Flood Level Estimates* at 5 feet MHHW

Flood Depth (feet)	# of Buildings
0.1-1	108
1.1-2	228
2.1-3	346

Flood Depth (feet)	# of Buildings
3.1-4	548
4.1-5	401
5.1-6	360
6.1-7	215
7.1- 8	190
8.1-9	26

Source: Marin Map, COSMOS

Nearly 2,500 buildings, or 13 percent of buildings in San Rafael, could face some level of tidal flooding. More than 600 buildings could flood with up to three feet, more than 1,000 could flood with between three and six feet, and more than 400 could flood with up to nine feet of saltwater at mean higher high water. Buildings that flood to these extremes on a regular basis are not useable.

High tides would bring chronic flooding all areas and neighborhoods presented under previous tidal and 100-year storm surge scenarios and could extend further in to the low-lying inland areas in central and northern San Rafael and Peacock Gap. Areas that could experience tidal flooding that did not experience it in scenario 3 include:

- Kerner area- Housing on Spinnaker Point,
- Anderson area- Northern edge of Picnic Valley at Woodland Avenue,
- Downtown area- Downtown and Gerstle Park from A to C streets to the west and nearly Bayview Street to the south, leaving a small island of development west of San Rafael Creek to where A Street turns into Anderson Drive, US Highway 101 when Mahon Creek overflows its banks,
- San Pedro area- Up to 4th Street, over Point San Pedro Road into San Rafael High School, north of Loch Lormond Marina (may have been resolved in 2016 by elevation increases to property),
- Peacock Gap area- over Point San Pedro Road from Glenwood to Chapel Cove Road, and
- Las Gallinas area- McInnis Park soccer fields.

lists the roads and Table 15 lists a few assets and the flood depths that could flood at MHHW on a regular basis in scenario 5 within these areas.

Table 14. Scenario 5: Vulnerable Roads

Scenario 5: 35 road miles	
Canal	**San Pedro**
Roads in scenarios 1-4	Roads in scenarios 1-4
Lido Ln [L]	4th St [L]
Kerner	Embarcadero Wy [L]
Roads in scenarios 1-4	Leith Ln [L]
Avocet Ct [P]	Lochinvar Rd [L]
Dowitcher Wy [P]	Mary St [L]
Glacier Pt [L]	Park St [L]
Grange Ave [L]	Summit Ave [L]
Morphew St [L]	Surfwood Cir [L]
Piombo Pl [L]	Union St [L]
Portsmouth Cv [L]	**Peacock Gap**
Tern Ct [P]	Roads in scenarios 1-4
Turnstone Dr [P]	Chapel Cove Dr [L]
	Knight Dr [L]
	Peacock Ln [L]
	Riviera Pl [L]
	Silk Oak Cir [L]
Anderson	**Downtown**
Roads in scenarios 1-4	Roads in scenarios 1-4
Albert Park Ln [L]	A St [L]
Jacoby St [L]	B St [L]
Warner Ct [L]	Hetherton St [L]
Las Gallinas	Brooks St [L]
Roads in scenarios 1-4	Cijos St [L]
	Mission Ave [L]
	Lootens Pl [L]
	Ritter St [L]

M = Marin County; C = State; L = Local; P = Private.

Source: Marin Map, COSMOS

Table 15. Scenario 5: Example Vulnerable Assets

Asset	Scenarios		
	Near-term	Medium-term	Long-term
	1	3	5
SMART rail	-	-	1"-10'3"
Lincoln Ave.	-	-	10"-7'4"
Schoen Park	-	-	4'2"
4th St.	-	-	1'-3'5"
2nd St.	-	-	1'-3'4"
Ritter Clinic	-	-	2'10"
Hetherton St.	-	-	1'4"-2'4"
Marin County Emergency Services	-	-	2'2"
Peacock Ln.	-	-	1'4"-1'11"

Source: MarinMap, CoSMoS

100-year Storm Surge + 60 inches SLR

By scenario 6, 2,120 acres could be exposed to flooding, and all but about 300 acres would also experience tidal flooding. This flooded area in central San Rafael contains 75 percent of San Rafael's industrial parcels. Moreover, about 3,250 existing buildings (18%) could experience flood damage. Many could expect at least 1 to 3 feet of storm surge flooding. Downtown, buildings are older and not reinforced to withstand flooding. These buildings are primarily mixed-use, with businesses and housing, or commercial. Most single-family homes in the low-lying areas of San Rafael are one- and two-story homes, built in the Victorian era, the earlier part of the 20th century, post-WWII, with some modern homes interspersed and concentrated along the shoreline.[18]

FEMA Hazus post-disaster cost estimates for damage to buildings and their contents estimates that if all the buildings vulnerable in scenario 6 experience minor damage up to $16 million in damages could occur. If all these buildings were to be destroyed, the worst possible outcome, up to $1.5 billion (2016 dollars) in assessed structural value could be lost. By the time these impacts occur, the values would likely be higher, especially market value.

Areas that could experience flooding under this scenario that avoided flooding under previous scenarios are:

- San Pedro area- After Country Club over Pt. San Pedro Road south of Marin Boulevard,
- Downtown area- Bayview Street in Gerstle Park
- Anderson area- further into the Bret Harte and Picnic Valley neighborhoods.
- Las Gallinas area- Marin Lagoon and the commercial light industrial area north of Contempo Marin

lists the roads that could experience nuisance flooding in scenario 6. Named roads would only flood under storm surge conditions in this time period. Those that fall under previous scenarios have already experienced flooding under the previous scenarios.

Table 16. Scenario 6: Vulnerable Roads

Scenario 6: 41 road miles	
Canal	**San Pedro**
Roads in scenarios 1-5	Roads in scenarios 1-5 Loma Linda Rd. [L] Main Dr. [L] San Pedro Cv. [P]
Kerner	
Roads in scenarios 1-5 Newport Wy. [L]	**Peacock Gap**
Downtown	Roads in scenarios 1-5 Milano Pl. [L] Riviera Manor [L]
Roads in scenarios 1-5 Bayview St. [L] C St. [L] Commercial Pl. [L]	
Anderson	**Las Gallinas**
Roads in scenarios 1-5 Octavia St. [L] Taylor St. [L] Willow St. [L]	Roads in scenarios 1-5 Smith Ranch Rd. [L] Bridgewater Dr. [L] Mariners Cir. [L] Mark Dr. [L] McInnis Pkwy. [L] Mitchell Blvd. [L] Waterside Cir. [L] Paul Dr. [L] Sandpiper Ct. [L] Shores Ct. [L]

M = Marin County; C = State; L = Local; P = Private.

Source: Marin Map, COSMOS

This level of flooding would be highly destructive and devastating to thousands of residents, business owners, and workers who depend on the roads, buildings, and utilities in the vulnerable areas.

[18] BCDC. March 2015 Stronger Housing Safer Communities. Strategies for Seismic and Flood Risk. Summary Report. San Rafael Profile: http://resilience.abag.ca.gov/wp-content/documents/housing/San%20Rafael%20Community%20Profile_final_v2.pdf

Appendix C
Cost Estimates

<u>Measure BF-2</u>

Raise levee to FEMA-accredited level

Construction Costs

Line #	Item	Quantity (FT)	Unit	Unit Cost	Cost
1	Raise flood wall	1600	LF	$1,000	$1,600,000
Contingency				30%	$480,000
Subtotal: Construction					$2,080,000

Other Costs

Design	20%	$416,000
Environmental Compliance & Permitting	20%	$416,000
Project Management	2%	$41,600
Construction Admin/Inspection	2%	$41,600
Project Contingency	10%	$208,000

Total cost	**$3,200,000**

Measure BF-3

Raise levee to FEMA-accredited level

Construction Costs

Line #	Item	Quantity (FT)	Unit	Unit Cost	Cost
1	Raise shoreline levee	1600	LF	$1,000	$1,600,000
Contingency				30%	$480,000
Subtotal: Construction					$2,080,000

Other Costs

Design	20%	$416,000
Environmental Compliance & Permitting	20%	$416,000
Project Management	2%	$41,600
Construction Admin/Inspection	2%	$41,600
Project Contingency	10%	$208,000

Total cost	**$3,200,000**

Measure BF-5

Raise portions of Kerner Dr to prevent flooding within Target and Piombo marshes

Construction Costs

Line #	Item	Quantity (FT)	Unit	Unit Cost	Cost
1	Raise shoreline levee	4000	LF	$1,000	$4,000,000
Contingency				30%	$1,200,000
Subtotal: Construction					$5,200,000

Other Costs

Design	20%	$1,040,000
Environmental Compliance & Permitting	20%	$1,040,000
Project Management	2%	$104,000
Construction Admin/Inspection	2%	$104,000
Project Contingency	10%	$520,000

Total cost	**$8,000,000**

Measure CS-1

Raise low-lying portion of shoreline

Construction Costs

Line #	Item	Quantity (FT)	Unit	Unit Cost	Cost
1	Raise shoreline	50	LS	$1,000	$50,000
Contingency				30%	$15,000
Subtotal: Construction					$65,000

Other Costs

Design	20%	$13,000
Environmental Compliance & Permitting	20%	$13,000
Project Management	2%	$1,300
Construction Admin/Inspection	2%	$1,300
Project Contingency	10%	$6,500

Total cost	**$100,000**

Measure CN-1

Install flood walls on Mahon Creek from San Rafael Canal to B St

Construction Costs

Line #	Item	Quantity (FT)	Unit	Unit Cost	Cost
1	Install new floodwall	6600	LF	$2,000	$13,200,000
Contingency				30%	$3,960,000
Subtotal: Construction					$17,160,000

Other Costs

Design	20%	$3,432,000
Environmental Compliance & Permitting	20%	$3,432,000
Project Management	2%	$343,200
Construction Admin/Inspection	2%	$343,200
Project Contingency	10%	$1,716,000

Total cost	**$26,400,000**

Measure CN-2

Install flood wall on Irwin Creek from San Rafael Canal to Mission Ave

Construction Costs

Line #	Item	Quantity (FT)	Unit	Unit Cost	Cost
1	Install new floodwalls	2800	LF	$2,000	$5,600,000
Contingency				30%	$1,680,000
Subtotal: Construction					$7,280,000

Other Costs

Design	20%	$1,456,000
Environmental Compliance & Permitting	20%	$1,456,000
Project Management	2%	$145,600
Construction Admin/Inspection	2%	$145,600
Project Contingency	10%	$728,000

Total cost	**$11,200,000**

<u>Measure CN-4</u>

Install one-way flow valve on Node HW195

Construction Costs

Line #	Item	Quantity	Unit	Unit Cost	Cost
1	Underground pipeline inspection	1	LS	$5,000	$5,000
2	Retrofit storm drain	1	EA	$6,000	$6,000
Contingency				30%	$1,500
Subtotal: Construction					$12,500

Other Costs

Design	20%	$2,500
Environmental Compliance & Permitting	20%	$2,500
Project Management	2%	$250
Construction Admin/Inspection	2%	$250
Project Contingency	10%	$1,250

Total cost	**$19,000**

Measure CN-5

a) Install one-way flow valve on Node N477

Construction Costs

Line #	Item	Quantity	Unit	Unit Cost	Cost
1	Underground pipeline inspection	1	LS	$5,000	$5,000
2	Retrofit storm drain	1	EA	$6,000	$6,000
Contingency				30%	$1,500
Subtotal: Construction					$12,500

Other Costs

Design	20%	$2,500
Environmental Compliance & Permitting	20%	$2,500
Project Management	2%	$250
Construction Admin/Inspection	2%	$250
Project Contingency	10%	$1,250

Total cost	**$19,000**

b) Raise low-lying portion of shoreline

Construction Costs

Line #	Item	Length (FT)	Unit	Unit Cost	Cost
1	Raised levee	700	LF	$1,000	$700,000
Contingency				30%	$210,000
Subtotal: Construction					$910,000

Other Costs

Design	20%	$182,000
Environmental Compliance & Permitting	20%	$182,000
Project Management	2%	$18,200
Construction Admin/Inspection	2%	$18,200
Project Contingency	10%	$91,000

Total cost	**$1,400,000**

Measure CN-6

a) Raise low-lying portion of shoreline

Construction Costs

Line #	Item	Quantity (FT)	Unit	Unit Cost	Cost
1	Raised levee	800	LF	$1,000	$800,000
Contingency				30%	$240,000
Subtotal: Construction					$1,040,000

Other Costs

Design	20%	$208,000
Environmental Compliance & Permitting	20%	$208,000
Project Management	2%	$20,800
Construction Admin/Inspection	2%	$20,800
Project Contingency	10%	$104,000

Total cost		**$1,600,000**

b) Install one-way flow valve on Node N909

Construction Costs

Line #	Item	Quantity	Unit	Unit Cost	Cost
1	Underground pipeline inspection	1	LS	$5,000	$5,000
2	Retrofit storm drain	1	EA	$6,000	$6,000
Contingency				30%	$1,500
Subtotal: Construction					$12,500

Other Costs

Design	20%	$2,500
Environmental Compliance & Permitting	20%	$2,500
Project Management	2%	$250
Construction Admin/Inspection	2%	$250
Project Contingency	10%	$1,250

Total cost		**$19,000**

Measure LL-1

Study of flooding at the intersection to determine adaptation measures

Construction Costs

Line #	Item	Quantity	Unit	Unit Cost	Cost
1	Topographic survey and review of subgrade storage information from EIR/EIS	1	LS	$10,000	$10,000
2	Hydrologic study with HEC-RAS	1	LS	$25,000	$25,000
Contingency				30%	$3,000
Subtotal: (	Study				$38,000

Other Costs

Design	0%	$0
Environmental Compliance & Permitting	0%	$0
Project Management	2%	$760
Construction Admin/Inspection	0%	$0
Project Contingency	10%	$3,800

Total cost	**$43,000**

Measure SP-1

a) Levee widening with road re-alignment

Construction Costs

Line #	Item	Quantity	Unit	Unit Cost	Cost
1	re-align road	3200	LF	$2,000	$6,400,000
2	construct new levee at shore edge	3200	LF	$1,000	$3,200,000
Contingency				30%	$1,920,000
Subtotal: Construction					$11,520,000

Other Costs

Design	20%	$2,304,000
Environmental Compliance & Permitting	20%	$2,304,000
Project Management	2%	$230,400
Construction Admin/Inspection	2%	$230,400
Project Contingency	10%	$1,152,000

Total cost	**$17,700,000**

b) Install new floodwall

Construction Costs

Line #	Item	Quantity (FT)	Unit	Unit Cost	Cost
1	Install new floodwall	3200	LF	$2,000	$6,400,000
Contingency				30%	$1,920,000
Subtotal: Construction					$8,320,000

Other Costs

Design	20%	$1,664,000
Environmental Compliance & Permitting	20%	$1,664,000
Project Management	2%	$166,400
Construction Admin/Inspection	2%	$166,400
Project Contingency	10%	$832,000

Total cost	**$12,800,000**

Measure SP-2

Install new side-hinge tide gates (Node HW542)

Construction Costs

Line #	Item	Quantity	Unit	Unit Cost	Cost
1	Install new HDPE pipeline under roadway	100	LF	$350	$35,000
2	Install new tide gates	2	LS	$7,000	$14,000
3	allowance for new RSP, concrete headwall	1	LS	$30,000	$30,000
Contingency				30%	$10,500
Subtotal: Construction					$89,500

Other Costs

Design	20%	$17,900
Environmental Compliance & Permitting	20%	$17,900
Project Management	2%	$1,790
Construction Admin/Inspection	2%	$1,790
Project Contingency	10%	$8,950

Total cost	**$140,000**

Geotechnical Investigation

GEOTECHNICAL INVESTIGATION

RESTORE ERODED AND DIKED MARSH
TISCORNIA MARSH HABITAT RESTORATION
SAN RAFAEL, CALIFORNIA

Project No. 923.01
January 14, 2021

Prepared by

Hultgren – Tillis Engineers

January 14, 2021
Project No. 923.01

Environmental Science Associates
180 Grand Avenue, Suite 1050
Oakland, California 94612

Attention: Mr. Dane Behrens

Geotechnical Investigation
Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Dear Mr. Behrens:

We performed a geotechnical investigation for the proposed Restore Eroded and Diked Marsh alternative as part of the Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation project in San Rafael, California in accordance with the Subcontractor Agreement dated October 28, 2019. The results of the investigation are presented in the attached report.

It was a pleasure working with you on this project. If you have any questions, please call.

Sincerely,

Hultgren – Tillis Engineers

Callan J. Yu
Geotechnical Engineer

R. Kevin Tillis
Geotechnical Engineer

CJY:RKT:lm:la

cc: Ann Borgonovo, Environmental Science Associates (via email)

File Name. 92301R01 Levee

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APPENDIX F – Seismic Deformation

I. INTRODUCTION

This report presents the results of our geotechnical investigation for the proposed Restore Eroded and Diked Marsh alternative as part of the Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation project in San Rafael, California. The project is located on the south bank of the San Rafael Creek adjacent to Pickleweed Park. A vicinity map showing the location of the site is presented on Plate 1. The site is shown on the Site Plan, Plate 2.

The project elements consist of tidal restoration of existing upland landside areas and redeveloping former tidal bayside marsh areas.

The upland landside area habitat improvements include constructing a new setback ecotone levee within the existing 4 to 8 acres diked marsh and rehabilitating the existing levees with habitat transition slopes. The new setback levee is approximately 600-feet-long and located near the northern edge of the soccer field. The new setback levee will be about 7 feet tall and include an ecotone slope. The existing levee rehabilitation includes raising and offsetting the levee crest. The existing levee raising extents are about 550 feet long and located east of the soccer field. The offset levee alignment extents are about 450 feet long and adjacent to Canal Street. Borrow material for levee fill will be imported to the site.

The existing tidal habitat marsh has experienced considerable erosion along its bayward edge, retreating as much as 200 feet and losing approximately 3 acres over the past 30 years. The tidal bayside marsh area habitat improvements include expanding the previously eroded tidal marsh and constructing a coarse beach and rock jetty. The project will restore approximately 10 to 15 acres of tidal marsh habitat to historic conditions. The eroded tidal marsh area will be restored to previous elevations by placing dredged fill. The coarse beach and rock jetty will protect the dredged fill from erosion.

Topographic data provided by Environmental Science Associates (ESA) is based on the North American Vertical Datum of 1988 (NAVD88). Unless otherwise specifically noted, all elevations in this report refer to the NAVD88.

Our scope of services was outlined in the Subcontractor Agreement dated October 28, 2019. Our services consisted of conducting a geotechnical investigation that included subsurface exploration for the proposed levee alignment, laboratory testing, and developing conclusions and recommendations regarding geotechnical aspects of the project. The results of our geotechnical investigation are presented in this report. The tidal marsh restoration and dredged containment was initially proposed as a design-build project. The project is currently considering additional design for plans and specifications for contractor bid. We performed geotechnical engineering analyses using presumptive soil parameters and developed preliminary design and construction configurations. Additional geotechnical exploration will be needed for final design.

II. FIELD EXPLORATION AND LABORATORY TESTING

A. Field Exploration

We explored subsurface conditions along the existing levee and proposed new setback ecotone levee alignment by advancing Cone Penetration Tests (CPTs) and drilling borings. The approximate locations of the CPTs and borings are shown on the Site Plan, Plate 2.

1. Cone Penetration Tests

We explored subsurface conditions on November 1 and 4, 2019 by pushing five CPTs to depths of about 51.5 to 87.5 feet below existing grade. The CPTs were performed by our subcontractor with a 25-ton truck-mounted CPT rig. After pushing each CPT, the holes were backfilled with grout. The CPT logs are presented in Appendix A, Plates A-1 through A-5. Soil descriptions on the CPT logs are in general accordance with the CPT Soil Behavior Type Legend presented on Plate A-6. Pore pressure dissipation test results are presented in Plates A-7 and A-8.

2. Borings

We explored subsurface conditions on November 7 and November 8, 2019 by drilling six borings to depths of 17.5 to 51.5 feet below existing grade. Our subcontractor drilled the borings with truck-mounted hollow stem auger drilling equipment. We collected samples with a 2.5-inch outside diameter (OD), 1.9-inch inside diameter (ID) split barrel sampler or 3.0-inch OD, 2.87-inch ID Shelby tubes. The split barrel sampler was driven with a 140-pound hammer dropping approximately 30-inches for a penetration depth of up to 18-inches. The hammer utilized an automatic trip system. The Shelby tubes were advanced into the ground by hydraulic pressure.

We performed additional subsurface conditions on February 28, 2020 by conducting four hand auger borings to depths of 11 to 12.5 feet below existing grade. The hand auger borings were performed with a 3-inch diameter hydraulic powered hand auger tool. Our subcontractor collected samples with 3.0-inch OD, 2.87-inch ID Shelby tubes.

Our engineer logged the borings and recorded blow counts from driving the samplers. We recovered samples from the borings for further visual classification and for selecting materials for laboratory testing. Our engineer used a pocket penetrometer to evaluate unconfined compressive strength or a torvane to evaluate the soil shear strength. The drilled borings were backfilled with neat cement grout upon completion. The hand auger borings were backfilled with tamped spoils.

We converted the field penetration resistance obtained while driving the 2.5-inch O.D. sampler to equivalent SPT N-value blow counts by multiplying by 0.8 to account for sampler size and 1.25 to account for the hammer energy. The two corrections were offsetting, resulting in a 1.0 correction factor. Soil descriptions and equivalent SPT N-value blow counts are shown on the Logs of Borings, Appendix B, Plates B-1 through B-13.

The soil descriptions on the logs of boring are presented in general accordance with the Soil Classification System presented on Plate B-14, and laboratory test results are presented in the manner described by the Key to Test Data.

B. Laboratory Testing

The laboratory test results are presented in Appendix C. The laboratory tests consisted of moisture content, dry density, and organic content measurements, Atterberg limits, sieve analysis, unconsolidated-undrained triaxial shear strength (TxUU) tests, and consolidation tests. The moisture content, dry density and organic content measurements are presented on the individual boring logs. Atterberg limits test results are shown on Plate C-1. Sieve analysis test results are shown on Plate C-2. TxUU test results are presented on Plates C-3 through C-9. The consolidation and associated time-rate plots are presented on Plates C-10 through C-21.

A hand-held vane shear (Geonor Model H-60), commonly used to measure shear strength in situ, was used to measure shear strength within select Shelby tube samples. The vane shear data was modified by using a Bjerrum's vane correction factor (μ) of 0.85 in correlation with the plasticity index. The vane shear measurements are presented on the individual boring logs.

III. SITE CONDITIONS

A. Geologic Setting

The present configuration of the greater San Francisco Bay area, including the site, began to form after the last ice age when the sea level rose, flooding the valleys. Eroded fine-grained silt and clay particles were carried down streams to the bay, where they met the salty and relatively quiet bay waters. There they settled to form the highly plastic clay and silt estuary deposit known as San Francisco Bay Mud (Bay Mud). The accretion of Bay Mud formed mudflats and marshlands. The marshlands were diked and reclaimed in the early- to mid-1900s.

Blake, Graymer, Jones, and Soule published a geologic map for parts of Marin County in 2000. Selected portions of their geologic map and the descriptions of map units are presented on Plate 3. The geology map indicates artificial fill over marine and marsh deposits (Qmf) within the study area boundaries. The study area is mapped as artificial fill because it has been diked and reclaimed.

The geologic map by Goldman in 1969, presented on Plate 4, indicates that the site is underlain by Bay Mud extending to between Elevation -20 feet to Elevation -60 feet (Mean Lower Low Water (MLLW) datum). On Plate 4, we also presented our estimated contours of the bottom of Bay Mud within our project site. The map indicates that the Bay Mud is shallower to the north and becomes deeper to the south. Bay Mud is typically normally-consolidated to slightly over-consolidated, weak and highly compressible soil. Bay Mud typically exhibits low permeability and low shear strength. Bay Mud is typically underlain by stronger and less compressible alluvial soils.

The predominant seismic hazard for this site is strong groundshaking resulting from earthquakes. The improvements should be designed to accommodate such groundshaking in accordance with existing codes. No known active faults pass through the site and we conclude that the risk of fault rupture is low. The nearest active faults are the Hayward fault located about 7.2 miles east of the site and the San Andreas fault located approximately 10.5 miles west of the site.

Soil liquefaction is the phenomenon in which a loose to medium dense saturated granular soil undergoes reduction of internal strength as a result of increased pore water pressure generated by shear strains within the soil mass. This behavior is most commonly induced by strong ground shaking associated with earthquakes. Soil conditions consist predominately of medium dense to dense sand fill underlain by Bay Mud. We judge that the potential for liquefaction and/or loss of strength is low.

B. Site History

We reviewed available historic shoreline surveys (t-sheets) by NOAA published in 1853, 1943, and 1979. The historic shoreline surveys are presented on Plates 5 through 7. We also reviewed available historic topographic maps published by USGS. The existing perimeter levees around the diked marsh and soccer field were likely built in the early- to mid-1900s. The perimeter levee was then extended along the shoreline of San Rafael Creek to San Pablo Bay in the 1960s to accommodate further development. The levees were likely constructed by excavating Bay Mud from the adjacent land, waterways or ditches. The tidal marshplain located east of the soccer field has been eroding at a rate up to 4 to 5 feet per year for the last several decades.

C. Surface Conditions

1. Upland Landside Area

a. New Setback Ecotone Levee

The setback ecotone levee alignment will extend along the approximate 600-foot-long northern edge of the soccer field and within the existing diked marsh. The LIDAR topographic survey data from 2019 indicates that the ground surface of the soccer field is relatively flat and generally varies from Elevation +7 feet to Elevation +8 feet. A small berm is located along the northern edge of the soccer field. The ground surface along the northern edge of the soccer field and berm varies from Elevation +8 feet to Elevation +10 feet. The diked marsh, north of the soccer field, is relatively flat, generally at Elevation +7 feet. The soccer field is covered predominately by grass. The diked marsh is covered predominately by low brush or other vegetation.

b. Existing Perimeter Levee

The rehabilitation of the existing levee includes the approximate 550-foot long levee located adjacent and east of the soccer field and the 450-foot-long levee located adjacent and north of Canal Street. The LIDAR topographic survey indicates that the top of the existing levee crest east of the soccer field varies from Elevation +11 feet to Elevation +12 feet. The top of the existing levee crest north of Canal Street varies from Elevation +10 feet to Elevation +11 feet. The levee crest generally ranges from about 10 to 15 feet wide. The height of the levee crest ranges from one to 3 feet above the landside interior. The levee landside toe is near Elevation +8 feet. The levee slopes are generally inclined 2.5H:1V (horizontal to vertical) or flatter on both the landside and waterside. The levee waterside toe adjacent to the tidal marsh is generally at Elevation +6 feet.

The levee crest is covered with asphalt concrete pavement where the levee is adjacent to the soccer field. The levee crest adjacent to Canal Street is covered with gravel. The levee landside toe adjacent to Canal Street was previously a playground area and is currently covered with sand. Some trees and brush exist along the landside toe of the levee.

2. Tidal Marsh Area

The topographic and bathymetric data indicate that the tidal marshplain ranges from about 150 to 500 feet wide and varies from Elevation +5.5 feet to Elevation +6.5 feet. Brush and low-lying vegetation typically covers the marshplain areas. The marshplain areas are generally near or above daily tide water but can be inundated during high tides and wind generated waves. The typical outboard edge of the marshplain has a steep, nearly vertical scarp about 3 to 4 feet in height. The scarp is the result of the active erosion of the marsh. The edge of the marshplain transitions to the mudflat. The mudflat is generally at Elevation +2 feet and slopes down gently to Elevation +1 foot toward the east. The mudflat areas are generally inundated with bay water at tide levels higher than mean sea level.

D. Subsurface Conditions

1. Upland Landside Area

We subdivided the subsurface conditions encountered during our field exploration into three strata based on their engineering properties: Existing Fill, Bay Mud, and Alluvium. These layers are described further below.

a. Existing Fill

The existing fill is present along the planned levee alignment and generally consists of mixtures of silts and sands with occasional gravels. The silt fill is generally stiff and the sand fill is generally medium dense to dense. The fill was encountered in our borings and CPTs to depths of 2 to 9 feet below existing grade. Boring 5 encountered gravelly clay fill beneath the silt and sand fill. The fill extended to the depth explored of 17.5 feet.

b. Bay Mud

Bay Mud underlies the fill along the planned levee alignment. The upper portions of Bay Mud underlying existing fill is likely fill placed during initial construction of the levee but is indistinct from the native Bay Mud. Bay Mud also blankets the diked marsh interior. Within the diked marsh interior, the upper several feet is dryer due to desiccation, creating a medium stiff to stiff surficial layer. Beneath the crust, the Bay Mud is typically normally-consolidated to slightly over-consolidated, weak and highly compressible fat clay. The Bay Mud typically ranges from very soft to medium stiff. The strength of Bay Mud generally increases with depth. Atterberg limits performed within the Bay Mud indicate the soil has liquid limits ranging between 56 to 95 and plasticity indices between 28 to 56. The base of the Bay Mud extends to depths ranging from 44 to 64 feet below grade at the borings and CPTs locations. The depths correspond to Elevation -35 feet to Elevation -53 feet. The base of the Bay Mud is typically shallower to the northwest and deeper to the southeast. The base of the Bay Mud at the exploration locations appear to be consistent with the geologic mapping (Goldman 1969) shown on Plate 4.

c. Alluvium

Alluvium underlies Bay Mud. The alluvial soils generally consist of silts and clays. The alluvial silt and clays are stiff to very stiff. The alluvium extends to the maximum depth explored of about 87 feet.

2. Tidal Marsh Area

We did not perform geotechnical exploration within the tidal marsh areas. Review of geologic maps indicate that Bay Mud blankets the tidal marsh area. The base of the Bay Mud likely varies to depths ranging from 20 to 60 feet below existing grade. The base of the Bay Mud is likely shallower to the north and deeper to the south. The strength of the Bay Mud likely increases with depth. Alluvial soils are expected to underly the Bay Mud.

We subdivided the footprint of the tidal marsh into two areas based on their engineering properties: Eroded Marsh Area and Virgin Marsh Area. These areas are described further below.

a. Eroded Marsh Area

The eroded marsh areas are underlain by Bay Mud. The ground surface was previously about 4 feet higher than existing grade, resulting in a slightly over-consolidated, but still weak and highly compressible clay.

b. Virgin Marsh Area

The virgin marsh areas are mudflat areas that have not been previously loaded and are located beyond the historic limits of the marsh. The Bay Mud is likely normally-consolidated, and very weak and highly compressible. The surface of the Bay Mud will be composed of recent sediments that are also very weak and very compressible.

E. Groundwater

1. Upland Landside Area

The groundwater levels within the site are primarily controlled by evapo-transpiration and drainage. During exploration, water was noted at 12 feet below ground surface in Boring 3. Water was encountered in Hand Auger Borings 7 through 10 at depths of 4- to 6-inches below existing grade. Water was not measured in Borings 1, 2, 4, 5, and 6 because they were obscured due to hollow stem auger drilling. The borings were backfilled immediately, and stabilized water levels were not obtained.

The above descriptions of soil conditions summarize observations at the time of the investigations. Conditions are expected to vary across the site, with time, and depend on several factors including changes in moisture content resulting from seasonal precipitation, drainage operations, and tides.

2. Tidal Marsh Area

Within mudflat areas, daily water depths can vary from about 0 to 4 feet. The typical daily tidal range at the site varies from about Elevation +0.2 feet to Elevation +6.1

feet. The mean tide level at the site is at about Elevation +3.3 feet. The FEMA 100-year base flood elevation along the San Rafael shoreline is at about Elevation +9.5 feet.

IV. DISCUSSION AND CONCLUSIONS

A. General

Geotechnical concerns for this project include the presence of Bay Mud, the presence of sand fill along the proposed levee alignment, and potential impacts from fill placement. Bay Mud blankets the entire project area. The Bay Mud is weak and highly compressible. Considerable settlement will occur under the weight of new fills. In addition, Bay Mud is weak and has limited capacity to support new loads. The issues described above and other considerations for design and construction of the project are discussed further below.

B. Upland Landside Area

1. Levee Design

The new and rehabilitated levees will retain flood water and protect the urban areas from inundation. The levee should be designed to prevent overtopping during flood stages. Levee overtopping could cause erosion damage and increases the risk of breach. The levee will include 3 feet of freeboard above the design water surface and be further raised to accommodate future estimated settlement.

The levee crest design elevation was provided by ESA. The design water surface is at Elevation +10 feet (the approximate 100-year flood). The levee crest includes 3 feet of freeboard above the design water surface corresponding to a minimum levee crest height of Elevation +13 feet. The levee crest will have a 12-foot wide crest with side slopes inclined at 3H:1V. The new setback levee and offset levee adjacent to Canal Street will include a waterside ecotone slope inclined at 10H:1V or flatter. The ecotone slope will extend up to at least Elevation +9 feet or at least 3 feet above Mean Higher High Water (MHHW).

We evaluated the levees for settlement, slope stability, seismic vulnerability, and seepage. We chose two cross sections for analysis. One cross section is located within the setback ecotone levee and the second cross section is located within the offset levee. An overview of the analysis for the levee is presented in the report body with more details on the design parameters, sections and analyses provided in the appendices.

2. Settlement Analyses

The new fills will cause the Bay Mud to consolidate and the levees will settle. Considerable settlement will occur under the loading of the new levee embankment fill and the settlement will continue for the next several decades. The levee will need to be constructed higher than the minimum grade initially to accommodate settlement. The intent is to raise the levee to a sufficient height initially to accommodate the estimated settlement.

The actual settlement will vary from our estimates both in magnitude and in the time for settlement to occur. The process of soil consolidation occurs over time as water is pushed out of the Bay Mud. The method to estimate settlement and the rate that the water flows from the soil are not precise. If the levee settles more than the overbuild provision it will need to be raised in the future to maintain the 3 feet of freeboard.

We performed consolidation analyses to estimate the magnitude of settlement due to the weight of new fill along several different levee reaches. We used data obtained from the borings and laboratory testing to develop material properties. A more detailed discussion and details of the settlement analyses and soil parameters are presented in Appendix D. The results of the settlement estimates at the centerline, levee toe, and at 25 feet from the levee toe are shown in Tables 1 and 2, below.

Table 1: Settlement Estimates for Setback Ecotone Levee

Thickness of New Fill (feet)	Settlement at Centerline (feet)	Settlement at Levee Toe (feet)	Settlement 25 feet from Levee Toe (feet)
2	0.9	0.6	<0.10
4	1.6	0.8	0.15
6	2.2	1.0	0.20
8	2.5	1.1	0.23
10	2.8	1.2	0.25

Table 2: Settlement Estimates for Offset Levee

Thickness of New Fill (feet)	Settlement at Centerline (feet)	Settlement at Levee Toe (feet)	Settlement 25 feet from Levee Toe (feet)
2	0.8	0.4	<0.10
4	1.4	0.6	0.15
6	1.8	0.7	0.18
8	2.1	0.8	0.20

For the levee raising adjacent to the soccer field, where approximately 2 to 3 feet thick of fill is anticipated to raise the crest, we estimate that placement of every 1-foot of fill will cause about 3-inches of settlement.

For the new setback and offset levees, the rate of settlement is expected to continue for about 20 years assuming double drainage conditions. We estimate that about half the settlement will occur over the next 2 to 5 years. The rate of settlement is dependent on several factors including the permeability, compressibility and thickness of the Bay Mud soils. The magnitude and time for settlement to occur can vary from our estimates.

3. Slope Stability Analyses

We performed slope stability analyses for the levee configurations. We developed soil parameters using data from borings and laboratory test results, along with our assessment of undrained shear strengths and effective stress. A more detailed discussion and details of the slope stability analysis and results are presented in Appendix E.

The results indicate that the factors of safety for the end of construction configurations are at least 1.5 for the landside and waterside slopes. The results indicate that the levee configurations can be constructed in one stage according to the typical details provided on Plates 8 and 9.

4. Seismic Deformation

We used a simplified procedure to evaluate seismic deformations of the levee embankment. The analysis suggests that these earthquake scenarios will result in small vertical deformations for the levee crest generally less than 4-inches. Some regrading of the levee embankment may be needed following a large earthquake. Further details and discussions of the seismic vulnerability analyses and results are presented in Appendix F.

5. Seepage Considerations

The levee embankment will be constructed using import materials predominately consisting of fine-grained, low permeability silt and clay. The levee foundation consists of variable fill including clay and sand over Bay Mud. Borings 3, 4, and 6 encountered surficial layers of sand to depths of 3 to 6 feet below existing grade. The sand may be deeper in some areas. The existing sand fill is a concern for seepage beneath the levee (underseepage).

We judge that along the footprint of the setback ecotone levee and offset levee, the underlying sand fill should be overexcavated and backfilled with compacted, low permeable clay.

In addition, the footprint of new setback ecotone levee will extend onto the existing diked marsh. The interface between the new levee fill and the foundation soils are a preferential seepage path. To disrupt preferential seepage paths, we conclude that the subgrade preparation should include a keyway constructed below the levee crest.

6. Levee Abutments

The new setback levee will tie into existing levees on the east and west. Seepage is a concern at the abutments. Where the new setback levee abuts the existing levees, the existing levees will have already settled under the weight of the existing levee fill. The new levee section will settle as new fill loads are placed. Differential settlement will occur due to unequal consolidation of Bay Mud in the abutment areas. Differential settlement can cause cracks to form within the compressing layer and the fill above. To reduce the risk of settlement-induced cracking and the associated seepage risk, flatter levee embankment slopes can be used in these transition areas. We understand that the abutment areas may be limited. Other alternatives include installing sheetpiles or cutoffs. The levee abutments will need to be monitored and if cracking or seepage develops, then remedial work will be needed. In addition, the new fill should be benched into the existing levee.

7. Erosion Protection

The project does not plan to initially armor the waterside slopes with riprap. The design of the erosion protection is not within our scope. The waterside of the setback levee will consist of clay. The existing perimeter levee waterside slopes are not armored. Riprap facing is a traditional scheme for erosion protection when erosion is a concern. Riprap can be added in the future if needed. As an alternative, riprap can be buried within the ecotone slope. The buried riprap would provide a redundancy for erosion protection in the design.

8. Interior Drainage

The drainage pattern changes due to the new setback levee should be assessed. The current drainage typically flows off from the soccer field property to the low-lying marsh to the north. We understand that gravity drainage structures are not anticipated.

C. Tidal Marsh Area

1. Function and Design

The existing tidal habitat marsh has experienced considerable erosion along its bayward edge, resulting in significant loss of habitat. ESA developed conceptual alternatives for marsh restoration. The selected project elements include an expanded tidal marsh through placement of dredge materials to raise site grades, a coarse beach along the eastern marsh edge, and a rock jetty along the San Rafael Canal to the north. The function of the expanded marsh is to increase and enhance tidal marsh habitat at a marshplain height of about Elevation +6 feet. The intent of the coarse beach is to protect the expanded marsh from erosion. The purpose of the rock jetty is to trap and accumulate sediment within the proposed expanded tidal marsh and to reduce erosion of the coarse beach.

The footprint for the tidal marsh restoration, including the location of the coarse beach and rock jetty, have not been determined. The preliminary plan is to restore to at least the historic footprint of the eroded marsh with dredged fill. We understand the design team is also evaluating alternatives for an expanded marsh into the virgin mudflat areas.

Design criteria for the coarse beach and rock jetty was provided by ESA. The coarse beach includes an 8-foot wide crest at Elevation +8 feet with a landside slope inclined 2H:1V and a waterside slope inclined 8H:1V. The rock jetty includes an 8-foot wide crest at Elevation +9 feet with both slopes inclined at 2H:1V. The landside of the coarse beach and rock jetty will be buttressed and partially buried by the dredge material.

We performed preliminary settlement and slope stability analyses for the construction of the coarse beach and rock jetty using presumptive soil parameters. The results should be considered preliminary. During final design, additional subsurface exploration and laboratory testing should be performed to characterize the subsurface conditions and engineering properties within the footprint of the expanded marsh.

2. Settlement Analyses

The marsh will settle as the Bay Mud consolidates from the weight of new fills. The minimum design coarse beach and rock jetty elevations can be maintained by overbuilding to accommodate the estimated consolidation settlement. We evaluated alternatives for restoring the marsh to the historic footprint (eroded marsh area) and restoring the marsh beyond the historic footprint (virgin marsh area). We performed consolidation analyses to estimate the magnitude of settlement due to the weight of new fill, including rock and dredged fill materials. The estimated settlement results for the thicknesses of new rock and new dredged fill materials are shown in Tables 3 and 4, below. As discussed previously, the actual settlement will vary from our estimates both in magnitude and in the time for settlement to occur. Further discussion and details of the settlement analyses are presented in Appendix D. While the coarse beach and rock jetty need to maintain a minimum height to limit overtopping, the elevation of the marsh and tolerances for settlement should be determined by the elevation range that is desirable for the type of vegetation.

Table 3: Settlement Estimates Within Eroded Marsh Areas

Thickness of New Fill (feet)	Rock Fill, 135 pcf* (feet)	Dredged Fill, 100 pcf (feet)
2	0.1	0.1
4	0.7	0.2
6	1.5	0.9
8	2.3	1.5
10	3.0	2.1
12	3.6	2.7

Table 4: Settlement Estimates Within Virgin Marsh Areas

Thickness of New Fill (feet)	Rock Fill, 135 pcf (feet)	Dredged Fill, 100 pcf (feet)
2	1.0	0.8
4	2.0	1.5
6	2.8	2.2
8	3.5	2.8
10	4.1	3.3
12	4.7	3.8

*pcf: pounds per cubic foot

The rate of settlement for the coarse beach and rock jetty is expected to continue for about 20 years assuming double drainage conditions. We estimate that about half the settlement will occur over the next 2 to 5 years. The rate of settlement is dependent on several factors including the permeability, compressibility and thickness of the Bay Mud soils. The magnitude and time for settlement to occur can vary from our estimates.

3. Slope Stability Analyses

We performed slope stability analyses for the coarse beach constructed on eroded marsh areas or on virgin marsh areas as well as the rock jetty constructed on the eroded marsh areas. We used presumptive soil parameters for slope stability analyses. Discussion and details of the slope stability analysis and results are presented in Appendix E.

The results indicate that the fill for the coarse beach and rock jetty will need to be placed in stages. We concluded that the coarse beach constructed on the eroded marsh areas will require two stages of rock placement. The coarse beach constructed on the virgin marsh areas will require at least three stages of placement. The third stage would require a waiting period of 10 years or more. The timing and sequencing for the third stage can be completed in final design if the project decides to construct over the virgin marsh. The rock jetty on the eroded marsh areas will require two stages of rock placement and stability berms will be needed to buttress the side slopes between stages of rock placement. We conclude that berms are needed to support the crest levels and provide a more reliable level of safety.

4. Seismic Deformation

A discussion of seismic vulnerability analyses and results are presented in Appendix F. The analysis suggests that these earthquake scenarios will result in small vertical deformations of about 3-inches or less for the rock berms on eroded marsh areas and about 8-inches or less for rock berms on virgin marsh areas. Some regrading of the rock berms may be needed following a large earthquake.

5. Mudwaves

The expanded marsh, rock berms, coarse beach, and rock jetty will be constructed on weak recent Bay Mud sediments in tidal areas. It is not unusual for the weight of the new fill to create a “mudwave” as the displaced sediments are heaved up in front of and/or to the sides of advancing fill. We anticipate that there is a high risk of creating mudwaves during fill placement in the tidal marsh area even where the factor of safety suggests that fill can be safely loaded on the Bay Mud. Thin lifts should be placed to reduce the risk of mudwaves.

6. Overtopping, Inundation and Erosion

The eastern shoreline has experienced considerable historic erosion. The expanded marshplain will also be inundated during high tides. The project aims to expand the marshplain and reduce this ongoing erosion and loss of tidal marsh by placing a coarse beach and rock jetty. The coarse beach and rock jetty will be constructed to stabilize the shoreline and reduce the effects of waves on the marsh. The coarse beach and rock jetty is less susceptible to erosion than the dredged fill material. The protection of the expanded tidal marsh depends on the coarse beach materials preventing additional erosion. As an additional protection, we suggest that the protection include a zone of larger rock riprap buried beneath the upstream edge of the coarse beach.

7. Staged Construction

We conclude that the restored marsh fills need to be placed in stages to limit stress on the Bay Mud. We have developed preliminary construction sequences for the coarse beach and rock jetty. The construction sequence for the coarse beach on the eroded marsh areas is presented on Plate 11. The construction sequence for the coarse beach on the virgin marsh areas is presented on Plate 12. The construction sequence for the rock jetty on eroded marsh areas is presented on Plate 13. The sequences are also described below.

a. Coarse Beach on the Eroded Marsh Areas

1. Place first stage of rock materials consisting of 5 feet maximum thickness of fill with side slopes inclined at 2H:1V or flatter on the landside and 8H:1V on the waterside.
2. Place landside buttress consisting of a 4.5 feet thickness of dredged fill materials (assumed 100 pcf) at least 50 feet wide with side slope inclined at 2H:1V or flatter.
3. Place second stage of rock materials consisting of 3 feet thickness of fill with side slopes inclined at 2H:1V or flatter on the landside and 8H:1V on the waterside.

b. Coarse Beach on the Virgin Marsh Areas

1. Place first stage of rock materials consisting of 3.5 feet maximum thickness of fill with side slopes inclined at 2H:1V or flatter on the landside and 8H:1V on the waterside.

2. Place landside buttress consisting of 6 feet thickness of dredged fill materials (assumed 100 pcf) at least 50 feet wide with side slope inclined at 10H:1V or flatter.
3. Place second stage of rock materials consisting of 5 feet thickness of fill with side slopes inclined at 2H:1V or flatter on the landside and 8H:1V on the waterside.
4. After a waiting period (10 years or more), place third stage of rock materials consisting of 2 feet thickness of fill with side slopes inclined at 2H:1V or flatter on the landside and 8H:1V on the waterside.

c. Rock Jetty on Eroded Marsh Areas

1. Place first stage of rock materials consisting of 5 feet maximum thickness of fill with side slopes inclined at 2H:1V or flatter on both the landside and waterside.

2a. Place landside buttress consisting of 4.5 feet thickness of dredged fill materials (assumed 100 pcf) at least 50 feet wide with side slopes inclined at 2H:1V or flatter.

2b. Place waterside rock berm buttress consisting of 3 feet thickness of fill (assumed 135 pcf) at least 30 feet wide with side slopes inclined at 2H:1V or flatter on the waterside.

3. Place second stage of rock materials consisting of 5 feet thickness of fill with side slopes inclined at 2H:1V or flatter.

8. Temporary Water Retention Structures

To place dredged fill, the marsh needs to be isolated from the bay. The design team is considering using bladder dams for retaining tidal water for isolating the marsh. Bladder dams are flexible water-filled, watertight tubes for temporary water barrier and dewatering purposes. The bladder dam should be designed for the lateral water forces and for uplift.

Sheetpiles could be used as an alternative to bladder dams for retaining water. The sheetpiles would likely require placement of rock as a buttress to retain the differential water head during high tides. To reduce the deformations due to induced settlement from placement of rock, the sheetpiles may need to penetrate the full thickness of the Bay Mud. For cost estimating purposes, average sheetpiles lengths of about 60 feet can be used.

9. Temporary Access Roads

Equipment will need to cross marsh areas for construction of the tidal marsh restoration. Temporary access roads are proposed for the project and will include crossing the existing vegetated marshplain areas and the eroded marsh areas in an east-west direction toward the coarse beach.

The subgrade may become unstable and subject to pumping under heavy equipment loads. The contractor should be prepared to stabilize the subgrade bottom and construct temporary haul roads. The actual design of the temporary haul road should come from the contractor as one of their submittals. We have developed a typical detail to assist during the design and to help with permitting. The typical detail includes geogrid and compacting a nominally 2 feet thick layer of fill over the geogrid. Typical details of the temporary access roads are presented on Plate 10.

D. General Grading Considerations

The project requires cuts and fills to create the various habitat zones and channels within the proposed expanded tidal marsh. The main near surface soil material present across the site is Bay Mud. Much of the grading will create habitat zones where engineered compacted fills are not required and criteria for placement is not provided in this report.

The groundwater is located at shallow depths and excavating within the site should consider the presence of groundwater. The near surface soils are relatively wet and moisture processing will be required prior to use of these materials as compacted fill.

E. Impacts on Utilities and Setback Distance

1. Upland Landside Area

In general, the further away from the new levee embankment or new fills, the less ground settlement will occur. As currently planned, the toe of the levee slopes will be at least 25 feet from the nearest overhead utility. At that distance, we estimate that the levee embankment will cause less than 3-inches total ground settlement.

The design team is evaluating alternatives for the western abutment of the setback levee. We understand that two sanitary sewer force mains and a storm drain are located within the vicinity of the western abutment. The force mains consist of a 16-inch and a 26-inch diameter HDPE pipelines. The storm drain consists of a 54-inch diameter corrugated metal pipe.

The weight of the new levee fill may cause settlement to the existing pipelines, depending on the depths of the pipeline. We performed consolidation analyses to estimate the magnitude of pipe settlement due to the weight of new fill. A more detailed discussion and details of the settlement analyses and soil parameters are presented in Appendix D.

The force mains are relatively deep and range from 30 to 45 feet below existing grade near the western abutment. For the level marsh area and a force main depth of 30 feet below existing grade, we estimate that new fill will cause the force main pipe to settle about 0.25 feet. For a force main depth of 40 feet below existing grade, we estimate that new fill will cause negligible settlement of the pipe. We judge that at these fill thickness and depths, the settlement impacts can be considered minor.

The storm drain is shallower and ranges from about 5 feet below existing grade along the level marsh area to about 8 feet below existing grade near the existing levee. The shallow storm drain could undergo significant settlement from the weight of the new fill if the levee is constructed directly over the pipe. For the level marsh area and a storm drain depth of 5 feet below existing grade, we estimate that 7 feet of new fill will cause the pipe to settle about 2.1 feet. At the existing levee, with the storm drain at a depth of 8 feet below existing grade, we estimate that 4 feet of new fill will cause about 0.9 feet of settlement. For other thicknesses of fill, these values can change in proportion to the fill thicknesses.

To reduce settlement impacts, the western levee abutment alignment can be setback from the storm drain and/or force main. The settlement estimates shown in Table 1 can be used to evaluate settlement based on offset distances. We judge that the toe of the new levee should be at least 25 feet from the storm drain if a minimal impact is required. The floodwall will nominally be about 3 feet tall.

2. Western Abutment

To avoid the storm drain, the levee needs to tie into the existing levee north of the setback levee. The existing levee is lower than the setback levee and needs to be raised about 3 feet. As an alternative to raising the levee, a short floodwall could be constructed. The floodwall could be construed with driven sheetpiles (possibly capped with concrete). For planning purposes, the sheetpiles should extend at least 15 feet below the existing levee crest. The design of the floodwall will need to consider overtopping. Water should not be allowed to flow over the floodwall to avoid erosion and loss of support.

3. Tidal Marsh Area

Two PG&E overhead electrical transmission towers are located within the footprint of the proposed expanded tidal marsh area. One tower is within the existing marshplain and we anticipate minor grading is needed within the vicinity. The other tower is within the footprint of the previously eroded marshplain. Within the footprint of the previously eroded marsh plain, we estimate that 4 feet of new dredged fill will cause about 3-inches of settlement. Survey hubs can be installed and monitored during and after construction to check horizontal or vertical movement during and after placing fill. During final design, we should review project plans to check the fill thicknesses adjacent to utilities.

F. Borrow Materials

1. Levee Fill

We understand that borrow materials will be imported for levee fill. The levee should be constructed using low permeability, fine-grained soils. The U.S. Army Corps of Engineers (USACE) has fill specifications for levees that require use of fill that is typically lean clays or plastic clayey sand. Typically, fill materials require at least 20 percent fines (passing the No. 200 sieve), a plasticity index of 8 or more and a liquid limit of no more than 50.

2. Tidal Marsh Area

Borrow materials for the tidal marsh area will consist of various materials including dredged fill material for the expanded marsh, mixtures of sand, gravel, cobbles, and rock for the coarse beach, and various rock sizes for the rock jetty. During final design, we should review the sources of import borrow materials.

V. RECOMMENDATIONS

A. Upland Landside Area

1. Typical Levee Design Configuration

The levee crest should be designed and maintained at or above the minimum design elevation (Elevation +13 feet). The new levees should consist of at least a 12-foot wide crest with side slopes inclined at 3H:1V or flatter.

The existing sand fill beneath the footprint of the levee embankment along the new setback and offset levees should be overexcavated and removed. The new setback ecotone levee should also include a keyway. The levee keyway should be centered on the levee centerline and should be 3 feet deep and 12 feet wide at the base. The existing sand fill and keyway should be replaced with low-permeable material meeting the requirements below for fill. The slopes should extend up the ground surface at 2H:1V. We recommend that the levee geometry for the new setback ecotone levee and new offset levee conform to the details and configuration presented on Plates 8 and 9, respectively. We recommend that the crest height for the levee segment east of the soccer field be constructed initially to Elevation +14 feet to accommodate some future settlement.

2. Earthwork

a. Site Preparation

The footprint of the levee should be cleared and grubbed of surface and subsurface deleterious matter including trees, brush, and other vegetation and debris designated for removal. The site should be stripped to sufficient depth to remove vegetation and soil containing roots. Tree roots greater than 1-inch in diameter should be removed. Stripped and grubbed materials should be removed from the site and should not be used as fill. The existing asphalt or gravel base trail should be removed from the existing levee crest prior to reworking the levee surface and placing fill.

If loose or soft materials are encountered, they should be excavated to expose firm soil and placed in accordance with the recommendations presented below. Debris and deleterious materials encountered during grading should be removed from the site.

b. Fill Materials

Fill for the levee should be a soil or soil/rock mixture free of deleterious matter and have no rocks or hard fragments greater than 6-inches in maximum dimension with less than 15 percent larger than 1-inch in maximum dimension. Fill material should have at least 20 percent fines passing the No. 200 sieve. Fill should have a plasticity index of 8 or more and a liquid limit below 50.

Aggregate base should meet the requirements for Caltrans Class 2 aggregate base.

Samples of fill material should be submitted to us for approval before importing to the site.

c. Compaction

Surfaces in areas to be filled should be scarified to a depth of at least 8-inches or the full depth of shrinkage cracks, whichever is deeper. Although not anticipated, if shrinkage cracks extend below 12-inches, some excavation in addition to scarifying will be required to adequately moisture condition and compact soils. The scarified soil should be moisture conditioned at least 3 percent over optimum moisture content and compacted to at least 90 percent relative compaction. ASTM test D-1557 should be used to establish the reference values for computing optimum moisture content and relative compaction.

Fill should be placed in lifts 8-inches or less in loose thickness and moisture conditioned to at least 3 percent above the optimum. Moisture conditioning should be performed prior to compacting. Each lift should be methodically compacted to at least 90 percent relative compaction. A sheepsfoot compactor or equivalent kneading compaction equipment should be used for compacting clay soils. Material that fails to meet the moisture or compaction criteria should be loosened by ripping or scarifying, moisture conditioned, and then recompacted. After compaction, fills should not be allowed to dry out. This may require periodic sprinkling. Compacted fill that has dried should be scarified, remoisture conditioned and recompacted prior to receiving additional fill. Fill should be placed on horizontal surfaces. The fill should be benched into existing fill to allow recompaction of some of the existing soil. The horizontal bench width into the existing slopes should not exceed 5 feet.

On the levee crest and ramps, the upper 6-inches of subgrade should be compacted to at least 95 percent relative compaction and rolled to provide a smooth, non-yielding surface. Subgrade soils should be proof-rolled before placing aggregate base. Proof-rolling should be performed with the heaviest available rubber-tired construction equipment and should be observed by the geotechnical engineer. Soft or pumping areas should be aerated or excavated and recompacted.

Aggregate base should be placed in thin lifts no greater than 6-inches in loose thickness and in a manner that avoids segregation, moisture conditioned as necessary, and compacted to at least 95 percent relative compaction. A smooth drum roller compactor or equivalent compaction equipment should be used to compact aggregate base.

d. Slopes

Fill slopes should be inclined at 3H:1V or flatter except as noted. Fill slopes should be constructed fat and trimmed back to expose well-compacted fill. Finished slopes should be trackwalked perpendicular to the slope face with a bulldozer after completion. The slopes should be hydroseeded to promote vegetation. Vegetation should be limited to grasses or other vegetation that can be mowed or disced to allow inspection of levee slopes. Trees, bushes, and brush should not be allowed within the footprint of the levee slopes.

e. Surface Drainage and Maintenance

Drainage off the levee should be by sheetflow. Ground surfaces should slope away from the levee crest and toe. Irregularities that may tend to concentrate drainage should be corrected to re-establish sheetflow. Ponding of surface water should not be allowed on the levee crest or toe.

B. Tidal Marsh Area

1. Typical Configuration Details

We have developed preliminary construction sequences for the dredged containment including for the coarse beach on eroded marsh areas, the coarse beach on virgin marsh areas, and the rock jetty on eroded marsh areas. The preliminary construction sequence for the coarse beach on eroded marsh areas is presented on Plate 11, the coarse beach on virgin marsh areas is presented on Plate 12, and the rock jetty on eroded marsh areas is presented on Plate 13. The construction sequences are based on limited geotechnical data and presumptive soil conditions. We recommend that additional geotechnical exploration and laboratory testing be performed to characterize the subsurface conditions. During final design, we should review the preliminary analysis results and revise the preliminary construction sequences, as necessary.

2. Earthwork

Coarse beach fill material should be placed in lifts 24-inches or less in loose thickness and trackwalked perpendicular to the slope face with a bulldozer or similar equipment.

Rock fill should be inclined 2H:1V or flatter. All large rocks should be placed to achieve 3-point bearing on the underlying rock layer. Rock fill should be locked into place by systemically tamping with the bucket of an excavator or similar equipment. Rearranging of individual pieces of rock may be needed. Rock placement should meet the criteria presented in Caltrans specifications.

SELECTED REFERENCES

SELECTED REFERENCES

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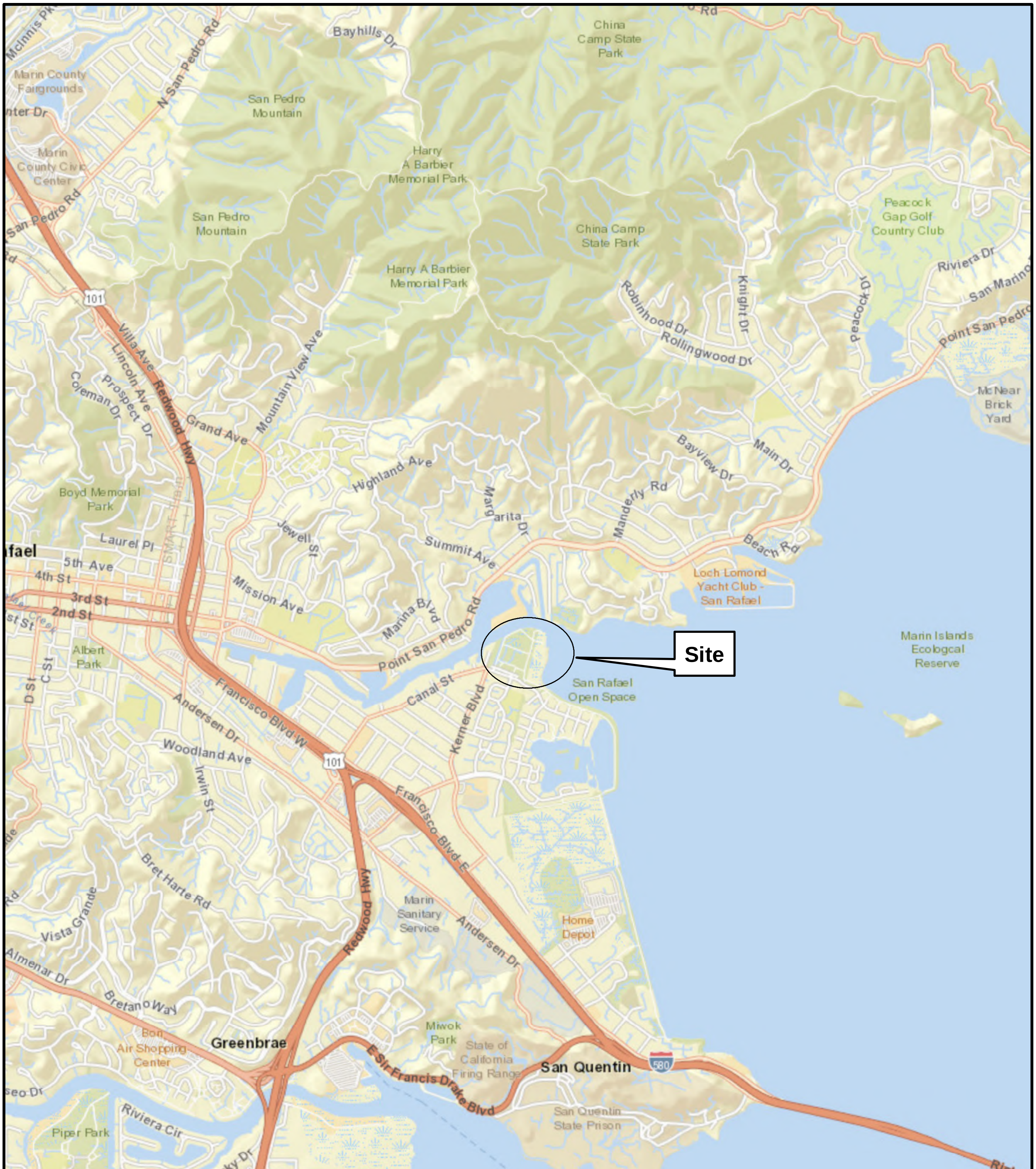
PLATES



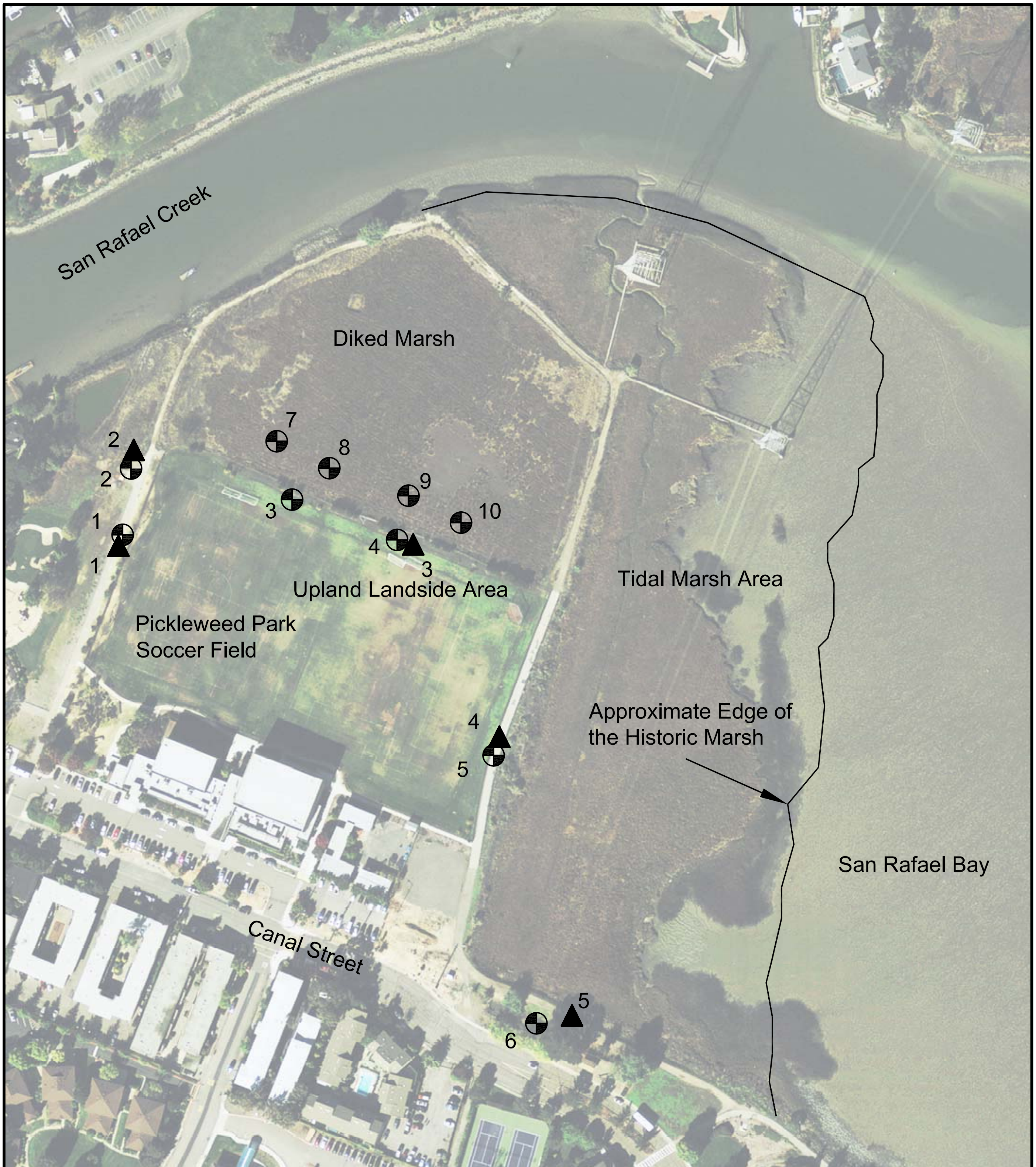
N

0 3,000 feet

1 inch = 3,000 feet

Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**Vicinity Map**

Hultgren - Tillis Engineers	Project No. 923.01	Plate No. 1



Approximate Location of Boring

Approximate Location of CPT

N

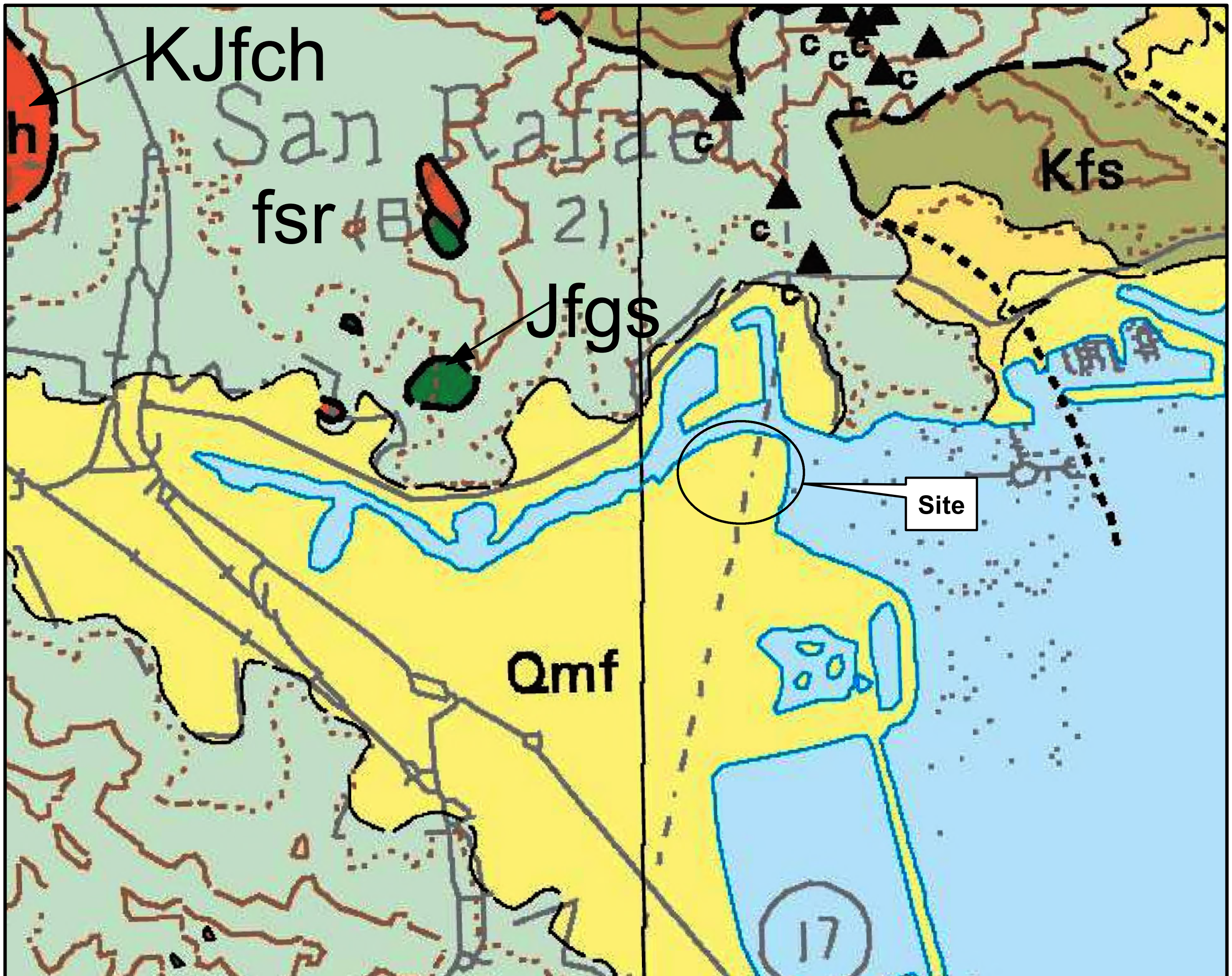
SCALE

0 200 feet

1 inch = 200 feet

Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**Site Plan**

Hultgren - Tillis Engineers	Project No. 923.01	Plate No. 2



Legend

Qmf	Artificial fill over marine and marsh deposits (Quaternary)
Kfs	Sandstone and shale (Cretaceous)
fsr	Melange
KJfch	Chert (Createaceous and Jurassic)
Jfgs	Greenstone (Jurassic)

SCALE 0 2,000 feet

1 inch = 2,000 feet

N

Fault - Dashed where approximately located, small dashed where inferred, dotted where concealed, queried where location is uncertain, inferred, dotted where concealed

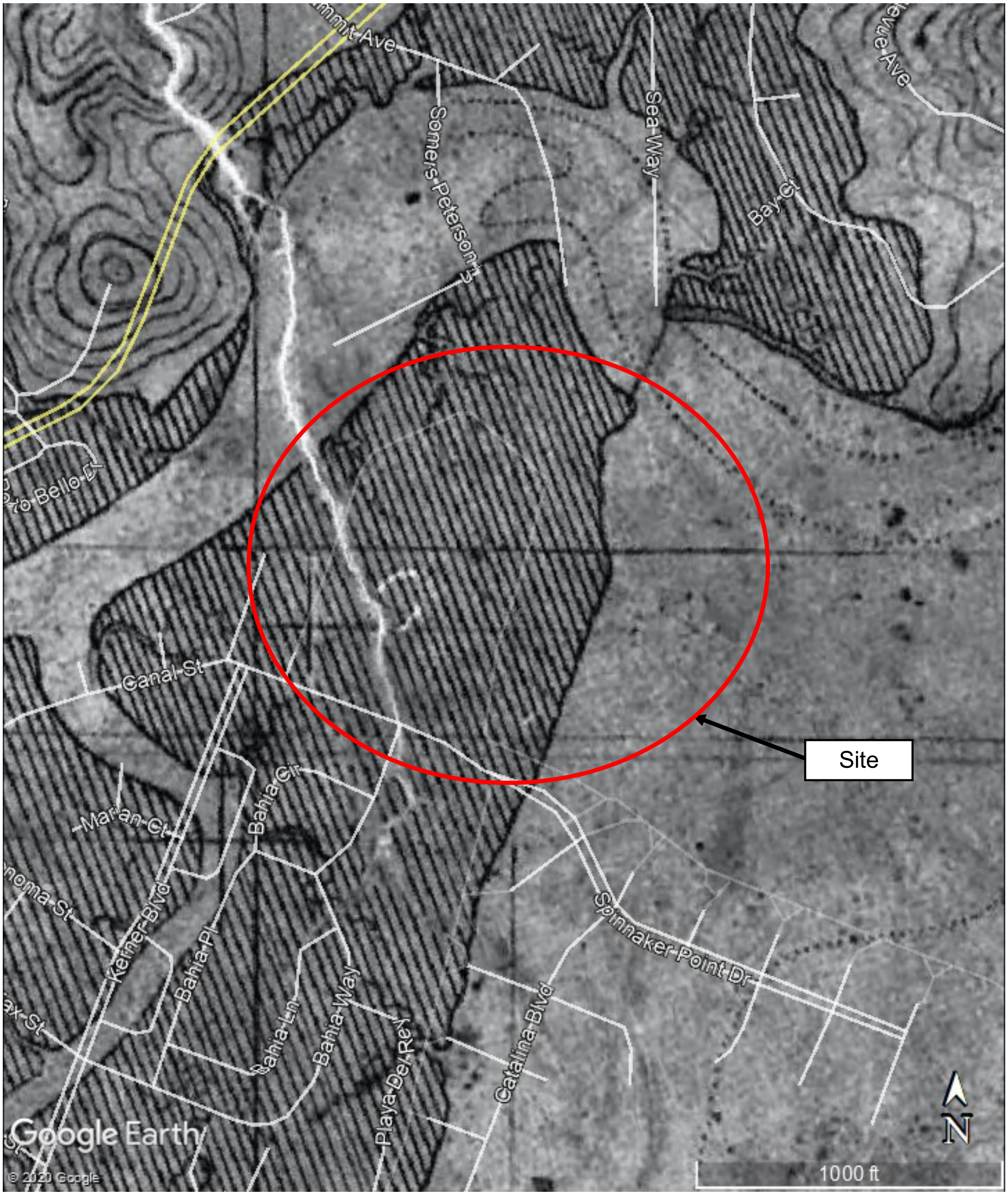
Source: Geologic Map and Map Database of Parts of Marin, San Francisco, Alameda, Contra Costa, and Sonoma Counties, California, by M.C. Blake Jr., R.W. Graymer, D.L. Jones, and A. Soule, 2000

Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**Geologic Map**

Hultgren - Tillis Engineers	Project No. 923.01	Plate No. 3

Source: Goldman, H. B., 1969. Geologic and Engineering Aspects of San Francisco Bay Fill: California Division of Mines and Geology Special Report 97 *(modified with dashed contours through site interpreted by HT)*.

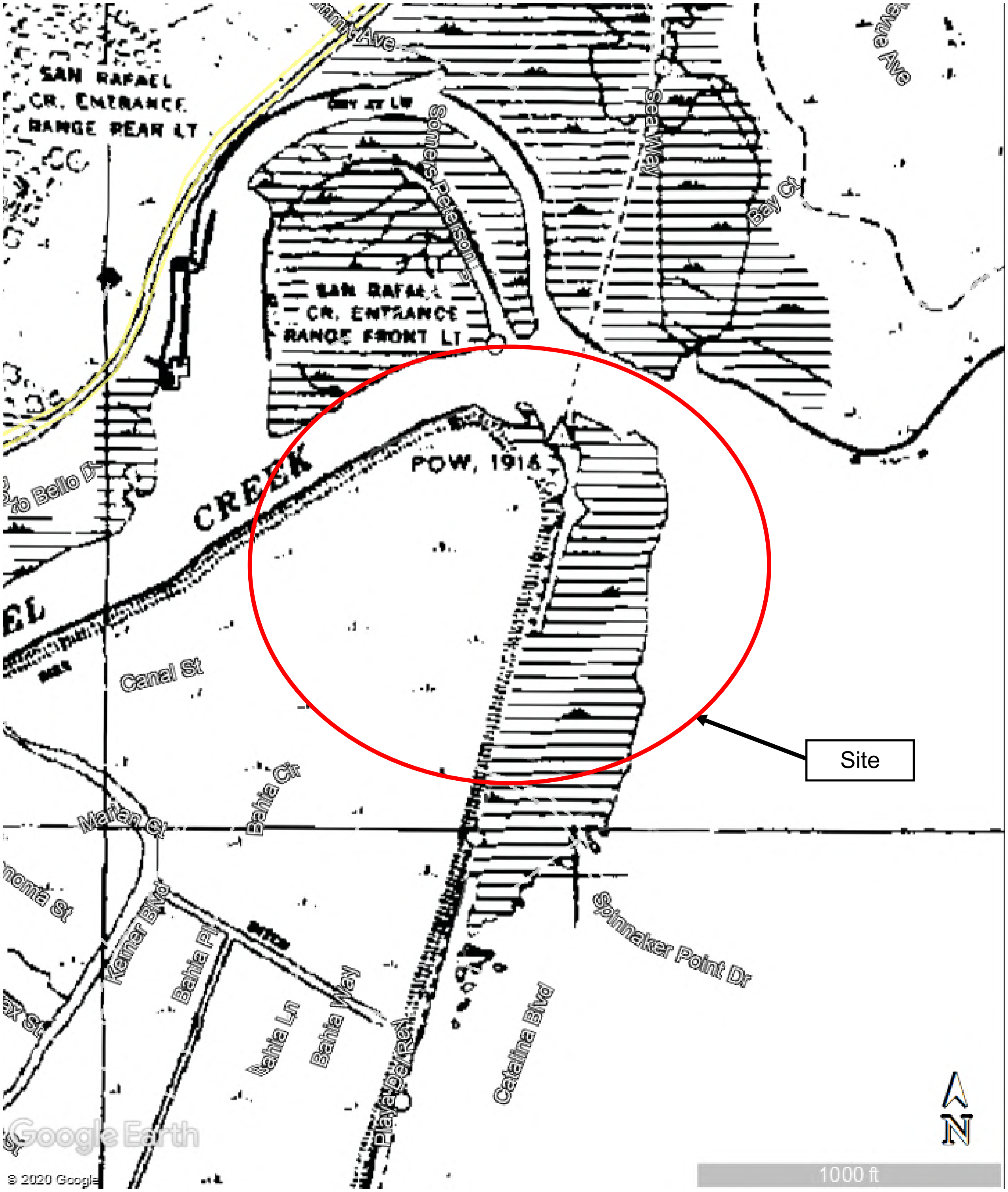
Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**Contours of the Bottom of Bay Mud**	
Hultgren - Tillis Engineers	Project No. 923.01	Plate No. 4



Source: U.S. Coast Survey, San Francisco, California, Plane Table Sheet No. IV, 1853.

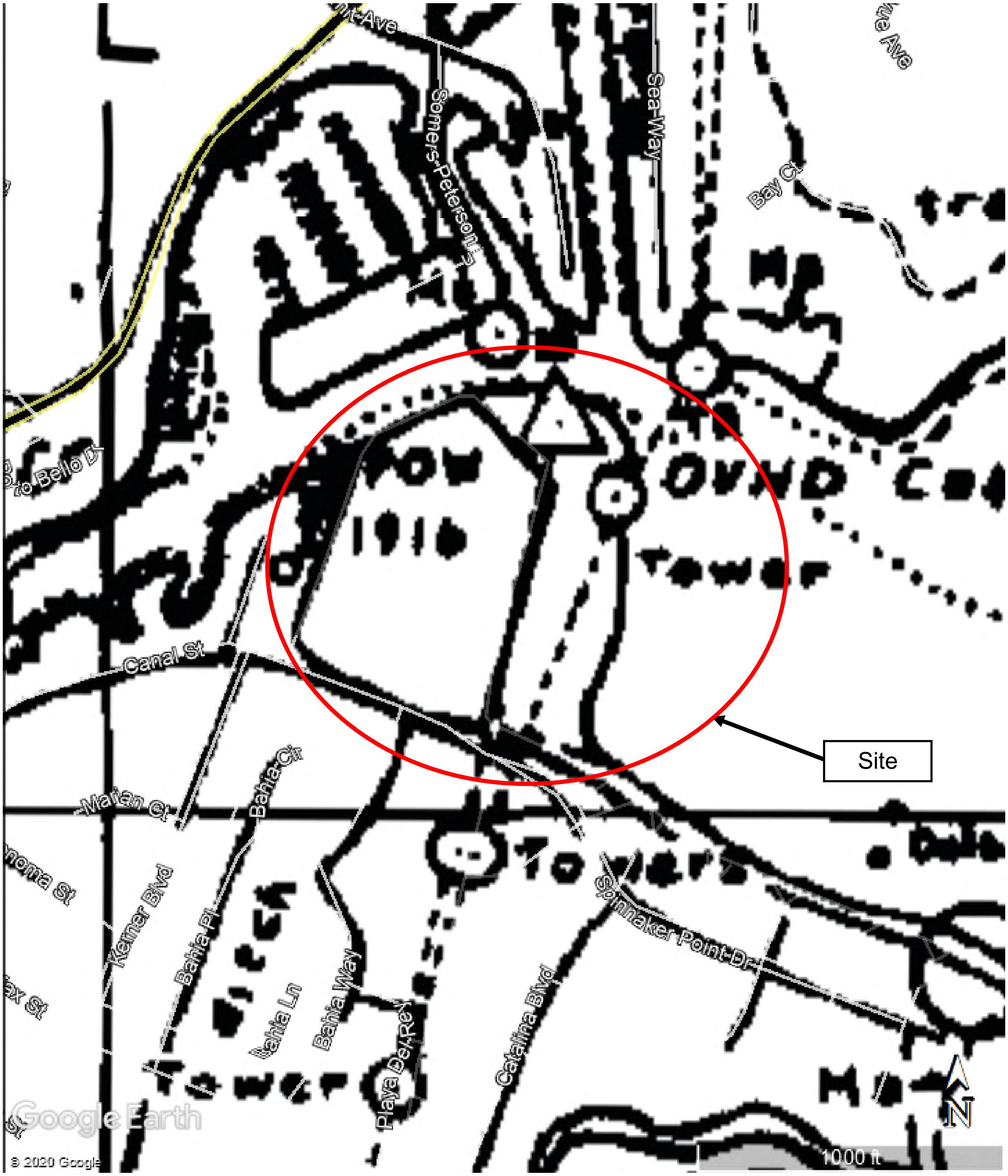
Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**Historic Shoreline Survey Map** **1853**

Hultgren - Tillis Engineers	Project No. 923.01	Plate No. 5



Source: U.S. Coast and Geodetic Survey, Planimetric Map, T-5930, California, San Pablo Strait, San Rafael and Vicinity, 1943

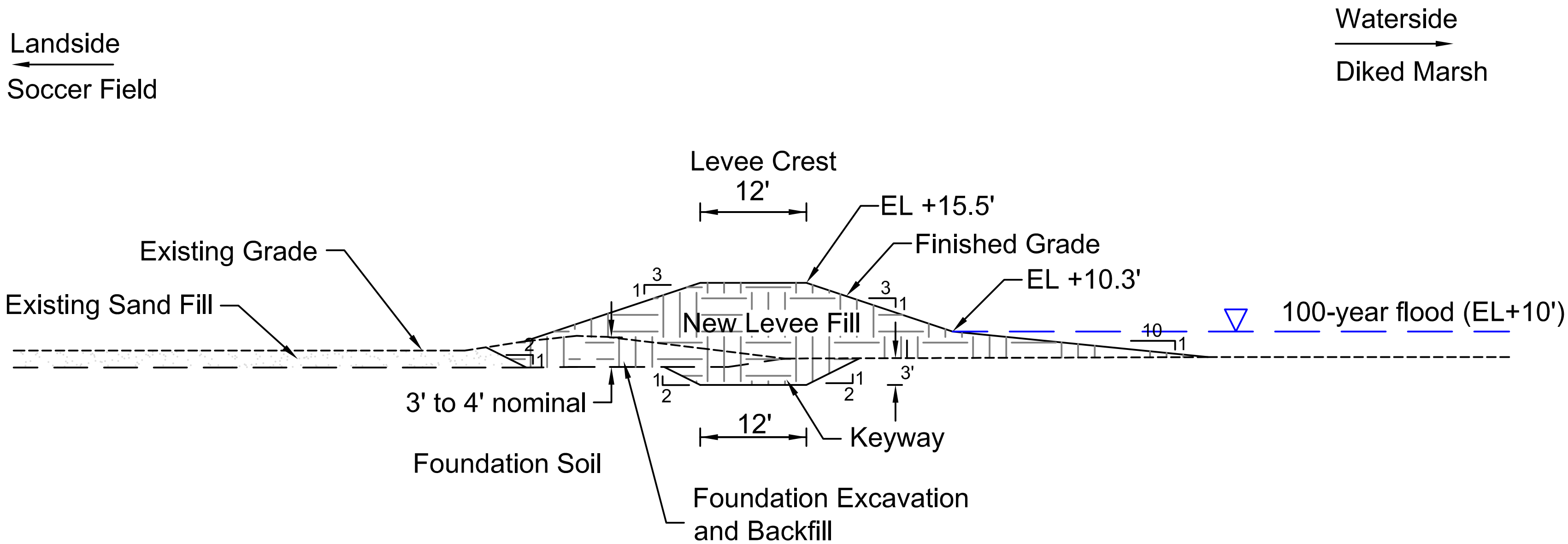
Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**Historic Shoreline Survey Map** **1943**	
Hultgren - Tillis Engineers	Project No. 923.01	Plate No. 6



Source: National Ocean Survey, Shoreline Manuscript, TP-00526, California, San Rafael Bay, San Francisco and San Pablo Bays, 1979.

Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**Historic Shoreline Survey Map 1979**

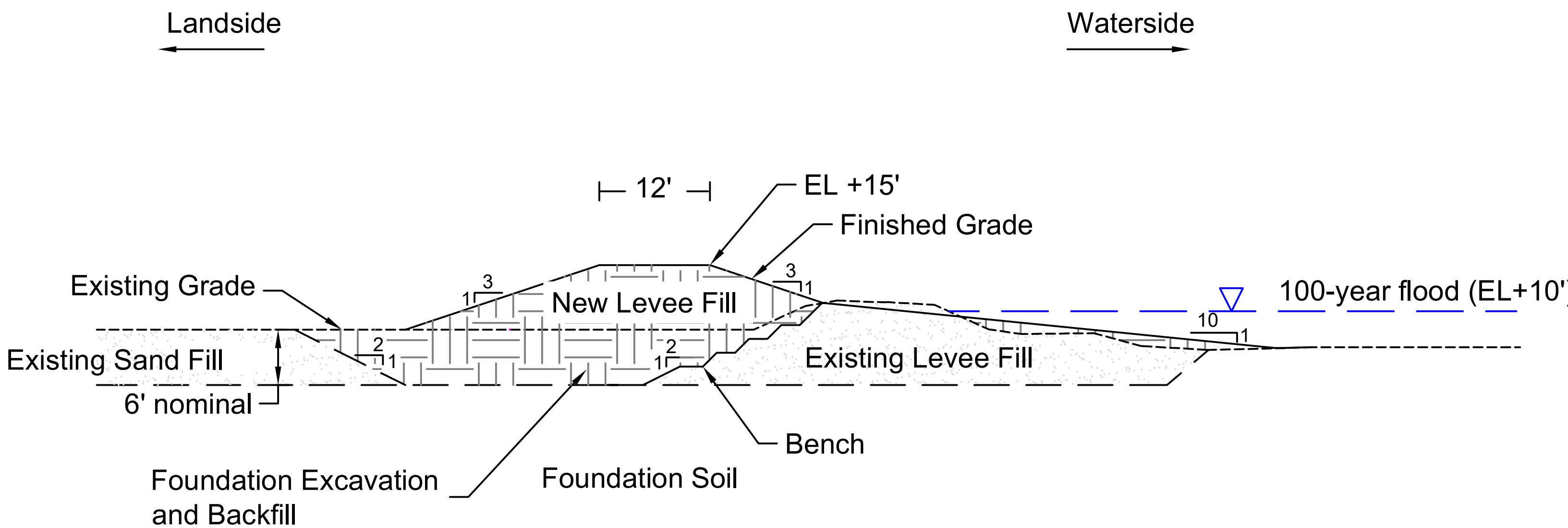
Hultgren - Tillis Engineers	Project No. 923.01	Plate No. 7



Notes:

(1) Foundation excavation should extend through the existing sand fill, nominally 3 to 4 feet below existing grade.
(2) Base of keyway should be at least 12 feet wide and at least 3 feet below existing grade.
(3) Foundation and keyway excavation should have side slopes inclined at 2H:1V or flatter.
(4) New levee fill should meet criteria per report.
(5) Levee crest fill thickness of 8.5 feet will cause estimated settlement of about 2.5 feet.
(6) Levee crest as shown includes 2.5 feet of overbuild to accommodate settlement.
(7) Ecotone slope fill thickness of 3 feet will cause estimated settlement of about 1.3 feet.
(8) Ecotone slope should include overbuild to accommodate settlement.

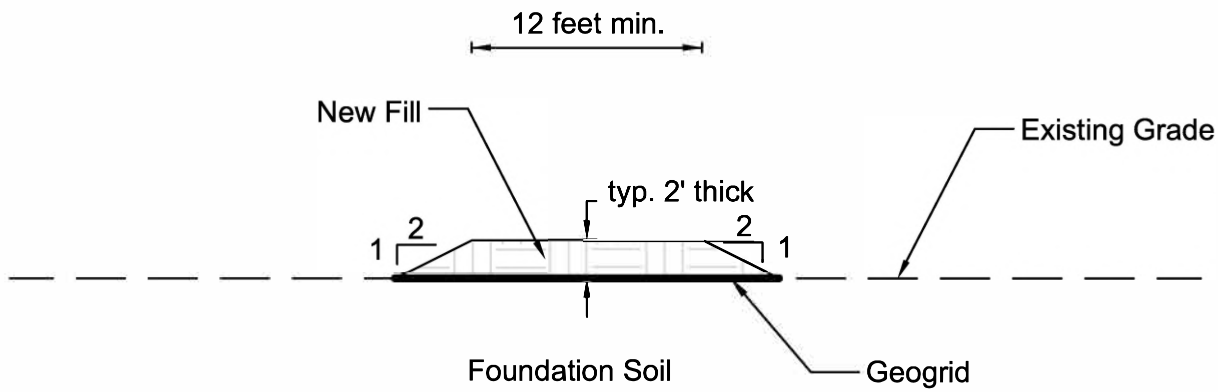
SCALE 0 — 20 feet 1 inch = 20 feet	Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**Typical Configuration Details** **Upland Landside Area** **Setback Ecotone Levee**	
	Hultgren - Tillis Engineers	Project No. 923.01	Plate No. 8



Notes:

(1) Foundation excavation should extend through the existing sand fill, nominally 6 feet below existing grade.
(2) Foundation excavation should have side slopes inclined at 2H:1V or flatter.
(3) New levee fill should meet criteria per report.
(4) Levee crest fill thickness of 7 feet will cause an estimated settlement of about 2 feet.
(5) Levee crest as shown includes two feet of overbuild to accommodate settlement.
(6) New fill should be benched into existing levee fill. Horizontal bench width should not exceed 5 feet.

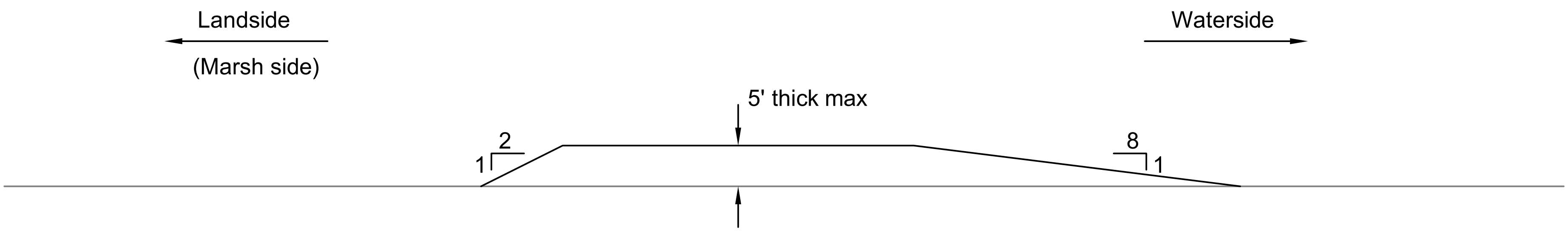
SCALE 0 20 feet 1 inch = 20 feet	Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**Typical Configuration Details** **Upland Landside Area** **Offset Levee Along Canal Street**
	Hultgren - Tillis Engineers	Project No. 923.01 / Plate No. 9



Notes:

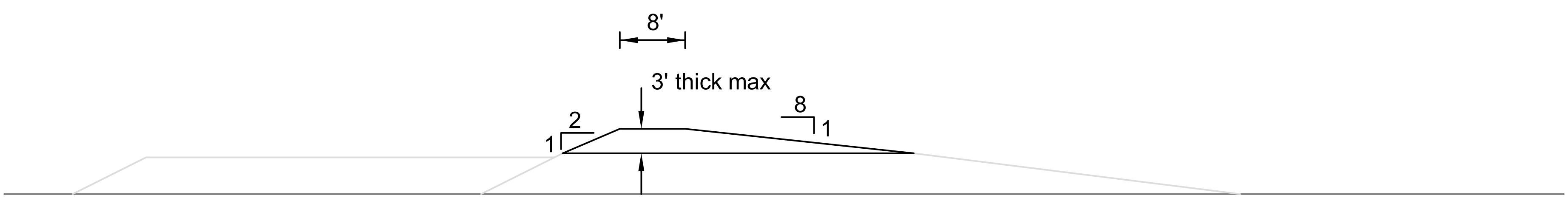
1. Geogrid should be placed underneath new fill.
2. Geogrid should consist of Tensar BX1100 or equal.

NOT TO SCALE	Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**Typical Detail** **Temporary Access Road**	
	Hultgren - Tillis Engineers	Project No. 923.01	Plate No. 10



Step 1: Place 5' thick rock fill, 2:1 slope or flatter on landside, 8:1 on waterside.

Step 2: Place 4.5' thick dredge fill (weighs 100 pcf) and at least 50' wide for buttress



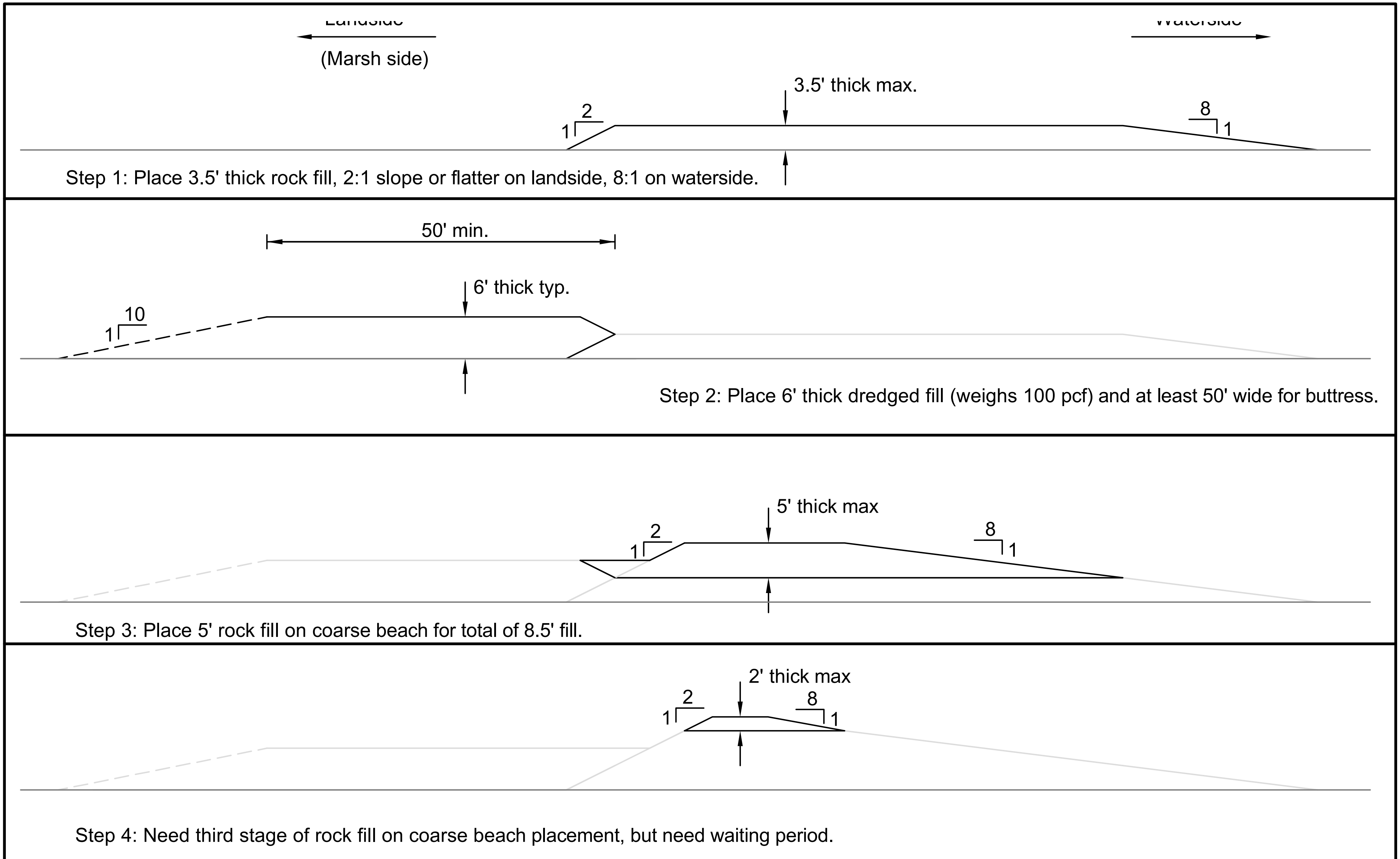
Step 3: Place 3' rock fill on coarse beach for total of 8' fill.

NOT TO SCALE

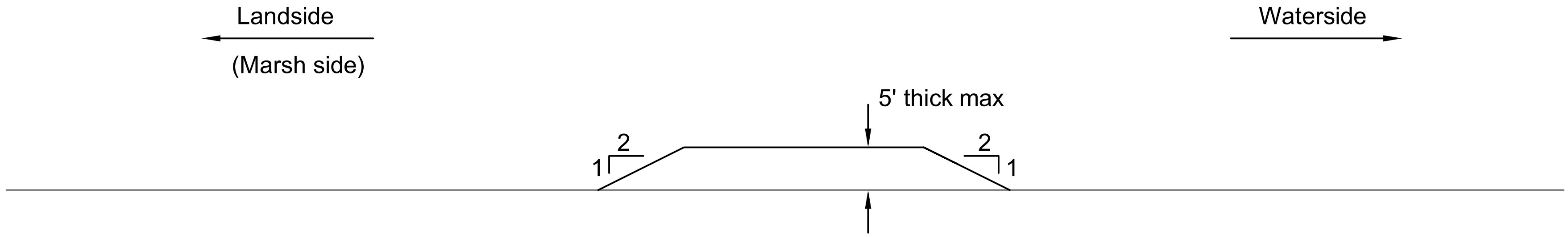
Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Preliminary Typical Configuration Details
Tidal Marsh Area
Coarse Beach Section on Eroded Marsh Areas

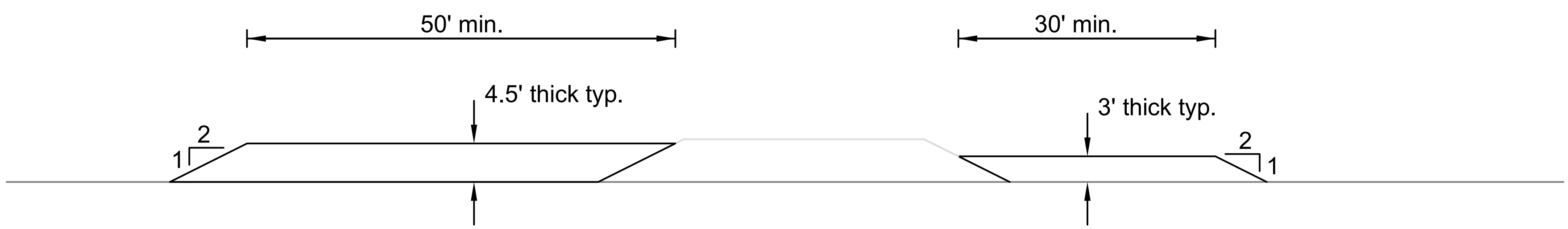
Hultgren - Tillis Engineers | Project No. 923.01 | Plate No. 11



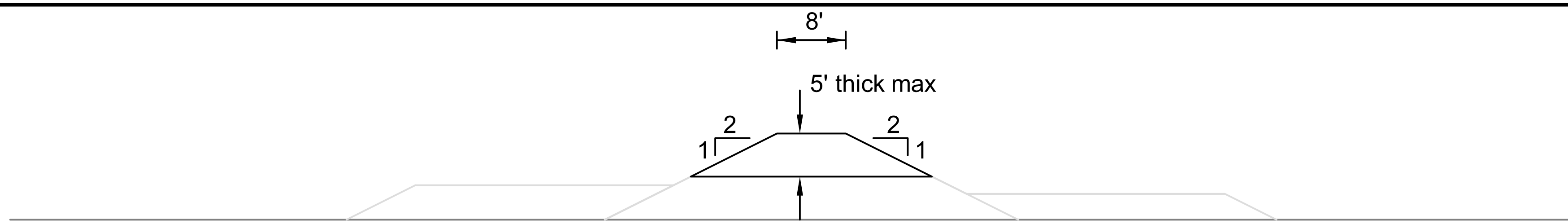
NOT TO SCALE	Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**Preliminary Typical Configuration Details** **Tidal Marsh Area** **Coarse Beach Section on Virgin Marsh Areas**	
	Hultgren - Tillis Engineers	Project No. 923.01	Plate No. 12



Step 1: Place 5' thick rock fill, 2:1 slope or flatter.



Step 2A: Place dredge fill (weights 100 pcf) to 4.5' thick and at least 50' wide for buttress.
Step 2B: Place rock berm fill (weights 135 pcf) 3' thick and at least 30' wide on waterside for buttress.

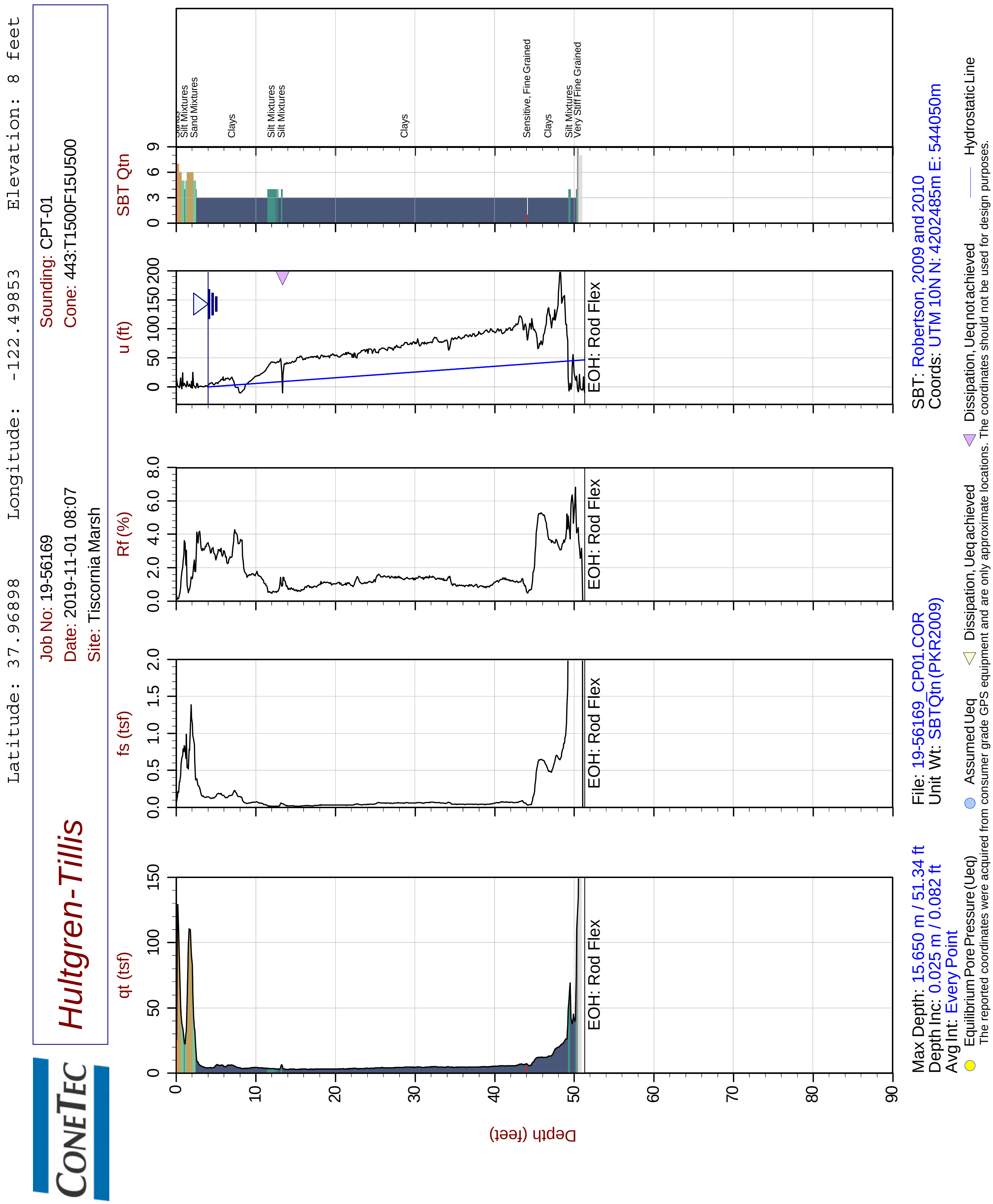


Step 3: Place 5' rock fill for a total of 10' fill.

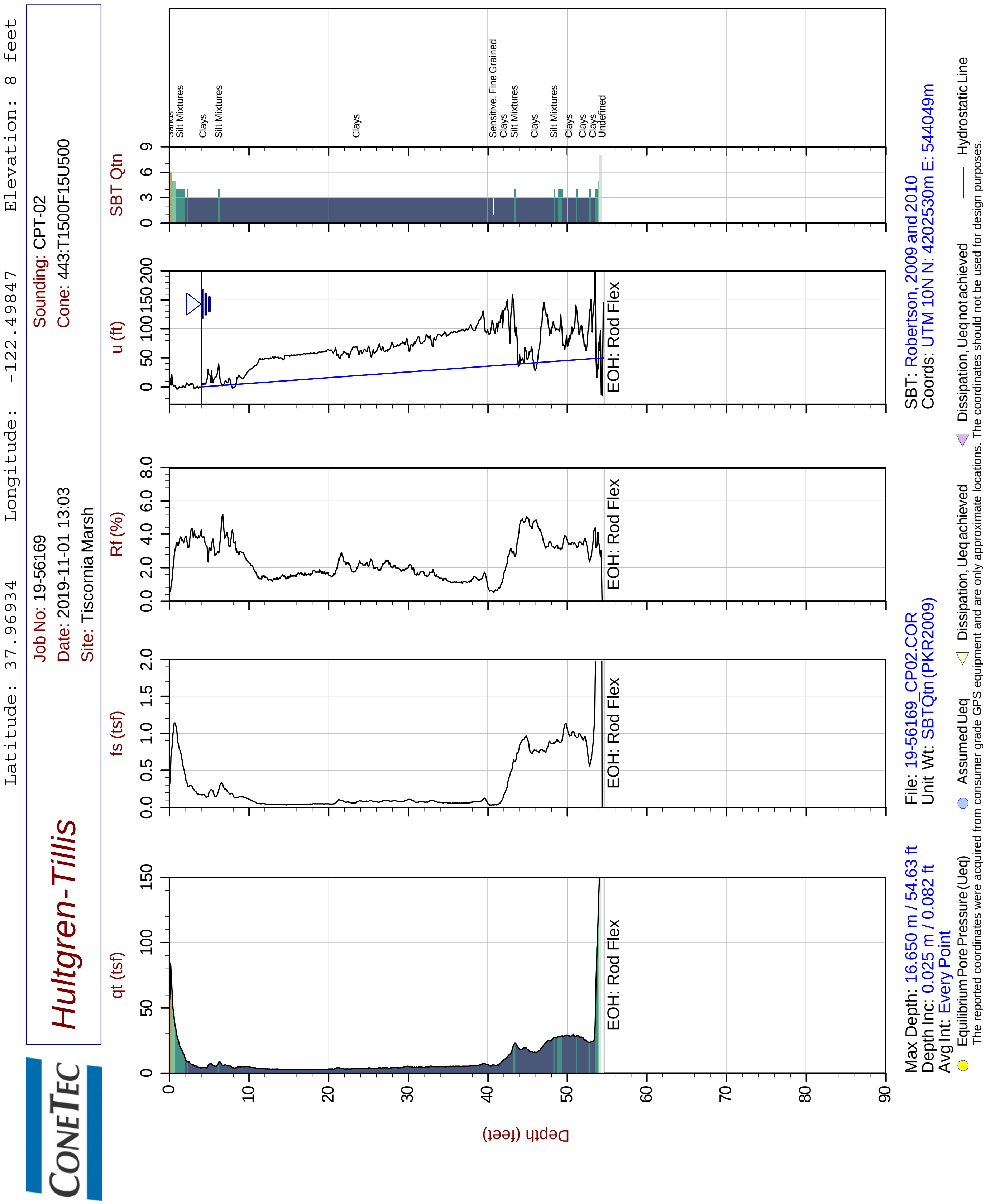
NOT TO SCALE	Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**Preliminary Typical Configuration Details** **Tidal Marsh Area** **Rock Jetty Section on Eroded Marsh Areas**	
	Hultgren - Tillis Engineers	Project No. 923.01	Plate No. 13

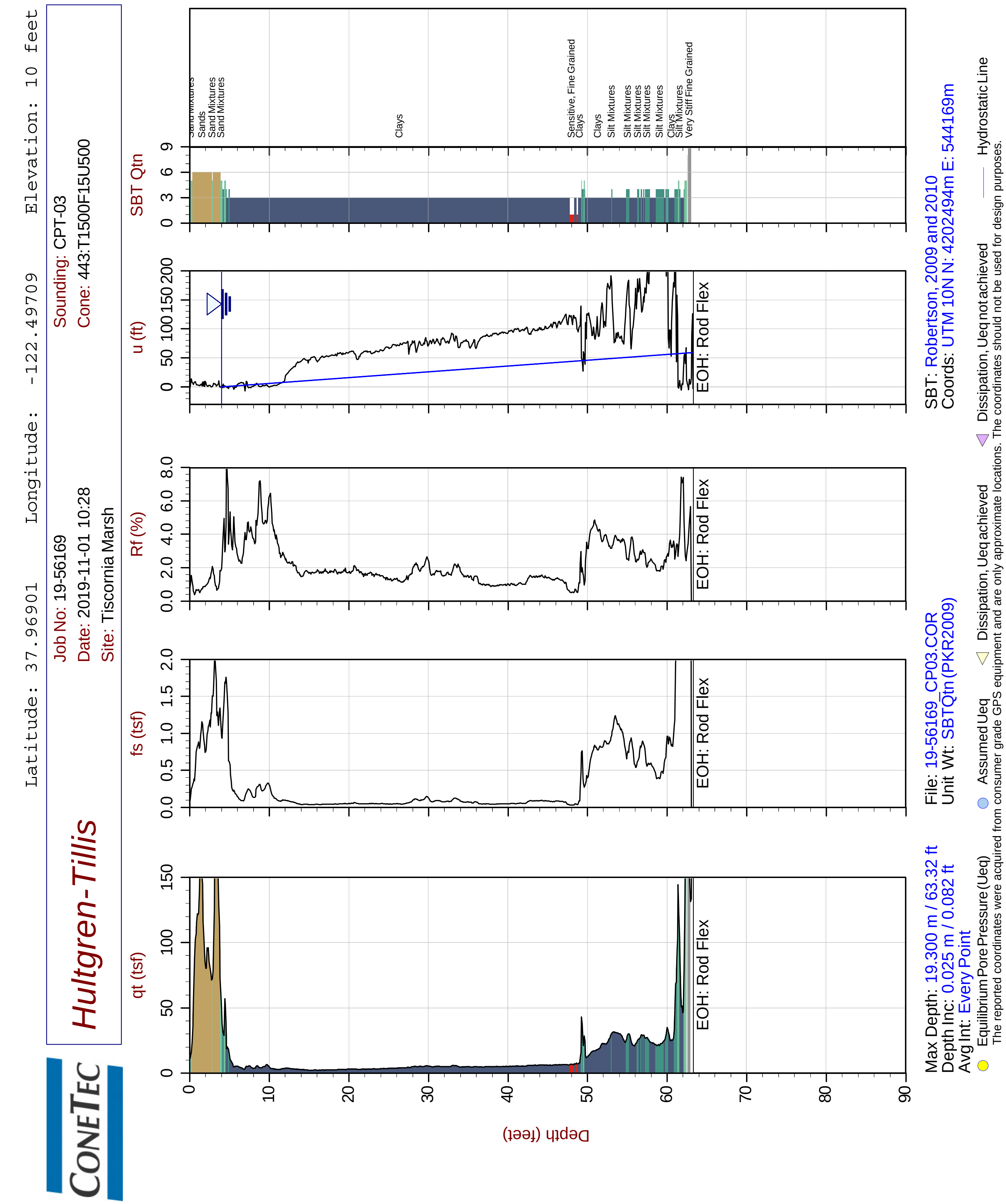
APPENDIX A

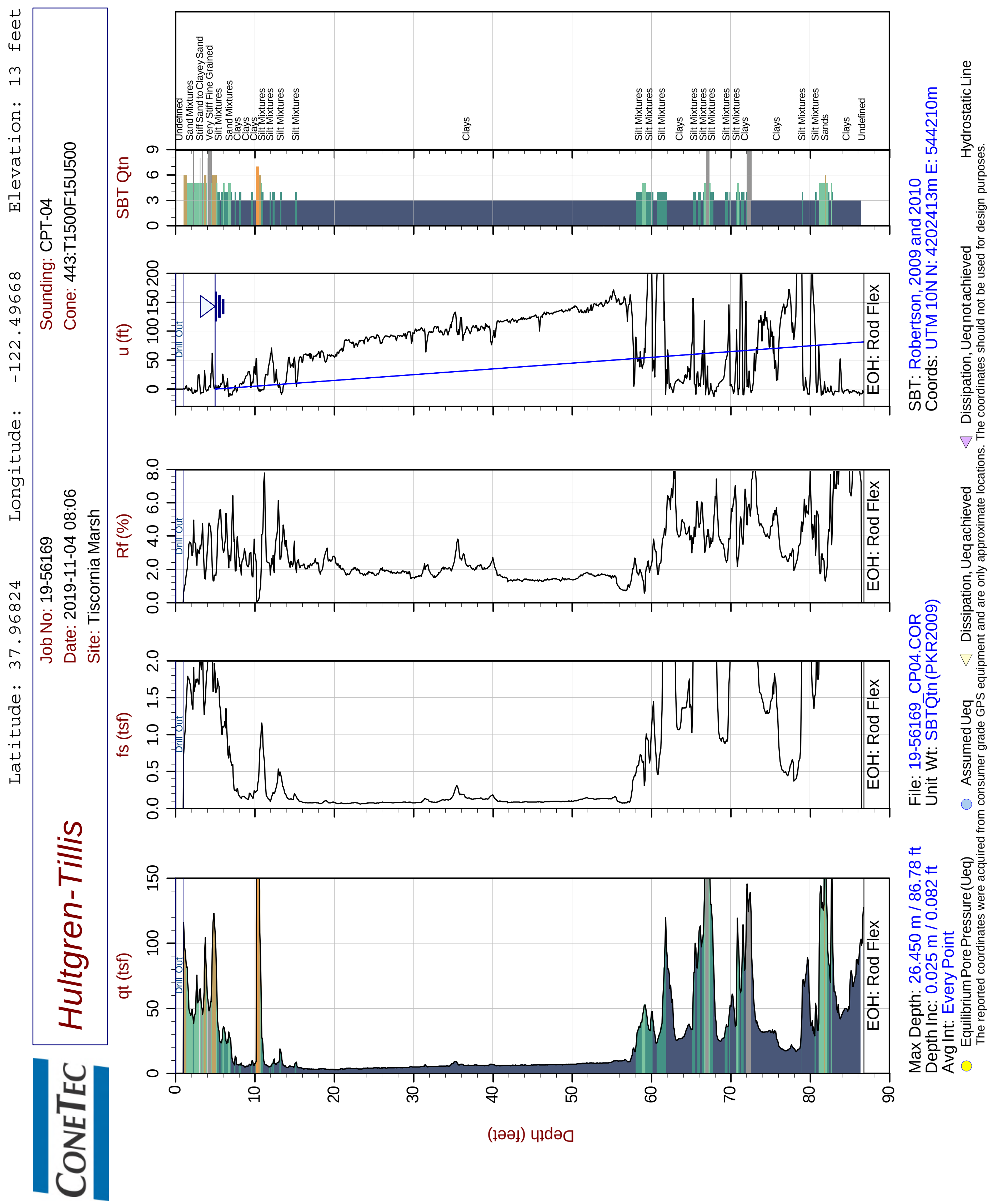
Logs of Cone Penetration Tests

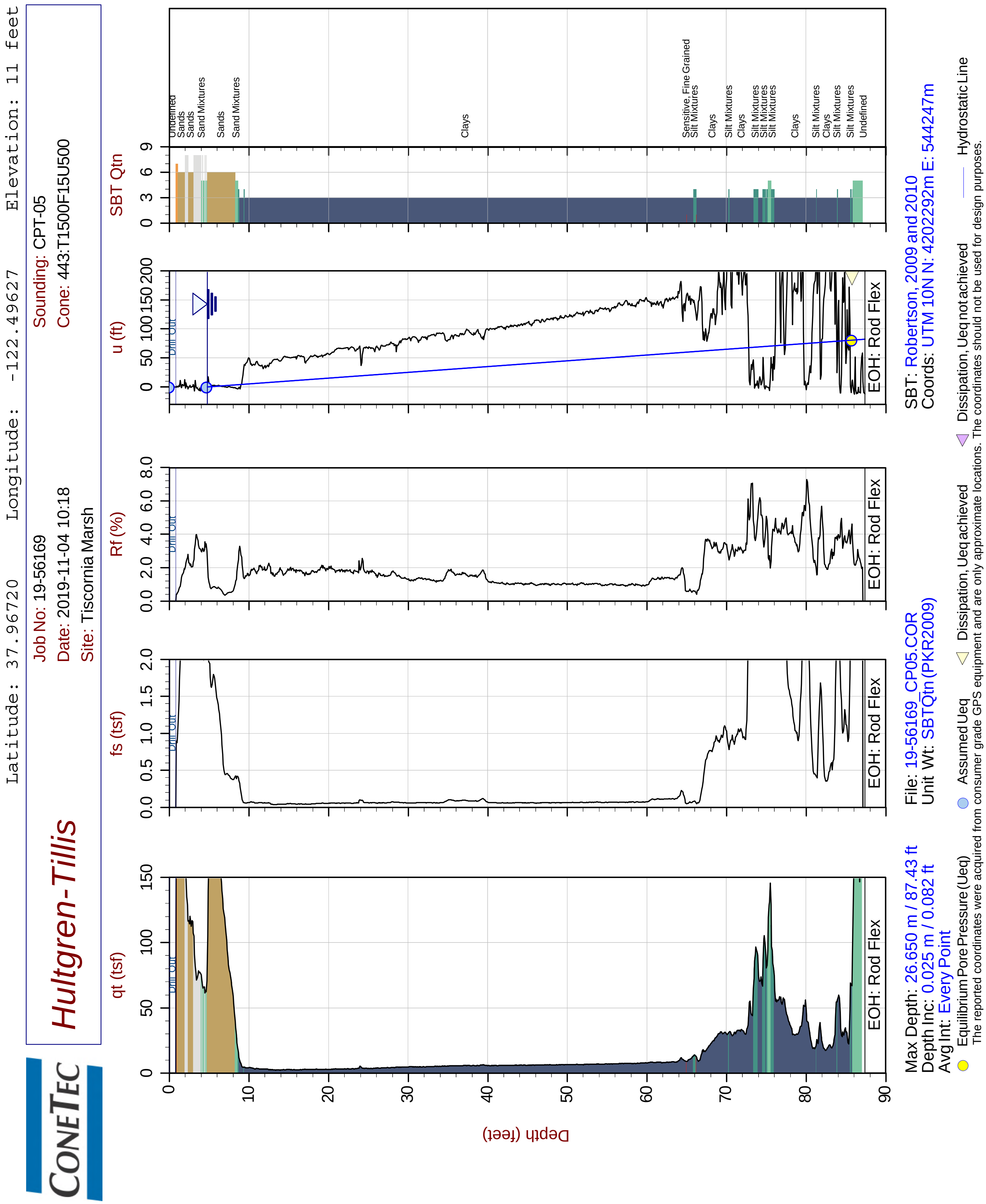


Latitude: 37.96898 Longitude: -122.49853 Elevation: 8 feet
Hultgren-Tillis
Job No: 19-56169
Date: 2019-11-01 08:07
Site: Tiscornia Marsh
Sounding: CPT-01
Cone: 443:T1500F15U500
ConeTec
qt (tsf)
fs (tsf)
Rf (%)
u (ft)
SBT Qtn
Depth (feet)
EOH: Rod Flex
Sands
Silt Mixtures
Sand Mixtures
Clays
Silt Mixtures
Silt Mixtures
Clays
Sensitive, Fine Grained
Clays
Silt Mixtures
Very Stiff Fine Grained
Max Depth: 15.650 m / 51.34 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
File: 19-56169_CP01.COR
Unit Wt: SBTQtn (PKR2009)
SBT: Robertson, 2009 and 2010
Coords: UTM 10N N: 4202485m E: 544050m
Equilibrium Pore Pressure (Ueq)
Assumed Ueq
Dissipation, Ueq achieved
Dissipation, Ueq not achieved
Hydrostatic Line
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.


Latitude: 37.96934 Longitude: -122.49847 Elevation: 8 feet
Hultgren-Tillis
Job No: 19-56169
Date: 2019-11-01 13:03
Site: Tiscornia Marsh
Sounding: CPT-02
Cone: 443:T1500F15U500
CONETEC
qt (tsf)
fs (tsf)
Rf (%)
u (ft)
SBT Qtn
EOH: Rod Flex
Depth (feet)
Sands
Silt Mixtures
Clays
Sensitive, Fine Grained
Undefined
Max Depth: 16.650 m / 54.63 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
File: 19-56169_CP02.COR
Unit Wt: SBTQtn (PKR2009)
SBT: Robertson, 2009 and 2010
Coords: UTM 10N N: 4202530m E: 544049m
Equilibrium Pore Pressure (Ueq)
Assumed Ueq
Dissipation, Ueq achieved
Dissipation, Ueq not achieved
Hydrostatic Line
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.


Latitude: 37.96901 Longitude: -122.49709 Elevation: 10 feet
Job No: 19-56169
Date: 2019-11-01 10:28
Site: Tiscornia Marsh
Sounding: CPT-03
Cone: 443:T1500F15U500
Hultgren-Tillis
ConeTec
qt (tsf)
fs (tsf)
Rf (%)
u (ft)
SBT Qtn
Depth (feet)
EOH: Rod Flex
Sands
Sand Mixtures
Clays
Sensitive, Fine Grained
Silt Mixtures
Very Stiff Fine Grained
Max Depth: 19.300 m / 63.32 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
File: 19-56169_CP03.COR
Unit Wt: SBTQtn (PKR2009)
SBT: Robertson, 2009 and 2010
Coords: UTM 10N N: 4202494m E: 544169m
Equilibrium Pore Pressure (Ueq)
Assumed Ueq
Dissipation, Ueq achieved
Dissipation, Ueq not achieved
Hydrostatic Line
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.


Latitude: 37.96824 Longitude: -122.49668 Elevation: 13 feet
Hultgren-Tillis
Job No: 19-56169
Date: 2019-11-04 08:06
Site: Tiscornia Marsh
Sounding: CPT-04
Cone: 443:T1500F15U500
ConeTec
qt (tsf)
fs (tsf)
Rf (%)
u (ft)
SBT Qtn
Depth (feet)
Drill Out
EOH: Rod Flex
Undefined
Sand Mixtures
Stiff Sand to Clayey Sand
Very Stiff Fine Grained
Silt Mixtures
Clays
Sands
Max Depth: 26.450 m / 86.78 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
File: 19-56169_CP04.COR
Unit Wt: SBTQtn (PKR2009)
SBT: Robertson, 2009 and 2010
Coords: UTM 10N N: 4202413m E: 544210m
Equilibrium Pore Pressure (Ueq)
Assumed Ueq
Dissipation, Ueq achieved
Dissipation, Ueq not achieved
Hydrostatic Line
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.



Restore Eroded and Diked Marsh
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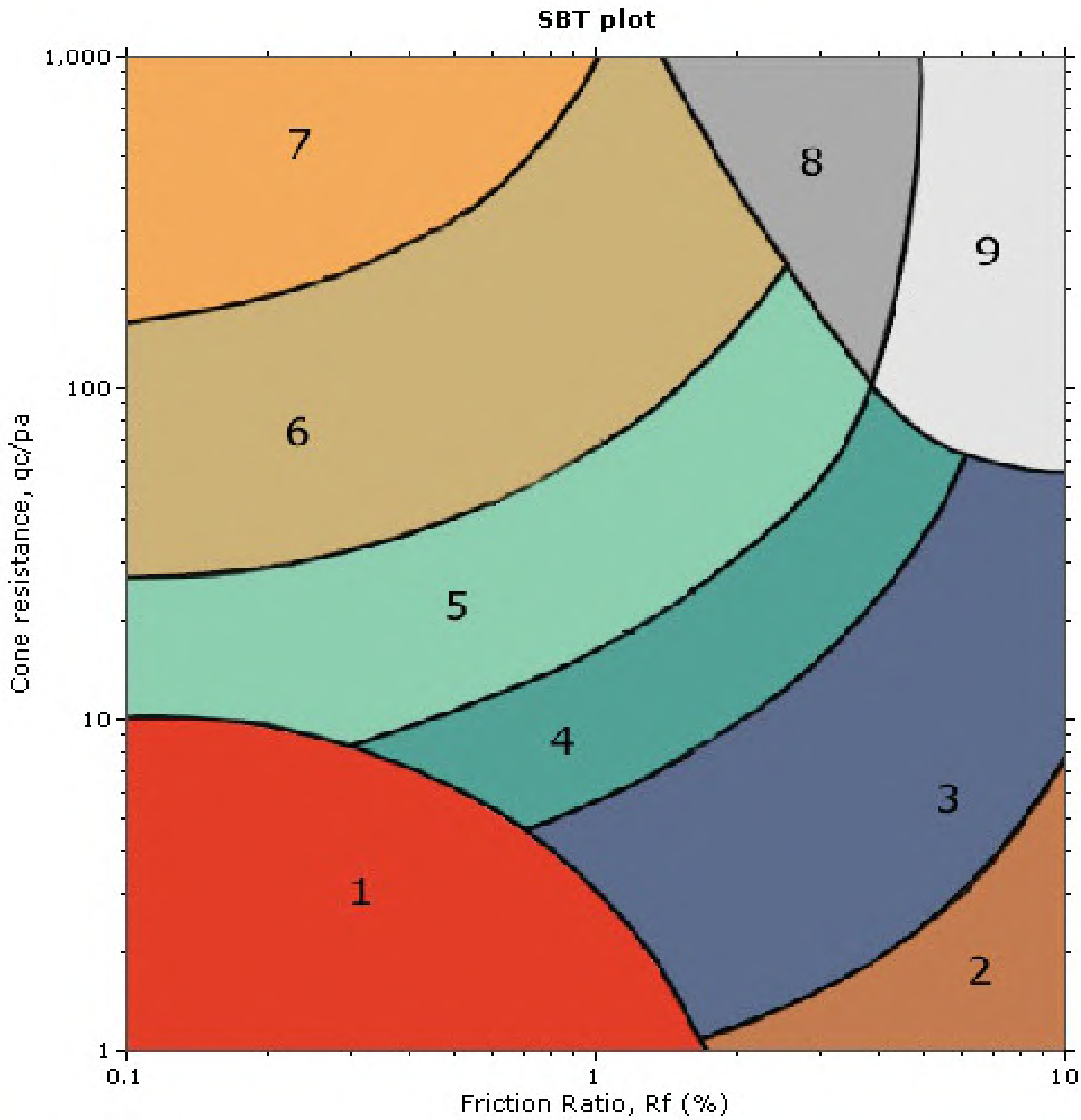
San Rafael, California

Project No. 923.01



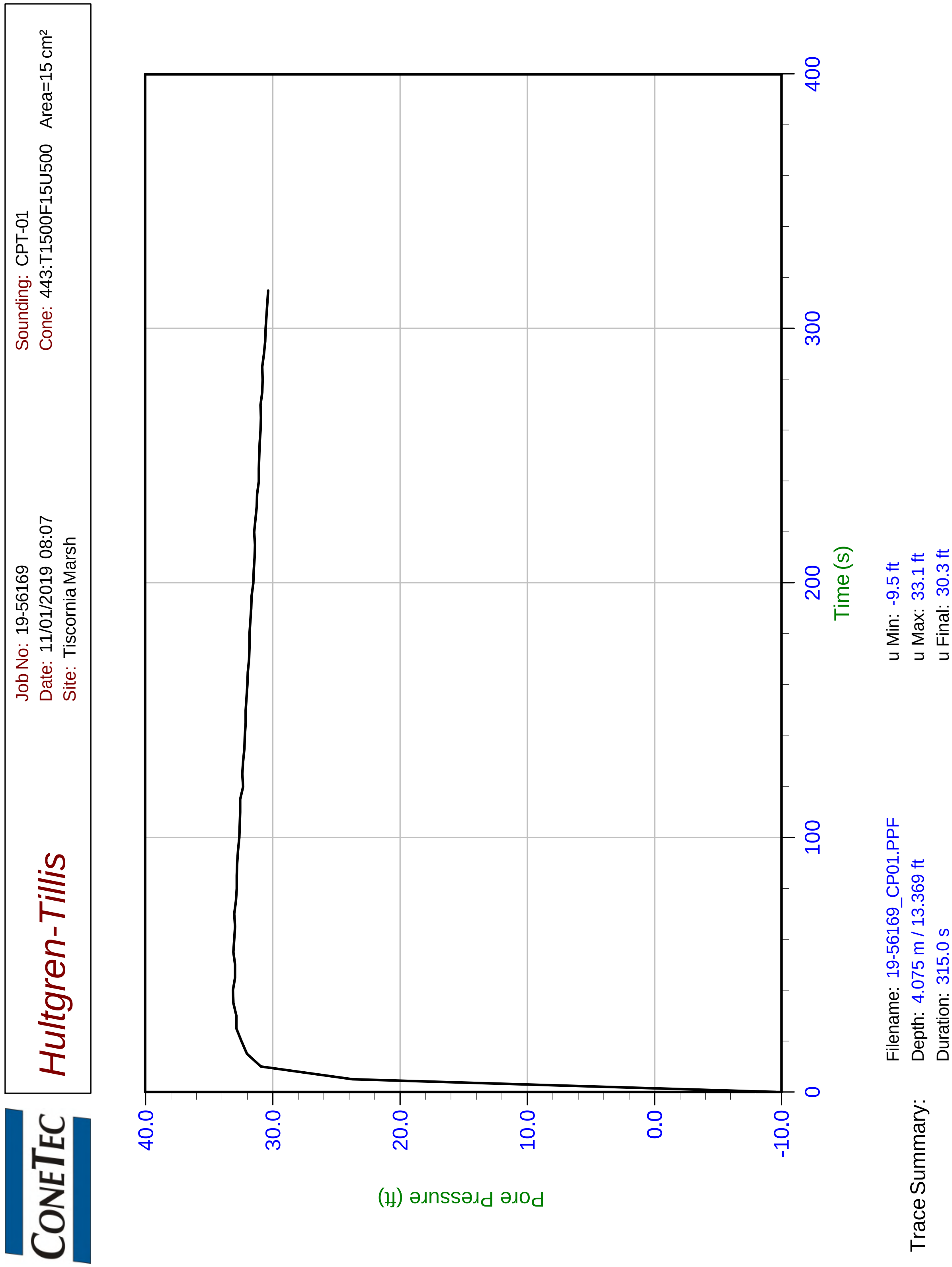
SBT zone	Proposed common SBT description
1	*Sensitive fine-grained*
2	*Clay - organic soil*
3	*Clays: clay to silty clay*
4	*Silt mixtures: clayey silt & silty clay*
5	*Sand mixtures: silty sand to sandy silt*
6	*Sands: clean sands to silty sands*
7	*Dense sand to gravelly sand*
8	*Stiff sand to clayey sand**
9	*Stiff fine-grained**

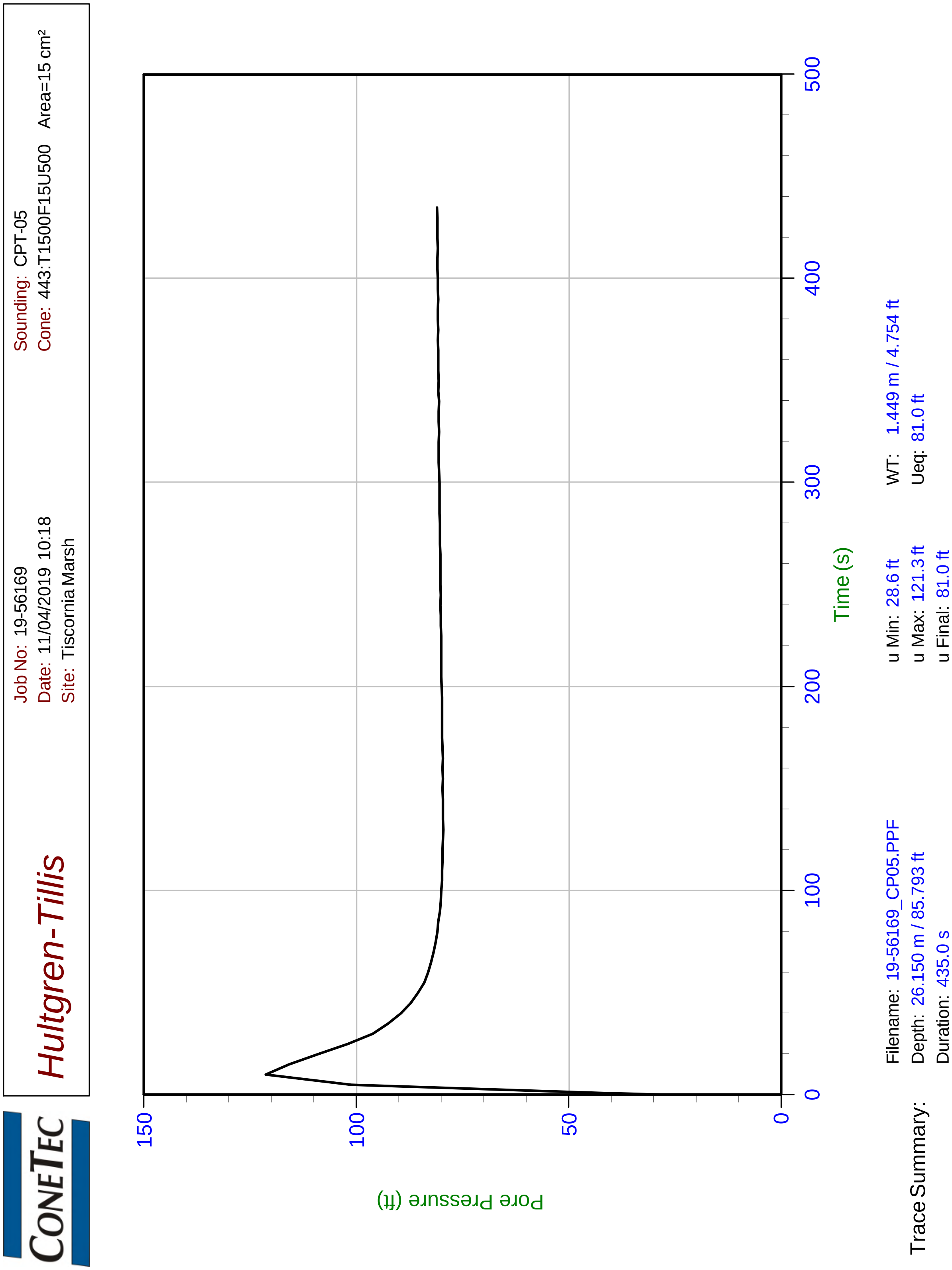
** Overconsolidated or cemented*

Note: Updated Soil Behavior Type (SBT) chart based on non-normalized CPT (after Robertson 2010a).

Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**CPT Soil Behavior Type Legend**

Hultgren - Tillis Engineers	Project No. 923.01	Plate No. A-6


ConeTec
Hultgren-Tillis
Job No: 19-56169
Date: 11/01/2019 08:07
Site: Tiscornia Marsh
Sounding: CPT-01
Cone: 443:T1500F15U500 Area=15 cm²
Pore Pressure (ft)
40.0
30.0
20.0
10.0
0.0
-10.0
Time (s)
0
100
200
300
400
Trace Summary:
Filename: 19-56169_CP01.PPF
Depth: 4.075 m / 13.369 ft
Duration: 315.0 s
u Min: -9.5 ft
u Max: 33.1 ft
u Final: 30.3 ft



ConeTec
Hultgren-Tillis
Job No: 19-56169
Date: 11/04/2019 10:18
Site: Tiscornia Marsh
Sounding: CPT-05
Cone: 443:T1500F15U500 Area=15 cm²
Pore Pressure (ft)
150
100
50
0
Time (s)
0
100
200
300
400
500
Trace Summary:
Filename: 19-56169_CP05.PPF
Depth: 26.150 m / 85.793 ft
Duration: 435.0 s
u Min: 28.6 ft
u Max: 121.3 ft
u Final: 81.0 ft
WT: 1.449 m / 4.754 ft
Ueq: 81.0 ft

APPENDIX B

Logs of Borings

Date : 11/7/2019
Drilling Method : Hollow-Stem Auger
Elevation (Feet) : 8
Latitude : 37.96903
Longitude : -122.49851

Depth in Feet	Samples Type/ Recovery	Blow Count	Graphic	USCS	Water Levels	Material Description	Torvane (tsf)	Pocket Pen (tsf)	Moisture Content (%)	Dry Density (pcf)	Other Laboratory Tests
				SM		Silty Sand (SM), yellowish brown, fine grained sand, dry, dense, some gravel, (fill)					
	M	7		CH		Fat Clay (CH), brown, moist, firm, high plasticity, no dilatancy, high toughness, high dry strength, (Bay Mud Crust)	0.25		63	61	
5	M	6		CH		Fat Clay (CH), dark olive gray, wet, stiff, high plasticity, no dilatancy, high toughness, high dry strength, trace organics, (Bay Mud)	0.57	1.3	60	66	
	M	6				Firm	0.41	0.8	65	56	
							0.25				
10	M	5		CH		Fat Clay (CH), dark olive gray, wet, firm, high plasticity, no dilatancy, high toughness, high dry strength, (Bay Mud)					
15	T	P				Soft	0.13				VS=340

Bottom of boring at 17.5 feet
Groundwater obscured due to hollow-stem augers
The laboratory vane shear strength shown was computed by mutiplying the data by an estimated Bjerrum's correction factor of 0.85

Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
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Log of Boring 1
(Page 1 of 1)

Hultgren - Tillis Engineers | Project No. 923.01 | Plate No. B-1

Date : 11/7/2019
Drilling Method : Hollow-Stem Auger
Elevation (Feet) : 8
Latitude : 37.96930
Longitude : -122.49849

Depth in Feet	Samples Type/ Recovery	Blow Count	Graphic	USCS	Water Levels	Material Description	Torvane (tsf)	Pocket Pen (tsf)	Moisture Content (%)	Dry Density (pcf)	Other Laboratory Tests
				SM		Silty Sand (SM), yellowish brown, fine grained sand, dry, dense, some gravel, (fill)					
	M	8		CH		Fat Clay (CH), brown, moist, stiff, high plasticity, no dilatancy, high toughness, high dry strength, (Bay Mud Crust)	0.53	2.5	49	66	
5	M	6		CH		Fat Clay (CH), dark olive gray, wet, stiff, high plasticity, no dilatancy, high toughness, high dry strength, trace organics, (Bay Mud)	0.52		55	67	
	M	5					0.35	0.8	61	65	
						Fat Clay (CH), dark olive gray, wet, soft, high plasticity, no dilatancy, high toughness, high dry strength, (Bay Mud)	0.50				
10	M	6					0.25	0.5	61	62	LL=56 PI=28
						Becoming soft					
				CH							
15	T	P				Very Soft					
							0.09				VS=180

Bottom of boring at 17.5 feet
Groundwater obscured due to hollow-stem augers
The laboratory vane shear strength shown was computed by mutiplying the data by an estimated Bjerrum's correction factor of 0.85

Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Log of Boring 2
(Page 1 of 1)

Hultgren - Tillis Engineers | Project No. 923.01 | Plate No. B-2

Date	: 11/8/2019
Drilling Method	: Hollow-Stem Auger
Elevation (Feet)	: 9
Latitude	: 37.96918
Longitude	: -122.49769

Depth in Feet	Samples Type/ Recovery	Blow Count	USCS	Water Levels	Material Description	Torvane (tsf)	Pocket Pen (tsf)	Moisture Content (%)	Dry Density (pcf)	Other Laboratory Tests
			SM		Silty Sand (SM), dark yellowish brown, fine grained sand, moist, dense, (fill)					
			SM		Silty Sand (SM), light yellowish brown, fine grained sand, dry, medium dense, some gravel, (fill)					
	M	17					2.5	42	71	
5	M	5	CH		Fat Clay (CH), olive brown, moist, medium stiff, low plasticity, no dilatancy, medium toughness, medium dry strength, oxidation marks, (Bay Mud Crust)	0.32		55	65	
	T	P	CH							
10	T	P			Fat Clay (CH), dark olive gray, wet, firm, high plasticity, no dilatancy, high toughness, high dry strength, with organics, (Bay Mud)	0.18		69	58	TxUU=290 VS=460
				▽				75	55	TxUU=220 VS=340
					Fat Clay (CH), dark olive gray, wet, soft, high plasticity, no dilatancy, high toughness, high dry strength, (Bay Mud) 11/8/2019					
15	M	4				0.20 0.17		86		Organic=4%
20	T	P						81 83	52 52	LL=68 PI=38 Consol TxUU=330 VS=380
						0.09				
25	M	4	CH			0.20 0.25				
30	T	P						67	59	TxUU=380
					Firm					VS=535
35	M	4				0.22 0.24				
40	T	P				0.28		95	47	TxUU=560 VS=750
			CL		Lean Clay (CL), greenish gray, wet, stiff, low					

Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
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Log of Boring 3
(Page 1 of 2)

Hultgren - Tillis Engineers	Project No. 923.01	Plate No. B-3

Depth in Feet	Samples Type/ Recovery	Blow Count	Graphic	USCS	Water Levels	Material Description	Torvane (tsf)	Pocket Pen (tsf)	Moisture Content (%)	Dry Density (pcf)	Other Laboratory Tests
	M	20		CL		plasticity, slow dilatancy, medium toughness, medium dry strength	0.26	1.0	19	103	
50								1.7			
	M	51					0.85	1.8	29	90	

Date : 11/8/2019
Drilling Method : Hollow-Stem Auger
Elevation (Feet) : 9
Latitude : 37.96918
Longitude : -122.49769

Bottom of boring at 51.5 feet
Groundwater encountered at 12 feet during drilling
The laboratory vane shear strength shown was computed by mutiplying the data by an estimated Bjerrum's correction factor of 0.85

Date	: 11/7/2019
Drilling Method	: Hollow-Stem Auger
Elevation (Feet)	: 10
Latitude	: 37.96903
Longitude	: -122.49717

Depth in Feet	Samples Type/ Recovery	Blow Count	Graphic	USCS	Water Levels	Material Description	Torvane (tsf)	Pocket Pen (tsf)	Moisture Content (%)	Dry Density (pcf)	Other Laboratory Tests
				SM		Silty Sand (SM), dark yellowish brown, fine grained sand, moist, dense, (fill)					
	M	83 / 11"		SM		Silty Sand with Gravel (SM), light yellowish brown, dry, very dense, some gravel, (fill)		4.5+	7	125	-200=32
5	M	10		CH		Fat Clay (CH), olive brown, wet, stiff, high plasticity, no dilatancy, high toughness, high dry strength, trace organics, (Bay Mud Crust)	0.53	1.0	20	83	
	M	6		CH		Fat Clay (CH), dark olive gray, wet, firm to stiff, high plasticity, no dilatancy, high toughness, high dry strength, trace organics, (Bay Mud)	0.39	1.3	44	70	
10	M	4					0.22	0.8	84		Organic=6%
							0.17		63	59	
						Fat Clay (CH), dark olive gray, wet, soft, high plasticity, no dilatancy, high toughness, high dry strength, (Bay Mud)					
15	T	P							79	54	TxUU=290 VS=410
							0.15				
20	M	4					0.20				
							0.17				
25	T	P					0.25		85	51	LL=72 PI=40 Consol
									82	52	TxUU=360 VS=410
				CH							
30	M	6					0.22	0.5			
							0.26				
35	T	P				Firm			73	57	TxUU=400 VS=460
							0.17				
40	M	5					0.19				

Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
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Log of Boring 4
(Page 1 of 2)

Hultgren - Tillis Engineers | Project No. 923.01 | Plate No. B-5

Depth in Feet	Samples Type/ Recovery	Blow Count	Graphic	USCS	Water Levels	Material Description	Torvane (tsf)	Pocket Pen (tsf)	Moisture Content (%)	Dry Density (pcf)	Other Laboratory Tests
	T	P		CH			0.32		73	56	TxUU=540 VS=620
50	M	24		CL		Lean Clay (CL), bluish green, wet, stiff, low plasticity, slow dilatancy, medium toughness, medium dry strength	0.45 0.67	1.0 1.4	23	103	

Date : 11/7/2019
Drilling Method : Hollow-Stem Auger
Elevation (Feet) : 10
Latitude : 37.96903
Longitude : -122.49717

Bottom of boring at 51.5 feet
Groundwater obscured due to hollow-stem augers
The laboratory vane shear strength shown was computed by mutiplying the data by an estimated Bjerrum's correction factor of 0.85

Date	:	11/7/2019
Drilling Method	:	Hollow-Stem Auger
Elevation (Feet)	:	13
Latitude	:	37.96821
Longitude	:	-122.49669

Depth in Feet	Samples Type/ Recovery	Blow Count	USCS	Water Levels	Material Description	Torvane (tsf)	Pocket Pen (tsf)	Moisture Content (%)	Dry Density (pcf)	Other Laboratory Tests
					Asphalt (3- to 4- inches)					
			SM		Silty Sand with Gravel (SM), light yellowish brown, dry, dense, (fill)					
	M	38	ML		Silt (ML), brown, moist, very stiff, some gravel and sand, (fill)		4.5+	8	123	
5	M	22	SM		Silty Sand with Gravel (SM), yellowish brown and olive, moist, medium dense, (fill)		4.5+	11	116	-200=25
	M	11	CH		Gravelly Fat Clay with Sand (CH), olive gray, wet, stiff, high plasticity, no dilatancy, high toughness, high dry strength, trace organics, 1/4-inch size angular gravel, (fill)	0.56	1.4	52	69	
10	M	14				0.30		20	102	
15	T	P				0.55		20	104	VS=1060

Bottom of boring at 17.5 feet
Groundwater obscured due to hollow-stem augers
The laboratory vane shear strength shown was computed by mutiplying the data by an estimated Bjerrum's correction factor of 0.85

Date	: 11/8/2019
Drilling Method	: Hollow-Stem Auger
Elevation (Feet)	: 8
Latitude	: 37.96717
Longitude	: -122.49644

Depth in Feet	Samples Type/ Recovery	Blow Count	USCS	Water Levels	Material Description	Torvane (tsf)	Pocket Pen (tsf)	Moisture Content (%)	Dry Density (pcf)	Other Laboratory Tests
			SP		Poorly-Graded Sand (SP), light yellowish brown, fine grained sand, dry, medium dense, (fill)					
	M	23						25	98	-200=4
5			SP		Poorly-Graded Sand (SP), dark gray, medium grained sand, wet, medium dense, (fill)					
	M	4	CH		Fat Clay (CH), olive brown, wet, soft, high plasticity, no dilatancy, high toughness, high dry strength, with organics. (Bay Mud crust)	0.25		38	84	
	M	4				0.15		90	48	LL=69 PI=30
10	T	P			Fat Clay (CH), dark olive gray, wet, very soft, high plasticity, no dilatancy, high toughness, high dry strength, with organics, (Bay Mud) With sea shells			80	53	TxUU=130
						0.09				VS=180
15	T	P				0.15		74 78	56 54	LL=68 PI=38 Consol TxUU=340 VS=340
20	M	6				0.17				
25	T	P	CH			0.17		79	54	TxUU=360 VS=440
30	M	6				0.19 0.15				
35	T	P				0.25		72	57	TxUU=370 VS=485
40	M	6			Soft	0.22		49	69	

Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
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Log of Boring 6
(Page 1 of 2)

Hultgren - Tillis Engineers | Project No. 923.01 | Plate No. B-8

Date	:	11/8/2019
Drilling Method	:	Hollow-Stem Auger
Elevation (Feet)	:	8
Latitude	:	37.96717
Longitude	:	-122.49644

Depth in Feet	Samples Type/ Recovery	Blow Count	Graphic	USCS	Water Levels	Material Description	Torvane (tsf)	Pocket Pen (tsf)	Moisture Content (%)	Dry Density (pcf)	Other Laboratory Tests
	T	P		CH			0.22		64	61	TxUU=350 VS=490
50	M	4					0.20		57	62	

Bottom of boring at 51.5 feet
Groundwater obscured due to hollow-stem augers
The laboratory vane shear strength shown was computed by mutiplying the data by an estimated Bjerrum's correction factor of 0.85

Date : 2/28/2020
Drilling Method : Hand Auger
Elevation (Feet) : 7
Latitude : 37.96940
Longitude : -122.49777

Depth in Feet	Samples Type/ Recovery	Blow Count	Graphic	USCS	Water Levels	Material Description	Torvane (tsf)	Pocket Pen (tsf)	Moisture Content (%)	Dry Density (pcf)	Other Laboratory Tests
	T	P		CH	▽	Fat Clay with Sand (CH), brown, wet, stiff, high plasticity, no dilatancy, high toughness, high dry strength, with organics, occasional gravel, (Bay Mud crust)			53	67	TxUU=420
							0.31				VS=850
5	T	P				Olive brown, medium stiff			60	62	TxUU=390
						Fat Clay (CH), gray, wet, soft, high plasticity, no dilatancy, high toughness, high dry strength, (Bay Mud)	0.38				VS=675
	T	P							63	59	LL=92 PI=53
							0.25				
	T	P		CH					71	56	VS=570
10							0.26				TxUU=365 VS=425
	T	P							70	52	
							0.19				VS=250

Bottom of boring at 12.5 feet
Groundwater encountered at 6-inches during hand augering

Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Log of Boring 7
(Page 1 of 1)

Hultgren - Tillis Engineers

Project No. 923.01

Plate No. B-10

Date : 2/28/2020
Drilling Method : Hand Auger
Elevation (Feet) : 7
Latitude : 37.96930
Longitude : -122.49751

Depth in Feet	Samples Type/ Recovery	Blow Count	Graphic	USCS	Water Levels	Material Description	Torvane (tsf)	Pocket Pen (tsf)	Moisture Content (%)	Dry Density (pcf)	Other Laboratory Tests
	T	P		CH	▽	Fat Clay with Sand (CH), brown, wet, stiff, high plasticity, no dilatancy, high toughness, high dry strength, with organics, occasional gravel, (Bay Mud crust)	0.25		64	60	TxUU=425 VS=425
	T	P							58	63	TxUU=290
5	T	P				Gray, medium stiff	0.35		36	78	VS=675 TxUU=480
	T	P		CH		Fat Clay (CH), gray, wet, soft, high plasticity, no dilatancy, high toughness, high dry strength, (Bay Mud)	0.38		86	51	VS=710 TxUU=370
10	T	P					0.18		60	63	VS=445
							0.26				VS=460

Bottom of boring at 11.5 feet
Groundwater encountered at 6-inches during hand augering

Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Log of Boring 8
(Page 1 of 1)

Hultgren - Tillis Engineers | Project No. 923.01 | Plate No. B-11

Date : 2/28/2020
Drilling Method : Hand Auger
Elevation (Feet) : 7
Latitude : 37.96920
Longitude : -122.49712

Depth in Feet	Samples Type/ Recovery	Blow Count	Graphic	USCS	Water Levels	Material Description	Torvane (tsf)	Pocket Pen (tsf)	Moisture Content (%)	Dry Density (pcf)	Other Laboratory Tests
				CH	▽	Fat Clay with Sand (CH), brown, wet, stiff, high plasticity, no dilatancy, high toughness, high dry strength, with organics, occasional gravel, (Bay Mud crust)					
	T	P							65	59	TxUU=315
							0.40				VS=850
5	T	P				Gray			56	64	TxUU=285
				CH		Fat Clay (CH), gray, wet, medium stiff, high plasticity, no dilatancy, high toughness, high dry strength, (Bay Mud)	0.46				VS=675
	T	P							74	54	
							0.43				VS=515
10	T	P							53	69	TxUU=415
						Soft	0.21				VS=390

Bottom of boring at 11 feet
Groundwater encountered at 4-inches during hand augering

Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Log of Boring 9
(Page 1 of 1)

Hultgren - Tillis Engineers | Project No. 923.01 | Plate No. B-12

Date : 2/28/2020
Drilling Method : Hand Auger
Elevation (Feet) : 7
Latitude : 37.96910
Longitude : -122.49686

Depth in Feet	Samples Type/ Recovery	Blow Count	Graphic	USCS	Water Levels	Material Description	Torvane (tsf)	Pocket Pen (tsf)	Moisture Content (%)	Dry Density (pcf)	Other Laboratory Tests
	T	P		CH		Fat Clay with Sand (CH), brown, wet, stiff, high plasticity, no dilatancy, high toughness, high dry strength, occasional gravel, (Bay Mud crust)	0.39		77	52	TxUU=305 VS=320
5	T	P		CH		Fat Clay (CH), gray, wet, medium stiff, high plasticity, no dilatancy, high toughness, high dry strength, (Bay Mud)	0.24		74	55	TxUU=285 VS=390
	T	P					0.11		82	50	LL=95 PI=56 VS=180
10	T	P					0.15		81	51	VS=180

Bottom of boring at 12 feet
Groundwater encountered at 4-inches during hand augering

Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Log of Boring 10
(Page 1 of 1)

Hultgren - Tillis Engineers | Project No. 923.01 | Plate No. B-13

MAJOR DIVISIONS				GROUP NAMES
COARSE GRAINED SOILS MORE THAN 50% RETAINED ON NO. 200 SIEVE	**GRAVELS** MORE THAN 50% OF COARSE FRACTION IS RETAINED ON NO. 4 SIEVE	**CLEAN GRAVELS** WITH LESS THAN 5% FINES	GW	WELL GRADED GRAVEL
			GP	POORLY GRADED GRAVEL
		GRAVELS WITH OVER 12% FINES	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	SANDS 50% OR MORE OF COARSE FRACTION PASSES NO. 4 SIEVE	**CLEAN SANDS** WITH LESS THAN 5% FINES	SW	WELL GRADED SAND
			SP	POORLY GRADED SAND
		SANDS WITH OVER 12% FINES	SM	SILTY SAND
			SC	CLAYEY SAND
FINE GRAINED SOILS 50% OR MORE PASSES NO. 200 SIEVE	**SILTS AND CLAYS** LIQUID LIMIT LESS THAN 50		ML	SILT
			CL	LEAN CLAY
			OL	ORGANIC CLAY, ORGANIC SILT
	SILTS AND CLAYS LIQUID LIMIT 50 OR MORE		MH	ELASTIC SILT
			CH	FAT CLAY
			OH	ORGANIC CLAY, ORGANIC SILT
HIGHLY ORGANIC SOILS			Pt	PEAT

UNIFIED SOIL CLASSIFICATION SYSTEM- ASTM D 2487

S	- SPT		- Water Level at Time of Drilling	P	- Push
			- Water Level after Drilling (with date measured)	Perm	- Permeability
M	- 2.5 inch	Consol	- Consolidation	Sieve	- Particle Size Analysis
		Gs	- Specific Gravity	VS	- Laboratory Vane Shear (psf)
C	- 3.0 inch	LL	- Liquid Limit (%)	-200	- % Passing No. 200 Sieve
		PI	- Plasticity Index (%)		
T	- Shelby Tube	TxUU	- Shear Strength (psf) - Unconsolidated Undrained Triaxial Shear		
		TxCU	- Shear Strength (psf) - Consolidated Undrained Triaxial Shear		
B	- Bag	UC	- Compressive Strength (psf) - Unconfined Compression		

KEY TO TEST DATA

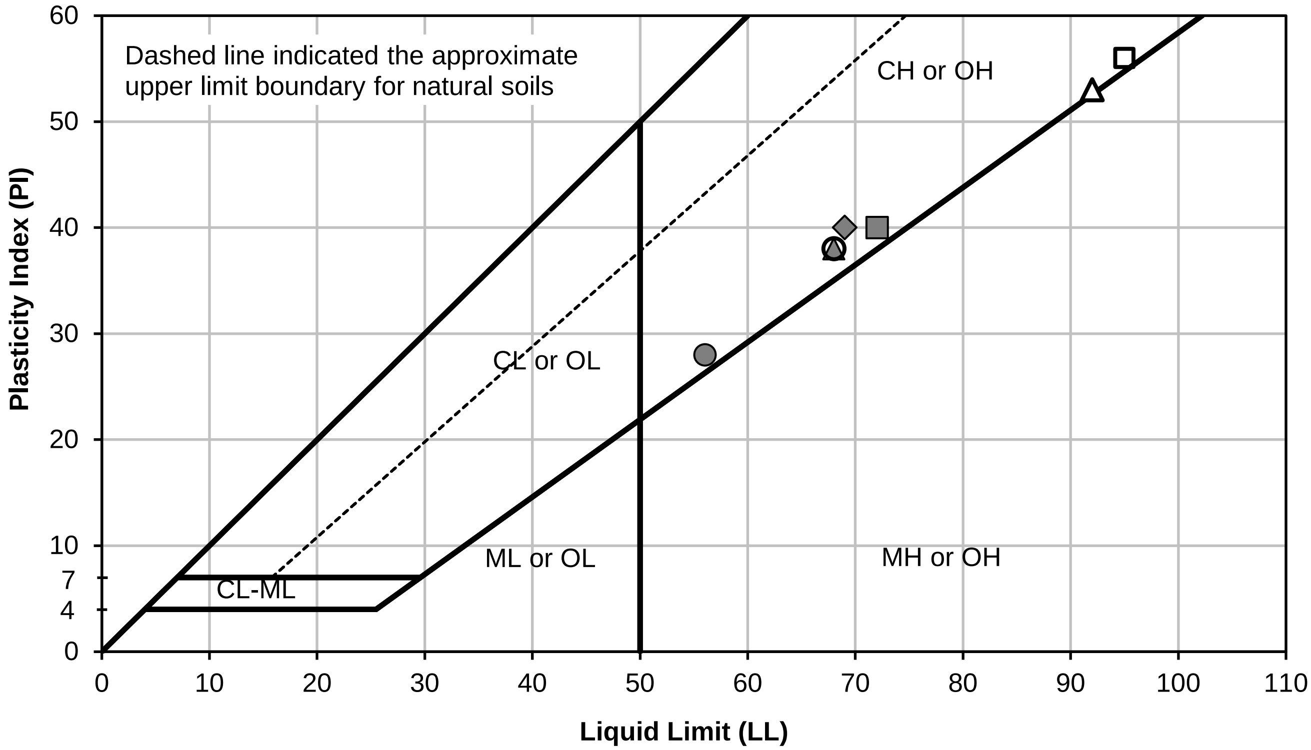
Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Soil Classification Chart

Hultgren - Tillis Engineers | Project No. 923.01 | Plate No. B-14

APPENDIX C

Laboratory Test Results

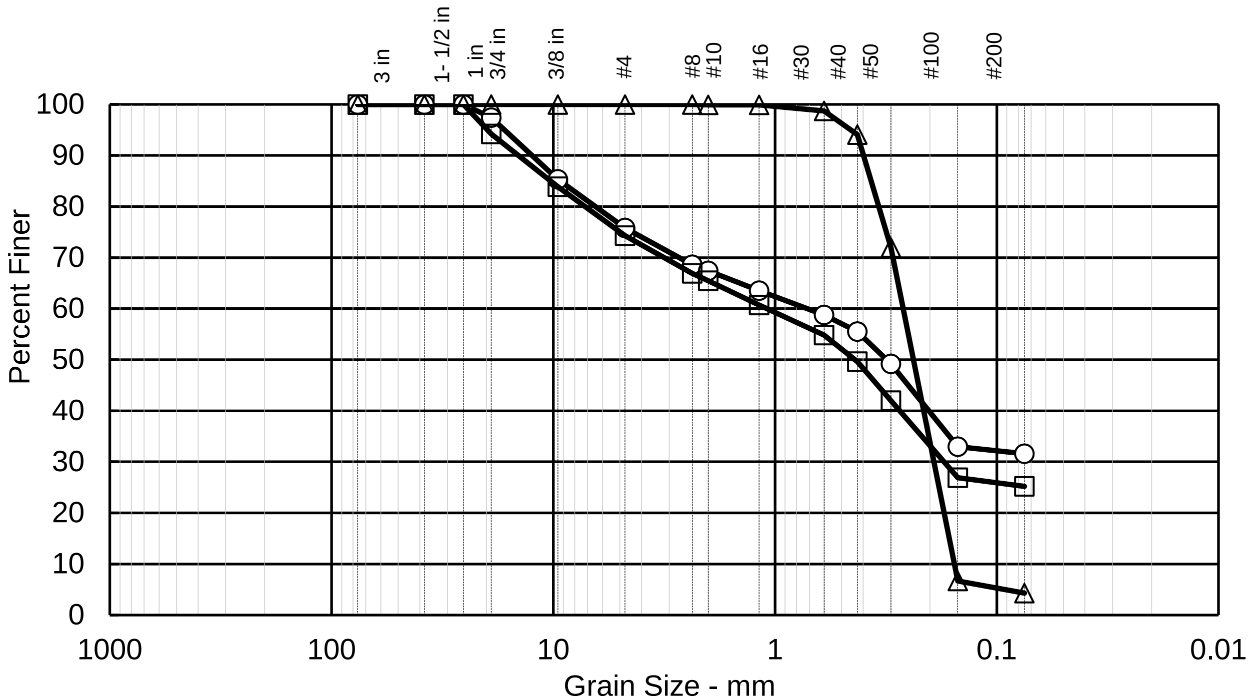


Symbol	Boring Number	Depth (feet)	Soil Description	LL (%)	PL (%)	PI (%)	Moisture Content (%)
●	2	11	Dark Olive Gray Fat CLAY	56	28	28	61
▲	3	20	Dark Olive Gray Fat CLAY	68	30	38	81
■	4	25	Dark Olive Gray Fat CLAY	72	32	40	85
◆	6	8.5	Dark Olive Brown Fat CLAY	69	29	40	90
○	6	15	Dark Olive Gray Fat CLAY	68	30	38	74
△	7	7	Gray Fat CLAY	92	39	53	63
□	10	8.5	Gray Fat CLAY	95	39	56	82

Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Atterberg Limits

Hultgren - Tillis Engineers | Project No. 923.01 | Plate No. C-1



Sieve Size	○	□	△
	Percent Finer		
3 in	100.0	100.0	100.0
1-1/2 in	100.0	100.0	100.0
1 in	100.0	100.0	100.0
3/4 in	97.4	94.2	100.0
3/8 in	85.3	83.9	100.0
#4	75.8	74.3	100.0
#8	68.6	66.9	100.0
#10	67.4	65.5	99.9
#16	63.5	60.7	99.9
#30	58.8	54.8	98.7
#40	55.5	49.6	94.1
#50	49.2	42.0	72.0
#100	33.0	26.9	6.7
#200	31.6	25.2	4.3
	Grain Size		
D60	0.711	1.086	0.265
D30	-	0.181	0.199
D10	-	-	0.158
	Coefficients		
Cc	-	-	0.95
Cu	-	-	1.68

Soil Description	
○	Light yellowish brown silty SAND with gravel (SM)
□	Yellowish brown and olive silty SAND with gravel (SM)
△	Dark gray poorly graded SAND (SP)

Sample Key	
○	Boring 4 at 3.0 ft
□	Boring 5 at 6.0 ft
△	Boring 6 at 3.5 ft

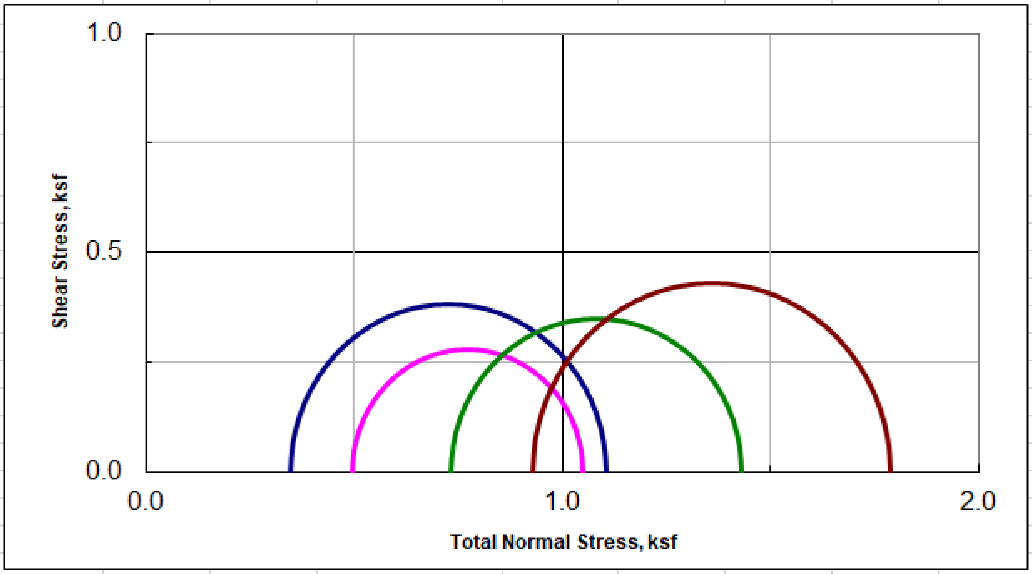
Testing performed by
B. Hillebrandt Soils Testing Inc.

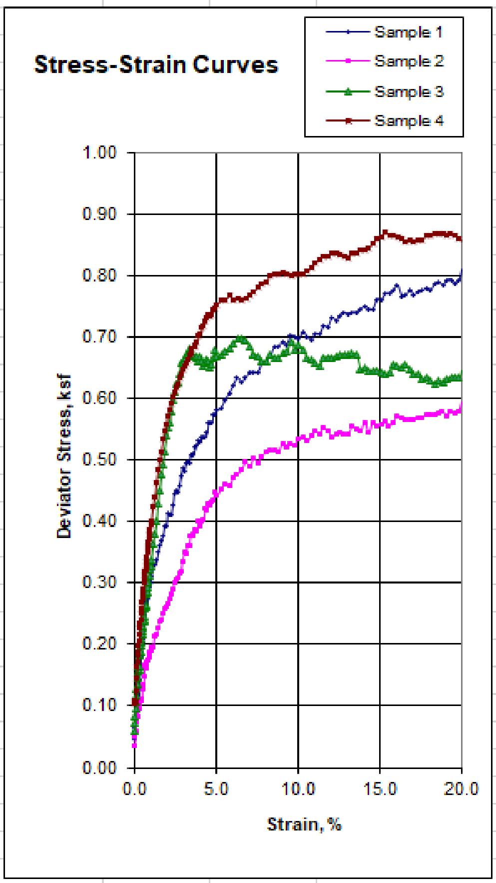
Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Sieve Analysis Results

Hultgren - Tillis Engineers | Project No. 923.01 | Plate No. C-2

Unconsolidated-Undrained Triaxial Test
ASTM D2850





Sample Data	1	2	3	4
Moisture %	69.1	75.1	82.5	67.4
Dry Den,pcf	58.3	55.4	52.0	59.0
Void Ratio	1.891	2.043	2.239	1.857
Saturation %	98.6	99.2	99.5	98.0
Height in	5.97	5.96	5.96	5.97
Diameter in	2.85	2.86	2.87	2.85
Cell psi	2.4	3.5	5.1	6.5
Strain %	15.00	15.00	6.56	15.00
Deviator, ksf	0.761	0.554	0.698	0.860
Rate %/min	1.00	1.00	1.00	1.00
in/min	0.060	0.059	0.060	0.060
Job No.:	212-180a			
Client:	Hultgren-Tillis Engineers			
Project:	923.01			
Boring:	B3	B3	B3	B3
Sample:				
Depth ft:	7.5	10-12.5	20(Tip-4")	30(Tip-3")

Visual Soil Description

Sample #	
1	Dark olive gray fat CLAY
2	Dark olive gray fat CLAY
3	Dark olive gray fat CLAY
4	Dark olive gray fat CLAY

Remarks:

Note: Strengths are picked at the peak deviator stress or 15% strain which ever occurs first per ASTM D2850.

Testing performed by Cooper Testing Laboratory

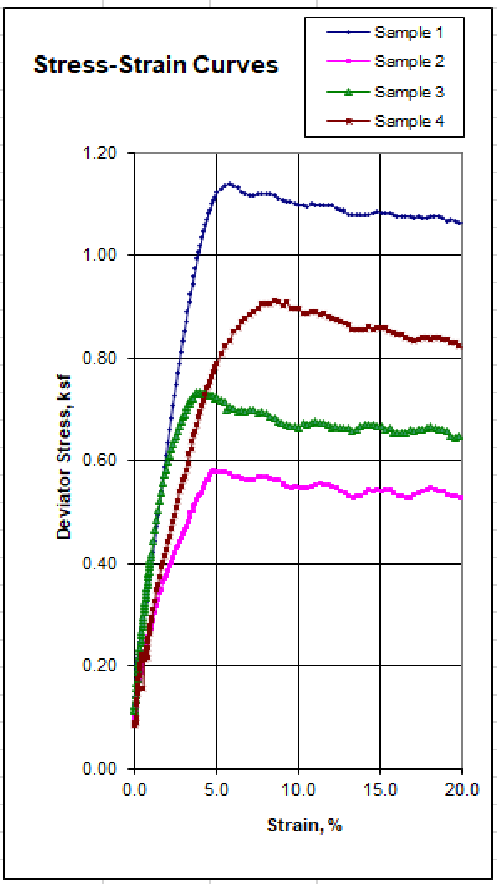
Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Triaxial (UU) Test Results

Hultgren - Tillis Engineers	Project No. 923.01	Plate No. C-3

COOPER TESTING LABORATORY

Unconsolidated-Undrained Triaxial Test
ASTM D2850



Sample Data				
	1	2	3	4
Moisture %	94.6	79.2	81.9	72.7
Dry Den,pcf	46.6	53.6	52.2	56.7
Void Ratio	2.613	2.145	2.229	1.971
Saturation %	97.7	99.7	99.2	99.6
Height in	5.91	5.97	5.98	5.95
Diameter in	2.85	2.87	2.85	2.87
Cell psi	7.6	4.3	5.7	6.9
Strain %	5.80	4.84	4.34	8.55
Deviator, ksf	1.139	0.581	0.731	0.912
Rate %/min	1.00	1.00	1.00	1.00
in/min	0.059	0.060	0.060	0.059
Job No.:	212-180b			
Client:	Hultgren-Tillis Engineers			
Project:	923.01			
Boring:	B3	B4	B4	B4
Sample:				
Depth ft:	40	15	25(Tip-4")	35

Visual Soil Description	
Sample #	
1	Dark olive gray fat CLAY
2	Dark olive gray fat CLAY
3	Dark olive gray fat CLAY
4	Dark olive gray fat CLAY

Remarks:

Note: Strengths are picked at the peak deviator stress or 15% strain which ever occurs first per ASTM D2850.

Testing performed by Cooper Testing Laboratory

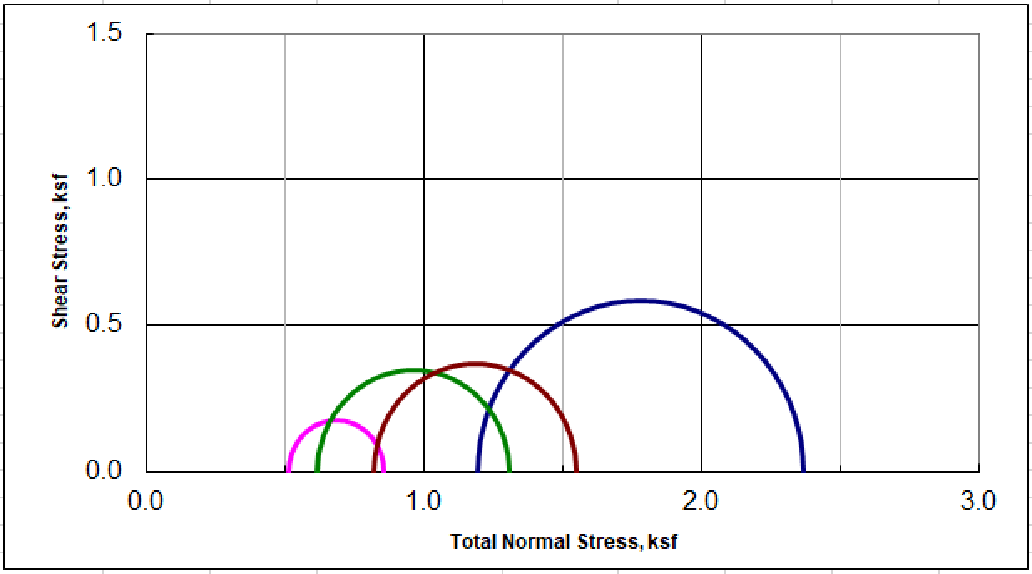
Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

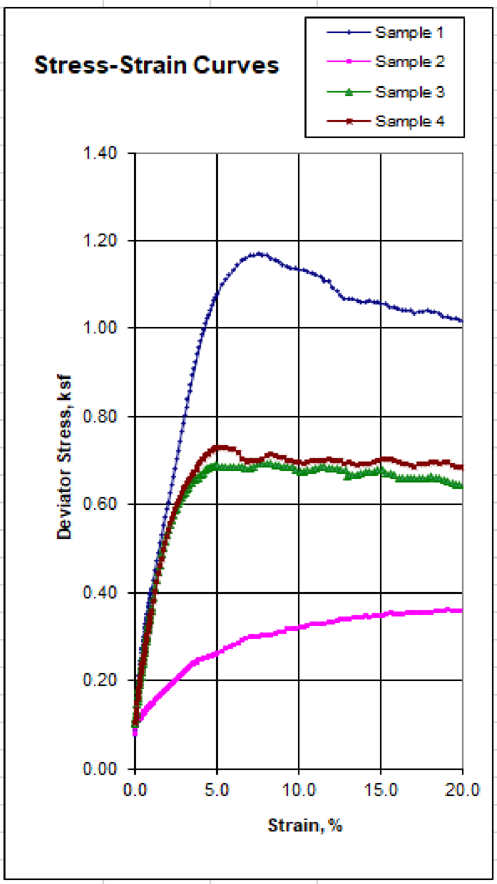
Triaxial (UU) Test Results

Hultgren - Tillis Engineers	Project No. 923.01	Plate No. C-4

Unconsolidated-Undrained Triaxial Test

ASTM D2850





Sample Data				
	1	2	3	4
Moisture %	73.4	79.6	77.9	78.8
Dry Den,pcf	56.4	53.2	54.0	53.6
Void Ratio	1.987	2.169	2.120	2.145
Saturation %	99.7	99.1	99.2	99.2
Height in	5.96	5.91	5.94	5.96
Diameter in	2.84	2.85	2.87	2.85
Cell psi	8.3	3.6	4.3	5.7
Strain %	7.55	15.00	8.30	5.30
Deviator, ksf	1.170	0.348	0.694	0.731
Rate %/min	1.00	1.00	1.00	1.00
in/min	0.060	0.059	0.059	0.060
Job No.:	212-180c			
Client:	Hultgren-Tillis Engineers			
Project:	923.01			
Boring:	B4	B6	B6	B6
Sample:				
Depth ft:	45(Tip-7")	10	15(Tip-4")	25

Visual Soil Description	
Sample #	
1	Dark olive gray fat CLAY
2	Dark olive gray fat CLAY
3	Dark olive gray fat CLAY
4	Dark olive gray fat CLAY

Remarks:

Note: Strengths are picked at the peak deviator stress or 15% strain which ever occurs first per ASTM D2850.

Testing performed by Cooper Testing Laboratory

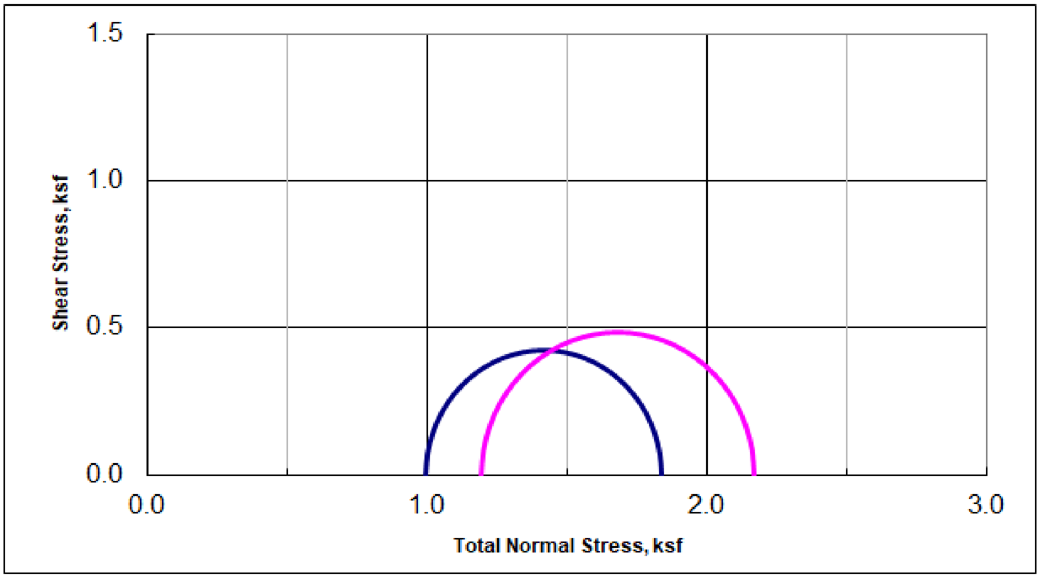
Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

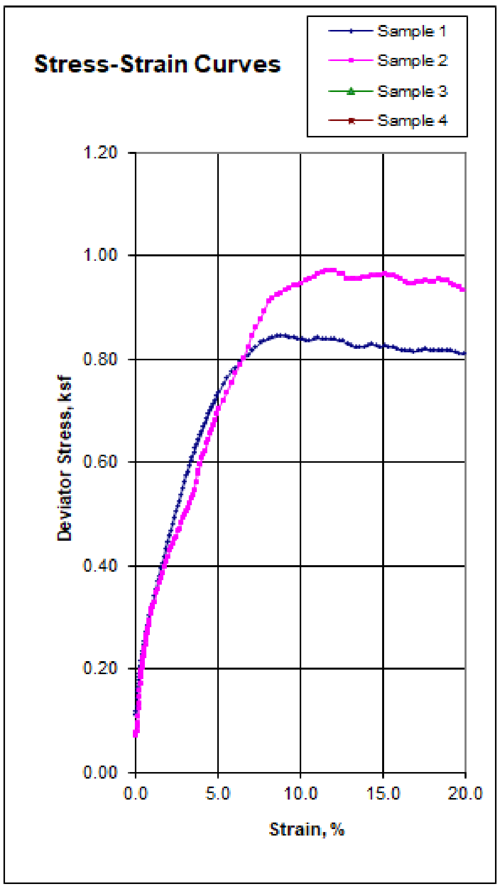
Triaxial (UU) Test Results

Hultgren - Tillis Engineers	Project No. 923.01	Plate No. C-5

COOPER TESTING LABORATORY

Unconsolidated-Undrained Triaxial Test
ASTM D2850





Sample Data	1	2	3	4
Moisture %	72.3	64.0		
Dry Den,pcf	56.9	61.4		
Void Ratio	1.960	1.743		
Saturation %	99.5	99.1		
Height in	5.93	5.95		
Diameter in	2.87	2.85		
Cell psi	6.9	8.3		
Strain %	8.82	12.08		
Deviator, ksf	0.847	0.971		
Rate %/min	1.00	1.00		
in/min	0.059	0.060		
Job No.:	212-180d			
Client:	Hultgren-Tillis Engineers			
Project:	923			
Boring:	B6	B6		
Sample:				
Depth ft:	35	45		

Visual Soil Description

Sample #	
1	Dark olive gray fat CLAY
2	Dark olive gray fat CLAY
3	
4	

Remarks:

Note: Strengths are picked at the peak deviator stress or 15% strain which ever occurs first per ASTM D2850.

Testing performed by Cooper Testing Laboratory

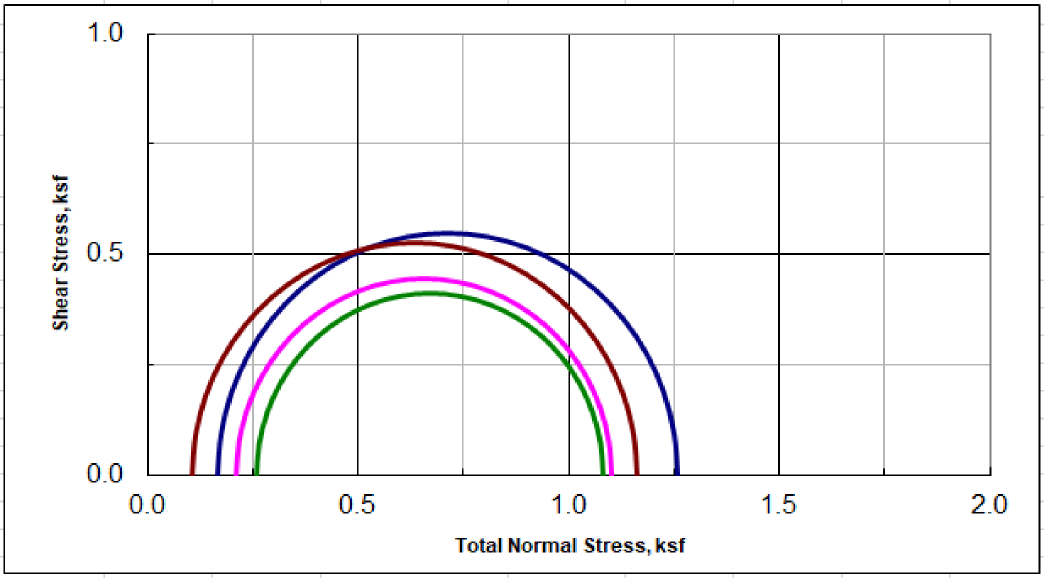
Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

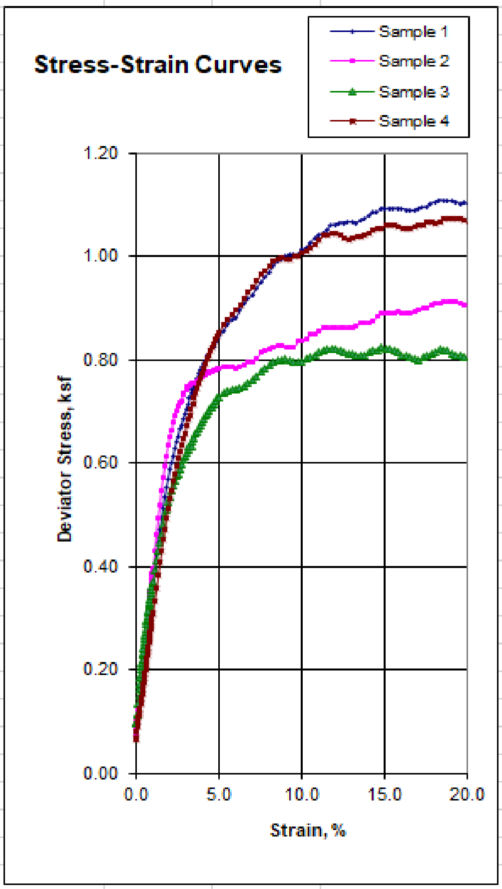
Triaxial (UU) Test Results

Hultgren - Tillis Engineers	Project No. 923.01	Plate No. C-6

COOPER TESTING LABORATORY

Unconsolidated-Undrained Triaxial Test
ASTM D2850





Sample Data				
	1	2	3	4
Moisture %	53.0	60.1	74.1	64.2
Dry Den,pcf	67.0	62.0	56.0	60.4
Void Ratio	1.517	1.720	2.010	1.789
Saturation %	94.4	94.4	99.5	96.8
Height in	5.92	5.97	5.98	5.99
Diameter in	2.86	2.85	2.86	2.85
Cell psi	1.2	1.5	1.8	0.8
Strain %	15.00	15.00	14.84	15.00
Deviator, ksf	1.093	0.890	0.823	1.053
Rate %/min	1.00	1.00	1.00	1.00
in/min	0.059	0.060	0.060	0.060
Job No.:	212-182a			
Client:	Hultgren-Tillis Engineers			
Project:	923.01			
Boring:	B7	B7	B7	B8
Sample:				
Depth ft:	1-3.5	3.5-6(Tip-3")	7.5-10	0-2(Tip-3")

Visual Soil Description	
Sample #	
1	Brown Fat CLAY w/ Sand
2	Olive Brown Fat CLAY /w Sand
3	Gray Fat CLAY
4	Brown Fat CLAY w/ Sand

Remarks:

Note: Strengths are picked at the peak deviator stress or 15% strain which ever occurs first per ASTM D2850.

Testing performed by Cooper Testing Laboratory

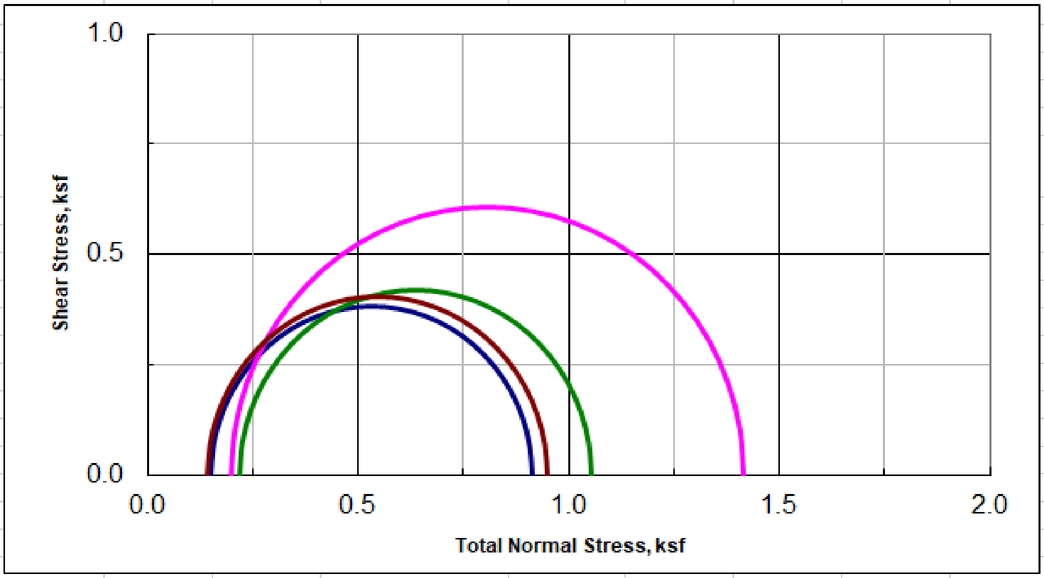
Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

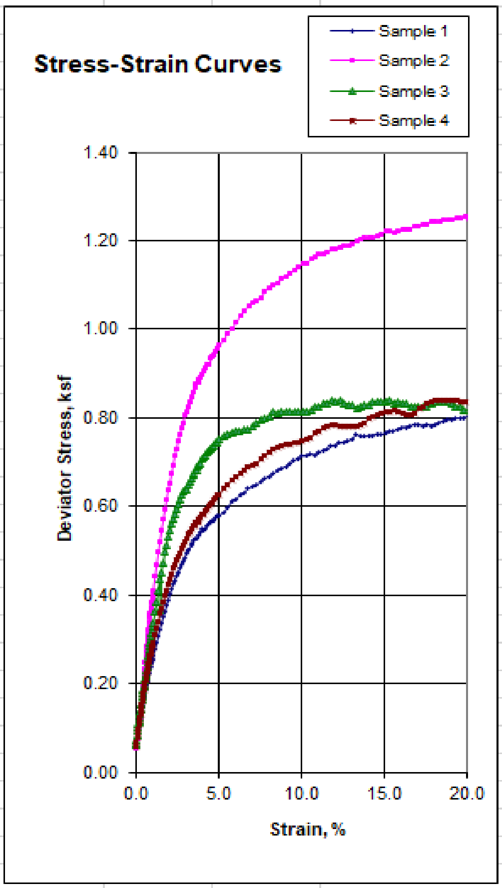
Triaxial (UU) Test Results

Hultgren - Tillis Engineers	Project No. 923.01	Plate No. C-7

COOPER TESTING LABORATORY

Unconsolidated-Undrained Triaxial Test
ASTM D2850





Sample Data	1	2	3	4
Moisture %	57.6	36.1	85.8	65.1
Dry Den,pcf	63.4	77.7	50.7	59.1
Void Ratio	1.658	1.168	2.326	1.853
Saturation %	93.8	83.5	99.6	94.9
Height in	6.00	5.96	5.96	6.00
Diameter in	2.85	2.84	2.85	2.87
Cell psi	1.0	1.4	1.5	1.0
Strain %	15.00	15.00	15.00	15.00
Deviator, ksf	0.762	1.216	0.837	0.811
Rate %/min	1.00	1.00	1.00	1.00
in/min	0.060	0.060	0.060	0.060
Job No.:	212-182b			
Client:	Hultgren-Tillis Engineers			
Project:	923.01			
Boring:	B8	B8	B8	B9
Sample:				
Depth ft:	2-4.5(Tip-2")	4.5-6.5(Tip-2")	6.5-9	1-3.5(Tip-2")

Visual Soil Description

Sample #	
1	Brown Fat CLAY w/ Sand
2	Gray Fat CLAY w/ Sand
3	Gray Fat CLAY
4	Brown Fat CLAY w/ Sand

Remarks:

Note: Strengths are picked at the peak deviator stress or 15% strain which ever occurs first per ASTM D2850.

Testing performed by Cooper Testing Laboratory

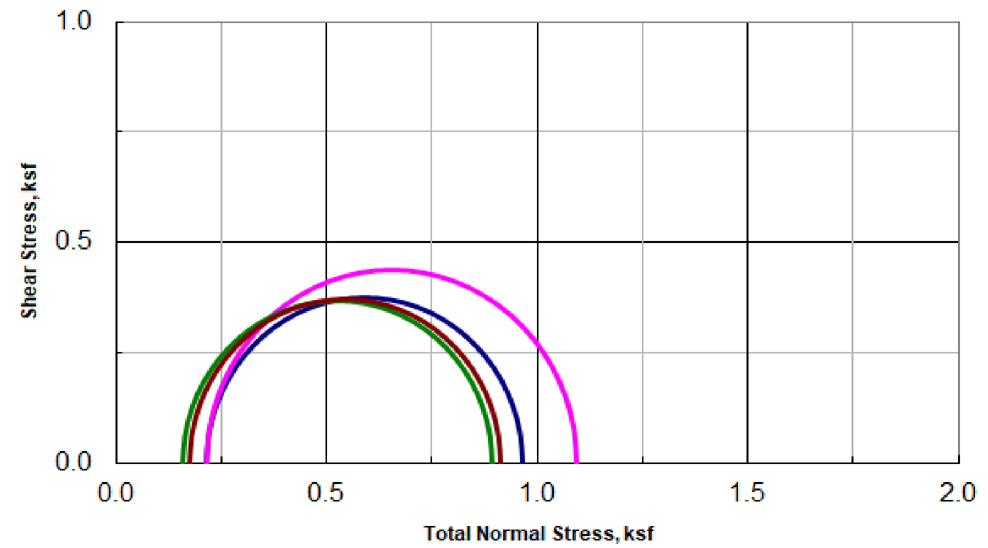
Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

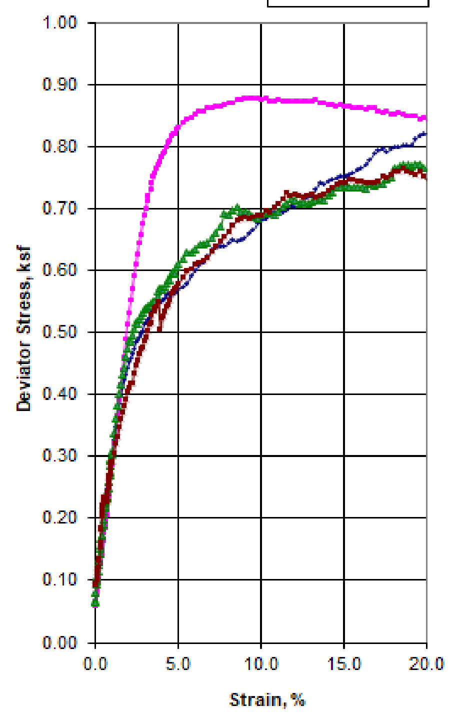
Triaxial (UU) Test Results

Hultgren - Tillis Engineers	Project No. 923.01	Plate No. C-8

COOPER TESTING LABORATORY

Unconsolidated-Undrained Triaxial Test
ASTM D2850





Sample Data	1	2	3	4
Moisture %	55.6	53.4	76.5	73.9
Dry Den,pcf	63.9	69.0	51.9	55.3
Void Ratio	1.636	1.443	2.245	2.047
Saturation %	91.8	99.9	92.0	97.5
Height in	6.00	5.96	6.00	6.00
Diameter in	2.86	2.86	2.85	2.85
Cell psi	1.5	1.5	1.1	1.2
Strain %	15.00	10.30	15.00	15.00
Deviator, ksf	0.751	0.878	0.735	0.742
Rate %/min	1.00	1.00	1.00	1.00
in/min	0.060	0.060	0.060	0.060
Job No.:	212-182c			
Client:	Hultgren-Tillis Engineers			
Project:	923.01			
Boring:	B9	B9	B10	B10
Sample:				
Depth ft:	3.5-6(Tip-2")	8.5-11(Tip-3")	1-3.5(Tip-5")	5-7

Visual Soil Description	
Sample #	
1	Gray Fat CLAY w/ Sand
2	Gray Fat CLAY
3	Brown Fat CLAY w/ Sand
4	Gray Fat CLAY

Remarks:

Note: Strengths are picked at the peak deviator stress or 15% strain which ever occurs first per ASTM D2850.

Testing performed by Cooper Testing Laboratory

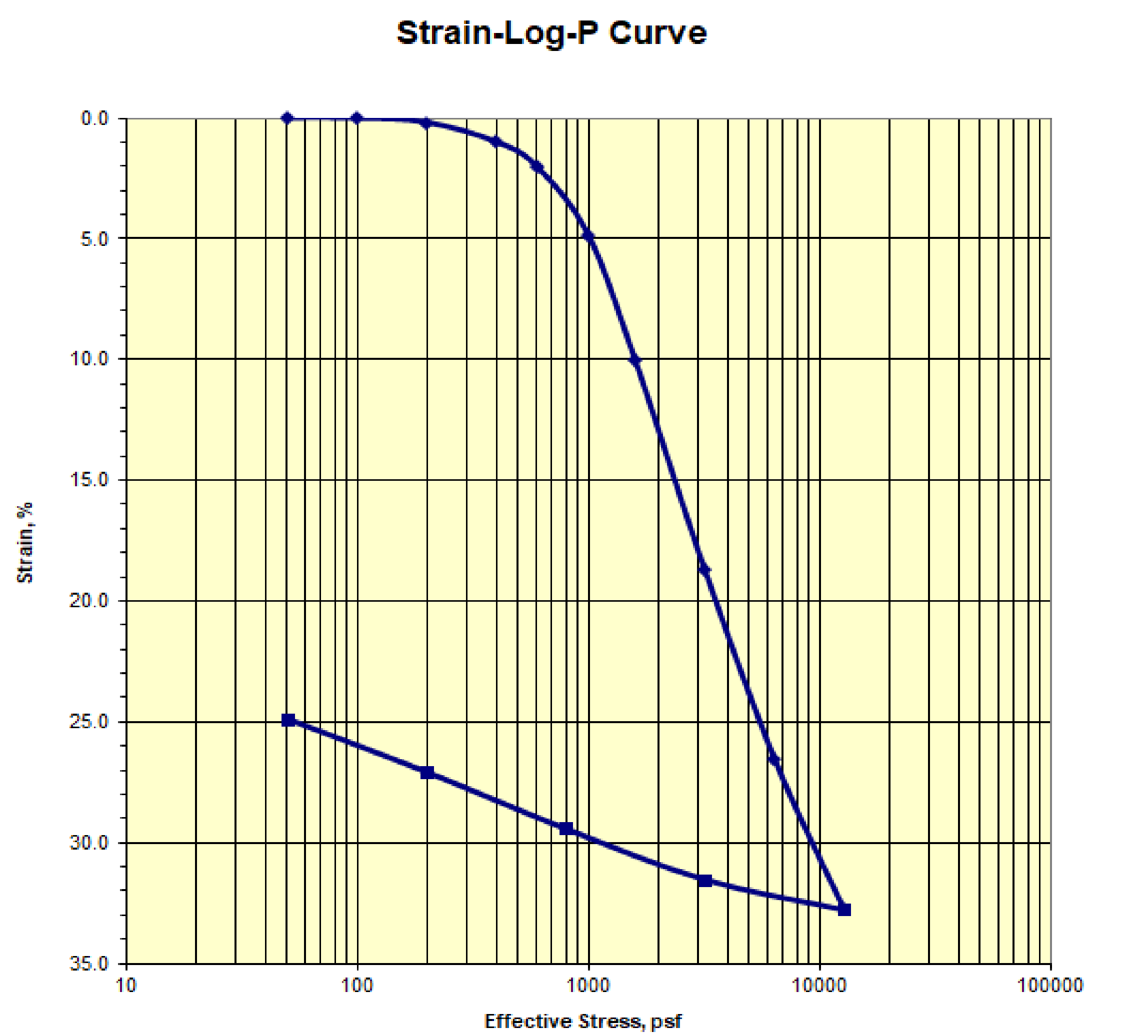
Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Triaxial (UU) Test Results

Hultgren - Tillis Engineers	Project No. 923.01	Plate No. C-9

Consolidation Test
ASTM D2435

Job No.:	212-180	**Boring:**	B3	**Run By:**	MD
Client:	Hultgren-Tillis Engineers	**Sample:**		**Reduced:**	PJ
Project:	923-01	**Depth, ft.:**	20(Tip-3")	**Checked:**	PJ/DC
Soil Type:				**Date:**	12/19/2019



Assumed Gs 2.6	**Initial**	**Final**
Moisture %:	80.5	50.9
Dry Density, pcf:	52.3	69.8
Void Ratio:	2.101	1.325
% Saturation:	99.7	100.0

Remarks:

Testing performed by Cooper Testing Laboratory

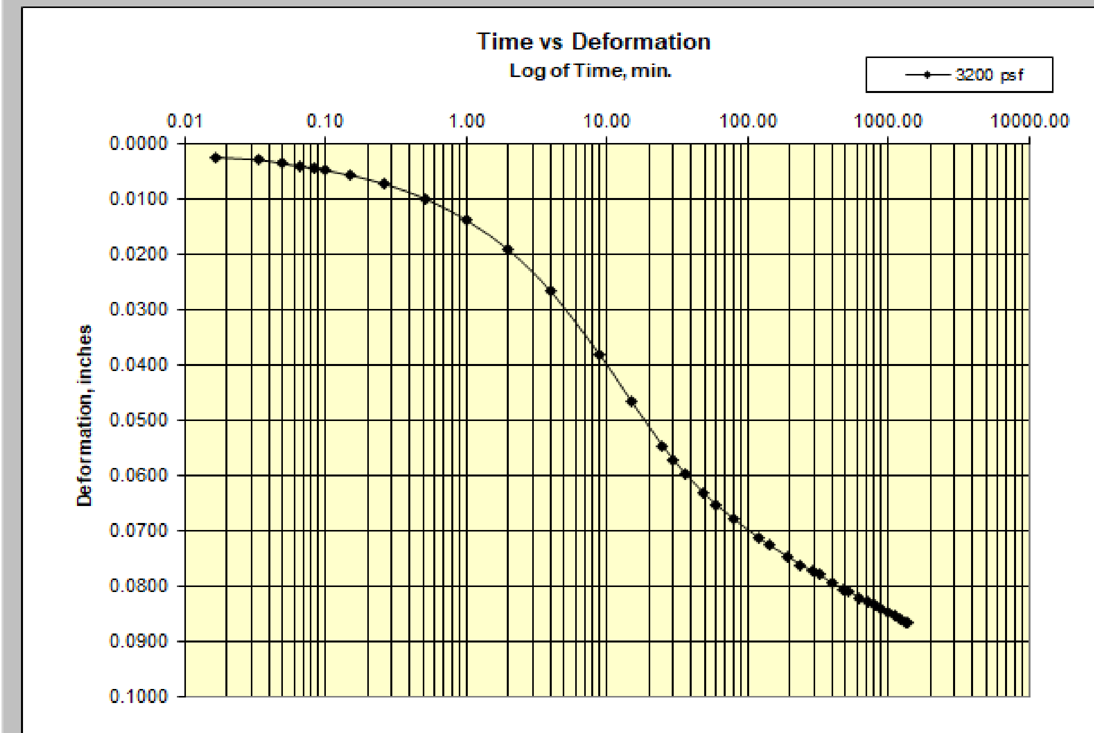
Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Consolidation Test Results

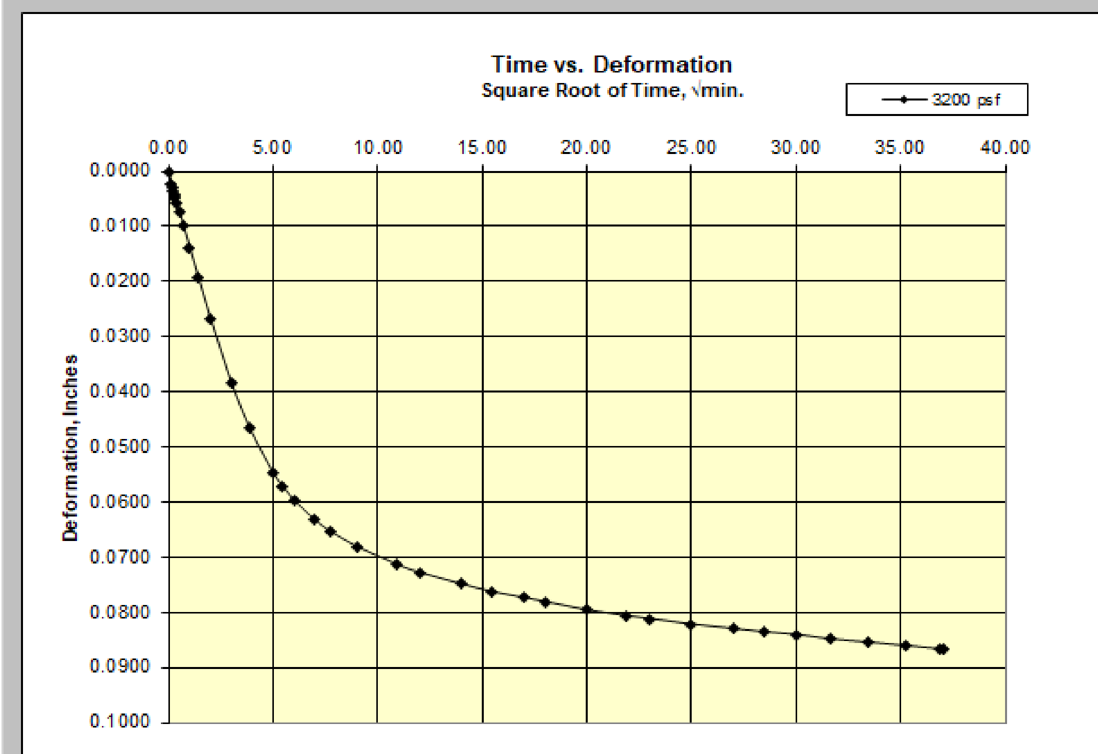
Hultgren - Tillis Engineers	Project No. 923.01	Plate No. C-10

Load 8

3200 psf



3200 psf



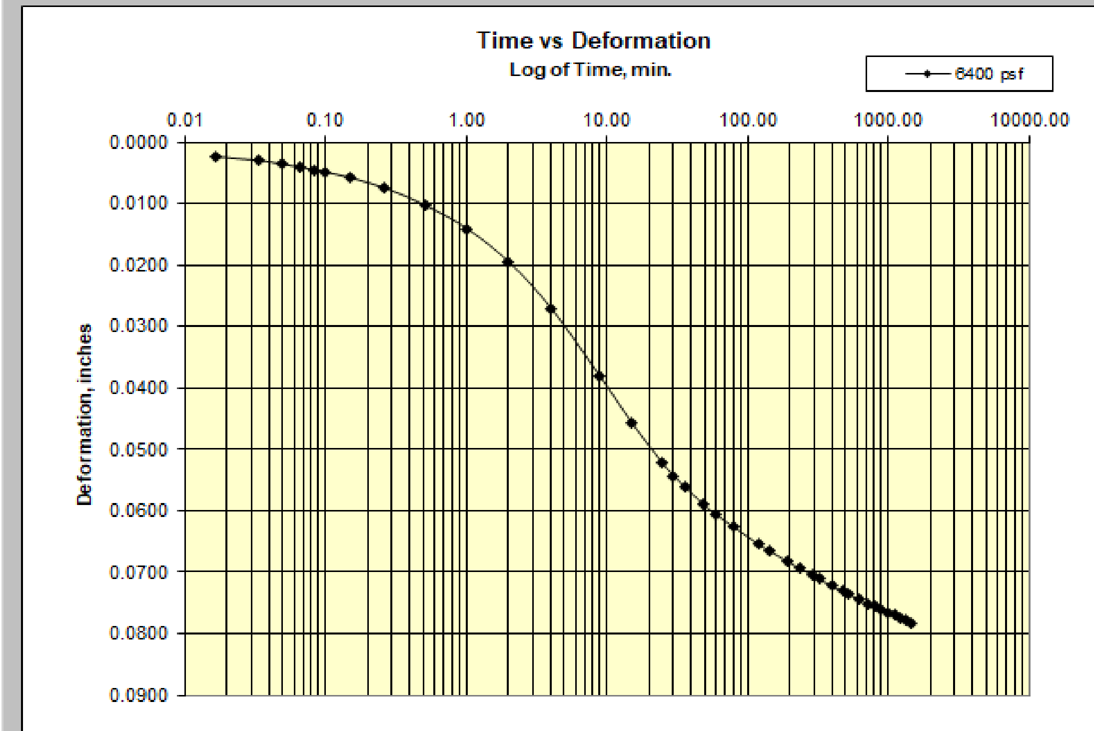
Testing performed by Cooper Testing Laboratory

Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

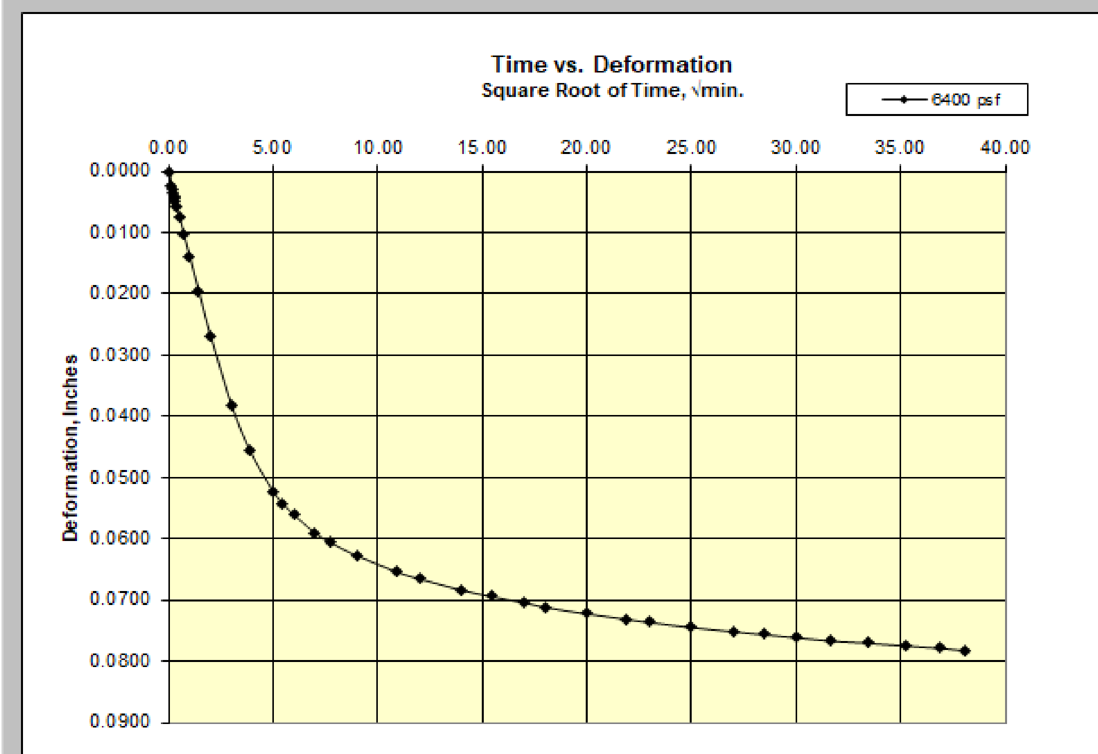
Consolidation Time-Rate Plots

Hultgren - Tillis Engineers	Project No. 923.01	Plate No. C-11

Load 9 6400 psf



6400 psf



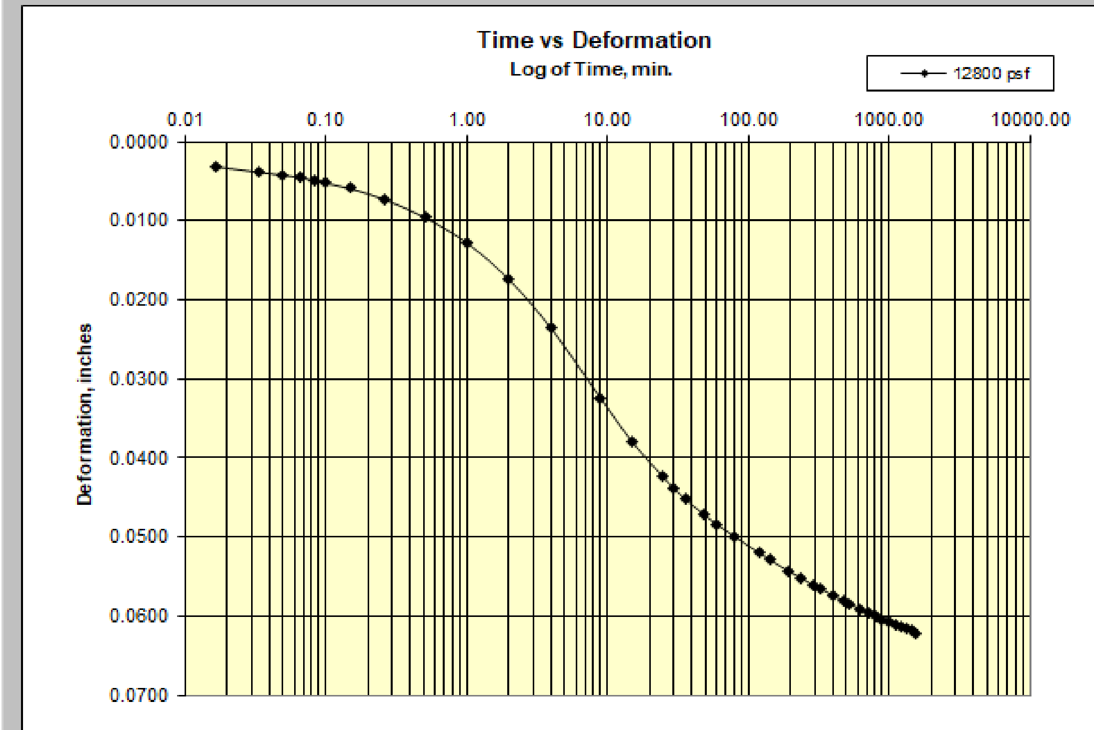
Testing performed by Cooper Testing Laboratory

Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**Consolidation Time-Rate Plots**

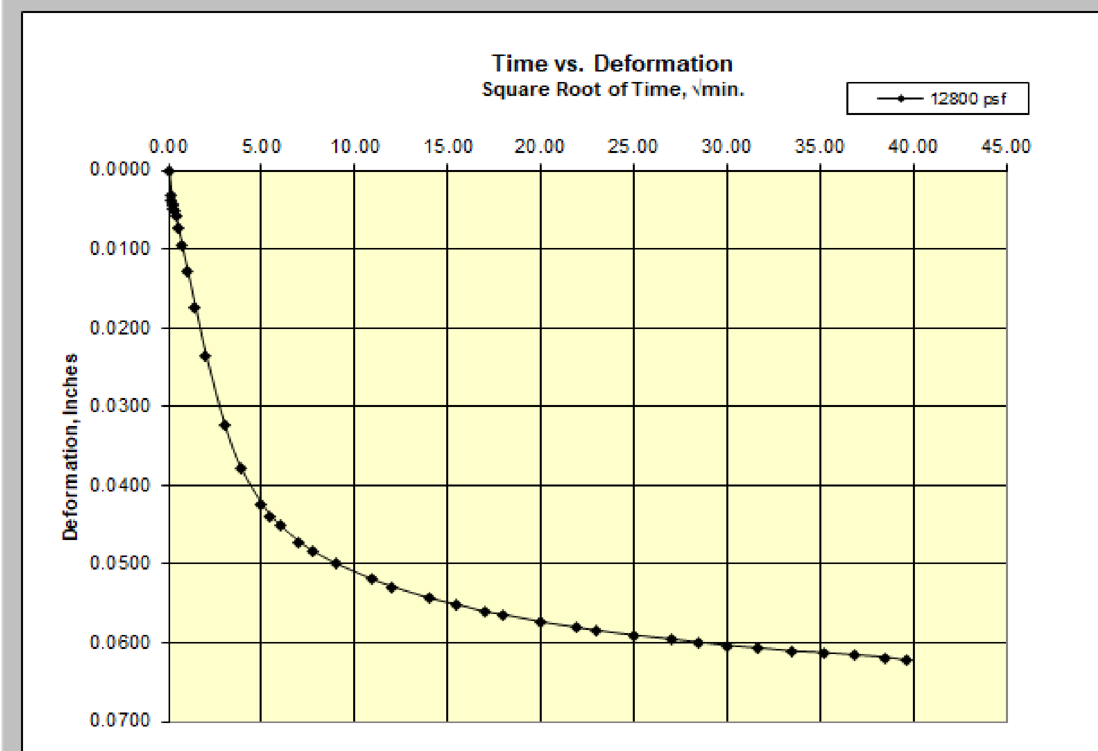
Hultgren - Tillis Engineers	Project No. 923.01	Plate No. C-12

Load 10

12800 psf



12800 psf



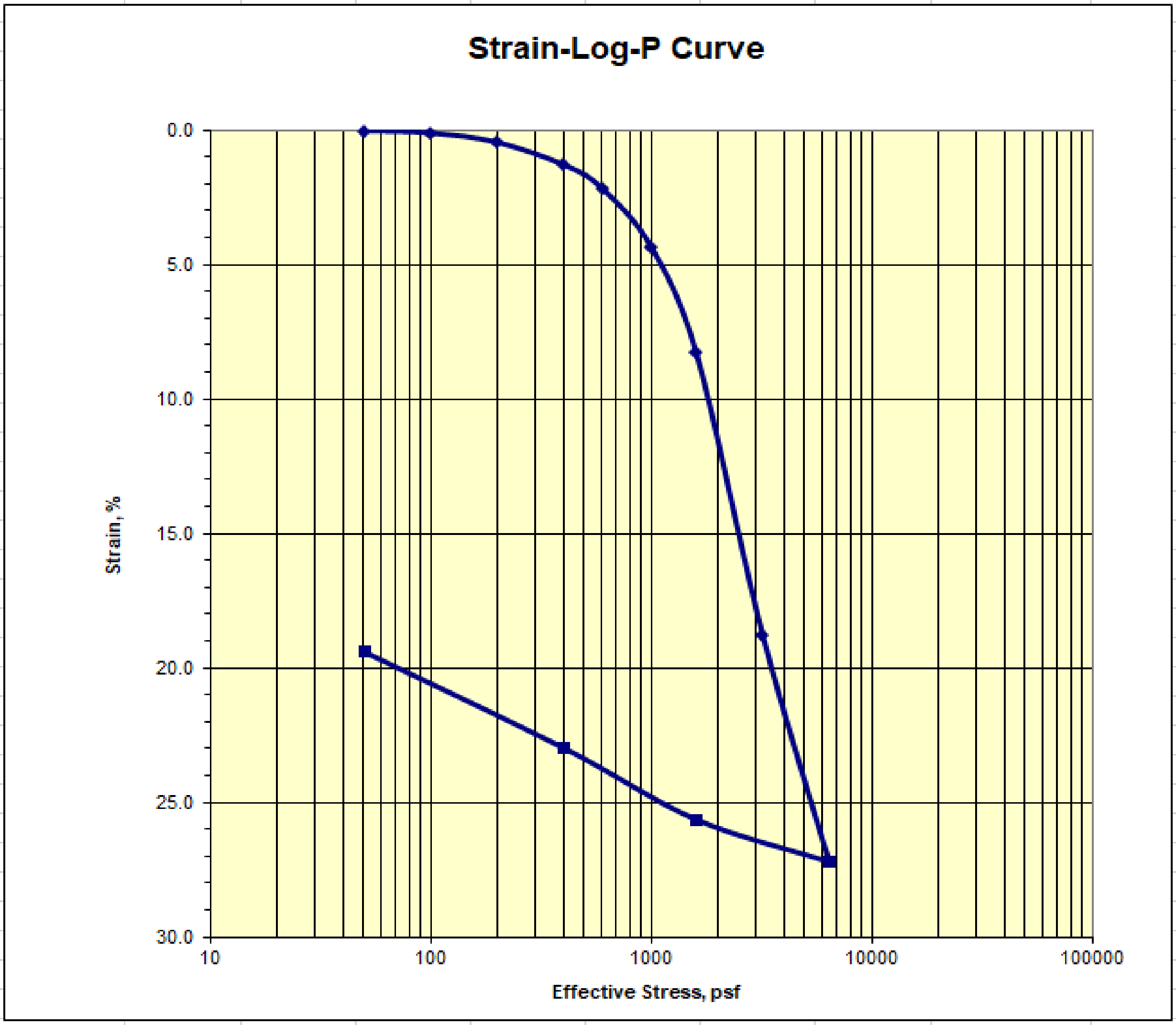
Testing performed by Cooper Testing Laboratory

Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**Consolidation Time-Rate Plots**

Hultgren - Tillis Engineers	Project No. 923.01	Plate No. C-13

Consolidation Test
ASTM D2435

Job No.:	212-180	**Boring:**	B4	**Run By:**	MD
Client:	Hultgren-Tillis Engineers	**Sample:**		**Reduced:**	PJ
Project:	923-01	**Depth, ft.:**	25(Tip-3")	**Checked:**	PJ/DC
Soil Type:				**Date:**	12/19/2019



Assumed Gs	2.75	**Initial**	**Final**
Moisture %:		85.2	61.6
Dry Density, pcf:		51.4	63.7
Void Ratio:		2.343	1.694
% Saturation:		99.9	100.0

Remarks:

Testing performed by Cooper Testing Laboratory

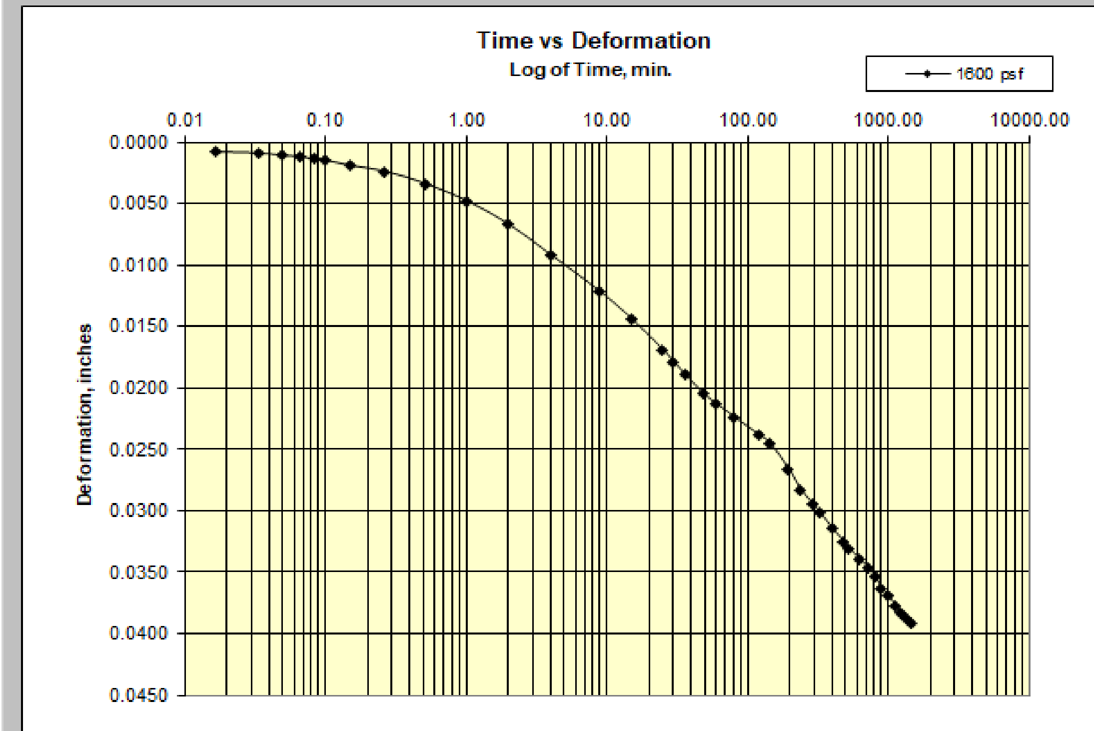
Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Consolidation Test Results

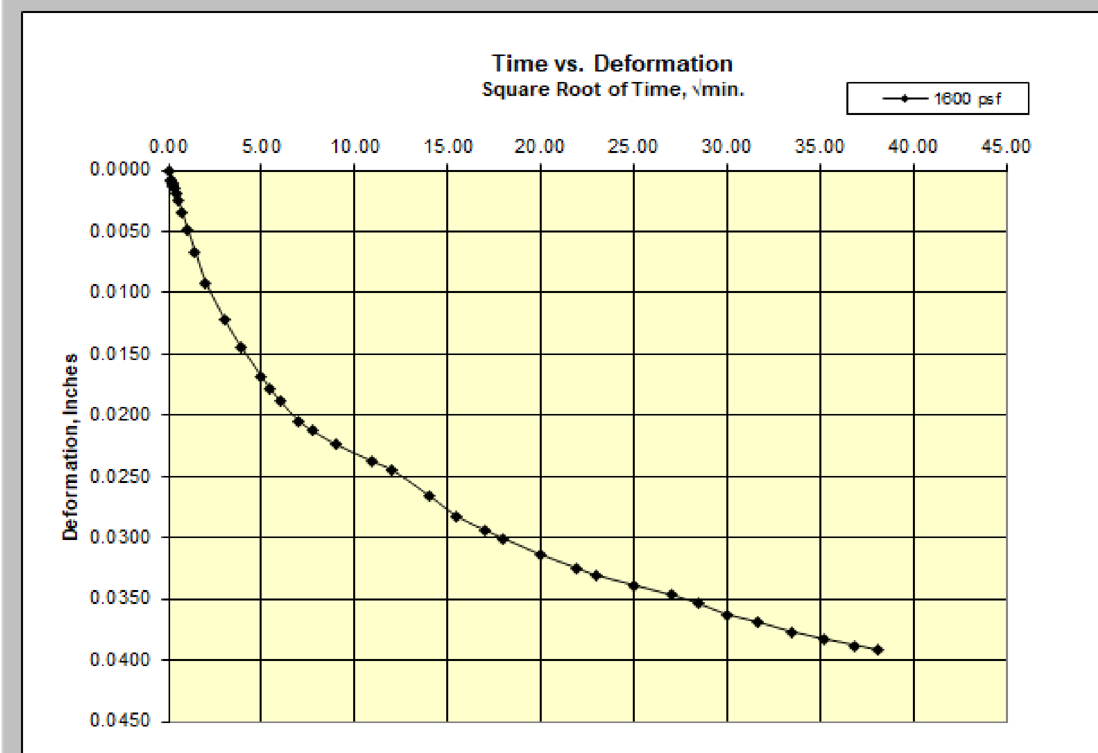
Hultgren - Tillis Engineers	Project No. 923.01	Plate No. C-14

Load 7

1600 psf



1600 psf



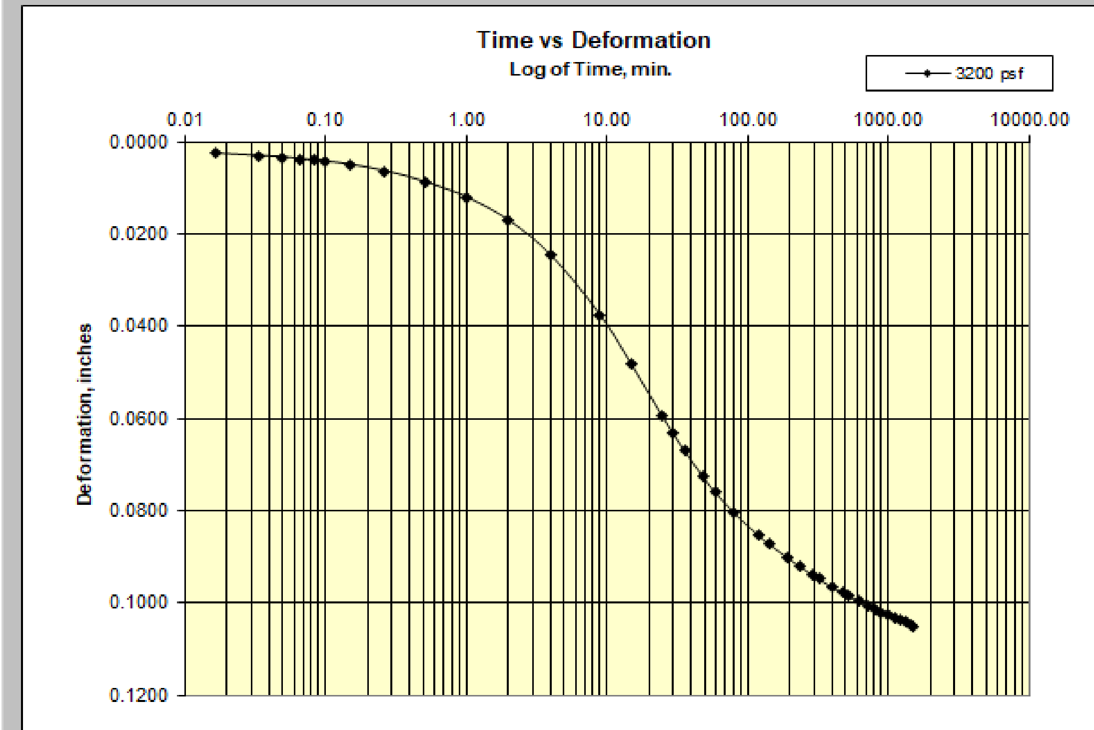
Testing performed by Cooper Testing Laboratory

Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

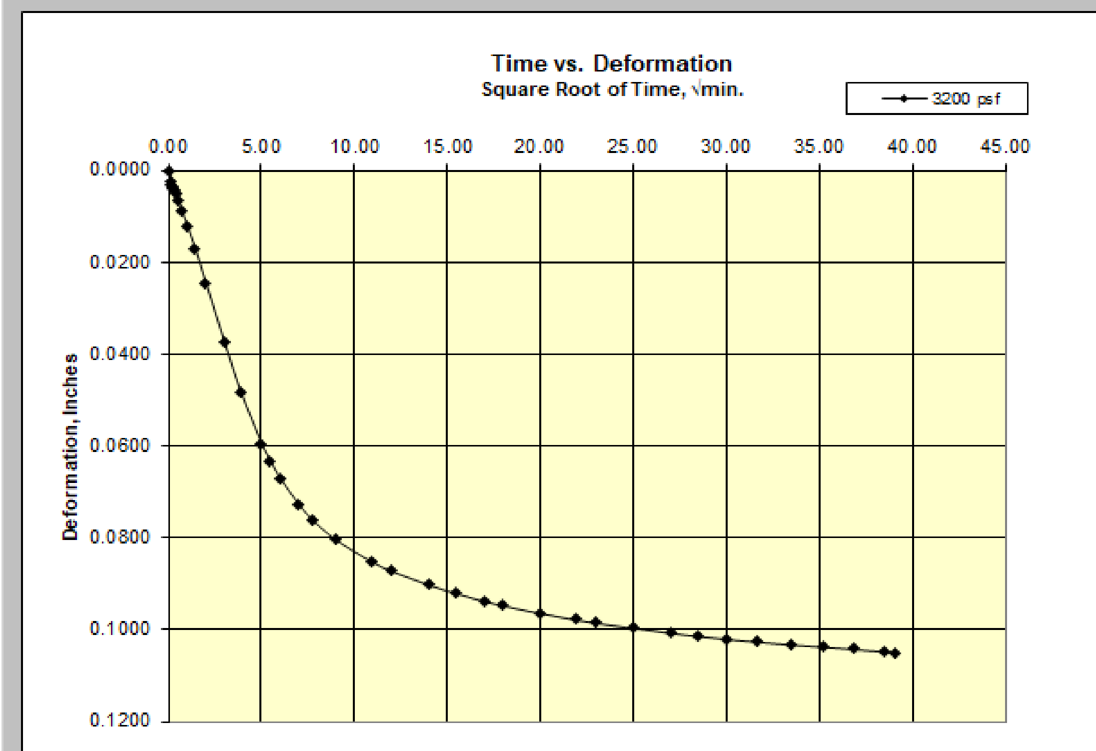
Consolidation Time-Rate Plots

Hultgren - Tillis Engineers	Project No. 923.01	Plate No. C-15

Load 8 3200 psf



3200 psf



Testing performed by Cooper Testing Laboratory

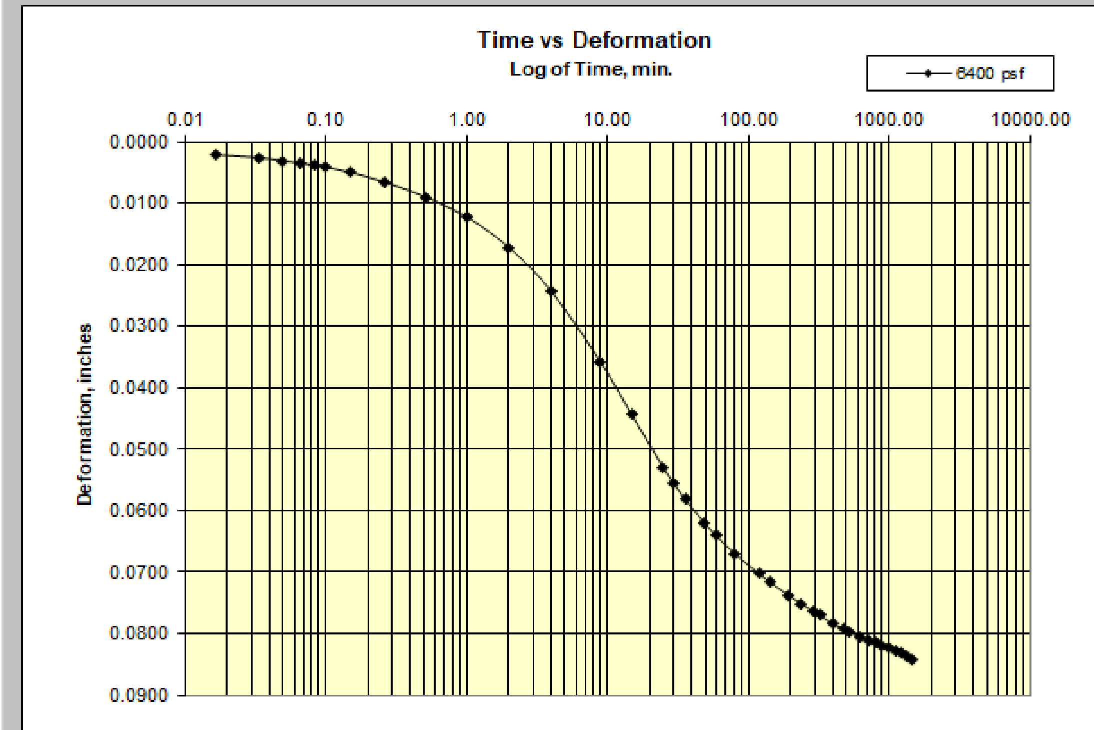
Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Consolidation Time-Rate Plots

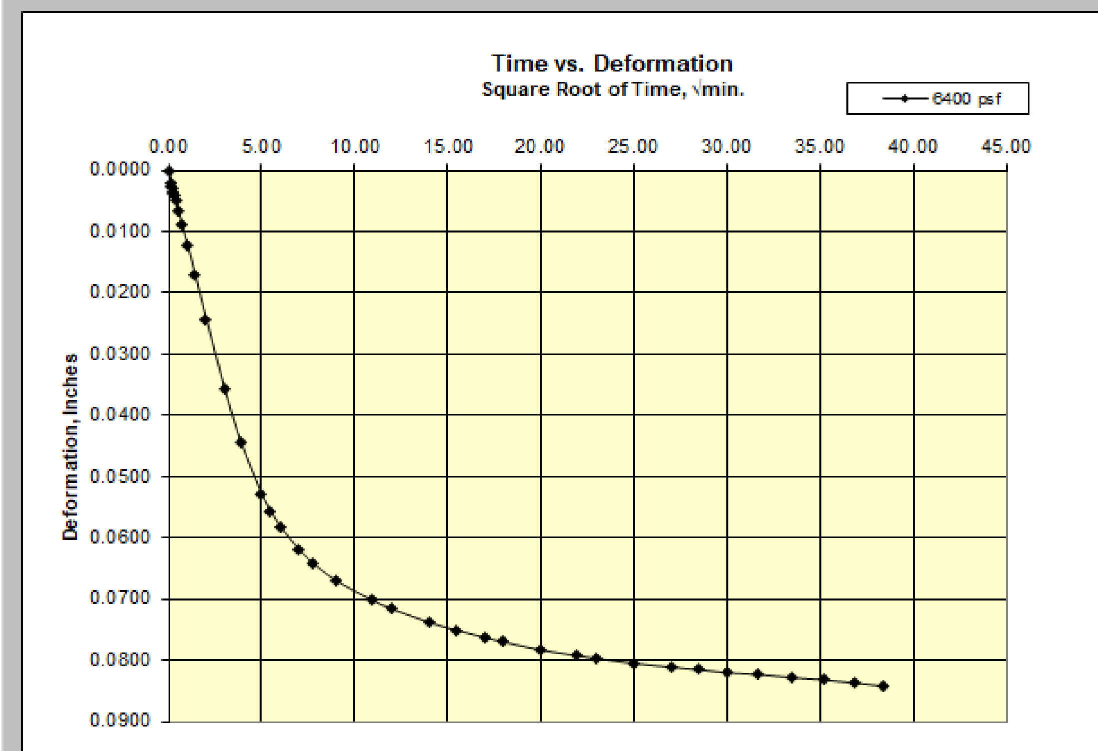
Hultgren - Tillis Engineers	Project No. 923.01	Plate No. C-16

Load 9

6400 psf



6400 psf



Testing performed by Cooper Testing Laboratory

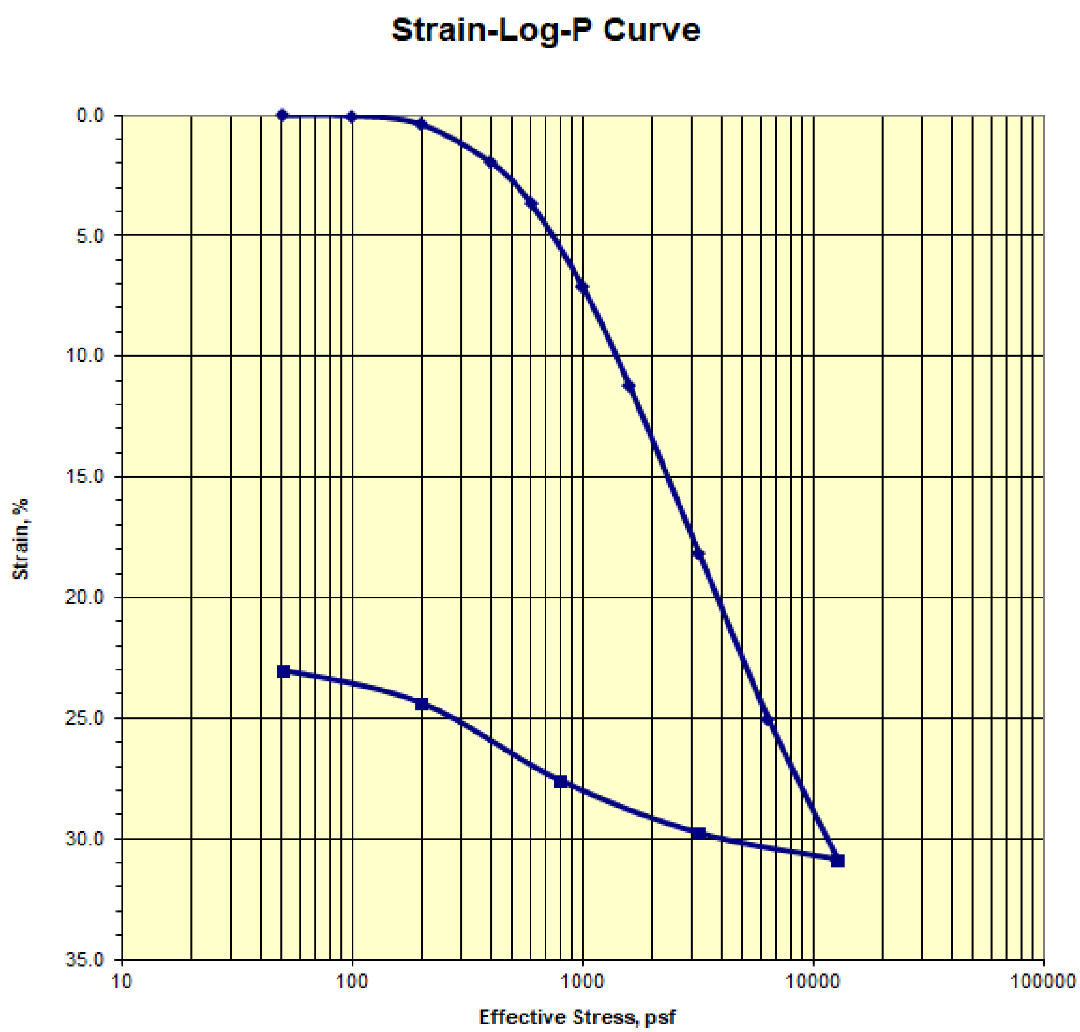
Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Consolidation Time-Rate Plots

Hultgren - Tillis Engineers	Project No. 923.01	Plate No. C-17

Consolidation Test
ASTM D2435

Job No.:	212-180	Boring:	B6	Run By:	MD
Client:	Hultgren-Tillis Engineers	Sample:		Reduced:	PJ
Project:	923-01	Depth, ft.:	15(Tip-3")	Checked:	PJ/DC
Soil Type:				Date:	12/19/2019



Assumed Gs	2.65	Initial	Final
Moisture %:		74.0	48.6
Dry Density, pcf:		55.7	72.3
Void Ratio:		1.968	1.288
% Saturation:		99.6	100.0

Remarks:

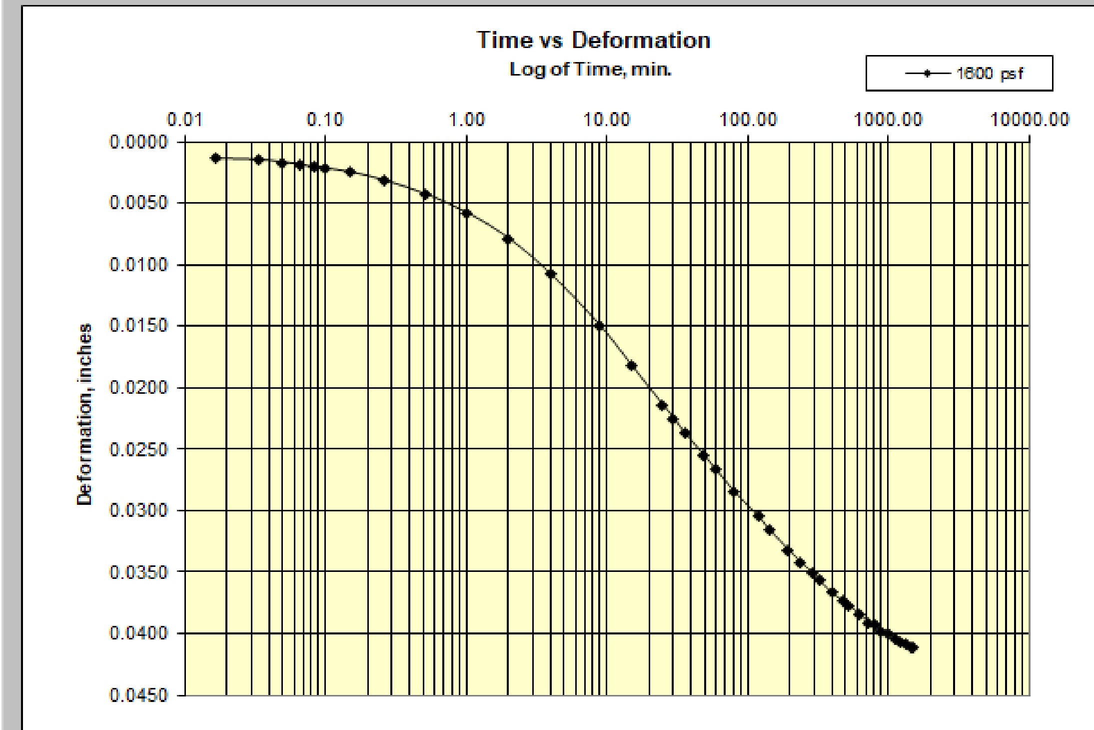
Testing performed by Cooper Testing Laboratory

Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

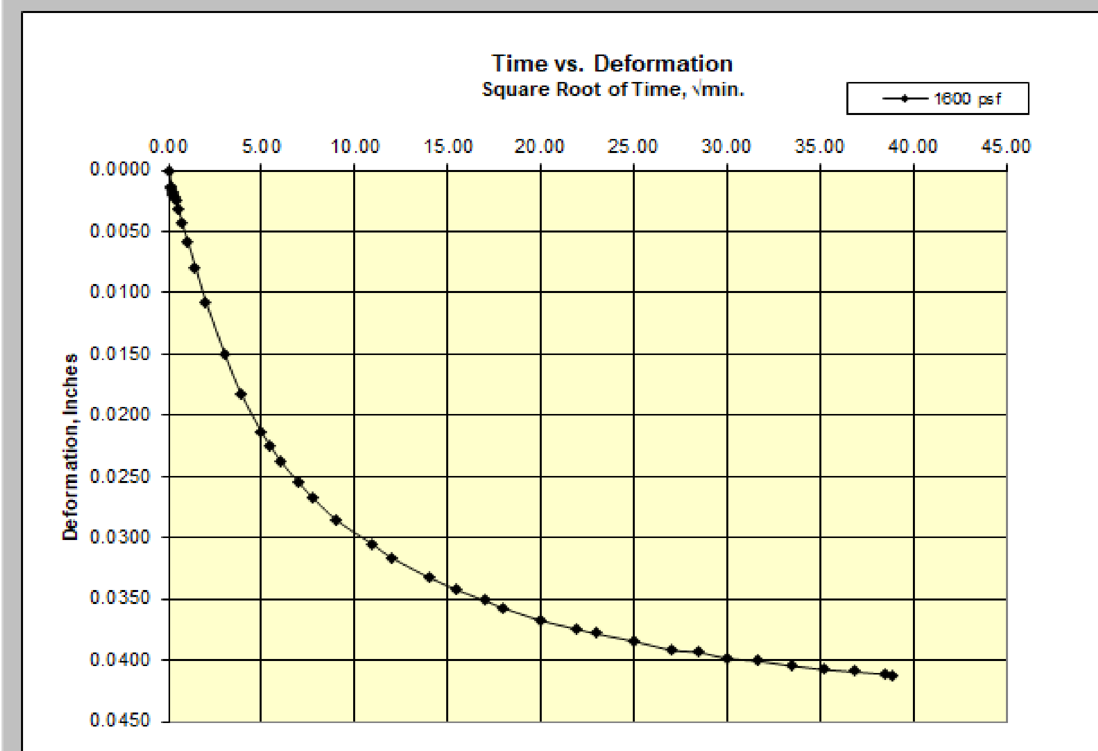
Consolidation Test Results

Hultgren - Tillis Engineers | Project No. 923.01 | Plate No. C-18

Load 7 1600 psf



1600 psf



Testing performed by Cooper Testing Laboratory

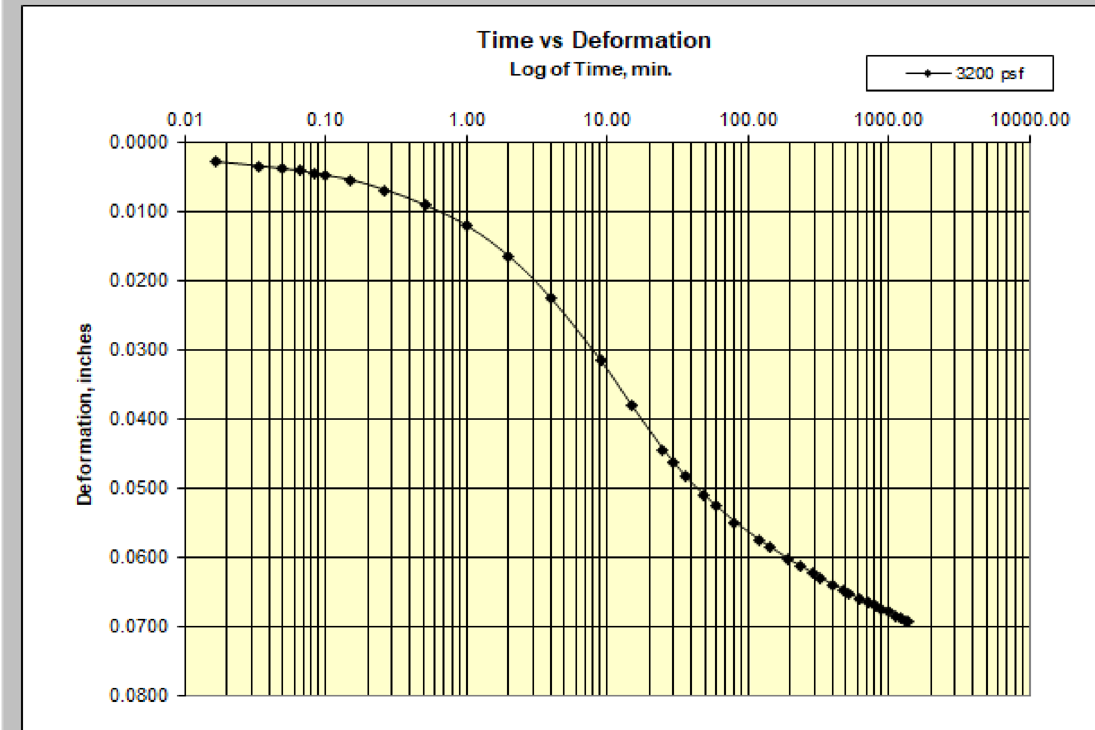
Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Consolidation Time-Rate Plots

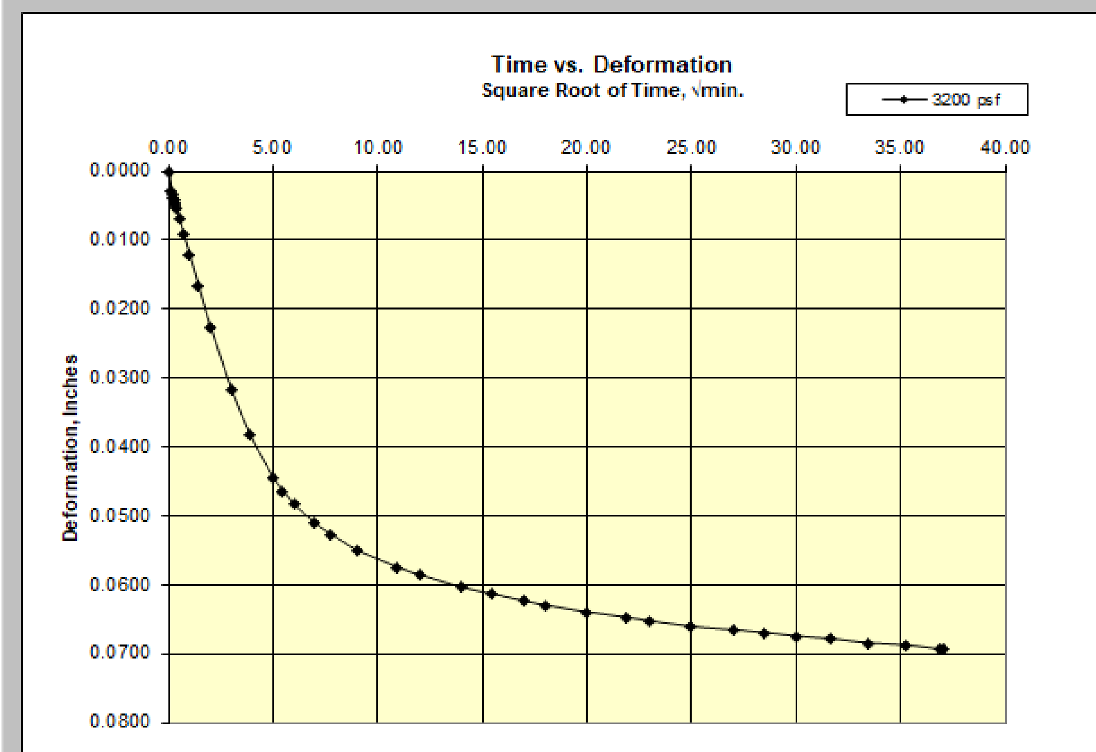
Hultgren - Tillis Engineers	Project No. 923.01	Plate No. C-19

Load 8

3200 psf



3200 psf

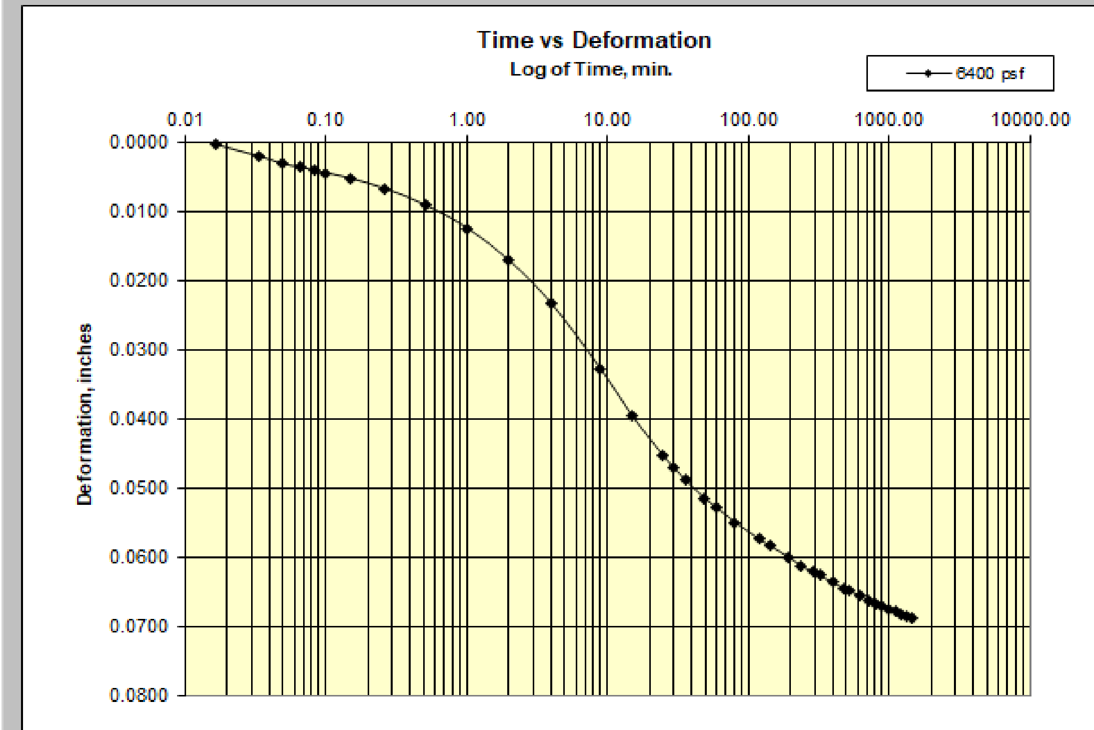


Testing performed by Cooper Testing Laboratory

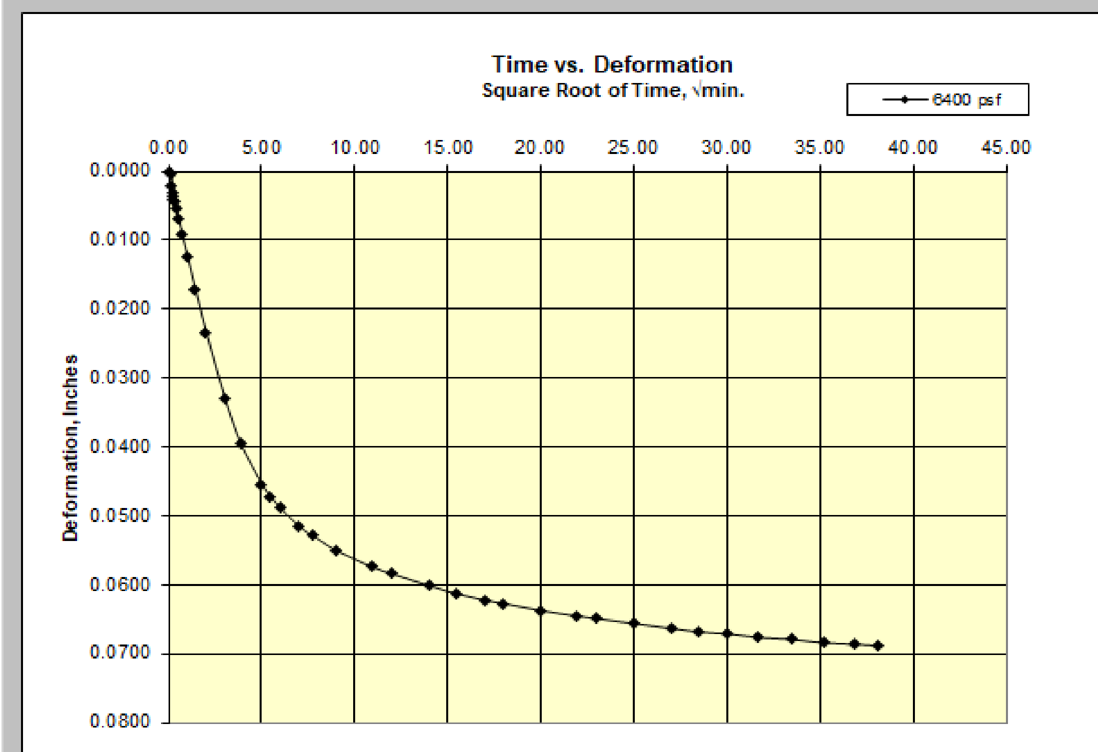
Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**Consolidation Time-Rate Plots**

Hultgren - Tillis Engineers	Project No. 923.01	Plate No. C-20

Load 9 6400 psf



6400 psf



Testing performed by Cooper Testing Laboratory

Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**Consolidation Time-Rate Plots**

Hultgren - Tillis Engineers	Project No. 923.01	Plate No. C-21

APPENDIX D

Settlement Analyses

D-1. SETTLEMENT ANALYSES

A. Levee Embankment

We performed consolidation analyses to estimate the magnitude of settlement due to the weight of new fill. We used data obtained from the borings and laboratory testing to develop material properties. To estimate the magnitude and time rate of settlement, we used the parameters in Table D-1, below.

Table D-1: Soil Properties Used for Settlement Analyses

New Fill Unit Weight	135 pcf*
Existing Fill Unit Weight	115 pcf
Bay Mud Crust	100 pcf
Bay Mud Unit Weight	97 pcf
Bay Mud Void Ratio, e_0	2.14
Bay Mud Compression Index, Cc	0.9
Bay Mud Recompression Index, Cr	0.1
Bay Mud Compression Ratio, Cc / (1+ e_0)	0.29
Bay Mud Recompression Ratio, Cr / (1+ e_0)	0.03
Bay Mud Coefficient of Consolidation, c_v	10 to 20 ft^2/year
Groundwater Elevation	+2 to +3 feet

*pcf: pounds per cubic foot

The settlement analyses was performed using the computer program CONSOL version 3.0. To characterize the stress distribution beneath the new levee fill, we modeled the load of the new fill as a series of superimposed infinite strip fills of varying widths to account for the trapezoidal cross section of the levee embankment. We assumed that the underlying Bay Mud is normally consolidated. We judge that the time rate of settlement can be reasonably characterized by assuming double drainage for the Bay Mud thicknesses.

Minimum levee crest design elevations were provided by ESA. The approximate 100-year flood elevation is at Elevation +10 feet. The levee includes 3 feet of freeboard and a minimum levee crest above Elevation +13 feet.

For the new setback ecotone levee alignment along the north edge of the soccer field, we analyzed a Bay Mud Crust thickness of 4 feet and a Bay Mud thickness of 43 feet. We assumed the ground surface is at Elevation +7 feet and the groundwater is at Elevation +3 feet. We analyzed varying new fill thicknesses and the results of the settlement estimates at the centerline of the levee, the levee toe, and at 25 feet from the levee toe are shown in Table D-2. To maintain a crest elevation of +13 feet, the total fill thickness is 8.5 feet (Elevation +15.5 feet initially) and causing about 2.5 feet of settlement.

Table D-2: Settlement Estimates for Setback Ecotone Levee

Thickness of New Fill (feet)	Settlement at Centerline (feet)	Settlement at Levee Toe (feet)	Settlement 25 feet from Levee Toe (feet)
2	0.9	0.6	<0.10
4	1.6	0.8	0.15
6	2.2	1.0	0.20
8	2.5	1.1	0.23
10	2.8	1.2	0.25

At the western setback levee abutment area, the force mains are relatively deep, ranging from 30 to 45 feet below existing grade. The Bay Mud is nominally 40 feet deep. The force mains, at a depth of 30 feet, are near the bottom of Bay Mud. The force mains, at a depth of 45 feet, are below the bottom of Bay Mud.

For the level marsh area and a force main depth of 30 feet below existing grade, we estimate that new fill will cause the force main pipe to settle about 0.25 feet. For a force main depth of 40 feet or deeper below existing grade, we estimate that new fill will cause negligible settlement of the pipe. We judge that at these fill thicknesses and depths, the settlement impacts can be consider minor.

The storm drain is shallower and ranges from about 5 feet below existing grade along the level marsh area and to about 8 feet below existing grade near the existing levee. The shallow storm drains could undergo significant settlement from the weight of the new fill if the levee is constructed directly over the pipe. For the level marsh area and a storm drain depth of 5 feet below existing grade, we estimate that 7 feet of new fill will cause the pipe to settle about 2.1 feet. At the existing levee, with the storm drain at a depth of 8 feet below existing grade, we estimate that 4 feet of new fill will cause about 0.9 feet of settlement. For other thicknesses of fill, these values can change in proportion to the fill thicknesses.

For the levee located east of the soccer field, the existing levee crest is near Elevation +11 feet to Elevation +12 feet. We judge that the levee crest should be constructed initially to Elevation +14 feet to accommodate 1-foot of settlement. Approximately 2 to 3 feet thick of new fill is anticipated. The settlement results indicate that placement of every 1-foot of fill will cause about 3-inches of settlement.

For the offset levee embankment alignment adjacent to Canal Street, we analyzed an existing fill thickness of 7 feet and a Bay Mud thickness of 55 feet. We assumed the ground surface is at Elevation +8 feet and the groundwater is at Elevation +2 feet. We analyzed varying new fill thicknesses and the resulting settlement estimates at the centerline of the levee, the levee toe, and at 25 feet from the levee toe are shown in Table D-3. For a long-term crest elevation of +13 feet, the total fill thickness is estimated to be 7 feet and causing about 2 feet of settlement.

Table D-3: Settlement Estimates for Offset Levee

Thickness of New Fill (feet)	Settlement at Centerline (feet)	Settlement at Levee Toe (feet)	Settlement 25 feet from Levee Toe (feet)
2	0.8	0.4	<0.10
4	1.4	0.6	0.15
6	1.8	0.7	0.18
8	2.1	0.8	0.20

B. Tidal Marsh Area

Various fill materials including dredged fill, rock berms, coarse beach, and rock jetty will be placed within the footprint of the tidal marsh area. For the purposes of analyses, we assumed that rock berms, coarse beach and rock jetty fill materials are similar in weight. We considered fill placement along two subsurface soil conditions: (1) eroded marsh areas, and (2) virgin marsh areas. We understand that the marshplain was likely near Elevation +6 feet prior to erosion. The bathymetric data indicates that the mudflat is near Elevation +2 feet.

We performed consolidation analyses to estimate the magnitude of settlement due to the weight of new fill within the eroded marsh areas and virgin marsh areas. We used presumptive soil parameters for analyses as shown in Table D-4. We assumed that the bottom of Bay Mud is at Elevation -40 feet.

Table D-4: Presumptive Soil Properties Used for Settlement Analyses

New Rock Fill Unit Weight	135 pcf*
New Dredged Fill Unit Weight	100 pcf
Bay Mud Unit Weight	97 pcf
Bay Mud Void Ratio, e_0	2.14
Bay Mud Compression Index, Cc	0.9
Bay Mud Recompression Index, Cr	0.1
Bay Mud Compression Ratio, Cc / (1+ e_0)	0.29
Bay Mud Recompression Ratio, Cr / (1+ e_0)	0.03
Groundwater Elevation	- 1 to +2 feet

*pcf: pounds per cubic foot

We computed the total settlement for varying thickness of areal fill for rock and dredged materials. We assumed that the underlying Bay Mud is slightly over-consolidated. The estimated settlement results for the thicknesses of new rock and new dredged fill materials are shown in Tables D-5 and D-6, below.

Table D-5: Settlement Estimates at Eroded Marsh Areas

Thickness of New Fill (feet)	Rock Fill, 135 pcf (feet)	Dredged Fill, 100 pcf (feet)
2	0.1	0.1
4	0.7	0.2
6	1.5	0.9
8	2.3	1.5
10	3.0	2.1
12	3.6	2.7

Table D-6: Settlement Estimates at Virgin Marsh Areas

Thickness of New Fill (feet)	Rock Fill, 135 pcf (feet)	Dredged Fill, 100 pcf (feet)
2	1.0	0.8
4	2.0	1.5
6	2.8	2.2
8	3.5	2.8
10	4.1	3.3
12	4.7	3.8

For the coarse beach on eroded marsh areas, total fill thickness is estimated to be 8 feet of fill causing about 2.3 feet of settlement. For the rock jetty on eroded marsh areas, total fill thickness is estimated to be 10 feet of fill causing about 3 feet of settlement. For the coarse beach on virgin marsh areas, fill thickness of 8.5 feet will cause about 3.6 feet of settlement.

APPENDIX E

Slope Stability Analyses

E-1. SLOPE STABILITY ANALYSES

A. Levee Embankment

1. Static

We performed analysis to check the factors of safety of the new levee slopes for static loading conditions. We used the computer program SLOPE/W and Spencer's method of analysis. We used data obtained from the borings and CPTs along with our assessment of effective stress and undrained shear strengths to develop material properties. Values from TxUU shear strength mobilized at 5 percent axial strain and vane shear strength data were plotted to develop undrained strength parameters within the Bay Mud. The TxUU and vane shear strength data within the Bay Mud are presented on Plate E-1. The soil parameters used in our analysis are presented on Table E-1 below.

Table E-1: Material Properties Used for Slope Stability Analyses

Material Type	Unit Weight (pcf)	Undrained Strength		Effective Strength	
		Cohesion (psf*)	Friction Angle (deg)	Cohesion (psf)	Friction Angle (deg)
New Levee Fill	135	-	-	50	32
Existing Fill	115	-	-	50	32
Bay Mud Crust	100	See Plates	0	-	-
Bay Mud	97	See Plates	0	-	-
Stiff Clay	115	1,000	-	-	-

psf: pounds per square foot

We reviewed topography and selected two cross sections to represent the new setback ecotone levee and new offset levee. For the new setback ecotone levee, the cross section used for analysis consists of a 12-foot wide levee crest at Elevation +15.5 feet with side slopes inclined at 3H:1V. The ecotone slope is inclined at 10H:1V below Elevation +10.3 feet. The ecotone slope includes an overbuild of 1.3 feet to accommodate settlement. The levee crest height included an overbuild of 2.5-feet to accommodate settlement. For the new offset levee, the cross section used for analysis consists of a 12-foot wide levee crest at Elevation +15 feet with side slopes inclined 3H:1V. The levee crest height included an overbuild of 2-feet to accommodate settlement.

We checked that cross section configurations for both the landside and waterside slopes have a minimum factor of safety of at least 1.5 for the end of construction condition. With time, the Bay Mud will gain strength as it consolidates and the long-term factors of safety will increase. The results of the slope stability factors of safety for the end of construction configurations are presented in Table E-2. We have presented the results of the slope stability cases and the soil properties used in our analysis on Plates E-2 through E-5.

Table E-2: Factors of Safety for the End-of-Construction Condition

	Factor of Safety	
Segment	**Landside**	**Waterside**
Setback Ecotone Levee	1.6	1.5
Offset Levee	1.7	1.5

2. Pseudo-Static

We performed a pseudo-static slope stability analysis for the levee configurations for the landside and waterside slopes. The pseudo-static analysis applies a horizontal force at the center of gravity to model an earthquake force. The yield coefficient is the value of the force resulting in a factor of safety of 1.0. The analysis assumes that materials do not lose strength during earthquake shaking.

For pseudo-static loading conditions, we analyzed the new levee configurations using undrained strengths and the parameters presented in Table E-1. We used an approximate average tide level at Elevation +3 feet for the analyses. Table E-3 presents the results. We have presented the results of the pseudo-static slope stability cases and the soil properties used in our analysis on Plates E-6 through E-9.

Table E-3: Yield Coefficients (K_y) from Pseudo-Static Loading

	Yield Coefficient	
Segment	**Landside**	**Waterside**
Setback Ecotone Levee	0.13	0.10
Offset Levee	0.14	0.08

The results can be used to determine the level of seismic vulnerability and to estimate seismic deformations.

B. Tidal Marsh Area

1. Static

We performed slope stability analyses to determine the factors of safety for the end of construction condition to evaluate the safe rate of fill placement. We used the computer program SLOPE/W and Spencer's method of analysis. We used presumptive undrained shear strengths for the underlying Bay Mud. In eroded marsh areas, we used an undrained strength of 140 psf at the ground surface and increasing 10 psf for each additional foot of depth. In virgin marsh areas, we used an undrained strength of 100 psf at the ground surface and increasing 10 psf for each additional foot of depth. The soil parameters used in our analysis are presented on Table E-4 below.

Table E-4: Presumptive Material Properties Used for Slope Stability Analyses

Material Type	Unit Weight (pcf)	Undrained Strength		Effective Strength	
		Cohesion (psf)	Friction Angle (deg)	Cohesion (psf)	Friction Angle (deg)
New Rock Fill	135	-	-	50	38
New Dredged Fill	100	-	-	50	30
Bay Mud in Eroded Marsh Areas	97	140 psf + 10 psf/ft	0	-	-
Bay Mud in Virgin Marsh Areas	97	100 psf + 10 psf/ft	0	-	-
Stiff Clay	115	1,000	-	-	-

The coarse beach consists of an 8-foot wide levee crest at Elevation +8 feet with side slopes inclined 2H:1V on the landside and 8H:1V on the waterside. The rock jetty consists of an 8-foot wide levee crest at Elevation +9 feet with side slopes inclined 2H:1V.

a. Coarse Beach on Eroded Marsh Areas

We performed slope stability analyses to assess the end of construction factor of safety for the coarse beach on the eroded marsh areas assuming one stage filling. The results as shown on Plates E-10 and E-11 indicate factors of safety of 1.1 and 1.7 on the landside (toward expanded marsh) and waterside, respectively. The results indicate that the fill cannot be placed in one stage and that a landside buttress and staged construction would be necessary to provide an acceptable level of safety.

A combination of landside stability berm widths and thicknesses were analyzed to develop a configuration to maintain for a minimum end-of-construction slope stability factor of safety of 1.5. We developed a sequence of construction to achieve the design elevation. The first step consists of a maximum rock fill thickness of 5 feet with side slopes inclined at 2H:1V or flatter on the landside and 8H:1V on the waterside. The second step is a landside buttress consisting of 4.5 feet thickness of dredged fill materials (assumes 100 pcf) at least 20 feet wide with side slope inclined at 2H:1V or flatter. The third step is to place a second stage of rock materials consisting of 3 feet thickness of fill with side slopes inclined at 2H:1V or flatter on the landside and 8H:1V on the waterside. The end of construction factors of safety are shown in Table E-5 and on Plates E-12 through E-17. We assumed no strength gain between stages in the underlying soils.

Table E-5: Factors of Safety for the End-of-Construction Condition

	Factor of Safety	
Stages	**Landside**	**Waterside**
Step 1	1.5	2.2
Step 2	2.2	2.2
Step 3	1.5	1.7

b. Coarse Beach on Virgin Marsh Areas

We performed slope stability analyses to assess the end of construction factor of safety for the coarse beach on virgin marsh areas assuming one stage filling. The results as shown on Plates E-18 and E-19 indicate factors of safety of 0.7 and 1.3 on the landside (toward expanded marsh) and waterside, respectively. The results indicate that the fill cannot be placed in one stage and that a landside buttress and staged construction would be necessary to provide an acceptable level of safety.

A combination of landside stability berm widths and thicknesses were analyzed to develop a configuration to achieve minimum end-of-construction slope stability factor of safety of 1.5. We developed a sequence of construction to achieve the design elevation. The first step consists of a maximum rock fill thickness of 3.5 feet with side slopes inclined at 2H:1V or flatter on the landside and 8H:1V on the waterside. The second step is a landside buttress consisting of 6 feet thickness of dredged fill materials (assumes 100 pcf) at least 45 feet wide with side slope inclined at 10H:1V or flatter. The third step is to place a second stage of rock materials consisting of 5 feet thickness of fill with side slopes inclined at

2H:1V or flatter on the landside and 8H:1V on the waterside. The end of construction factors of safety are shown in Table E-6 and on Plates E-20 through E-25.

Table E-6: Factors of Safety for the End-of-Construction Condition

	Factor of Safety	
Stages	**Landside**	**Waterside**
Step 1	1.5	2.3
Step 2	1.5	1.9
Step 3	1.7	1.5

We assumed no strength gain between stages in the underlying soils. A third stage of rock materials (Step 4) consisting of 2 feet thickness of fill with side slopes inclined at 2H:1V or flatter on the landside and 8H:1V on the waterside would be needed to maintain the design elevation. The third stage of rock materials would require a waiting period and strength gain of the underlying soils. We did not evaluate the potential strength gain required for the third stage of rock materials. We anticipate that the waiting period between stages would be about 10 years or more. The timing and sequencing for the third stage can be completed in final design.

c. Rock Jetty on Eroded Marsh Areas

We performed slope stability analyses to assess the end of construction factor of safety for the rock jetty on eroded marsh areas assuming one stage filling. The results as shown on Plate E-26 and E-27 indicate factors of safety of 0.9 for both the landside (toward expanded marsh) and waterside. The results indicate that more than one stage of fill placement is needed and that both landside and waterside buttresses and staged construction would be necessary to provide an acceptable level of safety.

A combination of landside stability berm widths and thicknesses were analyzed to develop a configuration to achieve for a minimum end-of-construction slope stability factor of safety of 1.5. We developed a sequence of construction to achieve the design elevation. The first step consists of a maximum rock fill thickness of 5 feet with side slopes inclined at 2H:1V or flatter on both the landside and waterside. The second step is a landside buttress consisting of 4.5 feet thickness of dredged fill materials (assumes 100 pcf) at least 30 feet wide with side slope inclined at 2H:1V or flatter and a waterside buttress consisting of 3 feet thickness of rock fill materials (assumes 135 pcf) at least 30 feet wide with side slope inclined at 2H:1V or flatter. The third step is to place a second stage of rock materials consisting of 5 feet thickness of fill with side slopes inclined at 2H:1V or flatter. The end of construction factors of safety are shown in Table E-7 and on Plates E-28 through E-33. We assumed that the waterside buttress is at least 10 feet from the top of the creek slope. We assumed no strength gain between stages in the underlying soils.

Table E-7: Factors of Safety for the End-of-Construction Condition

	Factor of Safety	
Stages	**Landside**	**Waterside**
Step 1	1.5	1.5
Step 2	2.3	2.5
Step 3	1.5	1.6

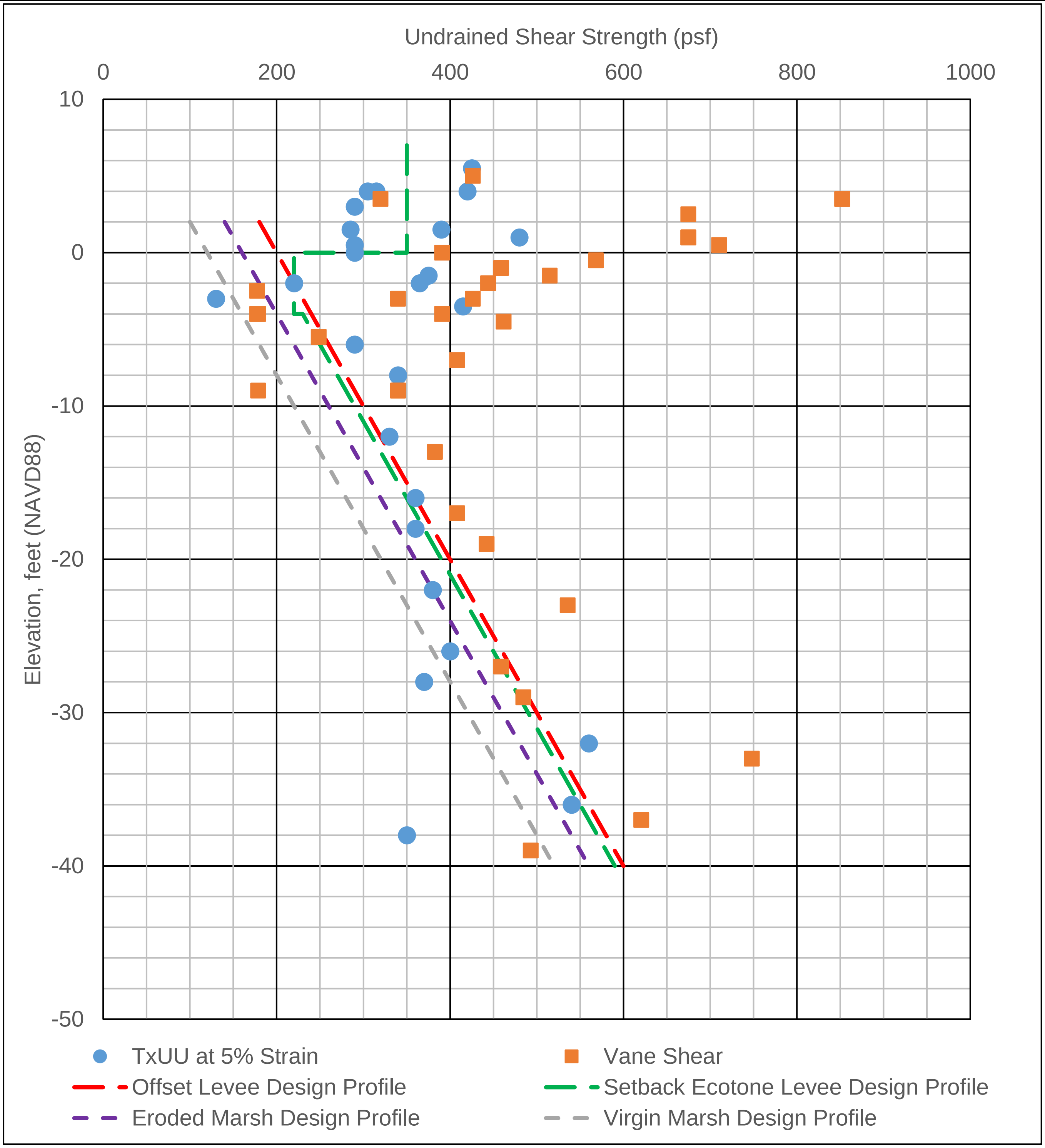
2. Pseudo-Static

For pseudo-static loading conditions, we analyzed the coarse beach on eroded marsh areas and virgin marsh areas and the rock jetty on eroded marsh areas. We used an approximate average tide level at Elevation +3 feet for analyses. Table E-8 presents the results of the yield coefficients (K_y). We have presented the results of the pseudo-static slope stability cases and the soil properties used in our analysis on Plates E-34 through E-39.

Table E-8: Yield Coefficients (K_y) from Pseudo-Static Loading

	Yield Coefficient	
Section	**Landside**	**Waterside**
Coarse Beach on Eroded Marsh Areas	0.16	0.10
Coarse Beach on Virgin Marsh Areas	0.12	0.06
Rock Jetty on Eroded Marsh Areas	0.15	0.09

The results can be used to determine the level of seismic vulnerability and to estimate seismic deformations.

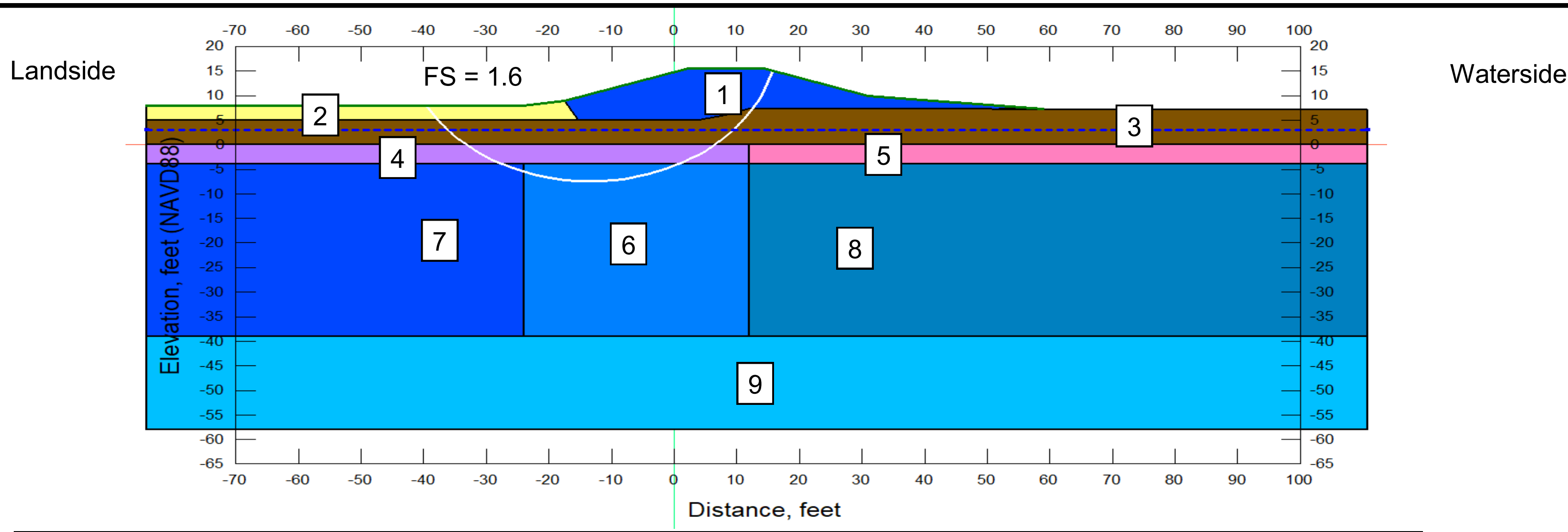


Notes:

1. Setback and offset levee design profiles at center of the existing levees.
2. Setback and offset levee design profiles at the landside and waterside of the existing levee are not shown.

Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**Shear Strength Data in Bay Mud and Design Profiles**

Hultgren - Tillis Engineers	Project No. 923.01	Plate No. E-1



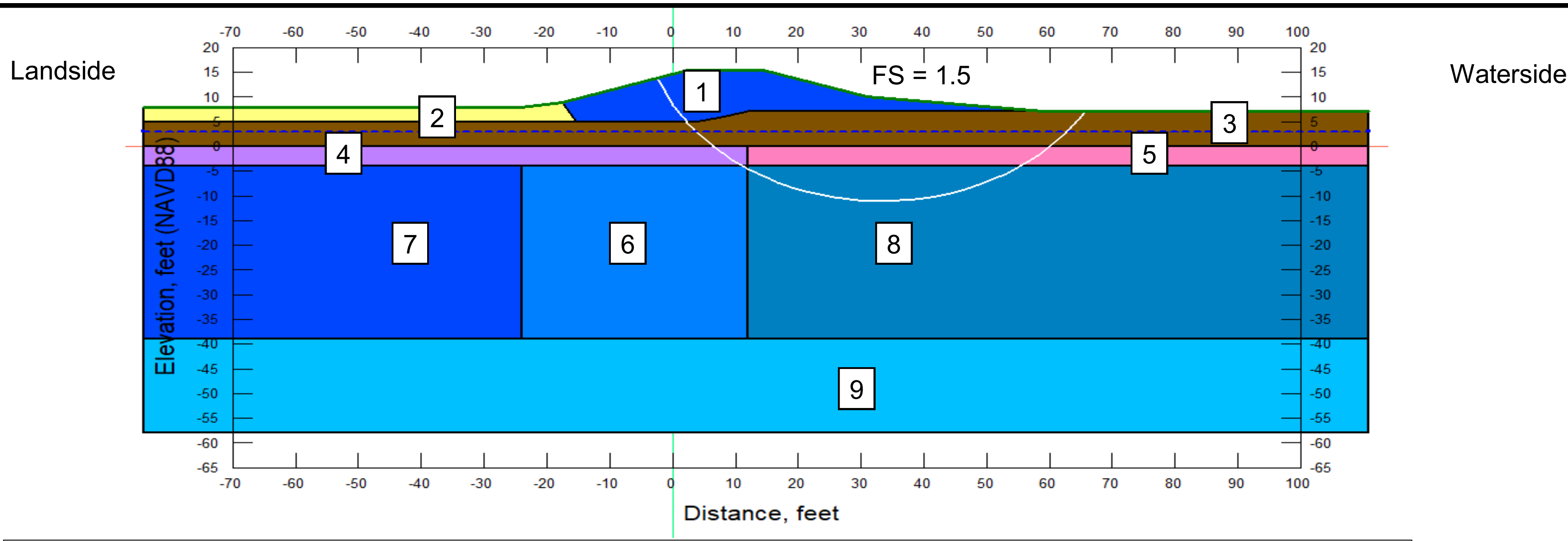
STABILITY MODEL MATERIAL PROPERTIES							
UNIT NO.	LAYER COLOR	MATERIAL TYPE	UNIT WEIGHT (pcf)	UNDRAINED STRENGTH		EFFECTIVE STRENGTH	
				COHESION (psf)	FRICTION ANGLE (degrees)	COHESION (psf)	FRICTION ANGLE (degrees)
1		New Fill	135	-	-	50	32
2		Existing Fill	115	-	-	50	32
3		Bay Mud Crust 1	100	350	-	-	-
4		Bay Mud Crust 2	100	220	-	-	-
5		Bay Mud Crust 3	100	200	-	-	-
6		Bay Mud 1	97	230 + 10H	-	-	-
7		Bay Mud 2	97	220 + 10H	-	-	-
8		Bay Mud 3	97	210 + 10H	-	-	-
9		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Slope Stability Analyses Results
Setback Ecotone Levee
End of Construction (LS)

Hultgren - Tillis Engineers | Project No. 923.01 | Plate No. E-2



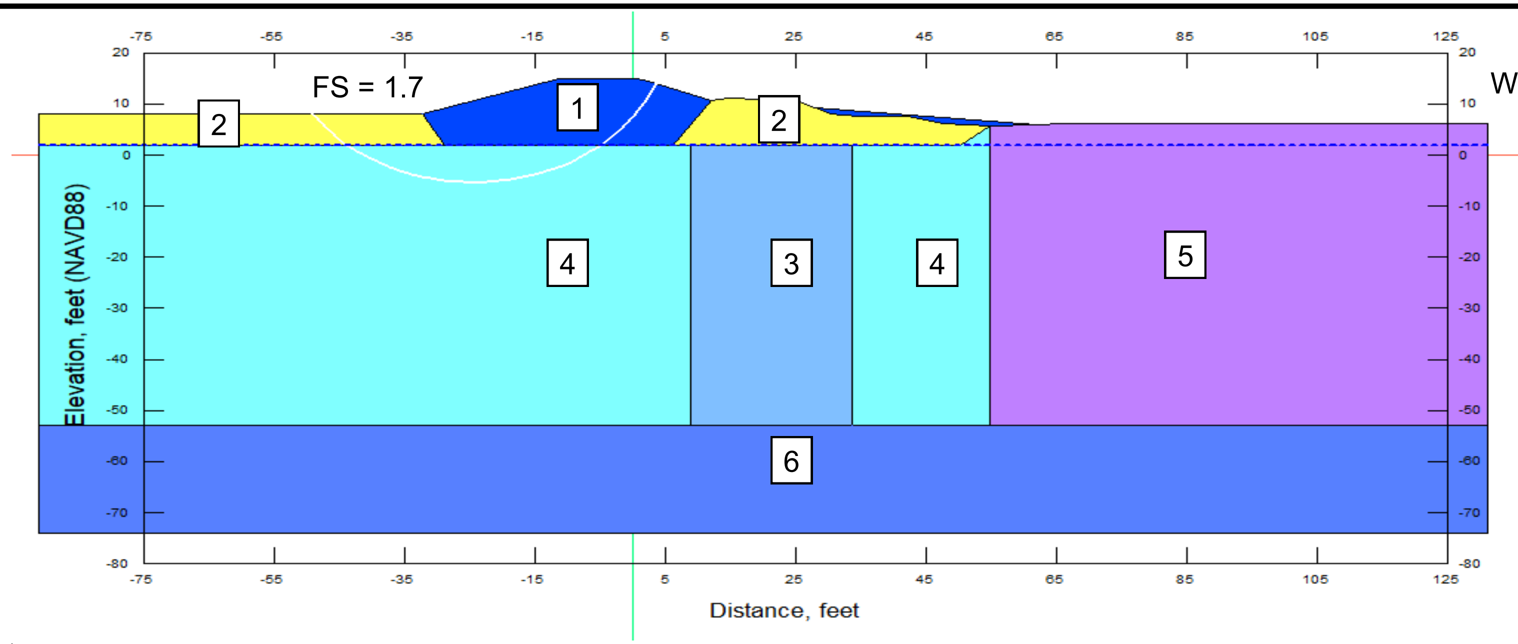
STABILITY MODEL MATERIAL PROPERTIES							
UNIT NO.	LAYER COLOR	MATERIAL TYPE	UNIT WEIGHT (pcf)	UNDRAINED STRENGTH		EFFECTIVE STRENGTH	
				COHESION (psf)	FRICTION ANGLE (degrees)	COHESION (psf)	FRICTION ANGLE (degrees)
1		New Fill	135	-	-	50	32
2		Existing Fill	115	-	-	50	32
3		Bay Mud Crust 1	100	350	-	-	-
4		Bay Mud Crust 2	100	220	-	-	-
5		Bay Mud Crust 3	100	200	-	-	-
6		Bay Mud 1	97	230 + 10H	-	-	-
7		Bay Mud 2	97	220 + 10H	-	-	-
8		Bay Mud 3	97	210 + 10H	-	-	-
9		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Slope Stability Analyses Results
Setback Ecotone Levee
End of Construction (WS)

Hultgren - Tillis Engineers | Project No. 923.01 | Plate No. E-3

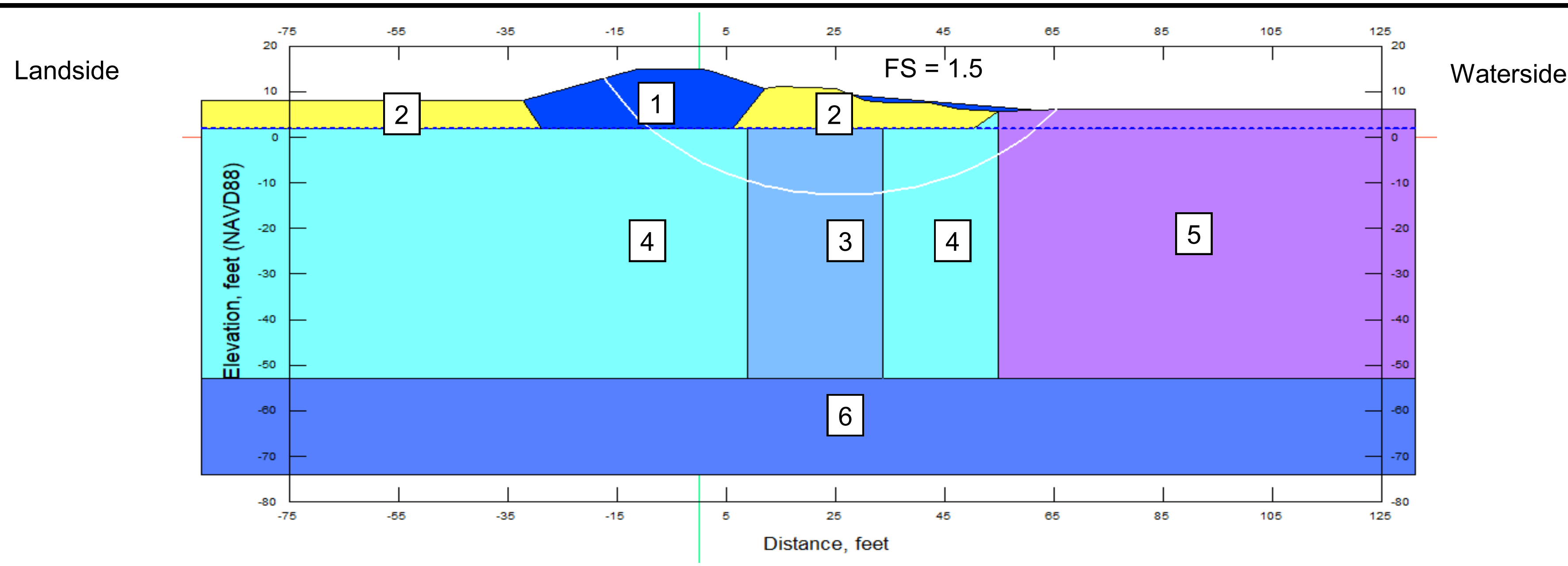


STABILITY MODEL MATERIAL PROPERTIES							
UNIT NO.	LAYER COLOR	MATERIAL TYPE	UNIT WEIGHT (pcf)	UNDRAINED STRENGTH		EFFECTIVE STRENGTH	
				COHESION (psf)	FRICTION ANGLE (degrees)	COHESION (psf)	FRICTION ANGLE (degrees)
1		New Fill	135	-	-	50	32
2		Existing Fill	115	-	-	50	32
3		Bay Mud 1	97	180 + 10H	-	-	-
4		Bay Mud 2	97	160 + 10H	-	-	-
5		Bay Mud 3	97	100 + 10H	-	-	-
6		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**Slope Stability Analyses Results** **Offset Levee** **End of Construction (LS)**

Hultgren - Tillis Engineers	Project No. 923.01	Plate No. E-4



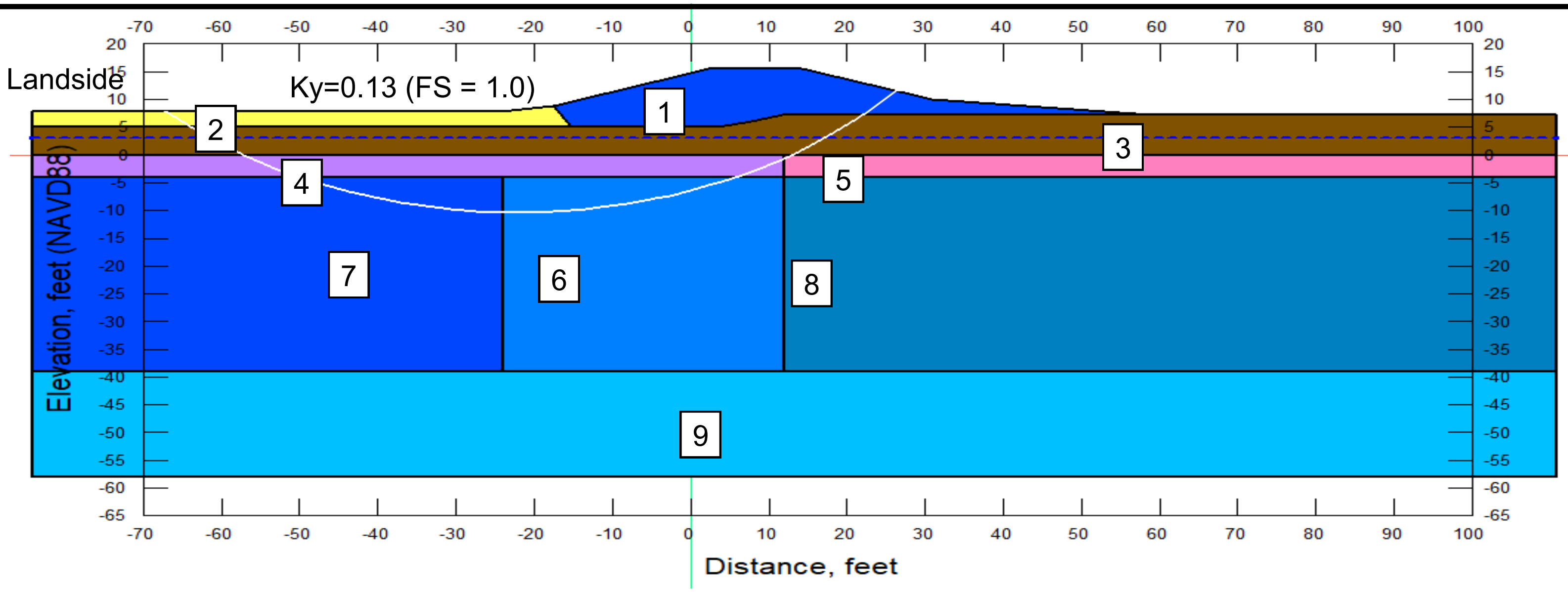
STABILITY MODEL MATERIAL PROPERTIES							
UNIT NO.	LAYER COLOR	MATERIAL TYPE	UNIT WEIGHT (pcf)	UNDRAINED STRENGTH		EFFECTIVE STRENGTH	
				COHESION (psf)	FRICTION ANGLE (degrees)	COHESION (psf)	FRICTION ANGLE (degrees)
1		New Fill	135	-	-	50	32
2		Existing Fill	115	-	-	50	32
3		Bay Mud 1	97	180 + 10H	-	-	-
4		Bay Mud 2	97	160 + 10H	-	-	-
5		Bay Mud 3	97	100 + 10H	-	-	-
6		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Slope Stability Analyses Results
Offset Levee
End of Construction (WS)

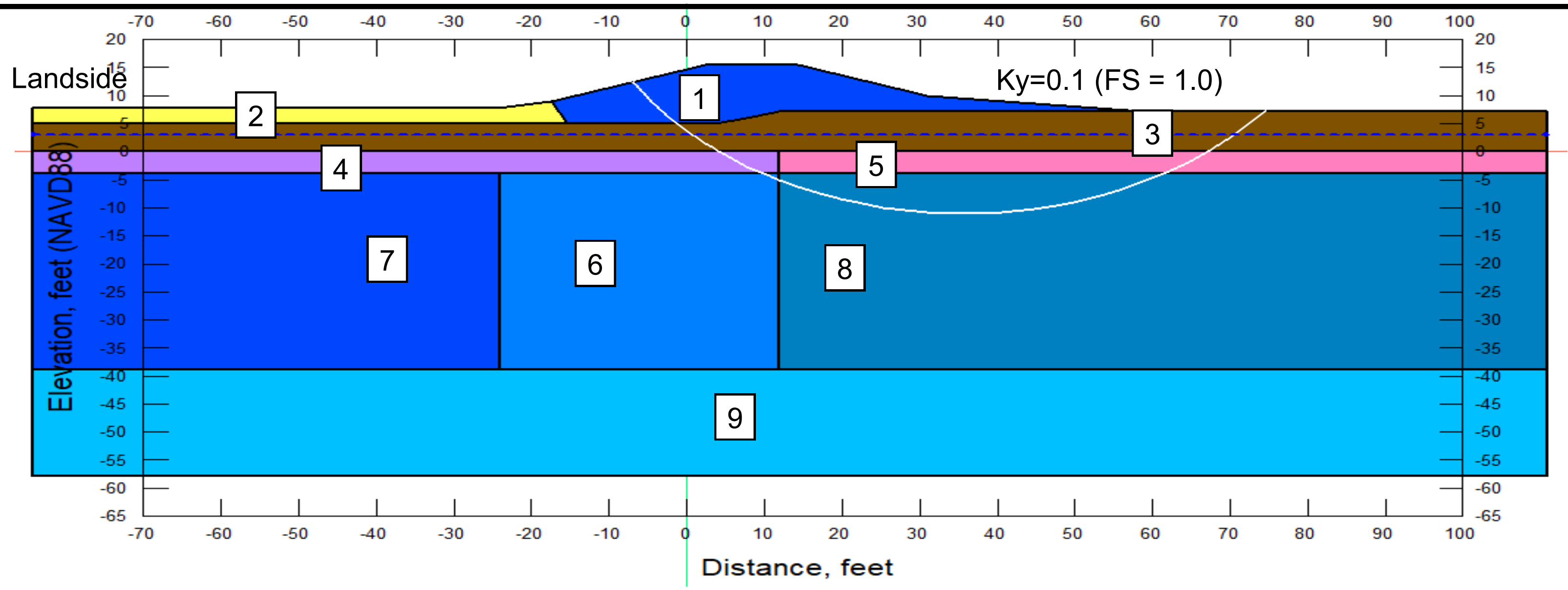
Hultgren - Tillis Engineers | Project No. 923.01 | Plate No. E-5



STABILITY MODEL MATERIAL PROPERTIES							
UNIT NO.	LAYER COLOR	MATERIAL TYPE	UNIT WEIGHT (pcf)	UNDRAINED STRENGTH		EFFECTIVE STRENGTH	
				COHESION (psf)	FRICTION ANGLE (degrees)	COHESION (psf)	FRICTION ANGLE (degrees)
1		New Fill	135	-	-	50	32
2		Existing Fill	115	-	-	50	32
3		Bay Mud Crust 1	100	350	-	-	-
4		Bay Mud Crust 2	100	220	-	-	-
5		Bay Mud Crust 3	100	200	-	-	-
6		Bay Mud 1	97	230 + 10H	-	-	-
7		Bay Mud 2	97	220 + 10H	-	-	-
8		Bay Mud 3	97	210 + 10H	-	-	-
9		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**Slope Stability Analyses Results Setback Ecotone Levee Pseudo Static (LS)**	
Hultgren - Tillis Engineers	Project No. 923.01	Plate No. E-6



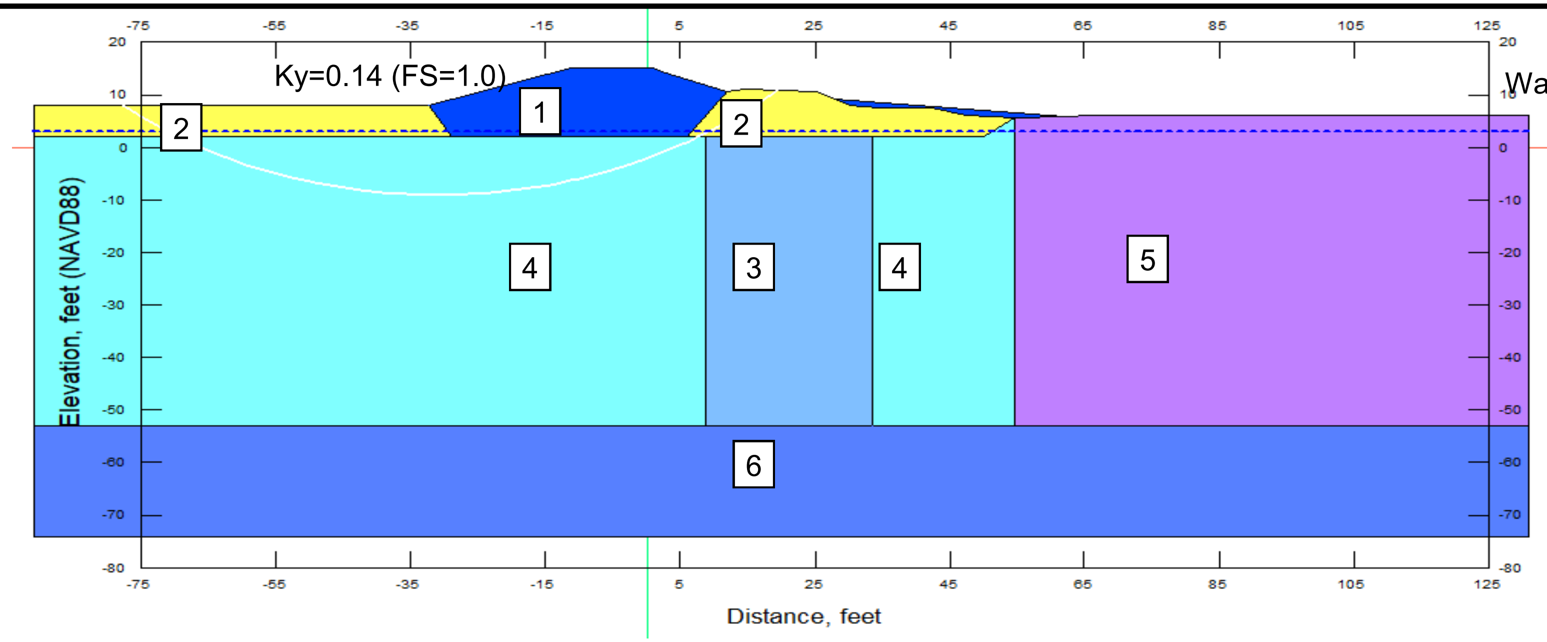
STABILITY MODEL MATERIAL PROPERTIES							
UNIT NO.	LAYER COLOR	MATERIAL TYPE	UNIT WEIGHT (pcf)	UNDRAINED STRENGTH		EFFECTIVE STRENGTH	
				COHESION (psf)	FRICTION ANGLE (degrees)	COHESION (psf)	FRICTION ANGLE (degrees)
1		New Fill	135	-	-	50	32
2		Existing Fill	115	-	-	50	32
3		Bay Mud Crust 1	100	350	-	-	-
4		Bay Mud Crust 2	100	220	-	-	-
5		Bay Mud Crust 3	100	200	-	-	-
6		Bay Mud 1	97	230 + 10H	-	-	-
7		Bay Mud 2	97	220 + 10H	-	-	-
8		Bay Mud 3	97	210 + 10H	-	-	-
9		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Slope Stability Analyses Results
Setback Ecotone Levee
Pseudo Static (WS)

Hultgren - Tillis Engineers | Project No. 923.01 | Plate No. E-7



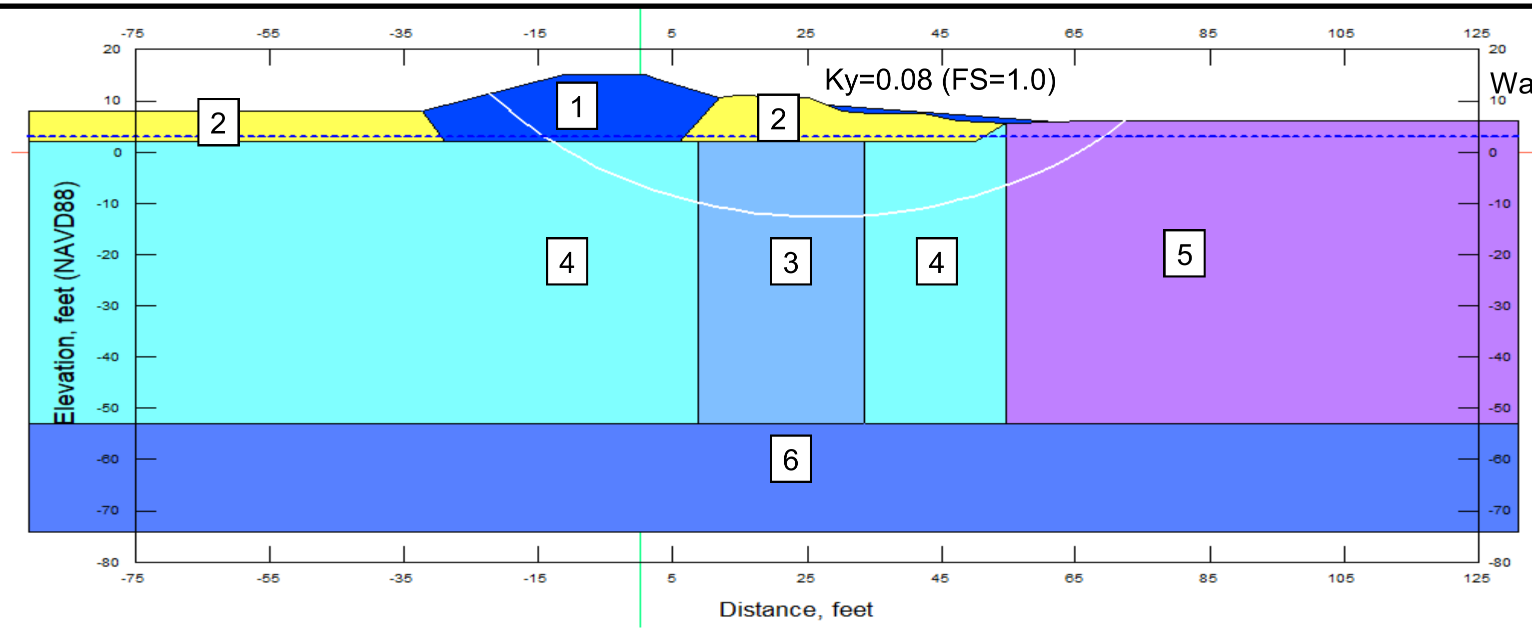
STABILITY MODEL MATERIAL PROPERTIES							
UNIT NO.	LAYER COLOR	MATERIAL TYPE	UNIT WEIGHT (pcf)	UNDRAINED STRENGTH		EFFECTIVE STRENGTH	
				COHESION (psf)	FRICTION ANGLE (degrees)	COHESION (psf)	FRICTION ANGLE (degrees)
1		New Fill	135	-	-	50	32
2		Existing Fill	115	-	-	50	32
3		Bay Mud 1	97	180 + 10H	-	-	-
4		Bay Mud 2	97	160 + 10H	-	-	-
5		Bay Mud 3	97	100 + 10H	-	-	-
6		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Slope Stability Analyses Results
Offset Levee
Pseudo Static (LS)

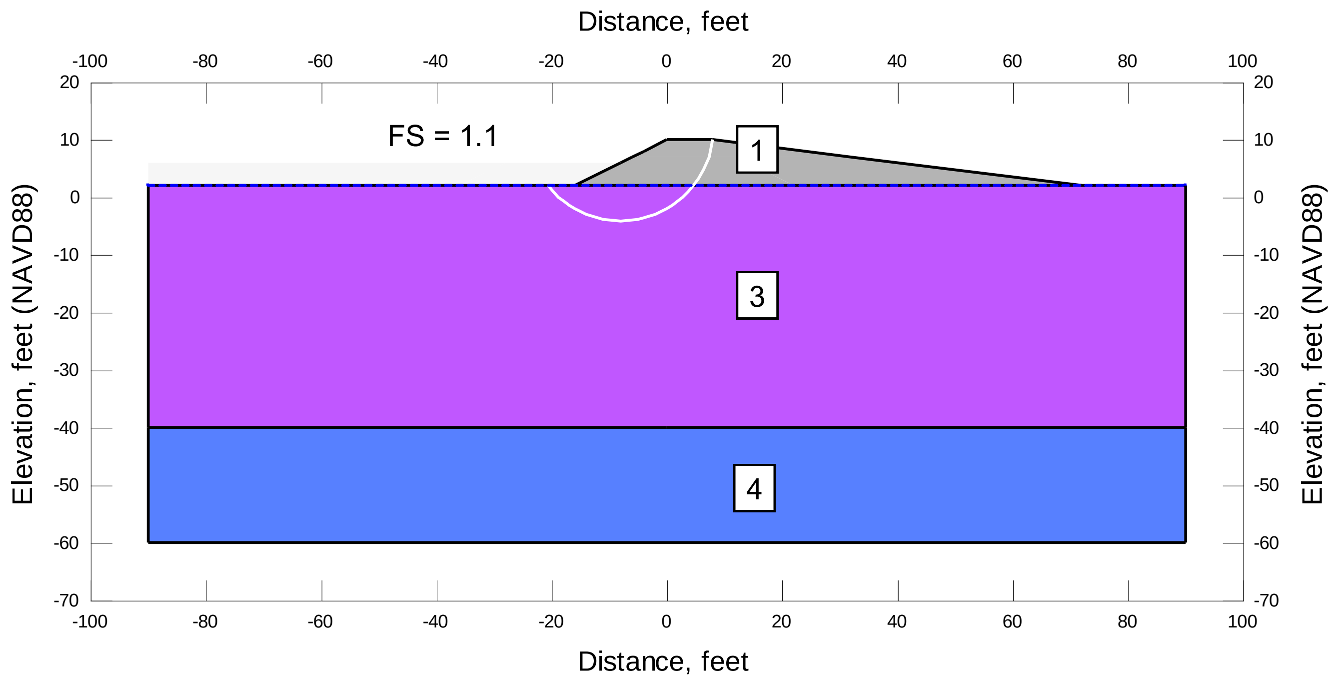
Hultgren - Tillis Engineers | Project No. 923.01 | Plate No. E-8



STABILITY MODEL MATERIAL PROPERTIES							
UNIT NO.	LAYER COLOR	MATERIAL TYPE	UNIT WEIGHT (pcf)	UNDRAINED STRENGTH		EFFECTIVE STRENGTH	
				COHESION (psf)	FRICTION ANGLE (degrees)	COHESION (psf)	FRICTION ANGLE (degrees)
1		New Fill	135	-	-	50	32
2		Existing Fill	115	-	-	50	32
3		Bay Mud 1	97	180 + 10H	-	-	-
4		Bay Mud 2	97	160 + 10H	-	-	-
5		Bay Mud 3	97	100 + 10H	-	-	-
6		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**Slope Stability Analyses Results** **Offset Levee** **Pseudo Static (WS)**
Hultgren - Tillis Engineers	Project No. 923.01 — Plate No. E-9

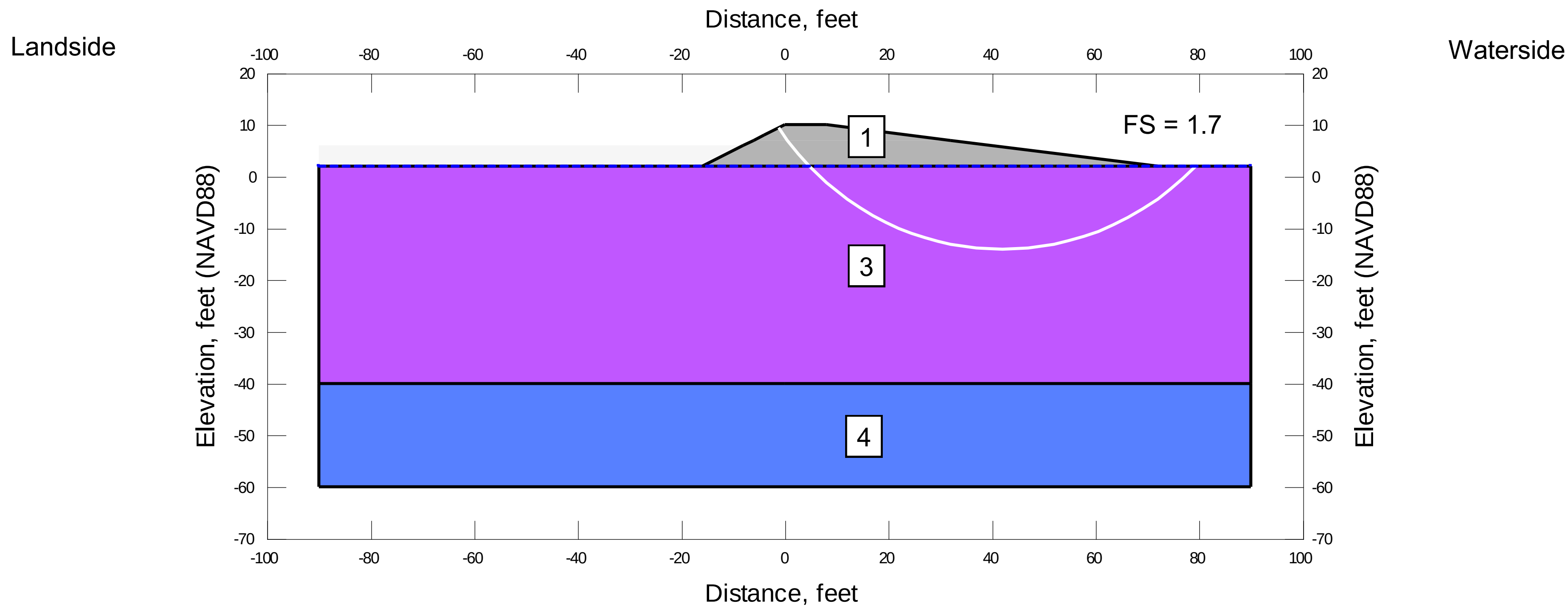


STABILITY MODEL MATERIAL PROPERTIES							
UNIT NO.	LAYER COLOR	MATERIAL TYPE	UNIT WEIGHT (pcf)	UNDRAINED STRENGTH		EFFECTIVE STRENGTH	
				COHESION (psf)	FRICTION ANGLE (degrees)	COHESION (psf)	FRICTION ANGLE (degrees)
1		New Rock Fill	135	-	-	50	38
2		New Dredged Fill	100	-	-	50	30
3		Eroded Bay Mud	97	140 + 10H	-	-	-
4		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**Slope Stability Analyses Results Coarse Beach on Eroded Marsh Full Section (LS)**

Hultgren - Tillis Engineers	Project No. 923.01	Plate No. E-10



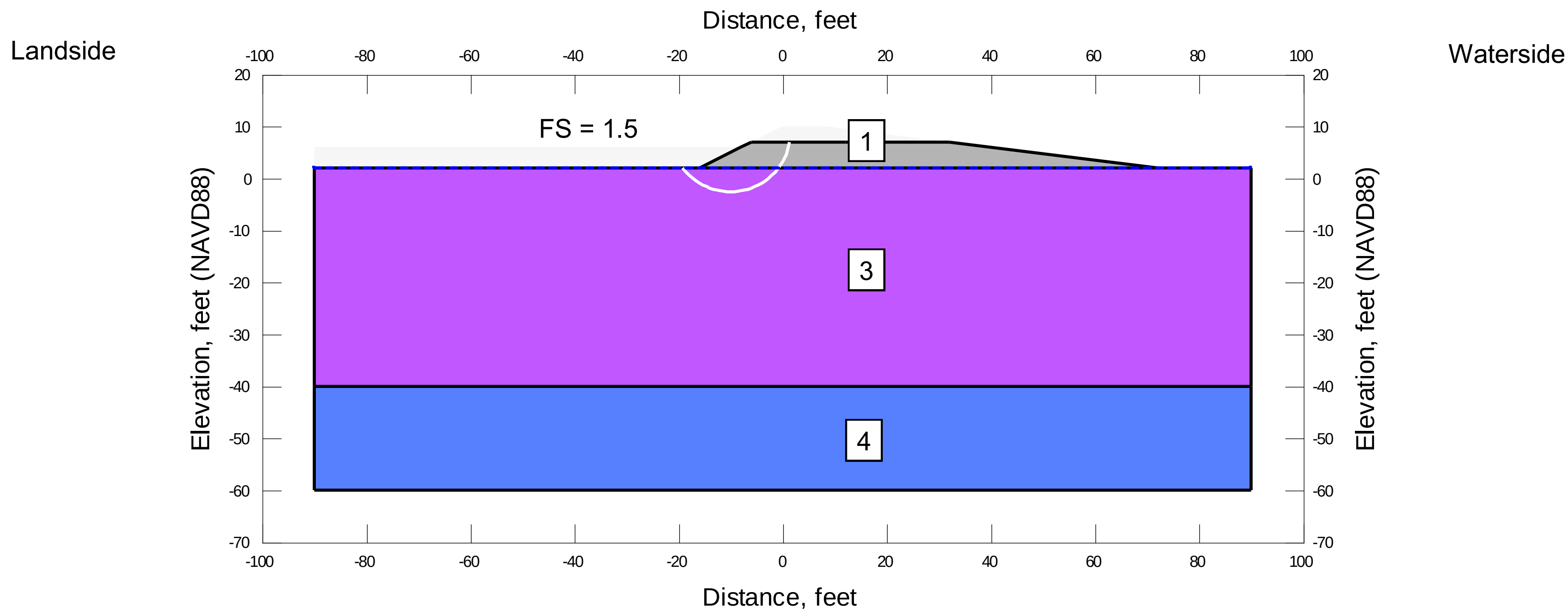
STABILITY MODEL MATERIAL PROPERTIES							
UNIT NO.	LAYER COLOR	MATERIAL TYPE	UNIT WEIGHT (pcf)	UNDRAINED STRENGTH		EFFECTIVE STRENGTH	
				COHESION (psf)	FRICTION ANGLE (degrees)	COHESION (psf)	FRICTION ANGLE (degrees)
1		New Rock Fill	135	-	-	50	38
2		New Dredged Fill	100	-	-	50	30
3		Eroded Bay Mud	97	140 + 10H	-	-	-
4		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Slope Stability Analyses Results
Coarse Beach on Eroded Marsh
Full Section (WS)

Hultgren - Tillis Engineers | Project No. 923.01 | Plate No. E-11

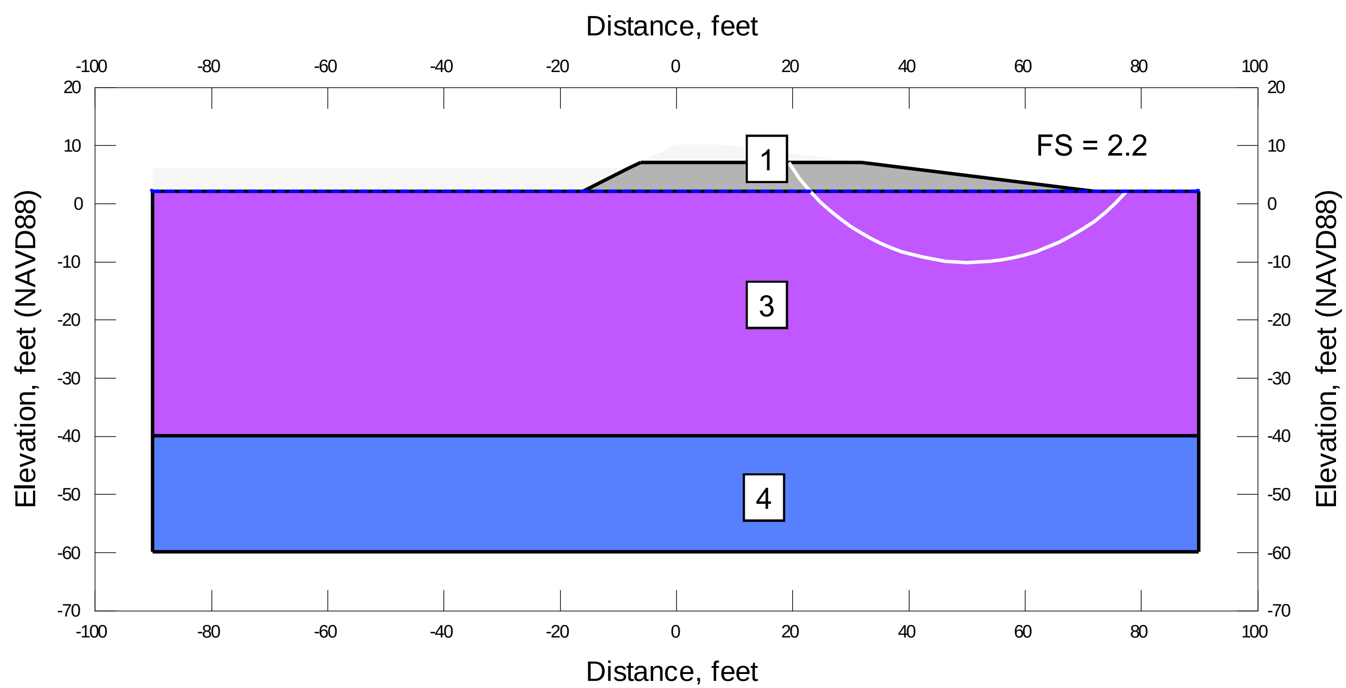


STABILITY MODEL MATERIAL PROPERTIES							
UNIT NO.	LAYER COLOR	MATERIAL TYPE	UNIT WEIGHT (pcf)	UNDRAINED STRENGTH		EFFECTIVE STRENGTH	
				COHESION (psf)	FRICTION ANGLE (degrees)	COHESION (psf)	FRICTION ANGLE (degrees)
1		New Rock Fill	135	-	-	50	38
2		New Dredged Fill	100	-	-	50	30
3		Eroded Bay Mud	97	140 + 10H	-	-	-
4		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**Slope Stability Analyses Results Coarse Beach on Eroded Marsh Step 1: First Lift Rock Fill (LS)**

Hultgren - Tillis Engineers	Project No. 923.01	Plate No. E-12



STABILITY MODEL MATERIAL PROPERTIES							
UNIT NO.	LAYER COLOR	MATERIAL TYPE	UNIT WEIGHT (pcf)	UNDRAINED STRENGTH		EFFECTIVE STRENGTH	
				COHESION (psf)	FRICTION ANGLE (degrees)	COHESION (psf)	FRICTION ANGLE (degrees)
1		New Rock Fill	135	-	-	50	38
2		New Dredged Fill	100	-	-	50	30
3		Eroded Bay Mud	97	140 + 10H	-	-	-
4		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

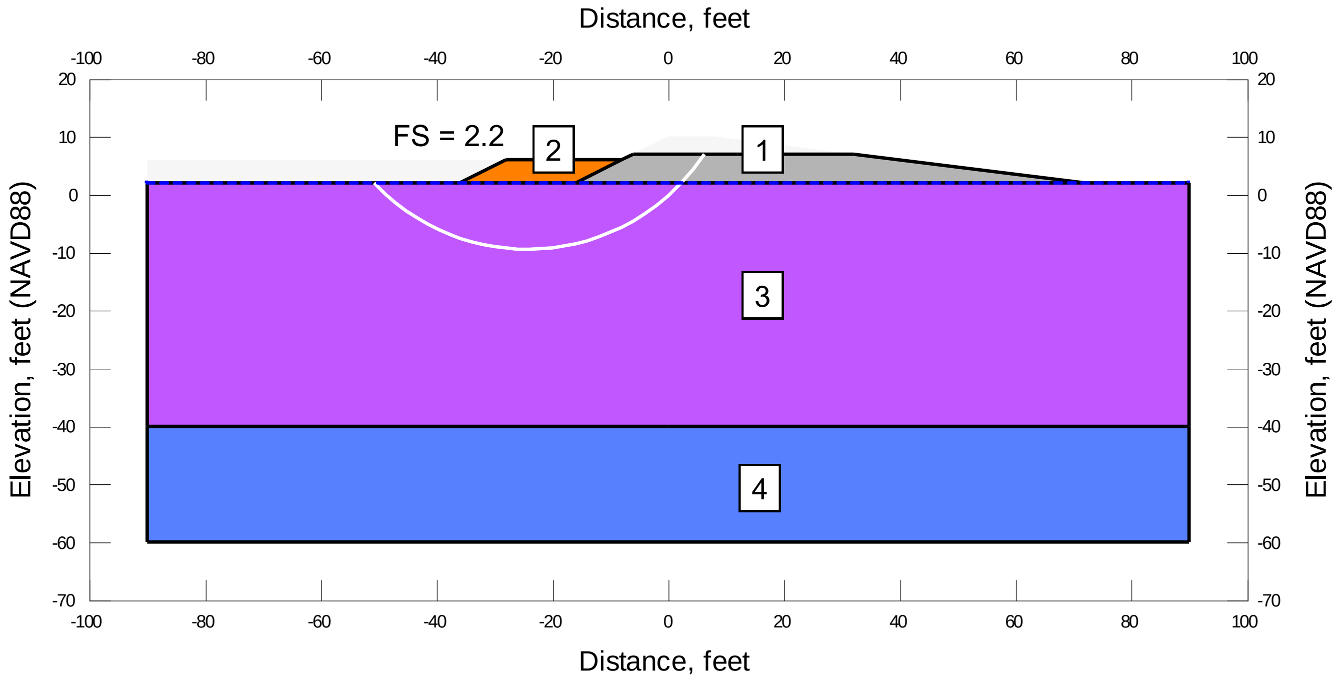
Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Slope Stability Analyses Results
Coarse Beach on Eroded Marsh
Step 1: First Lift Rock Fill (WS)

Hultgren - Tillis Engineers | Project No. 923.01 | Plate No. E-13

Landside

Waterside



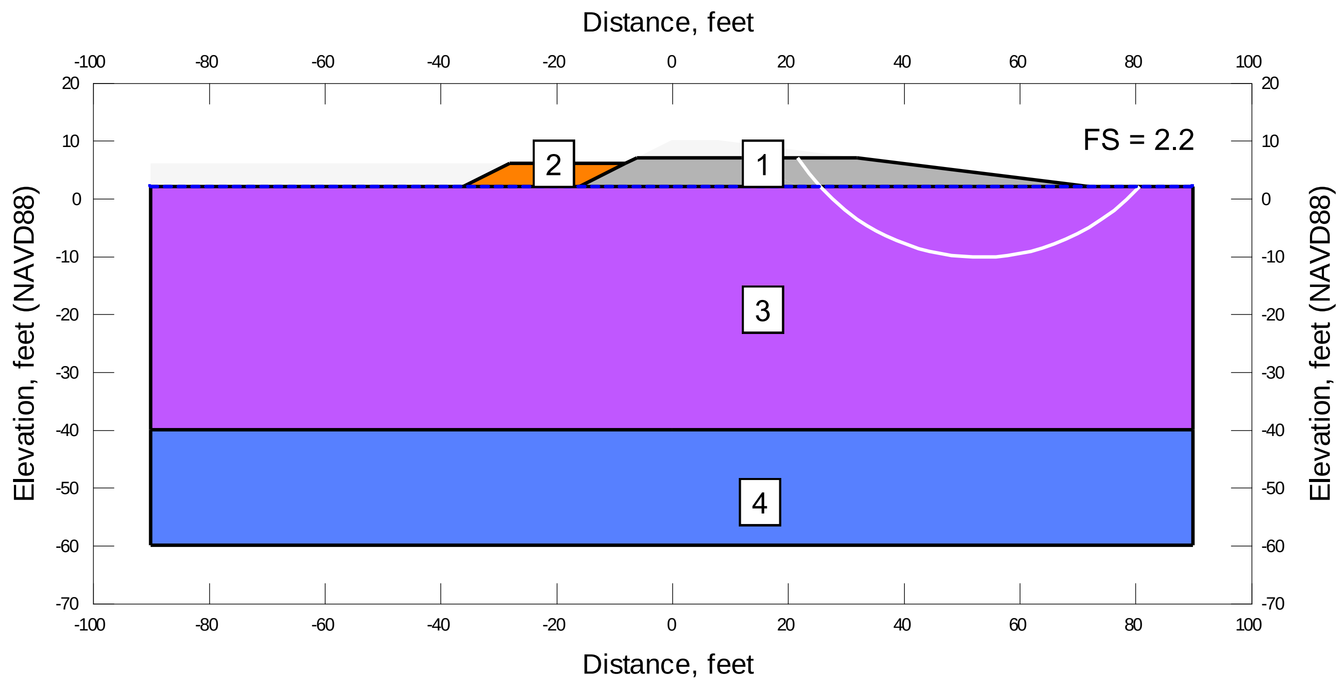
STABILITY MODEL MATERIAL PROPERTIES							
UNIT NO.	LAYER COLOR	MATERIAL TYPE	UNIT WEIGHT (pcf)	UNDRAINED STRENGTH		EFFECTIVE STRENGTH	
				COHESION (psf)	FRICTION ANGLE (degrees)	COHESION (psf)	FRICTION ANGLE (degrees)
1		New Rock Fill	135	-	-	50	38
2		New Dredged Fill	100	-	-	50	30
3		Eroded Bay Mud	97	140 + 10H	-	-	-
4		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**Slope Stability Analyses Results** **Coarse Beach on Eroded Marsh** **Step 2: Buttress Landside Slope (LS)**
Hultgren - Tillis Engineers	Project No. 923.01 | Plate No. E-14

Landside

Waterside



STABILITY MODEL MATERIAL PROPERTIES							
UNIT NO.	LAYER COLOR	MATERIAL TYPE	UNIT WEIGHT (pcf)	UNDRAINED STRENGTH		EFFECTIVE STRENGTH	
				COHESION (psf)	FRICTION ANGLE (degrees)	COHESION (psf)	FRICTION ANGLE (degrees)
1		New Rock Fill	135	-	-	50	38
2		New Dredged Fill	100	-	-	50	30
3		Eroded Bay Mud	97	140 + 10H	-	-	-
4		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

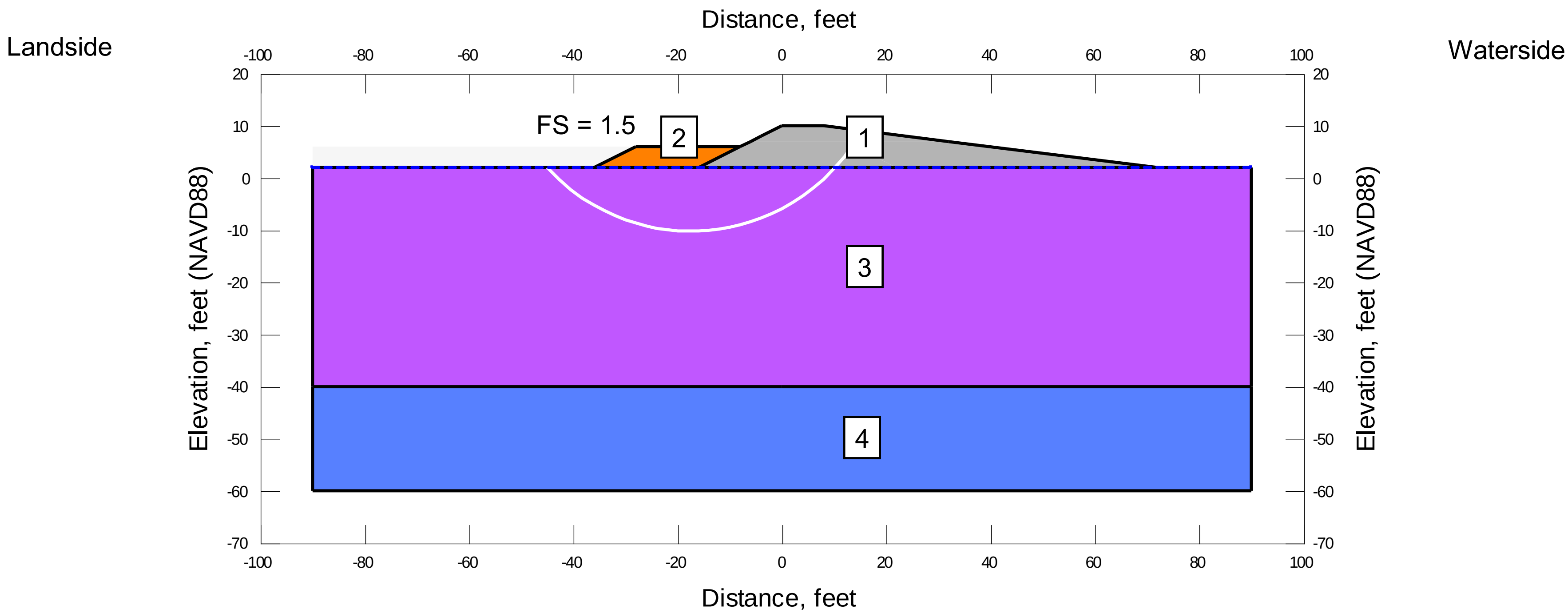
Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Slope Stability Analyses Results
Coarse Beach on Eroded Marsh
Step 2: Buttress Landside Slope (WS)

Hultgren - Tillis Engineers

Project No. 923.01

Plate No. E-15



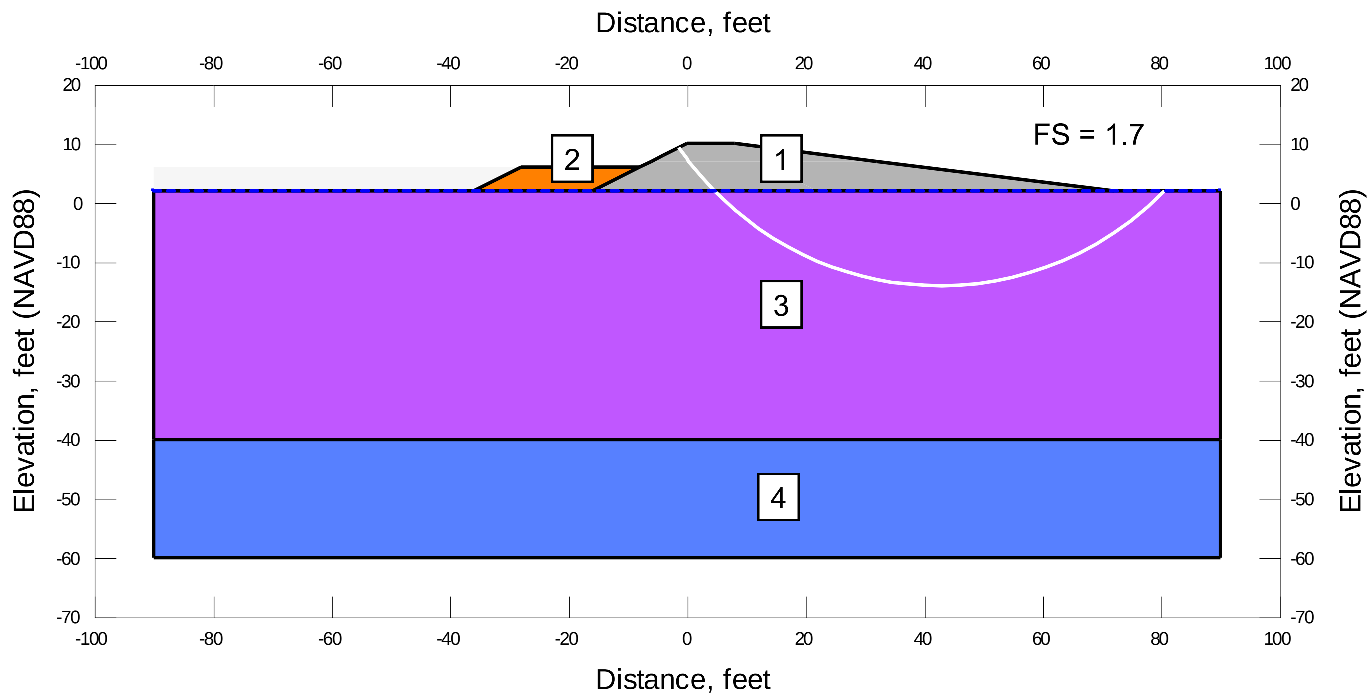
STABILITY MODEL MATERIAL PROPERTIES							
UNIT NO.	LAYER COLOR	MATERIAL TYPE	UNIT WEIGHT (pcf)	UNDRAINED STRENGTH		EFFECTIVE STRENGTH	
				COHESION (psf)	FRICTION ANGLE (degrees)	COHESION (psf)	FRICTION ANGLE (degrees)
1		New Rock Fill	135	-	-	50	38
2		New Dredged Fill	100	-	-	50	30
3		Eroded Bay Mud	97	140 + 10H	-	-	-
4		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Slope Stability Analyses Results
Coarse Beach on Eroded Marsh
Step 3: Second Lift Rock Fill (LS)

Hultgren - Tillis Engineers | Project No. 923.01 | Plate No. E-16



STABILITY MODEL MATERIAL PROPERTIES							
UNIT NO.	LAYER COLOR	MATERIAL TYPE	UNIT WEIGHT (pcf)	UNDRAINED STRENGTH		EFFECTIVE STRENGTH	
				COHESION (psf)	FRICTION ANGLE (degrees)	COHESION (psf)	FRICTION ANGLE (degrees)
1		New Rock Fill	135	-	-	50	38
2		New Dredged Fill	100	-	-	50	30
3		Eroded Bay Mud	97	140 + 10H	-	-	-
4		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

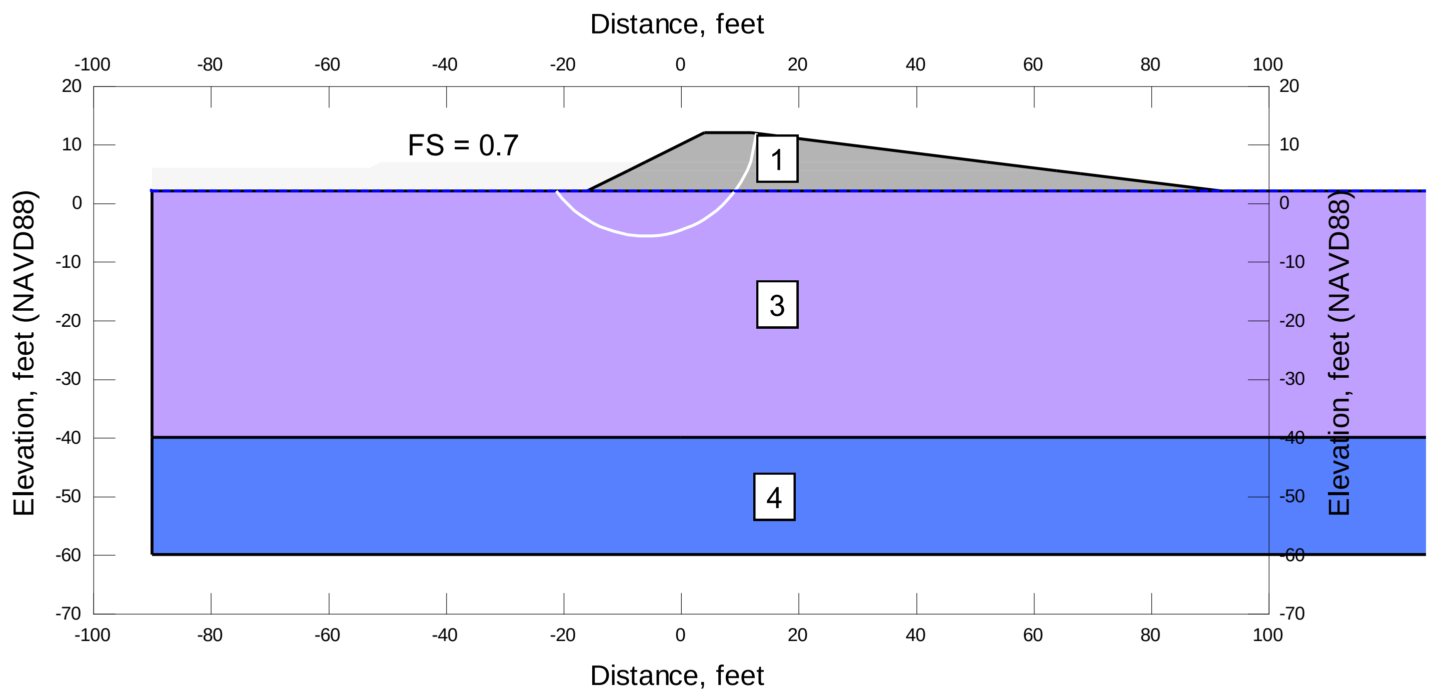
Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Slope Stability Analyses Results
Coarse Beach on Eroded Marsh
Step 3: Second Lift Rock Fill (WS)

Hultgren - Tillis Engineers | Project No. 923.01 | Plate No. E-17

Landside

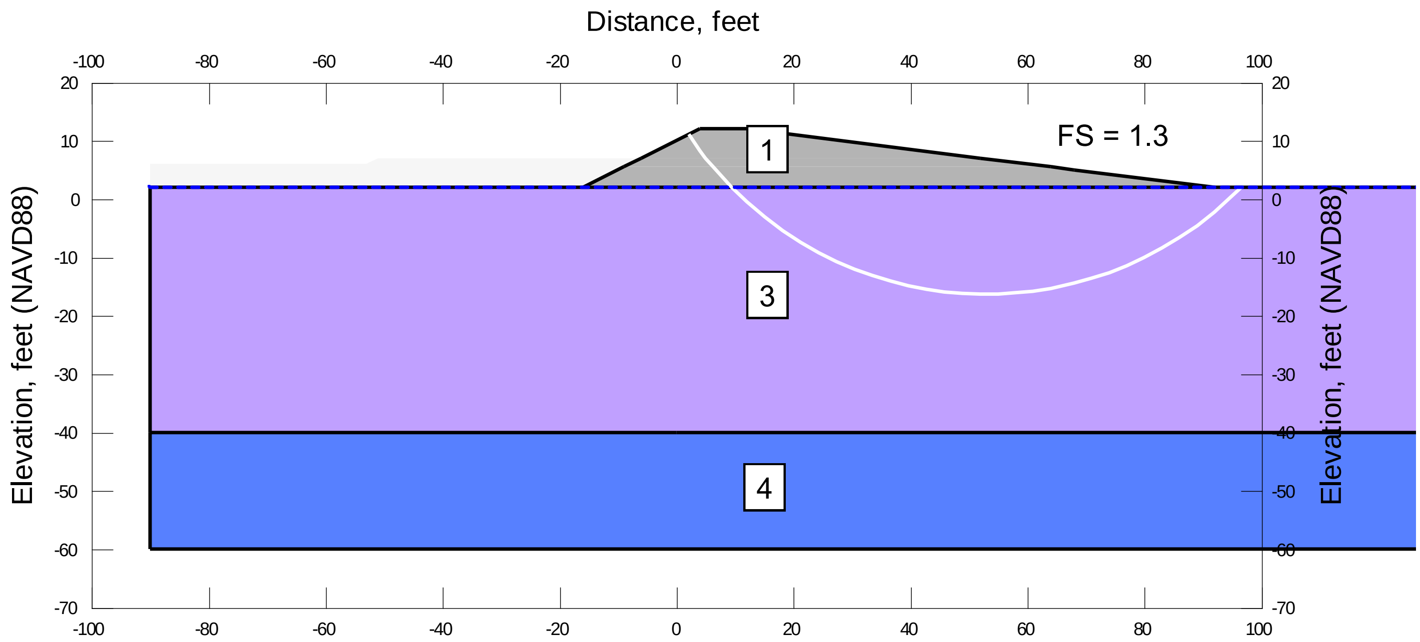
Waterside



STABILITY MODEL MATERIAL PROPERTIES							
UNIT NO.	LAYER COLOR	MATERIAL TYPE	UNIT WEIGHT (pcf)	UNDRAINED STRENGTH		EFFECTIVE STRENGTH	
				COHESION (psf)	FRICTION ANGLE (degrees)	COHESION (psf)	FRICTION ANGLE (degrees)
1		New Rock Fill	135	-	-	50	38
2		New Dredged Fill	100	-	-	50	30
3		Virgin Bay Mud	97	100 + 10H	-	-	-
4		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

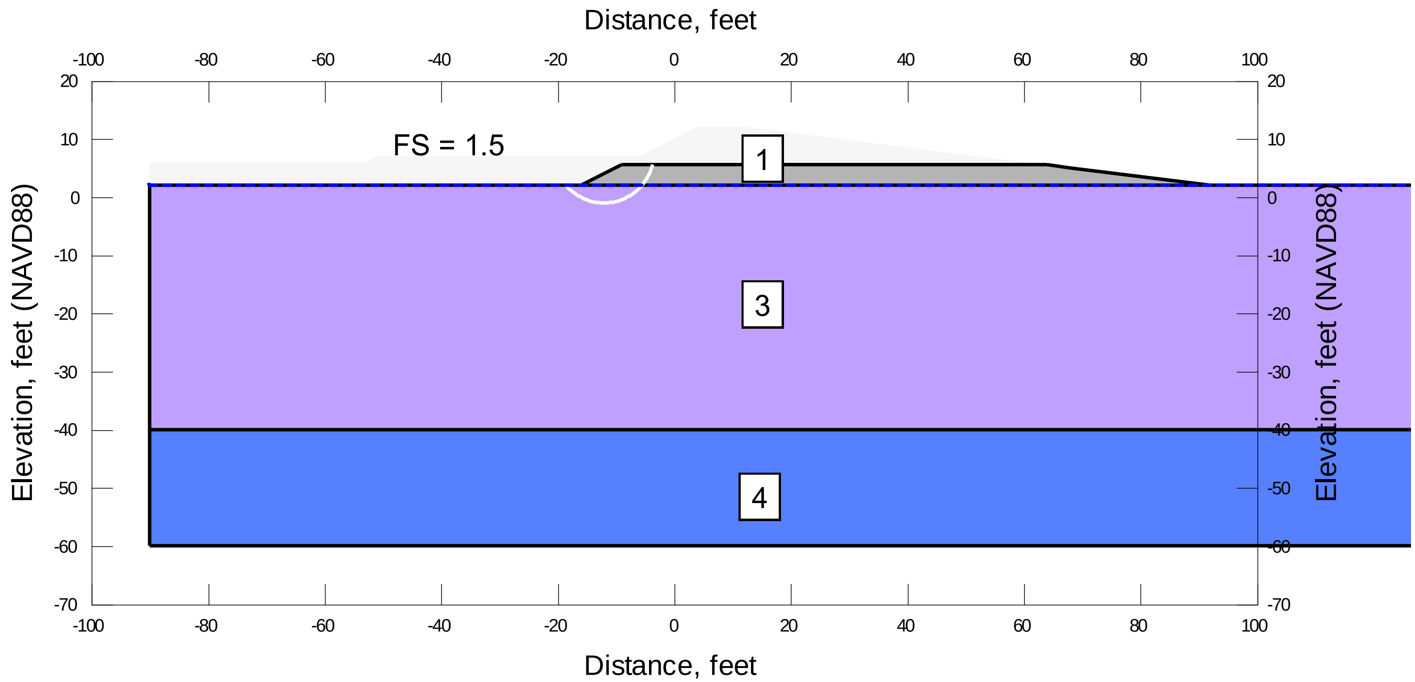
Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**Slope Stability Analyses Results Coarse Beach on Virgin Marsh Full Section (LS)**	
Hultgren - Tillis Engineers	Project No. 923.01	Plate No. E-18



STABILITY MODEL MATERIAL PROPERTIES							
UNIT NO.	LAYER COLOR	MATERIAL TYPE	UNIT WEIGHT (pcf)	UNDRAINED STRENGTH		EFFECTIVE STRENGTH	
				COHESION (psf)	FRICTION ANGLE (degrees)	COHESION (psf)	FRICTION ANGLE (degrees)
1		New Rock Fill	135	-	-	50	38
2		New Dredged Fill	100	-	-	50	30
3		Virgin Bay Mud	97	100 + 10H	-	-	-
4		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**Slope Stability Analyses Results** **Coarse Beach on Virgin Marsh** **Full Section (WS)**	
Hultgren - Tillis Engineers	Project No. 923.01	Plate No. E-19



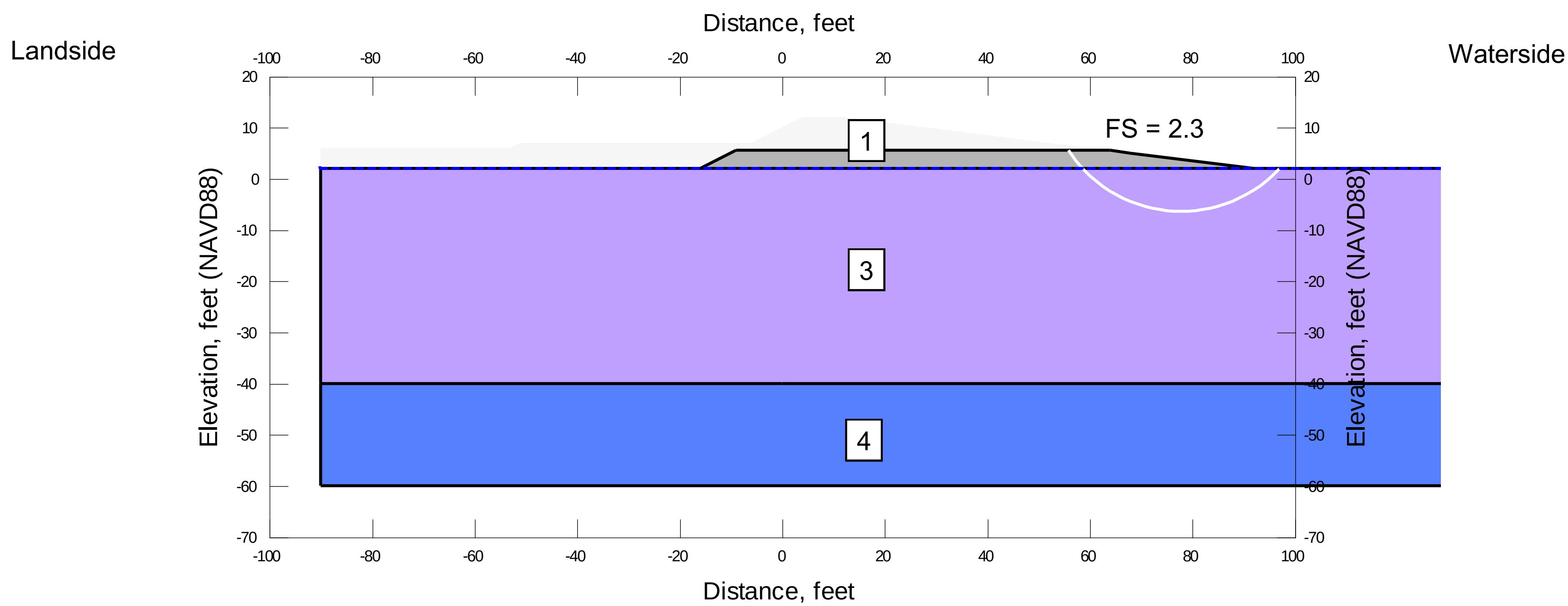
STABILITY MODEL MATERIAL PROPERTIES							
UNIT NO.	LAYER COLOR	MATERIAL TYPE	UNIT WEIGHT (pcf)	UNDRAINED STRENGTH		EFFECTIVE STRENGTH	
				COHESION (psf)	FRICTION ANGLE (degrees)	COHESION (psf)	FRICTION ANGLE (degrees)
1		New Rock Fill	135	-	-	50	38
2		New Dredged Fill	100	-	-	50	30
3		Virgin Bay Mud	97	100 + 10H	-	-	-
4		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Slope Stability Analyses Results
Coarse Beach on Virgin Marsh
Step 1: First Lift Rock Fill (LS)

Hultgren - Tillis Engineers | Project No. 923.01 | Plate No. E-20



STABILITY MODEL MATERIAL PROPERTIES							
UNIT NO.	LAYER COLOR	MATERIAL TYPE	UNIT WEIGHT (pcf)	UNDRAINED STRENGTH		EFFECTIVE STRENGTH	
				COHESION (psf)	FRICTION ANGLE (degrees)	COHESION (psf)	FRICTION ANGLE (degrees)
1		New Rock Fill	135	-	-	50	38
2		New Dredged Fill	100	-	-	50	30
3		Virgin Bay Mud	97	100 + 10H	-	-	-
4		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

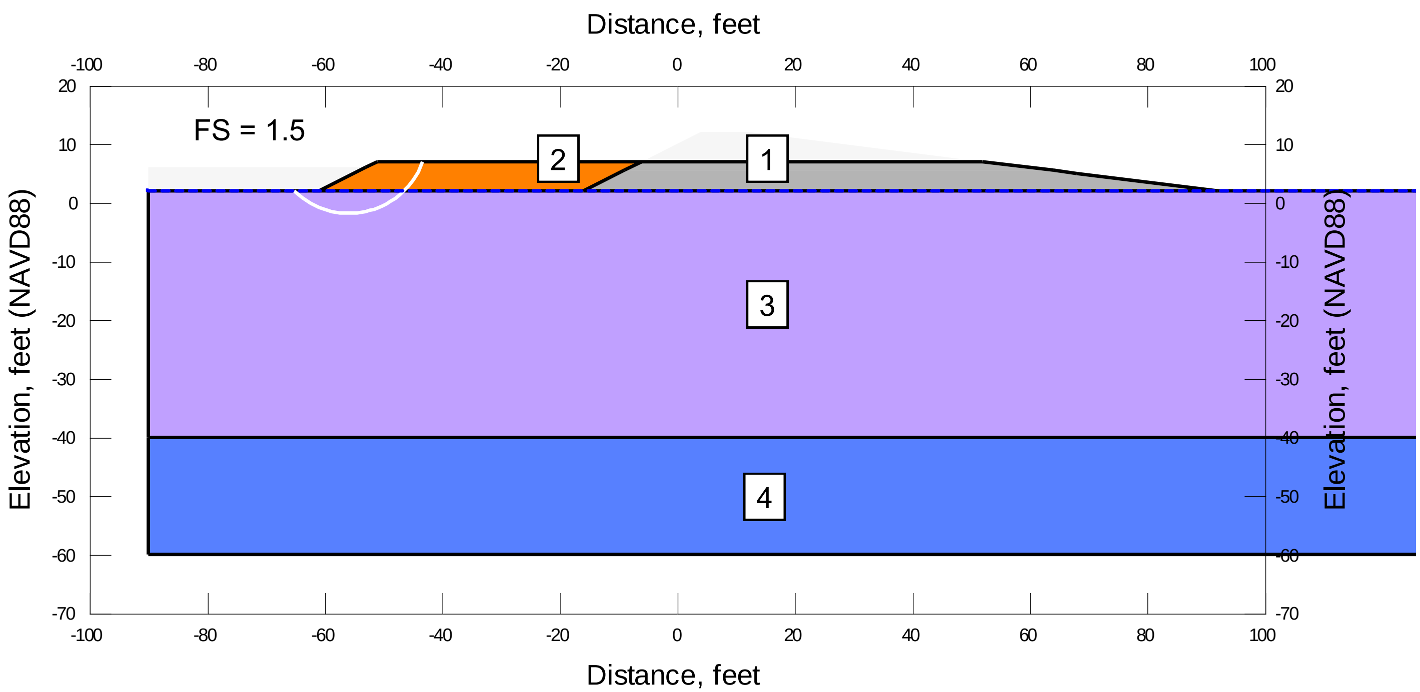
Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Slope Stability Analyses Results
Coarse Beach on Virgin Marsh
Step 1: First Lift Rock Fill (WS)

Hultgren - Tillis Engineers | Project No. 923.01 | Plate No. E-21

Landside

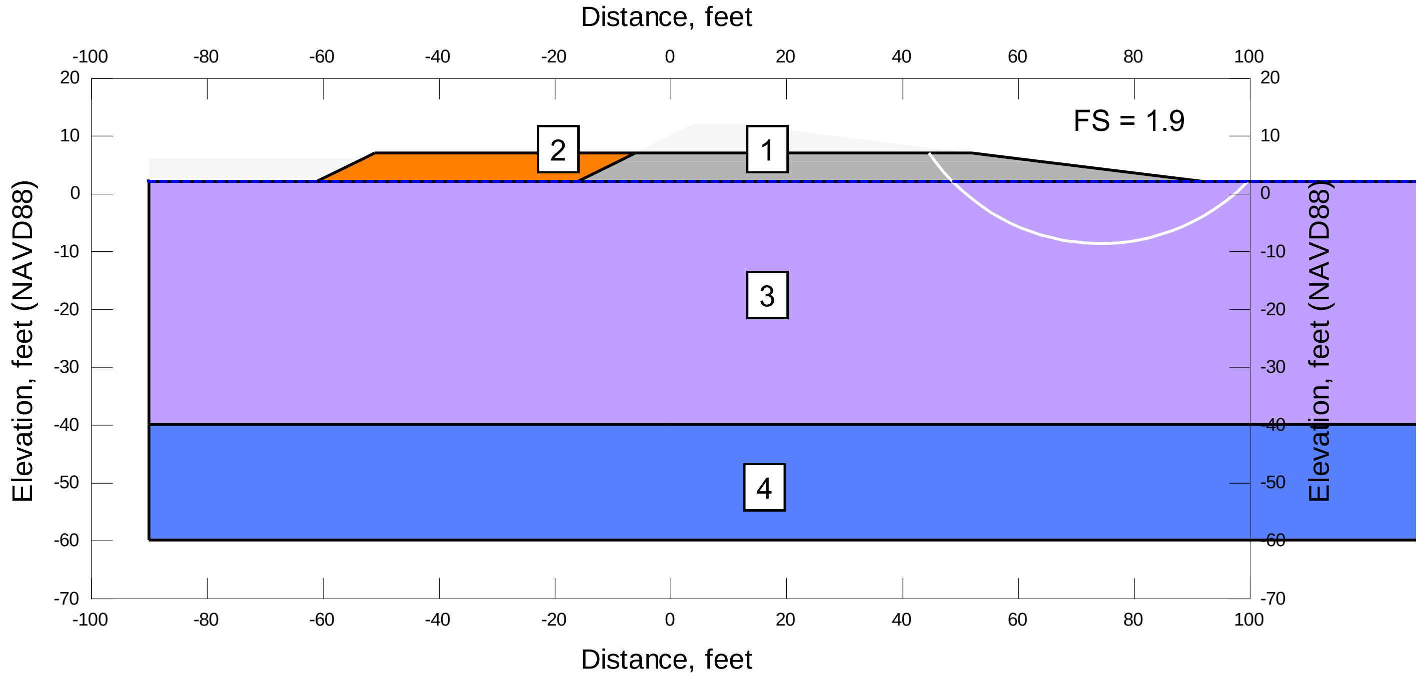
Waterside



STABILITY MODEL MATERIAL PROPERTIES							
UNIT NO.	LAYER COLOR	MATERIAL TYPE	UNIT WEIGHT (pcf)	UNDRAINED STRENGTH		EFFECTIVE STRENGTH	
				COHESION (psf)	FRICTION ANGLE (degrees)	COHESION (psf)	FRICTION ANGLE (degrees)
1		New Rock Fill	135	-	-	50	38
2		New Dredged Fill	100	-	-	50	30
3		Virgin Bay Mud	97	100 + 10H	-	-	-
4		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**Slope Stability Analyses Results** **Coarse Beach on Virgin Marsh** **Step 2: Buttress Landside Slope (LS)**
Hultgren - Tillis Engineers	Project No. 923.01 / Plate No. E-22



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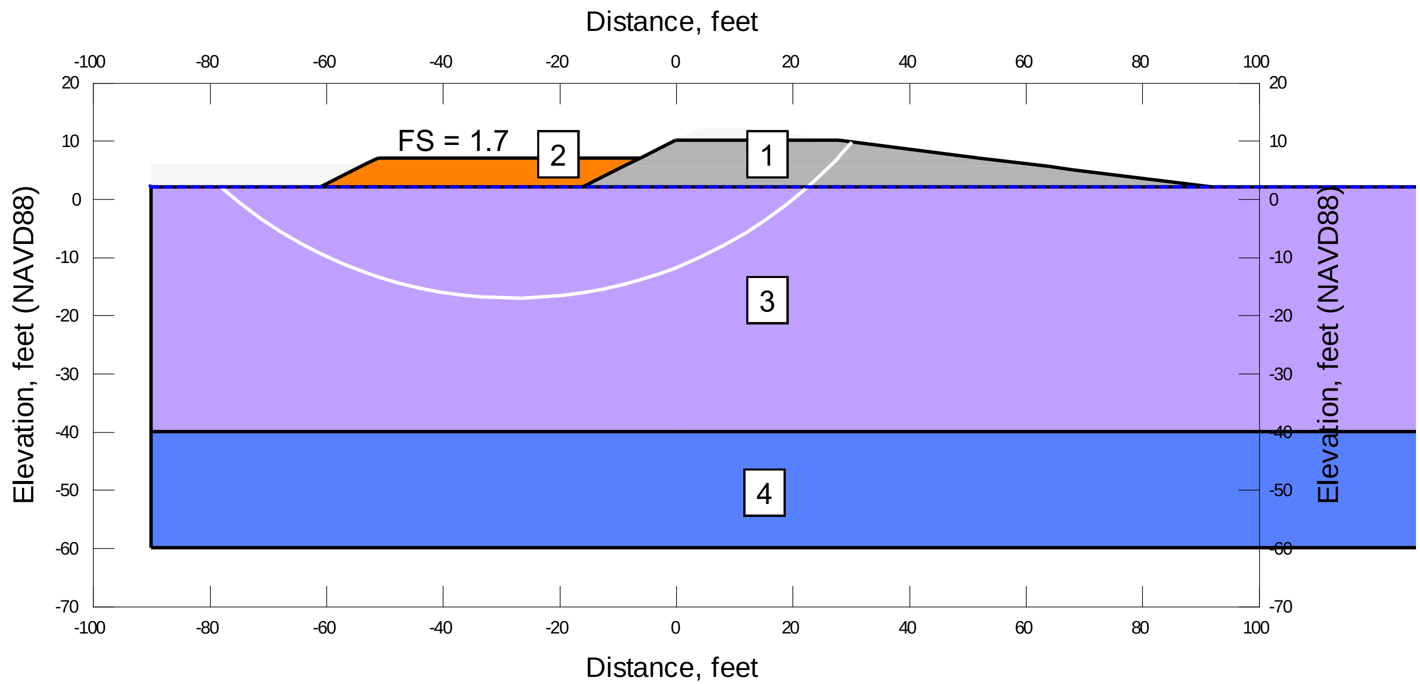
1		New Rock Fill	135	-	-	50	38
2		New Dredged Fill	100	-	-	50	30
3		Virgin Bay Mud	97	100 + 10H	-	-	-
4		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**Slope Stability Analyses Results** **Coarse Beach on Virgin Marsh** **Step 2: Buttress Landside Slope (WS)**
Hultgren - Tillis Engineers	Project No. 923.01 / Plate No. E-23



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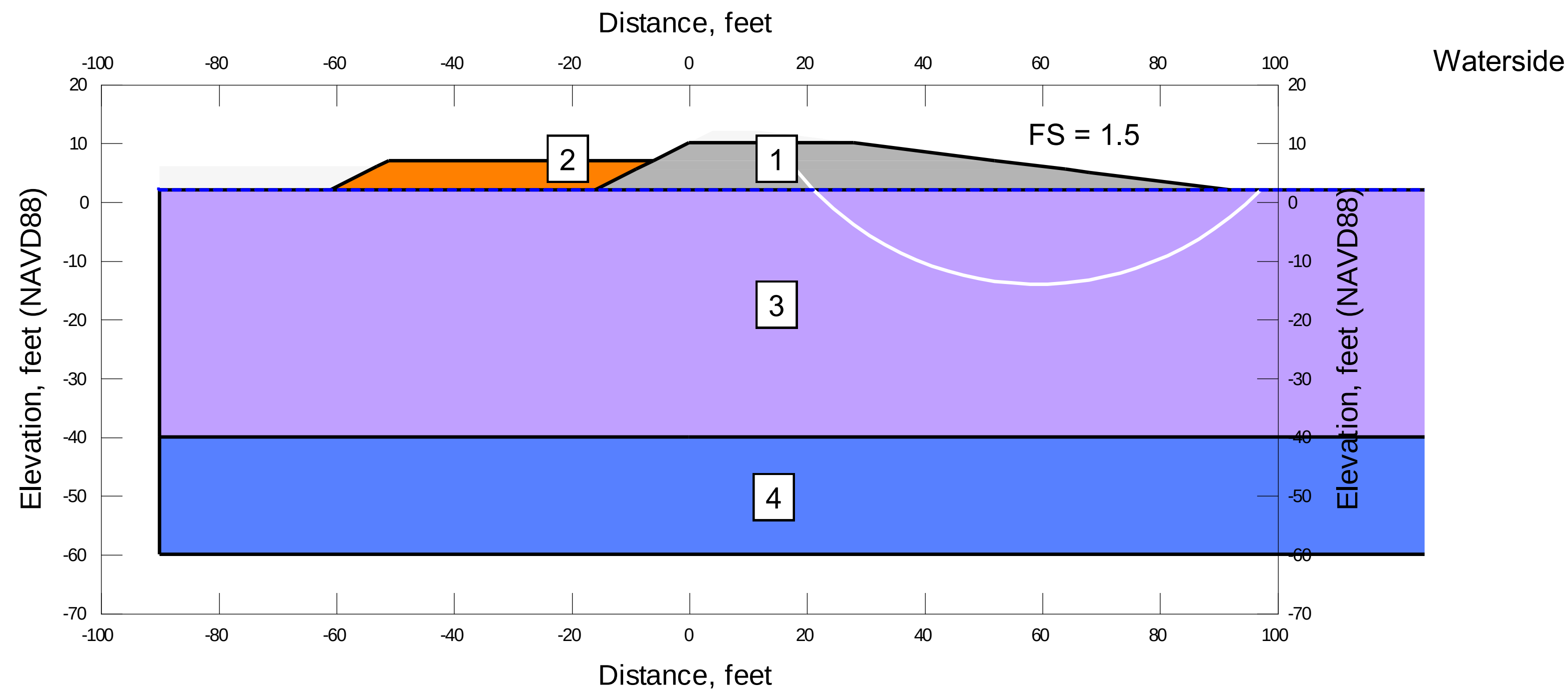
1		New Rock Fill	135	-	-	50	38
2		New Dredged Fill	100	-	-	50	30
3		Virgin Bay Mud	97	100 + 10H	-	-	-
4		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Slope Stability Analyses Results
Coarse Beach on Virgin Marsh
Step 3: Second Lift Rock Fill (LS)

Hultgren - Tillis Engineers | Project No. 923.01 | Plate No. E-24



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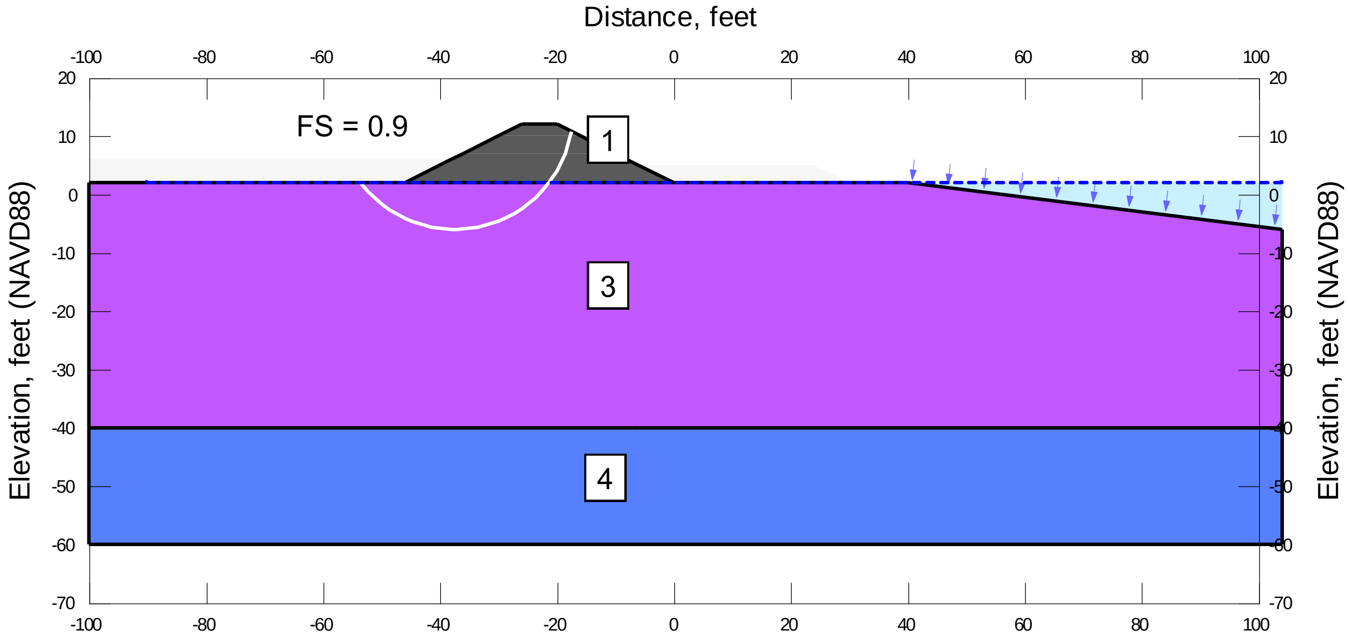
				COHESION (psf)	FRICTION ANGLE (degrees)	COHESION (psf)	FRICTION ANGLE (degrees)
1		New Rock Fill	135	-	-	50	38
2		New Dredged Fill	100	-	-	50	30
3		Virgin Bay Mud	97	100 + 10H	-	-	-
4		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Slope Stability Analyses Results
Coarse Beach on Virgin Marsh
Step 3: Second Lift Rock Fill (WS)

Hultgren - Tillis Engineers	Project No. 923.01	Plate No. E-25



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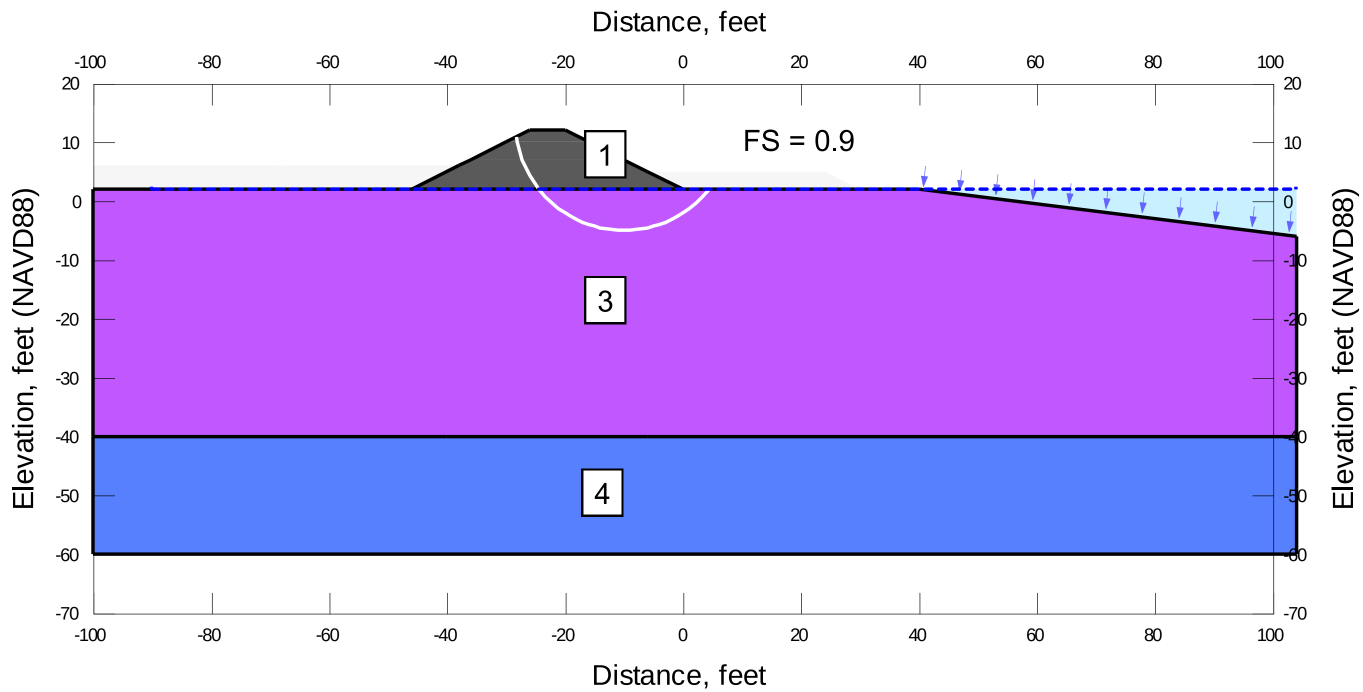
				COHESION (psf)	FRICTION ANGLE (degrees)	COHESION (psf)	FRICTION ANGLE (degrees)
1		New Rock Fill	135	-	-	50	38
2		New Dredged Fill	100	-	-	50	30
3		Eroded Bay Mud	97	140 + 10H	-	-	-
4		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**Slope Stability Analyses Results** **Rock Jetty on Eroded Marsh** **Full Section (LS)**
Hultgren - Tillis Engineers	Project No. 923.01 / Plate No. E-26



STABILITY MODEL MATERIAL PROPERTIES							
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				COHESION (psf)	FRICTION ANGLE (degrees)	COHESION (psf)	FRICTION ANGLE (degrees)
1		New Rock Fill	135	-	-	50	38
2		New Dredged Fill	100	-	-	50	30
3		Eroded Bay Mud	97	140 + 10H	-	-	-
4		Stiff Clay	120	1,000	-	-	-

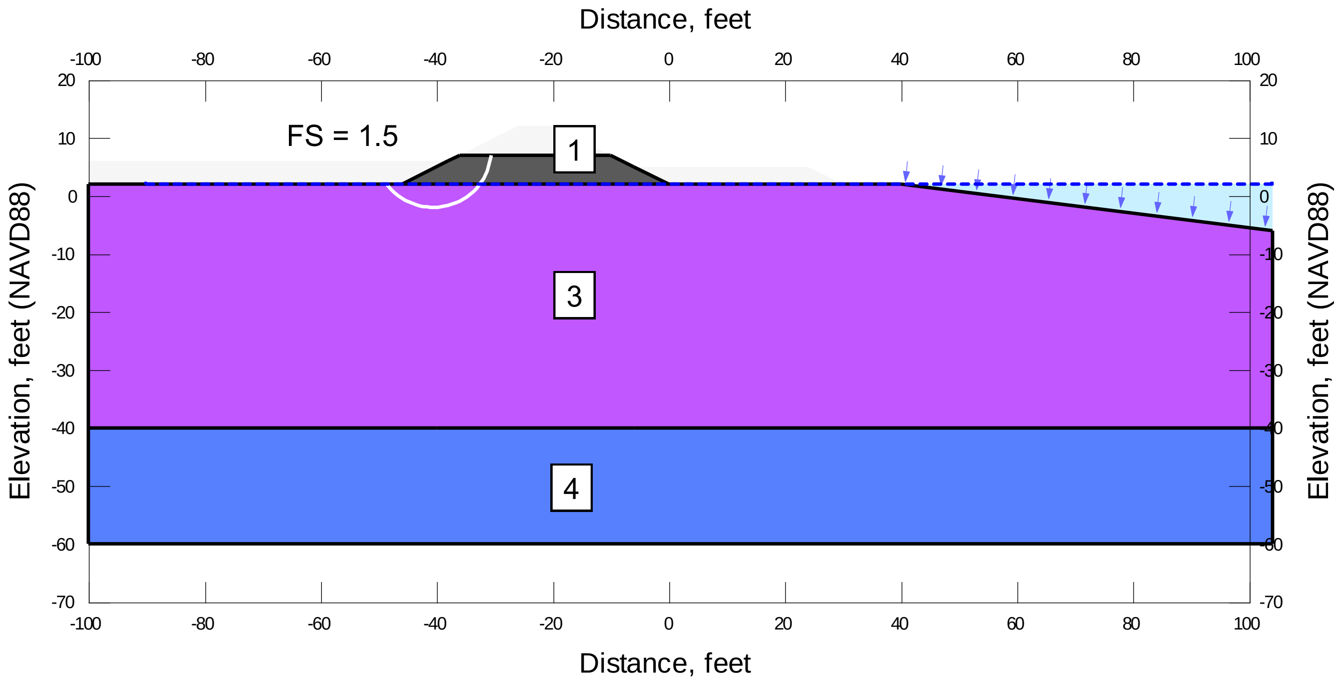
Note:
H is depth below top of unit layer.

Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**Slope Stability Analyses Results Rock Jetty on Eroded Marsh Full Section (WS)**

Hultgren - Tillis Engineers	Project No. 923.01	Plate No. E-27

Landside

Waterside



STABILITY MODEL MATERIAL PROPERTIES							
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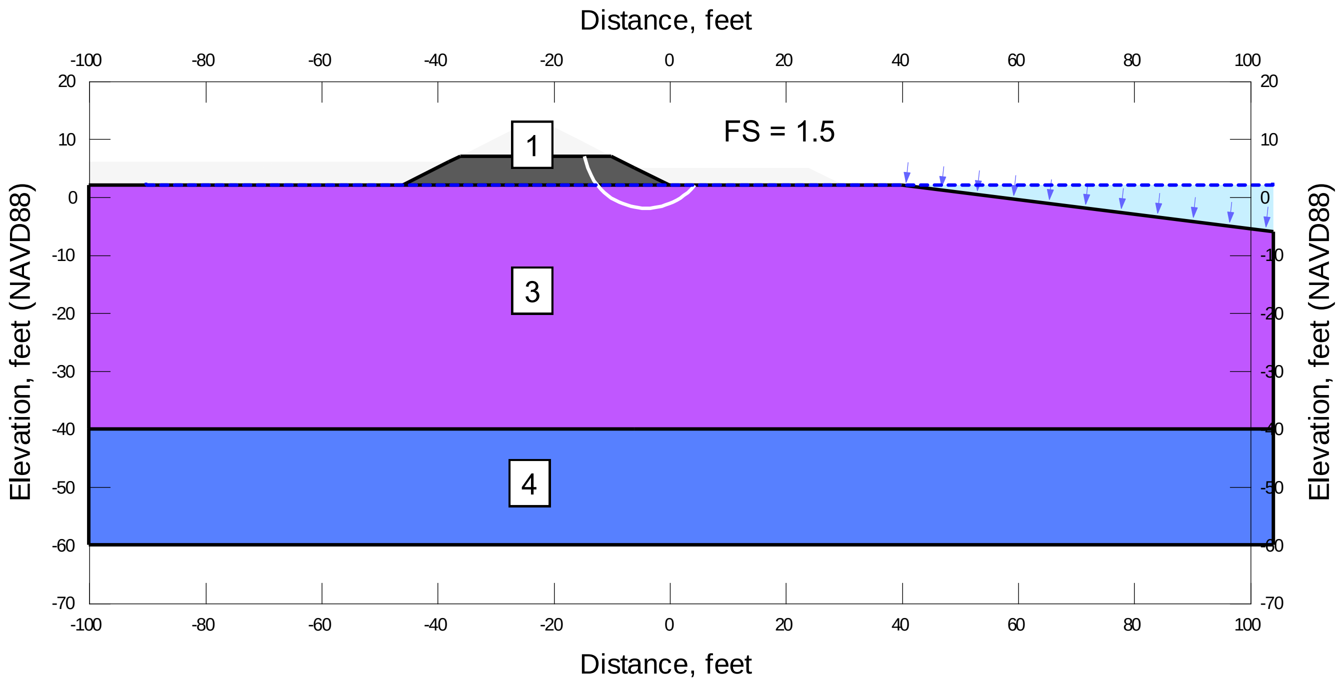
				COHESION (psf)	FRICTION ANGLE (degrees)	COHESION (psf)	FRICTION ANGLE (degrees)
1		New Rock Fill	135	-	-	50	38
2		New Dredged Fill	100	-	-	50	30
3		Eroded Bay Mud	97	140 + 10H	-	-	-
4		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Slope Stability Analyses Results
Rock Jetty on Eroded Marsh
Step 1: First Lift Rock Fill (LS)

Hultgren - Tillis Engineers | Project No. 923.01 | Plate No. E-28



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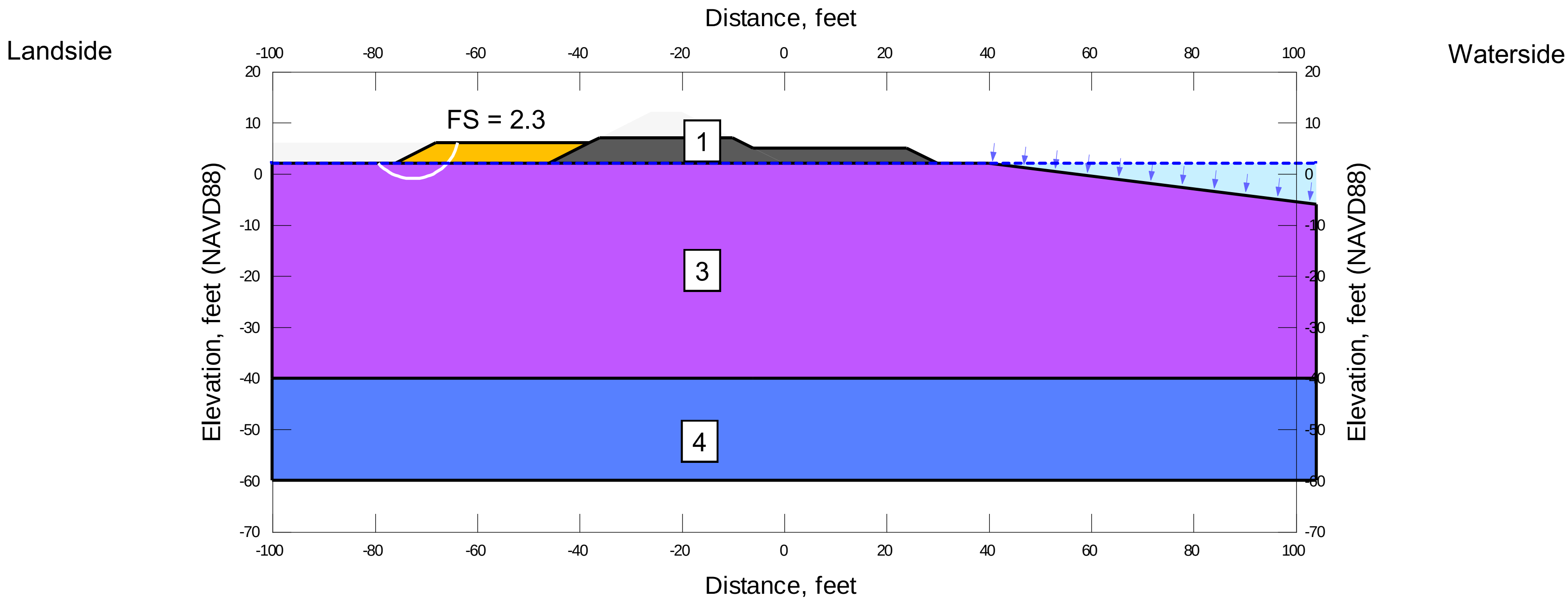
1		New Rock Fill	135	-	-	50	38
2		New Dredged Fill	100	-	-	50	30
3		Eroded Bay Mud	97	140 + 10H	-	-	-
4		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Slope Stability Analyses Results
Rock Jetty on Eroded Marsh
Step 1: First Lift Rock Fill (WS)

Hultgren - Tillis Engineers | Project No. 923.01 | Plate No. E-29



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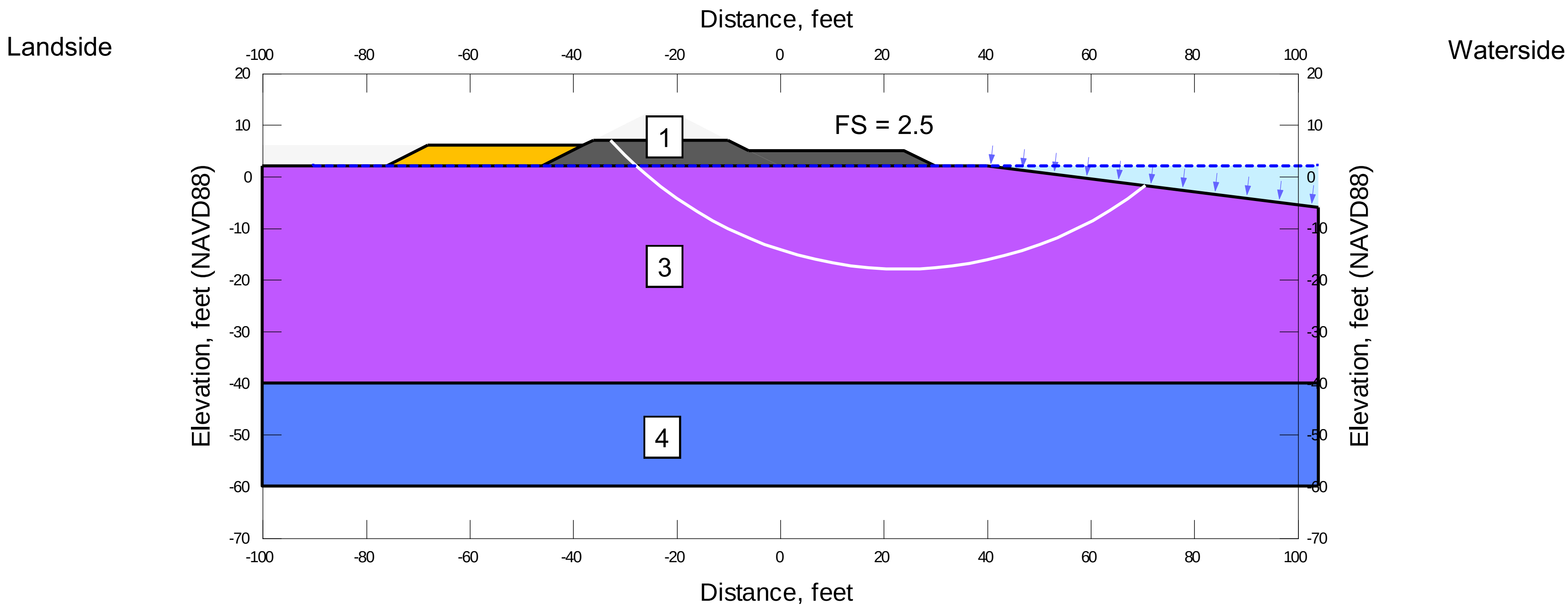
1		New Rock Fill	135	-	-	50	38
2		New Dredged Fill	100	-	-	50	30
3		Eroded Bay Mud	97	140 + 10H	-	-	-
4		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**Slope Stability Analyses Results** **Rock Jetty on Eroded Marsh** **Step 2: Buttress Slopes (LS)**	
Hultgren - Tillis Engineers	Project No. 923.01	Plate No. E-30



STABILITY MODEL MATERIAL PROPERTIES							
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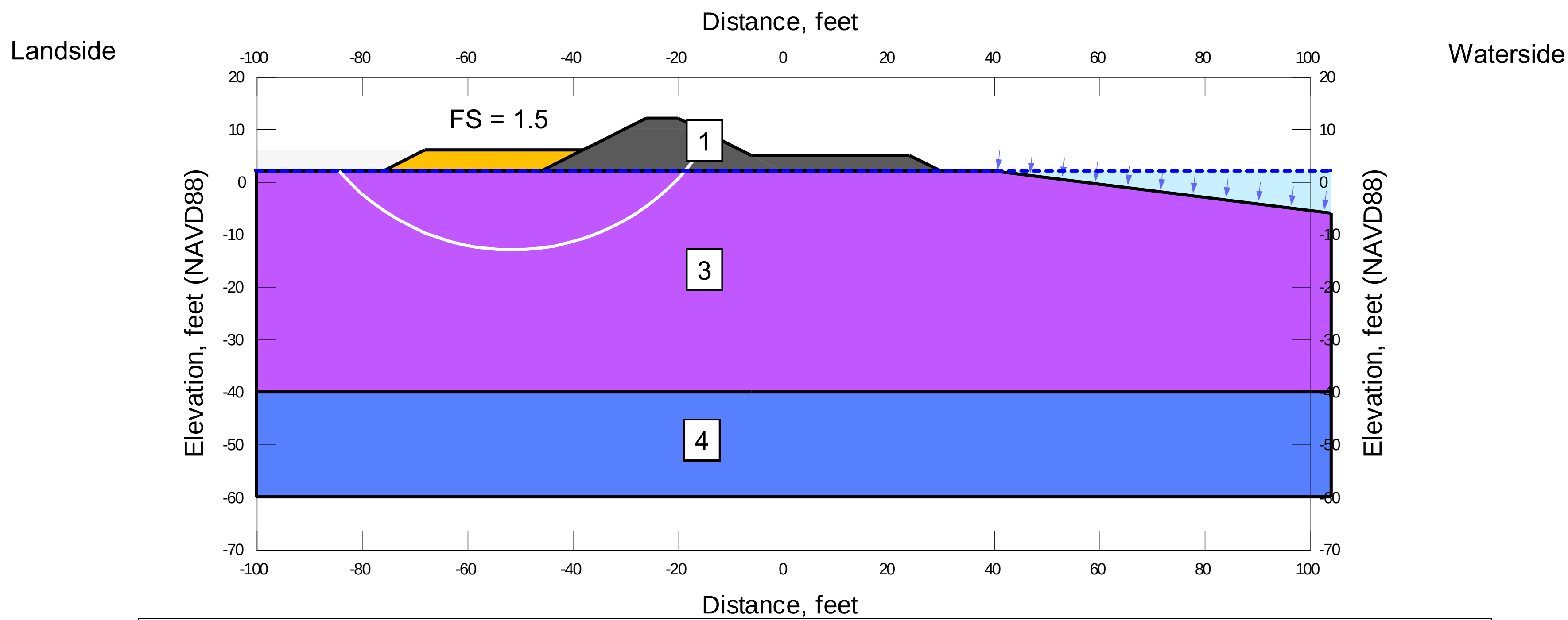
				COHESION (psf)	FRICTION ANGLE (degrees)	COHESION (psf)	FRICTION ANGLE (degrees)
1		New Rock Fill	135	-	-	50	38
2		New Dredged Fill	100	-	-	50	30
3		Eroded Bay Mud	97	140 + 10H	-	-	-
4		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Slope Stability Analyses Results
Rock Jetty on Eroded Marsh
Step 2: Buttress Slopes (WS)

Hultgren - Tillis Engineers	Project No. 923.01	Plate No. E-31



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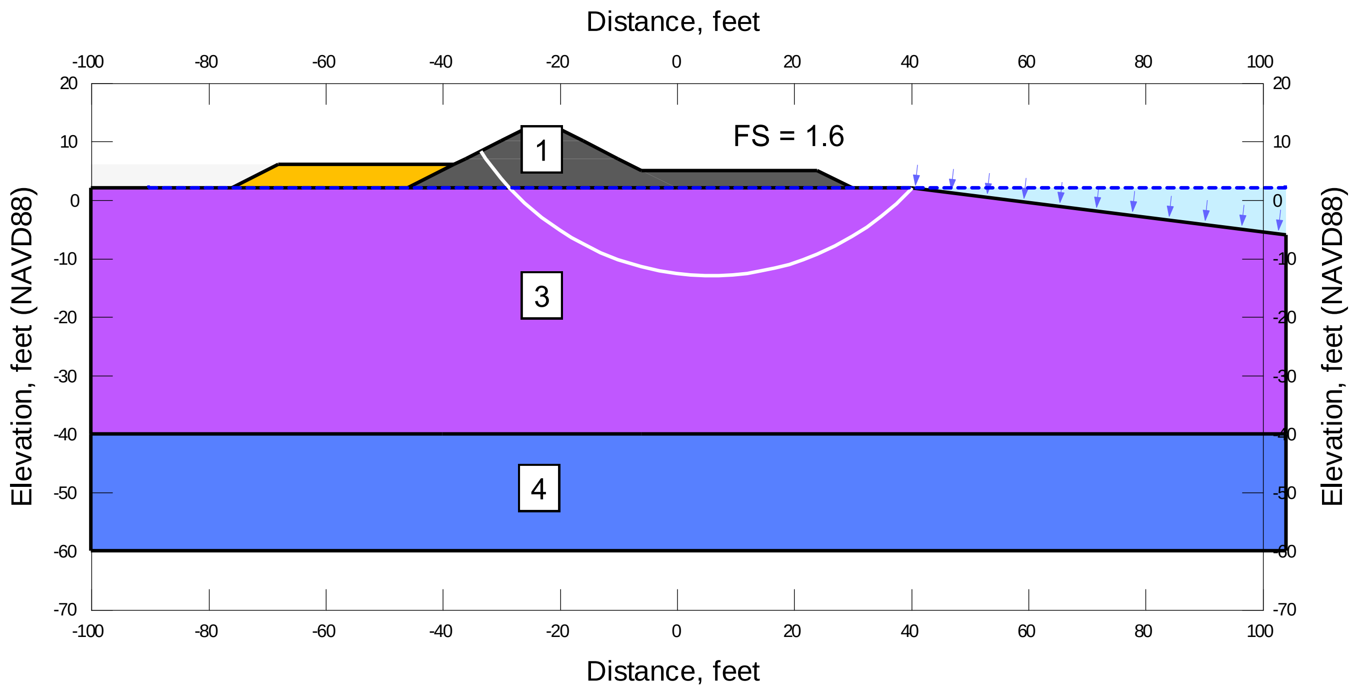
1		New Rock Fill	135	-	-	50	38
2		New Dredged Fill	100	-	-	50	30
3		Eroded Bay Mud	97	140 + 10H	-	-	-
4		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**Slope Stability Analyses Results** **Rock Jetty on Eroded Marsh** **Step 3: Second Lift Rock Fill (LS)**
Hultgren - Tillis Engineers	Project No. 923.01 / Plate No. E-32

Landside

Waterside



STABILITY MODEL MATERIAL PROPERTIES							
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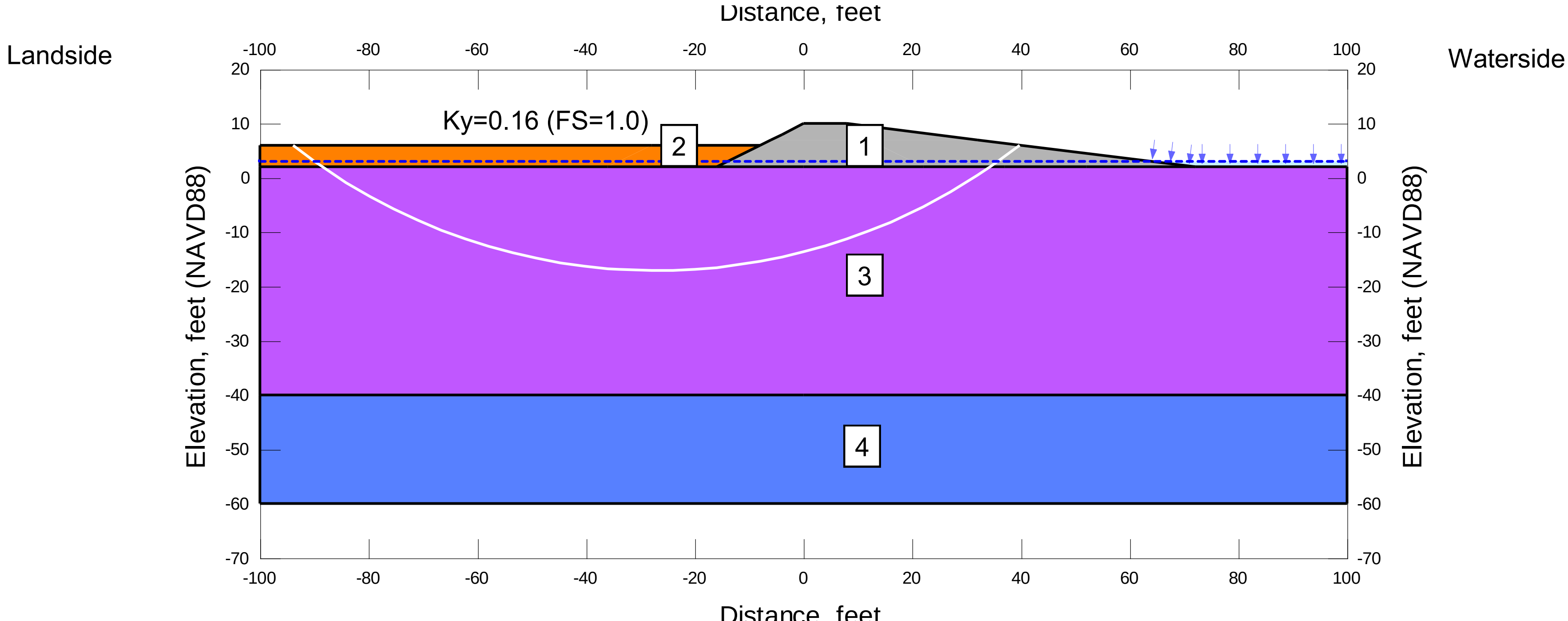
1		New Rock Fill	135	-	-	50	38
2		New Dredged Fill	100	-	-	50	30
3		Eroded Bay Mud	97	140 + 10H	-	-	-
4		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Slope Stability Analyses Results
Rock Jetty on Eroded Marsh
Step 3: Second Lift Rock Fill (WS)

Hultgren - Tillis Engineers | Project No. 923.01 | Plate No. E-33



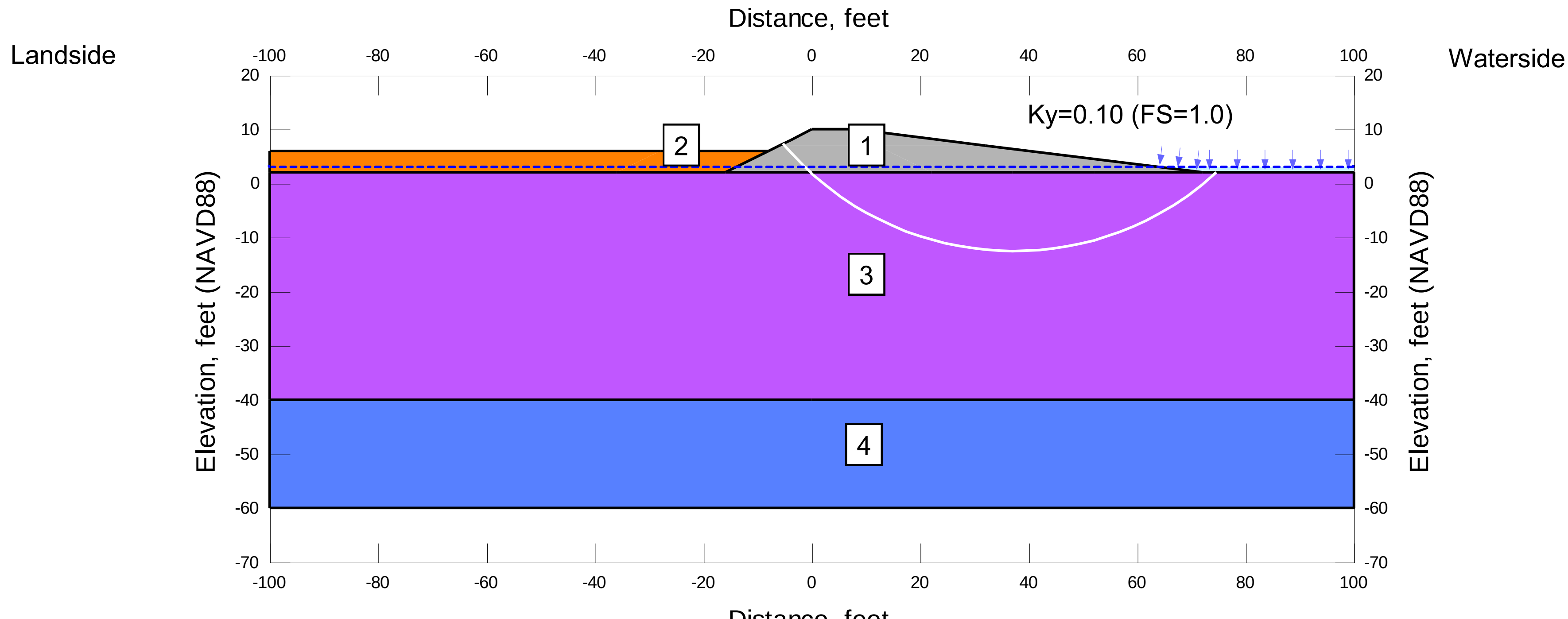
STABILITY MODEL MATERIAL PROPERTIES							
UNIT NO.	LAYER COLOR	MATERIAL TYPE	UNIT WEIGHT (pcf)	UNDRAINED STRENGTH		EFFECTIVE STRENGTH	
				COHESION (psf)	FRICTION ANGLE (degrees)	COHESION (psf)	FRICTION ANGLE (degrees)
1		New Rock Fill	135	-	-	50	38
2		New Dredged Fill	100	-	-	50	30
3		Eroded Bay Mud	97	140 + 10H	-	-	-
4		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Slope Stability Analyses Results
Coarse Beach on Eroded Marsh
Pseudo-Static (LS)

Hultgren - Tillis Engineers | Project No. 923.01 | Plate No. E-34



STABILITY MODEL MATERIAL PROPERTIES							
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1		New Rock Fill	135	-	-	50	38
2		New Dredged Fill	100	-	-	50	30
3		Eroded Bay Mud	97	140 + 10H	-	-	-
4		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

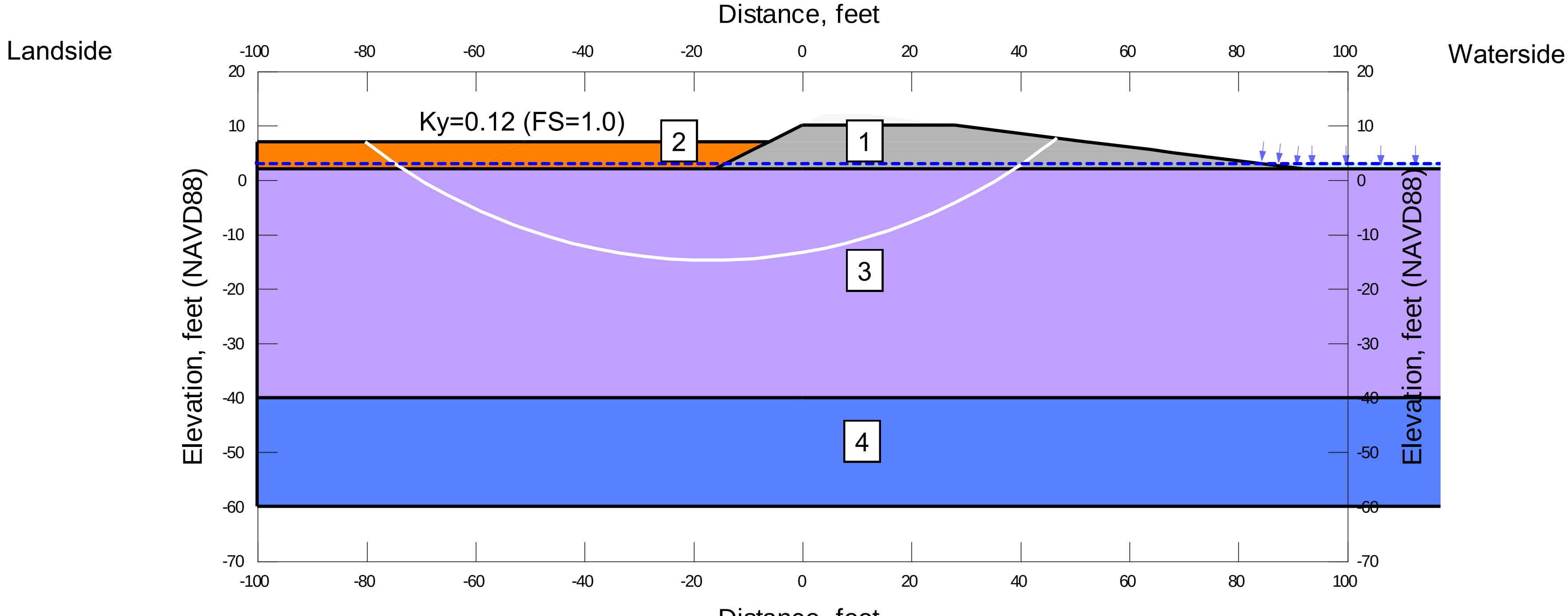
Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Slope Stability Analyses Results
Coarse Beach on Eroded Marsh
Pseudo-Static (WS)

Hultgren - Tillis Engineers

Project No. 923.01

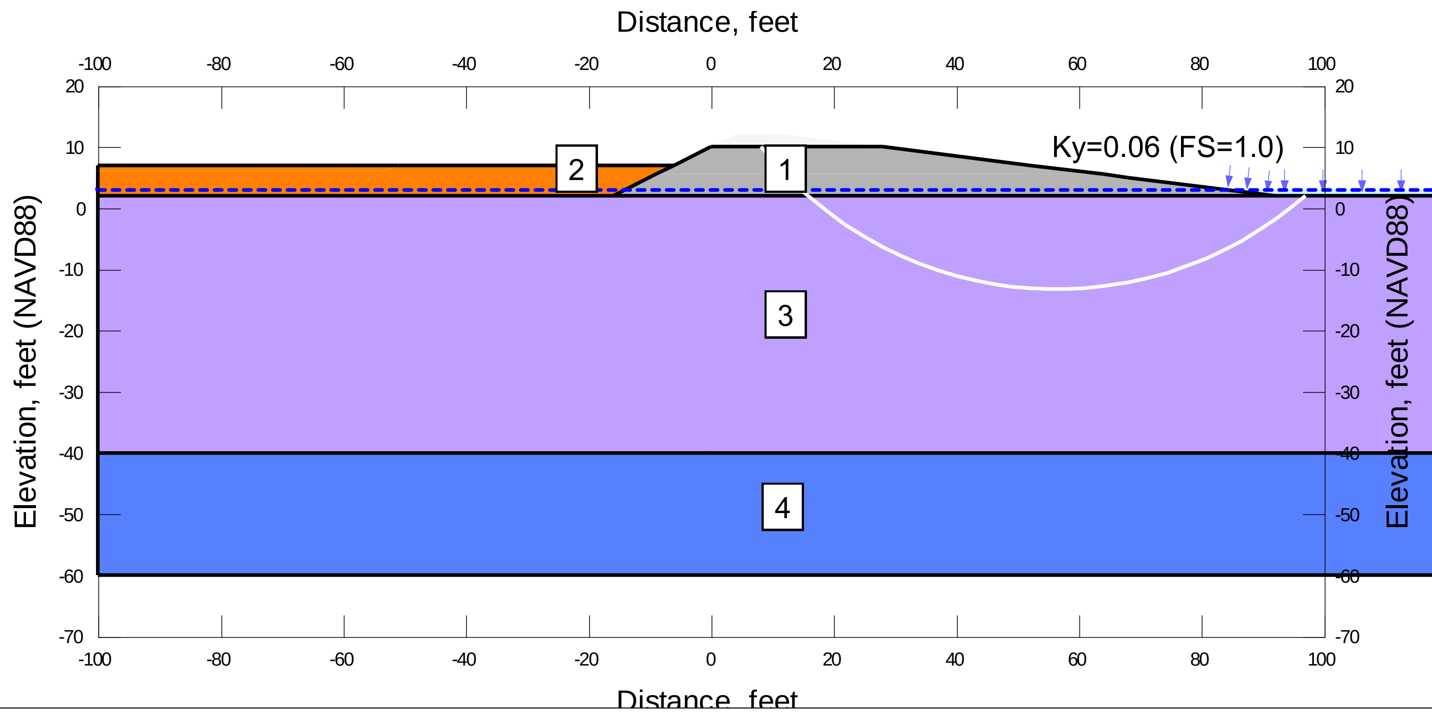
Plate No. E-35



STABILITY MODEL MATERIAL PROPERTIES							
UNIT NO.	LAYER COLOR	MATERIAL TYPE	UNIT WEIGHT (pcf)	UNDRAINED STRENGTH		EFFECTIVE STRENGTH	
				COHESION (psf)	FRICTION ANGLE (degrees)	COHESION (psf)	FRICTION ANGLE (degrees)
1		New Rock Fill	135	-	-	50	38
2		New Dredged Fill	100	-	-	50	30
3		Virgin Bay Mud	97	100 + 10H	-	-	-
4		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**Slope Stability Analyses Results Coarse Beach on Virgin Marsh Pseudo-Static (LS)**	
Hultgren - Tillis Engineers	Project No. 923.01	Plate No. E-36



STABILITY MODEL MATERIAL PROPERTIES							
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				COHESION (psf)	FRICTION ANGLE (degrees)	COHESION (psf)	FRICTION ANGLE (degrees)
1		New Rock Fill	135	-	-	50	38
2		New Dredged Fill	100	-	-	50	30
3		Virgin Bay Mud	97	100 + 10H	-	-	-
4		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

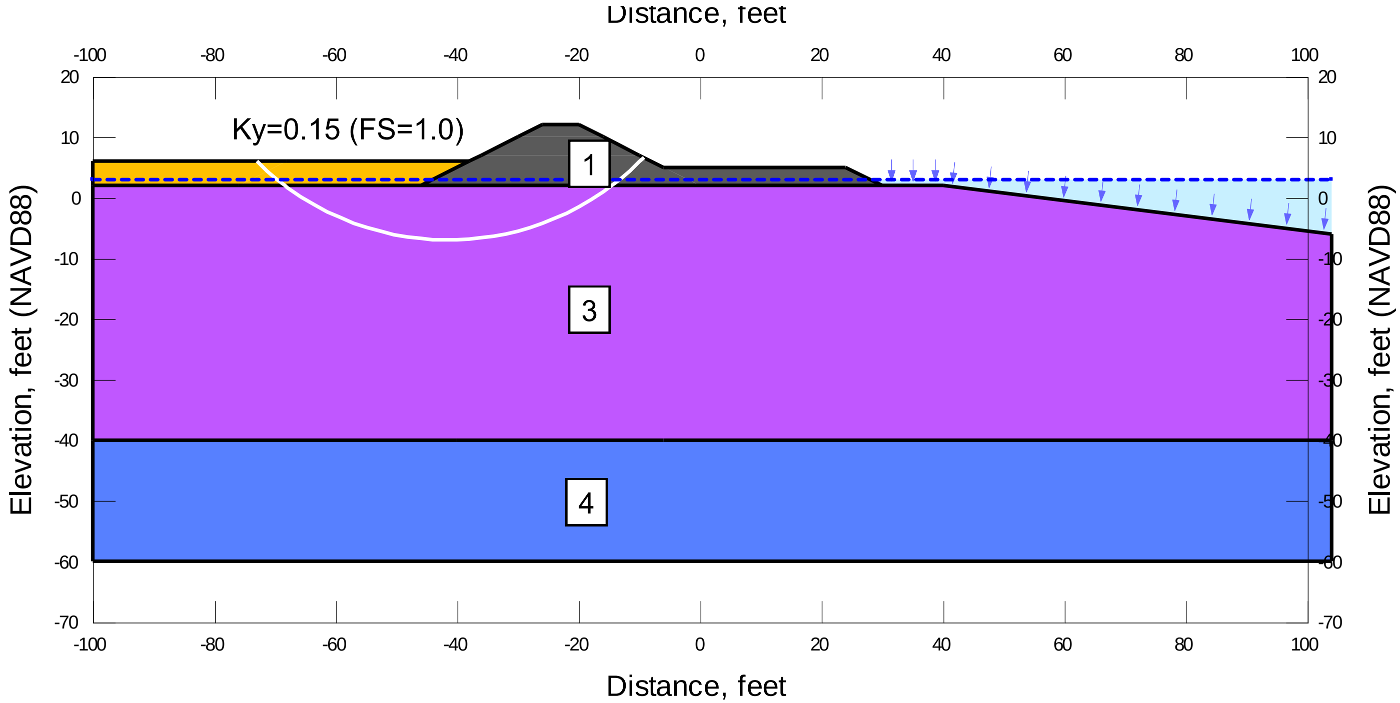
Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Slope Stability Analyses Results
Coarse Beach on Virgin Marsh
Pseudo-Static (WS)

Hultgren - Tillis Engineers | Project No. 923.01 | Plate No. E-37

Landside

Waterside



STABILITY MODEL MATERIAL PROPERTIES							
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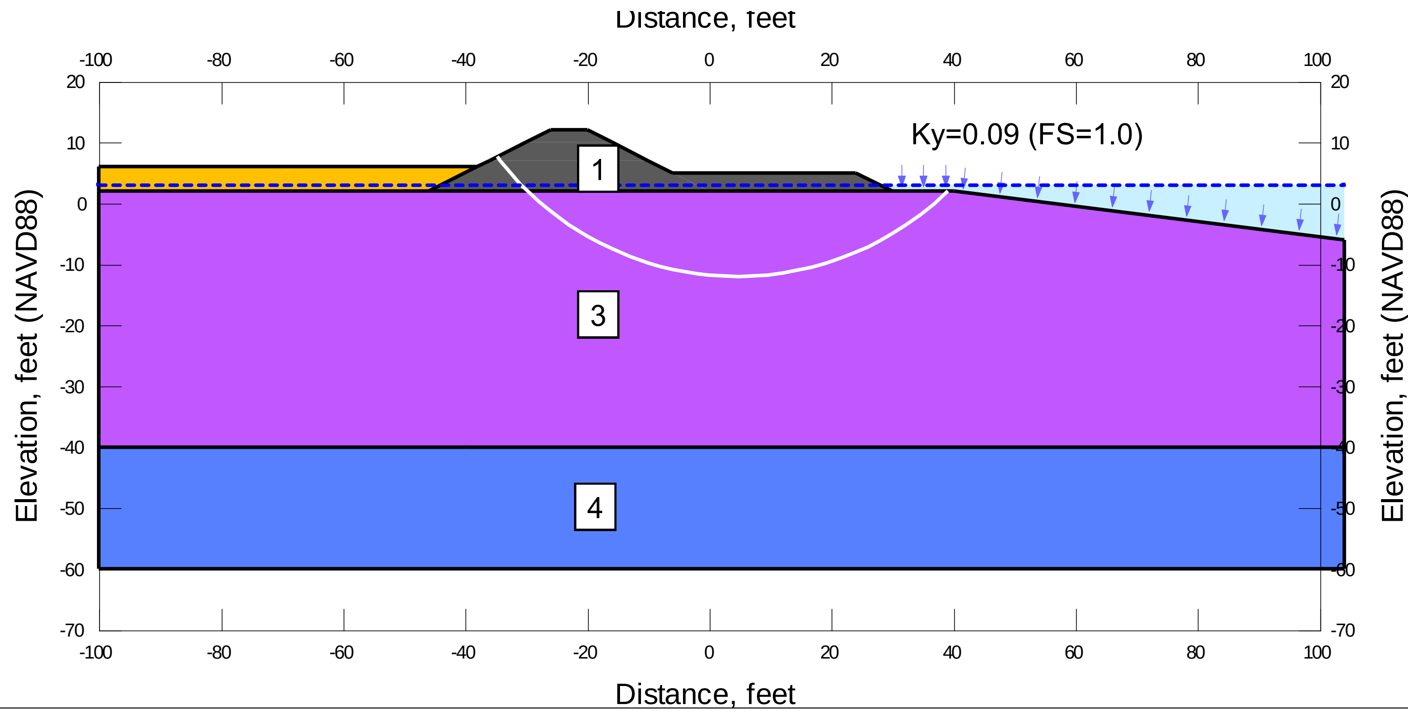
1		New Rock Fill	135	-	-	50	38
2		New Dredged Fill	100	-	-	50	30
3		Eroded Bay Mud	97	140 + 10H	-	-	-
4		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

Restore Eroded and Diked Marsh Tiscornia Marsh Habitat Restoration San Rafael, California	**Slope Stability Analyses Results** **Rock Jetty on Eroded Marsh** **Pseudo-Static (LS)**

Hultgren - Tillis Engineers	Project No. 923.01	Plate No. E-38



STABILITY MODEL MATERIAL PROPERTIES							
UNIT NO.	LAYER COLOR	MATERIAL TYPE	UNIT WEIGHT (pcf)	UNDRAINED STRENGTH		EFFECTIVE STRENGTH	
				COHESION (psf)	FRICTION ANGLE (degrees)	COHESION (psf)	FRICTION ANGLE (degrees)
1		New Rock Fill	135	-	-	50	38
2		New Dredged Fill	100	-	-	50	30
3		Eroded Bay Mud	97	140 + 10H	-	-	-
4		Stiff Clay	120	1,000	-	-	-

Note:
H is depth below top of unit layer.

Restore Eroded and Diked Marsh
Tiscornia Marsh Habitat Restoration
San Rafael, California

Slope Stability Analyses Results
Rock Jetty on Eroded Marsh
Pseudo-Static (WS)

Hultgren - Tillis Engineers | Project No. 923.01 | Plate No. E-39

APPENDIX F

Seismic Deformation

F-1. SEISMIC DEFORMATION

A. Levee Embankment

We analyzed seismic deformation using the simplified procedure presented in URS Guidance Document (2015) for Urban Levee Evaluations. The analysis is based on an earthquake with a 200-year return period and a moment magnitude of 7.0. The estimated peak horizontal acceleration (PHA) from the USGS Unified Hazard Tool calculator at the site is about 0.34g. Deformations can be estimated based on the ratio of the yield acceleration (k_y) to the maximum seismic coefficient (k_{max}). Using a symmetric levee geometry and assuming a potential deep shear surface, we estimate that k_{max} is 0.22g. For a k_y of 0.08, the analysis suggests that the calculated k_y to k_{max} ratio will result in horizontal deformations of 0.5 feet or less for the offset and setback levee. As a qualitative estimate of loss of freeboard, the vertical deformation of the levee crest is estimated as 0.7 times the total deformations. The resulting estimated vertical deformations is about 4-inches or less for the new levee crest. Some regrading of the levee embankment may be needed following a large earthquake.

B. Tidal Marsh Area

We also analyzed seismic deformation for the coarse beach and rock jetty using the simplified procedure presented in URS Guidance Document (2015) for Urban Levee Evaluations. Using a symmetric berm geometry and assuming a potential deep shear surface, we estimate that k_{max} is 0.22g. For a k_y of 0.09, the analysis suggests that the calculated k_y to k_{max} ratio will result in horizontal deformations of 0.4 feet or less. As a qualitative estimate of loss of freeboard, the vertical deformation of the berm crest is estimated as 0.7 times the total deformations. The resulting estimated vertical deformations is about 3-inches or less for the new coarse beach and rock jetty berm crest on eroded marsh areas. For a k_y of 0.09, the resulting estimated vertical deformations is about 8-inches or less for the new coarse beach or virgin marsh areas. Some regrading of the berms may be needed following a large earthquake.

Conceptual Design Report

TISCORNIA MARSH HABITAT RESTORATION AND SEA LEVEL RISE ADAPTATION PROJECT

Prepared for
Marin Audubon Society

July 2018

TISCORNIA MARSH HABITAT RESTORATION AND SEA LEVEL RISE ADAPTATION PROJECT

Prepared for
Marin Audubon Society

July 2018

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Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation Project

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ACRONYMS

Acronym	Definition
BAC	Bay Area Coastal Study
BCDC	San Francisco Bay Conservation and Development Commission
BFE	Base Flood Elevation
Canal	San Rafael Creek Canal
CCC	California Coastal Commission
CEQA	California Environmental Quality Act
CIMIS	California Irrigation Management Information System
CoSMoS	Coastal Storm Modeling System
DEM	Digital Elevation Model
DMMO	Dredged Material Management Office
EFH	Essential Fish Habitat
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
ITP	Incidental Take Permit
LSAA	Lake and Streambed Alteration Agreement
MAS	Marin Audubon Society
MLLW	Mean Lower-Low Water
MLW	Mean Low Water
MSL	Mean Sea Level
MTL	Mean Tidal Level
MHW	Mean High Water
MHHW	Mean Higher-High Water
MSFCMA	Magnuson-Stevens Fishery Management and Conservation Act
NAVD88	North American Vertical Datum of 1983
NEPA	National Environmental Protection Act
NHPA	National Historic Preservation Act of 1966
NMFS	National Marine Fisheries Service
NRC	National Resource Council
NOAA	National Oceanographic and Atmospheric Administration

Acronym	Definition
OCOF	Our Coast Our Future
OPC	California Ocean Protection Council
PG&E	Pacific Gas and Electric
RIRA	California Ridgway's Rail
RTK-GPS	Real-Time Kinetic Global Positioning System
RWQCM	Regional Water Quality Control Board
SHPO	State Historic Preservation Office
SLC	State Lands Commission
SCC	California State Coastal Conservancy
SMHM	Salt Marsh Harvest Mouse
SWAN	Simulating Waves and Nearshore software developed by TU Delft
SWEL	Still Water Elevation Level
TWL	Total Water Level
WARMER	Wetland Accretion Rate Model for Ecosystem Resilience
WDR	Water Discharge Requirements
WHAFIS	Wave Height Analysis for Flood Insurance Studies
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

1. INTRODUCTION

Marin Audubon Society (MAS) acquired Tiscornia Marsh, located at the mouth of the San Rafael Canal, in 2008. The 20-acre Tiscornia Marsh property, which was donated by Mary Tiscornia, consists of vegetated marsh, mudflats, shoreline levee, and a 500-foot reach of public trail that connects segments of the Bay Trail (Figure 1). ESA is working with MAS to develop conceptual restoration designs for the marsh. There are currently two main concerns for the Tiscornia Marsh property. First, the tidal marshlands have experienced considerable erosion over the past 30 years, retreating as much as 200 feet, with approximately 3 acres lost. This erosion has resulted in the significant loss of habitat for the endangered Ridgway's rail and salt marsh harvest mouse, migratory shorebirds, and other important marsh wildlife. Second, the levee segment on the Tiscornia property is relatively low, and therefore at risk of overtopping during an extreme coastal flood event. Both of these conditions are expected to worsen in the coming decades as sea level rises.

MAS applied for, and was awarded a grant to develop nature-based design concepts to address sea level rise at Tiscornia Marsh. The grant is from the Marin Community Foundation and is administered by the California State Coastal Conservancy (SCC). The two primary project goals stated in the grant are:

- **Goal 1:** Prepare and choose a preferred alternative that utilizes nature-based sea-level adaptation strategies at Tiscornia Marsh for the bay and upland edges that provide this segment of the San Rafael shoreline with an adaptation solution consistent with City-wide strategies to be developed over the long term. Alternatives could be expanded to include some city property.

- **Goal 2:** Raise awareness of climate change and sea level rise issues within the adjacent disadvantaged community and other residents.

While the goals are related, this report primarily focuses on the first goal of developing a concept design for nature-based sea-level rise adaptation strategies at Tiscornia Marsh. The two main site components addressed by the concept design(s) are the existing marsh, including the eroding Bay edge, and the upland edge, including the levee.

Concept designs were developed under a multi-step process. We first articulated the multiple – sometimes competing – project objectives based on input from MAS, the City of San Rafael (City) and other stakeholders. Next, we developed a suite of concept design alternatives, based on an understanding of existing conditions, projected future conditions, and opportunities and constraints of the site. We evaluated these alternatives relative to how well they achieved the project objectives. We also considered input from the City, SCC and residents of the adjacent Canal neighborhood of San Rafael, as solicited through two public meetings. Ultimately MAS selected its preferred alternative to move forward toward final design and implementation.

As noted, public outreach to the Canal neighborhood and consideration of their input was an important part of this project. Douglas Mundo and ShoreUp Marin led the public outreach, with support from Stuart Siegel. Public outreach included two public meetings, and a community site walk. The first public meeting aimed to raise awareness of sea level rise, coastal flooding, and nature-based adaptation solutions. The second public meeting was focused on obtaining public input on the alternatives. Members of the public were also able to submit comments on the Tiscornia Marsh website created by Shore Up Marin and also on Marin Audubon Society's website.

This report has been prepared by Environmental Science Associates (ESA), with contributions from Stuart Siegel of Siegel Environmental, Barbara Salzman and Ed Nute of MAS, and Marilyn Latta of SCC.

Project need and objectives are listed in Section 2. Existing conditions are described in Section 3, and site opportunities and constraints are listed in Section 4. Development and evaluation of concept alternatives is described in Section 5, and alternatives are evaluated under Section 6. The preferred alternative is discussed in greater detail in Section 7, including anticipated construction methods, permitting considerations and next steps for implementation.

2. PROJECT NEED AND OBJECTIVES

This section provides an overview of the project need, and presents project goals and objectives.

2.1 Site Location

Tiscornia Marsh is located on the south bank of the San Rafael Canal in San Rafael, CA (**Figure 1**). Tiscornia Marsh is bounded on the west by the Al Boro Community Center and Pickleweed Park, a soccer field, and diked salt marsh, all of which are enclosed by a combined perimeter levee and trail. This property to the west is owned by the City of San Rafael. To the north is San Rafael Canal and to the east is the Bay, consisting of various parcels owned by the City of San Rafael, the federal government and the State of California (**Figure 2**). South of the Tiscornia Marsh levee is a vacant lot and children's playground (Schoen Park) owned by of the City of San Rafael, then Spinnaker Point Drive, other streets and residential areas of the Canal Community. The MAS-owned section of levee connects with the City's levee to the west and east. This levee continues to the south along the San Rafael Bay shoreline, past the Spinnaker and Baypoint developments and the Canalways property, then down to near the Richmond-San Rafael Bridge. This levee is part of the San Francisco Bay Trail.

2.2 Project Need

There are currently two main concerns for the Tiscornia Marsh property: loss of marsh through erosion, and the need for tidal flood protection for the adjacent Canal Community.

The tidal marsh has experienced considerable erosion along its bayward edge, losing approximately 3 acres over the last 30 years (**Figure 1**). Loss of the existing marsh reduces the amount of already scarce habitat for the Ridgway's rail, salt marsh harvest mouse, and other native wildlife, and diminishes its wave-dissipation benefits. The cause of this erosion appears to be primarily driven by wind waves, but may also be exacerbated by boat wake and periodic dredging of the San Rafael Canal. Under current conditions, erosion is expected to be ongoing, and erosion rates will likely increase as sea level rises. Given the current rate of erosion, this important remnant habitat may be completely lost in the coming decades if no action is taken.

The second concern is flood protection. The low-lying Canal Community adjacent to Tiscornia Marsh is currently at risk to coastal flooding, as is a significant extent of Central San Rafael that occupies what was once tidal marshlands and open bay. The area is currently in the Federal Emergency Management Agency (FEMA) 100-year floodplain (**Figure 3**), and will be increasingly susceptible to flood hazards as sea level rises, as described in Marin County's recent Marin Bay Waterfront Adaptation Vulnerability Evaluation (BayWAVE) (BVB, 2017).

SOURCE: Background Image from Google Earth

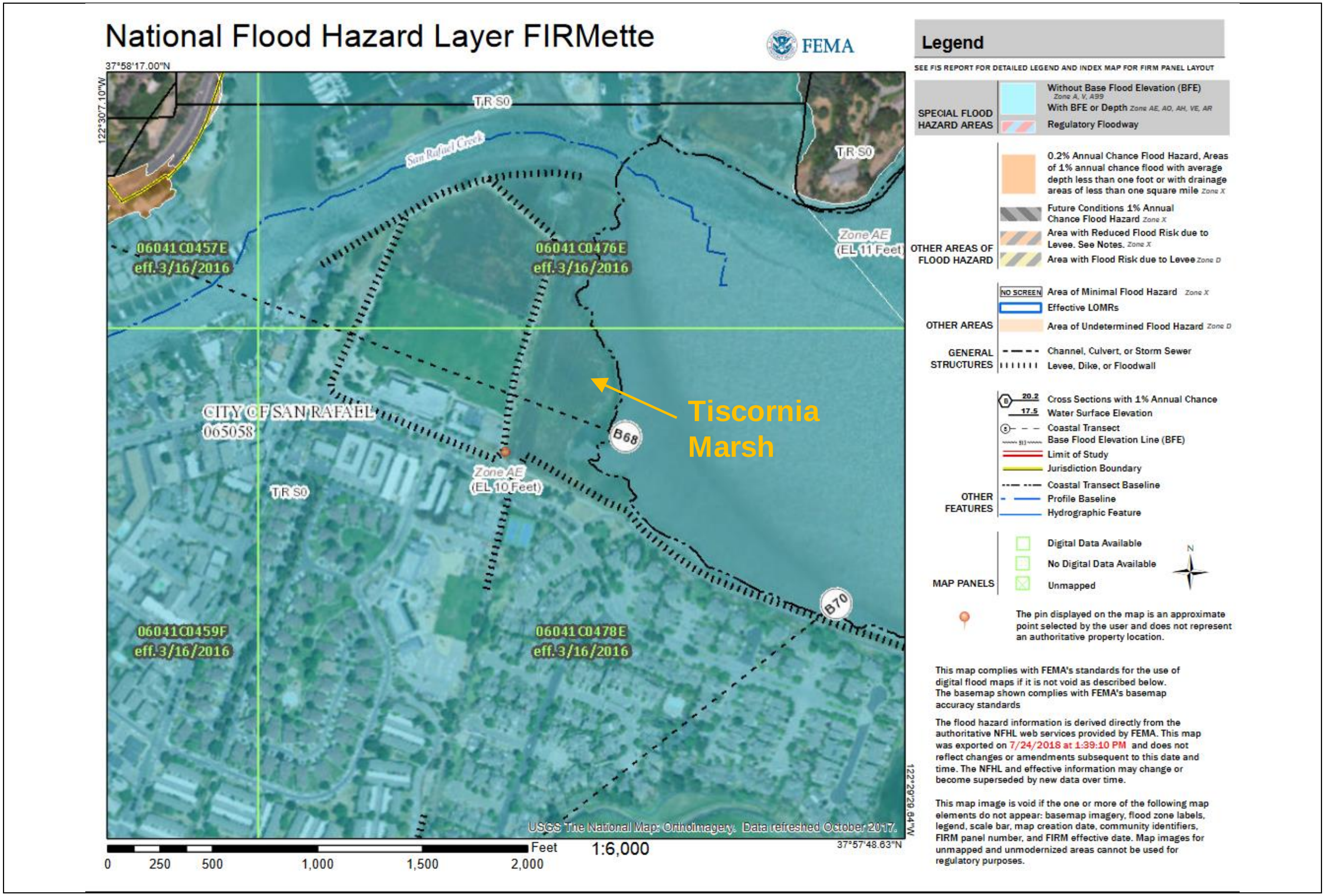
Tiscornia Marsh Habitat Restoration . D160888.0
Figure 1
Site Map

SOURCE: Map produced by Siegel Environmental with publically available parcel information

Tiscornia Marsh Habitat Restoration Arial **.D160888.0**

Figure 2

Parcel boundaries for Tiscornia Marsh and neighboring properties



SOURCE: FEMA

Tiscornia Marsh Habitat Restoration. D160888.00

Figure 3

FEMA 2016 Flood Insurance Rate (Flood Zone) Map

Much of the Canal District lies below high tide elevations, requiring pump stations to remove storm water and shoreline levees to protect against coastal flooding. The existing shoreline levee extends from Pickleweed Park, east along the San Rafael Canal and south along San Rafael Bay to the Marin Rod and Gun Club, and includes the Jean and John Starkweather Shoreline Park. Most of this levee was raised and improved with construction of the Bay Trail about 15 years ago, except for three segments: that at Tiscornia Marsh, around the adjacent diked marsh, and at Canalways, an 85-acre undeveloped, diked property further south. The levee segment on the Tiscornia property is relatively low compared to the rest of the levee, and in need of raising.

Both of these concerns – marsh loss and flood protection – are exacerbated by the current lack of a functional wetland-upland transition along the marsh's landward boundary. Currently the marsh transitions abruptly to the relatively steep levee embankment. A broad, gently-sloped wetland-upland transition would provide both ecological and flood benefits, including high tide refugia for native marsh wildlife, shoreline erosion protection through wave-dampening, and allow for marsh landward transgression under future sea level rise.

2.3 Goals and Objectives

One of the two primary goals of the grant is to "prepare and choose a preferred alternative that utilizes nature-based sea-level rise adaptation strategies at Tiscornia Marsh for the bay and upland edges that provide this segment of the San Rafael shoreline with an adaptation solution consistent with City-wide strategies to be developed over the long term. Alternatives could be expanded to include some city property."

Two main objectives to attain this goal are described in the grant:

- **Objective for Bay edge of marsh: "**Identify the setting and mechanisms leading to this marsh edge erosion and develop conceptual alternatives for shoreline stabilization and, if possible, accretion to rebuild lost marsh to enhance wildlife functions and retain tidal marsh for its shoreline protection functions. Marsh shoreline alternatives could include stabilization utilizing native plants, other natural materials and/or organisms where appropriate to the setting, and /or facilitate marsh accretion using sediment. Examples of natural systems from around Marin County and the bay will be drawn upon to identify possible alternatives."

- **Objective for upland edge of marsh: "**Develop a CEQA-ready preliminary design that will lead to construction of a raised "habitat" levee incorporating wetland-upland transition ecological features consistent with a high public use area. Levee design alternatives should include, to the extent possible, a gradually sloping levee that will allow for tidal waters to migrate up and provide a well-vegetated high-tide transition zone for the endangered species and other species that use the marsh. The top of the levee would be planned to connect with the Bay Trail."

To guide this study, we translated the above objectives into multiple design objectives that could be used to evaluate the concept alternatives. These more detailed objectives were formulated considering input from MAS, SCC, the Canal Community, the City, and other stakeholders.

The objectives for the vegetated marsh, including its eroding Bay edge, are to:

- Reduce current loss of vegetated marsh due to marsh edge erosion.
- Reduce future loss of vegetated marsh due to marsh "drowning" through sea level rise.
- Enhance habitat for endangered marsh species, including Ridgway's rail and salt marsh harvest mouse.
- As secondary ecological objectives, provide habitat for other wildlife, including shorebirds, ducks and other water birds, as well as native fish and oysters, including those species currently utilizing the site.
- Preserve and/or enhance the wave dissipation and flood protection functions of the marsh.
- Serve as a demonstration project for nature-based sea level rise adaptation strategies for San Francisco Bay.

The objectives for the upland edge, including the existing levee, are to:

- Improve ecological function of the outboard levee slope to benefit the endangered species and other native marsh and wetland-upland transition zone species.
- Contribute to local efforts to increase the level of flood protection for Central San Rafael by raising\reconfiguring the segment of levee adjacent to Tiscornia Marsh to reduce frequency of wave overtopping.
- Be compatible with adjacent public access uses, including the Bay Trail on the levee top and the City park/playground on the landward side of the levee.
- Allow for future adaptation as sea level rises.

2.4 Defining Future Conditions

Because this project is centered on the development of a strategy for nature-based sea-level rise adaptation, the planning horizon (the amount of time an organization will look into the future when preparing a strategy or plan) for evaluating future conditions is an important consideration. It is common to select a planning horizon for a restoration project, and then predict future conditions within this horizon. For this project, we selected a 50-year planning horizon, recognizing that our predictions for sea-level rise and the corresponding marsh sedimentation will have a number of uncertainties, especially as global and local predictions for sea-level rise are continually being revised, and sediment supply changes over time.

Though the exact rate of sea level rise is uncertain, the expected bay-wide decline in suspended sediment available for marsh accretion (Schoellhamer 2011, BCDC and ESA PWA 2013, Schoellhamer et al. 2018, Appendix A), means that the existing marsh surface of the project site will likely be inundated more frequently in the future. Sediment deposition is expected to at least partially slow this rise in inundation frequency through building marsh elevation, but local suspended sediment concentrations are relatively low (Appendix A) and are expected to decline in the future (Schoellhamer 2011). Increased inundation of the marsh would in turn have several effects:

- Eventual conversion of low marsh areas to mudflat, and conversion of high and mid marsh areas to mid and low marsh, respectively.
- More frequent exposure of the existing levees surrounding the site to erosive wave action during high tides.

We selected the 50-year horizon partly because this is the period within which significant marsh conversion would be expected to occur (see Section 6.1) given a medium emissions sea level rise scenario. For the scenarios with faster sea level rise, this conversion would be expected to occur sooner.

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3. EXISTING CONDITIONS

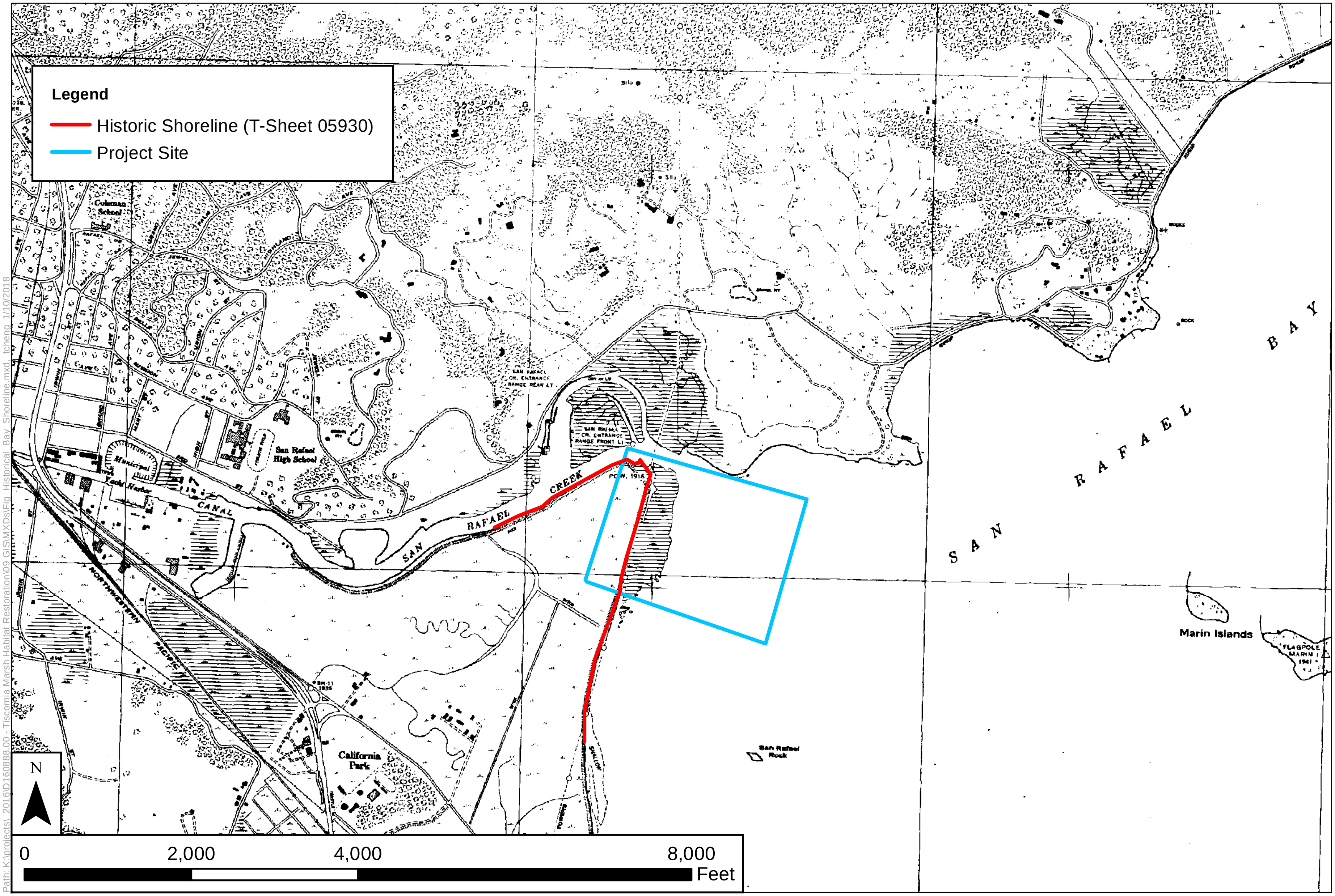
This section presents our understanding of existing conditions, an overview of historic conditions, and our projection of future hydrologic conditions.

Tiscornia Marsh is one of a very few small areas of tidal marsh in Central San Rafael. Historically, tidal marshes extended deep into what today is downtown San Rafael, and the mapped historic shoreline (see SFEI 2018) shows that the levee along the west side of Tiscornia Marsh was the wetland/bay shoreline. Tiscornia Marsh thus most likely formed from accretion on the mudflats. The marsh is comprised of a thin band of high marsh habitat, dominated by pickleweed (*Salicornia pacifica*) which transitions abruptly from a 3- to 4-foot escarpment to a wide mudflat extending bayward. This band of marshland is most narrow at its north end, expands along the adjacent soccer field, and becomes very thin as it curves eastward along the shoreline levee bordering the south end of the marsh. A single tidal channel enters the marsh from the northern San Rafael Canal edge and extends southward through most of the length of the marsh.

There are two Pacific Gas and Electric (PG&E) power line towers located within the marsh, which can be accessed by two wooden service walkways. One walkway runs generally northeast to southwest to a tower within the northern portion of the marsh, and the second runs in west-east to the tower adjacent to the bayward edge of the marsh. This tower was formerly surrounded by pickleweed marsh, which has since eroded as described below.

3.1 Site History and Ongoing Erosion

Prior to the development the San Rafael Regional Shoreline, Tiscornia Marsh was the edge of open bay/mudflats immediately adjacent to a larger marsh complex that existed from a little east of today's shoreline deep into downtown San Rafael, with San Rafael Creek bisecting and supporting much of this tidal marsh. By 1943, marsh had accreted on the mudflats bayward of what was the historic wetland shoreline and that had been leveed by that time. The general site location is illustrated in **Figure 4** on top of the 1853 U.S. Coast and Geodetic Survey T-Sheet for the area, which is available from SFEI. Given the complex history of sediment supply to San Francisco Bay, ongoing sea-level rise, and long term development, marsh areas in and around Central San Rafael (including the remnant fringing marsh that now comprises the project site) has probably varied in shape over the past two centuries (BCDC and ESA PWA 2013). Aside from the larger scale changes that were occurring throughout the Bay within the past century, sediment delivery to the site was also altered by the development of the City of San Rafael and the filling of the Bay and construction of the Spinnaker neighborhood to the south. Today's bayshore levees that encompass the Spinnaker and Baypoint neighborhoods, Canalways, and the properties further south to the Richmond Bridge east of Kerner Boulevard were constructed sometime after 1950 and before 1968 (Siegel Environmental 2016). More recently, recurrent maintenance dredging of San Rafael Creek for navigation purposes has created a local sediment sink adjacent to the marsh.



SOURCE: NOAA (T-Sheet)

D160888.00 Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation

Figure 4
Historical Marsh Shoreline
NOAA T-Sheet 05930 (1943)

ESA

Aerial images dating from 1987 indicate that the marsh has been eroding rapidly in the last several decades. We examined this trend by downloading and georeferencing the available images, and tracing the marsh edge at each point in time. **Figure 5a** shows the range of marsh shorelines, overlain with four marsh survey transects surveyed by ESA in September 2017 (see Section 3.2.1). The linear erosion over time for each of the four marsh transects is depicted in **Figure 5b**. The retreat of the bayward marsh edge has been most rapid at the northern edge of the site, eroding at a rate of 4-5 feet per year 2004, when most aerial images were available. The rate of retreat decreases with distance moving south along the marsh edge, declining to as little as 1 foot per year where the marsh intersects the shoreline.

3.2 Site Topography

Surface topography is available for the Tiscornia Marsh area from several sources:

- 2010 LiDAR topography data available from the NOAA (OCM 2018), and
- 2017 topographic survey conducted by ESA (Appendix B).

Existing grades at the site, based on the 2010 DEM, are shown on **Figure 6**. It should be noted that elevations may likely have an upward vertical bias due to existing vegetation. To supplement existing topographic data, ESA conducted a ground survey on September 19th, 2017. The ground survey included 10 transects of the southern levee along the site, a crest profile of the levee behind Tiscornia Marsh, and 4 transects that characterize the marsh plain, edge, and several hundred feet of the adjacent mudflat. An additional transect was surveyed in the diked marsh north of Pickleweed Park on October 27th, 2017. These data are summarized in Appendix B, and described briefly here for context.

3.2.1 Marsh and Mudflat Transects

Figure 7 illustrates the four marsh transects surveyed in September 2017. The existing levee that forms the western boundary of Tiscornia Marsh varies in elevation from roughly 10-12 feet NAVD88[1], and, moving east, the ground surface transitions rapidly into the marsh in a narrow (20-30 foot) band of upland to high-marsh transitional elevation land. This band drops from the levee into mid marsh dominated by pickleweed (*Salicornia pacifica*). This mid-marsh zone comprises the majority of the existing marsh area. The marsh plain varies in elevation from approximately 5.5 to 6.5 feet NAVD88, ranges from 150 to 500 feet wide, and covers approximately 8 acres. The marsh is narrowest at the northern edge of the site, in the vicinity of the PG&E towers (see Transect 1 in Figure 7). In the northern half of the marsh, the width between the levee and the bayward edge varies from 150 to 200 feet. The outboard edge is a steep scarp that drops to the adjacent mudflat elevation of approximately 2 feet NAVD88.

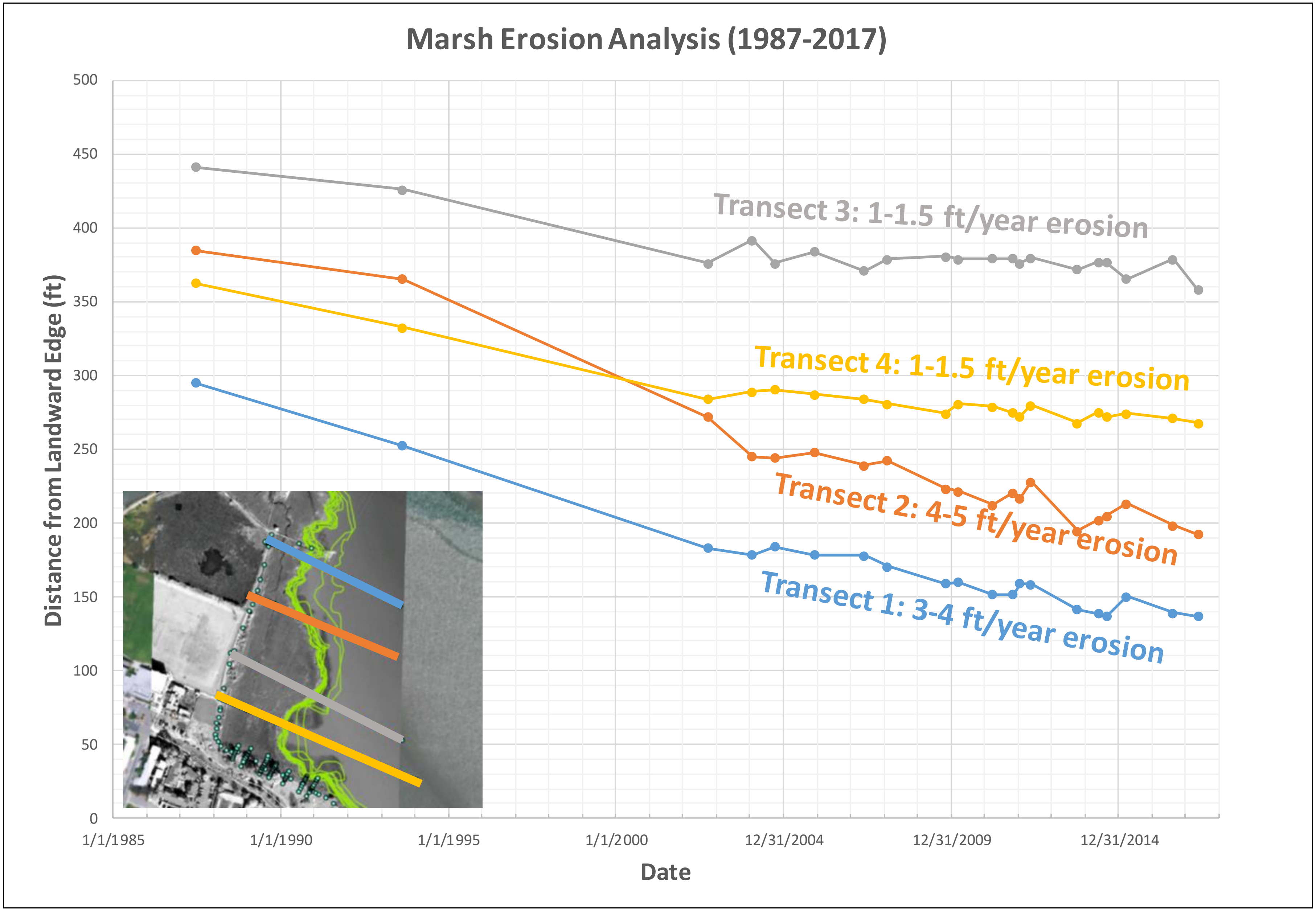
1 North American Vertical Datum of 1988

SOURCE: ESRI (Aerial Image)

D160888.00 Tiscornia Marsh Habitat Restoration

Figure 5a
Marsh Erosion Analysis using Historic Aerials
(1987 to present)

ESA

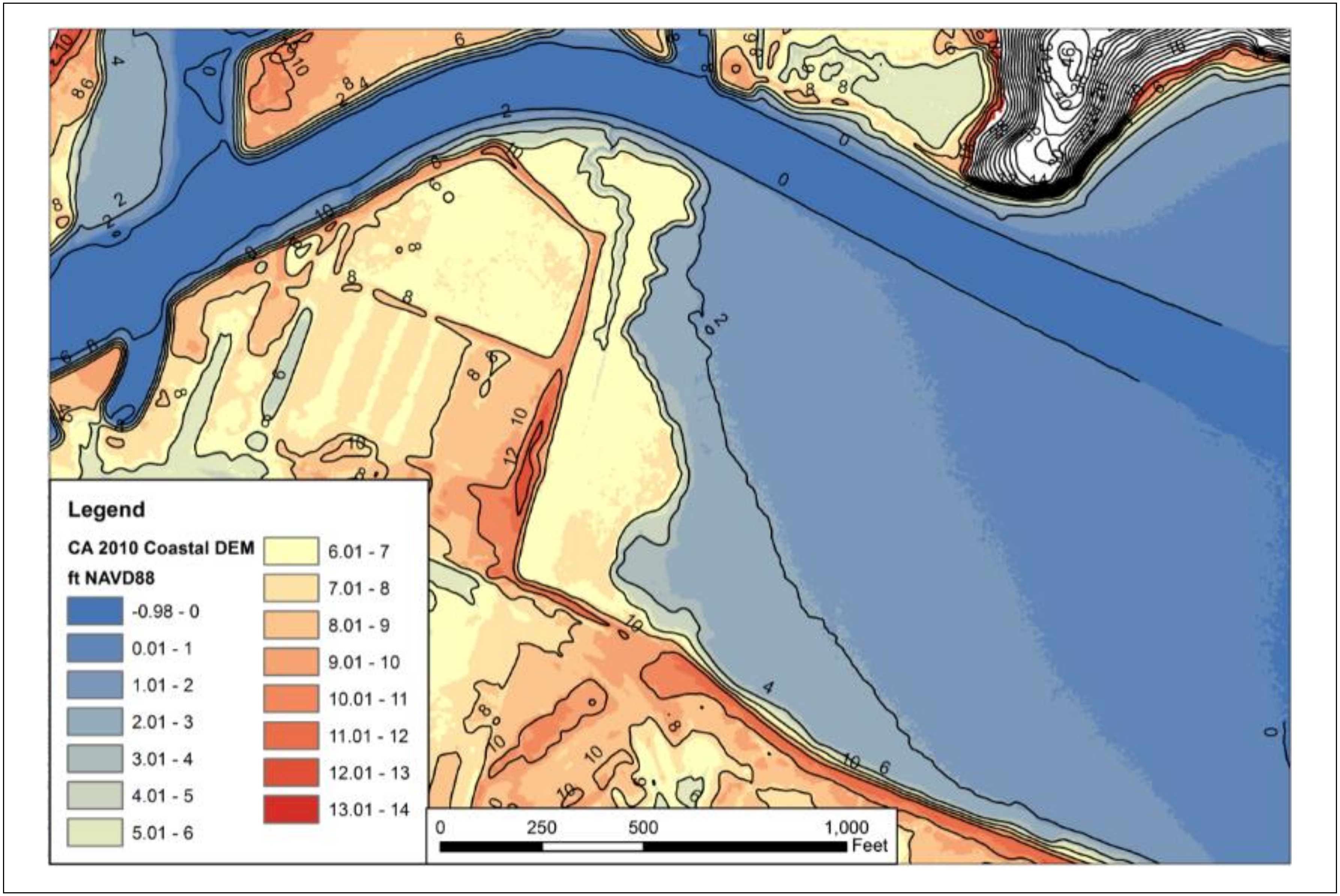


SOURCE: Background Image from Google Earth

Tiscornia Marsh Habitat Restoration . D160888.0

Figure 5b

Tiscornia Marsh erosion rates after 1987.



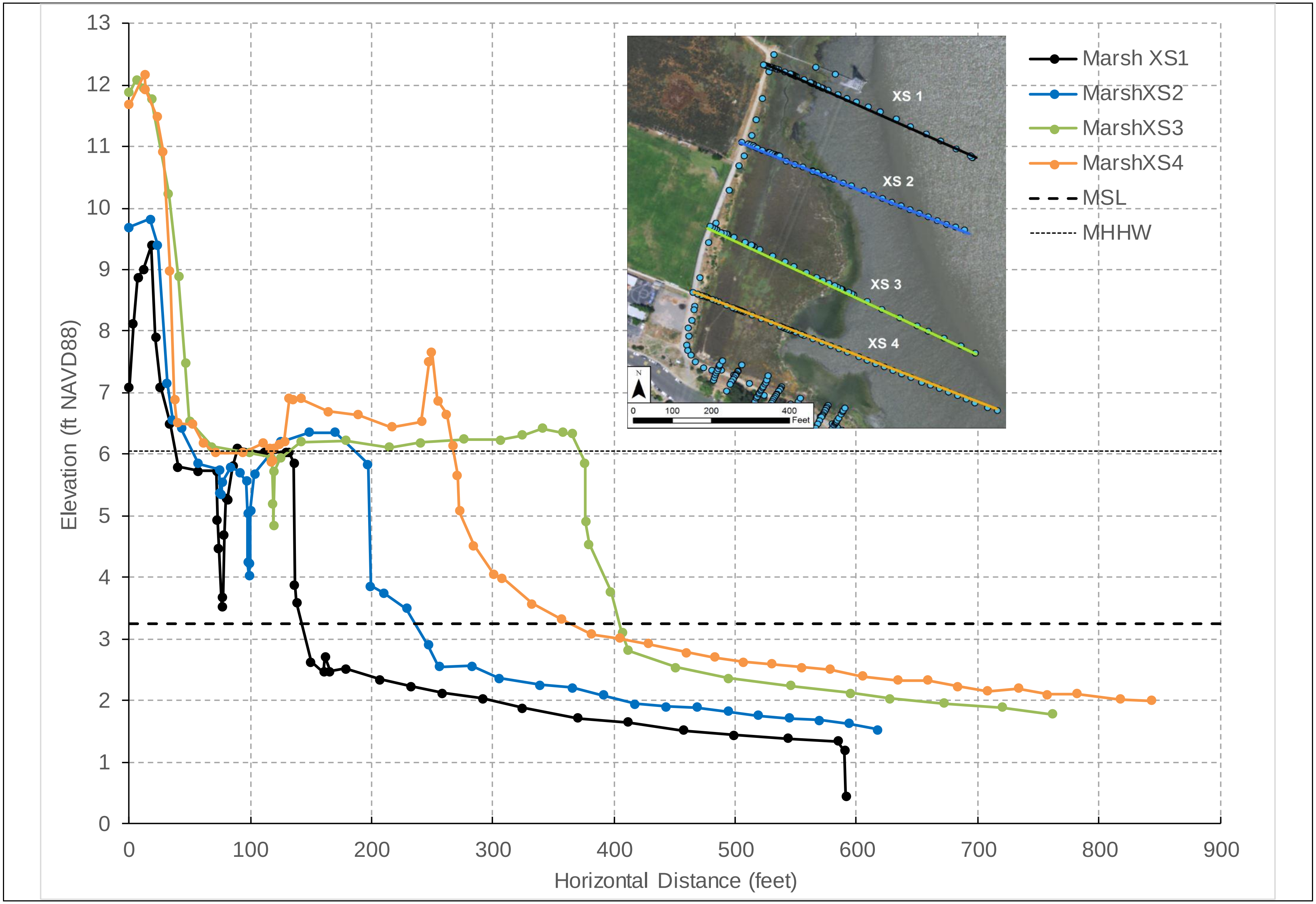
SOURCE: Topography and bathymetry provided by CA State Coastal Convservancy

NOTE: marsh topography not corrected for LiDAR bias due to vegetation

Tiscornia Marsh Habitat Restoration . D160888.0

Figure 6

Site topography in 2010.



SOURCE: ESA survey

Tiscornia Marsh Habitat Restoration . D160888.0

Figure 7

Tiscornia Marsh survey transects from September 19, 2017.

Moving south, the marsh widens to 200 to 500 feet. At the southernmost transect (Transect 4 in **Figure 7**), the mid marsh transitions to low marsh dominated by cordgrass (*Spartina foliosa*), and the edge escarpment is generally lower or is replaced by a more gradual gradient between mid and low marsh and mudflat. At Transect 4, the adjacent mudflat is higher than in northern transect locations (2-3.5 feet NAVD88). In general, the mudflat slopes downward toward the Canal from south to north, which is also apparent from the 2010 DEM (Figure 6). This is likely a response to the local sediment transport patterns, which are described in Section 3.4.7.

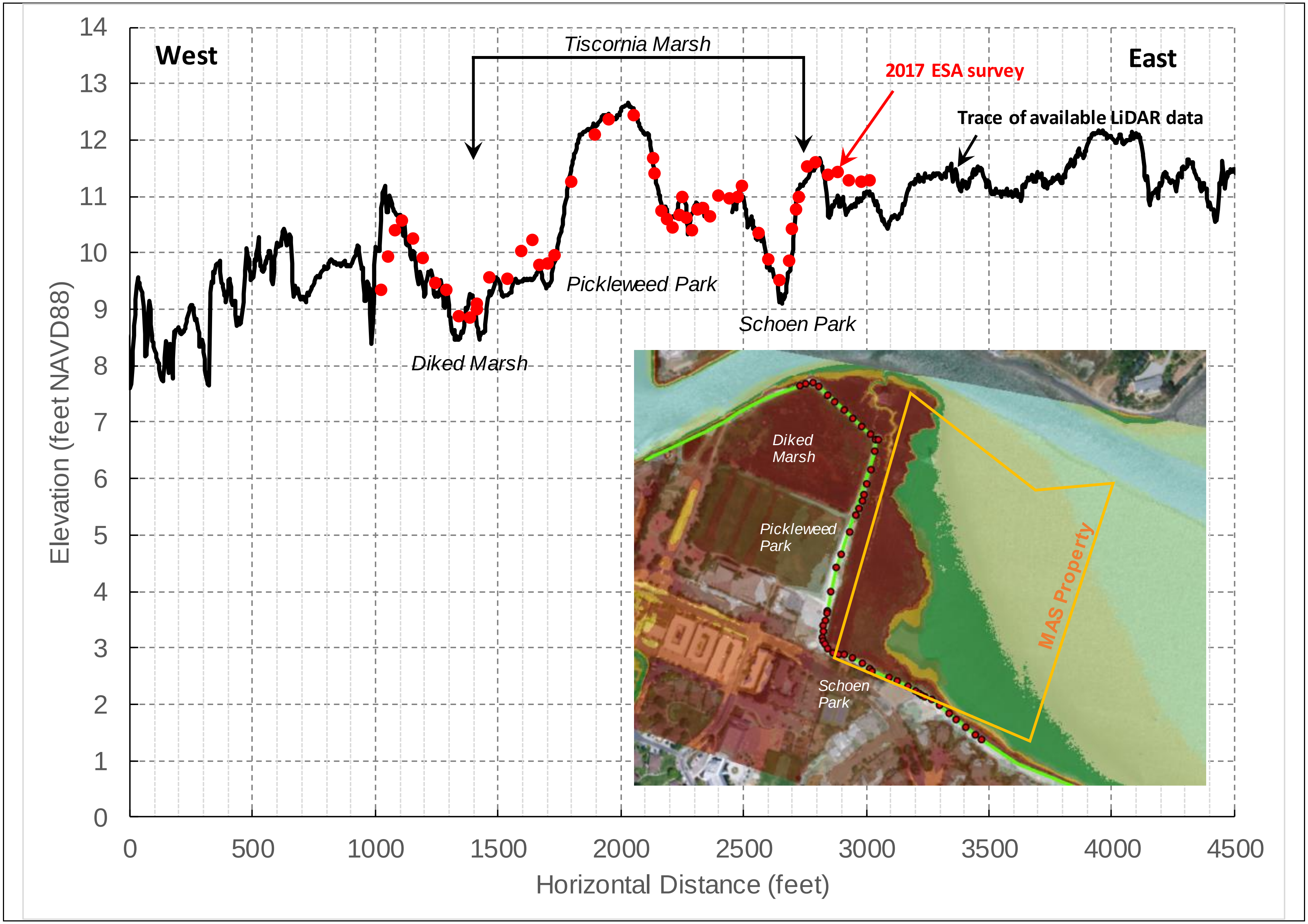
The diked pickleweed marsh immediately north of Pickleweed Park (west of Tiscornia Marsh and separated from the tidal marsh by the levee), has a roughly compatible surface elevation to the outboard pickleweed-dominated marsh surface in Tiscornia Marsh. Although only one transect was collected in the diked marsh, surface elevations tended to be roughly 5.5 to 6.5 feet NAVD88. This area does not appear to have any direct hydrologic connection to the tidal marsh, San Rafael Canal or San Rafael Bay.

3.2.2 Existing Levee

Figure 8 shows a profile of the levee crest to the immediate south and west of Tiscornia Marsh. Farther west and east, where survey data were not collected, the 2010 Marin County DEM was traced along the levee crest to give a larger picture of the levee elevations around this part of the Canal District. In general, the lowest segment of levee near the site is around 9-9.5 feet NAVD88 near Schoen Park, along the southern edge of the MAS property. The levee is lower, 7.5-8 feet NAVD88, on the west side of the diked marsh. The highest elevation is approximately 12 feet NAVD88 in front of the soccer field at Pickleweed Park. A series of transects across the levee (traversing from Schoen Park to Tiscornia Marsh) are shown in Appendix B.

3.2.3 Datums and Benchmarks

For the 2017 topographic survey of the levee and marsh, we used standard real-time kinetic global positioning system (RTK-GPS) surveying techniques to establish temporary vertical and horizontal controls. The survey tied into the North American Horizontal Datum of 1983 (NAD83) and North American Vertical Datum of 1988 (NAVD88). Appendix B provides more detail on the specific survey benchmarks used for this study.



Notes: Solid line represents a trace of 2010 LiDAR data. Circles represent spot elevations from ESA's 2017 ground survey.

Figure 8
Levee profile adjacent to Tiscornia Marsh.

3.3 Biology & Ecology

3.3.1 Vegetation

The marsh plain is dominated by pickleweed (*Salicornia pacifica)*, with thin bands of Pacific cordgrass (*Spartina foliosa*)[2] along its bayward edge and along the single tidal channel traversing the marsh. Gumplant (*Grindelia stricta* var. *angustifolia*), saltgrass (*Distichlis spicata*), jaumea (*Jaumea carnosa*), and marsh rosemary (*Limonium californicum*) also occur in scattered patches across the marsh. Plants restricted to the upper edge of the marsh include fat hen (*Atriplex patula*) and alkali heath (*Frankenia grandiflora*).

The upland boundary of Tiscornia Marsh, along the perimeter levee separating it from Pickleweed Park and the diked marsh, is comprised primarily of nonnative annual grasses, with scattered coyote brush (*Baccharis pilularis*), and acacia (*Acacia* sp.). Invasive plant species present in this zone include fennel (*Foeniculum vulgare*), wild radish (*Raphanus sativus*), and curly dock (*Rumex crispus*). Recently, volunteers have conducted native plantings and management of non-natives for STRAW (Students and Teachers Restoring a Watershed) and Point Blue Conservation Science. This has occurred along a portion of the levee fronting Pickleweed Park, and a recently-awarded Measure AA grant from the San Francisco Bay Restoration Authority is intended to fund a continuation of this work along additional parts of the levee.

Vegetation communities in tidal wetlands are defined by tidal hydroperiod, salinity, soils drainage and species competition. Typical vertical vegetation zones and approximate range of elevations for Tiscornia Marsh are identified in **Table 1**. (Note that these general elevation bands are consistent with limited spot elevations measured onsite, but are not based on a comprehensive vegetation survey.)

TABLE 1
VEGETATION ZONES IN TISCORNIA MARSH

Tidal Vegetation Zone	Dominant Plant Species	Approximate Tidal Range	Approximate Elevation Range (ft NAVD88)
Mudflat/Tidal Channel		<MTL	<3.3
Low Marsh	Pacific cordgrass	MTL to MHW	3.3 – 5.5
Mid Marsh	pickleweed, jaumea	MHW to MHHW	5.5 - 6.1
High Marsh	pickleweed, salt grass, gumplant, fat hen, alkali heath	MHHW to highest tide	6.1 – 7.3

2 Tiscornia Marsh is one of several marshes included in the SCC's Invasive Spartina Project (ISP), which is a coordinated regional effort to eradicate multiple introduced species of *Spartina* (cordgrass). The ISP has successfully removed *Spartina densiflora* along the outer edge of the Tiscornia Marsh.

3.3.2 Wildlife

A diverse assemblage of wildlife is common in the area. Small mammals likely using the marsh and adjacent seasonal wetlands (diked marsh) and uplands likely include California ground squirrel (*Otospermophilus beecheyi*), black-tailed jackrabbit (*Lepus californicus)*, striped skunk (*Mephitis mephitis*), raccoon (*Procyon lotor*), Opossum (*Didelphis virginiana*), California vole (*Microtus californicus*) and house mouse (*Mus musculus*). The levee and bordering uplands also likely support western fence lizard (*Sceloporus occidentalis*), San Francisco alligator lizard (*Elgaria coerulea corulea*), and coast garter snake (*Thamnophis elegans terrestris*). Salt marsh harvest mouse (*Reithrodontomys reviventris*) has also been documented and is discussed further in Section 3.3.4 below.

The site is an important foraging area for large wading birds such as great egret (*Ardea alba*), snowy egret (*Egretta thula*), black-crowned night heron (*Nycticorax nycticorax*), and great blue heron (*Ardea herodias*). West Marin Island, just off shore, provides nesting habitat to the largest heron and egret rookery in the San Francisco Bay area—and one of the largest in northern California. There are over 500 nesting pairs of great and snowy egrets, and great blue and black-crowned night herons. At low tides, the marsh plain and mudflats are used by shorebirds including dowitchers (*Limnodromus* spp.), black-necked stilt (*Himantopus mexicanus*), American avocet (*Recurvirostra americana*), greater yellowlegs (*Tringa melanoleuca*), and willet (*Tringa semipalmata*); and at high tides by waterfowl including canvasback (*Aythya valisineria*), mallard (*Anas platyrhynchos*), greater scaup (*Aythya marila*), bufflehead (*Bucephala albeola*), and ruddy duck (*Oxyura jamaicensis*). The shallow waters of the Bay adjacent to Tiscornia Marsh are also important rafting habitat for these waterfowl species.

3.3.3 Aquatic Habitat

San Rafael Canal and the nearshore waters of San Rafael Bay provide shallow subtidal and intertidal mud bottom estuarine habitat for a wide variety of fish, wildlife and invertebrate species. Riprap and other shoreline structures, such as piles, provide some solid substrates.

A twelve-month aquatic habitat survey of the Canal and nearshore waters adjacent to Tiscornia Marsh was conducted for the Corps of Engineers by the U.S. Fish and Wildlife Service in 1989 (Weinrich 1990). Benthic samples at the mouth of the Canal yielded numerous polychaete worms, as well as clams and snails. Three species of crabs were found: Dungeness (*Metacarcinus magister*), red rock (*Cancer productus*), and yellow shore crabs (*Hemigrapsus oregonensis*). Twenty-two species of fish were captured in the Canal and in San Rafael Bay during the year-long survey. The most common species (accounting for 91 percent of the total fish captured) were northern anchovy (*Engraulis mordax*), shiner perch *(Cymatogaster aggregata)*, yellowfin goby *(Acanthogobius flavimanus)*, threadfin shad *(Dorosoma petenense)*, and butter sole *(Isopetta isolepis)*. Seventeen species captured are endemic to California waters. Five introduced species were captured: Mississippi silverside (*Menidia audens*), threadfin shad, striped bass (*Morone saxatilis*), yellowfin goby and chameleon goby (*Tridentiger trigonocephalos*). Other aquatic species found included jellyfish, comb jellies, and two species of bay shrimp. (Weinrich 1990).

In 2017 Environmental Science Associates (ESA) conducted fish sampling in the (restored) Hamilton Wetlands Preserve, approximately 6 miles north of Tiscornia Marsh. This effort resulted in capture and identification of 1841 individual fish, representing 12 species including native species: northern anchovy, Pacific herring (*Clupea pallasii*), Pacific staghorn sculpin (*Leptocottus armatus*), three-spined stickleback (*Gasterosteus aculeatus*), topsmelt (*Atherinops affinis*), California halibut (*Paralichthys californicus*), and Chinook salmon (*Oncorhynchus tshawytscha*); as well as non-native species: chameleon goby, yellowfin goby, rainwater killifish (*Lucania parva*), Shokihaze goby (*Tridentiger barbatus*), and striped bass (HDR et al. 2017).

Information on Olympia oysters (*Ostrea lurida*) is provided from the SCC's San Francisco Bay Living Shorelines: Near-shore Linkages Project. This first living shorelines project in San Francisco Bay focused on restoration of two native species, eelgrass (*Zostera marina*) and Olympia oysters (*Ostrea lurida*) (Boyer et al. 2016). This pilot-scale project was implemented at two locations, the San Rafael shoreline off Spinnaker Point, and at Eden Landing Ecological Reserve in Hayward. The San Rafael site included a small-scale test of various oyster substrates including reef balls, oyster ball stacks, oyster blocks, and a "layer cake" design, all made of "baycrete" (20% cement and 80% native Bay materials). Monitoring conducted 4 years after implementation has indicated that oysters recruited readily to the small "baycrete" structures. Measures of these structures early in the project indicated that twice as many oysters were present at lower and mid-level elevations (approximately 0 to 8 inches below mean lower low water (MLLW), respectively) than at the high elevation (~+20 inches above MLLW). More oysters were present on vertical rather than on horizontal faces. The north sides of the elements also typically had 50% more oysters than did south sides. These differences have diminished over time with oyster densities declining at the low and mid-elevations. This may be the result of competition with other sessile species, which are more abundant at lower tidal elevations, or due to greater predation at lower tidal elevations (Boyer et al. 2016).

3.3.4 Special Status Species

Two State and Federally listed endangered species, the salt marsh harvest mouse (*Reithrodontomys reviventris*) and Ridgway's rail (*Rallus longirostris.obsoletus*) have been documented to be present in Tiscornia Marsh.

Salt Marsh Harvest Mouse

The salt marsh harvest mouse (SMHM) is endemic to the marshes which border San Francisco, San Pablo, and Suisun Bays. There are two subspecies of SMHM: the northern subspecies (*Reithrodontomys raviventris halicoetes*) is found in the Marin Peninsula and San Pablo and Suisun Bays (Shellhammer 2000). The southern (*R. r. raviventris*) lives in the marshes of Corte Madera, Richmond and South San Francisco Bay (Shellhammer 2000). Occurrence of both subspecies within this small range is highly fragmented.

The primary habitat of the SMHM is the middle to upper zone of salt and brackish marshes. The SMHM is dependent on dense vegetation cover, usually in the form of pickleweed (*Salicornia pacifica*, the dominant salt marsh vegetation in the Bay) and other salt dependent or salt tolerant vegetation. Optimal SMHM habitat has dense vegetative cover, with a high percentage cover of pickleweed, and has contiguous dense and tall cover in which the mice can escape extreme water levels without excessive exposure to predation. SMHM may also move into grasslands adjacent to marshes during extreme high tides if dense cover is present. The mouse is largely herbivorous with pickleweed known to be its primary food source. Loss of habitat due to the diking and filling of wetlands has been the major factor contributing to the decline of the SMHM.

Trapping studies conducted in 1990 for the US Army Corps of Engineers resulted in capture of fourteen SMHM in Tiscornia Marsh and fifteen in the adjacent diked wetland Pickleweed Park (Flannery and Bias 1990 as reported in USACE 1992). No other records of recent captures or trapping efforts in that area have been found, however based upon habitat suitability resource agencies would likely assume presence of this species for the purposes of project environmental compliance.

California Ridgway's Rail

The California Ridgway's rail (formerly known as the California clapper rail and hereafter RIRA) is a secretive, hen-like waterbird, that lives in salt and brackish tidal marshes in the San Francisco Bay. This species once occupied coastal California tidal marshes from Humboldt Bay southward to Morro Bay, and estuarine marshes of San Francisco Bay and San Pablo Bay to the Carquinez Strait (Raabe et al. 2010). Resident populations are currently limited to San Francisco Bay, San Pablo Bay, Suisun Bay, and associated tidal marshes.

RIRA occur almost exclusively in tidal salt and brackish marshes with unrestricted daily tidal flows, adequate invertebrate prey food supply, well developed tidal channel networks, and suitable nesting and escape cover during extreme high tides (Raabe et al. 2010). RIRA depend on mudflats or very shallow water within a network of tidal channels where there are both abundant invertebrate populations and taller plant material to provide cover, refuge during high tides, nesting opportunities above high tides and wave action, and protection from predators. RIRA rely on marsh plants such as Pacific cordgrass (*Spartina foliosa*), bulrush (*Bolboschoenus maritimus*), and pickleweed for breeding and feeding.

As part of the San Francisco Estuary Invasive Spartina Project, Olafson Environmental Inc (OEI) has conducted annual monitoring of RIRA at treatment sites since 2010. RIRA were detected in Tiscornia Marsh in 2010, 2011, 2012, 2016 and 2017. Monitoring recorded six (6) RIRA in 2016 and eleven (11) in 2017 (OEI 2016, OEI 2018). In its report on the 2017 RIRA monitoring, OEI notes about the Tiscornia Marsh site:

> "Surprisingly, this small marsh fragment had one of the highest density rail populations of all sites surveyed by OEI in 2017. The site is small, relatively isolated, and does not support exceptional rail habitat, however it has supported an intermittent population of Ridgway's rails. … It is likely a pair has been successfully breeding at the site since [2016]." (OEI 2018)

3.4 Hydrology and Geomorphology

3.4.1 Wind Climate

Local winds generate the wind waves that are an important driver for the observed erosion of the marsh edge, and for sediment transport patterns along the mudflat and marsh edge. Conceptual models for these processes are described in more detail in Section 3.5 Conceptual Models.

Wind data were collected from the California Irrigation Management Information System (CIMIS) at Point San Pedro (Station #157), and also at the NOAA monitoring stations at Chevron Pier (#9414863) and at Point Potrero (#9414847). An additional local wind monitoring station near Point San Pedro available from Weather Underground is summarized in Appendix A to give additional local context. Wind data were analyzed in Matlab©, to summarize direction and speed statistics, and were bracketed into 5-mile per hour (mph) intervals and displayed on wind roses to provide an understanding of the directionality.

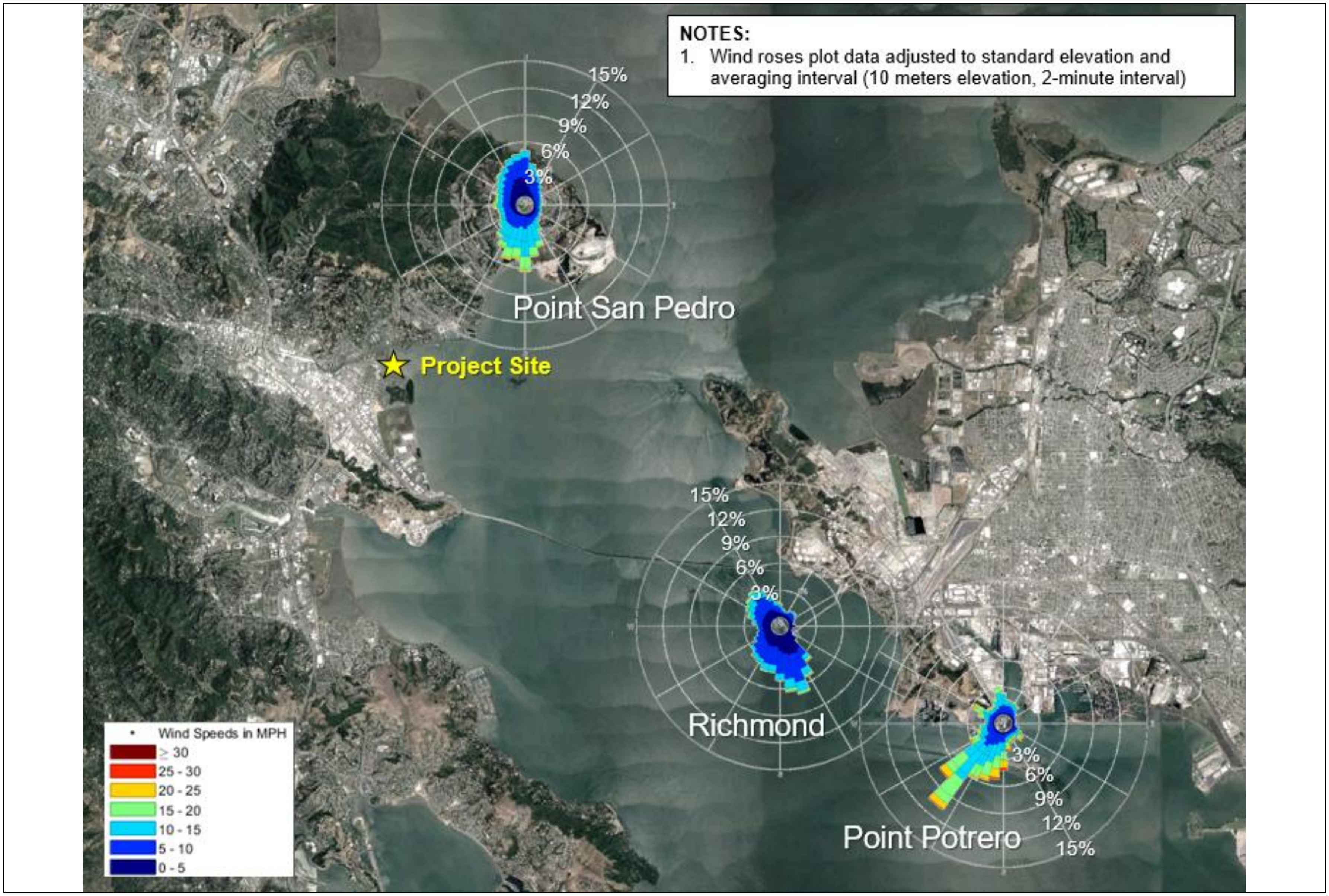
Though local winds generate the waves that drive geomorphic processes at Tiscornia Marsh, the local shoreline orientation limits their effect by constraining the wind waves that reach the marsh to a limited number of dominant fetches. This is especially true because Tiscornia Marsh is set back relative to the adjacent shorelines, and is likely shielded entirely from northerly or southerly winds by the local topography. Longer wind fetches (direct lines of sight across the Bay surface that are uninterrupted by topography) provide greater waves than short fetches, and these tend to be aligned to the northeast (‘Carquinez fetch’), and to the southeast (‘Richmond fetch’).

Figure 9 shows wind roses (illustrations of wind direction and speed) at each of the sites near Tiscornia Marsh. The Point San Pedro and Richmond sites suggest that the southeasterly Richmond and Berkeley fetches are especially important for generating waves that arrive at the site. The importance of these fetches is also apparent in the 30-year hindcast of wave conditions at the site used by FEMA to map coastal flooding (DHI 2011) described below.

3.4.2 Tidal Hydrology

The hydrology of the project site is controlled by the local tidal water levels in San Rafael Bay, which periodically inundate the marsh and adjacent mudflats. Since tides can vary locally throughout the Bay, it was important to compare local conditions against longer tidal records of nearby locations before assessing the potential response of the site to sea-level rise.

Local tidal conditions were assessed by installing a pressure gage to measure water levels at the site for a five-week period in 2017, and comparing the local record against longer tidal records documented nearby. Water levels adjacent to the marsh were measured from September 19th to October 27th, 2017, and these data were processed in Matlab© to obtain short-term tidal datums representative of the measurement period (**Table 2**). Water levels were referenced to the NAVD88 vertical datum by surveying the gauge and local benchmark, which is described in more detail in Appendix B.



SOURCE: CIMIS and NOAA wind gages

Figure 9
Wind roses for local NOAA and CIMIS wind gages near Tiscornia Marsh.

TABLE 2
TIDAL DATUMS IN VICINITY OF PROJECT SITE

	Nearby NOAA Tidal Datum Elevations (1983-2001 Tidal Epoch) ft NAVD88			Measured Tidal Elevations (Sep 17-Oct 29, 2017) ft NAVD88		Estimated Tiscornia Tidal Datums[5] ft NAVD88
	Chevron Pier[1]	Point San Pedro[2]	Point San Quentin[3]	Chevron Pier	Tiscornia Marsh	
Mean Higher High Water	6.06	6.04	5.95	5.90	5.81	6.06
Mean High Water	5.45	5.44	5.34	5.60	5.49	5.45
Mean Tide Level	3.29	3.33	3.29	3.49	--[4]	3.31
Mean Sea Level	3.26	3.24	3.24	3.47	--[4]	3.24
Mean Low Water	1.13	1.22	1.23	1.39	--[4]	1.23
Mean Lower Low Water	0.00	0.17	0.17	0.60	--[4]	0.17
NAVD88	0.00	0.00	0.00	0.00	--[4]	0

1 NOAA NOS Station 9414863, Richmond
2 NOAA NOS Station 9415009, Point San Pedro
3 NOAA NOS Station 9414873, Point San Quentin
4 Mudflats adjacent to Tiscornia Marsh prevented water levels from dropping below 2.3 feet NAVD88, so MLLW, MLW, MSL, MTL could not be estimated
5 MHHW and MHW adopted from NOAA Richmond gauge, while lower datums were estimated as an average of Point San Pedro and Point San Quentin values. Standard NOAA (2003) method could not be used to estimate lower tidal datums at the site due to influence of the adjacent mudflats.

The gauge was located approximately 50 feet offshore of the marsh scarp edge, in an area where the mudflat elevations are higher than low tides, so only the Mean High Water (MHW) and Mean Higher High Water (MHHW) were estimated from the record. To develop estimates of tidal datums at the site, we took the following approach:

- We estimated short-term datums at the ESA Tiscornia Marsh gauge and NOAA Richmond gauge for September 19th to October 27th, 2017.

- We also compared established tidal datums at the NOAA Richmond gauge (5 miles southeast) and at two local stations at Point San Pedro (3 miles northeast) and Point San Quentin (2 miles southeast).

In general, short-term estimates of MHW and MHHW from fall 2017 were within about 0.1 feet between Tiscornia Marsh and the NOAA Richmond gauge. Comparing datums among the three established gauges listed in Table 2 indicates that MSL, MTL, MHW, and MHHW are very close for all three sites. However, MLW and MLLW tended to be higher at the stations nearer to Tiscornia Marsh. Since the mudflats adjacent to Tiscornia Marsh cut off low tide levels, the standard NOAA (2003) method could not be used to obtain tidal datums at the site. Given the similarity of the Richmond and Tiscornia data, Richmond datums for MHHW and MHW are adopted, while lower datums (MSL, MTL, MLW, MLLW) are estimated at the site by averaging the Point San Pedro and Point San Quentin datums.

3.4.3 Wave Climate

We examined the local wave climate by using hindcasted conditions from 2006 to 2010 to understand seasonal and interannual variability. As described below, we also developed a local wind wave model for San Rafael Bay to look at spatial patterns in more detail for the dominant fetches.

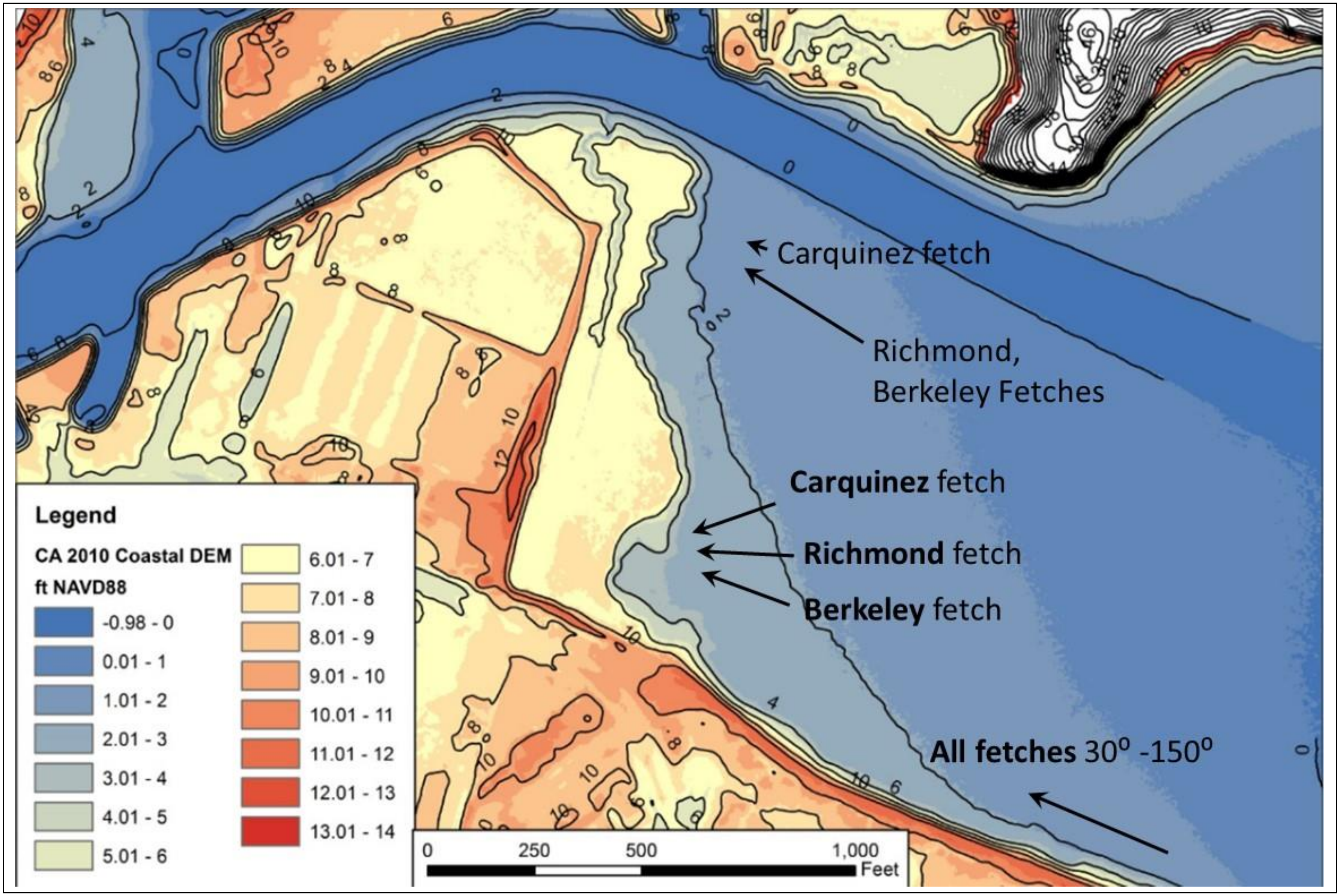
Temporal Patterns

Wave characteristics, including significant wave height, peak period, and mean direction, were extracted from a Central and North Bay wave hindcast for the coastal hazard modeling study conducted by DHI (2011). This hindcast was used to understand flooding conditions along the Bay shoreline, and the available 30-year hindcast used to calibrate the model was used to understand wave statistics throughout the Bay. The Central Bay region is defined as the area bounded by the San Mateo Bridge, Richmond Bridge and Golden Gate Bridge. The North Bay is defined as the region north of the Richmond Bridge and east toward Antioch. For the purposes of this study, wave hindcasts were extracted from July 2006 to July 2010, to provide a sufficient time period to characterize long term wave statistics at Tiscornia Marsh. These data were evaluated for three sites along Tiscornia Marsh, as illustrated in **Figure 10**.

All locations near the marsh experience relatively modest wave heights that are typically between 0.25 and 1 foot. The directionality of the arriving waves is strongly dependent on the exposure of different areas to the dominant wave fetches. As expected from the wind data, the southeasterly Richmond fetch produces the largest waves along the northern edge of Tiscornia Marsh, where scarp erosion is most severe. At this location, Point San Pedro appears to shelter the northern edge of the marsh from waves arriving from the Carquinez fetch. In contrast, the southern edge of Tiscornia Marsh experiences more waves arriving from the east or northeast, although southeasterly waves still dominate. Farther east, toward Spinnaker Point, the shift toward more exposure to easterly and northeasterly waves continues. Based on an extreme value analysis of the wave record, the 10-year and 20-year wave height experienced near the edge of Tiscornia Marsh is 2.2 and 2.5 feet, respectively.

Spatial Patterns

Though the wave time series helps to portray the causes of ongoing scarp erosion at the site, it is important to also look more closely at spatial patterns of waves along the marsh edge to better understand sediment transport. As part of the concurrent Giant Marsh restoration in the Central Bay, ESA developed a wind wave model using the Simulating Waves and Nearshore (SWAN) software. The existing model was refined in San Rafael Bay for the purposes of this project.



SOURCE:

- Background bathymetry data provided by California Coastal Conservancy (2010)
- Sediment transport directions inferred from ESA SWAN model

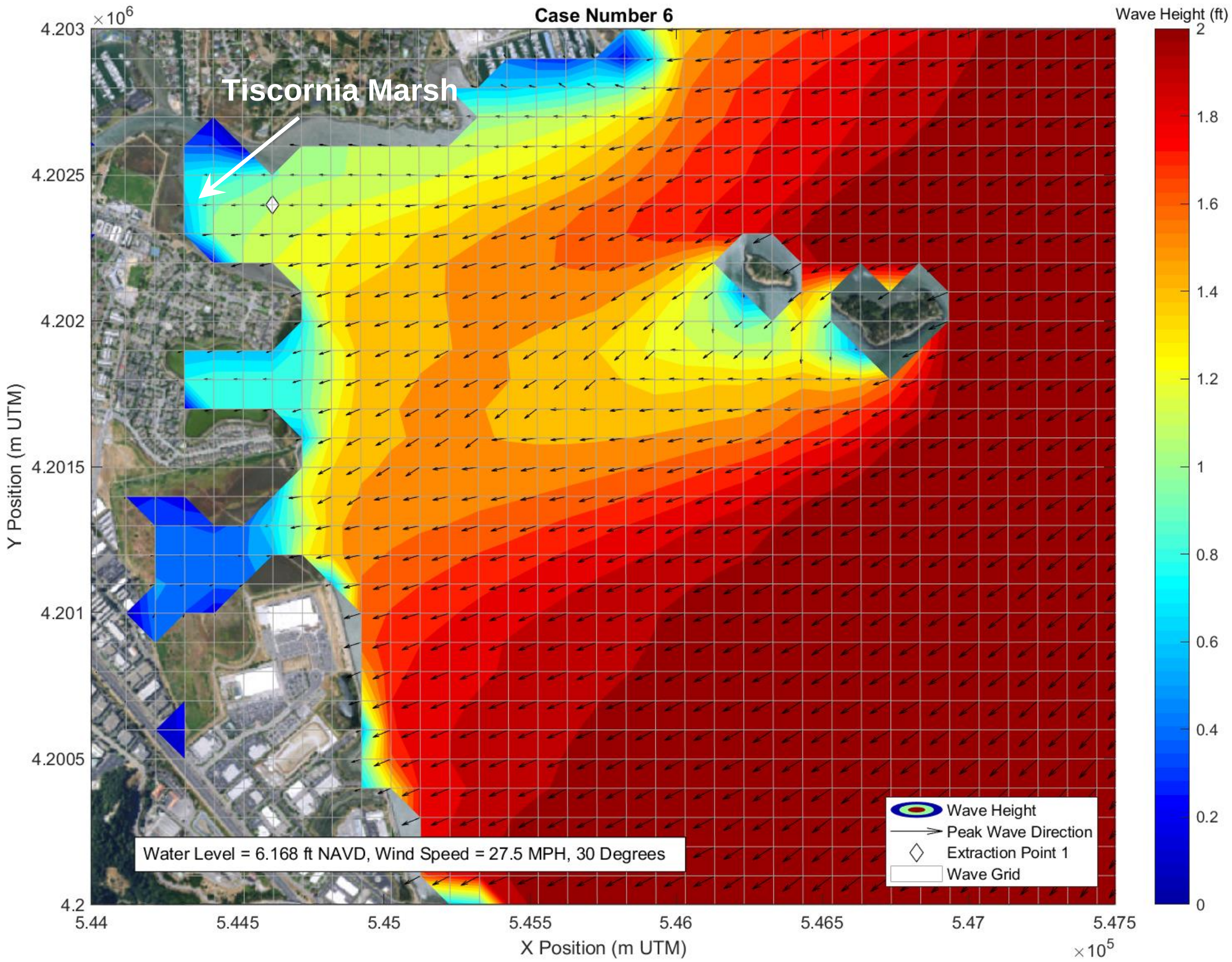
Figure 10
Conceptual model of sediment transport adjacent at Tiscornia Marsh. Arrows indicate direction of net sediment transport when waves arrive from specified fetch.

We used the model to evaluate the local wave conditions for a series of wind directions (30º to 150º from north) and wind speeds (2.5 mph to 32 mph). We assumed a water level of MHHW, when the marsh scarp at the project site would be exposed to wind wave action. **Figures 11** and **12** illustrate the wave patterns that would result from wind speeds of 27.5 mph and fetch directions of 30º and 150º (Carquinez and Richmond fetches, respectively). For the Carquinez fetch, waves were only on the order of 0.5 foot at the northern edge of the marsh, but increased to 0.5-1.0 foot at the southern edge and 1.0-1.5 feet farther east, near Spinnaker Point. The directionality of the waves suggested that the net sediment transport would be toward the southern edge of the marsh. For the dominant Richmond fetch, waves were larger at the northern edge of the marsh (1.0-1.5 feet) and minimal at the southern edge. The directionality suggested waves arriving at the north edge would transport suspended sediment north toward the San Rafael Canal, whereas waves arriving at the southern marsh edge would again transport sediment to the south, collecting at the southern corner of the site.

3.4.4 Sea-Level Rise

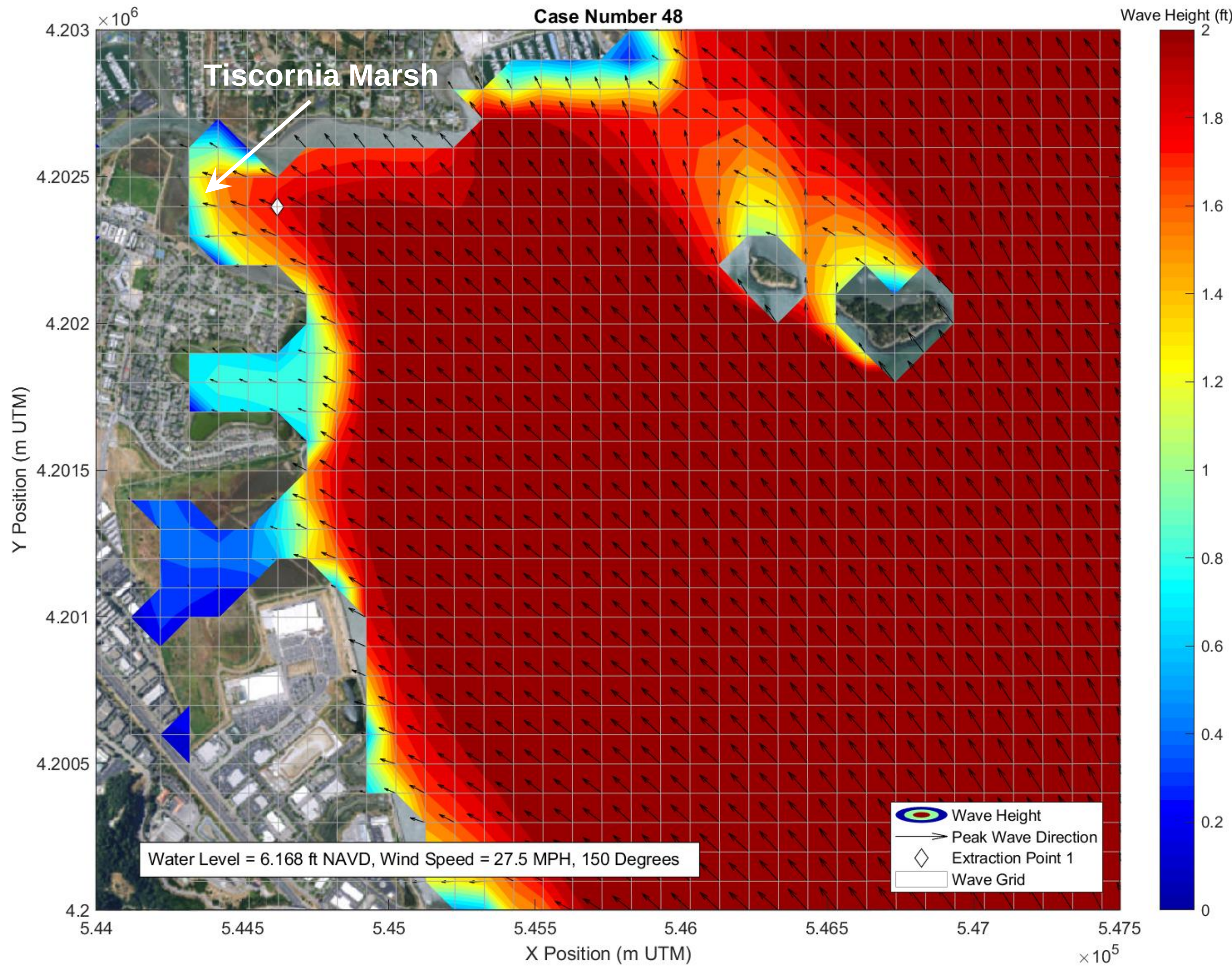
The accumulation of greenhouse gases in the Earth's atmosphere is causing and will continue to cause global warming and resultant climate change. For the coastal setting, the primary exposure will be an increase in sea levels (e.g., mean tide, high tide) due to thermal expansion of the ocean's waters and melting of ice sheets.

State planning guidance for coastal flood vulnerability assessments call for considering a range of emission scenarios (OPC 2013; CCC 2015). The California Ocean Protection Council (OPC) first released a statewide sea level rise guidance document in 2010 following Governor Schwarzenegger's executive order S-13-08. After being adopted by the OPC, this interim guidance document informed and assisted state agencies to develop approaches for incorporating sea level rise into planning decisions (OPC 2011). The OPC (2011) document was updated in 2013 (OPC 2013) after the National Resource Council (NRC) released its final report *Sea level Rise for the Coasts of California, Oregon, and Washington* (NRC 2012), which provided three projections of future sea level rise associated with low, mid, and high greenhouse gas emissions scenarios, respectively. The most current version of sea level rise projections is from the Ocean Protection Council in 2018 (OPC 2018). Whereas the prior guidance (OPC 2013) delineates future scenarios by specific greenhouse gas emission scenarios, the new guidance (OPC 2018) provides a more probabilistic approach, giving ranges of likely sea-level rise amounts in the future.



SOURCE: ESA SWAN model

Figure 11
Predicted wind-wave heights and directions for 27.5 mph wind speed from a 30º fetch angle.



SOURCE: ESA SWAN model

Tiscornia Marsh Habitat Restoration . D160888.0

Figure 12
Predicted wind-wave heights and directions for 27.5 mph wind speed from a 30º fetch angle.

Table 3 presents sea level rise projections from OPC (2013) and OPC (2018). The values for relative sea level rise[3] at 2030, 2050, 2070, and 2100 for San Francisco Bay are relative to sea level in 2000, and include regional projections of both mean sea level rise and vertical land motion of -1.5 millimeters per year for the San Andreas region south of Cape Mendocino.

TABLE 3
STATE GUIDANCE: SEA-LEVEL RISE PROJECTIONS FOR CALIFORNIA[1]

Scenario	2030	2050	2070	2100
OPC (2013) State Guidance				
Low Range	0.2 feet	0.4 feet	0.7 feet	1.5 feet
Mid Curve	0.5 feet	0.9 feet	1.6 feet	3.1 feet
High Range	1.0 feet	2.0 feet	3.2 feet	5.5 feet
OPC (2018) State Guidance				
Likely Range	0.5 feet	1.1 feet	1.5 - 1.9 feet	2.4 – 3.4 feet
1-in-200 Chance	0.8 feet	1.9 feet	3.1 – 3.5 feet	5.7 – 6.9 feet

1 Values are for the San Andreas region south of Cape Mendocino, where the vertical land motion is approximately -1.5 mm per year – indicating subsidence

SOURCE: Table 5.3, NRC (2012)

For this project, we consider a single sea level rise horizon of 2070 (~50 years), and consider a local sea-level rise values of 1.7 feet at Tiscornia Marsh. This is the midpoint of the likely range of sea-level rise of 1.5 – 1.9 feet from OPC (2018), and similar to the OPC (2013) medium emissions scenario prediction of 1.6 feet. An increase in local Bay levels by 1.7 feet would lead to significant changes in hydrology at Tiscornia Marsh (as the marsh would be inundated more frequently), as well as a corresponding increase in wind wave exposure of the surrounding levee.

Although higher amounts of sea-level rise are possible by 2070 (as indicated by a 1-in-200 chance of 3.1 – 3.5 feet of sea-level rise in Table 3), the amount of 1.7 feet is shown in Section 6 to have a significant effect on habitat conditions at the site. For sea-level rise higher than 1.7 feet, these affects would still occur, but would be expected to happen sooner than the 2070 horizon.

3.4.5 Flood Conditions

Data on flood conditions at the project site were investigated from several sources, including the Federal Emergency Management Agency (FEMA) and Marin BayWAVE study (BVB 2017).

FEMA Flood Study

FEMA performed detailed coastal engineering analyses and mapping of the San Francisco Bay shoreline within the nine San Francisco Bay Area counties under the Bay Area Coastal (BAC) Study. This study revised and updated the flood and wave data for the Marin County Flood

3 The term *relative sea level rise* indicates that the local effects of vertical land motion are included in the sea level rise projection

Insurance Study (FIS) report and Flood Insurance Rate Map (FIRM) panels along the San Francisco Bay shoreline. The revised coastal study became effective on March 16, 2016.

The updated FIRM is shown on **Figure 3**. The Base Flood Elevation (BFE) for the 100-year event varies along the San Rafael shoreline from elevations 10 to 12 feet NAVD88. The BFEs reflect that Total Water Level (TWL), which includes still water elevation level (SWEL), wave setup[4], and wave runup. The 100-year SWEL along the San Rafael shoreline is a constant 9.7 feet NAVD88. Therefore, the variability in BFEs is due to varying wave conditions predicted along the shoreline.

FEMA calculated TWLs for various transects along the shoreline. Wave hazards were analyzed using two primary methods depending on the shoreline type (FEMA, 2014). Steep-sloped shorelines and shoreline structures (e.g. steep revetments, vertical walls) were analyzed with wave run-up. Shallow-sloped shorelines and inland topography (e.g., marshes, developed areas) were analyzed with overland wave propagation, or WHAFIS (Wave Height Analysis for Flood Insurance Studies).

The FEMA BAC study includes a transect that bisects Tiscornia Marsh and Pickleweed Park. At this location, a shallow-sloped, “natural” shoreline was assumed, and waves were estimated using WHAFIS. The estimated TWL is 10.1 feet NAVD88, resulting in a Base Flood Elevation of 10 feet NAVD88[5]. The next closest transect to Tiscornia Marsh is roughly 800 feet to the east (bayward), where the shoreline was classified by FEMA as “revetment road.” At this transect, the TWL, estimated using both WHAFIS and wave runup, is 11.9 ft NAVD88. The approximately 2-foot increase in TWL, as compared to Tiscornia Marsh, is due to increased wave environment (more exposed, greater wind fetch) and differing shoreline conditions (steep outboard levee slope).

As previously noted, the majority of the neighborhood adjacent to Tiscornia Marsh is classified in the FIRM as Zone AE. Zone AE is defined as the flood insurance rate zone that corresponds to the 1-percent annual chance floodplain (also referred to as the 100-year flood zone). The FIRM indicates that the levees around the site are not FEMA accredited and thus do not provide protection against the 1% annual-chance flood.

Marin BayWAVE Study

The Marin BayWAVE study provides vulnerability assessments for cities throughout Marin County, including San Rafael (BVB, 2017). Potentially hazardous designations in this study are based on modeling results from the Coastal Storm Modeling System (CoSMoS), developed by USGS. CoSMoS provides predictions of coastal flooding with future sea level rise and extreme events from daily conditions to 100-year recurrence intervals. Currently, projections are available for the north-central coast, San Francisco Bay and southern California, and are accessible via Our Coast, Our Future (OCOF).

4 Though wave setup should be computed to calculate the depth at the toe of the structure during runup calculations on shore barriers, it is often the case that the runup height computed by empirical runup methods are referenced to SWEL. Therefore, the runup height implicitly includes the wave setup contribution.)

5 BFEs are derived from TWLs by interpolated between transects and rounding results to the nearest foot.

Tiscornia Marsh and the adjacent Canal district are designated as vulnerable areas in the 10-inch sea level rise scenario. Canal Drive and Spinnaker Point Drive, which border the project site, are classified as vulnerable transportation assets in the near term modeling scenarios. Compared to the FEMA FIRM, the BayWAVE study provides more information on relevant timelines and sea level rise projections for the project site.

3.4.6 Flood Protection

Much of the Canal district lies below high tide elevations. Pump stations are employed to remove storm water, and some of the shoreline levees have been constructed to protect against coastal flooding. The existing shoreline levee extends from Pickleweed Park, south along the San Rafael Canal to the Marin Rod and Gun Club, and includes the Jean and John Starkweather Shoreline Park. Most of this levee was raised and improved with construction of the Bay Trail about 15 years ago, with the exception of two segments: at Tiscornia Marsh, and at Canalways, an 85-acre property to the south. The shoreline to the west, upstream along the San Rafael Canal, also has various features that provide flood protection but because of the extensive shoreline and over-water development, the nature and elevations of this shoreline reach are not well established.

ESA surveyed the levee crest within the vicinity of Tiscornia Marsh. We also estimated the levee crest elevation beyond the surveyed portions from the available LiDAR data, which is assumed to be less accurate (**Figure 8**). In addition, we interpolated survey data from a 2007 ground survey (RTK GPS) from Oberkamper Associates for the Spinnaker Point Levee. As we did not have the source data, we interpolated from the survey map. The levee elevations from west to east range along a total levee centerline distance of approximately 4,500 feet as follows:

- Perimeter of Pickleweed Park: 9.7 to 12.4 feet NAVD88
- **Tiscornia Marsh property: 8.9 to10.5 feet NAVD88**
- Spinnaker Point (north side): 11.3 to 12.2 ft NAVD88
- Spinnaker Lagoon (east side): 11.5 to 12.2 ft NAVD88
- Spinnaker Lagoon (south side): 13.1 to 14.1 ft NAVD88

As noted above, the levee segment on the Tiscornia property is relatively low compared to the remainder of the levee.

3.4.7 Sediment Supply

Sediment availability at the site was assessed by Siegel Environmental, and is summarized in detail in Appendix A.

Suspended sediment is supplied to the site by tides, and possibly to a much lesser extent by discharge from San Rafael Creek (Canal). The latter is likely a small and sporadic source because most of the watershed is developed, meaning that formerly erodible surfaces have been paved. Scaling the watershed relative to Corte Madera Creek and noting the difference in land cover between the two watersheds indicates that the supply of sediment from San Rafael Creek is dwarfed by the volumes that have been periodically dredged from the Canal by the U.S. Army

Corps of Engineers (USACE). This implies that the mudflat adjacent to Tiscornia Marsh extending east toward the San Pablo Bay navigation channel supplies the majority of the sediment delivered to Tiscornia Marsh, San Rafael Creek, and local marinas including Loch Lomond.

Tides and local wind waves cause bed sediments to become suspended in the water column. Flood tides that rise high enough to inundate the marsh surface deposit sediment onto the marsh and vegetation also captures sediment on the marsh plain. This process is described in more detail by Williams and Orr (2002) and BCDC and ESA PWA (2013). Deposition also occurs on the mudflats, but is enhanced locally in areas that are sheltered from wind waves, or where drops in the bed elevation cause sediment to fall out of suspension. San Rafael Creek acts as a sediment sink, as its bed is maintained lower than the surrounding mud flat by periodic dredging to allow navigability. The south to north slope of the mudflat adjacent to Tiscornia Marsh suggests that the south end of the site is a depositional environment.

Sediment availability is a key consideration for the long term adaptability of Tiscornia Marsh to sea level rise. The site receives relatively low amounts of suspended sediment on average. As described in Appendix A, suspended sediment concentrations (SSC) at the site, based on data from China Camp State Park and offshore of Spinnaker Lagoon and an estimated conversion factor from the measured turbidity values to sediment concentration, have median values in the range of 34-44 mg/L and average values in the range of 64-82 mg/L.

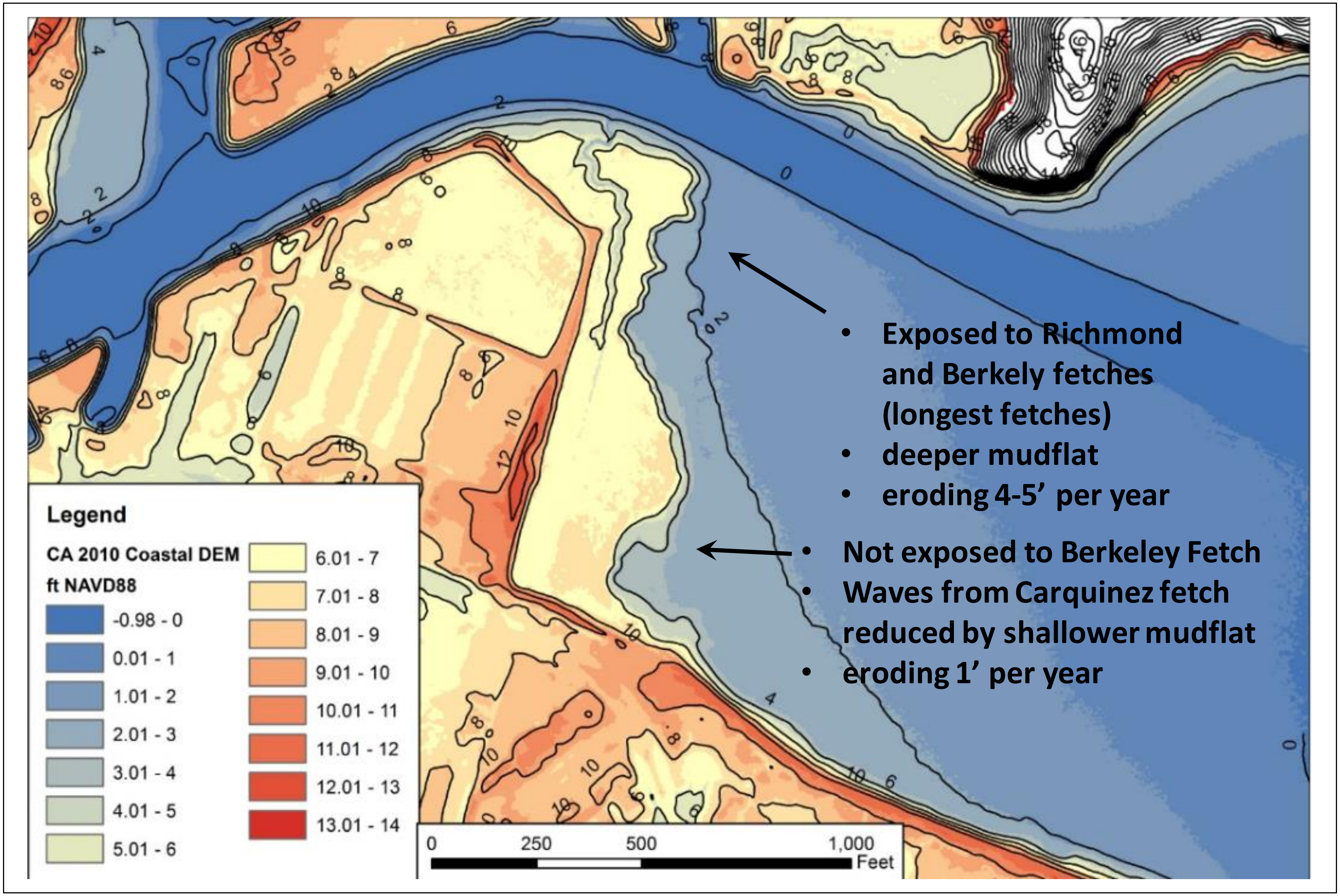
3.5 Conceptual Models

In order to understand the potential resiliency of Tiscornia Marsh in the face of climate change and rising sea level, we developed schematic conceptual models of marsh scarp erosion and sediment transport patterns at the site. These models were used to integrate the information from the sediment supply memorandum (Appendix A), wind data, and wave modeling at the site, in a way that can inform the conceptual design. The conceptual models were used in developing alternatives, and projecting how they are expected to evolve over time. The anticipated geomorphic and ecological responses to post-project and future conditions are presented in Section 6.1.

3.5.1 Scarp Erosion

Scarp erosion at the site has been most severe in the areas with the most wind wave exposure. As shown in **Figure 13**:

- Scarp erosion at the northern edge of the marsh (4-5 feet/year since 2004) is likely a result of full exposure of the northern marsh to the Berkeley and Richmond wind fetches.
- The lack of escarpments and/or slower rate of retreat at the southern end of the marsh (1-2 feet/year since 2004) is likely because this area is sheltered from full exposure to the Berkeley fetch. Despite being located farther south, exposure to the Carquinez fetch also appears to be small in this portion of the marsh.
- With sea-level rise, these patterns are not expected to change.
- Continued retreat of the marsh could further reduce exposure to the dominant wind fetches, but is not likely to be sufficient to stop erosion.



SOURCE:

- Background bathymetry data provided by California Coastal Conservancy (2010)

Figure 13

Conceptual model of marsh erosion at Tiscornia Marsh.

3.5.2 Sediment Transport

Figure 10 displays the conceptual model for sediment transport at the site, which is based on the following points:

- The majority of sediment arriving to the site is delivered from the mudflat which extends into San Rafael Bay.
- East of the site (near Spinnaker Point), wind waves arriving from the Carquinez and Richmond fetches lead to sediment transport along the San Rafael Bay shoreline toward the southern edge of Tiscornia Marsh.
- At the northern edge of Tiscornia Marsh, wave refraction patterns cause all fetches to drive sediment transport northward into San Rafael Creek.
- At the southern edge of Tiscornia Marsh, wave refraction patterns cause all fetches to drive sediment transport southward, trapping entrained sediment where the marsh and shoreline connect.

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4. OPPORTUNITIES AND CONSTRAINTS

Site opportunities and constraints were used to help guide development of the concept alternatives. The following opportunities and constraints were informed by the existing conditions analysis and stakeholder input. In some cases, a condition can be seen as both an opportunity and a constraint, such as the presence of RIRA or ongoing dredging of the San Rafael Canal.

4.1 Site Constraints

- The marsh is expected to continue to erode under current conditions due to the site's wave exposure, exacerbated by ongoing boat traffic in the Canal.
- The existing overhanging scarp on the eroding Bay edge of the marsh provides favorable habitat for RIRA that should not be disturbed.
- The vegetated marsh-mudflat edge with gentle slopes at the southeast corner of the marsh provides foraging habitat for shorebirds.
- The existing PG&E power lines that traverse the site cannot be disrupted, and access must be maintained to PG&E's single power tower on the site.
- Longshore sediment transport moves sediment from Tiscornia Marsh into the San Rafael Canal. Ongoing dredging of the Canal to maintain navigation will continue to create a local sediment sink, and could contribute to sediment depletion in subtidal marsh areas.
- Dredge sediments from the Canal and/or private marinas that are chemically contaminated are not suitable for reuse in in the restoration project.
- Current USACE and BCDC regulations strictly limit the placement of fill in Baylands.
- The ability to raise the height of MAS's levee is constrained due to the fact that expansion of the levee would impact existing marsh on the north (waterside), and extend onto City property boundary to the south (landside), which includes a children's playground.

4.2 Site Opportunities

- Coarse-grained marsh edge beaches are resilient to the current wave climate, adjusting bedform to a variable wave climate, rather than eroding.
- The bayward edge of the marsh is a gentle-sloped mudflat, which could serve as base for construction of a coarse-grained beach at the marsh edge, which would serve to adjust bedform to a variable wave climate and resist erosion.
- Tiscornia Marsh provides suitable foraging and breeding habitat for RIRA and SMHM.

- The site is well-suited as a nature-based sea-level rise demonstration project, owing to its relatively small size and active environmental stewardship of its owner, MAS.
- Sediment tends to accumulate at the southeast edge of the marsh due to the wave climate, providing potential sediment source for marsh accretion.
- Periodic local dredging of the San Rafael Canal, nearby marinas and private docks, and the Larkspur Ferry Terminal could provide a compatible source of sediment for reuse in a marsh restoration. Local beneficial reuse of dredged material could potentially reduce costs for dredge disposal.
- The vegetated marsh enhances the flood protection function of the landward levee by absorbing wave energy and reducing wave runup.
- Wave runup could be further reduced by creation of a gradually sloped ecotone between vegetated marsh and uplands, which would also provide valuable transition habitat.
- There may be potential to create suitable habitat to support establishing and expanding populations of native oysters in low tidal and subtidal portions of the site (e.g. along the San Rafael Canal).
- A marsh restoration project would create opportunities to better engage the local Canal community with Tiscornia Marsh through volunteer marsh cleanup days and/or volunteer planting efforts funded under Measure AA (see below).

4.3 Opportunities Beyond the Site

- The diked marsh immediately north of Pickleweed Park is currently at high marsh elevation, making it relatively easy to restore to tidal marsh.
- Raising the Tiscornia Marsh levee could be combined into one construction package with raising (and/or setting back) other portions of the levee on City property, to save the City and MAS in construction costs on future protection of the Canal Community from sea level rise.
- The property directly south of the levee is a City-owned playground, which could be reconfigured and/or replaced to allow that raised levee footprint to encroach on the park.
- Measure AA recently funded volunteer planting efforts by STRAW at several sites, including the western (City-owned) side of Tiscornia Marsh. A partnership project could benefit the new levee and local community.
- The Resilient by Design competition may develop sea level rise adaptation concepts that are compatible with the proposed project, such as redevelopment of Pickleweed Park and the Al Boro Community Center into sea-level rise resilient facilities with a focus on bay resources.

5. CONCEPT ALTERNATIVES DEVELOPMENT

A suite of conceptual alternatives was developed for restoration/enhancement of both the bay edge and the upland edge of Tiscornia Marsh. The alternatives were based on our understanding of existing and projected future conditions, a set of opportunities and constraints for the site, and a set of design criteria aimed at maximizing its potential for restoring habitat and adapting to future sea-level rise. Alternatives for the bay edge and upland edge are intended to be implemented together as one project.

5.1 Project Elements

The project envisions creating and/or enhancing a range of connected natural elements that provide habitat value as well as flood and erosion protection. The overarching design goal is to create a complete wetland system ranging from subtidal to upland elevations. The project elements proposed along the bay edge of the site in the subtidal to mid-intertidal range include a coarse-grained beach at the marsh edge, enhanced/expanded tidal marsh, and a rock jetty along the San Rafael Canal. Design elements along the upland edge of the site in the supratidal to uplands elevations include a transitional ecotone slope and flood protection levee. While the intent is to transition seamlessly between these habitat components, each is discussed separately below.

5.1.1 Coarse Beach

Though the actively eroding scarp at the marsh edge provides favorable cover and foraging habitat for RIRA, this condition is not sustainable. Given current rates of erosion, the northern extent of the marsh is expected to be completely eroded away in roughly 30-50 years, and the southern portion to continue to erode at current or accelerated rates. Therefore, construction of a coarse-grained or “cobble” beach is proposed at the marsh edge to help resist ongoing erosion. Additional measures to preserve and/or replace the eroding scarp elsewhere are discussed below under marsh habitat.

Although this feature would likely include a mixture of sand, gravel, cobbles, and/or oyster shell hash, it is referred to herein as an ‘coarse beach’ or ‘cobble beach’ to distinguish it from a sandy beach suitable for public access. Mixed cobble/gravel/sand beaches throughout the Bay provide multiple benefits, including increasing the stability of eroding shorelines, creating aquatic and wetland habitats, and providing a platform for future adaptation to sea-level rise. Guidance for developing coarse beaches as a protection from marsh erosion has been established by BCDC and ESA PWA (2013), and reference sites will be examined in detail in the next phase of the project.

Coarse-grained beaches within the Bay are typically shallow-sloped shorelines between subtidal and supratidal elevations. At Tiscornia Marsh, the proposed coarse beach feature would extend from the outboard mudflat up to approximately elevation 7-9 feet NAVD88. The actual height of the feature would be established by natural wave action reworking placed materials to the height naturally appropriate to this exact location. Sediment retention groins constructed of wood and/or rock may be incorporated into the beach face to restrict longshore drift and to allow sufficient retention of sand and gravel in the beach profile.

5.1.2 Tidal Marsh Habitat

The project seeks to increase the quantity and quality of vegetated tidal marsh habitat to benefit RIRA, SMHM and other native wildlife. Pickleweed-dominated mid to high marsh is the primary target, both for near term habitat and long term resilience to sea-level rise. In addition, more complex marsh features are proposed to address specific habitat needs of these and other species.

The primary target for marsh habitat restoration would be mid-marsh elevations of 5.5 to 6.1 feet NAVD88 (MHW to MHHW), with areas of high marsh up to roughly elevation 7 feet NAVD88. Other features desirable within the enhanced and/or expanded marsh to improve habitat include:

- An intricate network of tidal channels to provide abundant invertebrate populations for RIRA foraging.
- Channel bank erosional features with overhanging scarps that create cover "tunnels" through the marsh for RIRA and other wildlife.
- High tide refuge habitat with taller marsh vegetation to provide cover and refuge for RIRA and SMHM, located (a) along channel banks, (b) within the marsh as microtopography, and (c) in higher elevation transition zones into terrestrial ecotone and upland habitats. Target vegetation would include gumplant, Pacific cordgrass and bulrush.
- Features to discourage predators, such as strategic gaps that separate high tide refugia in the marsh from the upland perimeter to minimize edge and/or entry points for predators.

Improved marsh habitat could potentially be achieved at the site through four primary means:

- Enhancing the existing marsh through limited intervention (e.g. excavated additional channels and creating high berms along channel banks).
- Passively expanding the existing marsh eastward (bayward), by encouraging accelerated sediment deposition in the outboard mudflats.
- Actively expanding the existing marsh eastward, by placing suitable fill material to raise portions of the outboard mudflat to mid and/or high marsh elevation.
- Expanding the existing marsh westward, by restoring tidal action to the diked marsh (which is already at suitable marsh elevation), contingent upon on City of San Rafael's approval.

The approach for enhancing/creating marsh varies by alternative, as discussed further in Section 5.2 below.

5.1.3 Rock Jetty

Dredging of the San Rafael Canal for navigation, which enlarges it beyond its equilibrium widths and depth, is expected to continue indefinitely. Currently, much of the sediment lost from the Tiscornia Marsh through erosion is likely transported and deposited in the adjacent Canal and possibly nearby marinas and private boat docks (Appendix A). Though installation of a coarse beach would reduce the marsh erosion rate, there would still be a net sediment flux toward the Canal due to the local wave climate (as described in Section 3.5.2). Therefore, a rock jetty element is proposed at the north boundary of Tiscornia Marsh that would extend eastward, parallel to the Canal. The purpose of the rock jetty is to trap and accumulate sediment that would otherwise drift along the beach face and be deposited in the Canal. The rock jetty would reduce erosion of the newly constructed coarse beach, and should reduce the depositional rate in the Canal (possibly reducing the frequency of required dredging).

The rock jetty would be constructed of suitably-sized rock, and would extend vertically from the surface of the mudflats fringing the Canal to approximately 2 feet above MHHW. Given its expected proximity to the Canal, subsequent stages of this design will need to consider its effect on boat navigation. During the future detailed design phase, we will look for opportunities to incorporate features in the lower, subtidal portion of this feature to enhance its potential as oyster reef habitat.

5.1.4 Ecotone Slope

A gradual slope between high marsh and upland areas can create a wide ecotone (transition zone) that combines ecological and flood protection benefits. An expanded ecotone slope could be created at the south and west boundaries of Tiscornia Marsh. The ecotone would be located along the outboard slope of the existing trail and shoreline levee around the site.

The ecotone slope would serve several functions. It would provide high tide refugia for RIRA and SMHM, and create a buffer between the marsh and the Bay Trail on the levee top. The ecotone could also dissipate wave energy by inducing wave breaking over its shallow slope, and by resistance created by vegetation established on the slope. The ecotone would also create transgression space for tidal marsh habitats, whereby upland transitional habitats would gradually convert to tidal marsh as sea level rises.

The actual width of a constructed ecotone slope varies significantly, and depends on functional objectives, available space, ability for long term maintenance, and other factors. For restoration at the relatively expansive South Bay Salt Ponds, the ideal ecotone slope ranges from 20:1 to 100:1 (horizontal foot to vertical foot) (PWA, 2006). For the Oro Loma Ecotone Slope Demonstration Project[6] the ecotone was constructed at a 30:1 slope (ESA, 2018).

6 The Oro Loma Ecotone Slope Demonstration Project is designed to test various plant palletes and substrates for constructed ecotones. The ecotone is being irrigated with recycled wastewater. A secondary design objective being tested is the ability for the ecotone to achieve recycled wastewater polishing.

At Tiscornia Marsh, space available for an ecotone is limited by existing marsh and developed infrastructure. Given site constraints, we recommend sizing the ecotone (elevation range and slope) at a minimum needed to function as a wind wave dissipation bench. An ecotone sized with this approach can also provide ecological function for habitat and buffering. In general, greater bench widths would be expected to provide greater habitat and wave dissipation benefits. More detailed wind wave analysis will be performed in the future detailed design phase. At this stage, we have developed preliminary dimensions based on similar levee benches designed by ESA.

For example, for the Dutch Slough Tidal Marsh Restoration, ESA performed wind wave analysis and evaluated erosion potential using the wave power concept[7] for the transitional slopes between marsh and levees (ESA PWA, 2015). Results showed that erosion potential was greatest between Mean Tide Level (MTL) and MHW, and diminished significantly with increasing elevation, up to 1.5 feet above MHHW. Based on this analysis, an ecotone was designed to gently slope at 7:1 from the newly-restored low marsh up to 2.5 feet above MHHW. (A flatter slope of 10:1 was used for areas where the levees were fringed by subtidal waters.)

For Tiscornia Marsh, a preliminary design concept for the ecotone would be sloped at 10:1, up to approximately elevation 9 feet NAVD88 (3 feet above MHHW). This would result in an approximately 30-foot wide ecotone based on an existing marsh elevation of approximately 6 feet NAVD88. The slope would be planted with native vegetation adapted to ecotone environmental settings, intermixing high marsh and upland species adapted to infrequent flooding and salinity, and including grasses for nesting materials (e.g. creeping wildrye, *Elymus triticoides*). Plant cover must be entire (or nearly so) throughout the year, and reach elevations which remain emergent (above 1 foot in height) through the highest tides, so that small marsh mammals and secretive marsh birds can find cover from predation.

As a final check, we compared the ecotone width proposed for Tiscornia Marsh to prior designs for the Hamilton Wetlands (PWA, 1998) and Petaluma Marsh Expansion (PWA, 2002) projects. Both of these sites included construction of an earthen “bench” outboard of the new flood control levees to dissipate wave energy and allow for sacrificial erosion. The constructed benches at these sites are 50 to 55 feet wide. However, the levees at both of these sites are exposed to higher wave energy than occurs at Tiscornia Marsh, which is less exposed and has shorter wind fetch. In addition, the levees are fringed by high vegetated marsh at Tiscornia Marsh, as compared to unvegetated mudflat at the other two sites. Given the lower wave energy environment at Tiscornia Marsh, a 30-foot wide ecotone would likely be appropriate for dissipating wave energy, although a greater width (where possible given space constraints) could provide more refugia habitat. The actual design slope and elevations of the ecotone will be determined based on further analysis in the future detailed design phase.

In the project moves forward, we will also examine opportunities for expanding the ecotone along the approximately 800-foot section of western levee between the diked marsh owned by the City

[7] The potential erosion of an earthen levee slope is considered to be proportional to the wave power dissipated on it when averaged over a long time frame. It is noted that wave power, and similar wave energy approaches, are approximate indicators rather than predictors of erosion. The wave power approach considers the frequency of water levels to identify the elevations where the wave power is greatest. The flat, dissipative levee bench is then located vertically within this high-power area.

and the southern portion of the levee within MAS property. Much of this western levee crest is higher than at the southern segment, meaning that there may be opportunities to raise the levee and expand the ecotone without impacting the existing marsh or encroaching on City property in some areas. This could be achieved by increasing the outboard (marsh) ecotone slope above the 10:1 slope proposed for the southern portion or by expanding the ecotone selectively in areas where the levee could be set back slightly without impacting existing City property.

5.1.5 Raised Levee

The existing portion of the levee within MAS's property has a range of crest elevations (all below 12 feet NAVD88) and varies in top width from about 10 to 16 feet. The restored levee would be raised to a consistent height and constructed to a standard width. We have assumed a 16-foot crest width, which would allow 12 feet for the Bay Trail plus a 2-foot shoulder on each side. The actual side slopes and other geotechnical criteria for the raised levee will be addressed in the future design phase. At this stage, we have assumed that the levee would have uniform side slopes of 3:1 (horizontal:vertical) both on the landside, and on the outboard side above the ecotone slope.

The most important design criterion for the levee is the crest height. We selected the levee height for the conceptual design based on three considerations:

- FEMA guidance for accredited flood protection levees
- The existing elevation of the adjacent shoreline levee
- Predicted rates of future sea level rise

We started with FEMA guidance for 100-year flood protection as a design standard, even though the existing levee will likely not be accredited by FEMA due to geotechnical and other factors. FEMA provides the following guidance:

- Riverine levee: Base Flood Elevation (BFE) + 3 feet freeboard
- Coastal levees, the greater of:
  - 100-year stillwater surge level + 1% wave or maximum wave runup (whichever is greater) +1 foot freeboard,[8] OR
  - 100-year stillwater surge level + 2 feet freeboard

The Tiscornia Marsh levee is somewhere between a coastal and riverine levee, with required freeboard of 2 and 3 feet, respectively. Though it may be justifiable to apply the coastal levee criterion, we propose to design a levee to conform with the more conservative criterion for riverine levees. The additional foot of freeboard would provide additional buffer for future sea level rise. Per FEMA, "freeboard is a factor of safety usually expressed in feet above a flood level for purposes of floodplain management." For our purposes, freeboard includes a safety factor to account for (a) future settlement, (b) uncertainty in base flood elevations and (c) future sea-level

[8] Occasionally, exceptions to the minimum coastal levee freeboard requirement described may be approved, based on evaluation of the uncertainty in the estimated base flood loading conditions, with particular emphasis on the effects of wave attack and overtopping on the stability of the levee.

rise. Therefore, the proposed design levee height is 13 feet NAVD88, based on a base flood elevation of 10 feet NAVD88, plus 3 feet of freeboard.

We also compared this design levee height to the adjacent levee, since the raised portion of levee would act as a unit with the entire shoreline levee. As described in Section 3.2.2, most of the existing levee between Pickleweed Park and Spinnaker Lagoon varies in elevation between 11 and 12 feet NAVD88. Therefore, a design elevation of 13 feet NAVD88 for Tiscornia Marsh, which is more protected from wind waves than the east facing shoreline, seems appropriately conservative.

5.2 Alternatives for Marsh Edge Stabilization

We developed four alternative approaches for addressing ongoing erosion along the eastern edge of Tiscornia Marsh. We have three basic restoration alternatives, plus the No Action alternative, for comparison.

We developed the alternatives recognizing that the existing wind climate will persist, and wave power will increase as sea level rises. For this reason, both restoration alternatives include stabilizing the marsh edge with a coarse beach.

- **Alternative 1, No Action.** This alterative anticipates the consequences of not stabilizing the marsh edge
- **Alternative 2, Extended Shoreline Stabilization.** This alternative uses a passive approach of using natural sedimentation to aggrade the existing mudflat, the first approach for expanding the marsh to improve habitat value, as well as attenuating wave erosion.
- **Alternative 3, Restore Eroded Marsh.** This alternative uses a more direct approach of actively rebuilding the marsh using fill placement, the second approach for expanding the marsh to improve habitat value, as well as attenuating wave erosion.
- **Alternative 4, Restore Eroded Marsh and Diked Wetland.** This alternative expands on Alternative 3 to include restoring the diked marsh to the west of Tiscornia Marsh, in the event that City of San Rafael allows restoration actions on their Pickleweed Park property.

Each marsh edge stabilization alternative would include one of the levee raising options described in Section 5.3 below.

5.2.1 Alternative 1 – No Action

Under the No Action Alternative, Tiscornia Marsh would remain in its current condition, and there would be no physical modification to the site (**Figure 14**). We assume that the Canal would continue to be dredged periodically. These assumptions were used to predict the performance of the No Action Alternative in the future. Under the no action scenario, the marsh edge would continue to erode and loss of vegetated marsh would continue. At some future stage when the marsh has completely eroded away, the City would likely need to take action to prevent erosion of the levee surrounding Pickleweed Park.

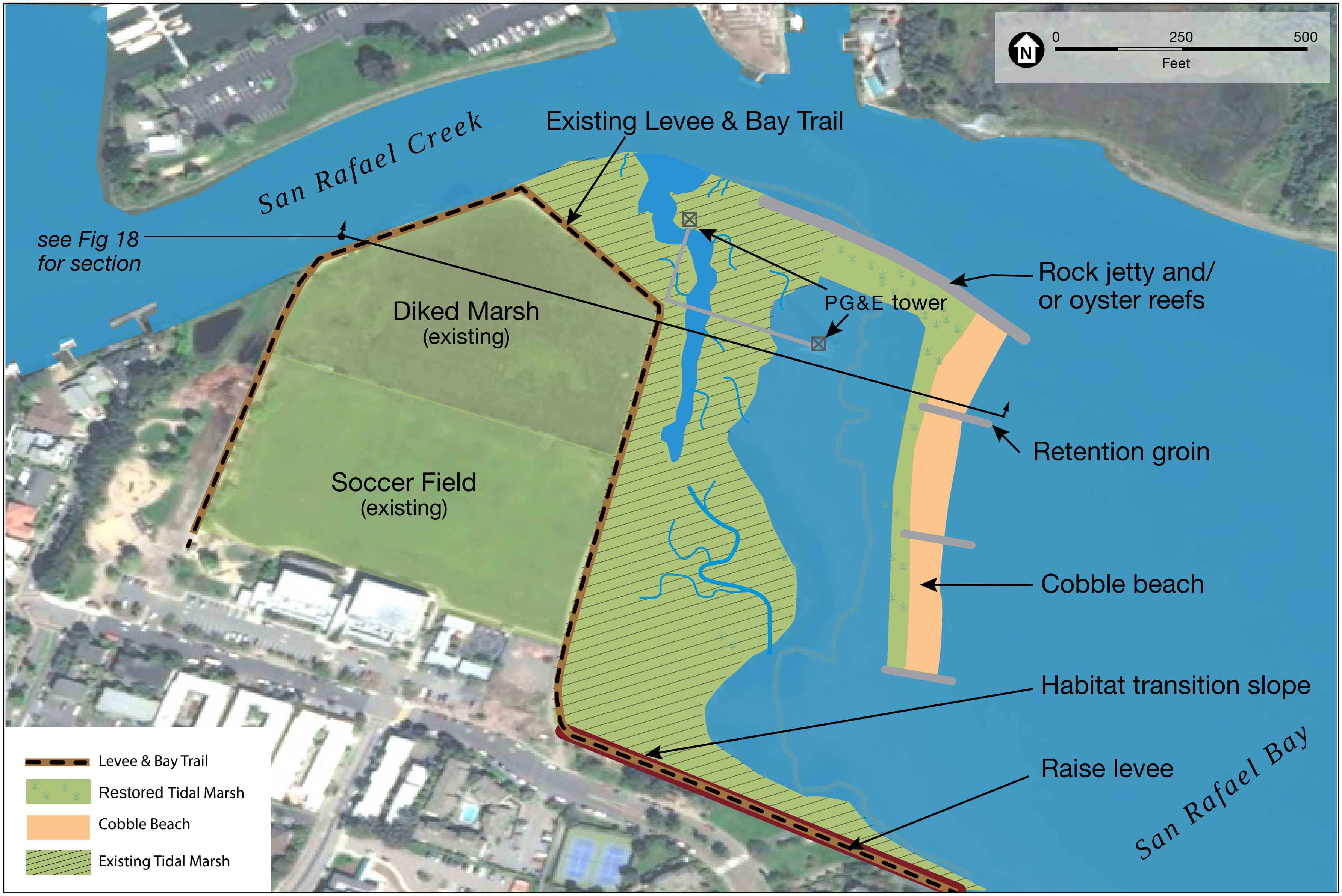
Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation Project

Figure 14

Alternative 1 – No Action

5.2.2 Alternative 2 – Extended Shoreline Stabilization

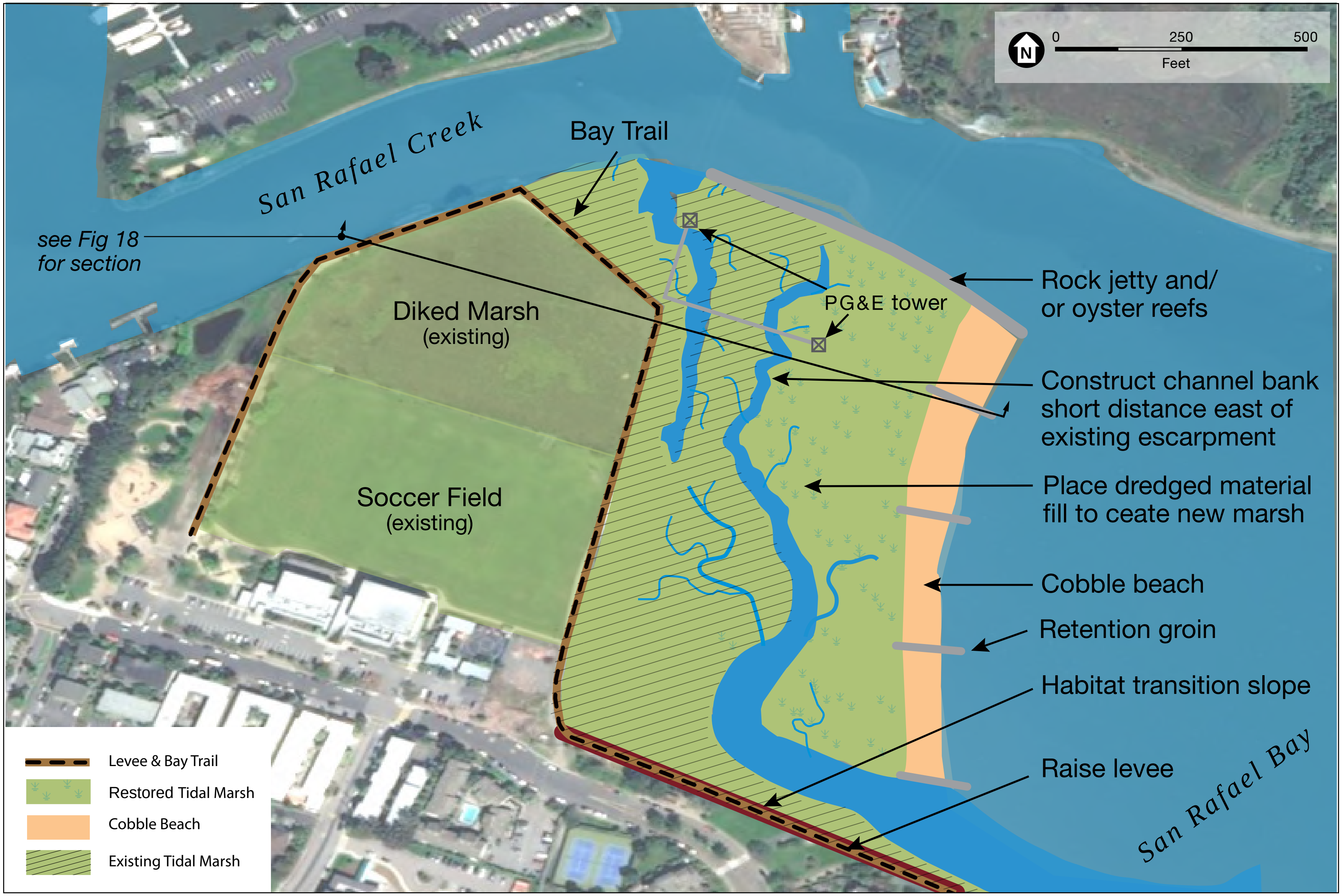
Alternative 2 consists of construction of a coarse beach offset from the marsh, with a rock jetty on its north side. The coarse beach at the marsh edge is designed offset from the existing shoreline both to preserve the existing marsh scarp, and to provide space for the mudflats to aggrade through natural sedimentation. Alternative 2 is shown in plan and section in **Figures 15** and **18**, respectively.



ESA

Figure 15

Alternative 2 – Extended Shoreline Stabilization



ESA

Figure 16
Alternative 3 – Restore Eroded Marsh

Figure 17
Alternative 4 – Restore Eroded and Diked Marsh

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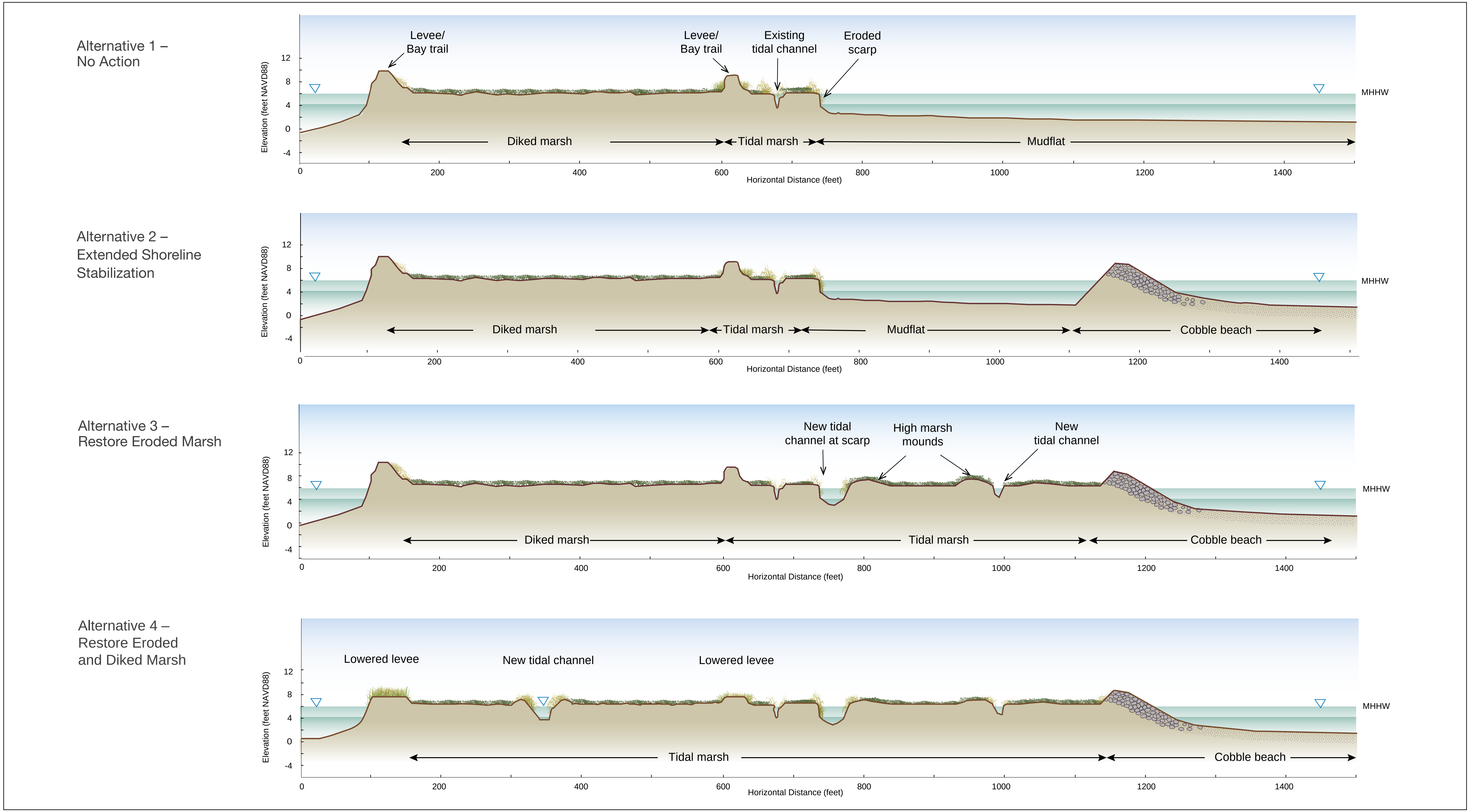

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Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation Project

Figure 18
Schematic Sections of Marsh Edge Alternatives

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The coarse beach would likely be placed at least 100 feet bayward of the existing marsh edge and would be designed to encourage sediment trapping and deposition in the mudflat on the lee side of the beach. This alternative would take advantage of the process that transports sediment that tends to accumulate in the southeast corner of Tiscornia Marsh. This alternative would also preserve the overhanging scarp along the existing marsh edge. The area between the existing marsh and the new beach would be expected to experience higher deposition rates than under existing conditions, as discussed in Section 6.1.2. This approach is an alternative to actively filling the mudflats as described under Alternative 3.

The coarse beach would be constructed approximately 100 to 400 feet from the existing marsh edge. The beach would serve to break incoming waves and dissipate wave energy before waves reach the marsh, and should arrest further erosion of the marsh edge. Because the beach would not be supported by the marsh on its lee side, additional micro-groins or other features would likely be needed to provide stability.

A rock jetty would also be constructed on the north side, parallel to the Canal. The jetty would help to trap sediment that would otherwise drift along the new beach face and deposit in the Canal.

With this alternative, there would be opportunity to create a wider ecotone transition on the south side of the marsh as part of the levee raising, as discussed in Section 5.3 below.

5.2.3 Alternative 3 – Restore Eroded Marsh

Alternative 3 includes an expanded marsh, fringed by coarse beach on the east and a rock jetty on its north side. This alternative was developed with the vision of restoring Tiscornia Marsh to its former size. The most direct approach for achieving this goal is to rebuild the marsh by placing fill in the outboard mudflat. Alternative 3 is shown in plan and section in Figures 16 and 18, respectively.

This alternative would expand the existing marsh by approximately 5 to 10 acres. The exact footprint of the new marsh would vary depending on several factors, including property ownership, fill availability, impact avoidance and other factors. The estimated fill volume could range from approximately 40,000 to 100,000 cubic yards.

Bay muds similar to those of the existing marsh would be the most appropriate fill material. Therefore, beneficially reusing dredged material from in or around the Canal or from the Larkspur Ferry Terminal would be the preferred fill method. Availability of local dredge materials is discussed in Appendix A. Dredged material could be placed either hydraulically or mechanically, and would require construction of a containment berm on the new marsh perimeter. The construction approach is discussed in more detail under Section 7.

The new marsh would incorporate desirable habitat features for RIRA and SMHM. The overhanging scarp along the existing marsh edge would be preserved as much as feasible for RIRA habitat. The marsh would include an appropriately-sized tidal channel network that would provide interior mudflats fringed by low marsh for RIRA foraging. High tide refuge habitat with taller marsh vegetation would be located along channel banks and within the marsh as microtopography, and would be disconnected from the upland perimeter to reduce predator access. The mouth of the channel would be placed at the southeast corner of the new marsh, to encourage sediment delivery to the marsh, potentially increasing the vertical accretion of the marsh in the future.

Similar to Alternative 2, a coarse beach would be installed along the eastern edge of the expanded marsh to provide erosion protection and natural beach habitat functions. In addition, a rock jetty will be constructed on the north side of the marsh, parallel to the Canal, to reduce sediment drift into the Canal.

The existing marsh currently has a narrow ecotone band along its west boundary which transitions to the levee/trail around Pickleweed Park and the diked pickleweed marsh to the west. There would be opportunity to create more of an ecotone transition on the south side of the marsh as part of the levee raising. Levee raising and ecotone expansion options are discussed further below.

Opportunities to expand the ecotone along the western edge of the site will also be explored. This levee along the west side of Tiscornia Marsh is on City property, adjacent to the Al Boro Community Center. The existing ecotone slope adjacent to the marsh varies from approximately 10 to 40 feet wide. An undeveloped lot, soccer field, and diked marsh are located on the landward side of the levee (from south to north). Although the existing trail and ecotone slope are relatively narrow, there may be some areas for expansion without encroaching on the marsh, particularly next to the undeveloped lot. In addition, since much of the levee along the soccer field is already at 11 to 12 feet NAVD, it would not require significant additional footprint to raise its crest to 13 feet NAVD and modestly widen the ecotone slope where space allows. Currently, planned work funded by Measure AA and conducted by STRAW is slated to augment the ecotone with native plantings along this western portion of the levee.

5.2.4 Alternative 4 – Restore Eroded and Diked Marsh

The City-owned diked marsh at the north end of Pickleweed Park, to the immediate west of Tiscornia Marsh, provides a low impact opportunity for restoring approximately four acres of pickleweed marsh. This final alternative is a variation of Alternative 3 that could be implemented in the event that the City becomes a project participant. The City has indicated its openness to considering this alternative, but has not committed to it. Alternative 4 is shown in plan and section in Figures 17 and 18, respectively.

This alternative includes all of the elements of Alternative 3, Restore Eroded Marsh, and also includes restoring the diked marsh to tidal marsh habitat. The diked marsh is already at mid-marsh elevation and dominated by pickleweed, but is isolated from tidal action by the perimeter levee/trail. Tidal action would be restored by breaching the perimeter levee. A tidal channel network connected to the levee breach would be excavated. (Because the marsh is covered with erosion-resistant vegetation, tidal channels may not form on their own in the foreseeable future.) Portions of the levee around the diked marsh would be lowered or removed to create disconnected high marsh and upland transitional habitat.

This alternative includes construction of a new setback levee along the north side of the soccer field to maintain or improve existing levels of tidal flood protection for the Al Boro Community Center, Pickleweed Park, and the Canal neighborhood from coastal flooding. The new levee could be designed by a geotechnical engineer to regional flood protection standards (e.g. seepage resistance, seismic performance, etc.). At this conceptual design stage, it is assumed that the levee height would be 13 feet NAVD88, matching MAS's raised levee described below. The existing levee along the east and west sides of the soccer field and community center would also be raised to this same height, providing approximately 2000 feet of uniform flood protection. The new levee would be designed with an ecotone transition to the outboard marsh, similar to MAS's levee as described above.

5.3 Habitat Levee

The levee segment proposed for enhancement as an ecotone slope is located along the south side of Tiscornia Marsh, and borders the existing playground on Spinnaker Point Drive owned by the City. Ideally a wide ecotone (transition zone) that combines ecological and flood protection benefits would be created between the levee crest and the outboard marsh. However, there is limited space for an ecotone along the MAS-owned levee due to the proximity of existing marsh to the north and the City's playground to the south.

We developed three approaches for raising the levee on MAS's property:

- **Option 1: Minimum Footprint.** This option utilizes the smallest levee improvement footprint by not including a gentler ecotone slope on the marsh side and instead utilizing the steepest stable slopes possible.
- **Option 2: Habitat Levee in the Marsh.** This option incorporates an ecotone gentler-sloped levee slope of the marsh side, with the ecotone extending outward atop the existing tidal marsh in order to preserve the footprint of City park.
- **Option 3: Habitat Levee outside of Marsh.** This option incorporates an ecotone gentler-sloped levee slope of the marsh side, with the ecotone extending inward toward the City park.

5.3.1 Option A – Minimum Footprint

Under this option the existing levee would be raised to elevation 13 feet NAVD88 and widened to a uniform crest width of 16 feet. The total footprint of the levee would be the minimum needed to meet these standards, including some allowance for levee settlement. This option would not include an ecotone slope, and therefore would have the minimal encroachment on either the marsh or the City's property.

The outboard toe of the raised levee would start at the marsh edge, slope at 3:1 slope up to the 16-foot wide crest, and slope down at 3:1 to existing grade on the inboard side. Assuming a starting marsh elevation of 6 feet NAVD88, and an initial crest elevation of 14 feet NAVD88 (to allowing for 1-foot of settlement during or soon after construction), the minimum width required for the new levee would be approximately 60 feet. As shown schematically in **Figure 19**, the new levee would encroach into the City's property a few feet in some locations.

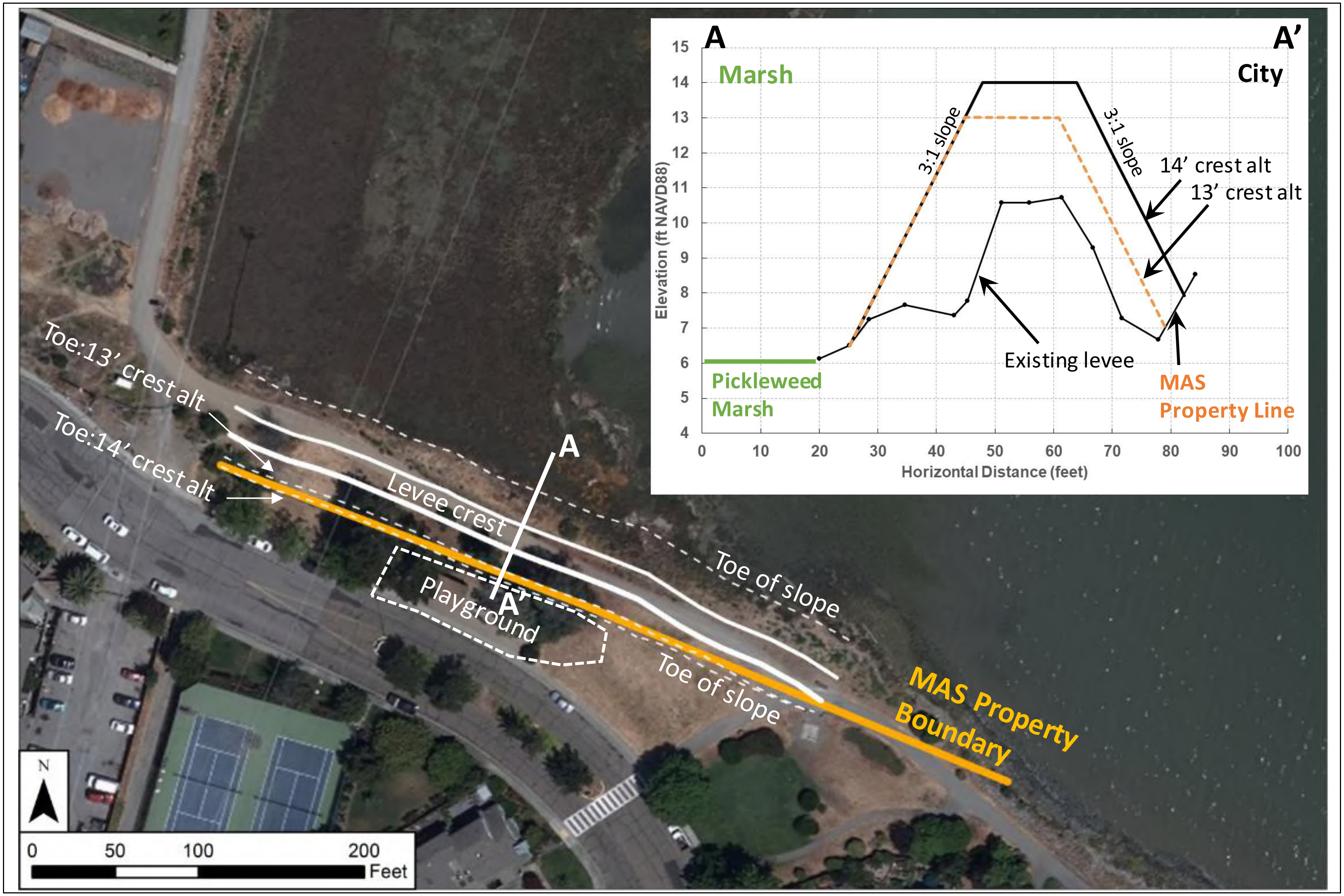

Figure 19

Levee footprint and cross section for Option A.

This option would have minimal impact on adjacent property and improvements. However, there are three trees, one large acacia and two smaller oaks, that could be impacted. In addition, the raised levee might fill the existing drainage swale between the levee and playground, resulting in the inboard levee slope draining directly toward the playground that would have to be addressed to maintain playground functionality. A geotechnical analysis will be performed in the next phase to estimate settlement potential, slope stability, seepage and drainage. Once these details are determined, more detailed layout of the total levee footprint will be performed. At that stage, it may also be possible to modify the levee design in some locations to reduce impacts to trees and other features.

5.3.2 Option B – Habitat Levee in Marsh

This option was developed to examine the potential for creating an ecotone slope with the raised levee, without encroaching on the City's property. The width of the ecotone slope could vary significantly, but for planning purposes is assumed to be 30 feet, as described above in Section 5.1.4. In this option, the earthen fill for levee raising would start at MAS's property boundary. The levee fill would slope up at 3:1 to the 16-foot wide levee crest and down at 3:1 to the top of ecotone (elevation 9 feet NAVD88). The ecotone would slope gradually at 10:1 slope down to existing marsh grade. Again, allowing for 1 foot of settlement, the total fill footprint will be approximately 80 feet wide. As shown in **Figure 20**, the ecotone fill would encroach 10 to 40 feet into the existing marsh. For this option, the habitat tradeoffs between reducing the existing marsh and creating an ecotone need to be carefully considered.

5.3.3 Option C – Habitat Levee Outside of Marsh

This option was developed with the assumption that the City would allow further encroachment onto the existing playground property. In that case, the levee and ecotone would have the same dimensions as in Option B, but would be shifted landward to minimize filling the existing marsh. The total fill footprint would be approximately 80 feet wide. The toe of the ecotone would meet the edge of the existing marsh, which is closest to the levee at the west end and further from the levee at the east end. Therefore, the amount of encroachment on the City's property would vary from 20 to 30 feet, west to east. For this alternative, the new levee crest would be offset from the existing crest, as shown in **Figure 21**. The geotechnical analysis would need to consider the uneven loading of the raised levee and mitigate for potential differential settlement. Under this alternative, the expanded levee would likely require removal of three mature pine trees within the playground. This alternative would also necessitate removing or reconfiguring the playground to accommodate the fill area.

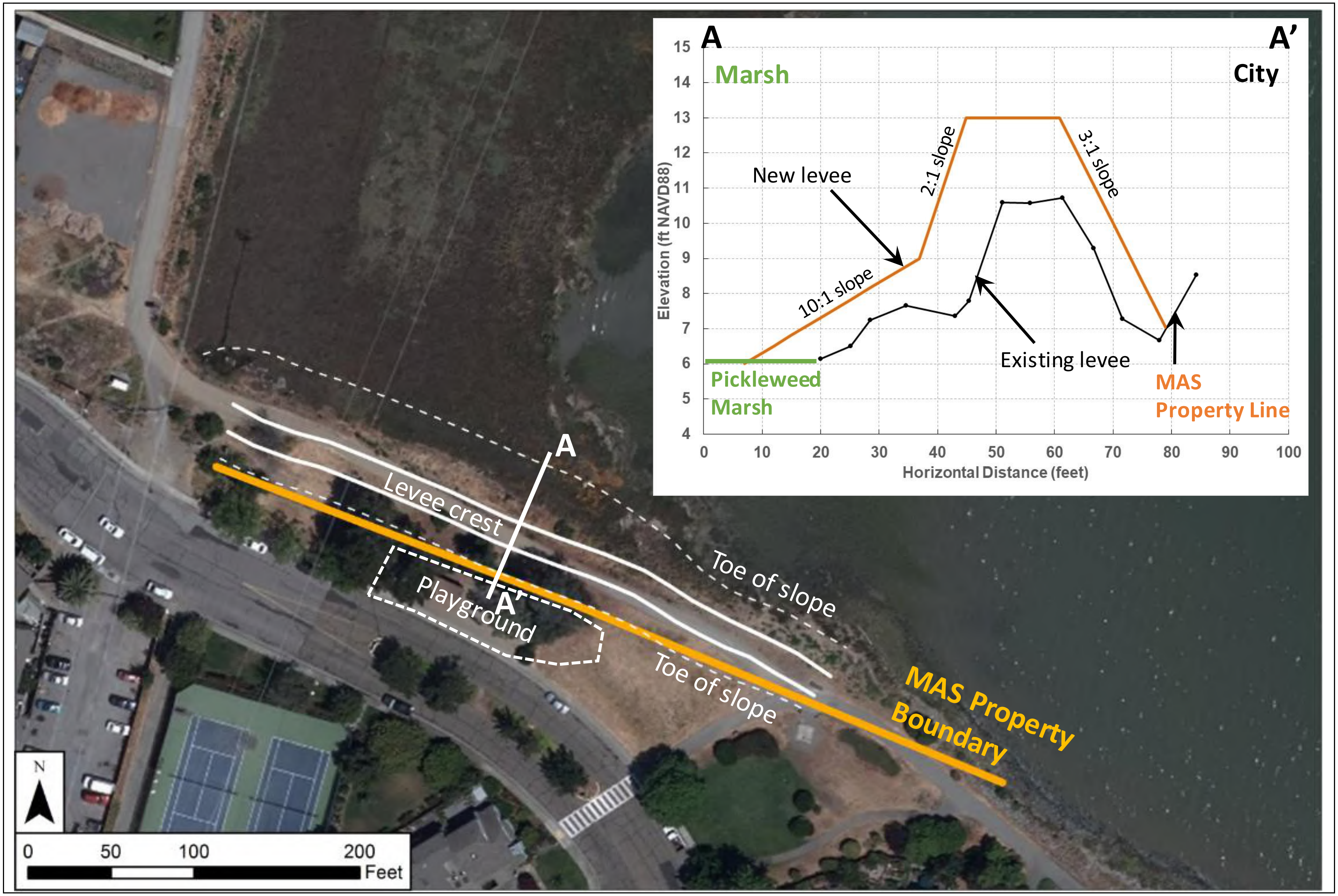

Figure 20

Levee footprint and cross section for Option B.

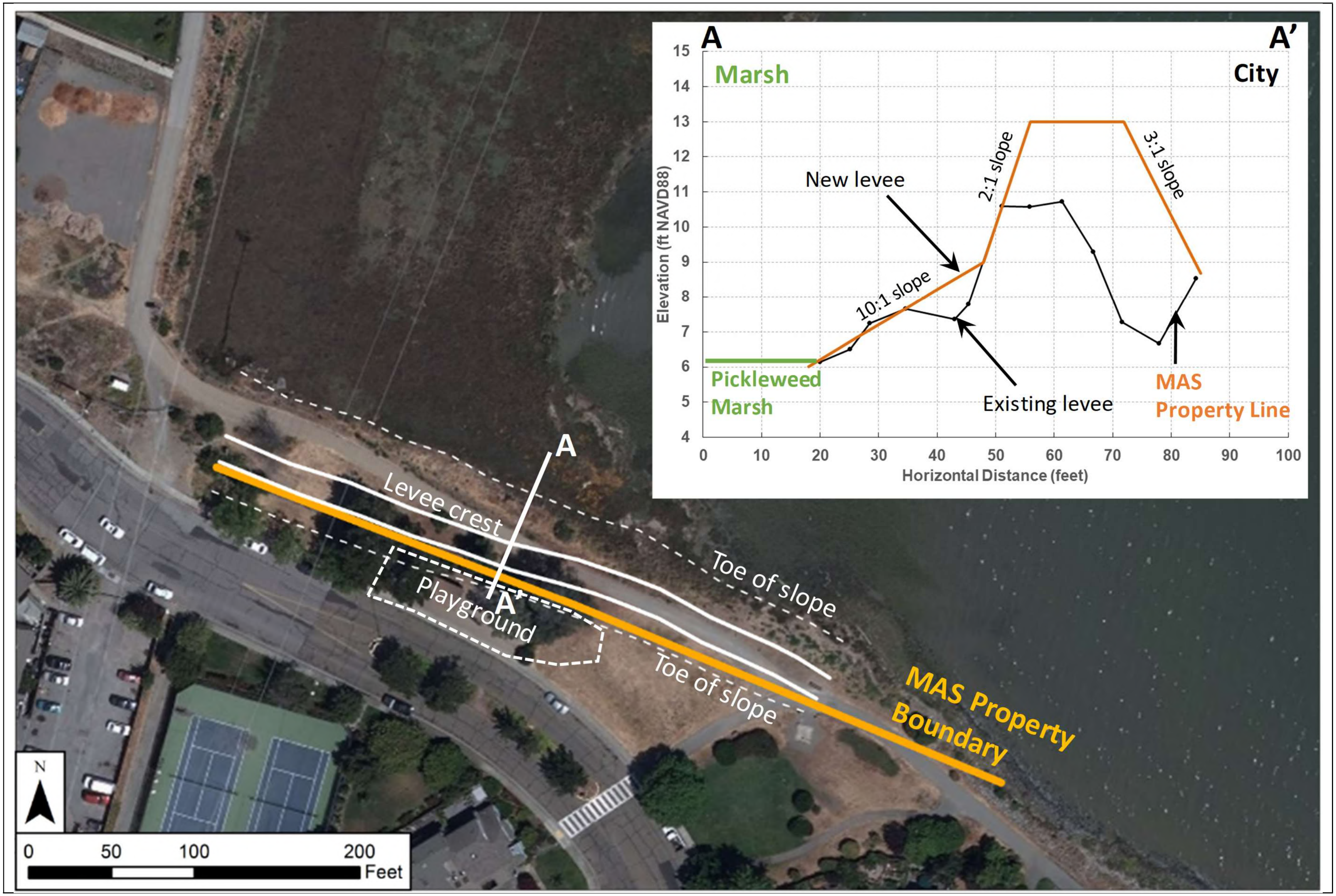

Figure 21
Levee footprint and cross section for Option C.

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6. ALTERNATIVES EVALUATION

The four alternatives for Tiscornia Marsh Edge Stabilization and the three options for the Habitat Levee were evaluated for their relative ability to meet the project goals and objectives described in Section 0. Below we describe the methods used to evaluate the alternatives, such analyses of future marsh erosion and marsh accretion rates. We then present a summary of how the alternatives measured up against the objectives for Tiscornia Marsh Edge Stabilization and the Habitat Levee.

6.1 Evaluation Methods for Marsh Alternatives

Each Marsh Alternative, including the No Action alternative, was evaluated to describe its expected geomorphic evolution over the 50-year planning horizon. We estimated both marsh erosion rates and future marsh accretion, and then predicted future habitat evolution in the face of sea level rise. This analysis relies on a number of simplifying assumptions and is subject to some uncertainty. The future conditions depicted are likely to occur at some point in the future, but the exact timing - whether in 30, 50 or 70 years, for example - is less certain.

6.1.1 Marsh Erosion Rates

Under the No Action alternative, erosion of the existing marsh was projected to continue at rates similar to recent erosion rates, as described in Section 3.1. The northern portion of the marsh has eroded an average of approximately 4 feet/year since 2004 (based on Transects 1 and 2), while the southern portion has eroded at slower rates, an average of 1.5 feet/year (based on Transects 3 and 4). The northern portion of the marsh, which is approximately 150 to 200 feet wide, is anticipated to be completely eroded away over the next 50 years. The southern portion of the marsh is wider than the northern portion, and is also eroding at a slower rate. Approximately 75 feet of landward erosion is expected to occur in the southern marsh over the 50-year planning horizon, based on an average erosion rate of 1.5 feet/year. Overall, the marsh width is expected to decrease to approximately 175 to 300 feet over the 50-years.

The three restoration alternatives described in Section 5 all include construction of a coarse beach outboard of the current marsh edge to reduce exposure to waves and attendant erosion. Therefore, future marsh erosion rates under these alternatives are expected to be negligible.

6.1.2 Marsh Accretion Rates

As discussed in Appendix A, marsh accretion rates are difficult to predict given the variability in inundation, sediment supply, and sediment recruitment by vegetation on the marsh. In general, lower areas tend to have longer quiet-water conditions and are supplied with suspended sediment more frequently than higher areas, leading to greater amounts of deposition and thus faster accretion rates. Local variations in topography that block or limit tidal and wind-wave currents also tend to contribute to higher accretion rates. For example, a design that would separate a mudflat area from the erosive tidal and wind wave currents would be expected to enhance sedimentation, which could lead to deposition rates above 10 cm/year in the early stages of restoration and slowing as marsh elevations rebuild and the deposited surface is submerged for shorter and shorter time periods. Additional factors to consider are the episodic nature of sediment supply, which can be substantial, and the projected long term decline of sediment availability as the Bay deepens with sea level rise (Schoellhamer 2011, Schoellhamer et al. 2018). To examine potential marsh accretion in more detail, we applied the following approach:

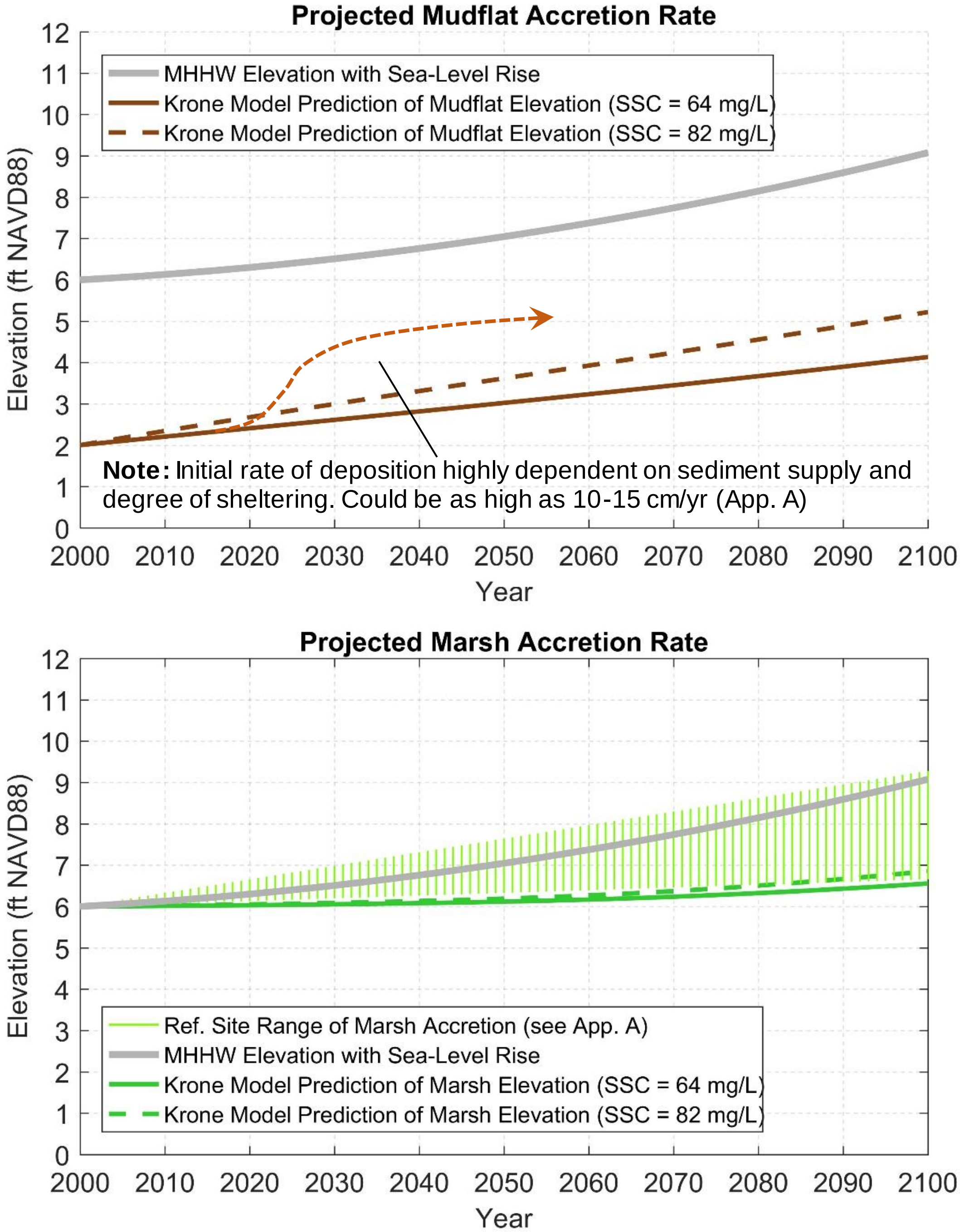
- A Krone (1979) model was applied to predict mudflat and marsh accretion rates into the future, based on the range of expected SSC at the site (Appendix A), and
- The ranges of accretion rates measured at nearby sites, including Corte Madera Marsh, Muzzi Marsh, and China Camp, were projected into the future to provide some additional context, and
- These were compared against the projected sea level rise curve to understand how the inundation regime could change over time (**Table 4** and **Figure 22**)

TABLE 4
ANTICIPATED ACCRETION OF TIDAL MARSH

Tidal Vegetation Zone	Approximate Accretion by 2070 (feet) [1]			Approximate net change relative to MHHW with 1.7 feet of sea level rise by 2070
	Suspended Sediment Concentration 64 mg/L	Suspended Sediment Concentration 82 mg/L	Value Used for Analysis	
Mudflat/Tidal Channel	1.45	2.24	1.8	0.1
Low Marsh	0.87	1.33	1.1	-0.6
Mid Marsh	0.24	0.37	0.3	-1.4
High Marsh	0.04	0.06	0.1	--1.6
Diked Marsh	0	0	0	-1.7

NOTES:
1 Accretion estimated with Krone (1979) model.

Overall, while the reference sites provide a useful comparison, their proximity to less developed watersheds and/or to the more sediment-rich San Pablo Bay environment led to predictions of higher rates of marsh and mudflat accretion than was predicted by the Krone model (Figure 22). The Krone (1979) model suggests that that an increase of 1.7 feet in sea level by 2070 would outpace sedimentation at all marsh zones, meaning that some natural habitat conversion would be expected if sedimentation was not augmented by artificial means. Mudflats were predicted to approximately keep pace with sea-level rise. Natural conversion would consist of some high-marsh areas converting to mid marsh as inundation increases over time, and similar downward transitions for mid and low marsh habitats (mid converting to low marsh and low marsh to subtidal habitats).



SOURCE: ESA Krone (1979) model and estimates of deposition summarized in Appendix A

Figure 22
Projected range of mudflat and marsh accretion rates compared against a medium-emission scenario sea-level rise case.

These results are generally consistent with those of Takekawa et al. (2013), who studied marsh accretion rates in detail throughout San Francisco Bay, and projected future marsh responses to sea-level rise. They used field measurements of inorganic and organic deposition rates to develop a Wetland Accretion Rate Model for Ecosystem Resilience (WARMER) model to project future conditions. Among their study sites, they included Corte Madera Marsh and China Camp, both of which were predicted to convert from primarily mid- and high-marsh to low-marsh and mudflat by 2070.

6.1.3 As-Built and Future Habitat Conditions

For each alternative we predicted habitat conditions immediately following project implementation (as-built conditions), as well as those expected in future conditions. As-built habitat conditions were estimated primarily by translating site grades to habitat types based on the elevation ranges presented in Table 6 and assuming that enough time has lapsed for equilibrium vegetation communities to have become established. As-built habitat conditions for the four marsh alternatives are presented in **Table 5**.

TABLE 5
AS-BUILT HABITAT AREAS FOR MARSH ALTERNATIVES

Tidal Vegetation Zone	Estimated Habitat Area (acres)			
	Alternative 1 No Action	Alternative 2* Intermediate Restoration	Alternative 3 Restore Eroded Marsh	Alternative 4 Restore Eroded Marsh & Diked Wetland
Mudflat/Tidal Channel	10.5	6.9	0.2	0.2
Low Marsh	2.1	2.1	2.1	2.1
Mid Marsh	2.6	5.2	10.7	16.4
High Marsh	3.5	3.3	4.1	4.1
Diked Marsh	5.7	5.7	5.7	0
Coarse Beach	0	1.2	1.6	1.6

* Alternative 2 assumed to create a narrow band of mid-marsh on the landward side of the coarse beach and jetty.

Future habitat evolution of the site is particularly important given the accelerating sea-level rise rate. We predicted future habitat conditions for existing and restored wetlands by applying anticipated marsh accretion and sea-level rise rates (Table 4). There is inherent uncertainty in predicting future conditions, as there are several variable factors anticipated to vary over time, including, but not limited to sea-level rise and local sediment concentrations. For this simplified analysis, we selected a single sea-level rise amount of 1.7 feet by 2017 (see Section 3.4.4) and used the average accretion rate from applying the low and high SSC values. From these two assumptions we extrapolated future habitat conditions. As noted above, the exact timing of when these future conditions would occur is uncertain. Higher sea-level rise rates and/or lower sedimentation rates would make these conditions more likely to occur sooner (i.e. less than 50 years); under lower sea-level rise rates and/or higher sediment concentrations these conditions would be expected farther into the future (i.e. greater than 50 years).

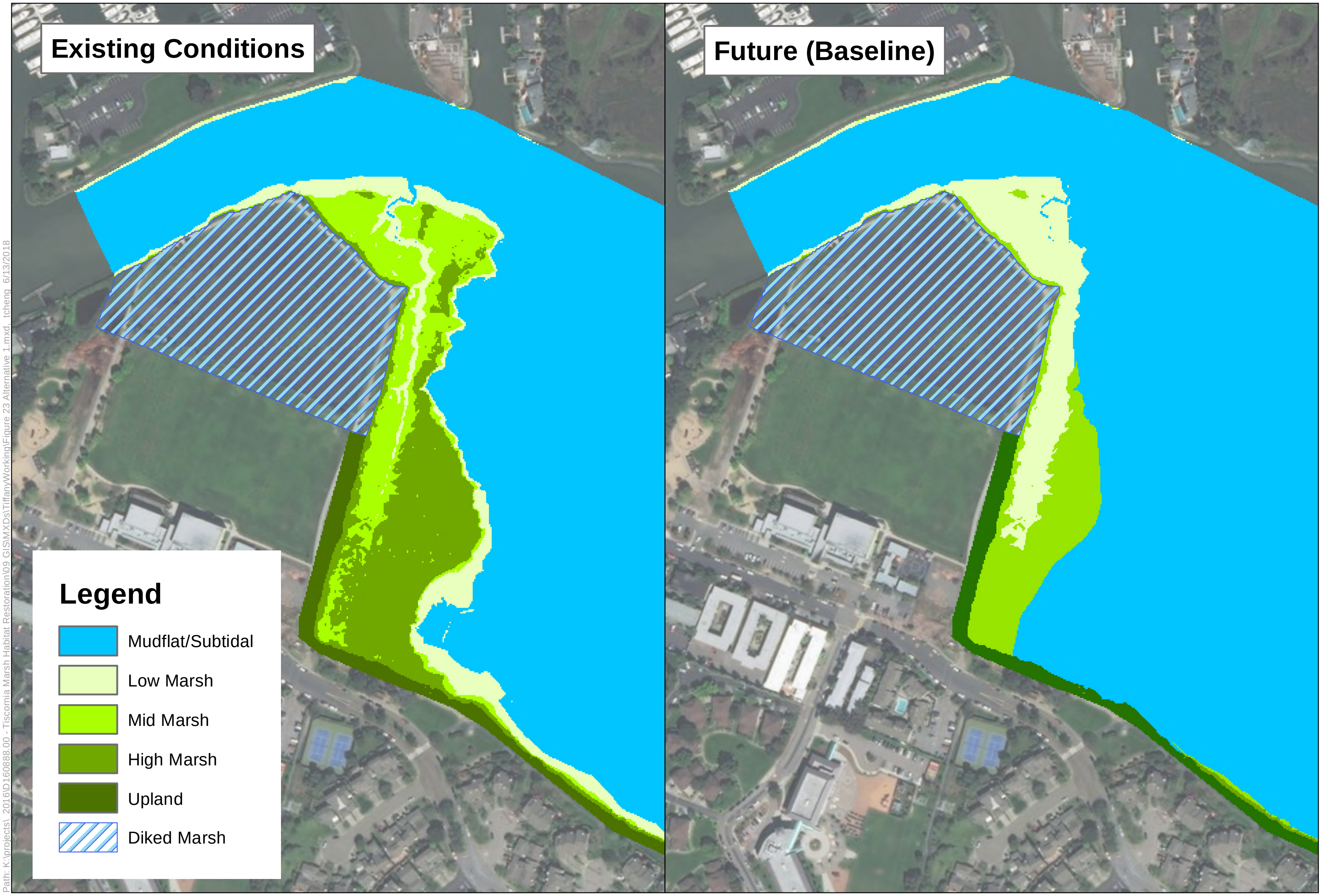
Wetland habitats are anticipated to transgress to higher elevations as estimated in **Table 6** using future tidal datums based on sea-level rise. At the same time, existing wetlands are expected to aggrade at the approximate rates presented in **Table 4**. Future habitat conditions were estimated by comparing future site elevations with future tidal datums. Future habitat conditions for the four marsh alternatives are presented in **Table 7**. **Figures 23 through 26** depict anticipated habitat types under post-project and future conditions for Alternatives 1 through 4, respectively.

TABLE 6
APPROXIMATE ELEVATIONS FOR EXISTING AND FUTURE VEGETATION COMMUNITIES

Tidal Vegetation Zone	Approximate Tidal Range	Existing (Year 2020)	Future (Year 2070)
		Approximate Elevation Range (ft NAVD88)	
Mudflat/Tidal Channel	<MTL	<3.3	<5.0
Low Marsh	MTL to MHW	3.3 – 5.5	5.0 – 7.2
Mid Marsh	MHW to MHHW	5.5 - 6.1	7.2 – 7.8
High Marsh	MHHW to high tide	6.1 – 7.3	7.8 – 9.0

TABLE 7
FUTURE (YEAR 2070) HABITAT AREAS FOR MARSH ALTERNATIVES

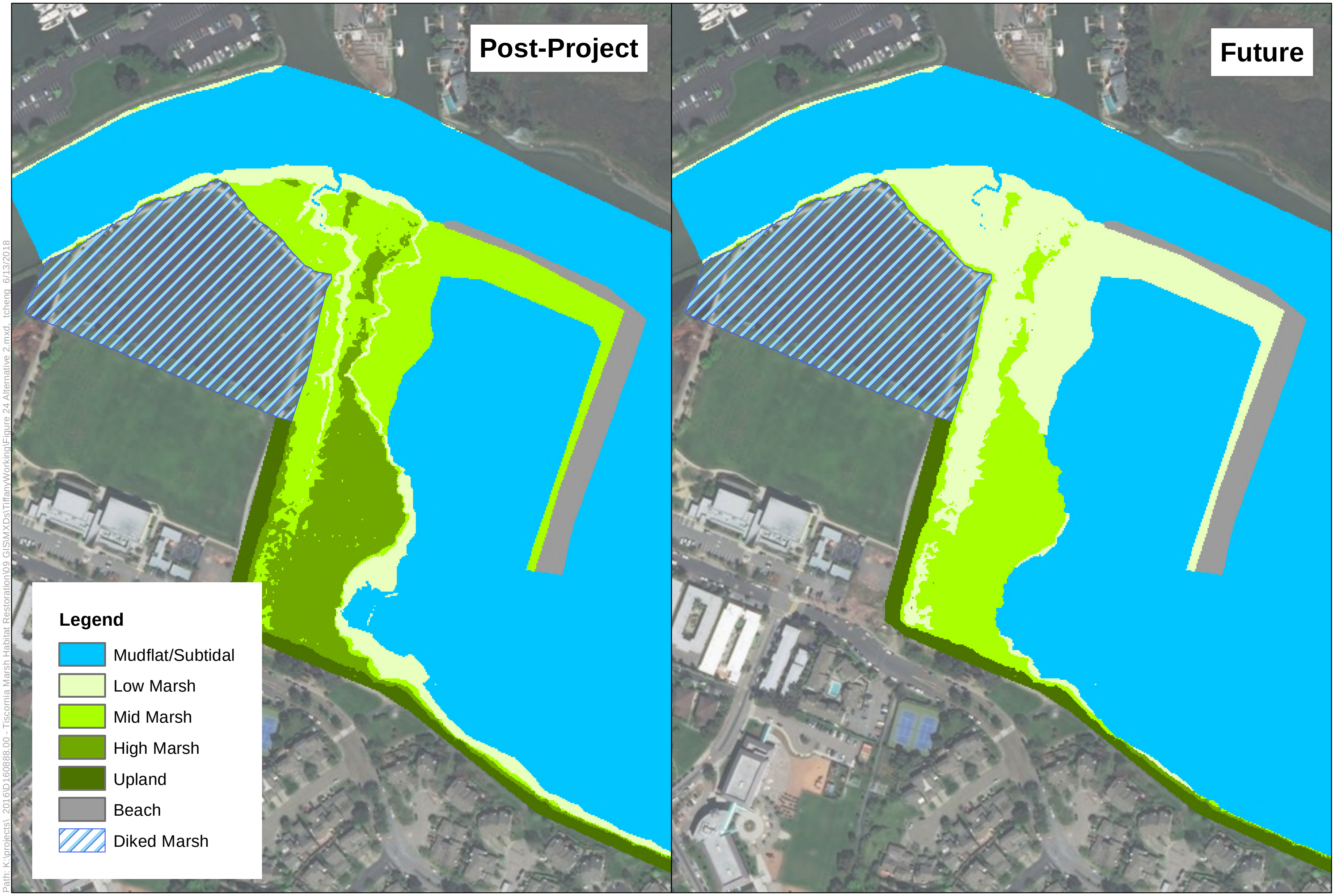
Tidal Vegetation Zone	Estimated Future Habitat Area (acres)			
	Alternative 1 No Action	Alternative 2 Intermediate Restoration	Alternative 3 Restore Eroded Marsh	Alternative 4 Restore Eroded Marsh & Diked Wetland
Mudflat/Tidal Channel	14.2	8.0	2.0	2.0
Low Marsh	2.3	5.9	10.4	16.3
Mid Marsh	2.1	3.5	4.6	4.4
High Marsh	0.1	0.1	0.1	0.1
Diked Marsh	5.7	5.7	5.7	0
Coarse Beach	0	1.2	1.6	1.6



SOURCE: ESRI (Aerial)

D160888.00 Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation Project

Figure 23
Alternative 1 - Existing and Future Habitat Conditions

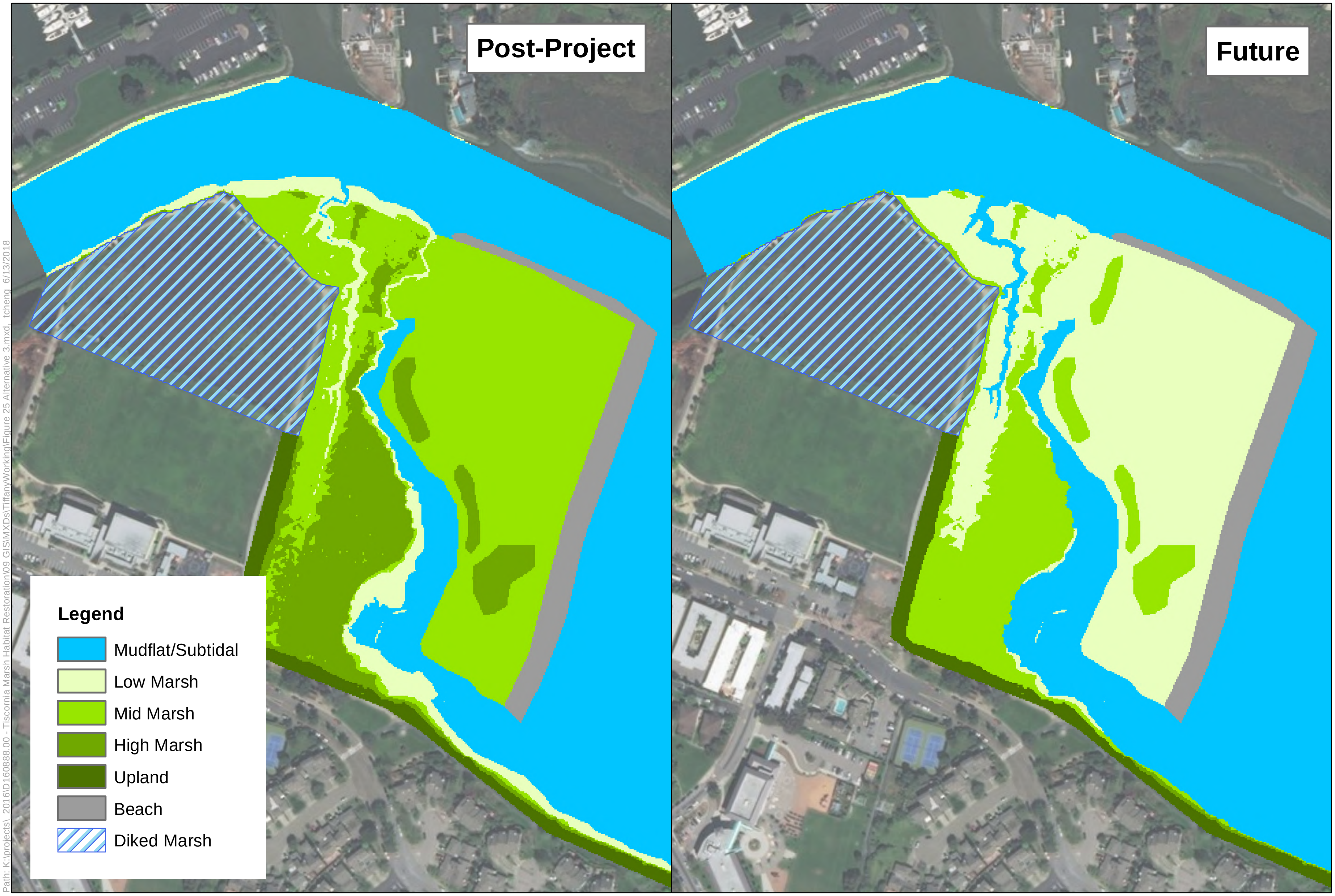


SOURCE: ESRI (Aerial)

D160888.00 Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation Project

Figure 24
Alternative 2 - Post-Project and Future Habitat Conditions
Vegetation Map

ESA

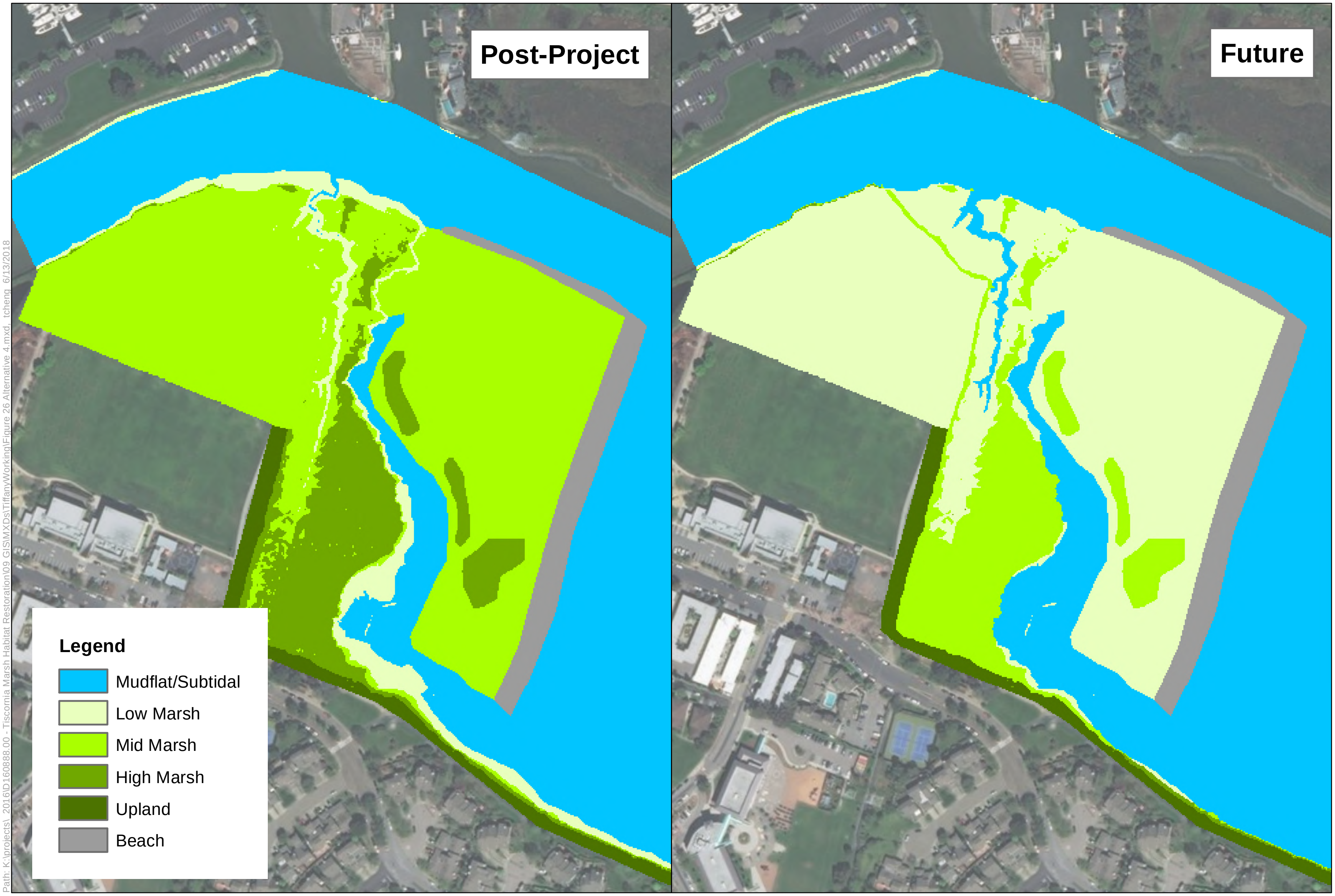


SOURCE: ESRI (Aerial)

D160888.00 Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation Project

Figure 25
Alternative 3 - Post-Project and Future Habitat Conditions

ESA



SOURCE: ESRI (Aerial)

D160888.00 Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation

Figure 26
Alternative 4 - Post-Project and Future Habitat Conditions

ESA

6.2 Evaluation of Tiscornia Marsh Alternatives

The four alternatives for marsh edge stabilization were evaluated relative to the six objectives listed in Section 0. The results of this evaluation are presented for each alternative below, and summarized in Table 8. After selection of a preferred alternative, this alternative is further evaluated for constructability and other considerations in Section 7.

6.2.1 Alternative 1 – No Action

Though limited in size, Tiscornia Marsh currently provides high marsh habitat for native wildlife, including the endangered RIRA and SMHM. Tiscornia is predominantly pickleweed-dominated high marsh, which is prime habitat for SMHM foraging and breeding. RIRA use a wider range of existing marsh habitats, foraging in tidal channels and mudflats at low tide, and nesting in higher marsh with taller marsh plants (such as gumplant, Pacific cordgrass and bulrush). The overhanging scarp along the marsh edge provides cover for the rail while foraging along the marsh edge in the outboard mudflat. In addition, the vegetated marsh-mudflat edge with gentle slopes at the southeast corner of the marsh is foraging habitat for shorebirds.

Existing habitat conditions at Tiscornia Marsh are not sustainable. Under the No Action scenario, the marsh edge would continue to erode at its current pace or potentially even more rapidly with sea-level rise. As shown in **Figure 14**, the northern portion of the marsh is expected to be completely eroded away in 50 years, and the southern portion will have eroded roughly 150 feet. Further, any remaining pickleweed marsh will be converted to low marsh and/or mudflat because sedimentation/marsh accretion rates are likely not sufficient to keep pace with future sea-level rise.

In future conditions under the No Action alternative, Tiscornia Marsh is expected to provide lower habitat values for SMHM due to conversion of pickleweed-dominated high marsh to cordgrass-dominated low marsh. The future marsh will be significantly reduced in size, and lack the full range of wetland zones used by RIRA for foraging and breeding. The impact to shorebirds is expected to be less, since ongoing erosion would likely cause the marsh-mudflat edge to shift landward, while still providing mudflat foraging habitat.

As the marsh erodes and lowers relative to tide levels in the future, its wave dissipation and flood protection benefits will decrease over time.

6.2.2 Alternative 2 – Extended Shoreline Stabilization

Alternative 2, Extended Shoreline Stabilization, would provide similar marsh habitat and ecological functions as Alternative 1, No Action under current conditions. As noted above, the existing marsh would provide habitat for SMHM and RIRA, with the outboard mudflat providing shorebird foraging habitat. The lower portions of the coarse beach, and the face of the rock jetty along the canal, would provide additional habitat values for native oysters where feasible. Another difference from Alternative 1 is that construction of the coarse beach would reduce the extent of mudflat available for shorebird foraging. We anticipate that this amount would be less than one acre.

The evolution of Alternative 2 would differ from Alternative 1, primarily because the coarse beach would protect the existing marsh from ongoing edge erosion. Under future conditions, the extent of marsh would be similar to current conditions, but its elevation relative to tidal levels would be lower. The marsh vegetation is expected to transition to cordgrass and other low marsh species over time. Therefore, Alternative 2 is expected to provide higher habitat values for both SMHM and RIRA compared to Alternative 1, and lower habitat value for both SMHM and RIRA in the future compared to Alternatives 3 and 4.

The evolution of the overhanging scarp along the marsh edge under this alternative is more uncertain. Most of the wave action that creates the erosional scarp would be dissipated by the coarse beach in the future. Therefore, the marsh edge may become more gently-sloped over time, as marsh edge slumps and sediments deposit. Overall, accelerated sediment deposition in the mudflat between the vegetated marsh and coarse beach is expected. However, as shown in **Figure 15**, this area would be expected to persist as mudflat, because the deposition rate was not predicted to outpace sea-level rise. However, since sites where mudflat areas are sheltered from wind-waves can experience high levels of deposition (see Appendix A), it is possible that modeled conditions are an under-prediction, and that the eventual bed elevation in the new channel feature will be more a function of tidal channel hydraulics (see Williams and Orr 2002).

6.2.3 Alternative 3 – Restore Eroded Marsh

Under Alternative 3, Restore Eroded Marsh, the total marsh area would be roughly double that for Alternatives 1 and 2. This alternative would provide more extensive marsh habitat for SMHM and RIRA. The marsh would be filled in a manner that preserves the overhanging scarp as the west bank of a new tidal channel, to the extent practicable. The expanded marsh would also provide a more extensive tidal channel network for RIRA foraging and movement across the marsh. Similar to Alternative 2, the lower portions of the coarse beach and rock jetty may be designed to enhance habitat for native oysters. It is noted that fill placement for the marsh and coarse beach would reduce the extent of existing mudflat used for shorebird foraging.

Under this alternative, the aerial extent of the expanded marsh is anticipated to persist over time, due to protection provided by the coarse beach on the outboard edge. Under future conditions, the marsh would accrete at a modest rate, but overall would be lower relative to rising tidal levels than under current conditions. High marsh is expected to transition to mid-marsh, and mid-marsh to become low marsh over time.

6.2.4 Alternative 4 – Restore Eroded Marsh and Diked Wetland

Alternative 4 incorporates all of the features of Alternative 3, and in addition, restores tidal action to the 6-acre diked marsh on City lands. This alternative would provide the largest extent of marsh as compared to the other alternatives. This alternative also offers the most opportunity to create and sustain the full range of wetland habitat zones, from mudflat and low marsh along the tidal channels, to high marsh refugia in the newly-created marsh. Therefore, this alternative is considered to have potential for the highest ecological value, particularly for SMHM and RIRA.

The future evolution of this alternative is anticipated to be similar to that projected for Alternative 3. The diked marsh, which is currently mostly at mid-marsh elevations, will evolve to low marsh over time, similar to the newly-created marsh. Again, this alternative is considered to have the highest future ecological value as compared to the other alternatives, based on the extent of vegetated marsh that would be provided.

This alternative also includes replacing the existing levee around the diked marsh with a new setback and/or raised levee. This would result in Alternative 4 also providing the highest level of flood protection compared to the other alternatives, which do not improve the City's levee to the immediate west of Tiscornia Marsh.

6.2.5 Goals and Objectives Evaluation Summary

The Marsh alternatives were evaluated for their relative ability to meet the six project objectives. We summarized this evaluation through a qualitative rating from low (**L**) to high (**H**) as summarized in **Table 8**.

TABLE 8
EVALUATION SUMMARY OF TISCORNIA MARSH ALTERNATIVES

Marsh Objective	Qualitative *Relative* Rankings of Each Alternative			
	Alternative 1 No Action	Alternative 2 Extended Shoreline Stabilization	Alternative 3 Restore Eroded Marsh	Alternative 4 Restore Eroded Marsh & Diked Wetland
Reduce current loss of vegetated marsh due to marsh edge erosion.	LOW	HIGH	HIGH	HIGH
Reduce future loss of vegetated marsh due to marsh "drowning" through sea level rise.	LOW	LOW	MEDIUM	MEDIUM
Enhance habitat for endangered marsh species, including RIRA and SMHM.	MEDIUM	LOW	MEDIUM	HIGH
Provide habitat for other wildlife, including shorebirds, ducks and other water birds as well as native fish and oysters.	MEDIUM	MEDIUM	LOW	LOW
Preserve and/or enhance flood protection function of the marsh for wave dissipation.	LOW	MEDIUM	HIGH	HIGH
Serve as a demonstration project for nature-based sea level rise adaptation strategies for SF Bay.	LOW	MEDIUM	HIGH	HIGH

Note that these ratings are both qualitative (estimates from best professional judgment of all the information presented in this report) and relative to each other alternative not to any external absolute raking.

Generally, the extent and resilience of vegetated marsh increases in order from Alternative 1 to Alternative 4. Alternative 1, No Action, provides the smallest extent of marsh, with increasing amounts provided under Alternatives 2 and 3, and Alternative 4, Restore Eroded and Diked Marsh, providing the largest area. The extent and resilience of vegetated marsh translates to improved habitat conditions for endangered marsh species. In addition, the larger the marsh, particularly in the mid to high marsh zones, the higher the wave attenuation function provided.

None of the alternatives can adequately counter eventual marsh “drowning” due to sea-level rise, but presumably the larger amounts of high marsh in Alternatives 3 and 4 would have greater resilience as compared to the more limited areas provided with Alternatives 1 and 2. Alternatives 3 and 4 provide a significant local increase in the near term after project construction, before sea-level rise begins to convert high marsh to mid marsh.

Alternatives 1 and 2 are anticipated to provide better habitat value for shorebirds, owing to the preservation of mudflats outboard of the marsh. While the rock jetty and coarse beach under Alternatives 2 through 4 may provide increased habitat for oysters, at this stage the potential for this benefit is uncertain.

The restoration alternatives incorporate three different nature-based sea-level rise adaptation strategies, coarse beach, beneficial reuse of dredged sediments, and levee ecotone slope. Since Alternatives 3 and 4 incorporate both strategies, they rate higher as suitable for a demonstration project than does Alternative 2, which only includes one such strategy.

6.3 Evaluation of Habitat Levee Options

The three options for the Habitat Levee were qualitatively evaluated against the four objectives of improving ecologic function, increasing flood protection, being compatible with City’s adjacent land use, and accommodating sea-level rise adaptation. The results of this evaluation are presented by objective below, and summarized in **Table 9**.

TABLE 9
EVALUATION SUMMARY OF HABITAT LEVEE OPTIONS

Habitat Levee Objective	Option A Minimum Footprint	Option B Habitat Levee in Marsh	Option C Habitat Levee outside of Marsh
Improve ecological function of the outboard levee slope for the endangered species and other native marsh species.	**LOW**	**MEDIUM**	**HIGH**
Increase level of flood protection for the adjacent Canal District, by raising\reconfiguring the levee to reduce frequency of wave overtopping (same level or better than adjacent levee segments).	**LOW**	**HIGH**	**HIGH**
Be compatible with adjacent public access uses, including the Bay Trail on the levee top and the City park/playground on the landward side of the levee.	**HIGH**	**HIGH**	**MEDIUM**
Allow for future adaptation as sea level rises.	**LOW**	**HIGH**	**HIGH**

Note that these ratings are both qualitative (estimates from best professional judgment of all the information presented in this report) and relative to each other alternative not to any external absolute raking.

The first objective is improving ecologic function. Option A, the minimum footprint option, has relatively low ecological benefit owing to the abrupt transition from the marsh to uplands. Options B and C, which incorporate a 30-foot wide ecotone slope, have similar ecologic value for high tide refugia and provide a buffer between the Bay Trail and the marsh. However, Option B requires filling existing outboard marsh to create the ecotone slope, which reduces the ecological value of the existing high marsh that it fills. Option C is assumed to have the highest ecological value of the three options, as it provides the same benefits as Option B but without impacts to the existing marsh.

In terms of flood management, each levee option will increase flood protection by raising the levee crest elevation to 13 feet NAVD88. In addition, the ecotone slope in Options B and C should also attenuate wave action, which would help to reduce wave runup and potential overtopping of the levee. Given the relatively sheltered wave environment along the south side of Tiscornia Marsh, the ecotone slope is assumed to provides a relatively moderate increased flood benefit, as compared to Option A.

The selected option needs to be compatible with the City's adjacent land use. Options A and B do not encroach upon City-owned property, so are considered most compatible with adjacent land use. Option C entails extending the levee footprint onto the City's property, a portion of which is a children's playground. The City has indicated it is open to considering reconfiguring, or possibly relocating, the playground. Therefore, Option C ranks the lowest in terms of compatibility with adjacent land use.

The final objective is accommodating sea-level rise adaptation. Over time, it will be necessary to raise the levee crest in response to sea-level rise. The expanded levee footprint under Options B and C provides more flexibility for future levee raising, as compared to Option A. In addition, in Option A, the ecotone slope provides a narrow fringe for marsh transgression as sea level rises. Therefore, both Options B and C are rated more highly than Option A for sea-level rise adaptation.

Both Options B and C have similar overall performance, except that Option B is more compatible with adjacent land use, while Option C provides higher habitat value.

Based on this evaluation, and given the emphasis on nature-based solutions in the grant, Option C, Habitat Levee outside the Marsh, is the preferred option.

Implementation of this option relies on the cooperation of the City. It is recognized that the City has its own constraints and priorities, and has not yet approved of this option. If ultimately the City does not agree to this option, then Option A would likely be implemented. It is possible that some of the ecotone slope toward the east end of the site could be constructed as part of the newly created marsh under Alternative 3 or 4.

7. PREFERRED ALTERNATIVE

7.1 Selection of Preferred Alternative

The preferred alternative is a combination of Alternative 4, Restore Eroded Marsh and Diked Wetlands, and Option C, Habitat Levee outside the Marsh. The city has indicated willingness to allow their property to be included in this plan, subject to further discussion. If ultimately the City opts not to move forward with restoration of the diked marsh, then the scope of the marsh stabilization would have to be scaled back to Alternative 3, Restore Eroded Marsh.

Likewise, if the City does not allow the raised levee to encroach into Schoen Park, then the width of the ecotone slope would have to be reduced to minimize filling the existing marsh. In this case, the preferred habitat levee option would be a hybrid between Option A, Minimal Footprint and Option B, Habitat Levee in Marsh, with a gentle ecotone slope (for example 10:1) where space allows.

The following sections describe the conceptual design, permitting considerations and constructability and next steps for the preferred alternative.

7.2 Conceptual Design for Preferred Alternative

Under the preferred alternative, Tiscornia Marsh will be restored to its approximate size in 1987, with a coarse beach and rock jetty on its east and north sides, respectively. In addition, tidal action would be restored to the City-owned diked marsh at the north end of Pickleweed Park. Altogether, the preferred alternative would create approximately 10 to 15 acres of new tidal marsh. Alternative 4 is shown in plan and section in Figures 17 and 18, respectively.

This alternative includes improving approximately 2000 feet of the shoreline levee for flood protection, public access and habitat benefits. The existing levee along the perimeter of the diked wetland at Pickleweed Park would be replaced with a new setback levee along the north side of the soccer field. The rest of the existing levee between Pickleweed Park and MAS's property would be raised and/or widened in place to provide uniform flood protection and public access. The new setback levee and MAS's levee on the south side of Tiscornia Marsh would include a gradually-sloped ecotone transition to the outboard marsh.

7.2.1 Coarse Beach

A coarse beach will be constructed at the marsh edge to help resist ongoing erosion. This coarse-grained feature would emulate naturally-occurring beaches in San Francisco Bay, and would be comprised of a mixture of sand, gravel, cobble, and/or oyster shell hash. The coarse beach would provide multiple benefits, including increasing the stability of eroding shorelines, creating aquatic and wetland habitats, and providing a platform for ecosystem adaptation to sea-level rise.

Coarse beaches within the Bay are typically shallow-sloped shorelines between subtidal and supratidal elevations. At Tiscornia Marsh, the proposed coarse beach feature would extend from the outboard mudflat up to approximately elevation 8 feet NAVD88. Retention groins (or “micro-groins”) constructed of wood and/or rock may be incorporated into the beach to restrict longshore drift and to allow sufficient retention of sand and gravel in the beach profile.

7.2.2 Newly Created Tidal Marsh

The existing mudflat outboard of Tiscornia Marsh would be filled to re-create approximately 8 acres of tidal marsh. Most of the marsh would be at elevation 6 feet NAVD88, with areas of high marsh up to roughly elevation 7 feet NAVD88 along channel banks and other locations. The overhanging scarp along the existing marsh edge would be preserved as much as feasible for RIRA habitat. The marsh would include an appropriately-sized tidal channel network that would provide interior mudflats fringed by low marsh for RIRA foraging.

The exact footprint of the new marsh would vary depending on several factors, including property ownership, fill availability, reducing impacts and other factors. The extent of the marsh as conceptually shown, extends beyond MAS’s property boundary to the north. Adjacent property within the San Rafael Canal is within State Lands Commission’s (SLC) jurisdiction. Further consultation with SLC is needed to approve use of their property for the project. If needed, the marsh footprint could be scaled back to only include MAS’s property.

Bay muds similar to the existing marsh would be the most appropriate fill material. Therefore, beneficially reusing dredged material from in or around the San Rafael Canal is the preferred fill method. At this stage, we have assumed a proposed marsh footprint of 8.5 acres, which is slightly larger than that shown on the 1987 aerial photo footprint. The estimated fill volume for the footprint shown is approximately 60,000 to 100,000 cubic yards.

The exact footprint of the marsh could be somewhat variable between approximately 5 and 10 acres, considering the need for protection against sea-level rise and transition zone habitat, the availability of suitable fill material, cost and other factors.

7.2.3 Restore Diked Wetlands

The diked marsh is already at mid-marsh elevation and dominated by pickleweed, but is isolated from tidal action by the perimeter levee/trail. Tidal action would be restored by breaching the perimeter levee. A tidal channel network connected to the levee breach would be excavated. Also portions of the levee around the diked marsh would be lowered or removed to create disconnected high marsh and upland transitional habitat.

7.2.4 Rock Jetty

A rock jetty would be constructed at the north boundary of Tiscornia Marsh that extends eastward, parallel to the Canal. The purpose of the rock jetty is to trap and accumulate sediment that would otherwise drift along the beach face and deposit in the Canal. The jetty will reduce erosion of the newly constructed beach, and should reduce the depositional rate of the Canal. The jetty would likely be a flexible structure constructed of suitably-sized rock. The jetty would extend from the Canal bottom up to approximately 2 feet above MHHW, (approximately elevation 7 to 9 ft NAVD88). During the future detailed design phase, we will look for opportunities to incorporate features in the lower, subtidal portion of this feature to enhance its potential as oyster reef habitat.

7.2.5 Ecotone Slope

A gradual slope between high marsh and upland areas would create a wide ecotone (transition zone) that combines ecological and flood protection benefits. The ecotone would be located along the outboard slope of the existing shoreline levee and trail. The actual width of a constructed ecotone slope varies significantly, and depends on functional objectives, available space, and other factors. Given site constraints, we recommend sizing the ecotone (elevation range and slope) at a minimum to function as a wind wave dissipation bench. An ecotone sized with this approach can also provide ecological function for habitat and buffering. More detailed wind wave analysis will be performed in the future detailed design phase. At this stage, we have developed preliminary dimensions based on similar levee benches designed by ESA.

As described above, we have developed preliminary dimensions for the ecotone slope for Tiscornia Marsh based on our experience with similar projects. At this stage, the ecotone would be approximately 30 feet wide, assuming a 10:1 slope between elevations 6 and 9 feet NAVD88. The actual slope and elevations of the ecotone will be determined based on further analysis in the future detailed design phase.

The slope will be planted with native vegetation adapted to historic ecotones, intermixing high marsh and upland species adapted to infrequent flooding and salinity, and including grasses for nesting materials (e.g. creeping wildrye, *Elymus triticoides*). Plant cover must be entire (or nearly so) throughout the year, and reach elevations which remain emergent (above 1 foot in height) through the highest tides, so that small marsh mammals and secretive marsh birds can find cover from predation.

7.2.6 Raised Levee

The portion of the existing levee on MAS's property will be raised to a consistent height and constructed to a standard width. We have assumed a crest elevation of 13 feet NAVD88 and a 16-foot crest width, to accommodate the Bay Trail. At this stage, we have assumed that the levee will have uniform side slopes of 3:1 (horizontal:vertical) on the landside, and on the outboard side above the ecotone slope. The actual side slopes and other geotechnical criteria for the raised levee will be addressed in the future design phase. The new levee would be designed by a geotechnical engineer to regional flood protection standards (e.g. seepage resistance, seismic performance, etc.)

Under the preferred Option C, the new levee footprint would encroach into the City-owned Schoen Park. The total fill footprint will be approximately 80 feet wide. The toe of the ecotone will be at the edge of the existing marsh, which is closer to the levee at the west end, and further at the east end. Therefore, the amount of encroachment on the City's property will vary from 20 to 30 feet, west to east. For this alternative, the new levee crest will be offset from the existing crest, as shown in Figure 21. The geotechnical analysis will need to consider the uneven loading of the raised levee and mitigate for potential differential settlement. Under this alternative, the expanded levee would likely require removal of existing trees. This alternative would also necessitate reconfiguring the existing playground, so that it is moved landward of the new levee or relocated nearby.

7.3 Construction Approach

Given that much of the work needs to occur in the open Bay waters, the construction approach is a significant consideration for cost, permitting and feasibility. Potential construction methods for the conceptual design are described below. This section has been prepared with input from B.K. Cooper, a marine contractor who has constructed many marsh restorations and other marine improvements in the Bay Area. The construction approach is subject to refinement in future phases based on more detailed studies, input from regulatory agencies, information on potential dredged material and other fill sources and further discussion with local contractors.

7.3.1 Fill Placement Options

The project entails significant fill placement for several elements including: raising and/or building the flood protection levee; rebuilding the marsh; and constructing the beach and rock jetty. Potential fill sources can generally be divided into two categories: fill excavated from uplands, and material dredged from open waters. Uplands fill is transported to the site using trucks and placed using land-based construction equipment (excavator, bulldozers, etc.). Importing significant volumes of upland fill requires multiple truck trips, which could become problematic for residents due to traffic congestion and noise.

The second source is dredged material, which is typically excavated by hydraulic dredging (e.g. using a suction dredge), or mechanically (e.g. using a crane). The dredging method determines the composition of dredged material (e.g. water content) and delivery method to the site. For hydraulic dredging, excavated sediment is mixed with water to form a slurry that can be pumped to a discharge location. Slurries are generally 15-20% sediment and 80-85% water. As an alternative, dredging can be performed mechanically using a crane outfitted with a clamshell bucket, dragline or similar. Mechanically dredged material is wet - but with much lower water content than slurried material - and is usually loaded into a barge for transport to the disposal location.

At this stage, we have made preliminary assumptions regarding fill sources and placement methods for the major design elements. We assume that uplands fill will be used to improve the existing levee and construct the ecotone slope, since there is relatively good road access to the levee locations, and the required fill volumes are not excessive (roughly 10,000 to 13,000 cubic yards).

For marsh construction, we assume that it would be most feasible to hydraulically-place the fill material. Placing fill mechanically (either upland soils or dredged spoils) would require staging a crane or excavator in the mudflat to place and spread material. We anticipate significant challenges with constructing access roads or crane pads in the existing mudflat given the soft, saturated sediments. Significant volume of imported rock material and geotextiles would likely be required, and would create mud waves until the road/pad were stabilized. Therefore, hydraulically placing fill material as a slurry appears to be a more feasible method for obtaining uniform fill placement throughout the marsh.

For the beach and jetty construction, fill materials (rock, sand, gravel and/or shell hash) would likely be imported from commercial suppliers within the Bay (e.g. Hanson Products, Dutra or Syar quarry, and/or Jericho Products) and transported by barge to the project site. Beach materials would be offloaded and placed along the constructed marsh edge using a floating crane. The placement of beach materials would be coordinated with construction of a containment cell and placement of marsh fill, with the exact sequence to be determined.

The assumed fill sources and placement methods for the various design elements, as well as alternatives for further consideration, are summarized in **Table 10** below.

TABLE 10
ASSUMED FILL SOURCES AND PLACEMENT METHOD

Design Element	Fill Source	Transport & Placement Method	Alternative Types of Fill & Placement Methods to be Considered
Levee & Ecotone Slope	Upland soils (meeting levee core criteria)	Trucked to site and mechanically placed and compacted	Potential to use dried and conditioned dredged sediments, if needed
Marsh Reconstruction	Dredged sediments (see Appendix B for potential sources)	Barge transport & hydraulic placement	Consider mechanical placement of fill material.
Beach and Jetty Construction	Imported rock, sand, gravel and/or shell hash	Barge transport & mechanical placement, in conjunction with marsh reconstruction	To be evaluated as design develops

7.3.2 Dredged Material Sources

As part of this project, Stuart Siegel of Siegel Environmental examined potential sources of dredged sediment for beneficial reuse at Tiscornia Marsh (see April 11, 2018 memorandum included in Appendix A). This memorandum identifies several maintenance dredging projects along San Rafael Creek and other nearby locations that could feasibly provide dredged sediment for Tiscornia Marsh. **Table 11** lists all the dredging along San Rafael Creek since 2010, which includes dredging the Canal, as well as marinas and private boat docks.

TABLE 11
DREDGING RECORDS ALONG SAN RAFAEL CREEK SINCE 2010

Location	Year	Approximate Volume (cubic yards)
Marin Yacht Club 2016 7,106 SF-10	2016	7,106
Larkspur Ferry Terminal	2015	378,654
Aqua Vista Drive #16, 20, 24 (private docks)	2015	1,241
Loch Lomond Marina	2015	66,068
Lowrie Yacht Harbor 2015	2015	1,306
Marin Yacht Club	2015	24,820
Pt San Pedro Road #100-110 (private docks)	2015	1,794
Mooring Road HOA (private docks)	2013	4,403
Aqua Vista homeowners (private docks)	2012	1,538
Lowrie Yacht Harbor 2012 26,376 SF-10	2012	26,376
Porto Bello HOA (private docks) 2012 6,073 SF-10	2012	6,073
Royal Court homeowners (private docks)	2012	1,815
Marin Yacht Club	2011	21,206
San Rafael Yacht Harbor	2011	4,400
San Rafael Channel (USACE)	2011	48,600
Larkspur Ferry Terminal	2010	310,449
San Rafael Yacht Harbor	2010	900

SOURCE: Dredged Material Management Office annual reports (DMMO 2011 to 2017), as reported in Appendix A.

Unfortunately, the timing of future dredging of the San Rafael navigation canal is uncertain, as it is a low priority for the U.S. Army Corps of Engineers (USACE). However, the volumes of sediment from dredging marinas and private dock range from as anywhere between 1,000 and 66,000 cubic yards. It is possible that two or more local dredging projects could provide suitable fill volume required for the project. In addition, Larkspur Ferry Terminal is dredged by Golden Gate Bridge, Highway and Transportation District every four to five years. One dredge cycle for the ferry terminal generates more than enough material needed for Tiscornia Marsh. More detail on the proposed fill sources is provided in Appendix A.

Depending on the source, dredged material will either be hydraulically or mechanically dredged. If the dredge material comes directly from a site that has been hydraulically dredged, it may be possible to discharge the material directly into the mudflat, provided it is fully contained. If the dredge material comes by barge from a mechanically dredged site, it would best be transferred to an offshore unloader, slurried and pumped into the contained mudflat.

7.3.3 Dredge Material Placement

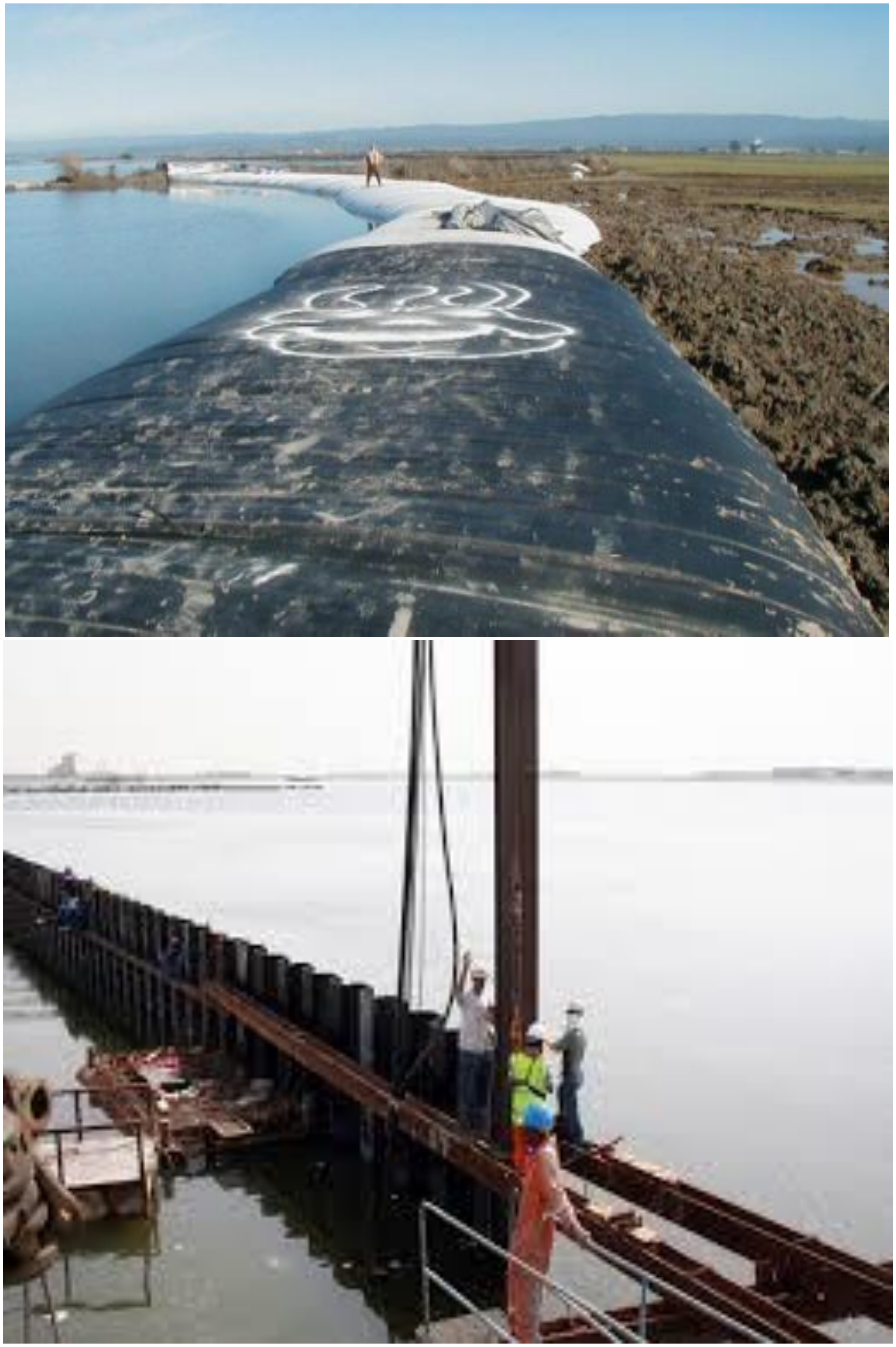
As noted above, we currently assume that hydraulic-placement of dredged material is most feasible. Prior to fill placement, a containment cell needs to be constructed around the entire area. The containment cell is needed to contain sediments over several months of draining and consolidation, while protecting adjacent waters and wildlife. Since we are applying a hydraulic slurry to build the marsh, the containment method needs to be close to watertight to hold decant water until it meets water quality discharge requirements. Ideally the containment cell would extend 5 to 7 feet above finished marsh elevation (i.e. up to elevation 11 to 13 feet NAVD88).

B.K. Cooper considered numerous types of containment, and concluded that steel sheet piling and water dams were the two most feasible options. Steel sheet piling, while relatively costly, are predictable and efficient. A steel sheet piling wall can accommodate water control structures such as flap gates, slide gates, weirs or pumping systems, and/or can be used to support a working platform. Sheet piling are relatively water tight, although a sealant applied to the connecting joints, before installation, provides a water tight barrier. Sheet pilings, while expensive, retain a high resale value. Installation of steel sheet piling in this mud flat environment is typically performed by a barge crane with a shallow draft, using a vibratory hammer.

Portable water (or bladder) dams may be a reasonable alternative to steel sheet piling and they are less expensive to purchase. Water dams are flexible tubes that can be placed from the water using marine floating gear (e.g. small barge-mounted crane), then filled with water using portable pumps. For Tiscornia Marsh, a series of 16-foot tall, 32-foot wide water bags would likely provide sufficient containment; additional smaller tubes may be needed for stability. If the water dams were used, water control structures would need to be installed separately. Some disadvantages of water dams are that they can deteriorate over time and do not usually have reuse value. One viable containment option may be to install a water dam along the existing marsh edge to protect the overhanging escarpment in-place, and install a sheet pile wall along the new outboard marsh edge.

Water removal and management are key considerations for hydraulically-placed material. Since placed material is 80% or more water, water needs to be constantly decanted and removed to allow drying and consolidation of sediments. Removed water can either be discharged directly to the Bay, or be recycled in a closed-loop system, where decant water is pumped to the dredge pump and used as slurry makeup water. If discharging directly to Bay, a decant weir can be built into the sheet pile wall. For a closed loop system, a standpipe or similar would be installed within the fill placement area, and the removed decant water would be pumped to back to the dredge pump. We assume a closed system would be somewhat more costly, but would be more acceptable to regulatory agencies, and could possibly accelerate dewatering (since water quality standards for removing water would be lower than discharging directly to Bay).

Onsite conditioning of the dredge materials will be important to shape the new marsh. Initially the dredge discharge pipes will be maneuvered using low ground pressure dozers and/or amphibious excavators to distribute the slurry throughout the new marsh. As material is dewatered, it can be further dried and conditioned using low ground pressure dozer pulling a disk. It is likely that dredged material may need to be placed in at least two phases. The majority of dredged sediments would be placed in an initial phase, and allowed to dewater, consolidate and settle over several months. A second phase of material placement may be needed to raise the site to final grades. Interior berms may be constructed to focus subsequent phases of dredged fill placement. It is anticipated that dredged fill placement and consolidation will occur over three to five years.



SOURCE: B.K.Cooper

Figure 27
Containment options: examples of bladder dam (top) and sheetpile wall (bottom).

7.3.4 Permitting Considerations

Potential jurisdictional wetlands and other waters are considered sensitive biological resources under the California Environmental Quality Act (CEQA), and are regulated by the USACE, RWQCB, BCDC, and CDFW. Wetlands and waters in the Study Area consist of mudflats, tidal channels, low marsh, mid-marsh, and high marsh/transition zone biological communities. Mudflats and tidal channels are considered potential jurisdictional waters, and the remainder of these communities is considered wetlands. In addition, the site does or has the potential to support special status plant and wildlife species as listed in Section 3.3.4 and as regulated by the USFWS, NMFS, and CDFW; impacts to these wildlife resources may also require permits or authorizations.

Those permits or approvals expected to be required are listed below, by agency. In particular, we anticipate that significant effort may be required to obtain permits from the USACE, RWQCB, BCDC, and the DMMO as restoration activities will involve:

- Significant in-water work
- Placement of significant volumes of dredged and/or fill material in the Bay and adjacent marsh habitats
- Potential for construction-related turbidity, noise, and vibration; and
- Potential for associated disturbances to protected habitats and/or sensitive species which utilize the site.

U.S. Army Corps of Engineers

The discharge of dredged and/or fill material within the San Francisco Bay requires a Section 404 CWA permit from the USACE. In addition, the placement of structures or conducting work in navigable waters requires a Section 10 Rivers & Harbors Act permit from the USACE. A jurisdictional delineation would need to be performed under the next phase of the project to support permitting. However, at this stage it is assumed that most of the site is jurisdictional wetlands or waters. It is also assumed that none of the site’s existing levees are built or maintained by the USACE, and therefore, no Section 408 approval from the USACE would be required for levee alteration.

USACE Section 404 CWA authorization can be obtained by complying with specific Nationwide Permit conditions that are applicable to a proposed action. If there are no applicable Nationwide Permits that fit a project, the applicant must apply for an Individual Permit, which can be rigorous to prepare, requires an associated NEPA analysis (typically prepared by the USACE, but with significant applicant support) as well as an alternatives analysis to demonstrate project compliance with the EPA/USACE’s 404(b)(1) Guidelines, and can take much longer for the USACE to review.

As a result, the simplest and most efficient way to obtain a USACE permit is to meet the requirements of a Nationwide Permit, and obtain USACE’s written verification of compliance. It appears that some, if not all, components of the proposed project could meet the requirements of

USACE' Nationwide Permit #27-Aquatic Habitat Restoration, Enhancement, and Establishment Activities, provided the project can demonstrate a net increase in aquatic resources functions and services. The Tiscornia Marsh should qualify, since it results in a net increase in tidal wetland and tidal channel acreage, improves habitat value for endangered marsh species, as well as providing sea-level rise resilience. If the entire project is determined to be suitable for authorization under NWP 27, then the USACE does not typically require compensatory mitigation (say, for project activities that may result in small wetland acreage losses that are necessary to achieve significant aquatic resource gains in functions and services).

However, some project components such as the rock jetty, and possibly also the raised levee may not be viewed as fitting the intent of NWP 27. Instead these components would need to be authorized under an additional NWP, such as NWP 13 – Bank Stabilization, which could then have associated compensatory mitigation requirements for net permanent losses of waters or wetlands. Such 'stacking' of more than one NWPs is permitted under many circumstances. However, if all project components cannot fit into one or stacked NWPs, due for example to exceedances of certain NWP thresholds for acreage or linear foot limits, an Individual Permit may be required. Because the appropriate permit approach for the USACE is not obvious at this time, the potential permitting approach(es) should be discussed with the USACE before applying for project permits.

Dredged Material Management Office

With respect to the disposal of dredged material in Bay waters, the USACE hosts and participates in the inter-agency Dredged Material Management Office (DMMO), which reviews all proposals for dredging and dredge disposal in the Bay. The DMMO also includes participation by the BCDC, RWQCB, SLC, CDFW, NMFS, and EPA. As the proposed project anticipates to beneficially re-use some dredged material for tidal marsh creation, it will be subject to review and suitability determination(s) by the DMMO.

Regional Water Quality Control Board (RWQCB)

The RWQCB, which administers both federal and state water quality laws, must provide its approval of all permits issued by the USACE in the form of a Clean Water Act Section 401 Water Quality Certification and/or Waste Discharge Requirements (WDRs) under the state's Porter-Cologne Water Quality Control Act. Often, the RWQCB issues a combined 401 Certification/WDR for a project. Certifications and/or WDRs issued by the RWQCB can be assumed to include water quality standards for the discharge of dredged material decant water to the Bay, as well as best management practices and avoidance and/or minimization measures aimed at minimizing turbidity and other construction-related impacts that could adversely affect water quality.

It should be noted that the State Water Resources Control Board (SWRCB) is currently proposing the "State Wetland Definition and Procedures for Discharges of Dredged or Fill Material to Waters of the State" for inclusion in the forthcoming "Water Quality Control Plan for Inland Surface Waters and Enclosed Bays and Estuaries and Ocean Waters of California." If adopted as currently drafted, it is expected to include clarifications on the definition of a wetland under both federal and state regulations administered by the RWQCB, wetland delineation procedures, and permitting process changes, all of which could have implications, though not anticipated to be major, for the project's RWQCB permitting process.

In addition, under its current interpretation of the state's No Net Loss policy for wetlands (Executive Order W-59-93), the project can be expected to require compensatory mitigation for net permanent increases in Bay fill. However, it should also be noted that, as with several other regulatory agencies around the Bay, RWQCB may be currently attempting to revise its regulations and/or implementation guidance, to better enable the beneficial reuse of dredged and/or fill material in the Bay for habitat creation, restoration, and enhancement and especially for such actions that also promote sea-level rise resiliency and adaptability. In fact, based on ESA's similar recent project experience, it may be possible to deduct those project areas that are temporarily converted to uplands, but will become wetlands under projected sea-level rise, from the overall accounting of project 'net loss' and the subsequent requirement for compensatory mitigation.

U.S. Fish and Wildlife Service (USFWS)

The USFWS must issue their approval of any projects that require federal approval (e.g., a USACE permit) and that have a potential to adversely affect federal-listed species regulated by the USFWS. Two federally-listed species regulated by the USFWS, RIRA and SMHM, have the potential to occur within the project site and have been documented as present at the site in the past (Section 3.3.4).

As a result, the USACE (as the assumed federal lead agency for the project) will initiate consultation with the USFWS pursuant to Section 7 of the Endangered Species Act, during processing of the Nationwide Permit or Individual Permit application. Assuming the project results in some adverse effects to USFWS-listed species during construction (despite proposed avoidance and minimization measures), a focused Biological Assessment report would be required. Field survey data collection is likely needed to prepare a Section 7 Biological Assessment report.

Focused species surveys have not been performed recently to assess presence or absence of SMHM at the project site. Wildlife resource agencies would likely assume presence of the SMHM for the purposes of project environmental compliance and permitting. While the presence of RIRA has been recently documented (OEI 2018), it is possible that focused surveys would be requested by the USFWS during the consultation process. Generally, wildlife resource agencies do not accept either general habitat assessments or focused species surveys that are older than 3 years.

National Marine Fisheries Service (NMFS)

Similar to the USFWS, NMFS must issue their approval of any projects that require federal approval (e.g., a USACE permit) and that have a potential to adversely affect federally-listed species regulated by NMFS, such as federally-listed fish including green sturgeon and several species of salmonids), under Section 7 of the Endangered Species Act. In addition, NMFS regulates potential impacts to non-listed marine mammals such as seals, sea lions, and porpoises under the Marine Mammal Protection Act (MMPA). Finally, NMFS regulates activities that may affect Essential Fish Habitat (EFH) under the Magnuson-Stevens Fishery Management and Conservation Act (MSFCMA); EFH is essentially ubiquitous throughout the San Francisco Bay and can therefore be assumed present in the waters surrounding the project site. As a result, the USACE will request Section 7 consultation with NMFS during processing of the USACE's Nationwide Permit or Individual Permit application.

Assuming the project can effectively minimize potential construction-related effects to listed fish, marine mammals, and EFH through measures it may be possible to avoid adverse effects and the need for formal take authorization. Protective measures would likely include using a containment cell for the controlled placement of dredged material, and observing in-water work windows to protect listed fish and EFH (typically June 1 – November 30), and use of vibratory pile driver (instead of impact hammer) for sheetpile installation. If this is the case, NMFS can concur with a Not Likely to Adversely Affect determination, via the informal Section 7 consultation process.

If, instead, it is determined that the project will result in some unavoidable adverse effects, a formal Section 7 consultation process may be required. Regardless of the nature of the anticipated effects to NMFS-listed species and the form of consultation determined suitable, field survey data collection will likely be needed to prepare an assessment of effects to NMFS-protected biological resources.

Bay Conservation and Development Commission

BCDC asserts jurisdiction over the tidal waters of the San Francisco Bay, certain tributaries to the Bay, adjacent tidal marsh areas up to the elevation of 5 feet above the Mean Tide Line, plus a 100-foot 'shoreline band' as measured from the edge of areas subject to tidal action. As we currently understand, the extent of BCDC jurisdiction at the site may end at the powerlines traversing the San Rafael Canal at Tiscornia Marsh (Brenda Goeden, pers. Comm. February 9, 2018). The remainder of the site east of the existing power lines is assumed to be within BCDC's jurisdiction, as are the waters surrounding the site.

A Regionwide, Administrative, or Major Permit Application would be prepared for BCDC, with the specific permit type to be based on the nature of the proposed activities, prior BCDC permits issued for the site, and direction provided by BCDC staff. The permit application would incorporate much of the information contained in the USACE and RWQCB permit applications, including a focus on the proposed placement of in-water fill, plus additional detail on public access, improved shoreline appearance and/or public amenities.

It should be noted that the BCDC, similar to the RWQCB, can be expected to require compensatory mitigation for net permanent increases in Bay fill, which is likely to include some or all in-water fill to create new tidal marsh, the rock jetty and coarse beach. However, it should also be noted that, as with RWQCB and other regulatory agencies around the Bay, BCDC is currently attempting to revise their regulations and/or implementation guidance, to 1) better enable the beneficial reuse of dredged and/or fill material in the Bay for habitat creation, restoration, and enhancement, especially for such actions that also promote sea-level rise resiliency and adaptability, and 2) to acknowledge certain site and project limitations on provision of public access or amenities, in light of potentially conflicting objectives such as wildlife conservation.

California Department of Fish & Wildlife (CDFW)

The CDFW regulates activities that occur in streams, lake beds, and some tidal tributaries to the Bay that support wildlife and their habitats, and therefore may require a Section 1602 Lake and Streambed Alteration Agreement (LSAA) for the project based on its location in and around San Rafael Creek. While some information required in the CDFW LSAA notification is similar to that required by the USACE and RWQCB, as well as an assessment of potential impacts to water quality and quantity, trees and vegetation, and wildlife movement or other life stage functions.

The CDFW also regulates activities that may affect state-listed species and their habitat protected under the California Endangered Species Act (CESA). If the project would adversely affect state-listed species, need for a Section 2080.1 Consistency Determination or a separate Section 2081 Incidental Take Permit (ITP), may be required under the California Endangered Species Act.

State Lands Commission (SLC)

The California SLC (Commission) has jurisdiction and management control over sovereign lands of the State that were received by the State from the United States. Sovereign lands, or lands underlying the State’s navigable and tidal waterways, as well as the state’s tide and submerged lands along the State’s coastline.

The SLC holds its sovereign lands for the benefit of all the people of the State, subject to the Public Trust for water related commerce, navigation, fisheries, recreation, open space and other recognized Public Trust uses. The Commission maintains a multiple use management policy to assure the greatest possible public benefit is derived from these lands. The Commission will consider numerous factors in determining whether a proposed use of the State's land is appropriate, including, but not limited to, consistency with the Public Trust under which the Commission holds the State's sovereign lands. Proposed projects on land with SLC jurisdiction must typically apply either for a lease from the SLC for their proposed structures and/or uses of the land, or, if a lease already exists, a lease amendment.

As we currently understand, some adjacent property within the San Rafael Canal is within SLC’s jurisdiction. Therefore, further consultation with SLC is needed to confirm the extent of their jurisdiction and approve use of their property for the project, which may include obtaining a lease or lease amendment.

Cultural Resources Assessment

As stated above, the project will require the issuance of a USACE Section 404 permit. Section 404 permit issuance by the USACE will require meeting the requirements of Section 106 of the National Historic Preservation Act (NHPA) of 1966 (as amended), which address cultural resources, through interagency coordination between the USACE and the State Historic Preservation Office (SHPO). It is anticipated that the Section 106 coordination requirements will include the preparation of a combination *Historic Properties Survey Report/Finding of Effect* report (*HPSR/FOE*) that can also be used to meet the cultural resources requirements of CEQA

7.3.5 Next Steps for Implementation

This phase of the project concludes with conceptual design for the preferred alternative for the marsh edge and the habitat levee. The overall goal is to move the project forward to implementation. Below is a summary of some of the major next steps.

Obtain additional grant funding for next phase. As a non-profit organization, MAS relies on grant funding to accomplish marsh restoration and sea-level rise adaptation demonstration projects. Potential funding sources include local, state and federal grant programs focused multi-benefit ecosystem restoration projects, particularly those with an emphasis on sea-level rise adaptation.

Partner with the City. Continue to coordinate with the City to better define conditions for City participation in the project. This may require adjusting the design as needed to address the City's concerns regarding flooding, recreational use and other considerations.

Perform additional technical studies including:

- Topographic Mapping: use licensed surveyor to identify property boundaries, perform utilities survey and perform more detailed mapping of park, diked marsh and other features.
- Geotechnical Investigation: Hire geotechnical engineer to perform subsurface investigation and provide geotechnical design recommendations for raising the existing levee, constructing the new setback levee and installing the temporary containment cell.
- Wave analysis: perform more detailed wave analysis to inform the design dimensions and elevations of the beach and the ecotone slope.
- Ecological/Biological Surveys: Perform jurisdictional wetland delineation and biological surveys needed to inform the design, perform CEQA and initiate permitting.

Continue to perform outreach with the public, regulatory agencies and potential fill sources.

- Public Outreach: to build on the momentum already started, keep the community informed and better understand public concerns to be considered in CEQA documentation and project design.
- Initiate outreach to the regulatory agencies (including the SLC, who have jurisdiction over the property immediately adjacent to Tiscornia Marsh to the north) to obtain early input on potential concerns, required studies, and permitting restrictions.
- Perform outreach to identify potential sources of fill material, including prospective sediment and soil generators, BCDC and the DMMO, and the San Francisco Bay Joint Venture's SediMatch program (developed for this purpose).

Develop the preliminary design for preferred project. Advance the design based on results of technical studies, and input from the City, regulators and the public. Preliminary design will completely define the scope of the project, including portions requiring City participation, and will provide an initial estimate of construction costs.

Perform CEQA Analysis. Once the project is better defined, we recommend initiating the CEQA process to further advance the project toward implementation. The initial approach would be to pursue an Initial Study/Mitigated Negative Declaration, assuming that all potential impacts can be limited to less than significant by implementing suitable mitigation measures.

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APPENDIX A: MEMORANDA FROM SIEGEL ENVIRONMENTAL

This appendix includes the following memoranda provided by Siegel Environmental:

- A February 22nd 2018 memorandum: ‘Dredged Sediment and Upland Soils Reuse Potential for Tiscornia Marsh’
- A March 9th 2018 memorandum: ‘Tiscornia Marsh Sediment Supply Conditions and Potential Marsh Accretion Rates’

SIEGEL ENVIRONMENTAL

3027

Memorandum #2.1 (Final)

Dredged Sediment and Upland Soils Reuse Potential Tiscornia Marsh

By: **Stuart Siegel**

Date: **February 22, 2018**

This final memo incorporates feedback on the December 27, 2017 draft memorandum from Barbara Salzman (January 3, 2018 email) and Ed Nute (January 8, 2018 email), a field visit with Brenda Goeden of BCDC on February 9, 2018, and community efforts as described in a Marin Independent Journal story that ran on December 31, 2017 and an associated Editorial that ran on January 6, 2018.

This memorandum addresses one element of Task 2: the potential for dredged sediment to be available for reuse to rebuild the eroded eastern bayward edge of Tiscornia Marsh. Based on MAS review of the draft memorandum, consideration of upland soils reuse has been added to this final memorandum.

Stuart Siegel spoke with the City of San Rafael (Kevin McGowan) and Loch Lomond Marina (Pat Lopez, Harbormaster). He left a message for but has not spoken with Salt River Construction, the primary dredging contractor that works along San Rafael Creek. Based on those two conversations, dredging along San Rafael Creek can be divided into two categories each discussed below: (1) dredging along San Rafael Creek, and (2) dredging from other nearby locations.

1 Coordinating Prospective Sediment and Upland Soil Sources

There are three general methods for coordinating with prospective dredge or upland soils generators: direct outreach and communication with prospective sediment and soil generators, close coordination with BCDC and the Dredged Material Management Office, and engagement with the San Francisco Bay Joint Venture's SediMatch effort established for this specific purpose. As Tiscornia Marsh proceeds to the next phase of work after completing the Conceptual Plans and funding is secured for the next phase of project planning, pursuing these outreach efforts in the context of the final Conceptual Plan would be appropriate.

2 Dredging Methods, Uplands Soils, and Placement Considerations

__Dredging Methods__

Dredging is typically conducted in one of two general manners relative to how material could arrive at Tiscornia Marsh.

- **Hydraulic dredging:** sediment is mixed with water to form a slurry and pumped in a pipeline directly to a placement or discharge area. Slurries are generally 15-20% sediment and 80-85% water. Placement generally requires containment cells and discharge of slurry water after all the sediment settles out into the containment cell. Routing of dredge pipelines across the San Rafael Creek federal navigation channel may increase technical or regulatory challenges and potentially cost. Researching those issues is beyond the scope of this memorandum.
- **Clamshell or other excavation methods:** sediment is excavated from the dredge area and placed onto barges or trucks for transport to the reuse or disposal area. These sediments are generally mostly (wet) sediment with a minor amount of additional water, and the sediment cohesiveness and thus ease of handling is a direct function of sediment type and percent moisture. Barge transport is standard for dredging along San Rafael Creek where most sediment is currently disposed of in-bay at the approved SF-10 aquatic disposal site in San Pablo Bay. The cost difference to transport and bottom-dump barges at SF-10 versus transport a short distance and unload at Tiscornia or alternatively load sediment into trucks and drive around to Tiscornia is beyond the scope of this analysis to assess. Were there any cost increases, most likely they would need to be borne by the Tiscornia project.

If a source dredging project generates more sediment in its dredging cycle than Tiscornia will need, it is most likely that a single dredging method would be employed, so as to avoid additional equipment mobilization and demobilization costs. For all the dredged sediment sources reviewed below, clamshell dredging with barge transport is how they currently conduct their dredging. If it is to the advantage of the Tiscornia project to receive dredge material as a pumped slurry and if there are additional costs to the dredger, then the Tiscornia project would most likely need to provide the funding differential.

Upland Soils Reuse

Another approach for Tiscornia Marsh is reuse of upland soils in addition to or in place of using dredge material. The most notable example of this approach is Bair Island in Redwood City, which used substantial quantities of uplands soils. Upland soils most typically originate from a construction project that generates soil cut and is in need of identifying economical soil disposal locations. Upland project sponsors have two over-riding cost considerations in selecting disposal locations: trucking distances and tipping fees. Two assumptions and one statement of fact must be made for the analysis: (1) assume Tiscornia would not charge a tipping fee, (2) assume additional costs to the upland project sponsor, if any, would be borne by the Tiscornia Project, and (3) soil quality would have to meet regulatory standards for wetlands reuse. Consequently, feasibility for an upland soils generator relates to meeting or reducing their costs relative to other disposal options, which will relate to trucking distances and soil testing costs. Bair Island developed a comprehensive Quality Assurance Project Plan with the Regional Water Quality Control Board that served as the framework for assessing soil quality and soil physical characteristics. The other feasibility consideration for any soil generator is timing. Flexibility in timing may exist for some upland construction projects but not for all, so arranging timing alignment with Tiscornia could have challenges depending on the project details of the upland soils source.

Upland soils availability is generally known over fairly short time horizons before the upland construction begins (on the order of months) and less often with longer notice (many months to a year or more). From the perspective of constructing Tiscornia Marsh improvements including accounting for seasonal construction constraints likely to be required from the Resource agencies and construction costs, lining up all the necessary soils in advance for delivery within the target construction window would be beneficial, probably necessary, and can be challenging because of probable need to receive soils from multiple construction projects. Perhaps it might work to be an "open" upland soils placement area for an extended period of time, if a holding location can be identified and incorporated feasibly into the Conceptual Design that can make it through CEQA analysis. To obtain the to-be-determined soil volumes, MAS or its consultants would need to be in ongoing communication with construction firms and upland project sponsors working in Marin and local jurisdictions permitting construction projects.

Volumes Needed for Tiscornia

As part of Conceptual Design, ESA will make estimates of placement volumes desired for any of the design approaches identified and elected by MAS to be incorporated. Once those volume numbers are estimated, any future discussions with prospective dredge material or upland soils sources would include the volumes needed, that the Tiscornia Project would not be able accept additional material (unless the project includes a long term holding facility component), and that the project seeks the maximum amount of material consistent with the economics of dredge reuse of any dredge project.

Placement Considerations

The ability of the Tiscornia Marsh project to receive sediment from either or both of these dredging methods or uplands soils reuse will have to be incorporated into the Conceptual Designs being prepared by ESA and included to the extent appropriate for the project. Sediment reuse would conceivably be incorporated into restoring eroded marsh on the east side of Tiscornia Marsh, the wetland-upland transition, and perhaps thin layer deposition atop the remnant marsh. The Conceptual Design will also need to consider whether it is accepting the volume of dredge sediment needed for initial marsh restoration and enhancement work, or possibly additional sediment that is stockpiled somewhere for later addition as consolidation and sea level rise needs arise. This latter element is purely elective for MAS to pursue, and until the restoration project has well established goals and objectives it is difficult to determine whether stockpiling for future use would be an important part of the project.

Engineering considerations for receiving dredge material include but are not limited to: (1) geotechnical, construction, regulatory, and cost feasibility of any necessary containment features built on mudflats, marsh edge, or upland; (2) feasibility of managing decant water if hydraulic dredging is utilized; (3) geotechnical, construction, regulatory, and cost feasibility of features to ensure the placed sediment is retained and not scoured away and transported into the San Rafael Creek navigation channel.

3 Dredging Sources from San Rafael Creek (the "Canal")

Dredging along San Rafael Creek falls into three distinct dredge areas: federal channel maintenance dredging (San Rafael Creek is a federal authorized navigation channel), marina maintenance dredging, and private boat dock maintenance dredging. It is common that dredging across these three areas is done concurrently, in order to gain efficiencies with mobilization and demobilization costs in particular as well as with the dredging work itself. This is especially the case with the private dock dredging as homeowners seek the most economical path for their dredging. Table 1 lists all the dredging that has taken place along San Rafael Creek since 2010 across all three of these categories.

Table 1. Dredging Records along San Rafael Creek Since 2010

Location	Year	Volume	Disposal
Marin Yacht Club	2016	7,106	SF-10
Larkspur Ferry Terminal	2015	148,425	SF-10
		157,153	Ocean
		73,076	Montezuma
Aqua Vista Drive #16, 20, 24 (private docks)	2015	1,241	SF-10
Loch Lomond Marina	2015	66,068	SF-10
Lowrie Yacht Harbor	2015	1,306	SF-10
Marin Yacht Club	2015	24,820	SF-10
Pt San Pedro Road #100-110 (private docks)	2015	1,794	SF-10
Mooring Road HOA (private docks)	2013	4,403	SF-10
Aqua Vista homeowners (private docks)	2012	1,538	SF-10
Lowrie Yacht Harbor	2012	26,376	SF-10
Porto Bello HOA (private docks)	2012	6,073	SF-10
Royal Court homeowners (private docks)	2012	1,815	SF-10
Marin Yacht Club	2011	21,206	SF-10
San Rafael Yacht Harbor	2011	4,400	SF-10
San Rafael Channel (USACE)	2011	48,600	SF-10
Larkspur Ferry Terminal	2010	57,774	SF-10
		166,800	SF-11
		85,875	Ocean
San Rafael Yacht Harbor	2010	900	SF-10

Source: Dredged Material Management Office annual reports (DMMO 2011 to 2017)
Disposal Sites:

- *SF-10 = San Pablo Bay in-bay aquatic disposal site*
- *SF-11 = Alcatraz Island in-bay aquatic disposal site*
- *Ocean = Deep Ocean Disposal Site*
- *Montezuma = Montezuma Wetlands Restoration Project*

3.1 Federal Channel Maintenance Dredging

Federal channel maintenance took place in 2001 along the entirety of San Rafael Creek and in 2011 along the creek up to the point where contaminated sediments are known to be present, roughly in the vicinity of the San Rafael Yacht Club. Almost 49,000 cubic yards were dredged in 2011 and disposed in-bay at SF-10 (DMMO 2012). The U.S. Army Corps of Engineers is responsible for federal channel maintenance, and San Rafael Creek is not currently identified as a priority project. San Rafael is working with the local dredge sponsors for the Petaluma and Napa rivers to pursue a "combined" dredging project with the intent that its larger scope raises its priority with Corps of Engineers. As reported in the Marin IJ on December 31, 2017, this effort is being conceived as a Public-Private Partnership, which the federal Administration has recently required development of new procedures by the Corps of Engineers for this approach to be pursued. The effort also has the attention of the San Rafael City Council, Marin County Board of Supervisors, and Congressman Huffman.

Based on these findings, the timing of any federal channel maintenance dredging is difficult to estimate and thus may or may not align with the unknown future timing of Tiscornia. As Tiscornia advances towards implementation planning, close coordination with these efforts should be pursued if deemed beneficial to Tiscornia Marsh.

3.2 Marina Maintenance Dredging

San Rafael has five marinas: Loch Lomond Yacht Harbor, Marin Yacht Club, Lowrie Yacht Harbor, the San Rafael Yacht Harbor, and the Municipal Yacht Harbor (Figure 1). Loch Lomond is located east across the open bay about ¾ mile from Tiscornia Marsh. Marin Yacht Club is located northwest across San Rafael Creek about ¼ mile from Tiscornia Marsh. The remaining marinas are all located upstream along San Rafael Creek to the west of Tiscornia Marsh.

Figure 1. Marina Locations Relative to Tiscornia Marsh

Stuart Siegel spoke with Pat Lopez, the Loch Lomond Harbormaster. Loch Lomond is the largest marina and dredges on a variable three-to-five year cycle, with the most recent being in 2015. Each cycle generates up to 90,000 cubic yards of dredged sediment, with 68,000 being dredged in 2015 (Table 1). Sediment quality is consistently not an issue with the exception in some dredging cycles of sediment from the immediate vicinity of the fueling dock and other localized areas. Salt River Construction most typically conducts this dredging, as it has the smallest equipment for accessing dredging areas. Currently, dredge disposal is in-bay at SF-10. Loch Lomond expressed interest in providing dredged sediment for Tiscornia Marsh, especially if it reduces their disposal costs. Conceivably, dredging could be conducted via hydraulic dredge and pumping through a temporary pipeline to Tiscornia Marsh or via clamshell dredge and barge transfer. Given the dredging cycle for Loch Lomond and its proximity, with advance planning and coordination it could well be possible to reuse dredge sediment for Tiscornia Marsh. The volume dredged is likely greater than Tiscornia Marsh will need, so this source could meet the entire needs for Tiscornia. That volume difference suggests that Loch Lomond would not split its dredging into clamshell and hydraulic at its own cost, so Tiscornia would likely have to pick up any added costs if hydraulic dredging and pumping were deemed preferable.

Similarly, Marin Yacht Club, the second largest marina, is also close by and with advance planning and coordination, it could also be a source of dredge sediment for marsh restoration reuse via hydraulic or clamshell dredging. Recent dredging includes 2016 with a volume of 7,100 cubic yards, 2015 with a volume of 25,000 cubic yards, and 2011 with a volume of 21,000 cubic yards, all with disposal at in-bay site SF-10 San Pablo Bay (Table 1). It could deliver sediment by pipeline across the navigation channel or by barge. The other three marinas are smaller in size and further away upstream of Tiscornia Marsh. They may all be viable options. Lowrie Marina, for example, had its last major dredging in 2012 with volume of 26,000 cubic yards disposed at SF-10 (Table 1). Information on sediment quality from these other marinas was not readily available so is not compiled or assessed here.

3.3 Private Dock Maintenance Dredging

San Rafael Creek is lined with private boat docks, directly along the creek and along a number of side channels. According to Pat Lopez from Loch Lomond, many private dock owners align their maintenance dredging needs with Salt River Construction dredging of one of more of the marinas, for cost effectiveness. Mr. Lopez suggested to work directly with Salt River if the need arises to consider dredged sediment from the private boat docks.

4 Dredging Sources from Other Nearby Areas

Two other nearby areas are dredged with varying degrees of frequency and conceivably are located close enough to Tiscornia Marsh that material transport costs to Tiscornia may be feasible: Gallinas Creek and Larkspur Ferry Terminal (Figure 2).

Figure 2. Nearby Dredging Projects in Relation to Tiscornia Marsh

4.1 Gallinas Creek Dredging

The South Fork of Gallinas Creek is a navigation channel serving residents in the Santa Margarita and Santa Venetia neighborhoods of North San Rafael. Marin County Service Area Number 6 – Gallinas Creek (CSA 6), which is staffed by the Marin County Department of Public Works, carries out this dredging. The last dredging of this channel was in 1992/1994 (Marin County 2015). CSD #6 is currently planning a "geomorphic dredge" of this channel. The "geomorphic dredge" concept reduces the total dredging volume, compared to historical dredging, by focusing on channel geometries that can be maintained more effectively by natural tidal and watershed runoff flows thus reducing future dredging needs. The current dredging plan is to place all the dredged sediment into the McGinnis Marsh Restoration Project nearby to the dredging area. Unless that plan breaks down, this sediment source is not available for Tiscornia.

4.2 Larkspur Ferry Dredging

The Golden Gate Bridge District dredges the Larkspur Ferry Terminal and navigation channel approximately every four to five years with about 300,000 to 400,000 cubic yards dredged each cycle[1]. The last dredging took place in 2015, with disposal split between the Deep Ocean Disposal Site (DODS) about 50 miles offshore (157,000 cubic yards), reuse at Montezuma Wetlands (73,000 cubic yards), and in-bay aquatic disposal at SF-10 (148,000 cubic yard) (Table 1). The previous dredging was in 2010, with 85,000 cubic yards to DODS, 225,000 cubic yards to in-bay (SF-10 and SF-11) (Table 1). Though data has

[1] Brenda Goeden, BCDC, personal communication, February 9, 2018.

not been obtained on sediment quality, BCDC confirmed[2] it is reasonable to assume that there is enough suitable material in each Larkspur Ferry Terminal dredging cycle for Tiscornia Marsh.

It is conceivable that reuse at Tiscornia Marsh is viable with Larkspur Ferry dredged sediment. Given the relatively high costs the District currently pays for transit to and tipping fees at Montezuma and transit to DODS, Tiscornia has strong potential to be an economical disposal alternative for the District.

Outreach to the Bridge District following completion of the Concept Designs for Tiscornia Marsh and with projections of implementation timing would be the appropriate strategy to initiate the discussion with the Bridge District.

5 Conclusions

It appears reasonable to consider dredge sediment reuse for Tiscornia Marsh. The time it will take for Tiscornia to be ready to accept dredge material, probably 3-5 years from now maybe sooner and possibly later, works to the advantage of dredged sediment reuse.

There are multiple viable sources of dredged material, listed in order of estimated overall feasibility:

1. **Larkspur Ferry Terminal dredging may be the most feasible** overall for two reasons. First, reuse at Tiscornia is probably less costly than Montezuma or DODS, which translates into a benefit to the Bridge District and no need for Tiscornia to raise supplemental funds to make reuse feasible for the dredger. Second, the reliability of periodic dredging reduces uncertainty of sediment availability, leaving timing of the dredging cycle as the primary uncertainty. This material would be delivered by barge.
2. **Marina and private dock dredging along San Rafael Creek has a reasonable chance of being feasible**. Being privately funded dredging translates to reliability of implementation. The uncertainty of feasibility of these sediment sources is cost. As these projects normally use low-cost in-bay aquatic disposal, it is possible that reuse costs could be higher necessitating the Tiscornia project raise funds to cover the differential. This conclusion is tentative at best as no cost analysis has been done. Barge delivery is the default method, hydraulic pumping and perhaps truck delivery may be possible.
3. **San Rafael Creek navigation channel dredging is the most uncertain.** Navigation channel dredging is a federal action. The currently relatively low priority by the Corps of Engineers and the history of long time periods between dredging cycles introduces comparatively high uncertainty of sediment availability and ability to plan around its availability. This situation may change with active efforts by the City of San Rafael, Marin County, and Congressman Huffman. Cost differentials may exist as for the marina and private dock dredging but again that conclusion is tentative until a cost analysis is performed. Barge delivery is the default method, hydraulic pumping and perhaps truck delivery may be possible.

[2] Brenda Goeden, BCDC, personal communication, February 22, 2018.

4. **Gallinas Creek dredging is already designated for reuse at the McGinnis marsh restoration project.** Unless the situation changes with that intended reuse, these sediments are not available for reuse at Tiscornia. If McGinnis falls through, then feasibility shifts to the uncertainty of when dredging might take place and the probable higher costs of reuse at Tiscornia relative to either in-bay aquatic disposal or the previously considered reuse at the San Rafael Airport property.

From an engineering perspective, dredged sediment reuse will most likely require construction of containment cells and a barrier to transport of any mobilized sediment into the San Rafael Creek navigation channel. The manner in which the dredge sediment is delivered, hydraulic or clamshell, dictates the specifics needed to meet containment requirements. The geotechnical, construction methods, environmental, and cost considerations of these containment features atop soft bay muds and the regulatory considerations of in-bay placement will play importantly into the overall feasibility of using dredged sediments.

Upland soil reuse is a reasonable possibility. Its upside is likely no cost to receive the soils and perhaps less complicated placement containment. The primary drawbacks are difficulty of long-range advance planning to meet the volume needs at Tiscornia combined with the possibility that such volumes may require multiple upland soil sources, and compatibility considerations of soil physical characteristics as marsh substrate.

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3027

Memorandum #2.2 (Draft #2)

Tiscornia Marsh Sediment Supply Conditions and Potential Marsh Accretion Rates

This memorandum addresses two elements of Task 2: review existing data to (1) characterize current and future sediment supply that may be available for natural deposition and (2) potential marsh accretion rates. This Draft #2 incorporates comments received from Ed Nute (February 21), Dane Behrens (February 21), and Ann Borgonovo (March 5).

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Figures and Tables

1 Tiscornia Marsh Setting

There are several setting factors for Tiscornia Marsh that influence the sediment concentrations it may experience for accretion.

1.1 Landscape Setting

Figure 1 shows its local bathymetric setting. Tiscornia Marsh sits at the confluence of San Rafael Creek with San Rafael Bay. The western edge of San Rafael Bay is very shallow intertidal (green in Figure 1). San Rafael Bay itself consists of a broad expanse of very shallow subtidal mudflats (blue in Figure 1). San Rafael Bay borders the deep San Pablo Straits channel (white in Figure 1). Cutting across San Rafael Bay is the dredged navigation channel for San Rafael Creek (straight black dashed line in Figure 1). These broad mudflats are a likely source of wind-wave sediment resuspension that can be transported toward Tiscornia Marsh on flood tides. San Rafael Creek itself may carry suspended sediment mainly during storms though such conditions are not monitored. When storm flows of San Rafael Creek meet flood tides of San Rafael Bay, the opposing-direction flows can result in increased deposition potential. The relatively regular frequency of dredging the lower reaches of San Rafael Creek and the nearby marinas suggest moderately high deposition potential where water velocities are low enough to allow settling and sediment concentrations are high enough to support actionable deposition.

Figure 2 shows the Tiscornia Marsh setting in relation to the shallow San Rafael and Corte Madera bays to the south and the deeper waters of Central Bay to the east. In addition to sediment resuspension potential of San Rafael Bay described above, similar resuspension can occur on Corte Madera Bay with flood tide transport north toward Tiscornia Marsh. Sediment carried in the deeper Central Bay waters from upstream and downstream sources have the potential to be transported west to San Rafael Bay and Tiscornia Marsh by wind and tidal currents.

Figure 3 shows the setting of Tiscornia Marsh in the broader extent of San Pablo Bay to the north. The broad, shallow expanse of San Pablo Bay is a significant source of wind and wave sediment resuspension (Ganju et al. 2004) that drive locally high deposition rates (see Section 2 below). Currents can carry these sediments great distances each tidal cycle. The extent to which Tiscornia Marsh can be on the receiving end of this sediment transport process may be limited by the relatively close proximity of Pt. San Pedro to San Pablo Straits. Transport to Tiscornia Marsh would more likely occur on ebb tide and suspended sediment would have some potential to be captured by the high flows in San Pablo Straits. To reach Tiscornia Marsh, sediment would then have to exit the high flows of San Pablo Straits and move west up San Rafael Bay. Wind direction and secondary currents during ebb tides would likely exert an influence on the extent to which this transport mechanism would occur.

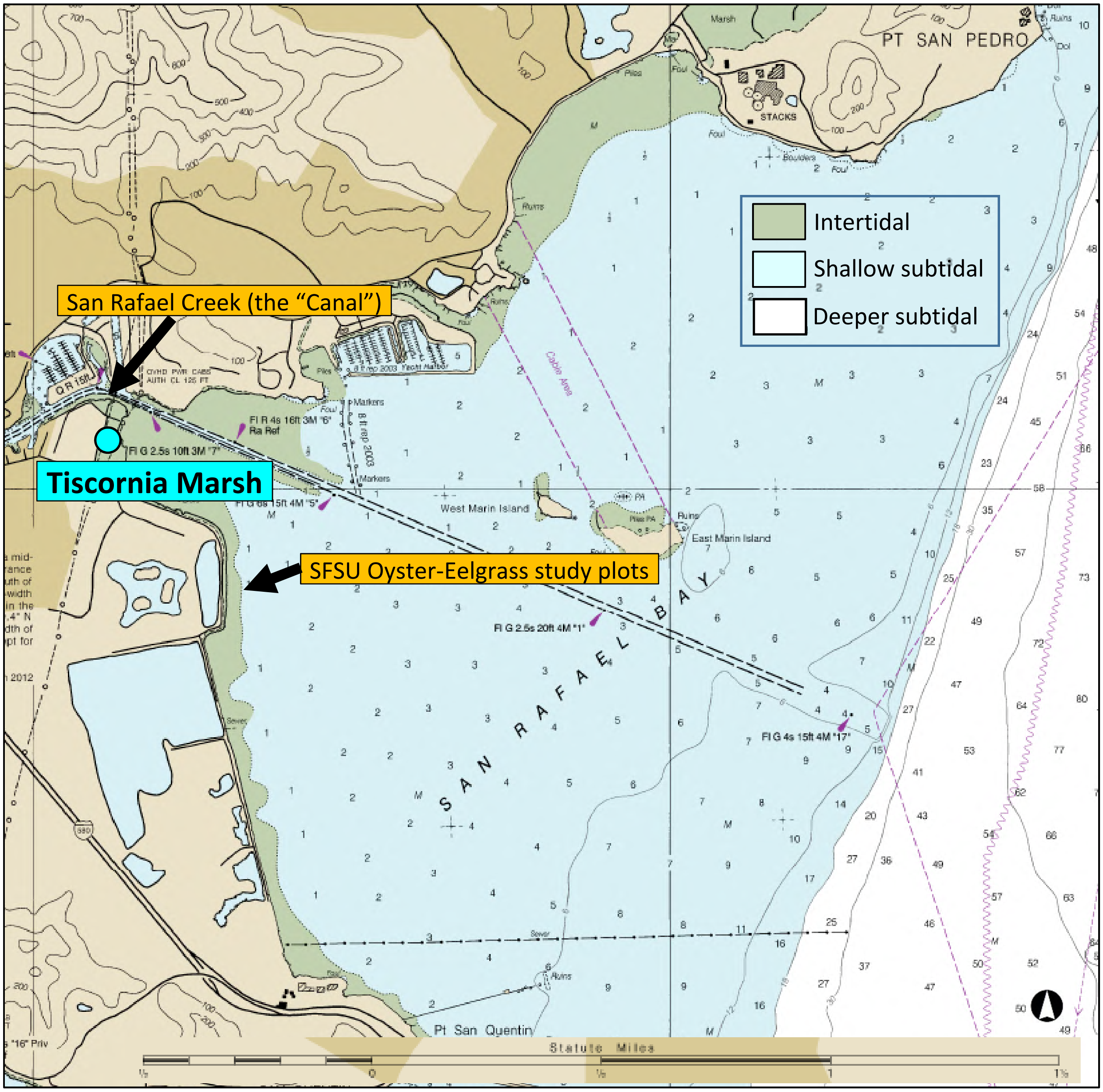


Figure 1. Local Bathymetric Setting of Tiscornia Marsh
Base Map Source: NOAA Chart 18653. All soundings in feet below mean lower low water.

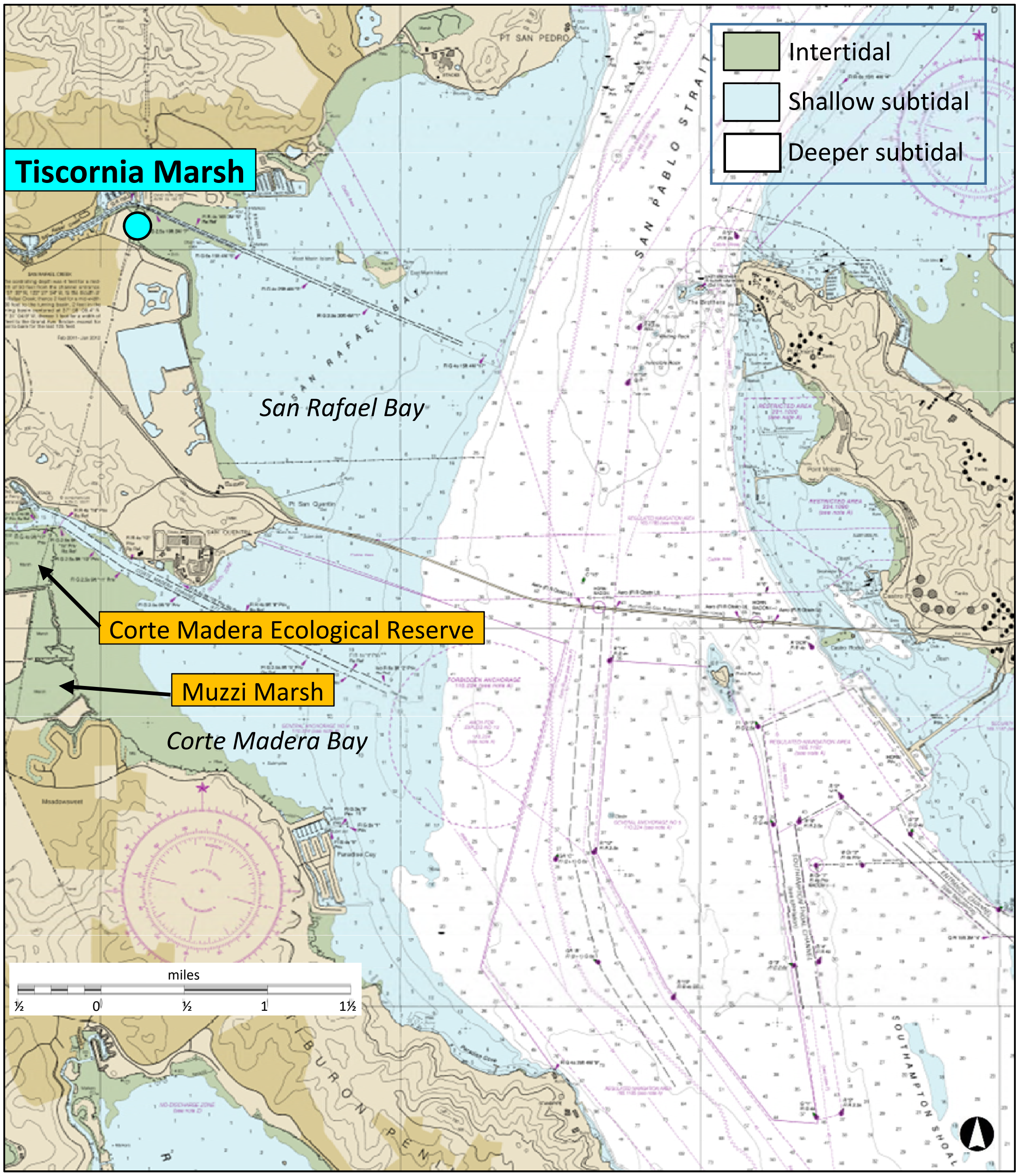


Figure 2. Setting in Relation to San Rafael and Corte Madera Bays and the Deeper Central Bay
Base Map Source: NOAA Chart 18653. All soundings in feet below mean lower low water.

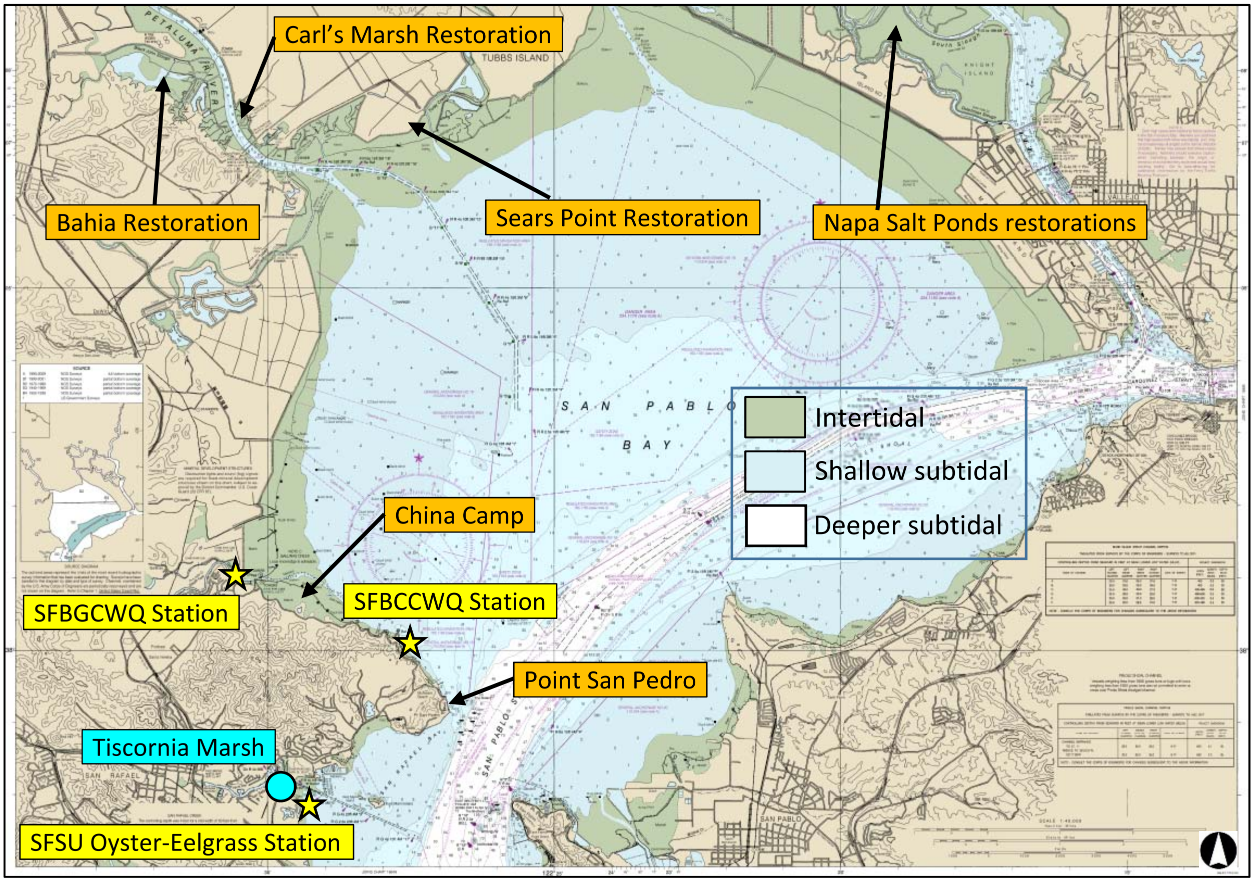


Figure 3. Water Quality Monitoring Stations Relatively Close to Tiscornia Marsh
Base Map Source: NOAA Navigation Chart 18654. All soundings in feet below mean lower low water.

1.2 Local Weather Station Wind Data

Given that sediment deposition and resuspension is affected by wind-wave resuspension, gaining some understanding of dominant wind directions helps to inform the setting.

Weather Underground compiles weather data from numerous privately-operated weather stations around the country and internationally. The closest station to Tiscornia Marsh is a short distance northeast across San Rafael Creek. Wind speed and direction data are available at this station beginning in January 2016 (Figure 4). These data indicate wind directions that are predominant from the southern direction west to east, with winds from the northern direction west to east being uncommon. This data period is relatively short and thus may not represent longer term wind conditions.

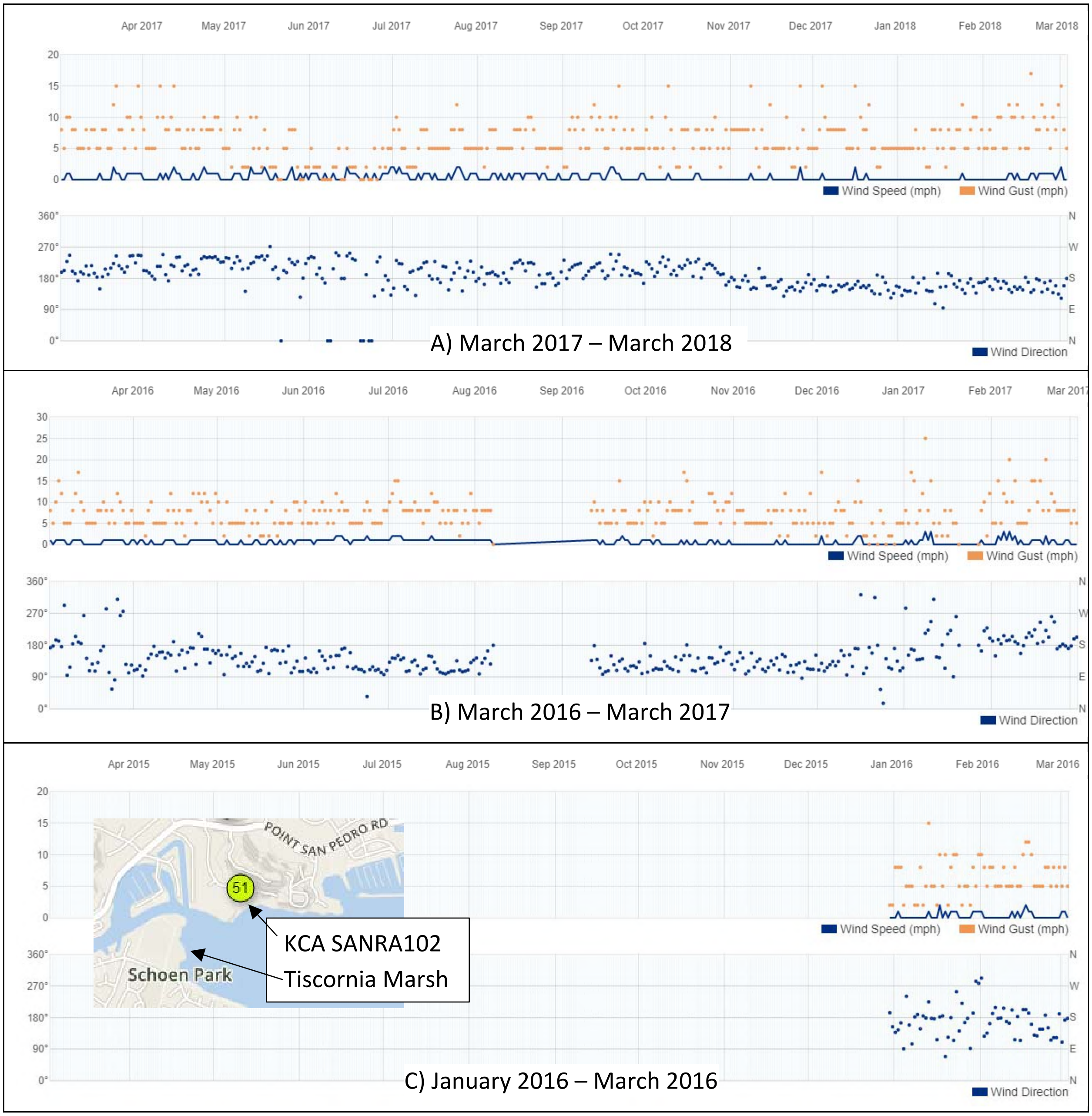


Figure 4. Wind Speed and Direction Data for KCA SANRA102, January 2016-March 2018
Source: Weather Underground, www.wunderground.com

2 Sediment Supply

Estimating sediment supply that may be available for accretion at Tiscornia Marsh is an imprecise exercise in the absence of long-term on-site measurements. Sediment supply perhaps can be roughly estimated utilizing available data from nearby locations, which requires interpreting the representativeness of these available data to conditions at Tiscornia Marsh and recognizing the inherent complexity of suspended sediment characteristics in the San Francisco Estuary. The main factors that affect how representative any given existing data source are include distance from Tiscornia, station depth, station location relative to surrounding mudflats that can generate suspended sediment, station location relative to prevailing winds and currents that influence sediment suspension and transport processes, station location relative to watershed flows, and station location relative to the main channel of San Pablo Bay that carry sediment from the Delta and from upstream local tributaries.

2.1 Prospective Sediment Concentration Data Sources

There are three relatively nearby water quality monitoring stations that measure turbidity levels over long time periods at nearshore locations and that perhaps may reasonably represent conditions at Tiscornia, and a fourth data set that has both sediment concentration and accretion rate data (Figure 3):

1) **San Francisco State University study plot for oyster and eelgrass recruitment** located about 0.7 mile to the southeast (Figure 1). Water quality data (turbidity) were collected by ESA (2018) on behalf of SFSU at this station from May 2013 to October 2017 with some extended data gaps. Attributes of this station that support its applicability to Tiscornia Marsh are its close proximity, its location along the margins of San Rafael Bay near to the confluence of San Rafael Creek where Tiscornia Marsh is located, and its location on shallow subtidal mudflats that may help elucidate sediment resuspension. Its primary drawback is the relatively short period of data and its data collection largely during the prolonged California drought though data do cover much of the wet 2017 winter. Turbidity data may not be well representative of longer term and more varied conditions but do provide reasonable insight.
2) **SF Bay NERR water quality monitoring station at the China Camp Village pier**, located about 4¾ water miles to the northeast (Station "SFBCCWQ" on Figure 3). Turbidity data have been collected at this station since March 2005. Attributes of this station that support its applicability to Tiscornia Marsh are its location along the southwest margin of San Pablo Bay where it experiences sediment concentrations reflecting local resuspension, transport of sediment from more distant mudflats to the north, transport of sediment along the main San Pablo Bay channel, and its long data period. Its primary drawbacks are its greater distance, its location on the north side of Point San Pedro putting it into a somewhat different sediment regime (see discussion above). Its proximity to the tidal marshes at China Camp State Park that have been monitored for accretion allow it to contribute to the accretion assessment in Section 2 below.
3) **SF Bay NERR water quality monitoring station at the mouth of Gallinas Creek**, located about 7½ water miles to the north (Station "SFBGCWQ" on Figure 3). Turbidity data have been collected at this station since May 2008. Attributes of this station that support its applicability to Tiscornia Marsh are its location at the mouth of a local stream at the Bay where it experiences a mix of watershed discharges. It is approximately similar to the China Camp Village pier station both in its exposure to Bay sediments and its proximity to the China Camp tidal marshes.
4) **Carl's Marsh sediment accretion study.** Carl's Marsh, a tidal marsh restoration project opened in 1994, is located at the confluence of the Petaluma River with San Pablo Bay, on the east side of the river. Stuart Siegel studied accretion at this site for his dissertation research at UC Berkeley (Siegel 2002) and collected turbidity data and calibrated it to suspended sediment

concentration. He also collected accretion rate data. Carl's Marsh is located directly across the river from the Marin Audubon Society Bahia Tidal Marsh Restoration Project. Carl's Marsh will have higher sediment concentrations than Tiscornia Marsh, so its paired sediment concentration-accretion rate data and the comparison of accretion rates to Bahia provide insight into prospective conditions at Tiscornia Marsh.

5) **Integrated Regional Wetland Monitoring Pilot Project.** This CALFED-funded intensive field study took place at six tidal marshes in the North Bay and upper estuary: Carl's Marsh at the Petaluma River mouth, Pond 2A, Coon Island and Bull Island in the Napa-Sonoma marsh complex, and Browns Island and Sherman Lake at the Delta's confluence with Suisun Marsh (WWR 2007). This study collected turbidity data and calibrated it to suspended sediment concentration. Carl's Marsh is the closest site and thus may have higher data applicability. The Napa sites have similarities that supports data applicability. The Suisun/West Delta sites are the most different and would have lesser data applicability.

2.2 The Difficulty of Calibrating Turbidity to Suspended Sediment Concentration

The primary challenge in using the three nearby turbidity data sets is the reliability of converting turbidity to suspended sediment concentration in absence of associated calibration data. Turbidity is a measure of light scattering in the water column and has high utility in studying aquatic productivity related to incident sunlight (e.g., phytoplankton and submerged aquatic vegetation such as eelgrass). Turbidity is relatively easily measured with optical backscatter sensors commercially available (such as YSI water quality sondes widely used including at China Camp and Spinnaker Point). In contrast, suspended sediment concentration (SSC) is a measure of sediment mass per unit volume in the water column and has high utility in studying sediment dynamics processes such as marsh accretion. SSC is measured by laboratory analysis of water samples. Much of the tidal marsh restoration literature and assessments of marsh resiliency with sea level rise utilize SSC (e.g., Williams and Orr 2002, PWA and Faber 2004, Schile et al. 2014).

Turbidity data can be converted to SSC data via sensor calibration, a process that involves approaches relating independent measures of water column SSC to concurrent turbidity sensor readings. There are many factors that affect this relationship, including sediment concentrations, sensor ranges, sediment grain size, mineralogical composition, organics, cation exchange capacity, and fluid properties including salinity, pH and temperature (Mehta 1986, Guillen et al. 2000). Given the relatively high level of effort to calibrate turbidity to SSC, oftentimes it is omitted and data are reported as turbidity and without SSC. Such is the case for the three nearby data sources (Matt Ferner, SF Bay NERR, pers. comm. March 2018 and Damien Kunz, ESA, pers. comm. March 2018).

These many controlling factors on the turbidity-SSC conversion mean that converting data after-the-fact reliably depends on the specific conditions at the study site. Consequently for the purposes of the analysis presented in this memorandum, the conversion values to be applied will be approximate, the estimate will be conservative so that potential accretion rates are not overly optimistic, and necessarily result in the findings requiring an error estimate that is made qualitatively. Table 1 below lists some San Francisco Estuary data with included conversion equations.

Based on the data in Table 1, this assessment will use the following conversion for the NERR China Camp and SFSU-ESA Spinnaker Point turbidity data sets:

$$SSC\ (mgL^{-1}) = 1.0 * NTU/FTU \pm \text{at least } 20\% \qquad \text{(Eq. 1)}$$

Table 1. Turbidity to Suspended Sediment Concentration Conversion Equations

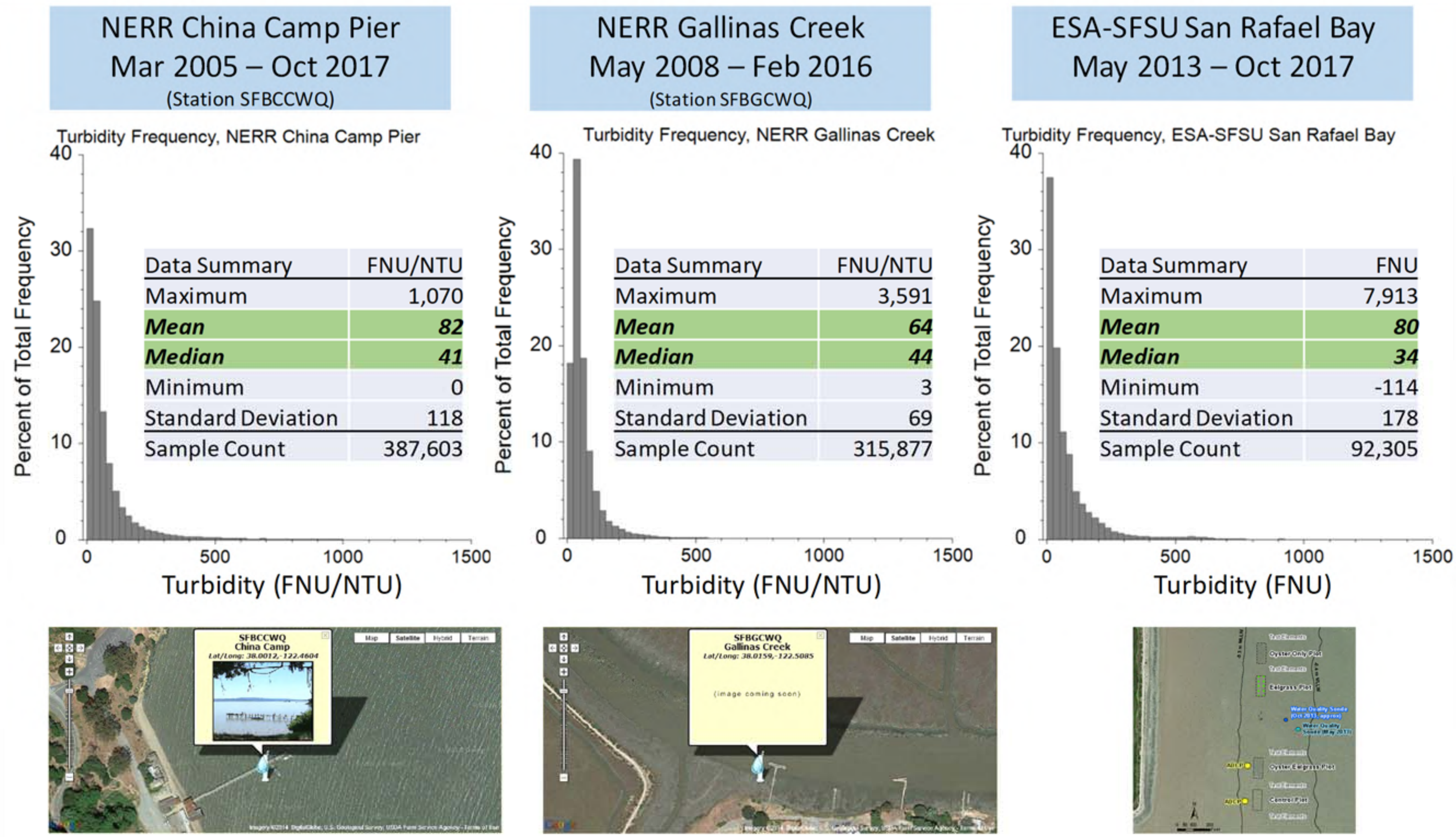
Data Source	Conversion Equation	Site Location	Comments
IRWM (WWR 2007)			
Carl's Marsh	0.89*NTU	San Pablo Bay at Petaluma River	Brackish/saline
Pond 2A	1.01*NTU	Napa-Sonoma Marsh Complex interior	Brackish/saline
Coon Island	0.90*NTU	Napa-Sonoma Marsh Complex Napa River	Brackish/saline
Bull Island	1.02*NTU	Napa River	Brackish/saline
Browns Island	0.47*NTU	Suisun/West Delta confluence	Brackish/fresh
Other Sources			
NERR – Rush Ranch	1.26*NTU	Suisun Marsh	Brackish (M. Ferner pers. comm.)
West Mediterranean	1.74*FTU	Europe	For context (Guellin et al. 2000)
Eastern Australia	4.85*NTU	Australia subtropical estuary	For context (Chanson et al. 2008)

Another source for calibration data is the long-term USGS sediment monitoring in the San Francisco Estuary (e.g., Buchanan and Morgan 2010, Buchanan and Rule 2000). However, USGS uses different instrumentation that yields voltage outputs rather than turbidity. For the purposes of this analysis, sorting out how these data might be applied has not been undertaken.

2.3 Suspended Sediment Concentration Data Converted from Turbidity without Calibration Data

Figure 5 presents histogram plots and summary statistics of all the turbidity data from the two China Camp NERR stations and the Spinnaker Point SFSU-ESA station described above. Histogram plots illustrate the frequency of sediment concentration data on the y-axis (measured at these stations as turbidity) against turbidity values on the x-axis. The summary statistics provide the maximum, mean, median, and minimum values recorded during the monitoring period of each data set. All data are reported as turbidity, in units of Nephelometric Turbidity Units (NTU) or Formazin Nephelometric Units (FNU), which measure light scattering by particles in the water column. Both these units are equivalent and reflect sensor type employed[1].

[1] https://www.iso.org/standard/62801.html



NERR China Camp Pier

Data Summary	FNU/NTU
Maximum	1,070
Mean	***82***
Median	***41***
Minimum	0
Standard Deviation	118
Sample Count	387,603

NERR Gallinas Creek

Data Summary	FNU/NTU
Maximum	3,591
Mean	***64***
Median	***44***
Minimum	3
Standard Deviation	69
Sample Count	315,877

ESA-SFSU San Rafael Bay

Data Summary	FNU
Maximum	7,913
Mean	***80***
Median	***34***
Minimum	-114
Standard Deviation	178
Sample Count	92,305

These data represent 15-minute sampling interval mostly continuously over the stated time periods, from YSI or similar water quality sondes. NERR data are post quality assurance and quality control downloaded from national SWMP database (http://cdmo.baruch.sc.edu/). ESA-SFSU data collected and provided by ESA.

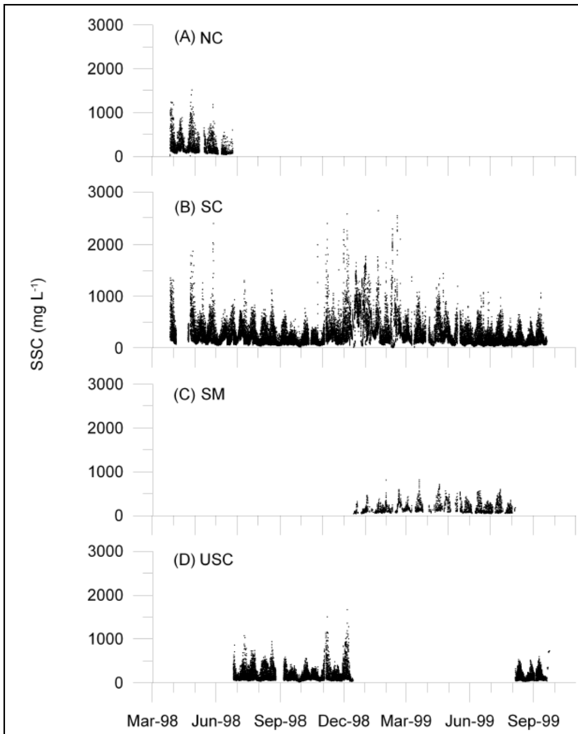
Figure 5. Histograms of Turbidity Data, China Camp, Gallinas Creek and San Rafael Bay, Variable Dates 2005-2017

NTU = Nephelometric Turbidity Units / FNU = Formazin Nephelometric Unit

2.4 Suspended Sediment Concentration Data Calibrated from Turbidity

Carl's Marsh 1998-1999

The fourth data set, from Carl's Marsh for the period February 1998 to September 1999 (Siegel 2002), shows average SSC values ranging from 182 to 284 mg/L, with the most representative sampling station (sediment entering the subsided restoration site) being at the upper end of the range (Figure 6). Carl's Marsh was breached in 1994 and the site had subsided to about local mean lower low water elevation. This data period covers an active depositional period starting four years after levee breach in a location with known high sediment rates (as evidenced by the now-vacant Port Sonoma Marina).



Statistic	SSC (mg/L) by Station			
	NC	SC	SM	USC
Minimum	7	20	40	19
Mean	228	284	227	182
Median	159	208	183	131
Maximum	1,514	2,633	932	1,665
Count	3,349	40,151	3,611	11,959

Sample locations:

- SC = southern main channel, near bed (most representative of sediment influx)
- USC = southern main channel, mid water column
- NC = interior (northern) end of southern channel
- SM= southern mudflat adjacent to SC station

Figure 6. Suspended Sediment Concentration Data for Carl's Marsh, February 1998 to September 1999
Source: Siegel (2002)

Integrated Regional Wetland Monitoring Pilot Project 2003-2005

The final data set considered in this analysis is from six North Bay to West Delta study sites studied from December 2003 to September 2005 by the CALFED Science Program-funded *Integrated Regional Wetland Monitoring Pilot Project*. These data do not have accompanying accretion rate data and thus are provided for their context of sediment concentrations in restored tidal marshlands.

Table 2. Suspended Sediment Data from the IRWM Study Sites, Dec 2003 – Sep 2005

		SSC in milligrams per liter			
Site	**Count**	**Minimum**	**Maximum**	**Mean**	**Median**
Carl's Marsh	29191	0.0	2034.1	94.6	70.5
P2A	44431	0.0	2028.2	42.8	31.3
Coon	25063	0.0	797.0	38.5	30.6
Bul	27772	0.0	1686.4	27.9	16.5
Bri	45279	0.0	854.8	12.5	8.3
Sherman Lake	---	---	---	---	---

Notes:
1. Suspended sediment data converted from NTU data recorded at CTDS station mooring located in inlet channel
2. Carl's Marsh and Coon Island instruments exposed during some low tides. Exposed values excluded.

Source: WWR (2007)

2.5 Findings Regarding Sediment Supply Data from China Camp and Spinnaker Point

The key findings of these data relative to understanding available sediment supply and assessing the potential for tidal marsh accretion are:

- **Data applicability is high for Spinnaker Point and China Camp.** The close proximity of these stations to Tiscornia Marsh and their relatively similar turbidity measurements support these data being reasonably applicable for Tiscornia Marsh. Mean and median values range from 64 to 82 and from 34 to 44 FNU-NTU, respectively. This relative similarity suggests that these data can be applied with an acceptable level of confidence as representing conditions that Tiscornia Marsh experiences over the long term.
- **Sediment concentration is on the lower end meaning slower accretion rates.** The turbidity/SSC values are within the range of estimates considered in Williams and Orr (2002) relating SSC to accretion rates, and these lower values would land on the less rapid accretion spectrum (see discussion below in Section 3). These data are also skewed to lower concentrations as reflected in the much lower median versus mean values. Thus, concentrations toward the lower values are the "norm."
- **Maximum sediment concentrations were very high.** All three stations had very high maximum values which, though experienced over short time periods, can support major sedimentation events such as occurs during major wet winters. Siegel (2002), for example, found accretion of about 0.5 foot over three months in early 1998 during that El Niño winter at Carl's Marsh at the mouth of the Petaluma River. Similar rapid rates were observed during the very wet winter 2017 at Sears Point Restoration on the northwest shore of San Pablo Bay (SLT and SF Bay NERR 2017). Predictability of extreme event occurrence is low, so counting on bursts of high sediment loads can be risky as a means to achieve restoration goals.

2.6 San Rafael Creek as Possible Fluvial Sediment Supply

There is no monitoring of flows or sediment concentrations for San Rafael Creek nor any analysis of watershed erosion conditions. Thus, the analysis presented here is general in nature and draws from regional understandings of local watersheds combined with a description of this watershed. Two useful sources of information are McKee et al. (2013) which utilized a mixture of USGS measurement stations and modeling to estimate sediment yields from 39 Bay Area watersheds in contrast to sediment delivery from the Central Valley. San Rafael Creek was not one of the assessed watersheds but other Marin watersheds were. The second is the Marin County (2010) Stormwater Plan which provides comparative information on Marin Watersheds helpful to apply the McKee et al. (2013) data. The key findings of the McKee et al. (2013) analysis is that local watersheds have the potential to generate considerable sediment loads episodically, their sediment loads are highly variable and dependent on rainfall, local geology, and land use, and that they should be considered when planning wetland restoration efforts. In addition, the Marin County Watersheds Program provides overview information of all of Marin's watersheds including San Rafael Creek[2].

The San Rafael Creek watershed comprises 11 square miles (Figure 7) and is densely developed from its hills to filled wetlands. The creek originates in the hills above Tamalpais Cemetery and flows through residential and industrialized areas before forming the San Rafael Canal in the vicinity of Highway 101. The upper stream corridor consists of short stretches of open stream channel, underground culverts, and trapezoidal open channels. Much of the watershed consists of impervious surfaces (Figure 8). This map shows that the lower watershed is developed and thus quickly converts rainfall to runoff, and that the upper watershed is largely undeveloped and thus absorbs more rainfall and is also where much of the available sediment can be derived via erosion and transport.

For comparison, the Corte Madera Creek Watershed, which was examined in the McKee et al. (2013) study, is 28 square miles and has a much larger percent of open lands with less than 10% impervious surfaces[2]. This means it has a much greater potential to generate and deliver sediment via hillslope erosion processes and stormwater runoff than does San Rafael Creek. McKee et al. (2013) reported that Corte Madera Creek delivered 10,500 metrics tonnes of sediment annually on average, with a range of sediment yield by area of 217 to 246 metric tonnes of sediment per square kilometer per year. If we assume San Rafael Creek with its much more developed watershed delivers half this annual sediment supply per unit area and is 40% the size of Corte Madera Creek watershed, then it might yield about 2,100 metric tonnes of sediment annually on average. Converting this average sediment yield to cubic yards requires estimating bulk density. If one assumes a bulk density of 1 g/cm^3, which is very roughly reasonable, then 2,100 metric tonnes per year equates to roughly 2,750 cubic yards of sediment volume delivered per year from the watershed. Between 2010 and 2016, about 218,000 cubic yards of sediment were dredged from the marinas, private boat docks, and federal navigation channel of San Rafael Creek, or about 31,000 cubic yards per year on average. The watershed contribution to this dredging volume

[2] http://www.marinwatersheds.org/creeks-watersheds/san-rafael-creek

thus is about 9%. Recognizing the several assumptions employed to arrive at this value, it must be considered approximate and it could have a range of ±25-50%.

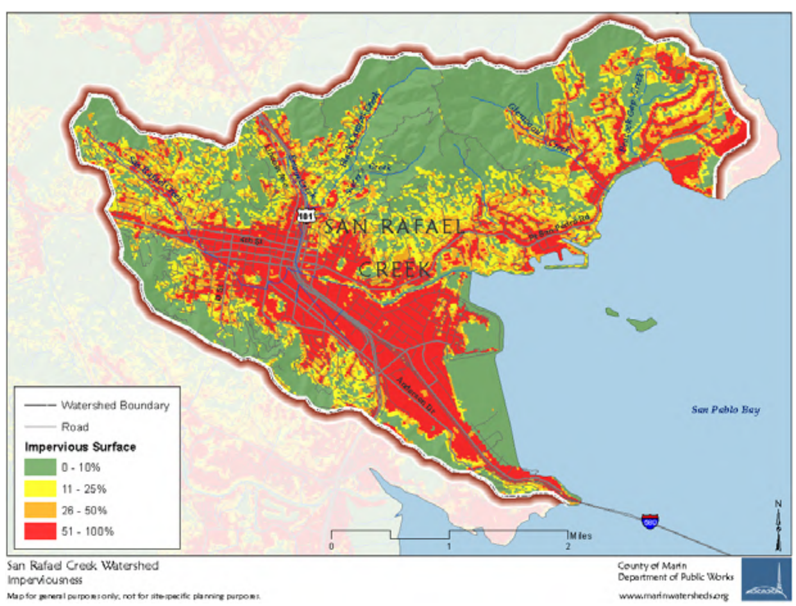
Erosion within the watershed falls into two categories. First is low-level routine erosion in small volumes from rainstorms that has a moderate chance to reach San Rafael Creek over shorter time scales. This material may originate as coarser grained bedload material that initially deposits in the lower ends of tributary channels before it reaches San Rafael Creek and that is winnowed down in grain size and transported further downstream over time. Second is locally-high erosion from landslides. Landslide sediment would work its way through drainages down to San Rafael Creek over time as well as deposit higher in the watershed initially. These episodic and unpredictable sediment deliveries could be larger in volume per event but it is difficult to estimate on long-term average whether they deliver more or less sediment than routine low-level watershed erosion and transport processes.

The fate of watershed sediment once it reaches San Rafael Creek depends on its grain size, flow rates to transport the sediment, and ebb vs. flood tide conditions in the creek at the time of the storm flows. Base watershed flow in San Rafael Creek is not monitored and is likely to be very low in the summer and fall and fairly small in the winter and spring. Because the watershed is fairly urbanized, it presumably has a very flashy discharge curve, spiking during and shortly following storms and dropping to base flow relatively quickly (probably on the order of days, depending on storm size). In addition, the City of San Rafael operates several stormwater pumps that discharge into San Rafael Creek. These operate only during storms and can add considerable downstream flows and yield some sediment, as well as potentially trapping some sediment in pump basins.

Since most fluvial sediment is transported only during storm events, tide direction exerts a very important influence. If storm flows with their fluvial loads occur on ebb tide, then a greater proportion of the sediment would likely be transported out into the bay where it either deposits on local mudflats or is carried out to the deeper San Pablo Bay straits channel. Mudflat deposited sediment then could be tidally resuspended later and transported on flood tides back into San Rafael Creek. If storm flows occur on a flood tide, then there is greater potential for reduced flow velocities and thus deposition within San Rafael Creek and the adjacent marinas and side channels.

Figure 7. Marin County Bay-Side Watersheds Map
Source: MCSTOPPP 2010.

Figure 8. Impervious Surfaces of San Rafael Creek Watershed
Source: Marinwatersheds.org



2.7 Projections of Future Sediment Supply

"Past performance does not indicate future conditions." This famous stock market adage applies well to future sediment supply projections for the San Francisco Estuary. Schoellhamer (2011) published the seminal paper describing the shift in the San Francisco Estuary to a sediment supply-limited system from a sediment transport-limited system, resulting in the increased role of within-embayment sediment dynamics becoming more important drivers of suspended sediment concentrations. This work has formed informed regional understanding that the future suspended sediment concentrations are likely to be lower than those observed over the past several decades of active tidal marsh restoration. Ganju and Schoellhamer (2010) also report a 57% decline in sediment supply from the Sacramento River watershed between 1957 and 2004, forming the prelude the Schoellhamer (2011) paper. Also, the wind-wave resuspension processes that mobilize mudflat sediment will decline in magnitude as sea level rise puts the bay bottom deeper and thus less accessible to the wind wave forces. These projected changes are well summarized in the recent Baylands Ecosystem Habitat Goals Update (Goals Project 2015).

3 Potential Marsh Accretion Rates

3.1 Factors that Influence Accretion Rates

As with suspended sediment data, estimating marsh accretion rates requires consideration of many factors, including water velocity, roughness of the bed surface including vegetation, wind and wave regime, and sediment grain size characteristics (commonly silts and clays are in suspension and can flocculate in salt water). The three dominant controls on marsh accretion rates are sediment concentrations (see discussion above), elevation of depositional area as it relates to time submerged for deposition to occur (the lower the elevation the longer amount of time submerged for deposition to occur), and flow velocities as it relates to allowing sediment to settle out from the water column and exposure to or shelter from resuspension forces.

3.2 Accretion Rates from Nearby Locations

Marsh accretion can be measured in several ways, from use of stable isotopes in sediment cores to reconstruct longer duration accretion to deployed field techniques such as sediment elevation tables (SETs) with marker horizons which are very involved to install and read yet very accurate, to sediment plates or sediment pins and similar methods, and to topographic surveys (field or aerial based) repeated over time.

To keep the analysis as local and thus applicable as possible, several North Bay studies are reported here, and the data presented in Table 3:

- **Corte Madera Bay data.** Callaway et al. (2012) employed four field strategies (sediment pads, feldspar markers, SETs, and sediment cores) across low, middle and high marsh at the remnant historical tidal marshes at the Corte Madera Ecological Reserve and at the nearby tidally restored Muzzi Marsh (Figure 2). No SSC or turbidity data were collected.

- **China Camp data.** Philip Williams and Associates reported sedimentation data at China Camp for 1991 to 2000 from sediment plate installations. No SSC data were collected at comparable times, but extensive turbidity data are available from 2005 onward.
- **Napa Pond 3.** Brand et al. (2012) reported data for some of the restored Napa salt ponds (Figure 3). No SSC or turbidity data were collected.
- **Carl's Marsh.** Siegel (2002) reported data from DEM comparisons and sedimentation pins at Carl's Marsh (Figure 3). Net accretion rates are presented, and considerable sediment consolidation of the rapidly accreting sediment was reported prior to vegetation colonization, due to daytime desiccation during summer low tides and regular winds. This location, at the mouth of the Petaluma River, is understood to have routinely high sediment concentrations (Ganju et al. 2003). Siegel collected SSC data from February 1998 to September 1999 which encompassed a major El Niño event. The IRWM project collected SSC data there from December 2003 to September 2005 which represented a drier period. SSC values differed by about three times between the earlier and later data periods.
- **Sears Point.** SLT and SF Bay NERR (2017) reported data from one DEM comparison at Sears Point (Figure 3). Net accretion rates are presented. Data applicability is limited due to insufficient baseline topographic data for the comparative topographic analysis. No SSC or turbidity data were collected.
- **Bahia Marsh.** WWR (2013) reported topographic transect results at numerous cross sections at Bahia (Figure 3). The data exhibited a wide range from significant scour to significant deposition on the restoring marsh plain. No SSC or turbidity data were collected.

Table 3. Marsh Accretion Rates, North Bay Tidal Marshes

Location	Data Period	Accretion Rates (cm/yr)	Method(s)	References
Napa Pond 3	2005 vs. 2009	2.8-8.2	DEM comparisons	Brand et al. 2012 [1]
CMER, low marsh	Long term	0.38-0.6	Isotopes (^{137}Cs and ^{210}Pb	Callaway et al. 2012 [2]
CMER, mid marsh		0.3-0.49		
CMER, high marsh		0.3-0.39		
CMER, low marsh	Apr 2011 – Jul 2012	0.34±0.04	SETs and feldspar markers	
CMER, mid marsh		0.26±0.07		
CMER, high marsh		0.2±0.02		
Muzzi, low marsh		0.94±0.04		
Muzzi, mid marsh		1.0±0.05		
Muzzi, high marsh		0.46±0.08		
China Camp	1991-2000	0.25-1.0	Topographic surveys, sediment plates	PWA and Faber 2004[3]
Carl's Marsh (early stage mudflat)	Aug 1994 – Aug 1999	30-60	Sediment pins	Siegel 2002

Location	Data Period	Accretion Rates (cm/yr)	Method(s)	References
Carl's Marsh (early stage mudflat)	Mar 1997 – Aug 1999	-39 to +68	DEM comparisons	
Bahia Marsh (early stage mudflat)	Jul 2009 – Apr 2012	-16 to +35	Topographic surveys	WWR 2013
Sears Point (early stage mudflat	Oct 2015 – Jun 2017	0-32	DEM comparisons from airborne LiDAR 2017 and truck LiDAR 2015 baseline	SF Bay NERR and SLT in preparation

Notes:

1. *Data reported in manuscript sedimentation results text.*
2. *Isotope data reported in Table 3, SET and feldspar data reported in Figures 5 and 6. These data were incorporated into the BCDC Corte Madera Bay Adaptation Strategy Report of 2013.*
3. *Data reported in Appendix B, Table 10.*
4. *Net accretion rates: sediment pin data reported in Figure 5-5, DEM comparison data reported in Figure 5-4.*

3.3 Sedimentation Estimates for Lower Elevation (Mudflat) East Side without Constructed Subsidence Reversal

What can influence sedimentation in lower elevation mudflat areas, including areas that may be considered for sediment or soil placement, is to shelter these areas from higher velocities driven by winds and currents. High velocities slow down or preclude deposition and promote resuspension. With sheltered conditions, sedimentation rates will be driven by available sediment supply and by the time of submergence which is a function of elevation. Based on the sedimentation rate data shown in Table 3 and assuming lower intertidal mudflats are the current condition, Table 4 presents estimates of initial sediment rates based on observed data from Bahia, Carl's Marsh and Sears Point and adjustments based on the SSC data sets shown in Table 2 and Figure 5 and Figure 6.

Suggested mudflat accretion rates: up to 10-15 cm/yr.

Table 4. Estimates of Sedimentation Rates at Lower Elevation Mudflat Sheltered Areas

Reference Location	Source Data	Initial Adjustment	Subsequent Adjustment
Carl's Marsh	30-60 cm/yr	Scale down by Siegel (2002) vs. IRWM (WWR 2007) SSC: 95 mgL^{-1}/284 mgL^{-1} = 0.33 ratio → 10-20 cm/yr	Scale down by IRWM vs. Spinnaker (ESA 2018): 80 mgL^{-1} /95 mgL^{-1} = 0.84 → **8.5-17 cm/yr**
Bahia	-16 to 35 cm/yr	Same basis as for Carl's Marsh → -5 to 12 cm/yr	Same basis as for Carl's Marsh → **-4 to 10 cm/yr**
Sears Point	0-32 cm/yr	Same basis as for Carl's Marsh → 0 to 11 cm/yr	Same basis as for Carl's Marsh → **0 to 9 cm/yr**

3.4 Sedimentation Estimates for Existing Tidal Marsh Platform and Constructed Higher Elevation Areas

Sedimentation on the high marsh platform is a function of sediment supply, duration of submergence, and sediment trapping capacity of vegetation and other surface roughness features. Table 5 summarizes the nearby high marsh accretion data and recommended adjustments based on landscape settings and possible differences in sediment supply. For the purposes of this analysis, no adjustments are suggested to these data.

Suggested high marsh accretion rates: 0.2 to 1 cm/yr.

Table 5. Estimates of Sedimentation Rates at Higher Elevation Areas

Reference Location	Source Data[1]	Initial Adjustment
CMER high marsh	0.2-0.4 cm/yr	Accept estimate without adjustment
Muzzi, high marsh	0.4-0.6 cm/yr	Accept estimate without adjustment
China Camp, high marsh	0.25-1 cm/yr	Accept estimate without adjustment

Notes:

1) *Sediment rates rounded from Table 3 to align with principle of estimating rates for Tiscornia*

3.5 Estimating Accretionary Time Periods Based on Estimated Suspended Sediment Concentration Data

There are empirical models used to estimate accretion rates based on a range of site factors including suspended sediment concentration data (see for example, Fagherazzi et al. 2012, Schile et al. 2014). Utilizing either any of these models is beyond the scope of this analysis. Instead, this analysis draws upon Williams and Orr (2002) to illustrate the comparative accretionary time frames based on sediment concentrations summarized above. Based on the simpler Williams and Orr (2002) model, sedimentation rates at Tiscornia Marsh appear to be on the lower end requiring longer time periods for accretion and risk of not maintaining elevations with sea level rise over time.

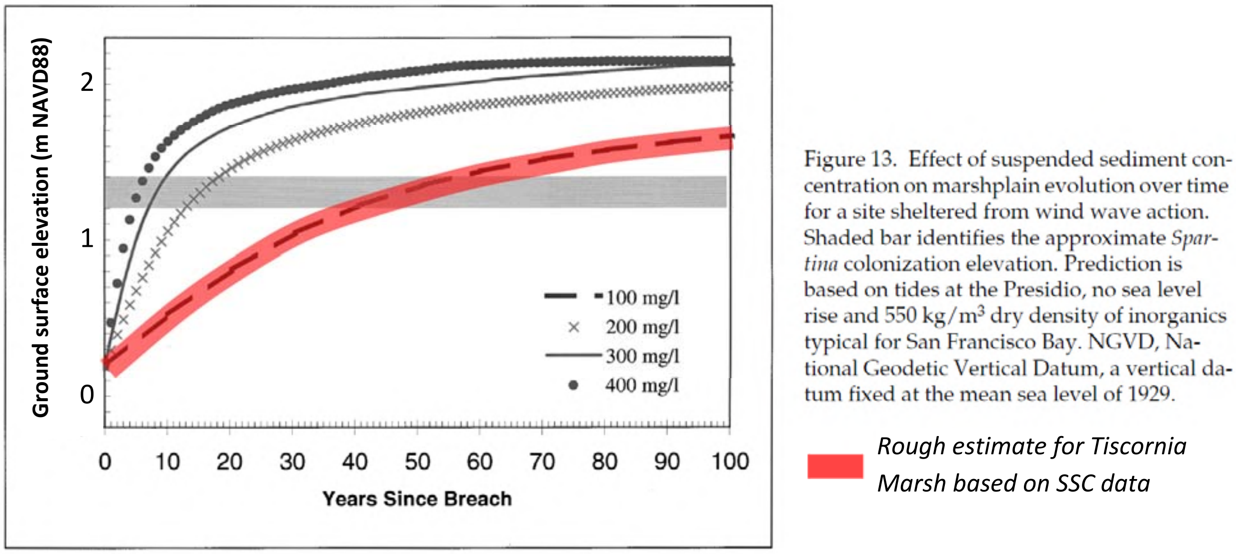


Figure 9. Effect of Suspended Sediment Concentration on Marshplain Evolution Over Time for a Site Sheltered from Wind Wave Action

Source: Williams and Orr (2002), Figure 13

Notes:

1) *Y-axis converted to meters NAVD88 from the original meters NGVD29*
2) *Red line provides very approximate estimation of accretion time periods, based on the Spinnaker Point and China Camp NERR data, assuming that the 1:1 conversion from turbidity to SSC applies to the available data sets, and with line thickness reflecting qualitative indication of uncertainty in the SSC concentrations.*

4 Conclusions: Relating Sediment Concentration and Accretion Data to Tiscornia Marsh Design Considerations

The data presented in the above two sections provides a number of insights about the potential for marsh accretion and associated design considerations at Tiscornia Marsh in the near and long term:

1) Local waters appear to have low to moderate sediment concentrations at present, supportive of lower rates of natural sedimentation under the right hydrodynamic conditions conducive to deposition.
2) Marsh accretion rates are strongly a function of marsh elevation as well as sediment supply and hydrodynamic conditions. Accretion rates for lower elevation mudflat areas are estimated to be up to 10-15 cm/yr. Accretion rates for high marsh are estimated to be up to 1 cm/yr. Given the importance of reducing flow velocities to promote settlement of sediment from the water column, incorporating design features at Tiscornia Marsh to create sheltered areas, consistent with protection of existing natural resource functions, would be expected to maximize accretion potential.
3) Long term projected declines in available regional suspended sediment supply are expected to reduce marsh accretion potential in general. The proximity of Tiscornia Marsh to the shallow San Rafael Bay may provide a moderate source of suspended sediment for years to come.

Inherently, long term sedimentation rate declines projected regionally are likely to apply also to Tiscornia Marsh, though perhaps they may be more delayed due to the nearby mudflat sediment sources.

4) Long term projected declines also suggest the value of starting restoration actions sooner than later to take advantage of available suspended sediments before the projected supply declines start to be observed.
5) Future Tiscornia Marsh design efforts may want to include geomorphic modeling to apply the currently documented sediment concentrations alongside future projections of supply decline to compare restoration design configurations and strategies, including differences between restoring marsh lost to previous erosion versus maintaining relative elevations of the remaining tidal marsh.
6) If more precise estimates of sediment accretion are desired for Tiscornia Marsh, then a combination of stable isotope sampling of cores taken from Tiscornia Marsh combined with additional water column suspended sediment concentration monitoring (inclusive of effort to calibrate turbidity sensor measurements to SSC) would be appropriate to consider.

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APPENDIX B: DATA COLLECTION

This appendix provides a brief overview of data collected at Tiscornia Marsh in September and October 2017. Section B1 describes water level data collected at the site, and Section B2 describes a topographic survey of the marsh, adjacent mudflats, and the levee backing the site.

B1. Water Level Data

ESA installed a Solinst pressure transducer and barometric pressure logger ('barologger') at Tiscornia Marsh on September 19th, 2017. Figure B1 shows the location of the logger, near the northern extent of the marsh. The pressure transducer was located near the mudflat surface, which was surveyed at about 2 feet NAVD88. The pressure logger was housed in a perforated pipe, to create still water conditions above the sensor while allowing tidal variations. Due to its position on the mudflat, the logger did not collect data during low tides (i.e. when the mudflats were exposed). The barologger collected continuous barometric pressure measurements. Both loggers were in place from September 19th to October 27th, 2017.

Pressure measurements were converted to depths by subtracting the barometric pressure at each time step, and using the hydrostatic assumption to convert pressure to depth in the pipe. Depths were then converted to elevations relative to the NAVD88 datum by surveying the sensor. Water surface elevations were also surveyed at the beginning and end of the deployment to check the sensor readings.

Figure B2 compares time series of water surface elevations at the site against water levels reported at the NOAA Richmond gauge. Water level data are described in more detail in Section 3 of the main report.

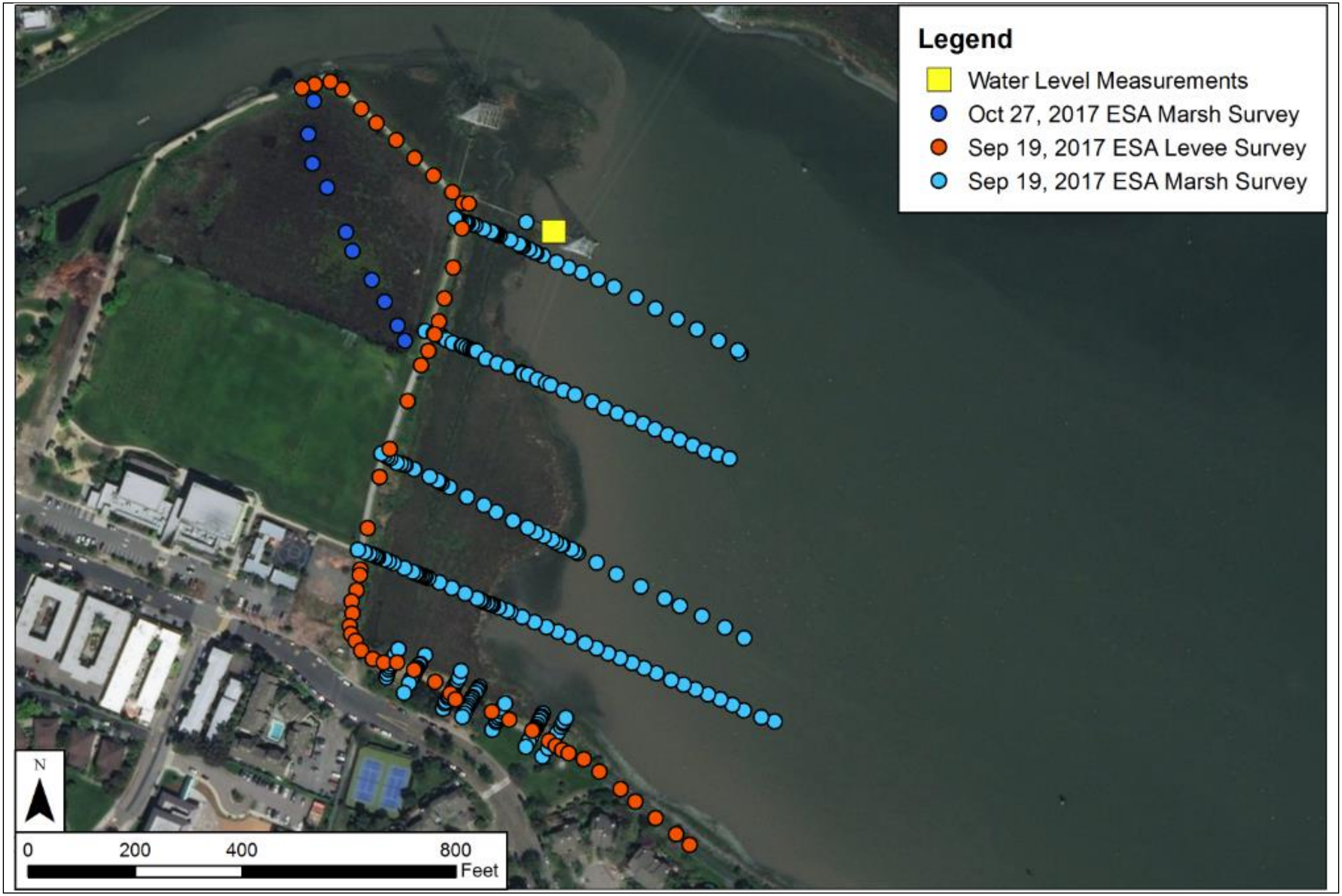
B2. Topographic Survey

ESA performed a topographic survey of the site on September 19th and October 27th 2017. During the first survey, 4 marsh and mudflat transects were collected in addition to 7 cross sections of the levee at the southern edge of the site (Figure B1). A levee profile was also collected (see Figure 8 in main report). On October 27th, and additional survey was performed to characterize elevations of the diked marsh immediately west of Tiscornia Marsh and north of the soccer field at Pickleweed Park. Both surveys were performed with RTK-GPS equipment, and were referenced to the NAVD88 vertical datum and NAD83 horizontal datum. Both surveys were completed relative to NGS control point PID = HT3837. The benchmark sheet for the control point can be accessed at the following site: https://www.ngs.noaa.gov/cgi-bin/ds_mark.prl?PidBox=HT3837

An addition to topographic data, the surveys also noted transitions between different bands of vegetation, and transitions between geomorphic features (e.g. location of marsh edge scarp). These were used in the main report to help delineate marsh areas for the assessment of alternatives.

Survey data on the marsh surface at Tiscornia Marsh and at the diked marsh to the west indicated a vertical bias due to marsh vegetation in the available LiDAR of the site. This was on the order of 0.25 to 0.5 feet in the diked marsh and in the upland transition area at Tiscornia Marsh.

Figures B3 and B4 provide illustrations of the marsh transects. Figure B5 illustrates the cross sections of the southern portion of the levee.

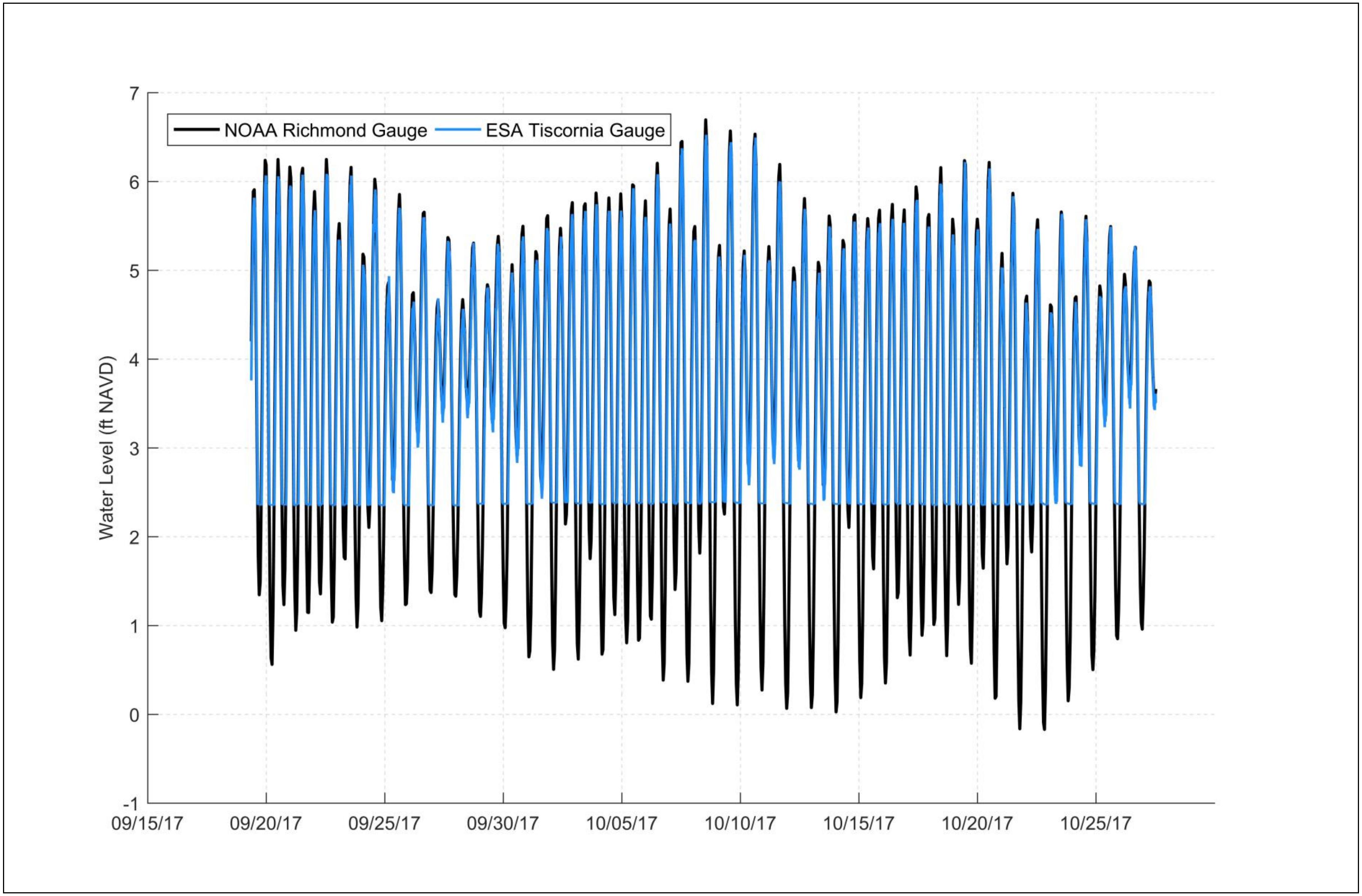


SOURCE: Background Image from Google Earth

Tiscornia Marsh Habitat Restoration . D160888.0

Figure B1

ESA survey points and water level gauge location

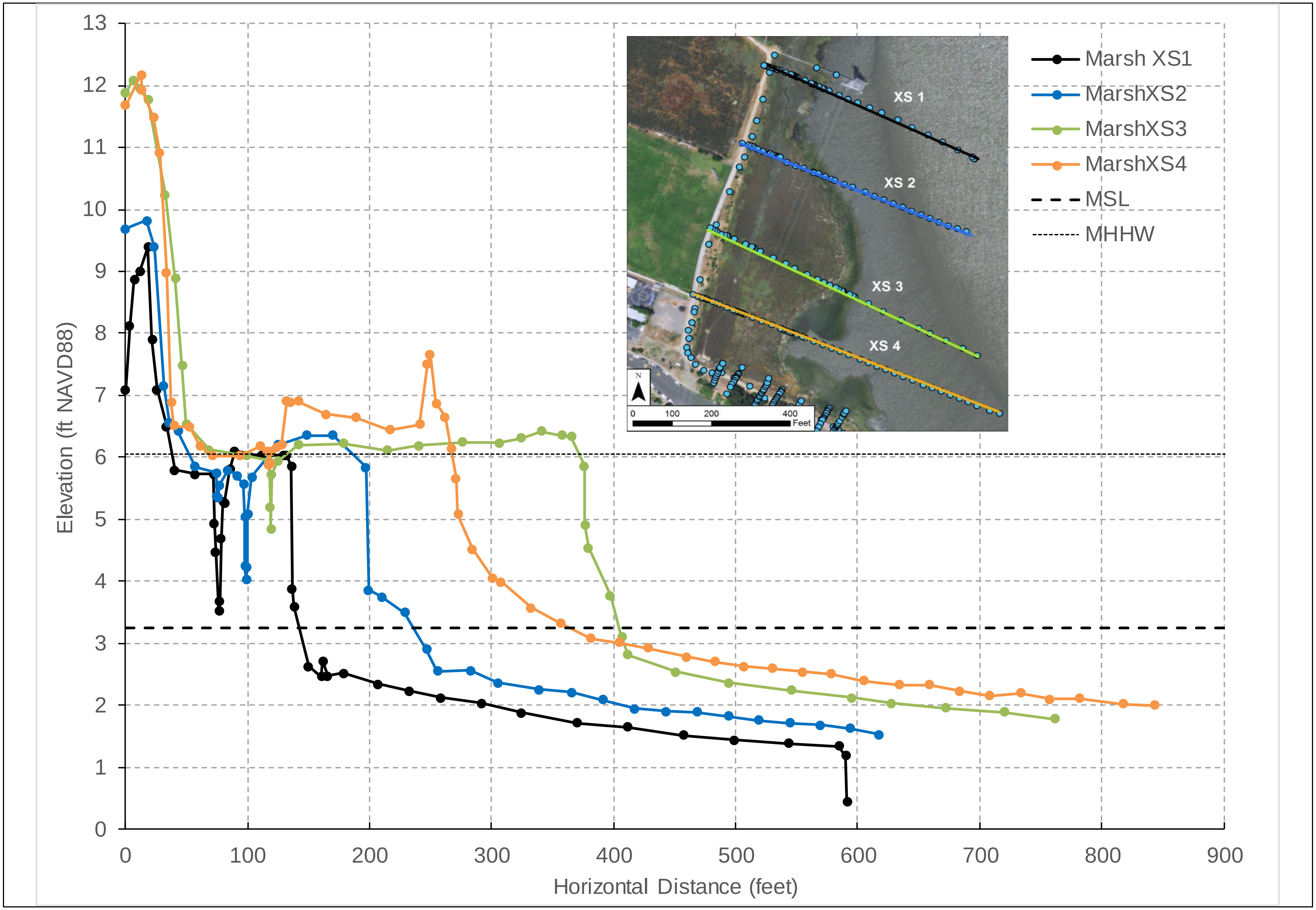


SOURCE: NOAA Richmond gauge and ESA temporary WL gauge at Tiscornia Marsh

Tiscornia Marsh Habitat Restoration . D160888.0

Figure B2

Time series of water levels in Richmond and at Tiscornia Marsh.

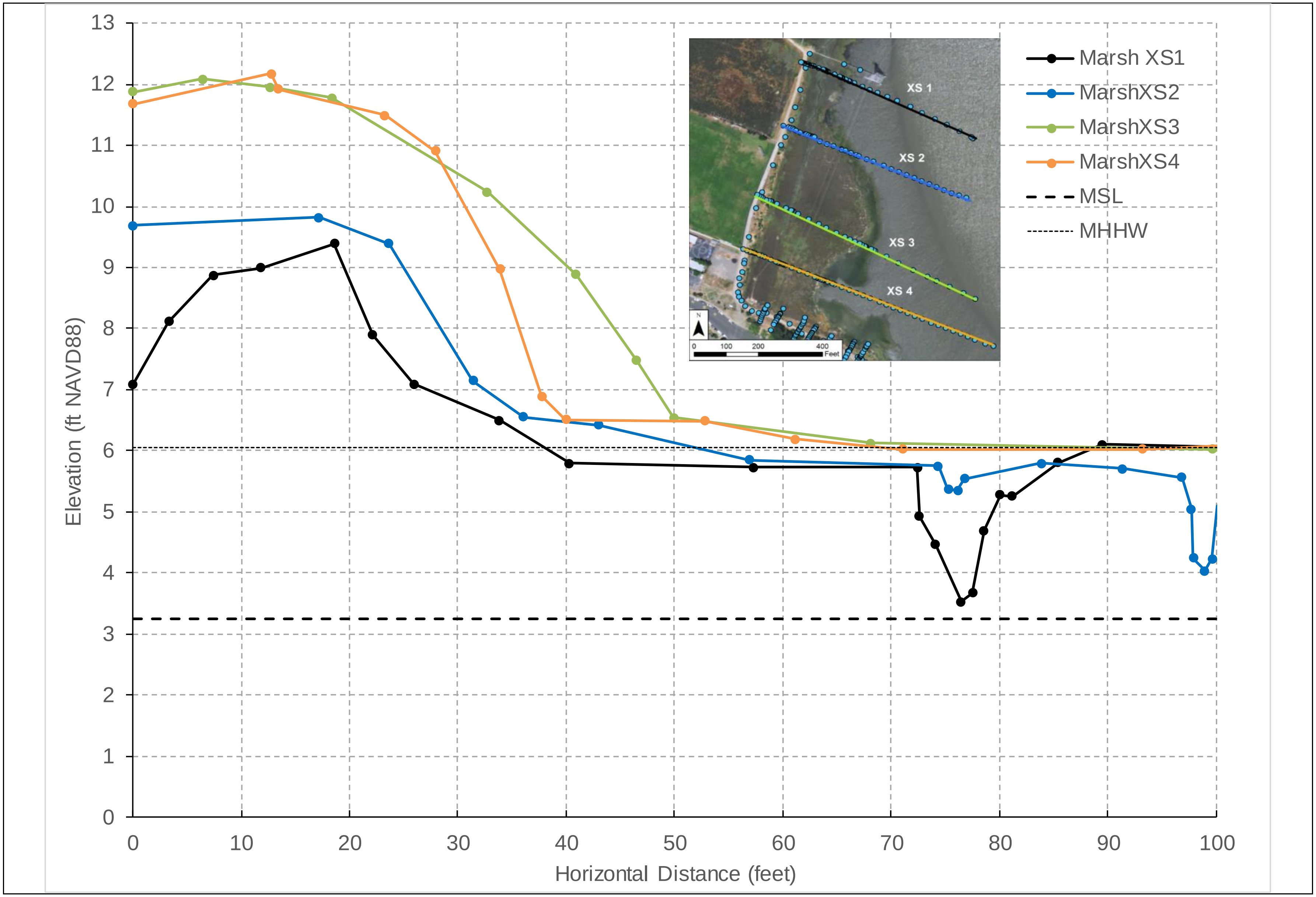


SOURCE: Tidal datums obtained from NOAA Richmond (Chevron Pier) Gauge

Tiscornia Marsh Habitat Restoration . D160888.0

Figure B3

Tiscornia Marsh transects surveyed on September 19th, 2017.

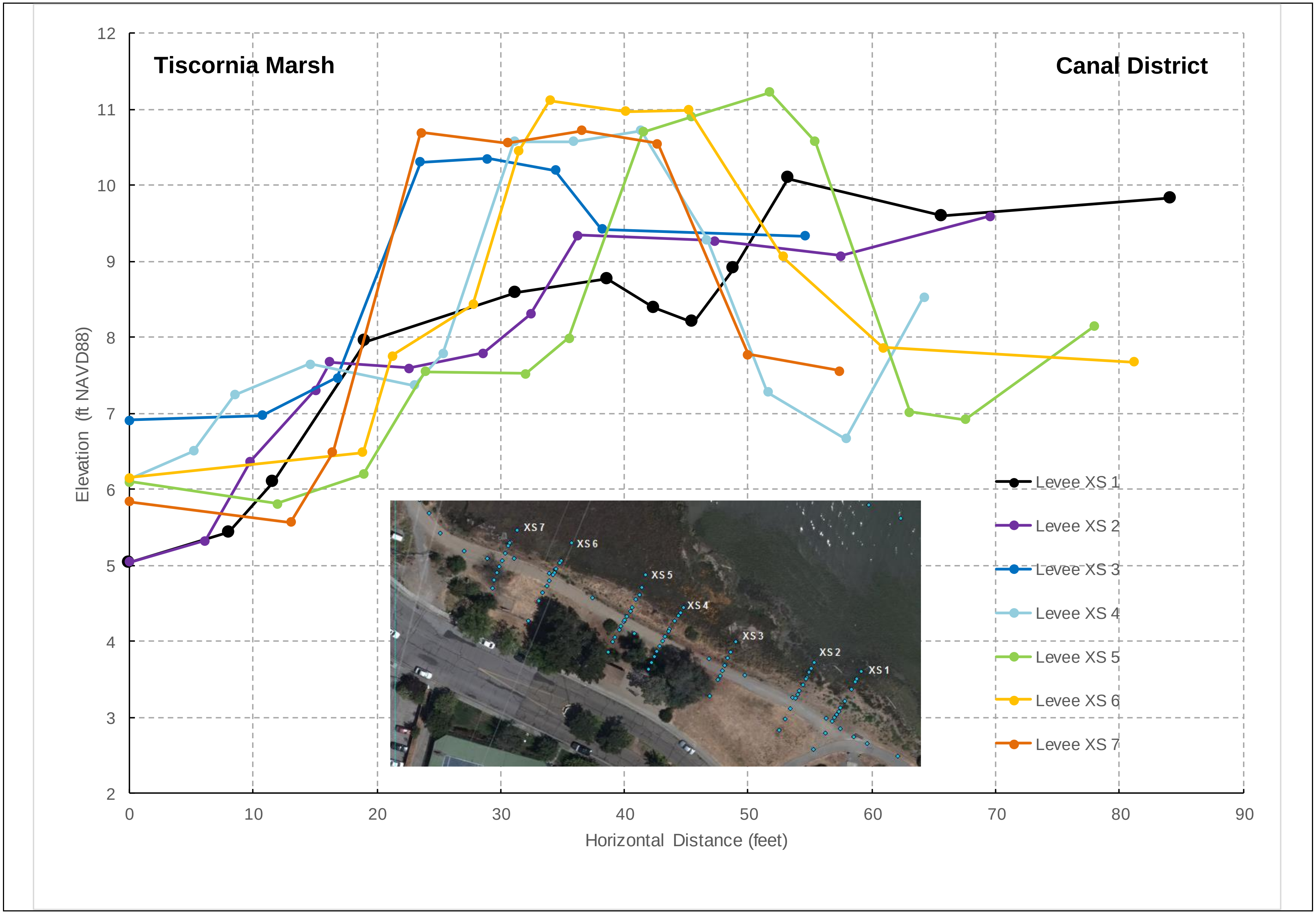


SOURCE: Background Image from Google Earth

Tiscornia Marsh Habitat Restoration . D160888.0

Figure B4

Close-up of September 19th topographic survey focusing on the upland transition between the levee and Tiscornia Marsh.



SOURCE: Background Image from Google Earth

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Figure B5

Levee cross sections collected on September 19th, 2017