Final

ORMOND BEACH RESTORATION AND PUBLIC ACCESS PROJECT

Preliminary Restoration Plan

Prepared for
California State Coastal Conservancy
The Nature Conservancy
City of Oxnard

May 2019

Final

ORMOND BEACH RESTORATION AND PUBLIC ACCESS PROJECT

Preliminary Restoration Plan

Prepared for
California State Coastal Conservancy
The Nature Conservancy
City of Oxnard

May 2019

770 Paseo Camarillo
Suite 310
Camarillo, CA 93010
805.914.1500
www.esassoc.com

ESA

Bend	Oakland	San Diego
Camarillo	Orlando	San Francisco
Delray Beach	Pasadena	Santa Monica
Destin	Petaluma	Sarasota
Irvine	Portland	Seattle
Los Angeles	Sacramento	Tampa

160447

OUR COMMITMENT TO SUSTAINABILITY | ESA helps a variety of public and private sector clients plan and prepare for climate change and emerging regulations that limit GHG emissions. ESA is a registered assessor with the California Climate Action Registry, a Climate Leader, and founding reporter for the Climate Registry. ESA is also a corporate member of the U.S. Green Building Council and the Business Council on Climate Change (BC3). Internally, ESA has adopted a Sustainability Vision and Policy Statement and a plan to reduce waste and energy within our operations. This document was produced using recycled paper.

TABLE OF CONTENTS

Ormond Beach Restoration and Public Access Project, Preliminary Restoration Plan

Page

Acronyms and Abbreviations v

Executive Summary **ES-1**

Section 1, Introduction **1-1**
- 1.1 Project Background 1-1
- 1.2 Project Area 1-1
- 1.3 Goals 1-4
- 1.4 Purpose and Scope of the Plan 1-4

Section 2, Site Conditions **2-1**
- 2.1 Project Setting 2-1
- 2.2 Historical Setting 2-5
- 2.3 Existing Conditions 2-6
  - 2.3.1 Topography 2-6
  - 2.3.2 Hydrology 2-15
  - 2.3.3 Water Quality 2-23
  - 2.3.4 Plant Communities 2-25
  - 2.3.5 Wildlife 2-28
- 2.4 Future Conditions 2-32
  - 2.4.1 Sea-Level Rise 2-32
  - 2.4.2 Shore Migration and Wave Overtopping 2-34
  - 2.4.3 Ormond Lagoon 2-39
  - 2.4.4 Wetland Habitats Evolution 2-44
- 2.5 Synthesis of Site Evolution – No Project 2-45
- 2.6 Potential Future Expansion 2-51
  - 2.6.1 Sod Farm 2-51
  - 2.6.2 MWD Parcel 2-52
  - 2.6.3 Ormond Beach Generating Station 2-52
  - 2.6.4 Halaco Properties 2-55
  - 2.6.5 Gateway Park 2-55

Section 3, Goals and Objectives **3-1**
- 3.1 Restoration Goal and Objectives 3-1
- 3.2 Public Access Goal and Objectives 3-2
- 3.3 Alternative Development Guidelines 3-3

Section 4, Opportunities and Constraints **4-1**
- 4.1 Restoration Opportunities and Constraints 4-1
  - 4.1.1 Restoration Opportunities (ROs) 4-2
  - 4.1.2 Restoration Constraints (RCs) 4-7

Page

4.2 Public Access Opportunities and Constraints 4-11
4.2.1 Public Access Opportunities (PAOs) 4-12
4.2.2 Public Access Constraints (PACs) 4-20

Section 5, Project Elements 5-1
5.1 Habitat Elements 5-1
5.1.1 Beach/Coastal Strand 5-1
5.1.2 Coastal Dunes 5-1
5.1.3 Dune Swale Wetlands 5-2
5.1.4 Lagoon and Open Water 5-2
5.1.5 Salt Panne 5-3
5.1.6 Salt Marsh 5-3
5.1.7 Seasonal Wetlands 5-4
5.1.8 Fresh-Brackish Wetland 5-5
5.1.9 Riparian 5-5
5.1.10 Wetland-Upland Transition 5-5
5.1.11 Bioswales 5-6
5.1.12 Upland 5-6
5.2 Public Access Elements 5-7
5.2.1 Trails 5-7
5.2.2 Site Amenities 5-8
5.2.3 Design Considerations 5-11

Section 6, Description of Project Alternatives 6-1
6.1 Alternatives Development 6-2
6.1.1 Ecological Basis 6-2
6.1.2 Public Access 6-12
6.2 Description of Alternatives 6-12
6.2.1 Alternative 1 6-20
6.2.2 Alternative 2 6-31
6.2.3 Alternative 3 6-43
6.3 Alternatives Evaluation 6-56
6.3.1 Technical Studies 6-57
6.3.2 Comparative Evaluation 6-68
6.3.3 OBRAP Science Advisory Committee 6-79
6.4 Preferred Alternative 6-80
6.4.1 Overview 6-81
6.4.2 Actions 6-81
6.4.3 Outcomes 6-96

Section 7, Data Gaps and Adaptive Management 7-1
7.1 Data Gaps 7-2
7.2 Restoration Uncertainties 7-3
7.3 Feasibility Study Recommended Activities 7-6
7.4 Adaptive Management and Adaptive Restoration 7-13

Section 8, List of Preparers 8-1
8.1 Project Partners 8-1
8.2 Consultant Team 8-1
8.3 Reviewers 8-1

Section 9, References 9-1

Page

Appendices

A. Sea-Level Rise A-1
B. Shore Migration and Overtopping (Beach QCM) B-1
C. Ormond Lagoon Hydrology and Morphology (Lagoon QCM).... C-1
D. Wetlands Habitat Evolution Modeling (SLAMM) D-1

List of Figures

Figure ES-1 Project Area and Vicinity.... ES-3
Figure ES-2 Project Area Map.... ES-4
Figure ES-3 Preferred Alternative of Ormond Beach Restoration and Public Access Plan ES-5
Figure 1-1 Project Area and Vicinity.... 1-2
Figure 1-2 Project Area Ownership.... 1-3
Figure 2-1 Project Area and Site Areas 2-2
Figure 2-2 Existing Topography.... 2-3
Figure 2-3 Existing Habitats.... 2-7
Figure 2-4 Project Area Historic Ecology in the Early 1800s.... 2-9
Figure 2-5 Topography- West Project Area 2-11
Figure 2-6 Topography- Central Project Area 2-12
Figure 2-7 Topography- East Project Area Existing Habitats.... 2-13
Figure 2-8 Schematic of Surface and Groundwater Flow Paths through the Project Area.... 2-16
Figure 2-9 Groundwater Contours 2006 2-18
Figure 2-10 Water Level and Groundwater Gauge Locations, and Survey Transects 2-19
Figure 2-11 Water Levels.... 2-20
Figure 2-12 Salinity.... 2-22
Figure 2-13 Sea-level rise scenarios from CRV and draft policy update.... 2-33
Figure 2-14 Beach Transects Location 2-35
Figure 2-15 Beach Transects.... 2-36
Figure 2-16 Sea-Level Rise Induced Drivers to Ormond Lagoon Change 2-38
Figure 2-17 Sea-Level Rise Induced Overtopping and Ponding in Areas 3, 4, and 5 2-39
Figure 2-18 Comparison of Modeled and Observed Water Levels in Ormond Lagoon.... 2-40
Figure 2-19 Lagoon Mouth Closures in Days per Month; Existing Conditions (No Project) 2-42
Figure 2-20 Modeled Lagoon Stage (Water Level) (left), Area (middle), & Volume (right) Probability Distributions for 2007–2017; Existing Conditions (No Project) 2-43
Figure 2-21 Historical Habitat Distribution.... 2-46
Figure 2-22 SLAMM Results with Beach Transgression Existing Conditions, Current-Day 2-47
Figure 2-23 SLAMM Results with Beach Transgression Existing Conditions, 2060, +2.1' SLR.... 2-48
Figure 2-24 SLAMM Results with Beach Transgression Existing Conditions, 2080, +3.4' SLR.... 2-49
Figure 2-25 SLAMM Results with Beach Transgression Existing Conditions, 2100, +4.8' SLR.... 2-50
Figure 2-26 Known Potential Land Acquisitions and Changes 2-53
Figure 4-1 Public Access Opportunities and Constraints.... 4-13
Figure 6-1 Alternative 1: Salt Marsh Theme, Light Intervention 6-3

Page

Figure 6-2 Alternative 2: Habitat Diversity Theme, Moderate Intervention 6-4
Figure 6-3 Alternative 3: Habitat Connectivity Theme, Greater Intervention 6-5
Figure 6-4a Cross Sections for Project Alternatives 6-13
Figure 6-4b Cross Sections for Project Alternatives 6-14
Figure 6-5 Alternative 1 Cross Section Locations 6-15
Figure 6-6 Alternative 2 Cross Section Locations 6-16
Figure 6-7 Alternative 3 Cross Section Locations 6-17
Figure 6-8 Habitat Distribution by Alternative 6-19
Figure 6-9 SLAMM Results with Beach Transgression Alternative 1, 2060, +2.1' SLR . 6-59
Figure 6-10 SLAMM Results with Beach Transgression Alternative 1, 2080, +3.4' SLR . 6-60
Figure 6-11 SLAMM Results with Beach Transgression Alternative 2, 2060, +2.1' SLR . 6-61
Figure 6-12 SLAMM Results with Beach Transgression Alternative 2, 2080, +3.4' SLR . 6-62
Figure 6-13 SLAMM Results with Beach Transgression Alternative 3, 2060, +2.1' SLR . 6-63
Figure 6-14 SLAMM Results with Beach Transgression Alternative 3, 2080, +3.4' SLR . 6-64
Figure 6-15 Modeled Lagoon Stage (Water Level) (left), Area (middle), & Volume (right) Probability Distributions for 2007-2017. 6-65
Figure 6-16 Modeled Lagoon Stage (Water Level) (left), Area (middle), & Volume (right) Probability Distributions for 2007–2017. With 3 feet of Sea-Level Rise 6-67
Figure 6-17 Preferred Alternative 6-83
Figure 6-18 Preferred Alternative Cross Section Locations 6-84

List of Tables

Table ES-1 Preferred Alternative Restoration and Public Access Elements by Area ES-7
Table 2-1 Existing Habitat Acreages in the Project Area 2-25
Table 2-2 Special-Status Plant Species Documented Within or Immediately Adjacent to the Project Area 2-26
Table 2-3 Special-Status Wildlife Species Documented At or Near the Project Area ... 2-28
Table 2-4 Sea-Level Rise Scenarios Used in this Study, from CRV 2-33
Table 4-1 Restoration Opportunities and Constraints 4-1
Table 4-2 Public Access Opportunities and Constraints 4-11
Table 5-1 Site Amenities 5-9
Table 6-1 Overview of Alternatives with Restoration and Public Access Elements 6-7
Table 6 2 Alternative 1 Actions by Area 6-22
Table 6-3 Alternative 1: Salt Marsh Theme Habitat Projections 6-30
Table 6-4 Alternative 2 Actions by Area 6-33
Table 6-5 Alternative 2: Wetland Diversity Theme Habitat Projections 6-42
Table 6-6 Alternative 3 Actions by Area 6-46
Table 6-7 Alternative 3: Connectivity Theme Habitat Projections 6-55
Table 6-8 Comparative Evaluation of Alternatives Relative to Restoration Objectives . 6-69
Table 6-9 Comparative Evaluation of Alternatives Relative to Access Objectives 6-75
Table 6-10 Comparative Evaluation of Alternatives Relative to Implementation Feasibility 6-78
Table 6-11 Preferred Alternative Restoration Actions by Area 6-86
Table 6-12 Preferred Alternative Restoration and Public Access Elements by Area 6-93
Table 6-13 Preferred Alternative Habitat Projections 6-97
Table 7-1 Summary of Recommendations to Fill Project Data Gaps (2009 Feasibility Study) 7-7
Table 7-2 List of Priority Studies 7-11

Acronyms and Abbreviations

ADA	Americans with Disabilities Act
CCC	California Coastal Commission
CDFW	California Department of Fish and Wildlife
CFS	cubic feet per second
CRC	Coastal Restoration Consultants
CNDDB	California Natural Diversity Database
CRV	Coastal Resilient Ventura
CSUCI	California State University Channel Islands
DEM	digital elevation model
EPA	Environmental Protection Agency
ESA	Environmental Science Associates
LiDAR	Light Detection and Ranging
MAMP	Monitoring and Adaptive Management Plan
MHHW	Mean Higher High Water
MLLW	Mean Lower Low Water
MWD	Metropolitan Water District
NAVD88	North American Vertical Datum of 1988
NBVC	Naval Base Ventura County
NRC	National Research Council
OBRAP	Ormond Beach Restoration and Public Access Project
ODD #3	Oxnard Drainage Ditch #3
OLW	Ormond Lagoon Waterway
OPC	Ocean Protection Council
PAC	Public Access Constraints
PAO	Public Access Opportunities
PCB	polychlorinated biphenyls
ppt	parts per thousand
PWA	Philip William and Associates
QCM	quantified conceptual model
RC	Restoration Constraints
RTK GPS	Real Time Kinematic Global Positioning System
RO	Restoration Opportunities
RWQCB	Regional Water Quality Control Board
SAC	Science Advisory Committee

SCC	State Coastal Conservancy
SCWRP or WRP	Southern California Wetland Recovery Project
SFEI	San Francisco Estuary Institute
SLAMM	Sea Level Affecting Marshes Model
SLR	sea-level rise
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy
USACE	US Army Corps of Engineers
USFWS	US Fish and Wildlife Service
UWCD	United Water Conservation District
VCWPD	Ventura County Watershed Protection District
WSE	water surface elevation
WWTP	wastewater treatment plant

EXECUTIVE SUMMARY

Background

Ormond Beach is located in southern Ventura County, predominantly in the city of Oxnard (**Figure ES-1**). It is the seaward edge of a large, flat alluvial plain and is surrounded by a mix of residential, industrial, and agricultural lands as well as federal military installations. Ormond Beach has been identified by wetland experts as the most important coastal wetland restoration opportunity in Southern California (SCC 2016). It has long been targeted for ecological enhancement and improved public access owing to its proximity to the large population centers in Los Angeles, Ventura, and Santa Barbara Counties and to the relatively rare opportunity to protect and restore a large area of dune/wetland/upland habitat in Southern California.

The California State Coastal Conservancy, the City of Oxnard, and The Nature Conservancy (collectively "Project Partners") are leading the Ormond Beach Restoration and Public Access Project (OBRAP). The vision of the OBRAP is a resilient coastal environment that inspires the enjoyment, use, and support of the local community and beyond. The Project Partners' goals for the OBRAP are:

1. Preserve, enhance, and restore natural habitats and processes that support a dynamic and self-sustaining ecosystem at Ormond Beach.
2. Enhance opportunities for people to easily and safely visit Ormond Beach and enjoy the nature, educational opportunities, and recreation that are compatible with the restored Ormond Beach ecosystem.

In total, the Project Partners own 630 acres within the city of Oxnard, which comprise the Project Area (**Figures ES-1 and ES-2**). The Project Partners are pursuing additional land acquisitions to add to the Project Area for the purpose of ecological enhancement and public access as it becomes available from willing landowners. This Preliminary Restoration Plan (Plan) describes a Preferred Alternative derived from an analysis of conceptual alternatives, and is intended to provide a basis for subsequent environmental review, followed by engineering design and regulatory approvals, and construction.

Preferred Alternative

The Preferred Alternative will enhance and restore existing habitat, increase public access to the Project Area and adjacent beach in an ecologically sensitive manner, and allow for habitat changes in response to projected sea-level rise and landward shore migration (**Figure ES-3**). The Project Area extends along the Pacific Ocean shore from the residential and commercial areas of

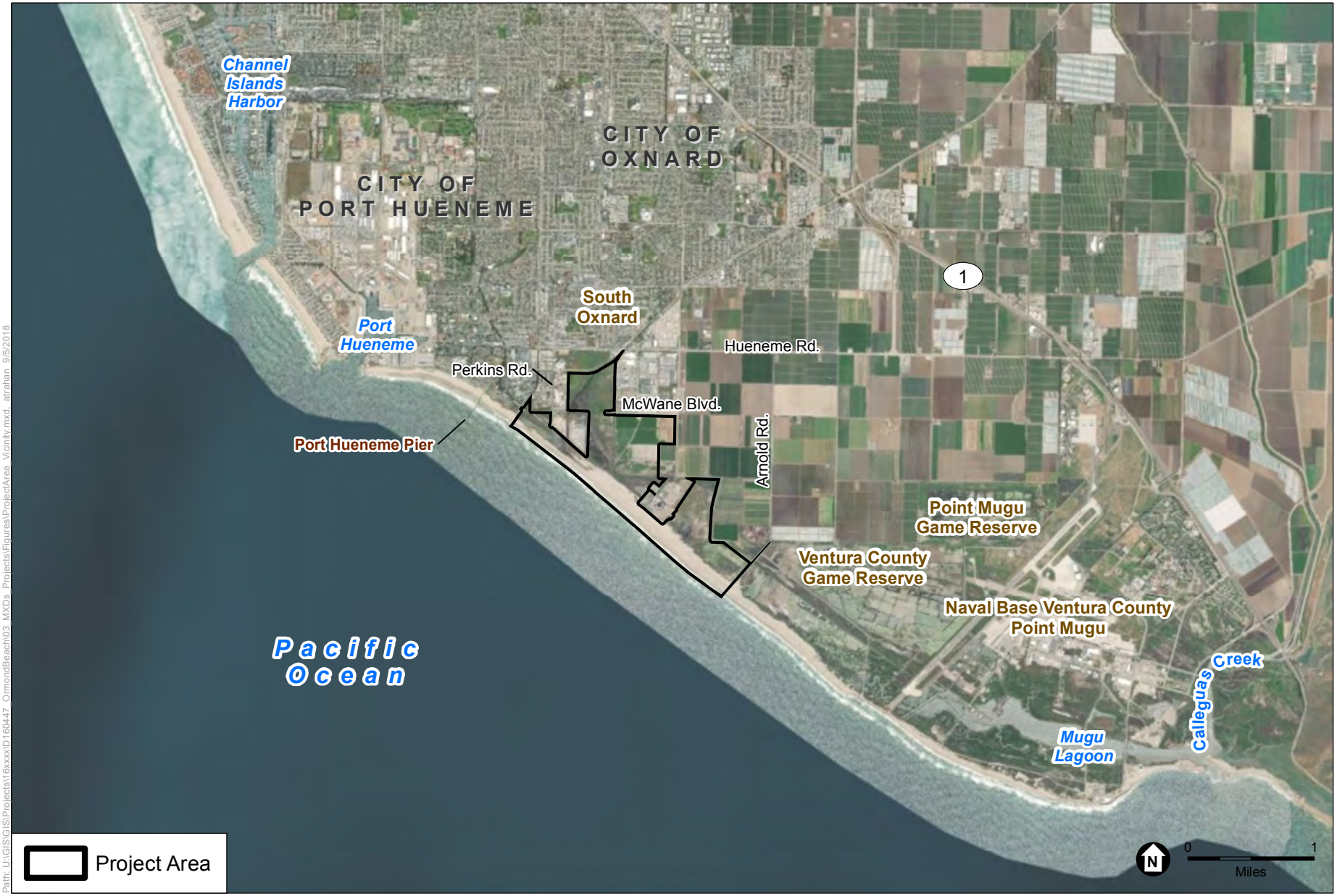
South Oxnard on the west to the Naval Base Ventura County–Point Mugu on the east. The Project Area has been divided into nine subareas for planning purposes. These subareas are numbered 1 to 9 to locate Project actions (see the legend in the Figure ES-3). Other key features depicted are public access nodes (letters A through F) and proposed vegetation areas indicating habitat types and public access features.

The Plan's recommended actions are summarized by area in **Table ES-1**. Implementation of these actions will result in the creation/restoration of a range of wetland habitats between the littoral strand (sandy beach and dunes) and the uplands. Existing habitats will be enhanced and new habitats developed via earth moving to change grades and modify water flow and ponding, and vegetation management. A range of wetland types (freshwater, brackish, saltmarsh, and salt flats ["pannes"]) will be reestablished based on what existed historically, with consideration of existing wetlands, Project Area grades, and other opportunities and constraints. Existing protected plants, animals, and habitats provide both opportunities and constraints that helped shape the Plan restoration and access elements. A variety of public access paths and amenities are envisioned, including pedestrian trails that link to existing roads to provide views of various habitats and provide access to the beach. A visitor center and parking are also proposed. Considerations of existing infrastructure, adjacent land uses, and flood potential have influenced the Plan. The public access components are intended to serve the community as well as visitors, while also maintaining protections for habitat and special-status plant and animal species.

Plan Development Process

The Plan was developed on behalf of the Project Partners. The Project was initiated in March 2017. Preparation of the Plan included a review of prior work, public and stakeholder outreach, additional data collection and analyses, modeling of future conditions, and technical review. The Plan builds upon and supersedes the Ormond Beach Wetland Restoration Feasibility Study (Feasibility Study) developed by the California State Coastal Conservancy (Aspen 2009).
A Scientific Advisory Committee (SAC) of technical experts in biological resources and wetlands restoration and processes was convened in 2010–2013 and again in 2016–2018. The SAC members provided preliminary guidance on Plan goals, priorities, key data gaps, and adaptive management approaches. The SAC reviewed and commented on a range of proposed alternatives, with two formal review meetings (see Section 6.3.3).

The Plan is also informed by public input collected in 2017 (see Section 6.1.2). Over 60 people attended a public meeting sponsored by the Project Partners on June 21, 2017, at the Oxnard Performing Arts Center. Attendees provided input about the area, public access, visitor activities, and ideas for improvements through one-page questionnaires, small discussion groups, and comment cards. In addition, door-to-door surveys were conducted by the Central Coast Alliance United for a Sustainable Economy (CAUSE), in Spanish, English, and Mixteco, in several residential neighborhoods near Ormond Beach. The Project Partners met with neighboring landowners and agencies operating in the Ormond Beach area that have a potential to be impacted by the Plan to discuss potential opportunities and constraints and inform development of the Plan (Section 4).



SOURCE: ESRI 7/19/2016, City of Oxnard, Ventura County

Ormond Beach Restoration and Public Access Plan

Figure ES-1
Project Area and Vicinity

ESA

Path: U:\GIS\GIS\Projects\16xxxx\D160447_OrmondBeach\03_MXDs_Projects\Figures\ProjectArea_Vicinity.mxd, atrahan, 9/5/2018

SOURCE: ESRI 7/19/2016, City of Oxnard, Ventura County

Ormond Beach Restoration and Public Access Plan

Figure ES-2
Project Area Map

ESA

Wetland Boardwalk

Wetland Bridge with Overlook

Wetland-Dune Boardwalk

Bike Service and Racks

Bike Lockers

Primary Developed Trail

Rustic Trail

Primitive Trail

Beach Trail

Exclusionary Bird Fencing (Netting)

Symbolic Bird Fencing

Designated Areas

1. Ormond Lagoon, Including Beach, Dunes, & Perkins Drainage
2. Ormond Lagoon Waterway (OLW)
3a. South-of-Railway, Near Halaco Property
3b. South-of-Railway, Near OBGS
4. Agriculture
5. Tank Farm
6. Salt Marsh / Panne
7. Beach & Dune South of 3
8. Beach & Dune South of 5
9. Beach & Dune South of 6

Vegetation

- Salt Marsh (SM)
- Wetland-upland Transition (WT)
- Seasonal Wetlands (SW)
- Brackish Marsh (BM)
- Open Water
- Salt Panne (SP)
- Bioswale (BI)
- Upland (U)
- Coastal Dune (D)
- Beach/Strand (B)
- Dune Swale Wetland (DSW)

Access Nodes

- A Perkins Road
- B_1 West McWane Blvd.
- B_2 East McWane Blvd.
- C Hueneme Road
- D Arnold Road
- E City of Port Hueneme
- F Edison Road

Access Elements

- Primary / Developed Trail
- Secondary / Rustic Trail
- Tertiary / Primitive Trail
- Beach Trail
- Boardwalk
- Bridge
- CA Coastal Bike Trail
- Overlook Platform
- Overlook or View
- Parking
- Major Trailhead
- Minor Trailhead
- Water Control Structure
- Project Boundary
- Railroad

SOURCE: ESA, 2019

Ormond Beach Restoration and Public Access Plan

Figure ES-3
Preferred Alternative of Ormond Beach Restoration and Public Access Plan

ESA

D160447.00 - Ormond Beach Wetlands Restoration\05 Graphics\Illustrator

This page intentionally left blank

TABLE ES-1
PREFERRED ALTERNATIVE RESTORATION AND PUBLIC ACCESS ELEMENTS BY AREA

Area	Design Element	Preferred Alternative
1	Restoration	• Weeding and planting in upland areas • Lagoon connection to Ormond Lagoon Waterway (OLW) moved to the east of Halaco properties • Lagoon connection to marsh in Area 3a increases capacity and leads to less frequent manual breaching
	Public Access	• All Primary trails at 12.0 elevation, Rustic trails at 11.0 -12.0 elevation where feasible, boardwalks at 13.0, Bridge/Pier at 15.0 • Bridge over tšumaš Creek • Bridge or boardwalk over Ormond Lagoon from island to beach • Boardwalk to overlook at Ormond Lagoon • Rustic trail to overlook • New bridge between Perkins and Ormond Lagoon • Expand Perkins Parking Lot footprint, adding 24 spaces • Restrooms, interpretive kiosk and docent station (±1,000 SF for school group focus), which can be relocated to accommodate sea level rise (SLR) • Bike racks and bike lockers (rental) • Primary trail in wetlands north of Perkins Road parking leading to West McWane Blvd.
2	Restoration	• Re-align OLW and grade to allow engagement with floodplain and brackish marsh • Minor grading to create gently sloping brackish marsh plain along new channel • Balance cut-fill within the area by filling old channel and adding flood protection around edges of property • Create smooth transition between Areas 2 and 3a • Create bioswale to capture nutrients in runoff from East McWane Blvd.
	Public Access	• New Major trailhead with 25+ parking spaces at West McWane Blvd. • Interpretive signage • New primary developed CA Coastal Trail heading east • Elevated wetland boardwalk to rustic loop trail • Bridge over OLW with birding overlook • Elevated overlook near East McWane Blvd. • Minor pedestrian and bike trailhead at Hueneme Road • Primary multi-modal trail at Hueneme Road (at-grade railroad crossing) to East McWane Blvd., CA Coastal Trail

TABLE ES-1
PREFERRED ALTERNATIVE RESTORATION AND PUBLIC ACCESS ELEMENTS BY AREA

Area	Design Element	Preferred Alternative
3	Restoration	• Re-align OLW and grade to allow engagement with floodplain and brackish marsh • Minor grading to create gently sloping brackish marsh plain along new channel • Let habitat naturally convert from salt marsh to brackish marsh • Establish additional Coulter's goldfield populations in other areas the Project Area by collecting seed and distributing in appropriate areas • Weeding and planting in upland areas • Water control structure (culvert) under the railroad
	Public Access	• Primary multi-modal trail, CA Coastal Trail • Overlook platforms • Bridge over OLW/agricultural ditch creek • Wetland boardwalks • Birding overlook platform with bird blinds • Wetland boardwalks through Area 3b • At-grade railroad crossing
4	Restoration	• Cease farming and excavate a series of shallow basins at increasing elevations from south to north • Water control structure (culvert) under the railroad • Basins will undergo type changes as sea level rises • Lower basin expected to support salt panne habitat at about 5 feet NAVD88[1] in the short term and evolve in to open water with moderate SLR • Middle basin(s) expected to support seasonal saline-affected wetlands at about 7 feet NAVD88 and evolve in to salt marsh and salt panne with moderate sea-level rise • Upper basin(s) expected to support seasonal wetlands and act as a bioswale at about 9 feet NAVD88 and evolve in to salt marsh and salt panne with greater sea-level rise • Establish salt marsh (below about 9 feet NAVD88) and transition zone vegetation (above about 9 feet) around basins
	Public Access	• Major trailhead and ±50 stall parking lot at East McWane Blvd. and Edison intersection (Future, high point of Project Area) • Bike services for CA coastal trail riders, including racks, lockers, and minor repair station. • Visitor Center • Multi-modal primary elevated trail at 12 feet NAVD88, CA Coastal Trail

TABLE ES-1
PREFERRED ALTERNATIVE RESTORATION AND PUBLIC ACCESS ELEMENTS BY AREA

Area	Design Element	Preferred Alternative
5	Restoration	• Block or reduce drainage through culverts between Area 5 and Oxnard Drainage Ditch (ODD) #3 • Remove levees and fill the ditch of ODD #3 between Areas 5 and 6 (the dead end channel) to create continuous marsh plain • Remove all old roads and building pads • Create series of shallow basins at increasing elevation • Lowest basin expected to support salt panne in the near term at about 5 NAVD88 feet and open water habitats with moderate sea-level rise • Middle basin expected to support seasonal saline-affected wetlands at about 6 feet NAVD88 and evolve into salt marsh and salt panne with moderate sea-level rise • Upper basin expected to support seasonal wetlands at about 8 feet NAVD88 and evolve in to salt marsh and salt panne with greater sea-level rise • Establish salt marsh (below about 7.5 feet NAVD88) and transition zone vegetation (above about 7.5 feet NAVD88) around basins
	Public Access	• Rustic trail to birding platform with wetland overlook • Opportunity for future connection to Edison Road for loop trail
6	Restoration	• Maintain salt panne and salt marsh habitats with some weeding and revegetation as needed on higher spots • Restore upland habitats along ODD #3 levee • Remove levees and fill the ditch of ODD #3 between Areas 5 and 6 (the dead end channel) to create continuous marsh plain (in coordination with Oxnard Drainage District 2)
	Public Access	• CA Coastal Trail Class II bike trail on Arnold Road (per County of Ventura Local Coastal Plan) • Reconfigure Arnold Road parking for drop-off/turnaround only and Americans with Disabilities Act (ADA) parking • Bike-focused trailhead with bike lockers and bike racks • Elevated wetland overlook • Primitive trail along ODD #3 to Area 5 and beach, or along rustic trail to Area 6 and beach • Birding overlook in back dunes • Rustic seasonal trail from trailhead to beach (closed during nesting season or if inundated in winter)
7, 8, 9	Restoration	• Weeding and planting to restore back dune scrub habitat and expand foredune scrub habitat • Excavate series of shallow depression between dune ridges and vegetate with dune swale wetland species • Add sand fencing and seed native dune species to facilitate wind-driven sand capture and dune building
	Public Access	• Area 7: New and existing bird fencing • Area 7-9: Continue to maintain CA Coastal Trail along beach strand (includes Area 1) • Area 7: Primitive beach strand trail connects to backdune boardwalks in Area 3a and Area 3b • Area 8: Beach strand trail connects to Arnold primitive trail, dune overlook area • Area 9: Beach strand trail connects to Rustic trail at Arnold Road

NOTE:
1 All elevations are in North American Vertical Datum of 1988 (NAVD88)

Plan Sections

This document is organized into several sections. The Introduction (Section 1) provides background information, locates the Project and its extent, lists the Project goals of ecosystem restoration and public access, and describes the purpose and scope of the Plan.

Project Setting (Section 2.1) is described in terms of key features and areas (e.g., Areas 1-9, Ormond Lagoon Waterway). Historical Setting (Section 2.2) reviews data and interpretations of the Project Area and vicinity conditions dating back to the earliest maps (late 1800s). The historical conditions provide a "reference" for the natural ecological and geomorphic[1] conditions prior to development. This historical reference is used to inform the ecosystem restoration, and indicated a mosaic of wetlands with numerous back-shore lagoon habitats. Existing Conditions (Section 2.3) summarizes existing physical and ecological conditions. Special-status species in the Project Area include California least tern and western snowy plover that nest at the beach and salt panne habitats, tidewater goby in Ormond Lagoon, Belding's savannah sparrow and salt marsh bird's beak in salt marsh, and Ridgway's rail in the wetland areas.

Section 2.4 addresses future conditions of the Project Area, focusing primarily on sea-level rise and implications from coastal flooding and landward shore migration. Predictions of future shore locations, condition of Ormond Lagoon and wetlands habitats are presented. Section 2.5 provides a synthesis of site evolution for "No Project" as part of the baseline from which to form and evaluate alternative restoration and public access improvements. Future conditions are forecast to include substantial reduction of beach widths, flooding of existing back-dune wetlands and conversion to open water lagoons with potential migration of wetlands to higher elevations. Existing agricultural and industrial land uses in the Project Area and vicinity are likely to be impacted by higher sea levels.

Section 3 of the report presents Project goals and objectives for restoration and public access, as well as implementation guidelines. Section 4 lays out opportunities and constraints for ecological restoration and public access. Section 5 defines habitats that could be restored in the Project Area, including those that currently exist or were historically present (such as beach, coastal dunes, salt pannes, salt marsh, lagoon), wetland-upland transition zones, and created bioswales.

Three alternatives are described and analyzed in Section 6. These alternatives were developed to represent a range of ecological outcomes resulting from a variety of landscape modification and management:

> *Alternative 1* is configured to enhance existing habitats through limited intervention, with an emphasis on preservation of salt marsh and salt panne habitats. Alternative 1 recognizes that there are significant existing wetlands resources in the Project Area that can be improved through enhancement, restoration, and improved management. This alternative also provides a lower impact approach with less earth moving. Alterative 1

[1] Geomorphology refers to the shaping of land by natural forces, in this case primarily water and plants, within the time frame of decades to centuries.

therefore has a "salt marsh theme" with minimal intervention, and is described in Section 6.2.1.

Alternative 2 has a "habitat diversity theme" with moderate intervention to expand a wide diversity of wetland habitats. The wetland types proposed are based on current conditions and are appropriate within the historic context of the region. A major action is the re-alignment of Ormond Lagoon Waterway to create extensive brackish wetlands. This alternative requires substantial earthwork to enhance, restore, and create higher functioning habitats. Alternative 2 is described in Section 6.2.2.

Alternative 3 emphasizes connectivity of habitat and restoration of historical processes. The Project Area is currently highly fragmented by levees, channels, roads, railroads, and other industrial infrastructure. This alternative focuses on earth moving and manipulations to increase hydrologic and ecological connectivity within the Project Area and between the Project Area and neighboring habitats. A new lagoon would be excavated with its own intermittently open mouth to allow unmanaged connectivity with the ocean. This alternative proposes the most earthwork and the greatest changes. Hence, the alternative has a "habitat connectivity theme" with the greatest degree of intervention. Alternative 3 is described in Section 6.2.3.

Public access elements were chosen to be most compatible with each alternative, while also covering a range of amenities that could be substituted across alternatives. Public access elements include pedestrian trails (developed, rustic, primitive, beach trails), bicycle trails, and site amenities such as parking, interpretive signs, viewing areas, and bicycle racks. Access features are integrated into the Project Area so that multiple habitat types can be experienced and natural processes can be observed by visitors. Simultaneously, sensitive species protection requires controlled access in certain areas so that natural processes are not degraded nor are species such as nesting birds disturbed. Connectivity to roads and other trails and parking is provided along with access amenities (such as trails, staging areas, interpretive signs, viewing areas, and parking) for community members and visitors.

Each alternative was evaluated in terms of the evolution of the Project Area with projected sea-level rise models (Section 6.3.1) using the same methods developed for the future "no-project" baseline (Section 2.4). The analysis resulted in a projection of habitat types and flood extents in response to sea-level rise, and the quantitative prediction of lagoon extents. Finally, each alternative was evaluated relative to Project objectives using quantitative and qualitative criteria (Section 6.3.2). The alternatives analysis was reviewed by the SAC, and the Project Partners defined a Preferred Alterative (Section 6.4, Figure ES-1, and Table ES-1). The Preferred Alternative is a "hybrid" of Alterative 2 generally for Areas 1 through 4 and Alternative 3 for Areas 5 and 6. This Preferred Alternative is subject to revision based on public input and subsequent analysis.

This Plan addresses several of the data gaps and uncertainties identified in the prior Feasibility Study (Aspen 2009). However, data gaps and uncertainties remain (Section 7). A list of actions to address data gaps is provided with the anticipation that these will be pursued as the Project progresses through environmental review. For example, surface water and groundwater levels and salinity vary substantially across the Project Area, and data collection is needed to quantify

variability and discern trends of net changes. Additional soil data and plant data are needed to develop a better understanding of how soil and water conditions affect the establishment of plants and inform restoration actions. Uncertainties in the responses to restoration actions are expected to remain. Therefore, an adaptive restoration approach, which uses a phased process to learn about habitat responses through monitoring of incremental restoration actions, is discussed in Section 7.4.

The contributors to this Plan are acknowledged in Section 8. A list of references is provided in Section 9. Appendix A describes the sea-level rise scenarios used to drive the future conditions analyses. Appendix B describes the model used to predict shore response to sea-level rise, and associated change in wave-drive seawater overtopping of the beach and dunes into the back-shore wetlands. Appendix C describes the model used to predict lagoon water levels and mouth dynamics. Appendix D describes the modeling used to predict wetland habitats in the future with sea-level rise.

Next Steps

This document informs the public and serves as a starting point for finalizing the OBRAP. Project Partners will solicit the public's input and finalize a Preferred Alternative following public review. Additional technical studies will be identified if they are needed to refine the Project description prior to initiating environmental review, in compliance with the California Environmental Quality Act and National Environmental Protection Act. Construction will adversely impact some existing habitat, but a net improvement will be achieved relative to both existing and future ecological conditions. The OBRAP will be refined during the next phases of design, environmental review (including public review), and regulatory approval in a way that maximizes beneficial effects while avoiding or minimizing potential adverse impacts.

SECTION 1
Introduction

1.1 Project Background

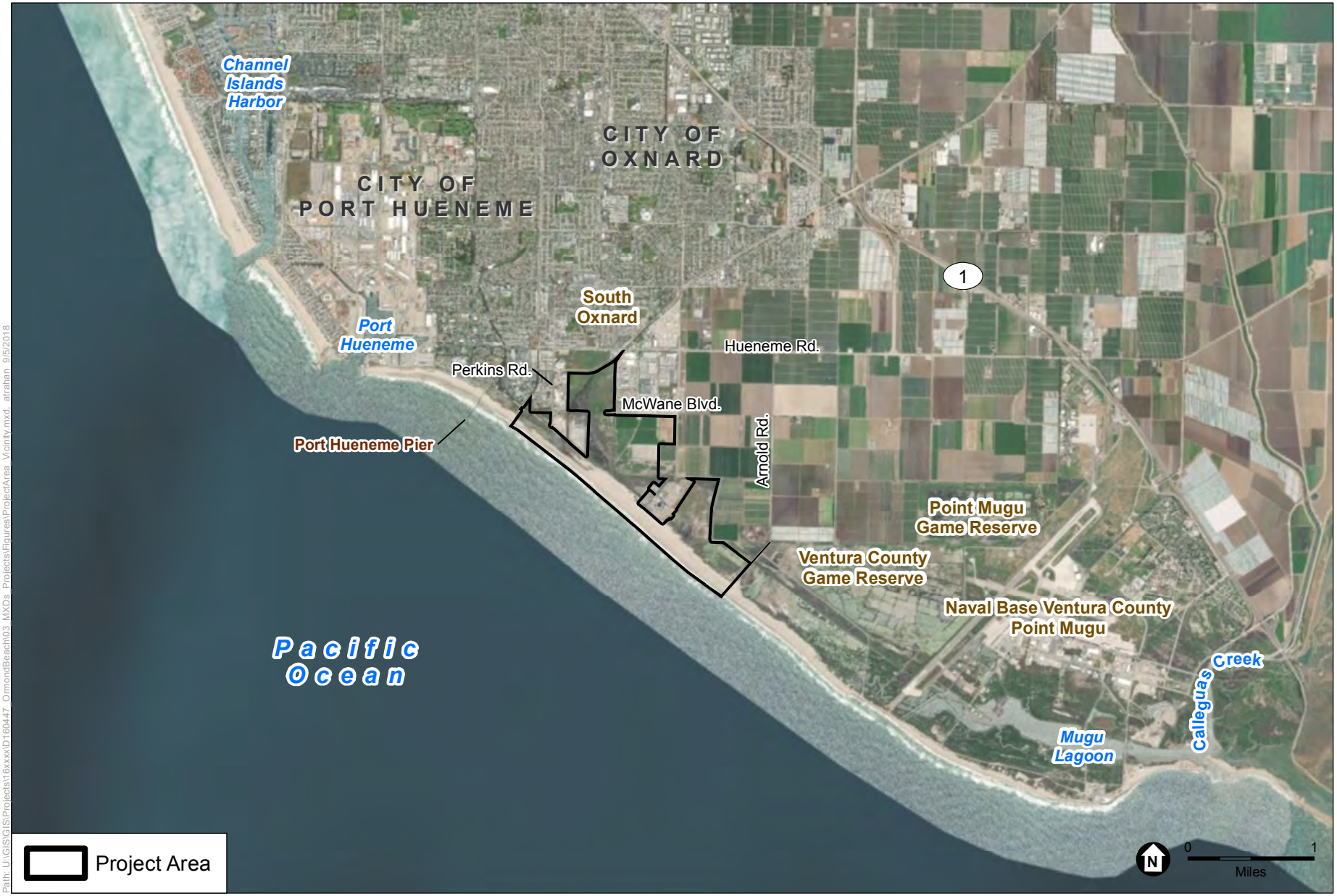
The Ormond Beach coastal area, which consists of Ormond Beach and its adjacent sand dunes, wetland and upland areas (collectively, Ormond Beach), has been identified by wetland experts as the most important coastal wetland restoration opportunity in Southern California (SCC 2016). The State Coastal Conservancy (SCC) and The Nature Conservancy (TNC) targeted Ormond Beach as a conservation priority in the early 1980s (TNC 2008). TNC partnered with SCC in 1999 to protect and restore the area. The City of Oxnard is also committed to restoring Ormond Beach, as reflected in its 2030 General Plan, which identifies numerous goals and policies for the area (City of Oxnard 2011). The SCC, TNC, and the City of Oxnard (collectively, "Project Partners") are leading the restoration of Ormond Beach. In 2016, SCC, TNC, and the City of Oxnard entered into a Memorandum of Understanding to collectively protect, manage, and restore the properties owned by the Project Partners at Ormond Beach.

The Ormond Beach Restoration and Public Access Plan (OBRAP) is being undertaken by the Project Partners to achieve a vision of a resilient coastal environment that inspires the enjoyment, use, and support of the local community and beyond.

1.2 Project Area

The Project Area consists of the properties currently owned by the Project Partners at Ormond Beach and spans 630 acres in the city of Oxnard along the County of Ventura coast (**Figure 1-1**; referred to as "Project Area" throughout this report). The SCC owns 260 acres, including a former tank farm site (acquired from Southern California Edison in 2002). TNC owns 290 acres, including an area in active agriculture. The City of Oxnard holds 80 acres of the Project Area. **Figure 1-2** shows the different parcels that make up the Project Area.

The land comprises beach, dune, wetlands, and agricultural lands (Section 2.1 Project Setting). Historically, this region had a dynamic complex of coastal wetlands that were intermittently connected to rivers and the ocean (Section 2.2 Historical Setting). Humans have had dramatic impacts on the landscape through filling wetlands and lagoons, excavating channels, and allowing development to encroach on habitats.



SOURCE: ESRI 7/19/2016, City of Oxnard, Ventura County

Ormond Beach Restoration and Public Access Plan

Figure 1-1
Project Area and Vicinity

ESA

SOURCE: ESRI 7/19/2016, City of Oxnard, Ventura County

Ormond Beach Restoration and Public Access Plan

Figure 1-2
Project Area Ownership

ESA

1.3 Goals

The OBRAP has two goals for ecosystem restoration and public access:

1. Preserve, enhance, and restore natural habitats and processes that support a dynamic and self-sustaining ecosystem at Ormond Beach.
2. Enhance opportunities for people to easily and safely visit Ormond Beach and enjoy the nature, educational opportunities, and recreation that are compatible with the restored Ormond Beach ecosystem.

1.4 Purpose and Scope of the Plan

The purpose of the OBRAP Preliminary Restoration Plan (Plan) is to describe and assess three integrated restoration and public access alternatives that seek to restore habitat functions within the context of existing opportunities and constraints and projected conditions with climate change. The alternatives include an array of public access features, with an emphasis on supporting ecological goals and allowing the public to experience the natural beauty and habitats to be protected and restored. The Plan also outlines potential adaptive restoration and adaptive management frameworks to resolve key scientific uncertainties and inform identification, development, and implementation of the preferred alternative. This Plan is based on a review of historical and existing conditions synthesized from previous studies and plans, including the 2009 Wetland Restoration Feasibility Report (Aspen 2009), with new data collected in 2017.

The Project Partners have selected a Preferred Alternative (Section 6.4) that best meets their identified restoration and public access goals and objectives. The Preferred Alternative will be developed in greater detail in the next phase of the OBRAP planning process. The Preferred Alternative, the three alternatives that were initially considered (Alternatives 1–3), and a "No Project" alternative will be reviewed during the environmental review process.

This Plan was prepared collaboratively by the Project Partners and a team of consultants led by Environmental Science Associates (ESA). Coastal Restoration Consultants (CRC) performed site surveys and assisted in formulating ecological criteria and target habitat configurations. ESA and CRC developed the restoration alternatives and conceptual designs. ESA refined the alternatives and conducted modeling (water balance, lagoon morphology, and climate change projections) to assess likely outcomes for each alternative. True Nature led the design of public access elements. The Plan, including the Preferred Alternative, also reflects the Project Partners' consideration of input from the Ormond Beach Science Advisory Committee (SAC) chaired by the SCC and TNC (see Section 8 for SAC member list) and the public.

The Plan includes the following:

Section 2 summarizes existing, historical, and future site conditions, including technical studies that served as the basis for future conditions.

Section 3 presents the Project goals and objectives.

Section 4 describes opportunities and constraints.

Section 5 describes ecological and public access Project elements.

Section 6 describes and evaluates the Project alternatives.

Section 7 identifies data gaps and uncertainties, and outlines a framework for adaptive management.

Section 8 identifies contributors and reviewers of this report.

Section 9 contains the report references.

The Appendices provide detailed descriptions of technical analyses:

A. Sea-Level Rise

B. Shore Migration and Overtopping (Beach QCM)

C. Ormond Lagoon Hydrology and Morphology (Lagoon QCM)

D. Wetlands Habitat Evolution Modeling (SLAMM)

This page intentionally left blank

SECTION 2
Site Conditions

Historical, existing, and future site conditions are summarized to inform an assessment of site evolution pertinent to ecology and access. Future projections are focused on the effects of sea-level rise without consideration of potential human interventions, from this Project or otherwise. The assessment of evolutionary trajectory emphasizes habitat conditions defined by dominant plant communities, with special focus on physical processes (hydrology, topography, geomorphology) that drive habitat changes and can be affected by restoration actions. This concept of physical processes driving habitat also informs public access design (Section 5.2).

This Site Conditions section starts with a Project Setting (Section 2.1) to orient the reader and establish site vernacular used throughout this report. Historical Conditions (Section 2.2) summarizes landscape patterns and processes prior to direct modification and development (Beller et al. 2011). Existing Conditions (Section 2.3) focuses on physical conditions, plants and wildlife currently present. Future Conditions (Section 2.4) identifies the sea-level rise scenarios selected for the Project, and summarizes analysis accomplished to predict the site response to sea-level rise. Synthesis of Site Evolution – No Project (Section 2.5) provides a summary of the site trajectory considered in the development of the alternatives. Apparent potential future land expansion opportunities are described in Section 2.6.

2.1 Project Setting

The Project Area consists of several parcels currently owned by the Project Partners and spans 630 acres in the city of Oxnard along the County of Ventura coast (**Figure 2-1**). Figure 2-1 also designates nine site areas within the Project Area (Areas 1-9), which are referred to throughout this report. The limits of each area coincide with man-made features which affect habitat, access or both.

Figure 2-2 shows the site topography of the overall Project Area. The site is very flat and low in elevation, with extensive perennial and seasonal wetlands, as well as agriculture on the TNC parcel in the central area. The wetlands result from high groundwater and seasonal ponding. The seasonal ponding results from the sandy beach and dune strand, which is elevated due to waves and winds, and blocks surface runoff from the land.

SOURCE: ESRI 7/19/2016, City of Oxnard, Ventura County

Ormond Beach Restoration and Public Access Plan

Figure 2-1
Project Area and Site Areas

ESA

SOURCE: ESA (2017), CA Coastal Conservancy LiDAR (2011)

Ormond Beach Restoration and Public Access Plan

ESA

Figure 2-2
Existing Topography

This page intentionally left blank

Drainage in and around the site has been modified for flood control and to enable various agriculture, commercial, and residential land uses. Three flood control channels (Hueneme Drain, tšumaš Creek, and Ormond Lagoon Waterway [OLW]), converge and feed Ormond Lagoon (Figure 2-1). A shore-parallel channel called Oxnard Drainage Ditch #3 (ODD #3) connects with Mugu Lagoon. There are multiple other parcel-level drainage systems that connect to these channels. One consequence of these man-made channels is that water supply is concentrated in some areas, and reduced where wetlands existed historically. The salty conditions in the soil result from the proximity to the ocean, onshore winds, groundwater and occasional wave overwash into backshore areas, as well as salts in soils and runoff. The historical seasonal ponding and evaporation have concentrated salts, which are likely leached from the soils during storm runoff. The addition of freshwater to these areas results in brackish and salt marsh.

Existing habitats are depicted by type in **Figure 2-3**. There are a range of wetlands types, varying in salinity and water supply. The wetlands are primarily salt and brackish marsh, with extensive salt pannes and several special-status plants, such as salt marsh bird's beak. Wetlands in the vicinity of the OLW are slightly brackish. The beach strand includes areas used by protected bird species (California least tern and Western snowy plover), with substantial portions off-limits to public access during the nesting season.

Existing, authorized public access to the Project Area, particularly beach access, is quite limited in relation to the overall area. On the west, there is a public parking lot and access to an informal trail at the seaward end of Perkins Road, but the Ormond Lagoon blocks beach access. The public may also access the Project Area by walking along the beach from the Port Hueneme Beach Park, approximately 0.2 miles west of Ormond Lagoon. A second public parking lot and access point at the end of Arnold Road is used for beach entry and access to another informal walking trail.

2.2 Historical Setting

The Project Area is located in a large alluvial plain created by the deposition of sediment eroded from the surrounding mountains (**Figure 2-4**) (Beller et al. 2011). The major regional drainage systems are those of the Ventura and Santa Clara Rivers and Calleguas Creek. Waves and wind built the sandy shore and form a ridge of littoral (coastal) sand dunes that inhibits drainage of rainfall to the ocean, resulting in lagoons and back-dune wetlands. Historic maps suggest that many of the wetlands were generally non-tidal, saline, and hydrologically connected in wet years.

The Ormond Beach area once supported a large complex of wetlands that were formed by the mouth of the Santa Clara River as it moved across the Oxnard Plain over thousands of years (Beller et al. 2011). The Ormond Lagoon, a former river mouth, was once larger and had a greater tidal prism that may have kept the mouth open for extended periods regardless of watershed runoff conditions (PWA 2007). Where there were year-round freshwater inflows, lagoons were permanently flooded and naturally breached somewhat regularly and therefore may have had some tidal influence intermittently. Prior to runway construction, wetlands closer to Mugu Lagoon probably had some tidal exchange in very wet years. Lagoons with only wet-season

freshwater inputs were flooded after rains and then dried to salty flats. The seasonal lagoons and salt pannes were inundated occasionally with saltwater when storms or large wave events overwashed the dunes.

Small remnants of permanently flooded lagoon, seasonal lagoon, and other wetlands persist within the Project Area but with altered hydrology. Some wetland-upland transition and upland habitats remain as well, but almost all are on landforms that have been altered over the years by berms, levees, agriculture, and development.

Beach and dune habitats migrated landward in the middle of the 20th century, resulting in a conversion of over 100 acres of wetlands to dunes. The current beach and dune system is nearly twice as wide as it was in the mid-1940s, which is attributed to the construction and management of Port Hueneme. When the port breakwaters were constructed, most of the wave-driven sand transport that had moved from north to south was blocked or diverted into the Hueneme submarine canyon, causing Ormond Beach to erode. As the beach eroded, waves were able to reach the dunes more frequently and the dunes eroded as well. Subsequently, sand was dredged and pumped past Port Hueneme in 2- to 4-year intervals, causing the beach to aggrade seaward, resulting in a much wider beach. The erosion of dune vegetation allowed more wind-driven sand transport into the wetlands areas.

Development has significantly modified the drainages to and from the site as well as the extent of wetlands. Invasive plant species have altered the structure and composition of some habitats. Despite the impacts to the site, there are still important remnant habitats, extensive wetlands, and considerable opportunities for ecological restoration.

2.3 Existing Conditions

Existing physical and biological conditions at the site are summarized in this section to offer comparison with historical conditions, provide a basis for changes associated with future sea levels, and establish the trajectory of the site without intervention. Public access existing conditions are discussed as part of Section 4 Opportunities and Constraints.

2.3.1 Topography

The topography of the Project Area is rather flat (Figure 2-2). **Figures 2-5, 2-6 and 2-7** show detailed topographic mapping. According to SCC Light Detection and Ranging (LiDAR) dataset, most of the Project Area falls within the elevation range of 2 to 14 feet NAVD88.[2] A survey was completed by ESA in 2017 to groundtruth the SCC LiDAR from 2011. As expected, the LiDAR data provide a good indication of site grades, with localized significant deviations (erroneous or missing elevations) where marsh and other vegetation and standing water interfere with the LiDAR, and where breaks in slope cannot be resolved by the elevation grid. For example, ground survey indicates the site grades in Area 3a marsh are locally more than 2 feet below, as indicated by the LiDAR.

[2] All elevations are in North American Vertical Datum of 1988 (NAVD88)

SOURCE: ESA (2017), CA Coastal Conservancy LiDAR (2011)

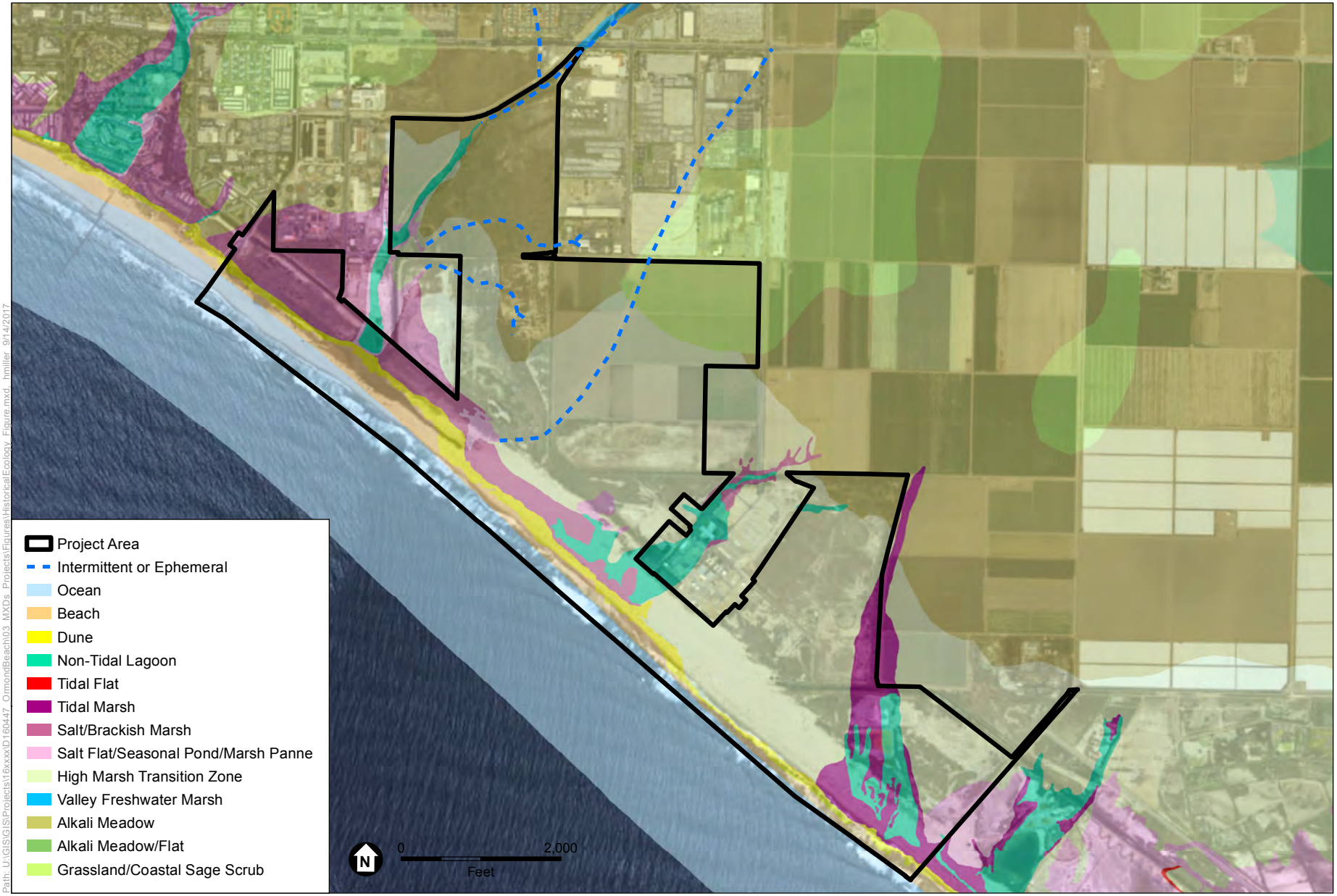
NOTE: Based on field mapping of site in Spring 2017. Minimum mapping unit was approximately one acre in most cases, so some small habitat features are not shown.

Ormond Beach Restoration and Public Access Plan

Figure 2-3
Existing Habitats

ESA

This page intentionally left blank



Path: U:\GIS\GIS\Projects\16xxxx\D160447_OrmondBeach\03_MXDs_Projects\Figures\HistoricalEcology_Figure.mxd hmiller 9/14/2017

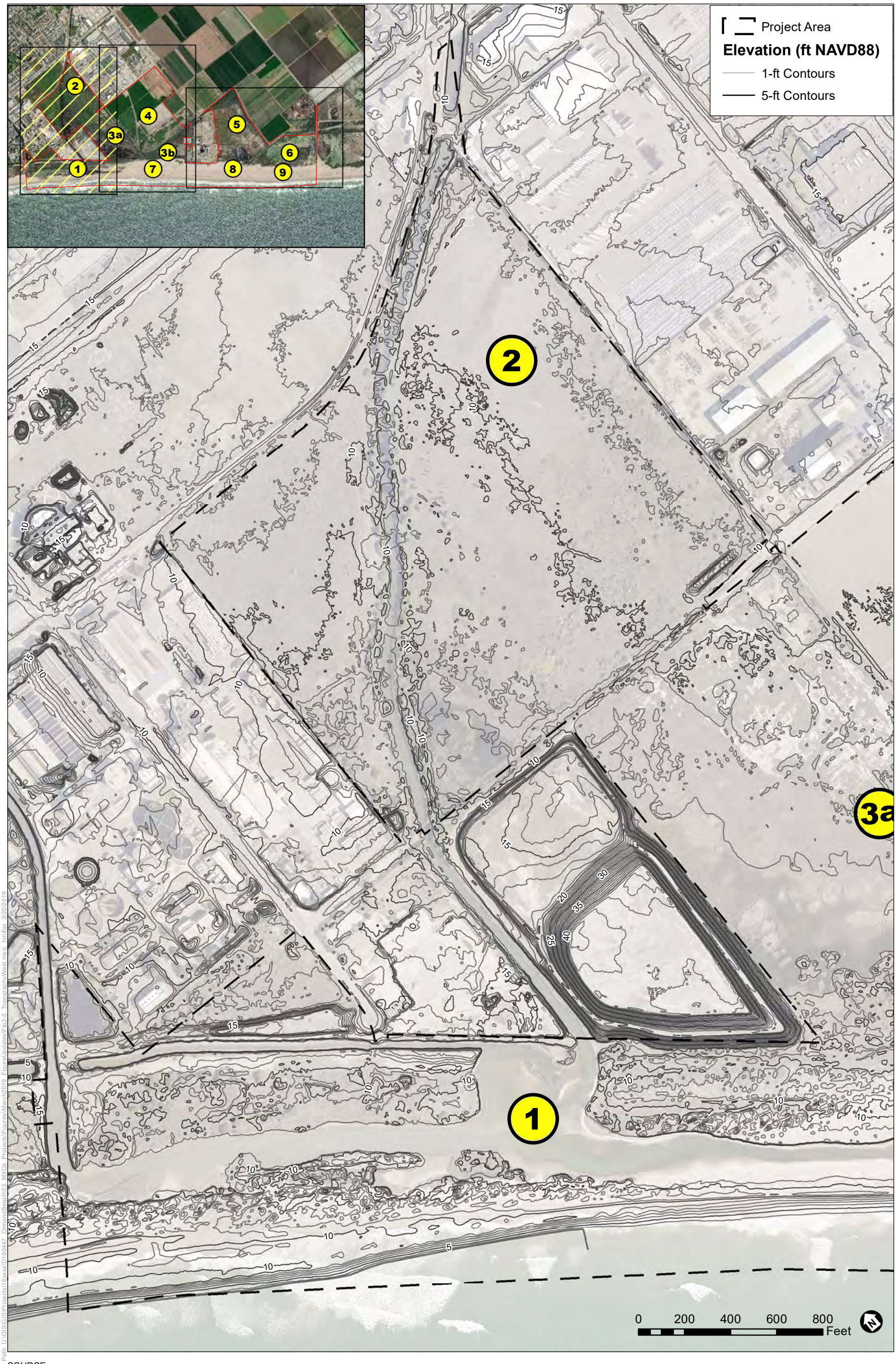
Source: ESRI 7/19/2016, San Francisco Estuary Institute, Ventura County,

Ormond Beach Restoration and Public Access Plan

Figure 2-4
Project Area Historic Ecology in the Early 1800s

ESA

This page intentionally left blank

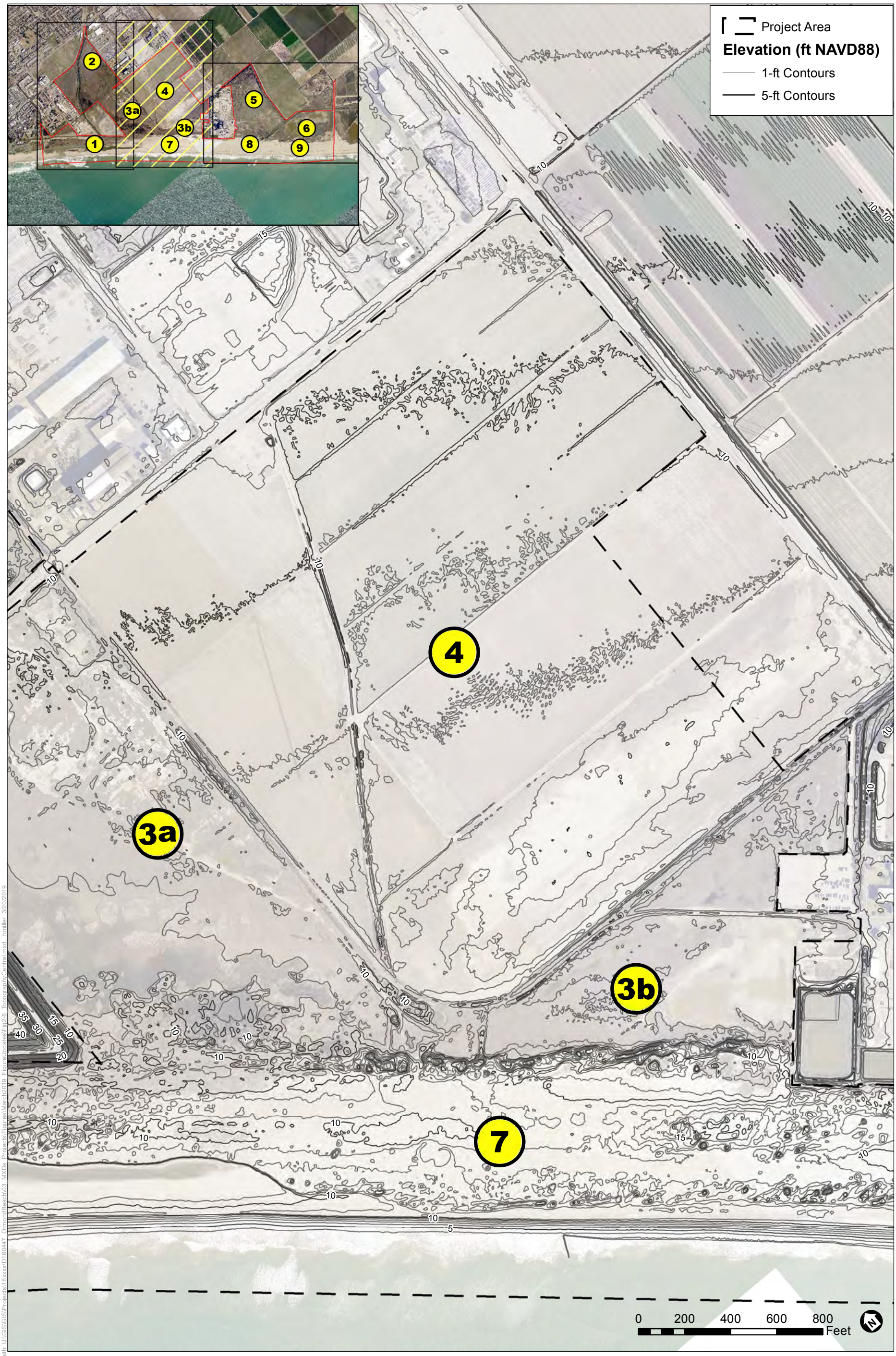


SOURCE:
LiDAR, SCC 2011
Imagery, County of Ventura, 2016

Ormond Beach Restoration and Public Access Plan

Figure 2-5
Topography- West Project Area

ESA

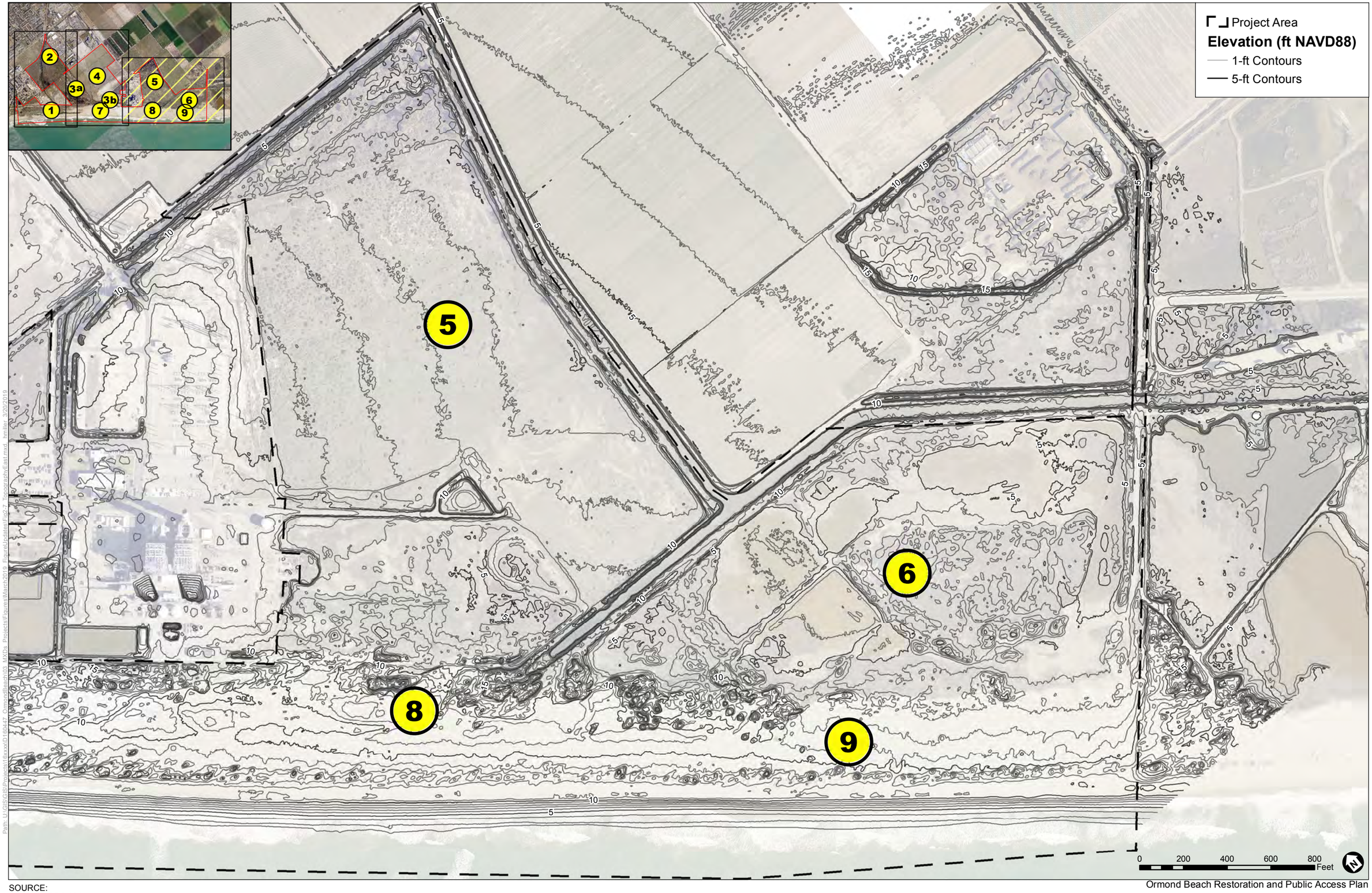


SOURCE:
LiDAR, SCC 2011
Imagery, County of Ventura, 2016

Ormond Beach Restoration and Public Access Plan

Figure 2-6
Topography- Central Project Area

ESA



SOURCE:
LiDAR, SCC 2011
Imagery, County of Ventura, 2016

ESA

Ormond Beach Restoration and Public Access Plan

Figure 2-7
Topography- East Project Area

Path: U:\GIS\GIS\Projects\16xxxx\D160447_OrmondBeach\03_MXDs_Projects\Figures\March2019_FigureUpdates\Fig2-7_TopographyEast.mxd, hmiller, 3/20/2019

This page intentionally left blank

Elevations of the beach along the Project Area range from 9.4 to 16.1 feet NAVD88. Dune crests achieve elevations of +15 feet NAVD88, but most are around 10 feet NAVD88, and lower in Area 9. High ground adjacent to OLW and ODD #3 in the form of embankment levees are around 10 feet NAVD88 and uneven. Area 4 slopes upward to the north and reaches elevation of 10 feet NAVD88 while the rest of the site is lower. Low areas are emergent brackish marsh in Areas 2 and 3a (estimated elevation of below 8 feet NAVD88 and potentially 6 feet and locally lower) and salt pannes in Areas 3b and 6 (5 to 6 feet NAVD88). OLW thalweg (low point) is about 3 feet NAVD88, and the low bed elevations in Ormond Lagoon are typically around 4 feet NAVD88 or higher except at the junction with OLW. Note that Ormond Lagoon geometry varies in response to sand transport caused by ocean and runoff processes. Developed areas in the west are generally at 10 feet NAVD88 and higher.

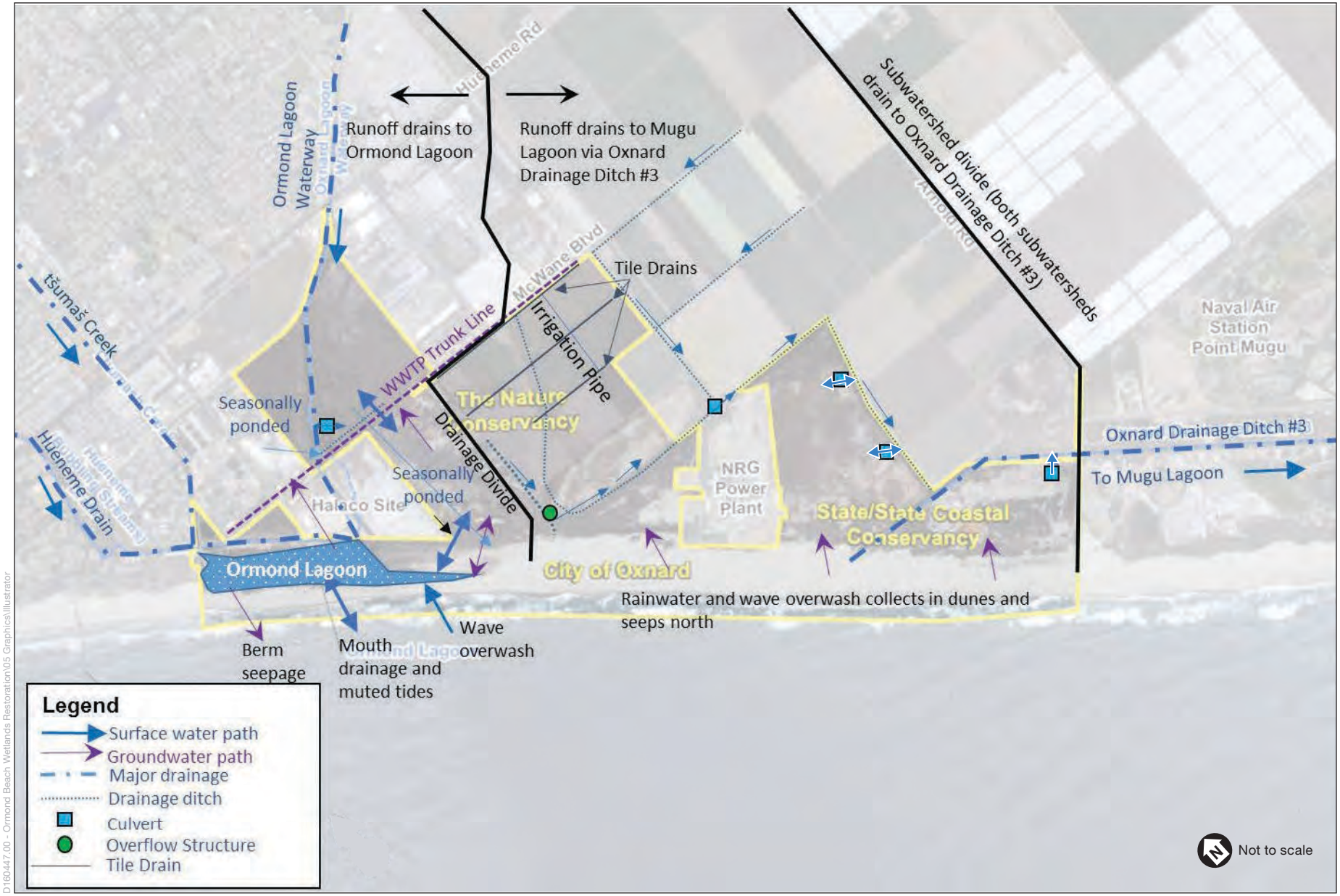
2.3.2 Hydrology

Runoff and Drainage

Water sources include rainfall, freshwater runoff, groundwater, wave overwash, and limited tidal inputs. A drainage divide bisects TNC parcel, with runoff in the western area of the Project Area (Areas 1 and 2) draining to OLW and Ormond Lagoon, as well as water flowing the opposite way, from OLW to Area 2 (**Figure 2-8**). The central area of the site (Areas 3 and 4) drains east to a channel known as ODD #3, which is under the authority of the Oxnard Drainage District No. 2.[3] ODD #3 drains to Mugu Lagoon via the Navy Base. Area 3a can also be connected with Area 1 at high water stages, and likely via groundwater as well, in both directions (from lagoon to Area 3a and vice versa, depending on relative water levels).

Hydrologic conditions in the west area (Figure 2-5) are dominated by the surface drainages and lagoon dynamics. Freshwater runoff is quickly routed to the Ormond Lagoon via the channelized drainages of OLW, tšumaš Creek and Hueneme Drain (which is also fed by Bubbling Springs, a natural spring). When the lagoon mouth is closed, the ponded water backs up into tšumaš Creek and OLW, and typically spills east and north into the TNC parcel Areas 2 and 3a (EPA 2008; CH2M Hill 2012). When large swell waves build a high beach berm, as on January 18, 2010, trapped runoff can flood developed areas further upstream (Ventura County Watershed Protection District [VCWPD] 2010). When the mouth breaches and the lagoon drains, water is trapped in the TNC parcel as seasonal ponds. The mouth may remain open for several weeks, allowing muted tides to enter the lagoon, but the tide levels are several feet lower than the surrounding area. In these conditions, TNC parcel and portions of tšumaš Creek and OLW are hydrologically disconnected from the lagoon.

[3] Oxnard Drainage District No. 2 operates surface and subsurface agricultural drainage systems east of the City of Oxnard. Historically, the water table in the Oxnard Plain was sufficiently high to prevent agricultural development (Ventura Local Agency Formation Commission 2005). Districts were formed to install and operate clay or tile pipe drainage systems to allow lands to be tilled. Oxnard Drainage District No. 1 was formed in 1918, and Oxnard Drainage District No. 2 was formed in 1926. There was an Oxnard Drainage District No. 3 formed in 1937, but because most of the territory in its boundaries had been developed for urban uses that District was dissolved and its remaining agricultural lands were merged into Oxnard Drainage District No. 2 in 1984. This district is also known as Oxnard Drainage District 2/3.



D160447.00 - Ormond Beach Wetlands Restoration\05 Graphics\Illustrator

SOURCE: ESRI 7/19/2016, PWA (2007), CH2M Hill (2008, 2012), HDR (2008a)

Ormond Beach Restoration and Public Access Plan

Figure 2-8
Schematic of Surface and Groundwater Flow Paths through the Project Area

ESA

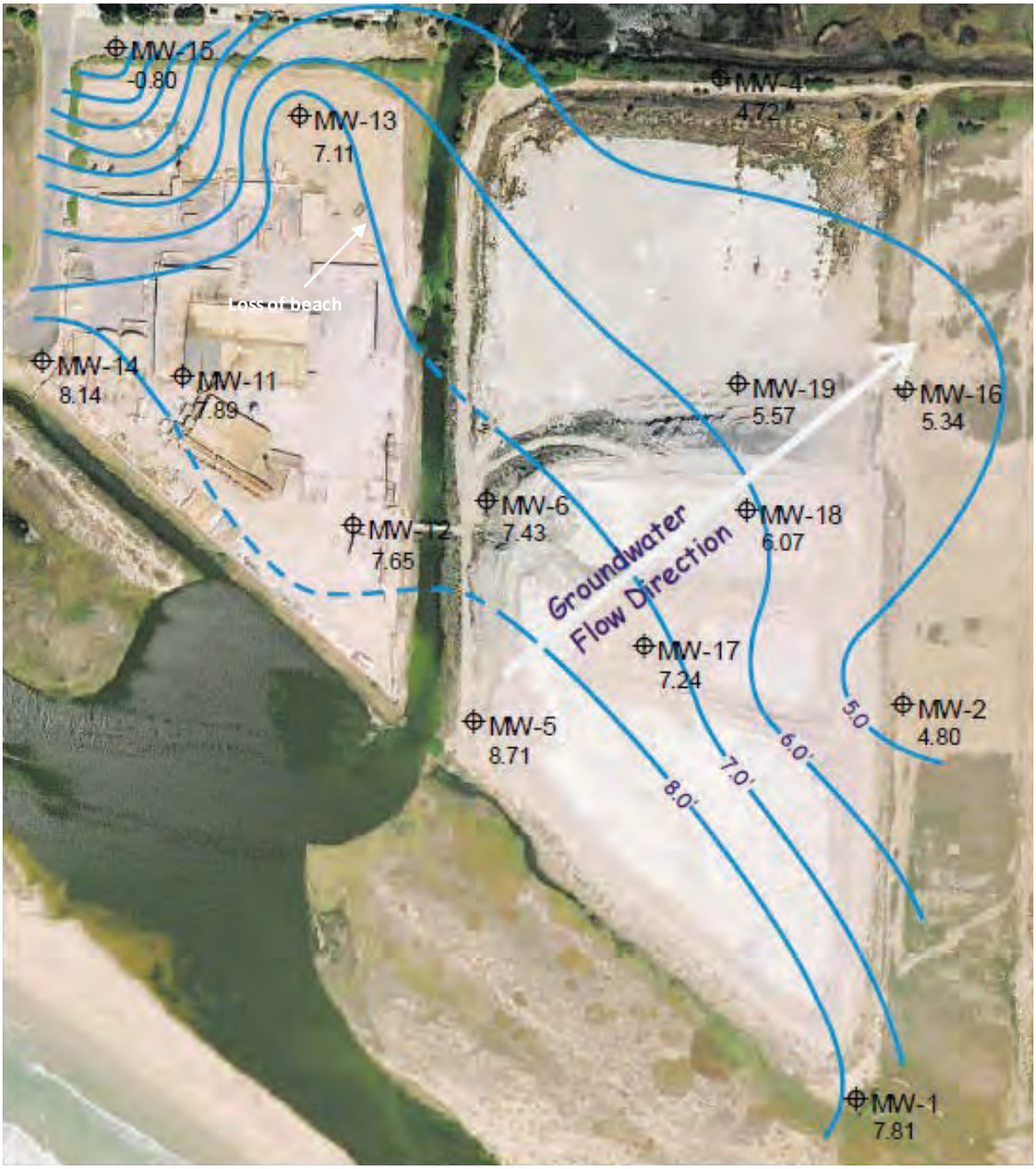
Runoff from the central area (Figure 2-6) drains from Areas 4 and 3b southeast to Mugu Lagoon via ODD #3. The eastern area (Figure 2-7) also drains to ODD #3. High rainfall on the agricultural lands draining to ODD #3 can sometimes overwhelm the drainage ditches and cause flooding, as seen in 2017 around Arnold Road. The leaky flap gate connecting Mugu Lagoon to ODD #3 connects muted tides (very small tide range) to the salt marsh, open water, and salt panne areas east of the SCC parcel. Water from ODD #3 does not typically flow into the Project Area, but the salt panne in the SCC parcel (Area 5) drains into the ditch.

Groundwater and Surface Water Levels

Shallow groundwater levels are seasonally dynamic, responding quickly to precipitation and runoff, and are affected by adjacent surface water levels in drainage channels, Ormond Lagoon, and the ocean. Water levels within the upper semi-perched aquifer fluctuate from a few feet below the surface at the end of the rainy season to about 10 feet below the surface by late fall (PWA 2007; United Water Conservation District [UWCD] 2018). Near the lagoon, groundwater tends to move northward away from the coast, even when the lagoon is open and lagoon water levels are low (**Figure 2-9**) (CH2M Hill 2008, 2012). Groundwater near OLW (monitoring well located near Hueneme Road, near the north end of Area 4) appears to be elevated due to the high water in OLW (UWCD 2018). Under the surface of the beach, groundwater responds to oceanic tide levels (PWA 2007). Dunes fronting TNC and SCC parcels are likely to absorb rainwater and wave overwash, and allow seasonal seepage of fresh or brackish groundwater toward seasonally ponded or salt panne areas immediately landward.

Groundwater and surface water levels were monitored during May to December 2017 at locations shown in **Figure 2-10**. The 2017 data were reviewed relative to prior studies and other available data, including recently collected data for a location close to OLW and Hueneme Road, near the north end of Area 4, which was provided by UWCD (UWCD 2018). These new data are generally consistent with prior data and findings, but also raise questions regarding groundwater dynamics and connectivity.

On the west side of the site, the groundwater elevations slope up to intersect with the Ormond Lagoon surface water level, which was 6.5 feet NAVD88 at its lowest observed level. In contrast, the shallow groundwater level adjacent to OLW is several feet lower. This description is consistent with groundwater data near the north limit of Area 4, near OLW and Hueneme Road, which shows elevations generally between 2 feet and 6 feet NAVD88, but reaching as low as 0 feet at times (UWCD 2018). This suppressed groundwater level has been attributed to infiltration into a wastewater trunkline buried below McWane Blvd. (CH2M Hill 2008, 2012), which implies that groundwater may depend partly on treatment plant operations, which may affect the flow in the culvert and the rate of groundwater infiltration. The UCWD data show water levels consistent with the OLW–Ormond Lagoon elevations except in the early 1990s and since 2015 when lower levels were recorded (UWCD 2015). The Ormond Lagoon and OLW water levels were similar during the 2017 monitoring period (**Figure 2-11**). These conditions are consistent with the dry season, whereas the wet season water levels have a greater range due to increased water inflows and breached mouth conditions. Groundwater levels measured between Ormond Lagoon and



0 500 1000

Scale in Feet

N

MW-2
4.80
Monitoring Well Location w/elevation in feet above mean sea level.

5.0
Groundwater elevation contours interpolated from field measurements in feet above mean sea level.

D160447.00 - Ormond Beach Wetlands Restoration\05 Graphics\Illustrator

SOURCE: CH2M Hill (2008)

Ormond Beach Restoration and Public Access Plan

Figure 2-9
Groundwater Contours 2006

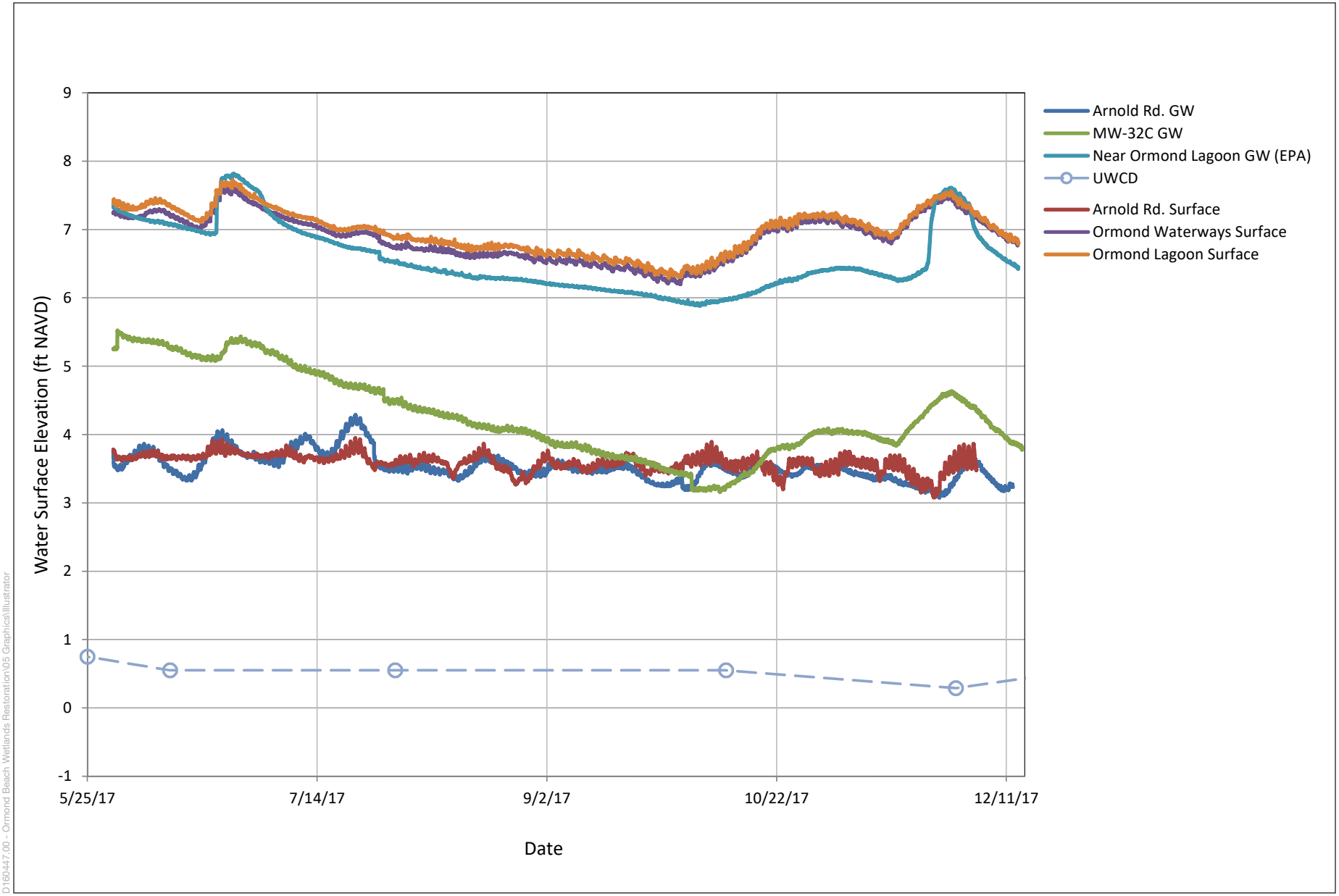
ESA

SOURCE: ESRI, City of Oxnard, Ventura County

Ormond Beach Restoration and Public Access Plan

Figure 2-10
Water Level and Groundwater Gauge Locations, and Survey Transects

ESA



D160447.00 - Ormond Beach Wetlands Restoration\05 Graphics\Illustrator

SOURCE: ESA Water Level Gauges UWCD Groundwater Well

Ormond Beach Restoration and Public Access Plan

Figure 2-11
Water Levels

ESA

Area 3a, to the south of the Halaco slag pile (line labeled "Near Ormond Lagoon GW[4] [EPA]") show a close correlation with the lagoon; the pattern suggests flow from the Ormond Lagoon "backwater" into Area 3a with the flowrate increasing with surface connectivity especially above elevation 7 feet NAVD88.

In stark contrast is a groundwater level north of the Halaco pile (labeled "MW-32C GW") that is approximately 2 feet below the adjacent OLW surface water level, but is also correlated and indicating flow from the higher surface water to the groundwater. Farther north, lower groundwater levels were recorded during 2017, mostly between elevations 0 and 3 feet NAVD88, which is about 3 feet lower than MW-32C GW.

On the east side of the site (Area 6), groundwater elevations are interpreted to slope gently upward from the ocean's mean tide level (2.7 feet NAVD88), and vary from 3.2 to 4.3 feet NAVD88, as confirmed by June–December 2017 observations at the end of Arnold Road (Figure 2-11). Of interest, the groundwater levels in Area 6 (labeled "Arnold Rd. GW") fluctuated more than the surface water in nearby ODD #3. The groundwater fluctuations had a periodicity similar to the spring-neap tidal cycle, indicating an effect of the ocean tides. The limited fluctuations in the ODD #3 levels is associated with limited connection to Mugu Lagoon due to the constrained geometry of culverts and canals on the Navy Base.

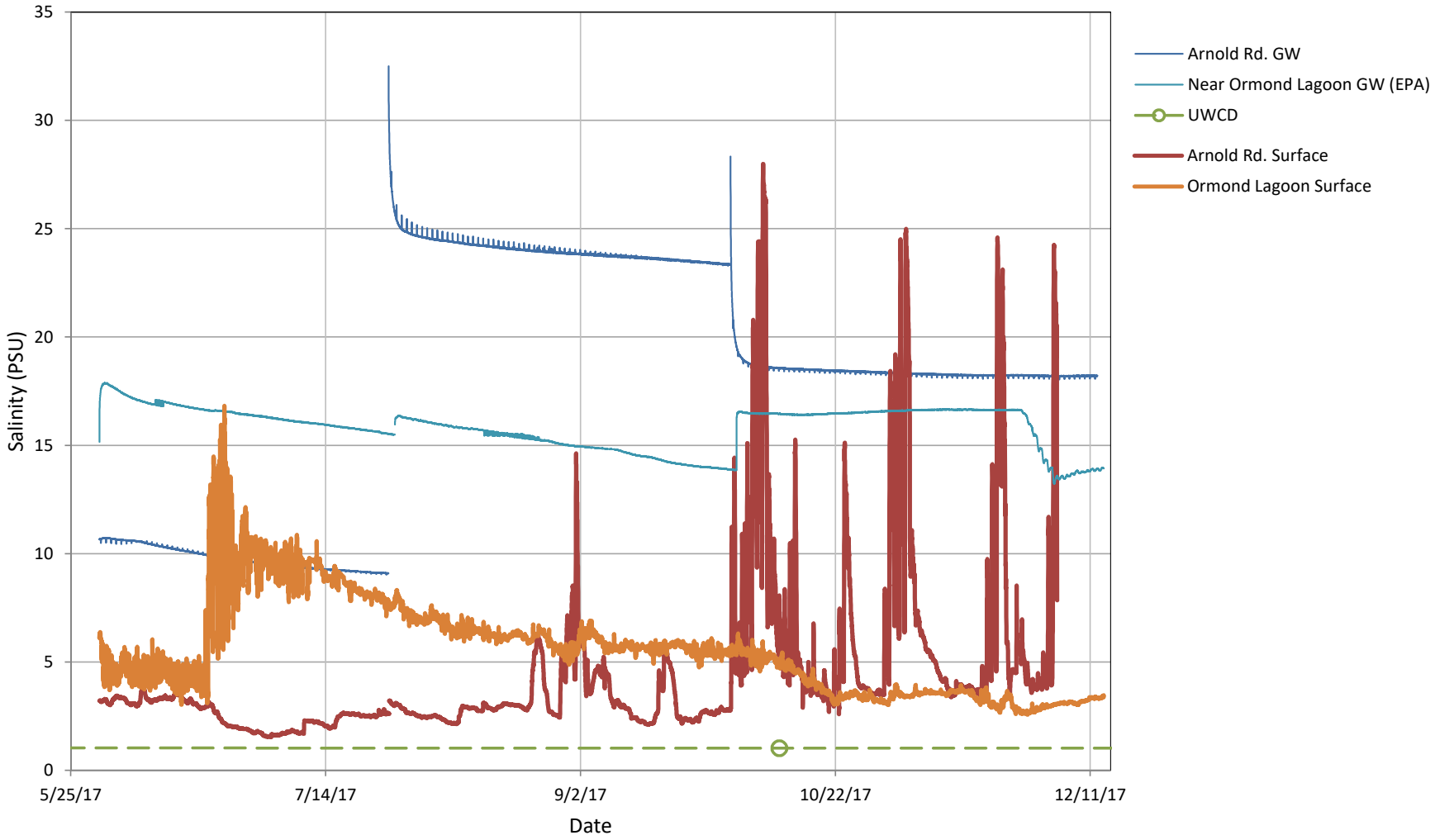
Salinity

Salinities were monitored during May to December 2017 at the same locations of water level monitoring (Figure 2-10). **Figure 2-12** presents the salinity time series. Also, water level and salinity were provided by the UWCD for a location close to OLW and Hueneme Road, near the north end of Area 4 (UWCD 2018).

Water levels and salinity are key drivers of coastal habitats. By definition, high soil moisture, either seasonal or perennial, drives wetland formation. High soil salinities due to regular influx of saltwater or concentration due to evaporation have resulted in salt marsh and salt panne habitats. Lower ground and/or water salinities have resulted in brackish marsh within the site. Changes in salinity in Areas 3a and 2 are attributed with a recent (last decade) conversion of salt marsh to brackish marsh.

Salinity data are more complex and interpretations are limited by the extent of available data, both in space and time (Figure 2-12). The salinity in the groundwater near Ormond Lagoon (13 to 17 parts per thousand [ppt]) was much higher than the surface salinity in the lagoon (mostly 3 to 10 ppt) except for a spike in lagoon salinity reaching about 17 ppt. These data imply that the lagoon salinity is affected by wave overtopping, likely higher at depth, and that groundwater salinity is not driven by lagoon surface salinity. Salinity of groundwater at SW-65 was very low, less than 2 ppt, which is nearly freshwater. For reference, the average ocean water salinity is 35 ppt.

[4] The label GW on Figure 2-11 means "groundwater."



D160447.00 - Ormond Beach Wetlands Restoration\05 Graphics\Illustrator

SOURCE: ESA Water Level Gauges UWCD Groundwater Well

Ormond Beach Restoration and Public Access Plan

Figure 2-12
Salinity

ESA

Continuous salinity observations in the east near ODD #3 recorded different values and patterns than in the western area, described above. For example, the highest Ormond Lagoon surface salinity was less than the highest ODD #3 surface salinity, and the seasonal patterns are very different. Peak salinity of about 17 ppt occurred in the lagoon in June, probably as the result of wave overwash. The salinity then gradually decreased over subsequent months to a minimum below 5 ppt as inflow from the watershed freshened the lagoon. In ODD #3, the opposite seasonal trend occurred, with salinity starting below 5 ppt from June to August, then salinity increasing in September in a series of pulses that peaked at about 25–27 ppt. The groundwater salinity in Area 6 remained in the salty range (18–33 ppt), with spikes in the record indicating stratification being mixed during instrument disturbance. The groundwater salinity and nearby surface salinity are not positively correlated.

The lack of flowrate data for the western drainage channels inhibits our understanding of seasonal salinity in OLW and Ormond Lagoon. Absent information about irrigation practices in the ODD #3 watershed, the cause of these fall salinity peaks are not clear. While evaporation is a driver of increased salinity, changes in runoff and backwater from Mugu Lagoon may also have effects on salinity in ODD #3.

Additional salinity measurements were taken manually during occasional site visits. The data support the use of vegetation as an indicator of salinity. A salinity gradient exists across the site; 2017 salinity measurements were lowest in the northwest on TNC parcel in Area 2 (6 ppt in March to 16 ppt in late May), increasing toward the center in Areas 3a and 3b (5 ppt in March to 37 ppt in early June), and greatest in the east on the SCC parcel, Areas 5 and 6 (20 ppt March to 81 ppt late May).

Shallow basins in the southeast and center retain water from rainfall or waves overwashing the dunes during winter storms. The ponded water then evaporates during warmer months, creating hypersaline soils. Shallow brackish or salty groundwater and low-permeability soils can result in evaporation-driven concentration of salts in the surface soils. Data collected in Area 6 by US Fish and Wildlife Service (USFWS) (WRA 2000) show correlation between salt marsh and salt pannes habitats and surface soil parameters (elevation relative to groundwater, texture, and salinity).

2.3.3 Water Quality

Halaco Superfund Site

The Environmental Protection Agency (EPA) is evaluating water quality at the Halaco Superfund Site to prepare remediation options. The EPA designated the Halaco properties and surrounding contaminated areas (including portions of TNC property Southwest and North Marshes (Area 3a), the OLW, and the Ormond Lagoon area) as a Superfund Site in 2007. Testing by the EPA in 2009 and 2010 showed that soil, sediments, and groundwater have been contaminated by Halaco's wastes (CH2M Hill 2012). Constituents found at elevated levels included aluminum, barium, beryllium, cadmium, chromium, copper, lead, magnesium, manganese, nickel, and zinc.

To examine whether Halaco Superfund Site-related contamination could cause adverse effects on biota, a baseline ecological risk assessment was prepared for the EPA (CH2M Hill 2015). Field surveys evaluating abundance and/or breeding success provide strong evidence that Belding's savannah sparrows, western snowy plovers, and California least terns nesting at Ormond Beach are not adversely affected by contamination at the Halaco Site. Risks identified for surface water exposures to aquatic biota, including tidewater goby, were not considered to be Halaco site-related. However, it was noted that contaminants found in surface water may originate elsewhere in the watershed, and fish are likely averaging concentrations across a range that likely includes areas outside of the Halaco Site (CH2M Hill 2015).

The Project Partners will coordinate OBRAP planning in the vicinity of the Halaco Superfund Site with EPA.

Agricultural and Urban Runoff

Water and sediment quality in tšumaš Creek, OLW, and TNC agricultural field drainage ditch may be impaired by pollutants from agricultural and urban runoff. The lagoon receives drainage from tšumaš Creek, OLW, and Hueneme Drain, as well as groundwater input and wave overtopping of the beach, all of which may contribute to the degraded water quality within the lagoon. Water quality monitoring between 1980 and 2002 showed periods of elevated levels (above typical levels found in natural systems) of ammonia, metals, anions, total dissolved solids (TDS), and enterococcus (Ent) (CH2M Hill 2012).

ODD #3 has been listed as an impaired water body on the California Clean Water Act Section 303(d) list (SWRCB 2010) since 1996 for the following pollutants: chemA[5] (tissue), chlordane (tissue), DDT (tissue), nitrogen, polychlorinated biphenyls (PCBs) (tissue), sediment toxicity, and toxaphene (tissue). Total Maximum Daily Load (TMDL) targets were developed to reduce pollutant concentrations in the drainage. Chlordane, DDT, and toxaphene were used as insecticides for agricultural land, which is likely the source of contamination in ODD #3. High concentrations of agricultural pesticides exceeding TMDL targets were found in ODD #3 in 2010 near Arnold Road and Edison Road (EPA 2011). Monitoring in 2015–2016 found exceedances for nitrate, dissolved copper, DDT and byproducts, toxaphene, and bifenthrin (Larry Walker Associates 2016). Oxnard Drainage District No. 2, which manages ODD#3, indicates that water quality is not degraded at present (personal communication to Project Partners, October 22, 2018).

Pyrethroid pesticides are used locally in both agricultural and urban settings (Lindley et al. 2018). Pollutants or reduction in dissolved oxygen concentrations in the water can lead to a sudden local die-off of fish populations (also called a "fish kill"). A fish kill in tšumaš Creek in July 2015 was attributed to bifenthrin and other pyrethroids (CDFW 2015) following an unusual summer rain that occurred during peak pyrethroid applications to strawberries (Lindley et al. 2018).

[5] ChemA is the sum of toxaphene, dieldrin, and chlordane

2.3.4 Plant Communities

The Project Area includes a broad mix of wetland and upland plant communities (**Table 2-1**). Select habitat types were "rolled-up" into a consolidated set in order to conform with wetland evolution modeling protocols and in recognition of the difficulty in discerning between fresh-brackish and salt-brackish habitats, as well as upland habitats. The simplified habitats are listed in Table 2-1 and mapped in Figure 2-3.

TABLE 2-1
EXISTING HABITAT ACREAGES IN THE PROJECT AREA

Habitat Type	Acreage[1]	Consolidated Habitat Type	Acreage
Beach/Coastal Strand	28.5	Beach/Coastal Strand	28.5
Coastal Dune/Back Dune	128.4	Coastal Dune	128.4
Open Water	27.1	Open Water	27.1
Salt Panne	25.9	Salt Panne	25.9
Salt Marsh	107.8	Salt Marsh	107.8
Brackish/Salt Marsh	25.0	Brackish Marsh	49.5
Fresh/Brackish Marsh	24.5		
Saline Seasonal Wetlands/Disturbed	78.8	Seasonal Wetlands	79.5
Willow Scrub	0.7		
Coyote Brush Scrub	29.7	Upland	96.6
Shrubs/Annual Grasses	49.0		
Berm and Ditch	17.9		
Agriculture	105.6	Agriculture	105.6
Total	**648.9**	**Total**	**648.9**

NOTE:
1. The Project Area boundary was created from imagery, parcel boundaries, and professional judgment. Project Area acreage for mapping habitat acres varies slightly from parcel ownership (630 acres). A portion of this discrepancy is explained by the seaward extent of SCC's ownership.

SOURCE: CRC 2017, ESA 2017

Special-Status Plant Species

Five special-status plant species are known to occur within 1 mile of the Project Area (**Table 2-2**). Their habitat requirements and distribution are described below. Note that elevated plant distributions are expected for coastal wetland plants in systems like Ormond Beach that do not get regular tidal exchange and where groundwater is not controlled by tidal processes. Since the system is perched above mean sea level, plant distributions are limited to higher elevations than typically expected under fully tidal systems. The physical conditions of inundation, soil saturation, and high soil salinity are important factors to consider in developing approaches to conserving these species under future climate change.

TABLE 2-2
SPECIAL-STATUS PLANT SPECIES DOCUMENTED WITHIN OR IMMEDIATELY ADJACENT TO THE PROJECT AREA

Species Name	Status	Habitat	Potential to Occur
Salt marsh bird's beak *(Cordylanthus maritimus* ssp. *maritimus)*	FE SE CNPS List 1B	Observed within several of the salt marsh habitats within the Project Area and to the southeast in the Ventura County Game Preserve (Aspen 2009) and throughout much of the salt marsh habitat on-site during surveys conducted by CRC and ESA in 2017. Additionally, this species was observed immediately southeast of the Project Area within the Naval Base Ventura County (NBVC)–Point Mugu property on June 30, 2005.	Present
Spiny Rush *(Juncus acutus* ssp. *Leopoldii)*	CNPS List 4	Observed within much of the wetland habitat within the Project Area during previous surveys (Aspen 2009) and during surveys conducted by CRC and ESA in 2017.	Present
Woolly seablite *(Suaeda taxifolia)*	CNPS List 4	Observed in much of the wetland habitat within the Project Area (Aspen 2009).	Present
Red sand-verbena *(Abronia maritima)*	CNPS List 4	Observed throughout the southern foredune and transitional habitat within the Project Area during previous surveys (Aspen 2009).	Present
Coulter's goldfields *(Lasthenia glabrata* ssp. *coulteri)*	CNPS List 1B	Observed within the southern coastal salt marsh on-site during previous surveys (Aspen 2009) and west of the terminus of McWane Blvd., within the Project Area, during surveys conducted by CRC and ESA in 2017. Additionally, this species was observed on March 8, 2002, in the same general location as in 2017 (CNDDB 2017).	Present

Listing Status Key:
FE = Federally Endangered
SE = State Endangered
CNPS = California Native Plant Society list

SOURCE: CNDDB 2017, ESA 2017

Salt Marsh Bird's Beak

Salt marsh bird's beak (*Cordylanthus maritimus* ssp. *maritimus*) is an annual plant that tends to establish in areas of low salt marsh cover, often on the edges between bare ground and vegetation. This species tends to be found in the same location year after year. The species is threatened here by conversion of salt marsh to brackish marsh.

This annual species was previously mapped throughout the Project Area, including a large patch north of the OBGS (Aspen 2009). Navy biologists have sporadically mapped this species in the SCC salt panne and marsh basin (adjacent to Arnold Road). In 2015 and 2016, Rancho Santa Ana Botanic Garden botanists surveyed the TNC property and documented a single salt marsh bird's beak plant in 2015 (Fraga and De Groot 2017). In May and June 2017, CRC surveyed all salt marsh areas. This species is generally easier to detect later in the season when individuals are larger and in flower. The 2017 survey found approximately 4,500 individual plants in total. More than 4,000 of these are in the wetland basin north of the OBGS (Area 3b). Eighteen plants were found in two patches within the wetland basin immediately south of the OBGS. This species had not been documented in this area before. In the SCC salt panne and marsh basin (Area 6), 265 plants were found in multiple patches. Sixteen individuals were found in one patch on TNC property (Area 3a). Previous mapping efforts did not appear to estimate or count individual plants, so the population trend is unclear.

The large patch north of the OBGS seems to have shrunk in size since mapping done for the Feasibility Study (Aspen 2009). Much of the area where it was previously found now has dense salt marsh cover and is beginning be invaded by salt marsh bulrush-–a sign that the area is becoming less salty than it was in the past.

The mean elevations of salt marsh bird's beak vary by about a foot among the three wetland basins. The lowest distribution (mean 5.8 feet NAVD88, range 5.3 to 6.5 feet) for plants in the SCC salt panne and marsh basin (Area 6) was nearly identical to the elevation distribution of salt marsh bird's beak in the muted tidal estuary at Carpinteria salt marsh in Santa Barbara County in 2017 (upper limit at Carpinteria 6.4 feet) (Page, Doheny, Hoesterey, Johnson, Hubbard, and Shroeter, *unpublished data*). The mean elevations for the other two basins surveyed at Ormond Beach were 6.4 feet NAVD88 (range 5.3 to 6.5 feet) and 6.8 feet NAVD88 (range 6.0 to 8.0 feet). These values are similar to the median reported by Zedler (2000) for fully tidal systems.

Coulter's Goldfields

Coulter's goldfields (*Lasthenia glabrata ssp. coulteri*) tends to establish on salty soils in areas where there is little or no plant cover. It is an annual plant that usually grows in wetlands (salt marsh, playas, vernal pools) but is occasionally found in non-wetlands. In salt marshes, Coulter's goldfields is found on the edges of salt pannes (unvegetated flats with salty soils) or in vernal basins (shallow pools that form in the cool season) (Zedler 2000). The population size of Coulter's goldfields varies strongly with soil moisture and salinity between years (Noe 1999).

CRC conducted surveys in the Project Area for this species in March 2017 when flowering was at or near its peak. The only population known is on TNC property in Area 3a. The size of the population probably varies widely between years due to rainfall. Mapping in 2017 found a large population (estimated at over 100,000 individuals). Despite interannual fluctuations, the population overall is presumed stable; however, the eventual leaching of salts out of soils will eventually open up its current habitat to other species that might outcompete it.

Coulter's goldfields occurred at elevations between 8.1 and 9.6 feet NAVD88, with an average elevation of 8.9 feet. This average distribution was more than 2 feet higher than in the fully tidal estuary at Carpinteria salt marsh in 2017 (Page, Doheny, Hoesterey, Johnson, Hubbard, and Shroeter, *unpublished data*). The distribution is also 1.3 feet higher than the median elevation reported by Zedler (2000).

Sea Blite

Sea blite[6] is a succulent-leaved perennial shrub of the goosefoot family (Chenopodiaceae). Plants that appear to be *Suaeda taxifolia* occur at the site along the path in the southern portion of the SCC salt panne and marsh basin (Area 6) and in a large patch in the southwest TNC marsh parcel

[6] Two special-status sea blites were previously documented on the site by others: woolly sea blite (*Suaeda taxifolia*) and California sea blite (*Suaeda californica*). However, *Suaeda taxifolia* is highly variable in appearance, and *Sueda californica* is now known to occur only north of Point Conception (USFWS 2010). Therefore, *Sueda californica* is not likely to be present on-site.

(Area 3a). Wooly sea blite grows in saline habitat at the margins of salt marshes and coastal dunes and bluffs (California Native Plant Society 2018).

Spiny Rush

Spiny rush (*Juncus acutus* ssp. *Leopoldii)* establishes on the edge of salt marshes, under moderately high salinities without inundation. This species was observed in 2017 scattered throughout the wetlands on SCC property (Areas 3b, 5, and 6) and it seems to have expanded since the Feasibility Study (Aspen 2009). Surveys indicate the species is expanding at the site, which may be a result of the conversion of salt marsh to brackish marsh.

Red Sand Verbena

Red sand verbena (*Abronia maritima*) is common and widely distributed throughout the dunes. This plant establishes in dune habitat and fulfills and important role in dune building. Surveys indicate the species is expanding at the site.

2.3.5 Wildlife

Special-Status Wildlife

A total of 25 special-status wildlife species are known or are highly likely to occur within 1 mile of the Project Area (**Table 2-3**). Of particular interest are five species that occur at the site and listed as a federally or state threatened or endangered species, as described below.

TABLE 2-3
SPECIAL-STATUS WILDLIFE SPECIES DOCUMENTED AT OR NEAR THE PROJECT AREA

Species Name	Status	Habitat	Potential to Occur
Fish			
Tidewater goby (*Eucyclogobius newberryi*)	FE CSC	The brackish open waters in the northwest corner of the Project Area provide suitable habitat for this species. This species was documented in the Lagoon by USFWS, Ventura Office in 2006 (Aspen 2009) and by ESA in the Lagoon in April 2017. Additionally, this species was observed within the J Street Drain in March 2007, just northwest of the Project Area (CNDDB 2017), and in November 2015 (USFWS 2013a).	Present
Birds			
American Peregrine Falcon (*Falco peregrinus* ssp. *anatum*)	FP	Suitable foraging and roosting habitat is available throughout the Project Area and a small population is currently present at NBVC–Point Mugu (Aspen 2009).	High
Western Snowy Plover (*Charadrius alexandrius* spp. *nivosus*)	FT BCC CSC	Present year-round at Ormond Beach. Several nest and roost in the southern foredune habitat and forage along shoreline and open waters (Aspen 2009); this species was observed nesting and foraging within the saltmarsh habitat and foraging within the southern foredune habitat within the Project Area during surveys conducted by CRC and ESA in 2017. Additionally, this species was observed foraging in the southern foredune habitat on September 1, 2015 (CNDDB 2017).	Present

TABLE 2-3
SPECIAL-STATUS WILDLIFE SPECIES DOCUMENTED AT OR NEAR THE PROJECT AREA

Species Name	Status	Habitat	Potential to Occur
Birds (cont.)			
California Least Tern (*Sterna antillarium* ssp. *browni*)	FE SE FP	A small colony nest and roost in the southern foredune habitat at south Ormond Beach, using open water habitat for foraging (Aspen 2009); this species was observed foraging within flooded drainages on-site as well as regular fly-over during surveys conducted by CRC and ESA in 2017. Additionally, this species was observed within the Project Area in 1996; note in observation specified that the species has been documented breeding within the immediate vicinity since 1936 (CNDDB 2017).	Present
Light-footed Ridgway's Rail (*Rallus longirostris levipes*)	FE, SE	Ridgway's Rail were not detected during field surveys in 2017. A single individual bird was detected in April 2016 and in 2013 during protocol surveys (Hall 2016). No birds were detected in follow-up surveys in May 2016.	Present
Belding's Savannah Sparrow (*Passerculus sandwichensis* ssp. *beldingi)*	SE	Present in fragmented patches of saltmarsh habitat throughout the Project Area, but concentrated primarily (1) between the Halaco properties and Ormond Beach Generating Station (OBGS), and (2) the saltmarsh in the southern portion of the Ventura County Game Preserve (Aspen 2009); this species was observed on-site during surveys conducted by CRC in 2017. Additionally, two breeding pairs were observed between the OBGS and the NBVC–Point Mugu fence line and 18 pairs were observed between the Edison and Halaco properties on May 23, 2006 (CNDDB 2017).	Present
Double-crested Cormorant (*Phalacrocorax auritus*)	CSC	Large colonies roost in the uplands immediately adjacent to the coastal freshwater/brackish marsh dominated by *Schoenoplectus* sp., *Typha* sp., and *Distichlis* sp. (Aspen 2009).	Present
White-faced Ibis (*Plegadis chihi*)	CSC	The coastal freshwater/brackish marsh dominated by Schoenoplectus provides suitable habitat for this species (Aspen 2009).	Present
Cooper's Hawk (*Accipiter cooperii*)	CSC	Roost and forage in upland habitats within the Project Area (Aspen 2009).	Present
Sharp-shinned Hawk (*Accipiter striatus*)	CSC	Roost and forage in upland habitats within the Project Area.	Present
Northern Harrier (*Circus cyaneus*)	CSC	Suitable nesting/roosting habitat available throughout the Project Area. Observed foraging over upland, salt and freshwater marshes, and ruderal areas (Aspen 2009).	Present
White-tailed Kite (*Elanus caeruleus*)	FP	Observed in non-native grassland, mixed transitional and coastal freshwater/brackish marsh dominated by *Schoenoplectus* sp. (Aspen 2009).	Present
Merlin (*Falco columbaries*)	CSC	Observed foraging in sod farm habitat. May also forage in open upland habitats. Not believed to breed in Project Area (Aspen 2009).	High (Foraging)
Long-billed Curlew (*Numinous americanus*)	BCC CSC	Observed foraging along the shoreline at the beach and in the open, dry ponds of the Ventura County Game Preserve (Aspen 2009).	Present
Western Burrowing Owl (*Athene cunicularia* ssp. *hypugea*)	BCC CSC	The non-native annual grassland and roadside berms within Project Area provide habitat (Aspen 2009).	High
Loggerhead Shrike (*Lanius ludovicianus*)	BCC CSC	Observed in the vicinity of non-native annual grassland habitats northeast of the Project Area (Aspen 2009).	High
California Horned Lark (*Eremophila alpestris* ssp. *actia*)	CSC	Regularly observed foraging in the sod farms. Non-native grassland and mixed transitional areas within Project Area also provide habitat (Aspen 2009).	High
Tri-colored Blackbird (*Agelaius tricolor*)	BCC CSC	Suitable emergent wetland habitat is available along Oxnard Industrial Drain, adjacent coastal freshwater/brackish marsh habitat, and dense emergent wetland vegetation at the managed duck ponds southeast of the Project Area (Aspen 2009).	High

TABLE 2-3
SPECIAL-STATUS WILDLIFE SPECIES DOCUMENTED AT OR NEAR THE PROJECT AREA

Species Name	Status	Habitat	Potential to Occur
Mammals			
Southern California saltmarsh shrew (*Sorex ornatus* ssp. *salicornicus*)	CSC	Potential habitat is available in many of the southern coastal salt marsh and coastal freshwater/brackish marsh habitats throughout the Project Area. This species was observed in the brackish marsh northeast of the Halaco properties, within the Project Area (Aspen 2009).	Present
San Diego black-tailed jackrabbit (*Lepus californicus* ssp. *bennettii*)	CSC	Observed in the southern foredune area southeast of the Halaco properties, within the Project Area. Other potential habitat includes the non-native grassland and mixed transitional habitats (Aspen 2009).	Present
Amphibians and Reptiles			
South Coast garter snake (*Thamnophis spiralis* ssp.)	CSC	One individual was observed crossing Arnold Road adjacent to the cultivated sod fields. Suitable habitat within the Project Area includes upland, salt marsh and brackish marsh (Aspen 2009).	High
Southern California legless lizard (*Anniella stebbinsi*)	SSC	Common in the back dune areas of the site, especially where there is iceplant (T. Munro-Burgess pers. obs.)	High
Invertebrates			
Sandy Beach tiger beetle (*Cicindela hirticollis* ssp. *gravida*)	G5T2/ S2	Observed within foredune habitat in Port Hueneme in 1979 approximately 0.5 mile northwest of the Project Area. However, this species is presumed to be extirpated from the original location.	Medium
Globose dune beetle (*Coelus globosus*)	G1G2/ S1S2	Observed within foredune habitat in Port Hueneme on July 17, 1926 approximately 0.5 mile northwest of the Project Area. This species is likely extirpated from this location.	Medium
Wandering (saltmarsh) skipper (*Panoquina errans*)	G4G5/ S2[1]	Observed in the southern coastal salt marsh, coastal freshwater/brackish marsh, and non-native annual grassland within the general vicinity of the Project Area (coyote brush/western ragweed association, Aspen 2009).	High
California brackishwater snail (*Tryonia imitator*)	G2/S2	Observed within the within the J Street Canal in March of 2007, just northwest of the Project Area (CNDDB 2017).	High

Listing Status Key:
FE = Federally Endangered
SE = State Endangered
ST = State Threatened
FP = Fully Protected
CSC = California Species of Special Concern
BCC = USFWS Bird of Conservation Concern
G#/S# = Global/state rank by World Conservation Union

NOTE:
[1] Extremely rare in California, considered globally imperiled by the World Conservation Union

SOURCE: CNDDB 2017, ESA 2017, WFVZ 2013, 2016

Tidewater Goby

The Tidewater Goby (*Eucyclogobius newberryi*) has been consistently documented in the Ormond Lagoon over the last several years (Aspen 2009, HDR 2011, USFWS 2013a&b, Cardno 2014 and 2017). In 2013, fish rescues on various dates in November and December captured a total of 7,399 tidewater gobies in the lower J Street Drain construction area as part of the VCWPD's J Street Drain Project (Cardno 2014). Post-construction monitoring has continued to find tidewater gobies throughout the lagoon: May 2015 (425 gobies), October 2015 (5 gobies, note this was after a fish kill in July 2015), April 2016 (59 gobies), October 2016 (184 gobies),

April 2017 (100 gobies) (Cardno 2015a, 2015b, 2016a, 2016b, 2017). The lagoon mouth was closed for all surveys, and salinity range was 2–13 ppt.

Favorable habitat attributes at Ormond Lagoon include a seasonally closed lagoon, shallow low-salinity waters, still-to-slow-moving water, sand and silt substrate, and submerged and emergent aquatic vegetation, such as pondweed (*Ruppia maritima*), bulrush (*Scirpus* spp.), and cattail (*Typha latifolia*) (USFWS 2013).

Non-native fishes are present in the lagoon, but not predatory bass or sunfish (Cardno 2017). A recent study raised concerns about possible impacts from pesticide runoff from surrounding agriculture and urban areas into Ormond Lagoon (Lindley et al. 2018).

California Least Tern

The California Least Tern (*Sterna antillarium* ssp. *browni*) nests on the bare sand near the lagoon. The adults forage for fish in the lagoon and nearshore waters (Hartley 2017). This species was regularly observed flying over the site and diving for fish in open water habitats throughout the site during all of the field visits in 2017. As of late June 2017, there were more than two-dozen nests established on bare sand near the lagoon.

Disturbance of nests by humans and dogs, and chick predation by gulls and ravens, have impacted nesting success.

Western Snowy Plover

The Western Snowy Plover (*Charadrius alexandrius* spp. *nivosus*) inhabits the beach, dunes, and salt panne on the SCC parcel. In 2017, nests were dispersed over the entire 2-mile length of Ormond Beach (Hartley 2017). Chicks and fledglings were either at the salt panne to the south or near the lagoon (Hartley 2017).

Disturbance of nests by humans and dogs and especially predation of plover chicks by gulls and ravens have impacted nesting and fledging success over the years.

Belding's Savannah Sparrow

Belding's Savannah Sparrow (*Passerculus sandwichensis beldingi*) nest in pickleweed (*Salicornia pacifica*) in coastal salt marshes. In 2017 CRC observed (visually and audibly) several individuals in different areas of Ormond Beach, including an adult feeding a juvenile in the salt marsh adjacent to Arnold Road in June 2017. Surveys for this species every five years or so at Ormond Beach between 1977 and 2015 identified between 15 and 61 pairs on territories (Zembal et al. 2015). In 2015, Mugu Lagoon had over 1,100 breeding pairs, which amounted to about one third of the statewide population (Zembal et al. 2015). Bird point counts conducted in 2016 on TNC property found 39 individuals: 11 in the farm fields and 28 in the wetland areas (Hall 2016). The pickleweed habitats at the site are appropriate for supporting nesting.

Areas that have converted from salt marsh to brackish marsh (cattail and tule) will generally not support nesting for this species. The conversion of salt marsh to brackish marsh is a threat to the species on-site.

Light-Footed Ridgway's Rail

Light-footed Ridgway's Rail (*Rallus longirostris levipes*) nest in tidal salt marshes, preferring tall intertidal cordgrass (*Spartina foliosa*) where it builds a floating nest. Nesting in muted tidal or non-tidal areas of tidal marshes has been documented at Mugu Lagoon and Carpinteria Salt Marsh in spiny rush (*Juncus acutus*) and saltmarsh bulrush (*Bolboschoenus maritimus*). Single individuals of this species have been observed on TNC property within the Project Area in 2013 and 2016 (Hall 2013, 2016). These birds were presumably short-term visitors from Mugu Lagoon since this species relies almost exclusively on prey (invertebrates and small fish) that occur in intertidal or sub-tidal marsh habitats, which are largely absent in the Project Area.

2.4 Future Conditions

Under future sea-level rise conditions, the Project Area will undergo a series of hydrologic changes as the beach responds geomorphically to the rising water levels. The beach will likely respond to rising oceanic water levels by migrating inland (transgressing) and shifting upward. Depending on the rate of transgression, the existing dune system may be eroded, since higher oceanic water levels would mean that existing dunes would be exposed to waves on a more frequent basis. If the future lagoon and wetland system are allowed to migrate inland, the hydrology may remain similar in the future, although the groundwater table will likely shift upward along with the rising tides, and habitats will also migrate up and landward in proportion to sea-level rise but also effected by grades, soils, and infrastructure.

Future conditions were analyzed in more detail in order to diagnose the future no-project conditions as well as influence development of the restoration and access alternatives. Sea-level rise is discussed in Section 2.4.1. Subsequent sections address shore migration, lagoon evolution, and habitat migration.

2.4.1 Sea-Level Rise

Future sea-level rise ("SLR" in context of scenario discussions) scenarios were chosen for this Project based on the latest California guidance (OPC 2018) and prior work for Coastal Resilience Ventura (CRV) (ESA PWA 2013). For this analysis we selected the Medium and High SLR scenarios from CRV, which are within the range of California guidance for low to moderate risk tolerance levels (30–40 inches and 60–80 inches, respectively). The sea-level rise values are also similar to those used in the Regional Strategy for southern California wetlands (SCWRP 2018). Use of the CRV values also provide continuity with the coastal planning since the County of Ventura and the City of Oxnard are using coastal hazard maps based on the CRV scenarios (ESA 2013).

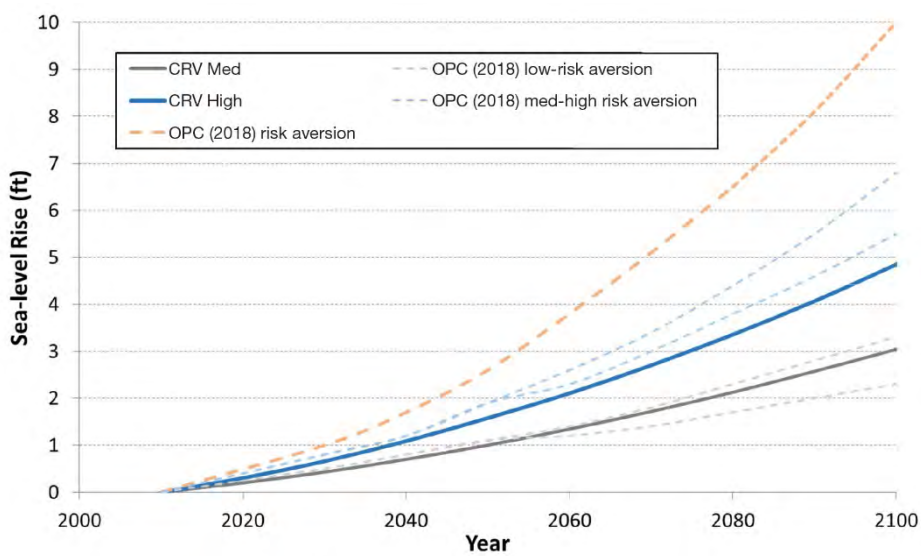
The selected sea-level rise values for Medium and High scenarios are listed in **Table 2-4** and graphed in **Figure 2-13**. These values range from 1 to 2 feet of sea-level rise by mid-century (years 2050–2060), and 3 to 5 feet for the end of century (year 2100). These scenarios were used to develop coastal hazard maps for all of Ventura County, and have been used for coastal zone planning. Figure 2-13 compares these CRV scenarios with the most recent State guidance (OPC 2017; 2018, derived from Griggs et al. 2017). The CRV medium and high scenarios are similar to the most recent OPC low-risk-aversion and medium-high-risk-aversion scenarios, respectively, and hence adequate for this study. For reference, the Regional Strategy selected 61 cm for 2050 and 166.5 cm for 2100 (Appendix 3 to SCWRP 2018), which are similar to the values used in this study (see "High SLR" Table 2-4, 64 cm for year 2060 and 148 cm for 2100). Note that these prior studies (CRV by ESA PWA 2013; SCWRP 2018) analyzed sea-level rise scenarios prior to the release of California's update to policy (OPC 2018), which is based on and followed the update of science (Griggs et al. 2017). Additional information about sea-level rise science and policy is provided in Appendix A – Sea-Level Rise.

TABLE 2-4
SEA-LEVEL RISE SCENARIOS USED IN THIS STUDY, FROM CRV

Year	Low SLR	Medium SLR	High SLR
2030	6 cm (2.3 inches)	13 cm (5.2 inches)	20 cm (8.0 inches)
2060	19 cm (7.4 inches)	41 cm (16.1 inches)	64 cm (25.3 inches)
2100	44 cm (17.1 inches)	93 cm (36.5 inches)	148 cm (58.1 inches)

NOTE:
SLR = sea-level rise

SOURCE: ESA PWA 2013



SOURCE: ESA 2013, OPC 2017

Ormond Beach Restoration and Public Access Plan

Figure 2-13
Sea-level rise scenarios from CRV and draft policy update

2.4.2 Shore Migration and Wave Overtopping

Sea-level rise will raise the elevation of surface waves, causing the beach to be reformed at a higher elevation and to migrate landward a distance of between 10 and 100 times the amount of sea-level rise. At Ormond Beach, we expect that sufficient room exists for this beach migration. Dunes will also migrate as long as there is sufficient dry beach to supply wind-blown sand: however, we do not expect the wind-blown sand transport rate to be sufficient to match the rate of shore migration with sea-level rise. The Ormond Lagoon will expand landward with higher water levels, primarily into relatively low areas, but the expansion will be impeded where the backshore is raised and armored (e.g., near Perkins Road). Hence, we expect that the existing dunes and wide inter-dune sandy strand will be reduced in width in Area 1, as will the existing Ormond Lagoon. At the same time, we expect Ormond Lagoon to shift toward the northeast and into the lowlands of Area 3a, behind the migrating beach. In addition, the narrowing beach-dune strand will allow wave overtopping to occur more frequently, thereby delivering saltwater and sand to the back dune wetlands at greater rates than occur now.

Shore migration was modeled using a beach quantified conceptual model (QCM – Beach) that uses cross-shore volume balance (Bruun 1962) and equilibrium profile (Dean 1990) equations consistent with the overall methodology described by Everts (1985) and using beach surveys collected by ESA in 2017. Additional information is provided in Appendix B – Shore Migration and Overtopping (Beach QCM).

Figure 2-14 shows the three locations selected for the shore migration analysis, which are locations of beach surveys. **Figure 2-15** shows the projected shore migration over time. The red line in each figure approximates the landward edge of the beach-dune strand. The shore migration modeling indicates that:

- The existing Ormond Lagoon will be “squeezed” into a smaller available space between the shore and backshore.
- The dunes in Areas 7 and 8 will persist.
- The low-relief dunes in Area 9 will be eroded such that wave overtopping will likely be more frequent.

Graphs in Figure 2-15 show the elevation of shore along the lines with the corresponding labels in Figure 2-14. Transect E is located on the west side at Ormond Lagoon (Area 1). Transect H is located in the central portion of the Project Area where the dune area is widest (Area 7). Transect I is located from the beach (Area 9) across to Area 6 where dunes are less vegetated and lower, and wave runup is known to occasionally reach the wetlands landward of the sandy dunes. These locations were selected to represent the three different coastal conditions that exist at the Project Area (west –Transect E, lagoon; center – Transect H, high and wide dune field; and east – Transect I, low and overtopped dune hummocks).

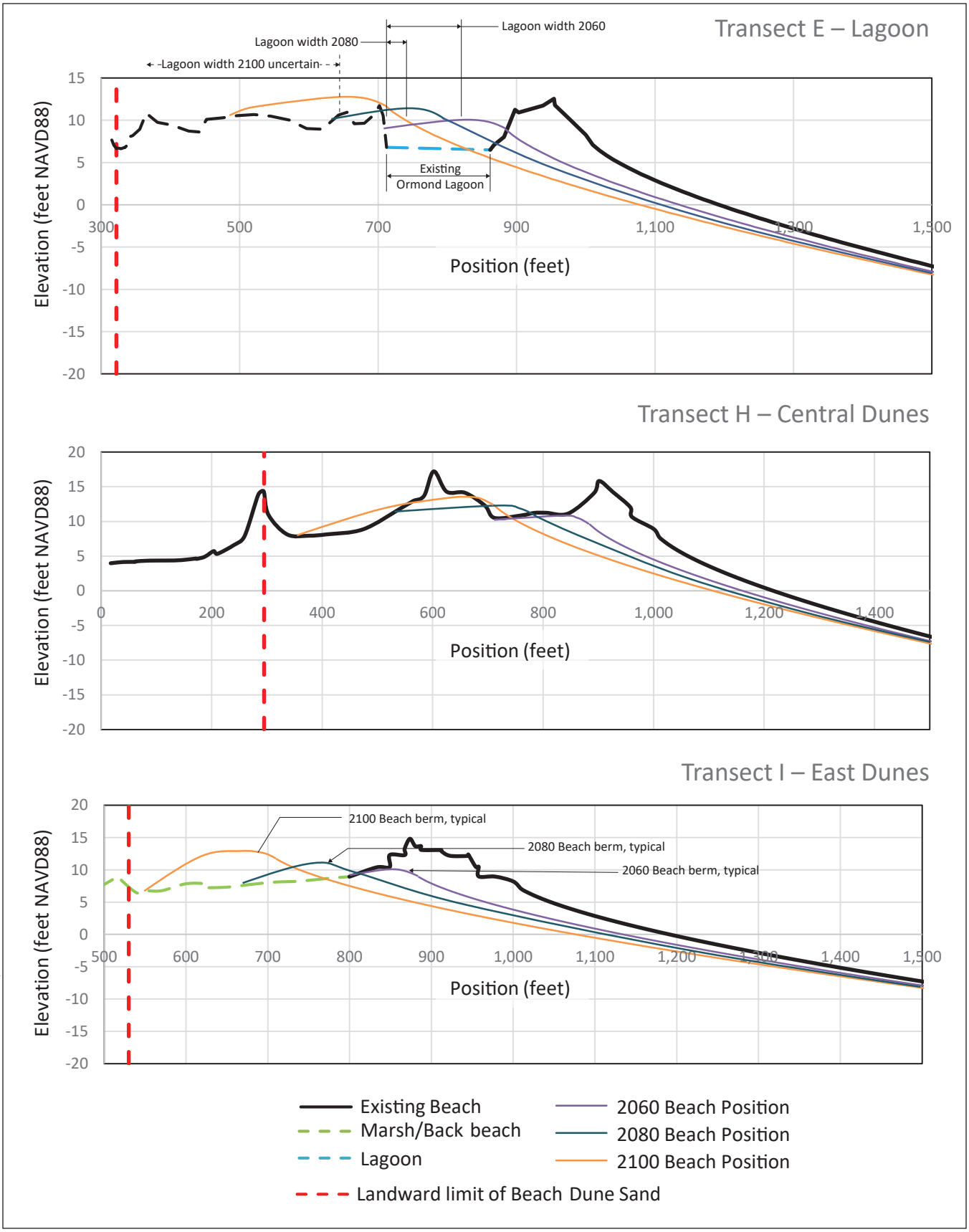
Path: U:\GIS\GIS\Projects\16xxxx\D160447_OrmondBeach\03_MXDs_Projects\Figures\March2019_FigureUpdates\Fig2-14_CrestandBerm.mxd, hmiller, 3/22/2019

SOURCE: ESA Survey (6/2017)

Ormond Beach Restoration and Public Access Plan

Figure 2-14
Beach Transects Locations

ESA



SOURCE: ESA, 2017

NOTE: Transect E (top) is located at western beach strand Area 1 at Ormond Lagoon; Transect H is located at central beach strand 7 near backshore Area 3 and Transect I is located at eastern beach strand Area 9 near backshore Area 6.

Ormond Beach Restoration and Public Access Plan

Figure 2-15
Beach Transect Elevations

ESA

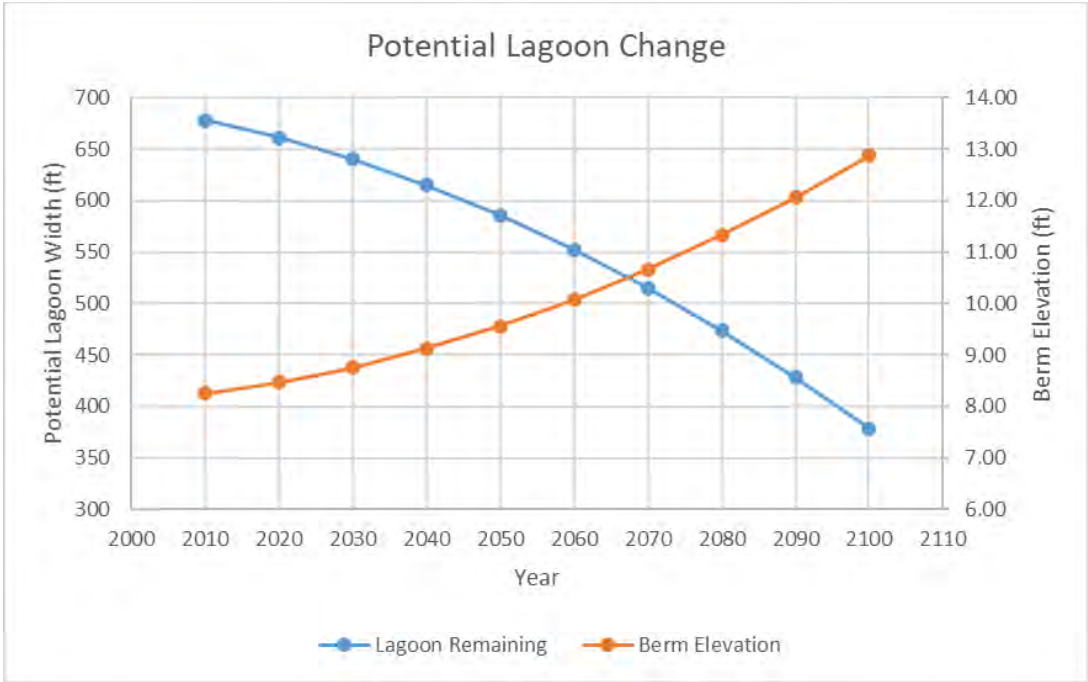
D160447.00 - Ormond Beach Wetlands Restoration\05 Graphics\Illustrator

At each of these three locations, the shore geometry is shown in black. For example, in the top schematic in Figure 2-15, the black solid line is based on a survey of ground elevations (beach transect I), the black dashed line is derived from lidar, and the blue dashed line is the water surface of Ormond Lagoon at the time of the lidar data collection. The vertical, red and dashed line corresponds to the landward edge of the beach-dune strand and corresponds to the red line in Figure 2-14. The horizontal position is a scale in feet with a "zero" location inland of the changes. The width of the existing lagoon is depicted by the blue, dashed line. Note that the vertical scale is exaggerated to clarify the relief. Future shore geometries are shown in other colors, per the figure legend. As sea level rises, the wave-shaped seaward face of the profile responds rapidly by migration, while landward elevations are held steady. Note that at Transect E, the waves overtop the beach and reach the lagoon, and hence this "overwash" area also migrates with the seaward beach.

At Transect E the existing Ormond Lagoon is impacted by shore migration. Note that the lagoon width decreases in 2030 and approaches zero in 2060. By 2100 the beach migrates inland of the existing dune and the extent of lagoon is difficult to predict. This profile modeling neglects scouring of the backshore, which may happen during breaching events with rapid drainage and high OLW discharge. Therefore, the resulting lagoon footprint may be larger than implied by the beach migration modeling. Also, large expanses of low-elevation areas in Area 3b and 3a are likely to pond during high beach levels, indicating that the lagoon may "shift" location to the north and east.

At Transect H, waves are not predicted to overtop the dunes sufficiently to cause the sand deposition in the lee of the dunes, resulting in a reduction of the width of the dune field.

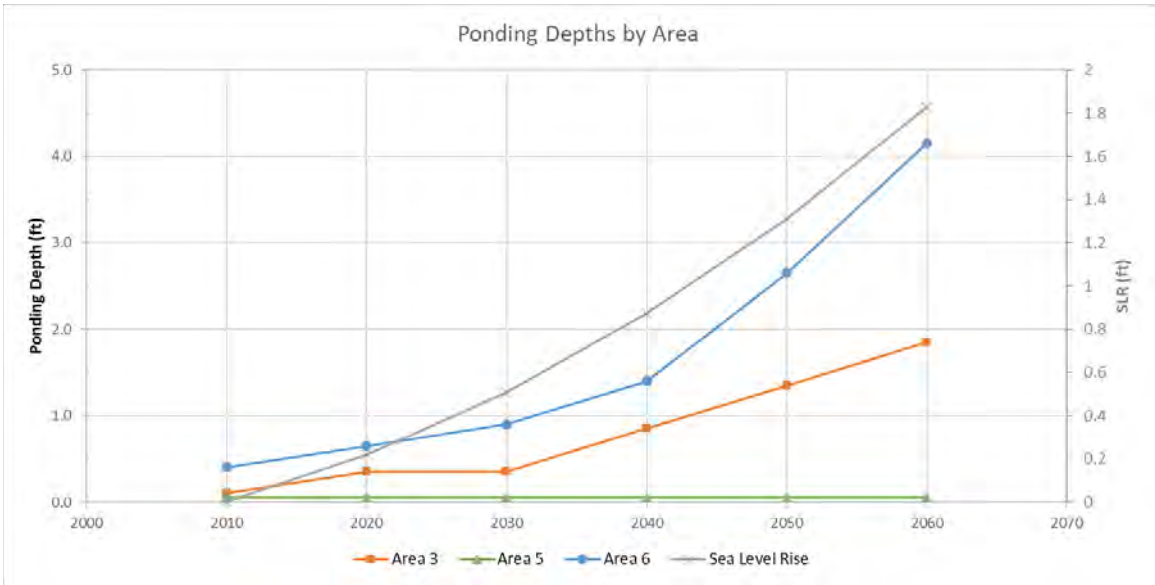
The reduction of space available for the existing Ormond Lagoon is depicted graphically in **Figure 2-16**. Figure 2-16 shows the increase in beach berm elevation (brown line) with sea-level rise and the corresponding reduction of the shore width available for lagoon formation (blue line). The available space is calculated as the distance between the shore line and the landward limit of the beach-dune strand (located in Figure 2-14). The beach berm elevation is derived from the profile change modeling (Figure 2-15). As SLR results in the landward migration of the shore line (see Figure 2-15), the width of the beach-dune strand is projected to reduce from over 600 feet to less than 400 feet by the year 2100. The beach berm elevation is projected to rise to nearly 13 feet NAVD88 by 2100. These projections correspond to sea-level rise scenario of 4.6 feet by 2100: Higher sea levels would result in reduced space for Ormond Lagoon. The lagoon evolution is further analyzed in Appendix C – Ormond Lagoon Hydrology and Morphology (Lagoon QCM).



Ormond Beach Restoration and Public Access Plan

Figure 2-16
Sea-Level Rise Induced Drivers to Ormond Lagoon Change

Wave overtopping is expected to increase due to the reduction in the width of the barrier beach and erosion of the dunes. The amount of overtopping was computed using the wave runup values from CRV (ESA 2013) for Areas 7 to 3 and Areas 9 to 5 and 6. Overtopping was computed using published equations driven by the height that potential wave runup exceeds the dune crest (FEMA 2005). The modeling of overtopping accounted for water losses resulting from travel over the beach-dune strand landward of the dune crest using a methodology derived from Laudier et al. (2011). A 1-year recurrence value for total water level (elevation of wave runup, including coincident tide) was used to compute overtopping volumes. The overtopping volumes were then converted to ponding depth in each back shore area based on the topography derived from LiDAR. **Figure 2-17** is a graph of the results, in terms of ponding depth over time, along with the sea-level rise curve. Area 6 ponding will increase about 200 percent by 2060 (from 0.5 feet to 1.5 feet), and much more in the latter half of the century. Area 5 is not expected to experience an increase in ponding from wave overtopping based on existing grades, at least as indicated by the 1-year event. Area 3 ponding is predicted to increase from about 0.1 foot to about 1.0 feet by mid-century, and to 2 feet by the end of century. These are approximate calculations of a complex physical process, but do indicate a strong likelihood of increased saltwater delivery.



Ormond Beach Restoration and Public Access Plan

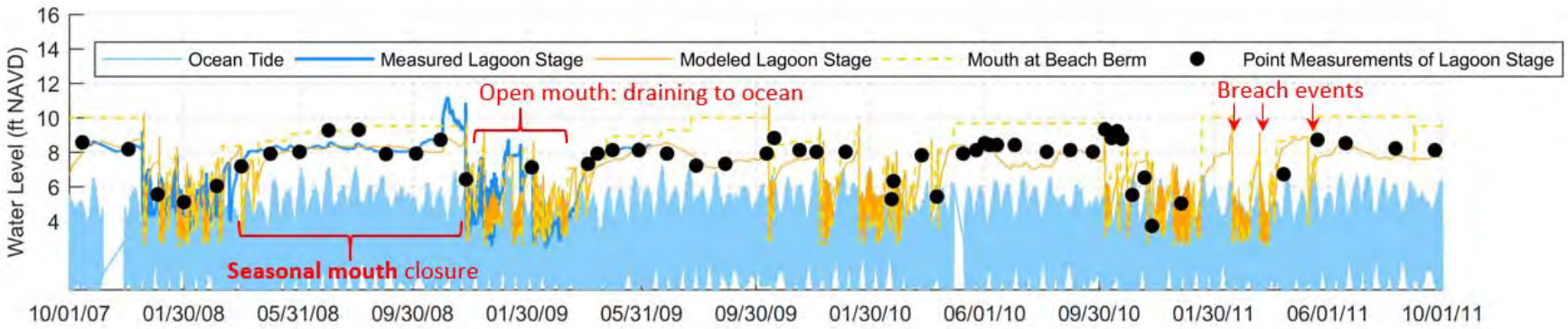
Figure 2-17
Sea-Level Rise Induced Overtopping and Ponding in Areas 3, 4, and 5

2.4.3 Ormond Lagoon

A lagoon quantified conceptual model (QCM) was developed to investigate Ormond Lagoon, assess response to sea-level rise and evaluate restoration alternatives. This section summarizes the existing conditions analysis. Alternatives analyses are provided in Section 6. Details on the setup of the model are provided in the Appendix C – Ormond Lagoon Hydrology and Morphology (Lagoon QCM).

The lagoon QCM complements the additional tools described in this report, the beach QCM and Sea Level Affecting Marshes Model (SLAMM). The beach QCM (Section 2.4.2) provided coastal boundary conditions which informed the sea-level rise scenarios modeled by the lagoon QCM. The lagoon QCM provides detailed information on temporal changes in mouth morphology, seasonal lagoon water levels, and brackish areas, which supplement the more spatially-detailed habitat information provided by the SLAMM model (Section 2.4.4). The lagoon QCM was also used to analyze the three Project alternatives (as described in Section 6.3.1), and to predict future changes under each alternative with sea-level rise.

The QCM was run from October 2007 to October 2017, a 10-year period that includes a range of wet and dry years, and a high overlap of available data sets for testing the model. **Figure 2-18** shows a subset of the time series of measured water levels and modeled water levels, chosen to highlight certain behaviors. Although the exact timing of the measured closure and breaching events are not always captured, the model reproduces a number of important aspects of the existing Ormond Lagoon, such as: (1) periods of mouth scour during high watershed runoff, (2) mouth closure during high wave events, (3) stabilization of the water level at 8-9 feet NAVD88 during seasonal closure events, and (4) natural mouth breaching during floods.



D160447.00 - Ormond Beach Wetlands Restoration\05 Graphics\Illustrator

SOURCE: ESA

Ormond Beach Restoration and Public Access Plan

Figure 2-18
Comparison of modeled and observed water levels in Ormond Lagoon

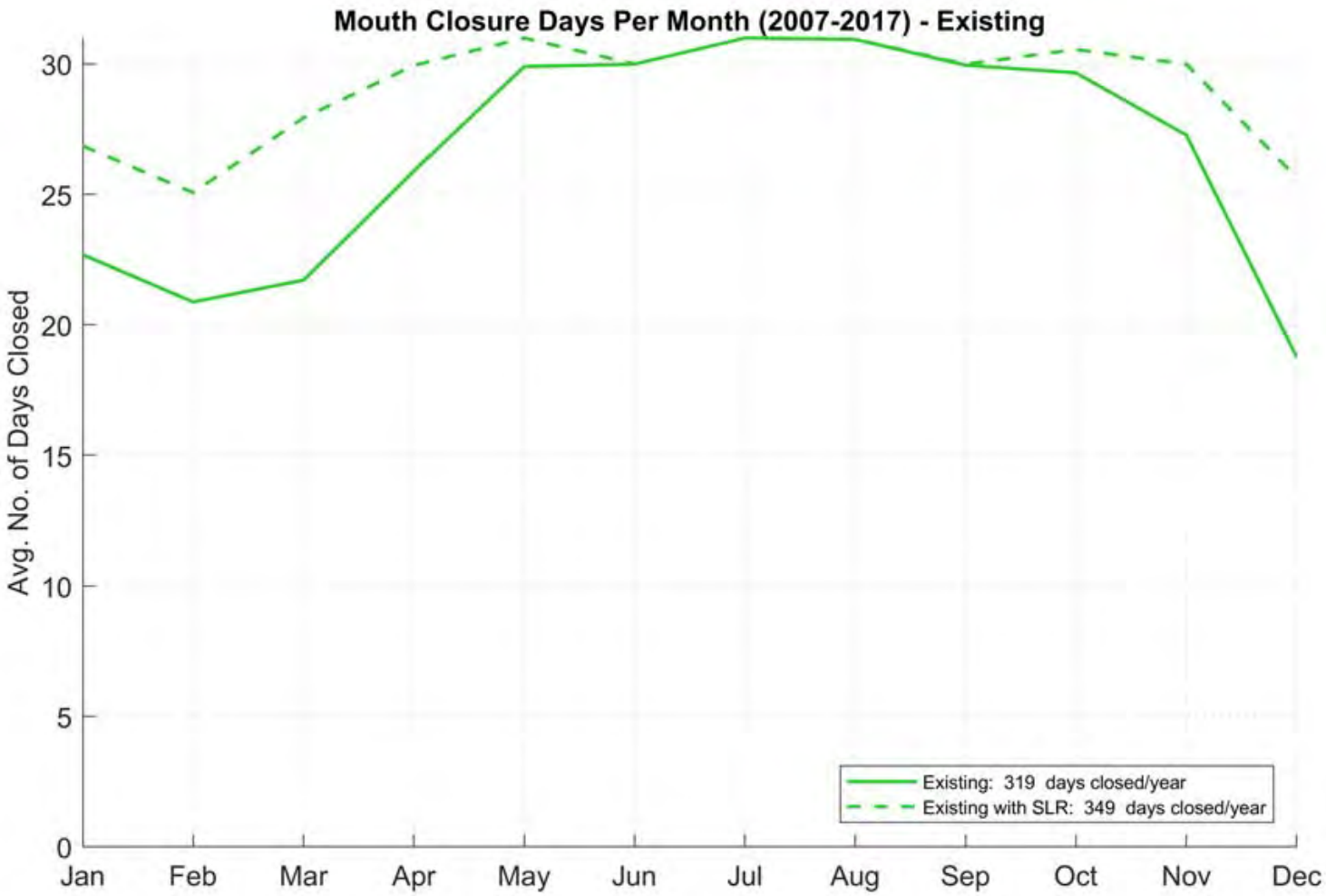
ESA

Under present conditions, Ormond Lagoon spills water out to the ocean during the winter months, when runoff from local municipal and agricultural runoff is highest. Flows from the watershed are concentrated into a series of drainage channels, which cause flood flows to rapidly arrive at the lagoon during rainfall events, and to rapidly tail off after rainfall ceases. The lagoon receives little tidal action when the mouth is open to the ocean, owing to its high elevation on the beach. When runoff declines in the spring, wave action closes the mouth seasonally, usually for periods of at least 4 to 6 months. During these closure periods, residual runoff ponds in the closed lagoon, but balances with seepage and evaporative losses, giving relatively stable water levels of about 8 to 8.5 feet NAVD88 in the dry season. Ormond Lagoon is an estuary lagoon with a drainage outlet (not a tidal lagoon and not a tidal inlet), as described in Behrens et al. 2015, and generally consistent with the multiple historical lagoon estuaries depicted in the historic maps and ecology interpretations (see Section 2.2 Historical Setting).

To explore how future changes could influence the behavior of Ormond Lagoon, ESA ran the QCM model for same (2007–2017) time series with 3 feet of sea-level rise. **Figure 2-19** presents outlet mouth closure frequency under existing conditions and with 3 feet of sea-level rise. **Figure 2-20** shows the hydrology statistics in terms of water level, wetted area and volume for existing conditions and with 3 feet of sea-level rise. With sea-level rise, the model predicts that Ormond Lagoon will continue to have periods of seasonal closure and times when water spills out to the ocean with limited tidal action. A similar seasonal pattern with winter and spring breaches is still observed, although the pattern is less pronounced. The number of days the lagoon is closed is anticipated to increase and closures are predicted to last longer than under existing conditions. During some years, the mouth of the lagoon may be closed for the entire year. Future changes in climate are expected to affect rainfall and runoff, and land use changes may also affect runoff: These future changes are not addressed in this study.

Water levels in the lagoon during closure periods are anticipated to be higher than under existing conditions, with typical closure elevations between 10 and 11 feet NAVD88. Flood flows may cause water levels in the lagoon to reach up to 13 feet NAVD88. Note that typical ocean tides with 3 feet of sea-level rise will regularly exceed 10 feet NAVD88. However, the County intervenes by grooming the beach to limit water levels above flood stage, which is about 9 feet NAVD88; more frequent interventions will be required to limit flooding as the sea level rises, and alternative adaptation actions will likely be necessary. Grooming refers to grading the beach to a lower elevation to facilitate overtopping and drainage to the ocean. While beyond the scope of this Project, management actions would affect hydrology, and hence ecology and access.

As the mouth remains closed more frequently and for longer durations, the amount of wetted area covered by the lagoon and the volume of water stored will increase. These results imply that the increase in the extent of inundated areas behind the dune line would contribute more to impoundment of water than to maintaining an open mouth. As sea-level rise increases water levels above 3 feet, more frequent open-mouth conditions may result. For Ormond Beach area, the very low topography would not constrain the water surface at these higher sea-levels, and a more detailed analysis of the basin hydrology is required to provide meaningful projections.



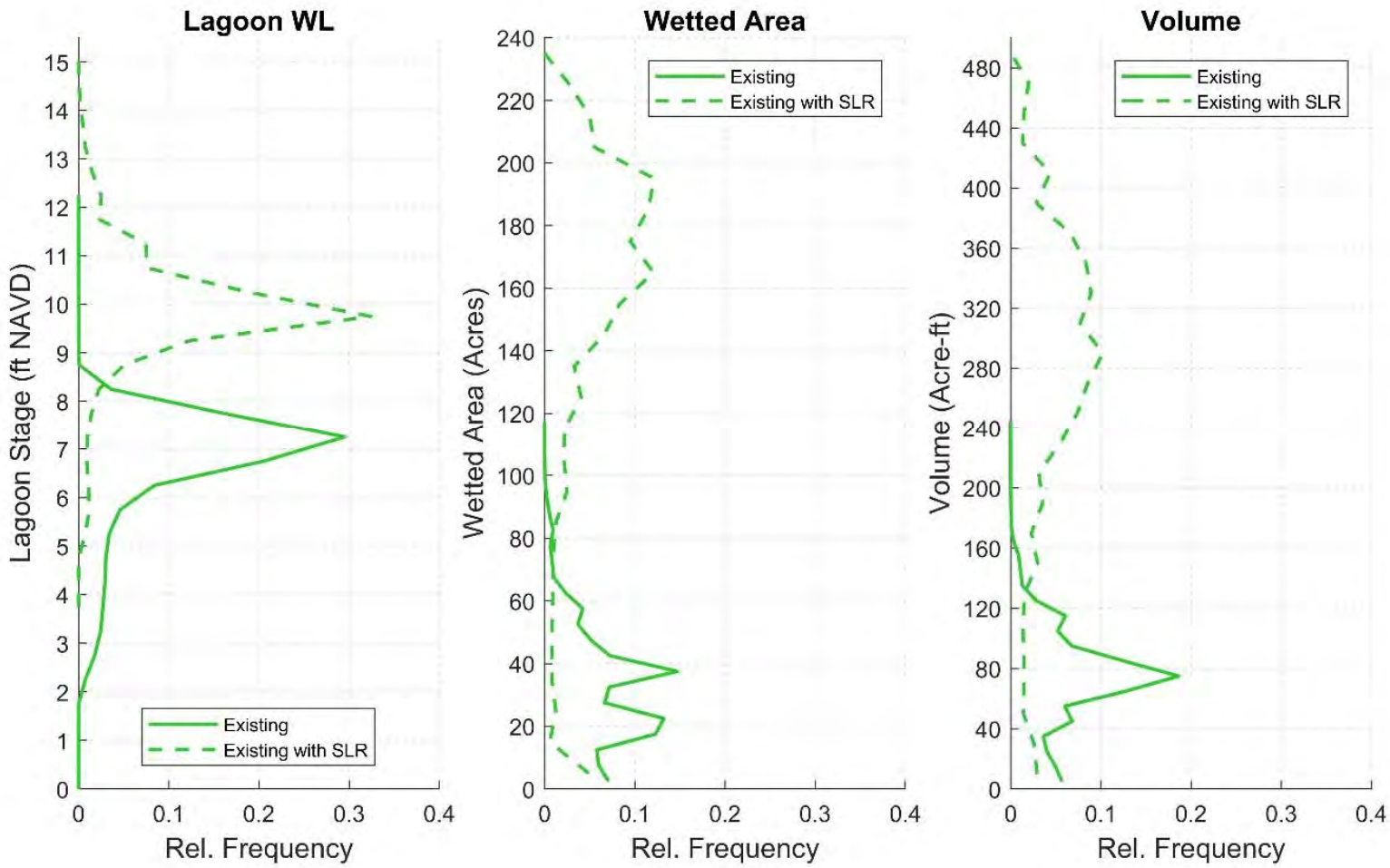
D160447.00 - Ormond Beach Wetlands Restoration\05 Graphics\Illustrator

SOURCE: ESA QCM model

Ormond Beach Restoration and Public Access Plan

Figure 2-19
Lagoon Mouth Closures in Days per Month
Existing Conditions (No Project)

ESA



D160447.00 - Ormond Beach Wetlands Restoration\05 Graphics\Illustrator

SOURCE: ESA QCM model

Ormond Beach Restoration and Public Access Plan

Figure 2-20
Modeled Lagoon Stage (Water Level) (left), Area (middle), &
Volume (right) Probability Distributions for 2007–2017; Existing Conditions (No Project)

ESA

2.4.4 Wetland Habitats Evolution

As the sea level rises, the beach and wetland habitats at Ormond Beach are expected to change due to increasing inundation and geomorphic migration inland. This study used SLAMM to predict potential habitat changes in the Project Area that would be caused by sea-level rise. SLAMM is a software program that simulates wetland conversion and shoreline change due to sea-level rise (Warren Pinnacle Consulting [WPC] 2016). SLAMM uses ground elevation and slope, along with an initial habitat map and a sea-level rise curve, to estimate the conversion and migration of habitat areas over years to decades. Details of this study's application of SLAMM are provided in Appendix D – Wetlands Habitat Evolution Modeling (SLAMM) and summarized in this section.

This study was performed with SLAMM version 6.7 because it is the latest iteration of the software and includes some features developed for California estuaries and perched lagoon systems (WPC 2016). Previously, the Coastal Resilience Ventura project applied SLAMM version 6.2 beta to the stretch of shoreline including both Ormond Beach and Mugu Lagoon to the southeast (ESA PWA 2014). Although these two versions of the model used somewhat different input data sets and methodologies to project habitat evolution, the findings from the two studies are generally similar. Both indicate that Ormond Beach will begin to experience a notable increase in inundation after 2 feet of sea-level rise, and the effect of sea-level rise escalates to inundate nearly all the Project Area as sea-level rise approaches 5 feet.

SLAMM's key inputs are ground elevations, habitat mapping, and sea-level rise. Ground elevations and habitat mapping were updated to incorporate data collected in 2017. For sea-level rise, the CRV "High SLR" sea-level rise curve was used, for consistency with that prior work and other County of Ventura planning, as discussed above. This curve projects sea-level rise of 4.8 feet at 2100.

A key feature of the most recent version of SLAMM is that it allows definition of subareas with different hydrologic parameters. For Ormond Beach, we defined two main subareas for the model: the Ormond Lagoon Subarea and the Arnold Road Subarea. The Ormond Lagoon Subarea was defined to capture the effects of perched Ormond Lagoon water levels on habitat conversion in the west, and the Arnold Road Subarea was defined to capture the effects of rising groundwater levels on habitat conversion in the east. The rest of the domain includes developed areas, which are assumed to have unchanged land use from their current development, and the exposed beach and dune areas, which directly experience the open ocean tides and waves. The hydrology of each subarea was characterized based on water level and barrier beach crest observations.

Sea-level rise will cause landward transgression of ocean water levels and waves, which, in turn, will cause erosion and shift the beach and dunes further inland. These processes were addressed outside SLAMM, in the manner described above, and then overlain on the SLAMM results. The shore transgression (migration landward and up with sea-level rise) modeling is described in Appendix B – Shore Migration and Overtopping (Beach QCM). The habitat bands were shifted up with sea-level rise at each profile location and then interpolated. The shore habitat bands were

then superimposed on the habitat mapping predicted by SLAMM. Note that SLAMM does not differentiate between "salt panne" and "mud flat" very well since these are often divided by salt supply and flushing patterns that are not captured in the model; thus, "salt panne" and "mud flats" are grouped and labeled "unvegetated flats" in the SLAMM results so as not to over-state model confidence in the distinction.

Results for the No Project scenario are incorporated into the next section, as part of the synthesis of the site's evolution.

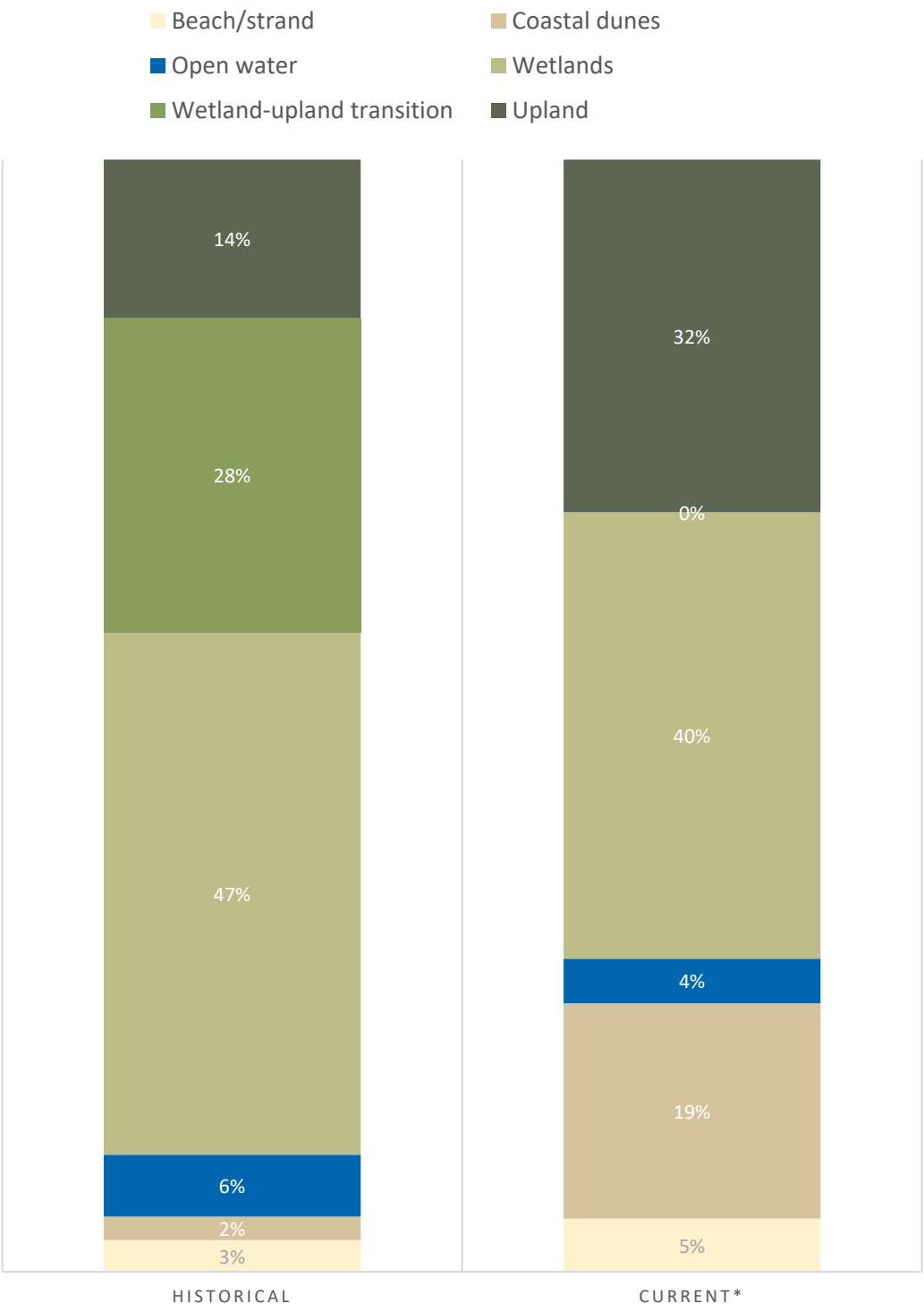
2.5 Synthesis of Site Evolution – No Project

The Project Area has experienced loss of wetlands due to land use changes and public works projects. The losses are quantified by comparing the habitat acreage percentages of the historical and existing conditions (**Figure 2-21**). The historical habitat acreages were taken from the historic ecology assessment by San Francisco Estuary Institute (SFEI) (Beller et al. 2011). To account for the natural ecological boundaries and distribution, the historic extent was defined by the five coastal lagoons between Hueneme and Mugu. Historically, wetlands covered nearly half the Project Area (47 percent) but now cover about 40 percent of the site. Wetlands plus wetland-upland transition covered about 75 percent of the site historically with an additional 14 percent upland for a total wetland/transition/upland of 89 percent, whereas wetland and upland (including potential transitional elevations) now covers about 62 percent of the Project Area.

Forty percent of the Project Area is characterized as wetland habitat (Figure 2-21 excluding beach, dune, open water and upland) and direct encroachments are limited, indicating that the degraded wetland conditions will likely improve. However, there are uncertainties and concerns about some processes. For example, the backwater from Ormond Lagoon may be influencing the conversion of salt marsh to brackish marsh in Areas 2 and 3a, which may impact several rare habitat and plant populations. Interestingly, the sandy beach and dune strand have become slightly larger, which is attributed to the construction and management of Port Hueneme.

Sea-level rise is projected to have a significant effect on habitats by the end of the century and potentially as early as mid-century. **Figures 2-22 through 2-25** show existing habitats and projected future habitats for years 2060, 2080, and 2100, respectively. These figures were constructed by applying SLAMM, and adjusted using beach migration projections computed from the Beach QCM.

Standing water will become more prevalent with 2 feet of sea-level rise (approximately by 2060, see Figure 2-23), with salt pannes and salt marsh being inundated first. Fortunately, the site includes upland areas that can provide space for migration of these habitats in Areas 2, 4 and 5. By the end of century when over 4 feet of sea-level rise is possible, we expect that the site will have much more standing water, and space for marshes would be limited to only higher portions of the Project Area, as well as adjacent properties, depending on land uses. Sea-level rise will also cause the shore to migrate landward, most likely maintaining a beach but diminishing the dunes and allowing more frequent wave overwash into the backdune marshes and pannes.



* Agricultural area (106 ac) and coyote brush scrub (30 ac) were grouped into "upland".
Willow scrub (<1 acre) was grouped with surrounding "seasonal wetlands".

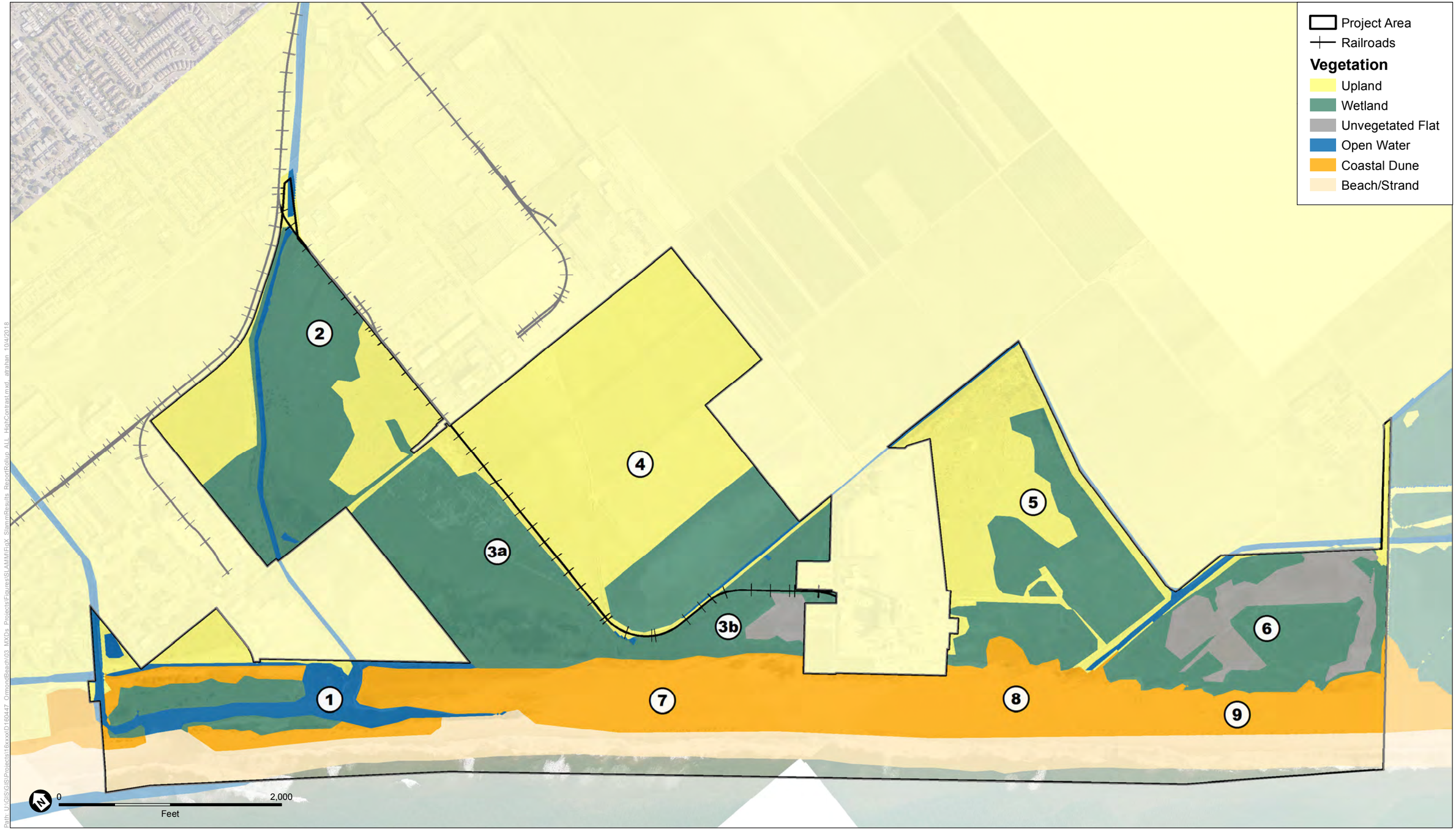
D160447.00 - Ormond Beach Wetlands Restoration\05 Graphics\Illustrator

SOURCE: SFEI 2011, CRC 2018

Ormond Beach Restoration and Public Access Plan

Figure 2-21
Historical Habitat Distribution

ESA



SOURCE: ESA (2017), CA Coastal Conservancy LiDAR (2011)

Ormond Beach Restoration and Public Access Plan

Figure 2-22
SLAMM Results with Beach Transgression
Existing Conditions, Current-Day

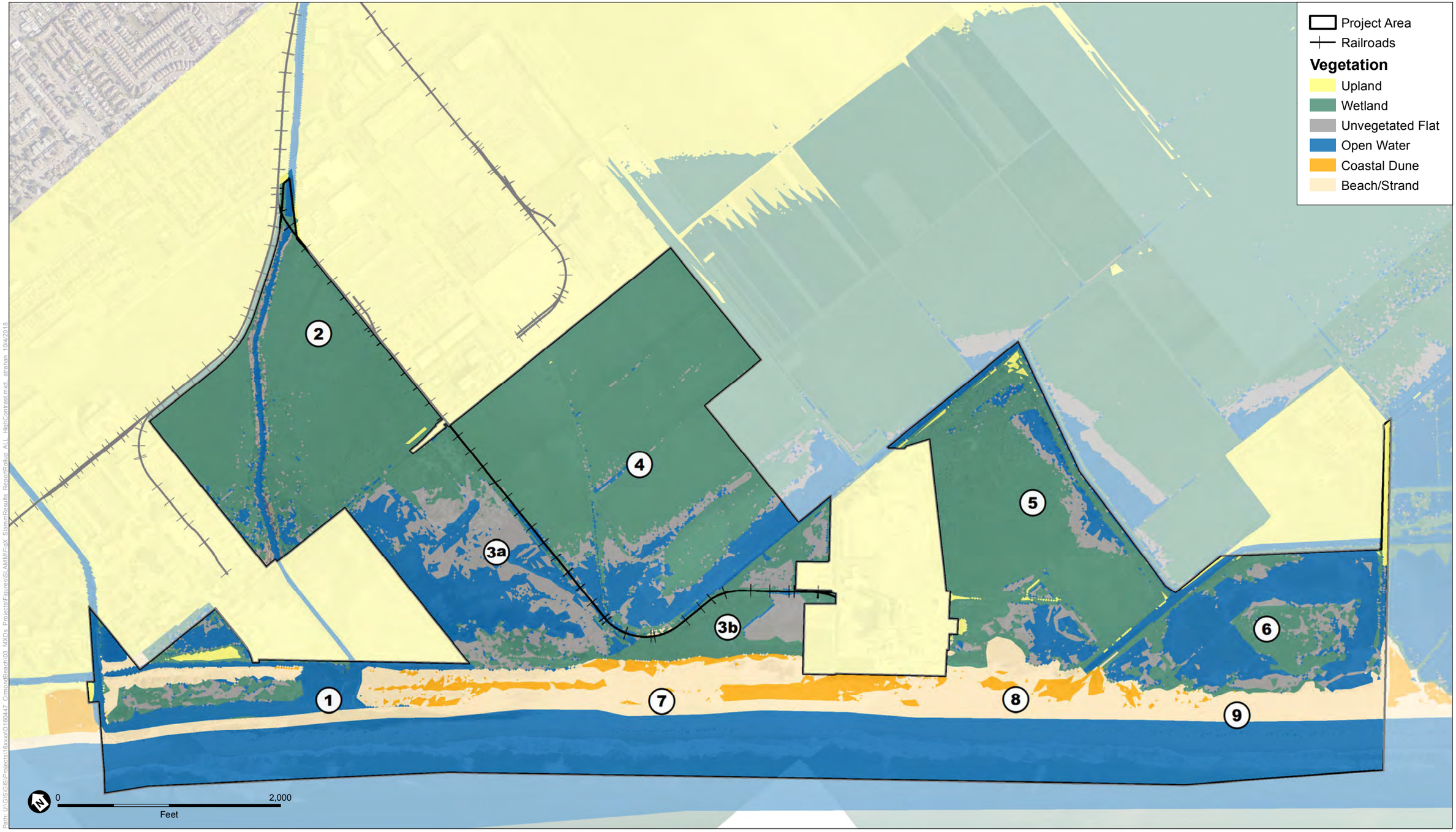
ESA

SOURCE: ESA (2017), CA Coastal Conservancy LiDAR (2011)

Ormond Beach Restoration and Public Access Plan

Figure 2-23
SLAMM Results with Beach Transgression
Existing Conditions, 2060, +2.1 ft SLR

ESA



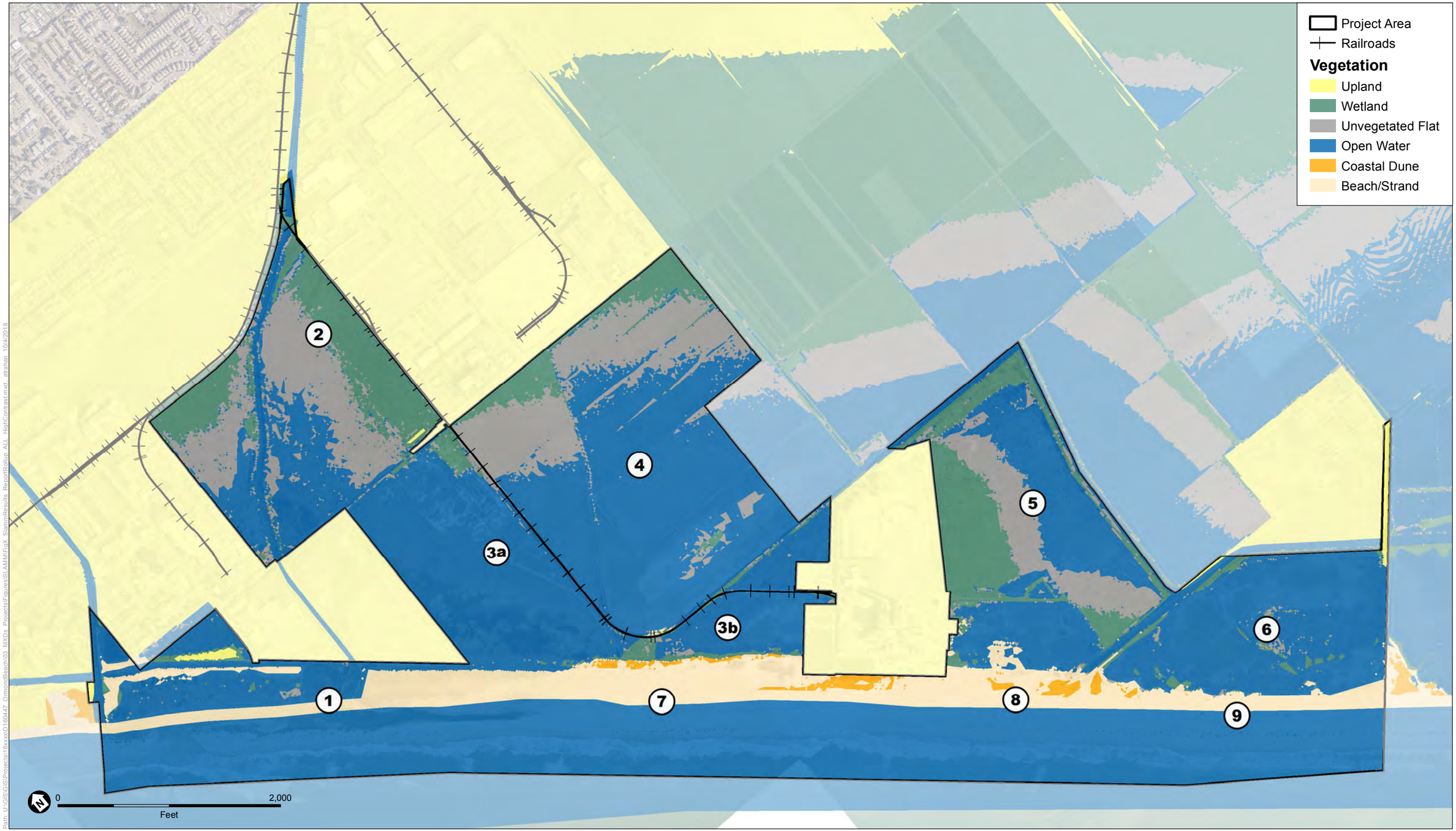
SOURCE: ESA (2017), CA Coastal Conservancy LiDAR (2011)

Ormond Beach Restoration and Public Access Plan

Figure 2-24
SLAMM Results with Beach Transgression
Existing Conditions, 2080, +3.4 ft SLR

ESA

Path: U:\GIS\GIS\Projects\16xxxx\D160447_OrmondBeach\03_MXDs_Projects\Figures\SLAMM\FigX_SlammResults_ReportRollup_ALL_HightContrast.mxd, atrahan 10/4/2018



SOURCE: ESA (2017), CA Coastal Conservancy LiDAR (2011)

Ormond Beach Restoration and Public Access Plan

Figure 2-25
SLAMM Results with Beach Transgression
Existing Conditions, 2100, +4.8 ft SLR

ESA

Path: U:\GIS\GIS\Projects\16xxxx\D160447_OrmondBeach\03_MXDs_Projects\Figures\SLAMM\FigX_SlammResults_ReportRollup_ALL_HighContrast.mxd, atrahan 10/4/2018

The figures show the progression of habitats and increase in ponded water. In particular:

- Ormond Lagoon is predicted to narrow as the shore migrates landward, and the potential water level rise as the beach rises.
- The higher lagoon waters will spread inland and essentially shift the lagoon into the low Area 3a.
- Groundwater augmented by wave overtopping will create a saline lagoon in Area 6, spreading into Area 5.
- Upland areas are projected to convert to saline and brackish wetlands, although it is not clear whether the rate of conversion will keep pace with the more rapid sea-level rise projected for the end of the century.

Note that the future predicted habitats are uncertain owing to both modeling limitations and uncertainty in water levels. Adaptive actions in response to future flooding are also factor that could locally change water levels and grades. For example, the projections indicate flooding in Oxnard around Areas 1 and 2, and flooding of the railway between Areas 3 and 4, which imply that either land use or other changes will be needed.

2.6 Potential Future Expansion

Expansion of the restoration site may occur in the future as a result of new land acquisitions and land use changes. Potential land acquisitions and changes are described below and located in **Figure 2-26**.

2.6.1 Sod Farm

The Southland Sod Farm Property (aka "Sod Farm") is an agricultural area north and west of Area 5 and the Ormond Beach Generating Station (OBGS) comprising about 561 acres between East Hueneme Road, Edison Drive, Arnold Road and the OBRAP site. TNC has negotiated with the owners to acquire the property, and is in the process of securing funding, including from the SCC (CSCC 2016). If purchased, the intended use of the property is "flood protection, wildlife habitat, wetland restoration, open space protection, public access, and limited agricultural uses."

The addition of the Sod Farm property would greatly expand the restoration site, and also:

- Provide space for wetland migration with future sea-level rise due to higher site grades
- Potential improvement of water quality downstream by reduction of pollutants, biological nutrient reduction
- Reduced downstream flood potential via additional storage
- Access facilities
- Interim agricultural uses

Constraints are likely to be similar to other agricultural properties (e.g., Area 4), and not expected to be an impediment to restoration and public uses.

2.6.2 MWD Parcel

A rectangular parcel of land owned by the Metropolitan Water District (MWD) exists adjacent to Edison Road, TNC parcel, and the OBGS, which is a potentially desirable site for parking and access toward the Beach. The parcel is approximately 20 acres. This is a speculative opportunity pending discussions with MWD regarding potential future land use(s).

Expanding the OBRAP project to include the MWD parcel could:

- Provide space for parking and other visitor serving facilities
- Additional area for habitat and future wetland migration with sea-level rise.

There are no apparent constraints beyond those associated with non-ownership.

2.6.3 Ormond Beach Generating Station

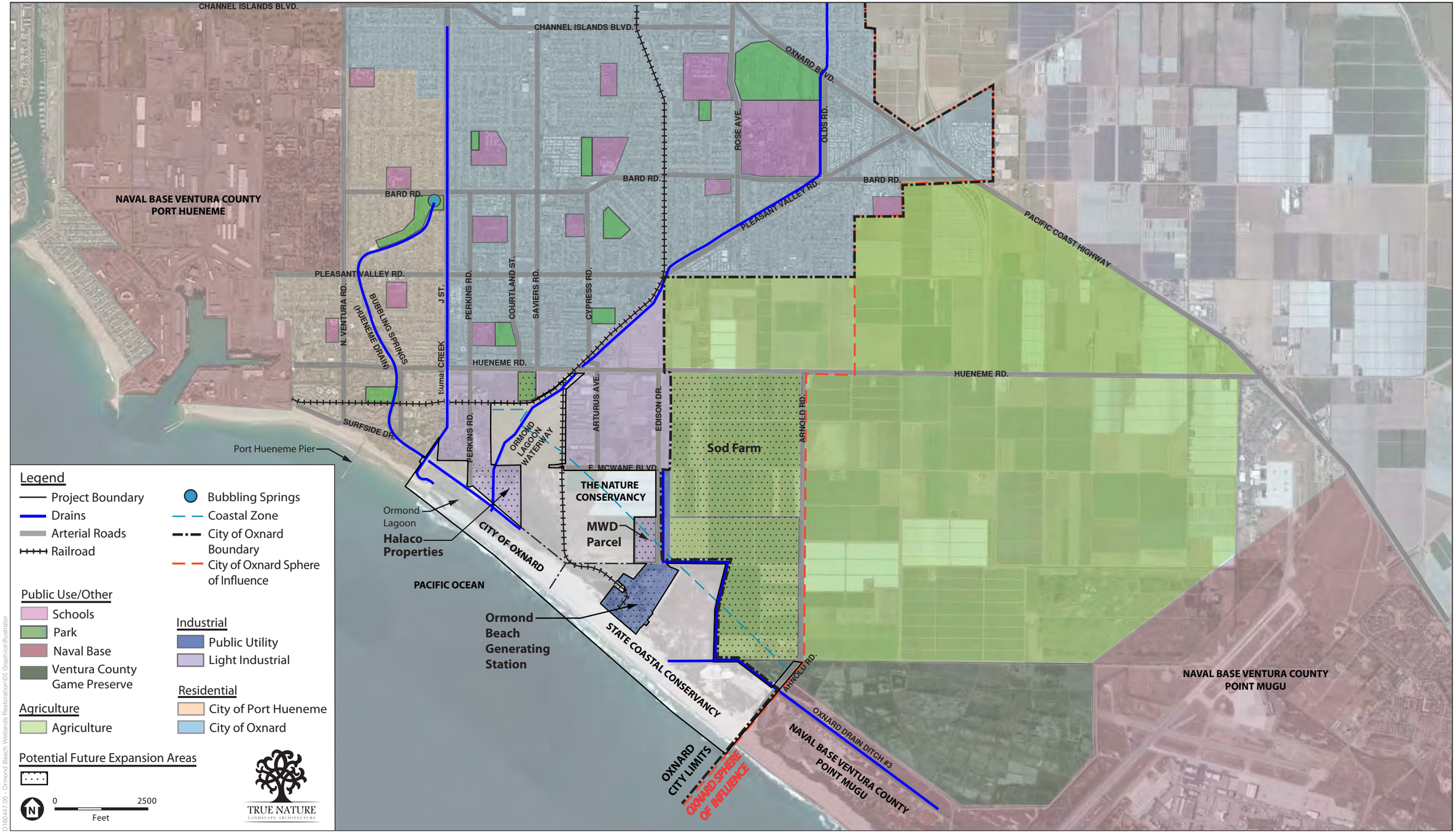
The OBGS comprises about 50 acres between the middle portion of the restoration area (Areas 3 and 4) and the eastern portion (Areas 5 and 6), from Edison Road to the dunes. The OBGS was originally constructed to produce electricity in the 1970s. However, the OBGS is expected to close by December 2020. The closure is related to a State policy restricting power plants with “once-through-cooling” established by the State Water Resources Control Board. The future owner and land use for this parcel have not been determined.

The addition of the OBGS property could benefit the OBRAP:

- Habitat connectivity between the middle and eastern portions of the restoration site
- Public access to the beach without crossing railways
- Parking, with good access off Edison Road
- Location for visitors’ center, potentially with an interpretive element addressing land use changes
- Remove unnatural structures and activities

Potential constraints that are apparent:

- Substantial structure demolition and removal
- Possible water and soil contamination



SOURCE: ESA, City of Oxnard 2030 General Plan,
Bing Maps, www.bing.com/maps; OBRAP Existing conditions Report, Figure 2-21

Ormond Beach Restoration and Public Access Plan

Figure 2-26
Potential Future Expansion Locations

ESA

This page intentionally left blank

2.6.4 Halaco Properties

The privately-owned Halaco properties—an 11-acre area where the metal smelter was located and an adjacent 26-acre area where the large waste pile is located—are both located at the southern end of the OLW, between Areas 1, 2, and 3. These properties are part of a U.S. Environmental Protection Agency designated Superfund Site for which the EPA is presently developing a remediation plan (CSCC 2016). There are no current plans for acquisition of these parcels.

Incorporation into the OBRAP would facilitate restoration and public access goals. The 2030 General Plan designates the privately-owned Halaco properties as "Resource Protection" and the Local Coastal Plan identifies both properties as being located within the Ormond Beach Coastal Zone Area with a coastal land use designation of Coastal Dependent Industrial.

2.6.5 Gateway Park

The City's 2030 General Plan designates the privately-owned 8.15-acre property on Hueneme Road, near the end of Saviers Road (Area 2) as "Park." This property and adjacent properties have long been identified as a potential "Gateway Park" area for Ormond Beach, which could also include a visitor/education center.

The Preferred Alternative identifies a visitors' center in Area 4 (East McWane and Edison). Development of the visitors' center would be expected to take place during a later phase of the OBRAP.

This page intentionally left blank

SECTION 3
Goals and Objectives

The overarching vision for the OBRAP is a resilient coastal environment that inspires the enjoyment, use, and support of the local community and beyond.

The Project Partners refined a set of goals and objectives, based on the Feasibility Study (Aspen 2005, 2009) and guiding scientific principles and considerations developed by the SAC (Ormond Beach SAC 2016, Appendix B). The OBRAP goals are also informed by two regional planning efforts: the Coastal Resilience Ventura project (ESA PWA 2014) and the Southern California Wetlands Recovery Project (SCWRP) Regional Strategy Update (SCWRP 2018).

The Project Alternatives are evaluated relative to how well they meet the following objectives and sub-objectives under Section 6.3.

3.1 Restoration Goal and Objectives

The restoration goal of the OBRAP is to preserve, enhance, and restore natural habitats and processes that support a dynamic and self-sustaining ecosystem at Ormond Beach.

Specific objectives and sub-objectives include the following:

1. Restore diverse, interconnected native habitats that consider the historical[7], current, and future landscape context.
    a. Enhance and restore habitats including: beach; dune; coastal lagoon; seasonally ponded saline wetland and salt flat; high marsh and wetland-upland transition zone; upland; and riparian.
    b. Enhance and restore habitat for Project Area special-status, rare, and extirpated species where feasible (e.g., tidewater goby, California least tern, western snowy plover, Belding's savannah sparrow, and salt marsh bird's beak).
2. Restore physical and biological processes that sustain native habitats and ecosystems.
    a. Restore physical processes, such as hydrology, sediment dynamics, and water quality.
    b. Restore biological processes, such as vegetation composition and structure and food web dynamics.

[7] Historical refers to conditions up to the late 1800s prior to direct modification and development of portions of the Ormond Beach Wetlands, as documented in the report "Historic Ecology of the lower Santa Clara River, Ventura River, and Oxnard Plain" (Beller et al. 2011).

   c. Allow for a mosaic of self-sustaining habitats that are naturally dynamic, which change and move over time in response to physical processes (e.g., inundation during storm events, wave over-washing, and dune migration and change driven by winds).
   d. Create large areas of interconnected habitat with broad transition zones (i.e., ecotones).
   e. Provide and enhance ecological and hydrological connectivity within the site and with the site's watershed, the coast, and, if feasible, Mugu Lagoon.
   f. Provide natural buffers between core habitat areas and adjacent development and public access points.

3. Restore an ecosystem that is naturally resilient (i.e., able to respond, recover, and adapt) to climate change and sea-level rise.
   a. Promote resiliency to projected future climate change, including accelerated sea-level rise, extreme coastal storms, precipitation variability and extremes (i.e., drought and flood cycles and magnitudes), saline groundwater intrusion, and temperature.
   b. As the sea level rises, allow for dunes to migrate landward, wetland types to change within the site, and upland and transition zone habitats to convert to wetland.
   c. Consider local and regional changes in species distributions due to climate change and the potential for assisted migration of imperiled species to or from the site
   d. Employ restoration as a nature-based climate change adaptation approach that provides ecological benefits (such as reducing flood and erosion hazards) and promotes natural habitat as protection to developed areas ("green infrastructure") as an alternative to human-built structures such as concrete channels and seawalls ("grey infrastructure").

4. Restore habitats that contribute to regional ecological wetland recovery goals.
   a. Implement the WRP Regional Strategy goals and principles.
   b. Enhance the site's ecological function as a part of an interconnected system of wetland and upland habitats along the coast, the Pacific flyway, and inland (e.g., by enhancing wildlife corridors; conditions that support migrating birds; and connectivity with Mugu Lagoon, the Santa Monica Mountains, and Los Padres National Forest).
   c. Consider opportunities to accommodate certain coastal wetland habitats and species that have experienced disproportionate loss at local and regional scales.

3.2 Public Access Goal and Objectives

The public access goal for the OBRAP is to enhance opportunities for people to easily and safely visit Ormond Beach and enjoy the nature, educational and research opportunities, and recreation that are compatible with the restored Ormond Beach ecosystem.

Specific objectives and sub-objectives include the following:

1. Provide improved access features, such as staging areas, trails, interpretive signs, viewing opportunities, restrooms, shade structures, picnic tables, benches, trash cans, and safe parking consistent with preserving natural ecosystems and minimizing disruption to natural processes, habitats and associated species, and ecological functions (e.g., that do not conflict with sand dune formation and lagoon hydrology).

2. Enhance opportunities for recreation, including walking/hiking, wildlife viewing and bird watching, picnicking, fishing, and surfing.
3. Improve local community connectivity to Ormond Beach.
    a. Connect regional and local bicycle and/or multi-use trails to the Ormond Beach trail networks.
    b. Provide directional and informational signs at local public transportation stops or entry points.
4. Identify the segment of the California Coastal Trail through Ormond Beach, with connections to the proposed trail alignment to the southeast and northwest of the site.
5. Establish buffers to protect sensitive species while allowing visitors to view these habitats in a manner consistent with their protection (e.g., maintaining adequate distances between public access features and sensitive habitats and use of bird blinds).
6. Ensure compatibility with and minimize disturbance to adjacent land uses.
7. Encourage community involvement and participation in restoration and/or management activities.

3.3 Alternative Development Guidelines

The following guidelines were considered in the development of alternatives and the adaptive management framework. The purpose is to ensure that the OBRAP preferred alternative avoids or minimizes potential impacts to resources and neighboring land uses where possible; is consistent with existing plans and regulations; can be implemented in a phased approach if necessary; and includes a science-based adaptive management framework for evaluation, decision-making and management. The guidelines include:

1. Minimize impacts to sensitive habitats.
2. Limit contaminant concentrations from upstream and adjacent (e.g., Halaco properties) sources (e.g., excess nutrients, heavy metals, organic compounds) below State/federal standards and other published/accepted levels of adverse effect.
3. Avoid impacts to the restored ecosystem and public access from existing operations on adjacent properties.
4. Avoid impacts to existing operations on adjacent properties.
    a. Maintain or improve the existing level of flood protection.
    b. Consider compatibility with adjacent agriculture practices.
5. Be consistent with natural resource management, habitat restoration, and flood protection as known at adjacent Naval Base Ventura County (NBVC)–Point Mugu.
6. Support recovery plans for rare, threatened, and endangered species and their listed critical habitats.

7. Employ adaptive management to learn, improve management, and address restoration and scientific uncertainties.
8. Design and implement Project elements in a manner that is timely, feasible, cost-effective, and sustainable.
    a. Phase implementation to start delivering ecological benefits within the near term and in the long term as funding and additional areas become available.
    b. Employ design, implementation, and maintenance practices that minimize the need for or intensity of ongoing maintenance and management (e.g., planting design and irrigation, weed control).
9. Prepare and implement a long-term monitoring and management plan for:
    a. Maintenance and management (e.g., invasive control, trespass prevention) with realistic (limited) scale, frequency and costs.
    b. Learning and adaptive actions consistent with regional and statewide protocols.
10. Monitor restoration performance using methods consistent with regional protocols to inform adaptive management and allow for statewide comparison of monitoring results.
11. Include quantifiable measures of success, and base goals on scientific evaluation of feasible alternatives.

SECTION 4
Opportunities and Constraints

The OBRAP faces a variety of opportunities and constraints, shaped by historic, existing, and future conditions. The Feasibility Study (Aspen 2009) identified opportunities and constraints for a larger footprint in the course of considering a broader "unconstrained alternative." The OBRAP reviewed and updated potential opportunities and constraints for habitat restoration and public access improvements. Potential opportunities will require further evaluation to confirm feasibility and to develop concepts and alternatives using these opportunities. Note that opportunities are often informed by constraints, and vice-a-versa. When applicable, associated constraints or opportunities are addressed briefly in each discussion.

4.1 Restoration Opportunities and Constraints

Table 4-1 outlines the current opportunities and constraints related to habitat restoration.

TABLE 4-1
RESTORATION OPPORTUNITIES AND CONSTRAINTS

Opportunities	
1.	Maintain the beach and dunes over the long-term with future sea-level rise.
2.	Enhance and restore a diverse array of wetland habitat types and ecotones that are resilient to sea-level rise and climate change.
3.	Restore a hydrologic connection between the Ormond Beach wetlands and Mugu Lagoon via ODD #3.
4.	Expand and enhance the lagoon's existing intermittently open and closed lagoon wetland habitat and potentially create a new lagoon not subject to mouth management.
5.	Route water from OLW to the Project Area.[1]
6.	Incorporate best management practices and treatment wetlands into the Project Area to improve the lagoon water quality.
7.	Enhance and restore seasonally inundated wetland and salt flat habitat.
8.	Restore creek channels and associated wetland habitats, thereby reducing channelization and increasing infiltration of freshwater channel inflows.
9.	Phasing of the Project if land acquisition is delayed, which could allow development and refinement of adaptive management techniques that promote long-term habitat viability and sustainability.[1]
10.	Support wetland restoration and enhancement with supplemental water sources that may be available. Potential sources identified in 2009 include the CMWD Brine Line, City of Oxnard Brine Line, seawater effluent from the OBGS, agricultural water from United Water Conservation District, and recycled water from the City of Oxnard.[1]

TABLE 4-1
RESTORATION OPPORTUNITIES AND CONSTRAINTS

Constraints	
1.	The channels that flow into and through the Project Area, including tšumaš Creek, OLW, and ODD #3, carry polluted water and sediment to and/or through the Project Area.
2.	The Halaco properties, Ventura County Railroad spur, and OBGS limit ecological connectivity across the site.
3.	Flooding of local industrial properties should not be increased and restoration should not conflict with flood management functions of tšumaš Creek, OLW, and/or the lagoon.
4.	The potential for bird air strike hazards for the NBVC–Point Mugu to the southeast should not be increased.
5.	Portions of the Project Area adjacent to the Halaco Properties are part of the Halaco Superfund Site and may require remediation prior to restoration.
6.	Historic Arnold Road dump could be a source of contaminants.
7.	Trespass, unauthorized uses, vandalism, and trampling of sites could affect restoration outcomes

NOTES:
1 This opportunity or constraint was first identified in the 2009 Feasibility Study (Aspen 2009)

4.1.1 Restoration Opportunities (ROs)

RO #1: Maintain the beach and dunes over the long-term with future sea-level rise.

Ormond Beach provides a large stretch of coastline in where the backshore is largely natural open space—a unique opportunity for Southern California. The beach and dune system can therefore move landward along much of the Project Area's coastline in response to future sea-level rise and beach erosion, allowing the beach and dunes to persist over many decades with several feet of sea-level rise (see Section 2.4.2 for a more precise forecast of response to sea-level rise). In contrast, coastal development and hardened infrastructure such as sea walls, roads, and buildings in other locations may "squeeze" beaches as the sea level rises, leading to beach loss and risk of flooding or damage to the developed areas by high tides and storm surges.

The ability for the beach and dunes to migrate inland over the long-term also provides the opportunity to maintain the ecological systems in the Project Area. By retaining critical habitat, ecological functions and services are preserved, such as bird nesting habitat and wetlands. A long-lasting beach and dune system also provides a natural buffer from coastal flooding and preserves access to a beach for future generations that could lose many other beach access opportunities due to sea-level rise.

The ability of the beach and the dunes to migrate and persist depends on sand supply and the relative rates of beach and dune migration. The Santa Clara River supplies sand to the Oxnard coast and waves transport sand down the coast to the beach in episodic cycles that depend on storms and dredging at Port Hueneme. Winds blow sand from the beach to build dunes. Adequate sand supply is necessary to maintain the beach and dunes. Also, if the rate of beach recession in response to coastal erosion with sea-level rise reduces sand supply to the dunes or is faster than the rate of wind-driven dune migration, the dunes could narrow over time. These processes will therefore be assessed in a sea-level rise assessment for the OBRAP.

RO #2: Enhance and restore a diverse array of wetland habitat types and ecotones that are resilient to sea-level rise and climate change.

In the late 1800s, the Ormond Beach area supported a diverse array of wetlands including a fresh/ brackish non-tidal lagoon, salt/brackish marshes supported by rainfall and beach overwash events, seasonal ponds that dried to salt flats, and dune swale wetlands in and behind the dune system. The Project Area provides the opportunity to restore a similar diversity of wetland habitats and the ecotones between them and adjacent uplands. Given that the Project Area extends almost a mile inland, there is also the opportunity for this mosaic of habitats to move inland with future sea-level rise, thereby maintaining the diversity of habitats with climate change.

The inland migration of wetland habitats with sea-level rise and resulting changes in habitat and "evolution" of the Project Area depends on many factors, including site topography, sedimentation and accretion, the influence and changes in the timing and quantity of fresh water and saltwater flows and groundwater inputs, and resulting vegetation response. These processes will also be assessed in a sea-level rise assessment for the OBRAP.

RO #3: Restore the historic hydrologic connection between the Ormond Beach wetlands and Mugu Lagoon via Oxnard Drainage Ditch #3.

The current ODD #3 provides the potential opportunity to create a muted-tidal connection between the Project Area and Mugu Lagoon. ODD #3, which is maintained by the Oxnard Drainage District No. 2, currently serves as an agricultural drainage ditch for agricultural fields to the north of the Project Area. The ditch drains toward the east under Arnold Road, through the NBVC– Point Mugu, and through a series of culverts under the Naval Base runway and South L and M Avenues to Mugu Lagoon. The ocean tide range is muted and reduced by the mouth of Mugu Lagoon and the series of culverts along ODD #3. Within the Project Area, the ditch primarily conveys agricultural drainage downstream, however, the ditch experiences some backwater tidal influence. The culverts under the Navy runway are partially filled-in and blocked with sediment. In cooperation with the Navy, impediments to tidal flows in the ditch could be removed, for example by cleaning out the runway culverts and/or removing drainage structures along the ditch. The ditch could be connected to restored wetlands on the Project Area, which would increase the volume of tidal flows (tidal prism) and could support muted-tidal marsh.

Additional information, assessment, and coordination with the Navy are required to determine the feasibility of this connection. Ongoing coordination with the Navy is expected to yield additional information. In order for this connection to be feasible, it would need to reduce potential effects to the Navy and agricultural operations. Navy considerations include the potential to increase inundation of wetlands on the base, thereby potentially increasing bird air strike hazards, and that construction near the runway (e.g., to remove sediment and/or expand the culverts) would affect use of the runway. In addition, as discussed in Constraint 2 below, ODD #3 water and sediment quality is impaired (polluted) by pesticides and PCBs and contains sediment that is toxic to benthic organisms. These pollutants would need to be addressed in planning a connection to

ODD #3, for example by not restoring a connection before water and sediment quality pollutants are remediated. Finally, any proposed changes to the structures or flows within the ODD #3 will require the cooperation and agreement of the Oxnard Drainage District No. 2.

RO #4: Expand and enhance the lagoon's existing intermittently open and closed lagoon wetland habitat and new lagoon habitat

The existing lagoon provides intermittently open and closed lagoon wetland habitat that supports sensitive species such as the federally-endangered tidewater goby. The existing lagoon habitat could be expanded by connecting the lagoon to restored wetland areas to the west and along the OLW to the north. The VCWPD currently maintains the lagoon outlet for flood management by lowering the beach berm to an elevation of 8.9 feet NAVD88, which allows for storm flows to overtop the berm and reduces flood levels in the lagoon and channels (see RC #4 below for additional discussion). Expanding the lagoon habitat could provide additional flood storage and reduce the need to maintain and lower the beach berm, which could potentially enhance habitat conditions in the lagoon. Alternatively, or in addition, creation of a new lagoon not subject to mouth and water level management could be considered.

Further hydrologic and ecologic assessment is required to identify restoration actions to expand the lagoon (e.g., new channel connections), evaluate the hydrologic response (e.g., change in lagoon water levels and flood levels), and evaluate potential ecological benefits (e.g., effect of increased closure on tidewater gobies).

RO #5: Route water from Ormond Lagoon Waterway to Project Area.

OLW flows through the North TNC Marsh, through the middle of the Halaco properties and into the Lagoon. There is an opportunity to divert high flows to the Project Area, construct a new channel into the Project Area, and then fill or block the existing channel upstream of the Halaco properties. The OLW flows would be used to enhance wetlands in Area 2. There could be a benefit to flood management by separating the channel from the most vulnerable properties and an improvement to water quality by avoiding the Halaco properties.

The OLW is maintained by the VCWPD upstream of TNC's property and they have a maintenance easement on TNC's property. Realignment of the OLW will require a Watercourse Permit from the VCWPD and a revision to their easement.

RO #6: Incorporate BMPs or treatment wetlands into the Project Area to improve lagoon water quality.

Water quality in Ormond Lagoon is degraded, due to pollutants in agricultural and urban runoff that drains into tšumaš Creek, OLW, Hueneme Drain, and TNC agricultural field drainage ditch. Filtering or treating urban or agricultural runoff can help improve water quality before flows enters Ormond Lagoon. When water flows across a broad area such as a wetland, pond, or swale, it slows down and many suspended solids settle out or are trapped by vegetation (EPA 2004).

Other pollutants are removed or transformed into other forms that may be more or less soluble or bioavailable (EPA 2004). Implementing strategies upstream can reduce potential for on-site exposure and toxicity (Sutula and Stein 2003).

Constructed treatment wetlands, which usually combine a sedimentation pond followed by a series of wetland cells, use natural processes to assist partially in treating a water source or effluent (EPA 2000). Low flows and the "first flush" or rising limb of storm hydrographs could be routed through treatment wetlands; however, higher storm flows would need to bypass treatment wetland due to storage limitations. A survey of freshwater wetlands in southern California found that treatment wetlands reduce contaminants relative to inflow conditions (Brown et al. 2008). However, these systems require long-term, regular management and maintenance, which would be an ongoing expense for the Project. EPA guidelines recommend constructed treatment wetlands be sited in uplands to avoid impacts to existing wetlands (EPA 2000). Suitable locations would be limited to Areas 2 and 4. In addition, these wetlands often pose a risk of elevated sediment contaminants and/or toxicity (Brown et al. 2008). Given these considerations, and the desire to have naturally functioning system, constructed treatment wetlands are likely not cost-effective.

Expansion of vegetated wetlands surrounding the OLW and the Ormond Lagoon may lower inputs of nutrients or sediment-borne contaminants to the lagoon and thereby improve water quality. Rerouting the OLW through the wetlands on TNC property in Area 3a would improve connectivity of the channel with the wetland floodplain, which could also facilitate deposition of sediments.

Best management practices (BMPs) such as vegetated filter strips and bioswales can help filter out pollutants without the intensive construction and ongoing management of a constructed treatment wetland. The treatment capacity will be more modest, but the system will function more naturally. These BMPs have been used in other southern California systems, and have been recommended to improve Ormond Lagoon water quality for tidewater goby (Lindley et al. 2018).

Further hydrologic and water quality assessment would be required to assess the potential water quality benefit based on the required size of a treatment wetland, extent of nutrient processing, resulting reduction in the lagoon, and operational costs. Also, consideration will be given to the potential for site contamination and associated wildlife effects by reviewing water quality data and, if needed, conducting additional analysis.

RO #7: Enhance and restore seasonally-inundated wetland and salt flat habitat.

Salt flat and non-tidal seasonally-inundated wetland habitat could be restored behind the beach dunes similar to the historic habitats present in the late 1800s. The existing salt flat area at Arnold Road is likely supported by residual soil salinity, direct precipitation, clay soils that pond water, as well as occasional wave overtopping of the lower elevation dunes and overflow from ODD #3 during periods of high rainfall and flow in the ditch. The former tank farm area was also inundated and supported wetlands after heavy rainfalls during the 2016/2017 winter. These areas

and others could be enhanced or restored as seasonally inundated wetland and/or salt flat habitat by restoring and/or managing hydrologic connections to surface water flows, groundwater, and tidal and/or wave overtopping inputs.

Seasonally-inundated habitats are highly variable in space and time and depend on many inherently uncertain factors, such as annual rainfall and large wave events coinciding with high tides. Habitats could be largely dry during extended periods of drought, such as the multi-year drought prior to 2016. Different types of vegetation might expand or contract during droughts. Pickleweed will grow lower in basins due to decreased flooding stress. Droughts might also result in higher soil salinities, which favor salt marsh vegetation over brackish species such as tule and cattail. Extended wet periods will favor the expansion of tule and cattail as soil salinities drop and years of especially high rainfall might lead to the upward contraction of pickleweed.

The dynamic nature of such wetlands is important for wildlife as well. For instance, the salt panne on the SCC parcel near Arnold Road provide nesting areas for western snowy plovers in dry years when the area is not flooded. In wet years, when the salt panne is flooded, the area becomes an important foraging area for this species due to the invertebrates that the ponded saline water supports.

The uncertainty and variability in habitat inundation is likely to increase with climate change, with the potential for longer periods of drought followed by winters with more extreme rainfall. The potential hydrology, inundation regime, uncertainties, and effects of climate change for seasonally-inundated habitats can be evaluated in a subsequent water balance assessment for the OBRAP.

RO #8: Restore creek channels and associated wetland habitats, thereby reducing channelization and increasing infiltration of freshwater channel inflows.

The OLW and the drainage ditch through TNC agricultural field are remnants of historic intermittent or ephemeral drainages (Beller et al. 2011). A portion of the ODD #3 also follows a historic “finger” of tidal marsh. These historic features and their hydrology and habitats have been heavily modified through channelization. These and other channels, such as tšumaš Creek, could be enhanced and connected to restored wetlands adjacent to the channels. Freshwater creek flows could support restored riparian, freshwater wetland, and brackish marsh habitats. Reconnecting these channels to restored wetland habitats would reduce channelization and could allow for creek flows to infiltrate into wetland soils. This provides the opportunity to enhance surface water and groundwater patterns to support restoration across the Project Area. This approach could also create wetlands that provide water and sediment quality treatment functions.

As discussed above and in Constraint #2 below, water and sediment quality in ODD #3 is impaired by pollutants. Water and sediment quality in OLW, tšumaš Creek, and TNC agricultural field drainage ditch may also be impaired by pollutants from agricultural and urban runoff. For example, a fish kill in tšumaš Creek in 2015 was attributed to pyrethroid pesticide (CDFW 2015). Water and sediment quality impairments would need to be considered further and addressed in

planning enhanced connection to these channels, for example by not restoring a connection before water and sediment quality pollutants are remediated, including upstream measures by others to reduce pollutant loading. If restored wetlands are used to provide water and sediment quality treatment functions, portions of the wetlands may require maintenance to remove sediments that accumulate pollutants. This could be accomplished by creating treatment wetland areas that are specifically planned, designed, and maintained for treatment functions.

RO #9: Phasing of the OBRAP and adaptive management.

Although the Project Partners have been pursuing the acquisition of additional parcels, their availability, and the timing of their availability, is currently unknown. Due to this uncertainty, it is possible that implementation of the OBRAP may require phasing to accommodate future land purchases, as well as resolve other logistical issues such as funding for implementation (Aspen 2009). In addition, phasing of the OBRAP may provide opportunities for the development and refinement of adaptive management techniques that promote long-term habitat viability and sustainability. "Adaptive restoration" (Zedler 2016) could also be used to reduce uncertainty among restoration actions. This approach uses field experimentation to simultaneously compare multiple actions, preferably in phased tests, so that early results can inform later restoration (Zedler 2016).

RO #10: Support wetland restoration and enhancement with supplemental water sources that may be available.

The Feasibility Study (Aspen 2009) identified five supplemental water sources other than groundwater that could be used at the Project Area: the Calleguas Municipal Water District Salinity Management Pipeline, the City of Oxnard brine line, seawater effluent from the OBGS, agricultural water from United Water Conservation District, and recycled water from the City of Oxnard. Many of these sources, however, may no longer be available, such as the City of Oxnard's brine line and the OBGS, which is projected to cease operations. Supplemental water could be used to maintain water levels in certain areas, but a final determination of needs cannot be determined until final design plans for the OBRAP are completed.

4.1.2 Restoration Constraints (RCs)

RC #1: The channels that flow into and through the Project Area, including tšumaš Creek, OLW, and ODD #3, carry polluted water and sediment to and/or through the Project Area.

The EPA and the Regional Water Quality Control Board (RWQCB) have listed ODD #3 for water and sediment quality and established TMDLs for pesticides, PCBs, and sediment toxicity (EPA 2011). The responsible parties identified by the EPA and RWQCB will be required to implement remediation actions to meet the TMDLs; however, the RWQCB has not yet developed or adopted schedules for TMDL implementation (E. Mutkowska, VCWPD, personal communication., July 21, 2017). The timing for remediation of ODD #3 is, therefore, uncertain.

Oxnard Drainage District No. 2, which manages ODD#3, indicates that water quality is not degraded at present (personal communication to Project Partners, October 22, 2018).

While the EPA has not listed tšumaš Creek and the OLW as impaired or polluted, these channels likely carry pollutants from urban and agricultural runoff. A fish kill in tšumaš Creek was likely due to exposure to pyrethroid pesticides (CDFW 2015). The USFWS is concerned about impacts of pyrethroids on tidewater goby (Lindley et al. 2018).

The OBRAP could address this constraint of impaired water and sediment quality using one or more of the following approaches (as described above under RO #6):

- Do not enhance the hydrological connection to ODD #3 until its TMDLs are met and water and sediment quality is remediated. A connection with the ditch could be planned for in a later restoration phase after remediation.
- Include water and sediment quality BMPs and/or treatment wetland features within the Project Area to treat portions of the flows from tšumaš Creek, OLW, and ODD #3. Portions of the treatment wetlands would need to maintained periodically by removing any accumulated contaminated sediment and vegetation. BMPs such as vegetated filter strips and bioswales would be a less intensive approach to filter out contaminants (Lindley et al. 2018).
- Implement a monitoring and adaptive management approach in which water and sediment quality would be monitored within restored habitat areas to assess whether pollutants and/or emerging constituents of concern are accumulating and approaching unacceptable levels for habitat protection and regulatory requirements, such as sediment quality objectives for wetlands as established by the State Water Quality Control Board. Adaptive management actions could be planned and implemented to reduce the potential for pollutants to accumulate, such as coordinating with the RWQCB and responsible parties upstream, managing and/or modifying hydrologic connections and any treatment wetlands to improve water and sediment quality conditions, and/or potentially removing sediments if and where pollutants accumulate.

RC #2: The Halaco Properties, Ventura County Railroad spur, and Ormond Beach Generating Station limit ecological connectivity across the Project Area.

The privately-held Halaco properties and OBGS properties and the Ventura County Railroad spur limit ecological, as well as public access, connectivity as follows:

- The Halaco properties limit the habitat connectivity along the north side of the lagoon and between the lagoon and habitat along the OLW upstream of the Halaco properties. Lagoon habitats do connect to habitats to the east and north of the Halaco properties and these connections could be enhanced (e.g., by possibly creating a new distributary channel for OLW to the east of the Halaco properties that would support a wetland habitat corridor).
- The OBGS and Edison Drive limit wetland habitat connectivity between the western and eastern halves of the Project Area. The beach and the dunes currently provide connectivity; however, this may be reduced as beach erosion and dune migration occur. The OBRAP could consider potential opportunities and benefits of facilitating habitat and wildlife connections across Edison Drive, such as wildlife passage culverts or other measures.

- The Ventura County Railroad spur segregates TNC agricultural field from the rest of the Project Area. As discussed in PAO #3 below, the railroad does not plan to abandon its easement, and the railroad spur is, therefore, a long-term constraint. Site observations indicate some hydrologic connection from Area 4 to Area 3b via a culvert and overflow of ODD #3. However, these connections are not confirmed or defined adequately at this time. The railway is easily crossed by foot in most areas where train cars are not parked. The constraint formed by the railway could be addressed by installing culverts under the railroad to provide hydrologic and wildlife connectivity, which would be planned and designed to minimize any effects to the railroad.

RC #3: Flooding of local industrial properties should not be increased, and restoration should not conflict with flood management functions of tšumaš Creek, OLW, and/or the lagoon.

Flooding occurs when freshwater trapped behind the beach begins to expand the lagoon and back up tšumaš Creek and the OLW. This can be mitigated by managing the beach at an elevation of 8.9 feet NAVD88 prior to forecasted rainfall events. Minor flooding begins to occur at stages of 9.4 to 10.9 feet NAVD88, and flooding begins to heavily impact the Oxnard waste water treatment plant and International Paper plant for stages above 11 feet NAVD88. Strategic grading as part of the Project design in areas prone to flooding can also reduce chances of flooding of these areas. This will be examined in future Project steps.

This flood management constraint can be addressed by planning the restoration to maintain or reduce existing flood levels, a for example by expanding the lagoon habitats that provide additional flood storage capacity.

RC #4: The potential for bird air strike hazards for the Naval Base Ventura County–Point Mugu to the southeast should not be increased.

NBVC–Point Mugu, located immediately south of the SCC parcel, has an active airfield. Wildlife can be a hazard to flight operations if they enter an airport's approach or departure airspace. According to the NBVC–Point Mugu Air Installations Compatible Use Zones Study (US Navy 2015), aircraft mishaps at the base (including but not limited to bird strikes) have been infrequent (six during 1990–2014), generally close to the runway itself and/or more than 8,000 feet from the boundary at Arnold Road. To reduce hazards, the Federal Aviation Administration and the military recommend locating land uses that attract birds and other wildlife (including wetlands) at least 10,000 feet from active movement areas of the airfields (US Navy 2015). This zone would extend into Areas 6 and 9, where dunes, salt panne, and salt marsh occur. This constraint can be addressed through design and coordination with the NBVC–Point Mugu in siting of new wetland features, especially any open water areas. Creation of wetlands outside the 10,000-foot buffer (i.e., all Areas except 6 and 9) could potentially reduce hazards to the airfield by providing alternative habitat away from the base.

RC #5: Portions of the Project Area adjacent to the Halaco Properties are part of the Halaco Superfund Site and may require remediation of water or soil contamination prior to restoration.

EPA's plans, funding and schedule are uncertain for remediating contamination in portions of the Project Area that are within the Halaco Superfund Site, including portions of TNC property immediately east of the slag pile and portions of the City of Oxnard's property to the south of the Halaco properties and slag pile. If these areas require remediation prior to restoration, the OBRAP could potentially implement the restoration in coordination with EPA's remediation efforts or restoration of areas within the Superfund Site could be phased and deferred until after the areas are remediated through the EPA's process. If the OBRAP includes excavation to below the groundwater table, then the extent of any groundwater plume would need to be defined in order to determine if special procedures and safety measures are needed, especially for any dewatering activities and handing of soils in contact with impacted groundwater. OBRAP implementation should also consider potential EPA access needs to assure damage to restored areas does not occur during remediation activities. The Project Partners and EPA are working to coordinate OBRAP planning with site cleanup to the extent possible.

RC #6: Historic Arnold Road dump could be a source of contaminants.

The end of Arnold Road was a site of uncontrolled dumping during 1950s and 1960s. However, there are no records of what was dumped, and no testing was conducted since it was already inactive by the 1980's when the County tested solid waste (Diane Wahl, County of Ventura Environmental Health Division, pers. comm. December 2017). This information should be noted in the CEQA document and permitting. If there is no site disturbance, leaving the dump in place would be unlikely to re-suspend or expose legacy pollutants. If this area is to be disturbed by restoration activities, then appropriate plans for health and safety would be developed as part of implementation. Increased exposure to coastal hazards (e.g., waves and high water) with sea-level rise could also disturb the site and expose pollutants in the future.

RC #7: Trespass, unauthorized uses, vandalism, and trampling of sites could affect restoration outcomes.

As seen throughout much of coastal Southern California, homelessness is a significant problem in Ventura County and at Ormond Beach. The Project Area's remote location makes it difficult to control unauthorized uses, camping and vandalism. Unauthorized use of the Project Area may result in trampling of restoration areas, contamination of soils and waters, accumulation of trash and hazardous materials and vandalism of visitor amenities. The Project Partners and the County of Ventura take their responsibility to the homeless community seriously and are working to address this issue constructively and in concert with the police department, county social services and homelessness advocates. See also Public Access Constraint #2 below.

4.2 Public Access Opportunities and Constraints

The different opportunities and constraints for public access are summarized in **Table 4-2** and illustrated in **Figure 4-1**. As identified in the Feasibility Study, public recreation and education are important goals of the OBRAP, but must be compatible with habitat restoration.

TABLE 4-2
PUBLIC ACCESS OPPORTUNITIES AND CONSTRAINTS

Opportunities	
1.	Provide trails and entrances that connect to existing bike paths and potential future bike paths.
2.	Use existing public and private paths as proposed circulation routes through the Project Area.
3.	Connect proposed paths to the beach at points closest to beach to minimize distance through sensitive habitats.
4.	Use adjacent existing creek channel corridors and green belts (i.e., Bubbling Springs Green Belt) to lead visitors from neighboring areas to the Project Area by providing trail connections in the Project Area.
5.	Provide new and/or enhanced public entrances to the Project Area, including: • Northwest entrance, which could utilize existing parking lots at Hueneme Beach including and using the adjacent Bubbling Springs Drain and Green Belt to lead visitors to the Project Area • Hueneme Road entrance through TNC's property, which extends to Hueneme Road • East McWane Blvd. entrance • West McWane Blvd. entrance
6.	Involve neighboring schools in stewardship programs.
7.	Stimulate ecotourism in Port Hueneme, Oxnard, and County of Ventura by providing a variety of activities for local residents and attracting tourists, which can drive opportunities for the local economy.
8.	Inspire and inform a diverse community that is actively engaged in using, enjoying, and protecting Ormond Beach.
9.	Extend the Oxnard, Camarillo, and Ventura Greenbelt to the Project Area.[1]
10.	Create a trail system to connect portions of the Project Area, and serve as extension of the California Coastal Trail.[1]
11.	Create bike trails within the Project Area that are incorporated into the City of Oxnard's Bicycle Facilities Master Plan. (This plan was completed in 2012, and the only relevant recommendation was extending a bike lane on Perkins Road to the Project Area).[1]
12.	Construct a future visitor center and/or educational center.[1]
13.	Provide public safety elements and access for fire department, security, and law enforcement.
14.	Address the scarcity of overnight accommodations for lower and middle-income individuals and families on the coast
Constraints	
1.	Public transportation options for visitors to the Project Area are limited.
2.	Existing and potential new entrances are remote and should consider safety and vagrancy issues.
3.	Future sea-level rise could cause inundation of low elevation public access features.
4.	Options for Parking Lot expansion constrained at Arnold Road.
5.	Limited parking, vehicular, and pedestrian (e.g., trail) access.[1]
6.	Physical barriers to pedestrian access such as channels and property line fences.[1]
7.	Public use disturbance of existing and newly restored sensitive species and their habitat or nesting areas such as the western snowy plover and California least tern.[1]
8.	Prominent current and past industrial uses (e.g., the OBGS, its associated transmission lines, the WWTP and the Halaco Site), which diminish visual quality and the public's perceived recreational/outdoor "experience".[1]

NOTES:
1 This opportunity or constraint was first identified in the 2009 Feasibility Study (Aspen 2009)

4.2.1 Public Access Opportunities (PAOs)

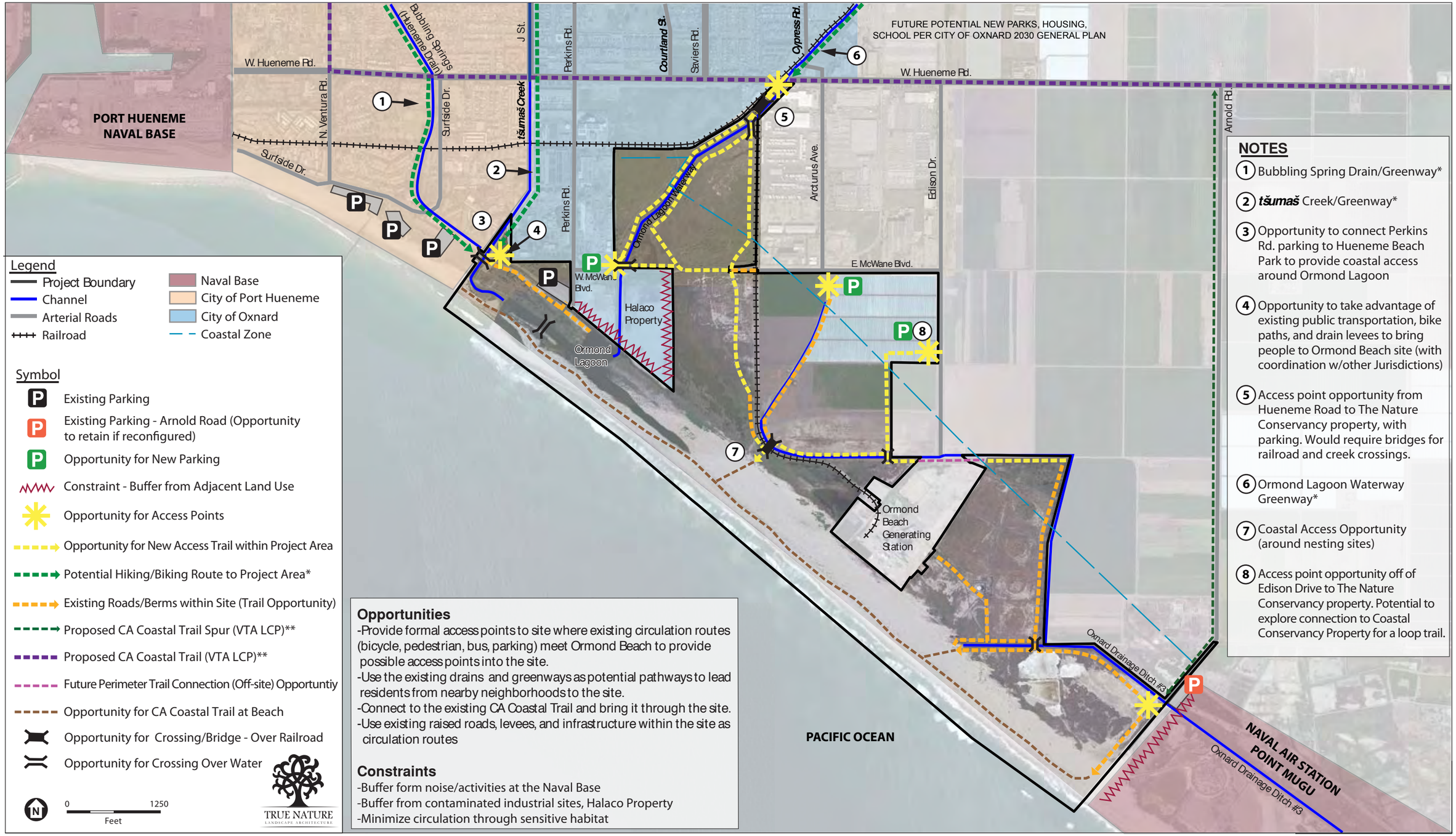
PAO #1: Provide trails and entrances that connect to existing bike paths and potential future bike paths.

Enabling and promoting bicycle use to the Project Area is compatible with sensitive habitat and ecosystem health, would result in less vehicle emissions, and requires less paving than automobiles, which require larger roads and large parking lots. Bicycle transportation provides opportunities to access the Project Area via bus routes or bike paths from, including from neighborhoods adjacent to the Project Area. Facilitating pedestrian, bike, and public transportation also helps preserves the existing sense of remoteness and wilderness currently experienced by visitors at the Project Area.

There are different classes of trails allowing for various levels of traffic and environmental impact (Ventura County Coastal Area Plan [Ventura County Planning Division 2017]). Many of these types of trails are currently existing or planned by local adjacent jurisdictions, and are illustrated in Figure 4-1. These types of trails include:

- **Type A: Multi-Modal Trails** – Accommodates more than one user group. Minimum of hikers/walkers and bicyclists
  - **Type A-1: Shared Routes** – Located within a public easement, public park, public trails (parks/beaches), or near the outer edge of a public right-of-way. Separated horizontally from the paved portion of the road.
  - **Type A-2: Separate within Public Right-of-Way Routes** – Bicyclists and hikers/walkers have separate paths, but follow the same route. Located within a public easement, public park, public trails (parks/beaches), or near the outer edge of a public right-of-way.
  - **Type A-3: Equestrian and Mountain Bike Routes** – Shared unpaved trail. Located away from public roads. May be used by hikers/walkers.
- **Type B: Single Mode Routes** – Accommodates one user group.
  - **Type B-1: Walking/Hiking Routes** – Accommodate walkers or experienced hikers. May be paved or unpaved. May be located within a public right-of-way (e.g., paved sidewalk), along a wide beach within a walkable surface at low tide, or a hiking trail.
  - **Type B-2: Bicycle Routes** – Class 1 or Class 2 Bike Paths. In limited circumstances may be Class 3 Bike Path.

Opportunities exist to connect these types of trails to the Project Area. The type of trail, i.e., multi-modal or single mode, can be determined based on the type of trails, which are planned or exist adjacent to the Project Area, and the level of sensitivity of the habitat areas on the Project Area through which the trail traverses.



SOURCE: ESA, City of Oxnard 2030 General Plan, *City of Oxnard Bicycle & Pedestrian Facilities Master Plan 2011, **County of Ventura Coastal Area Plan 2017, Bing Maps, www.bing.com/maps

ESA

Ormond Beach Restoration and Public Access Plan

Figure 4-1
Public Access Opportunities and Constraints

This page intentionally left blank

Existing drainage channel berms, road, and possibly existing roads or disturbed areas adjacent to the railroad tracks, currently provide the best opportunities for providing locations with which to align trails. These features are all elevated, which both allows views into habitat areas for bird viewing and makes them preferable for longer-term changes due to sea-level rise. In addition, these features take advantage of existing topography and thus would reduce impacts to existing habitat areas.

Currently, the majority of nearby residents are concentrated to the northwest of the Project Area, but the main beach access used is at Arnold Road, at the far eastern end of the Project Area. Public feedback indicates that most nearby residents do not go to Ormond Beach, but got to Hueneme Beach instead. Access is also possible to Ormond Beach by walking along the beach from Port Hueneme Beach. Figure 4-1 illustrates several opportunities to connect either existing or future planned bicycle paths or trails to the Project Area.

The Bubbling Springs Greenway proposed along the Hueneme Drain by the 2011 City of Oxnard Bicycle and Pedestrian Facilities Master Plan can be connected to the Project Area by providing an access point (bridge) over tšumaš Creek, linking the Port Hueneme neighborhoods and visitors to the pier to the Project Area. A formal bike path could be developed along tšumaš Creek to bring South Oxnard residents along J Street to the western edge of the Project Area. Both of these trails could provide safe bicycle access from local schools to the Project Area. The OLW, which includes a proposed bike path per the Oxnard and Ventura County Bicycle Master Plans, could be connected to the Project Area at TNC property along Hueneme Road. This would provide access to additional local South Oxnard neighborhood residents, in addition to providing larger regional access via the California Coastal Trail and trails from California State University Channel Islands (CSUCI). Focusing on providing trail access connections on the western edge of the Project Area, which is closest to developed existing neighborhoods, can increase visitation by local residents who are currently underserved by park and open space, and shift use away from the Arnold Road entrance.

PAO #2: Use existing public and private dirt roads or trails as proposed circulation routes through the Project Area.

Private trails are existing dirt roads for footpaths which are currently located on private property and not open to the public. Public trails are existing trails noted in planning documents and open to the public. The use of existing dirt roads or trails can minimize impacts to existing habitats and lower construction costs, since they are already existing and just need improvements.

Existing informal private trails located on private property could be easily formalized and utilized as public access features. For example, the existing trails along the OLW through TNC parcel contains habitat of interest to local birders and school science teachers. Impacts to habitat can be reduced by using existing trails along the creek, which are elevated above the surrounding lower wetland habitats, allowing views into the habitats and longer resistance to sea-level rise. Additional opportunities for trail alignments along existing features are illustrated in Figure 4-1.

The Port of Hueneme and Ventura County Railroad operates in the Project Area and traverses the Project Area. Any trails along existing railroad tracks would require fencing, and crossings would require at-grade crossings. Since these features are prominent aligning trails adjacent to them would concentrate existing uses of trails and rails and open up larger habitat areas for restoration.

Providing trail connections at existing paved roads provide opportunity for informal parking along road right-of-ways, for example along East McWane Blvd. Existing dirt roads leading from McWane Blvd. can provide the foundation for new formalized trails, birding overlooks, and interpretive or educational visitor amenities.

Existing official trails include the canal trail at the end of Arnold Road, which heads west along ODD #3 to the beach, and a small trail network between the Perkins Road parking lot and the OLW. These trails could be utilized and combined with existing informal trails on private property, along with new proposed trails, to form a more comprehensive and connected trail network.

PAO #3: Connect proposed paths to the beach at points that are closest to the beach to minimize distance through sensitive habitats.

Many of the existing wide beach and adjacent lowland wetland habitat areas provide important nesting and foraging habitat for various birds. By utilizing existing trails or berms to connect trails to the beach, a shorter distance of trail is required to travel through these habitat areas. A bridge across tšumaš Creek could link the Perkins Road parking area and existing informal trails to Hueneme beach, and visitors could then walk around the western edge of the lagoon to access the beach on the Project Area. Existing trails through TNC parcel can be formalized and connected to the beach at the center of the Project Area, providing birding opportunities along the way.

Trails leading through productive agricultural areas would need to be fenced or signed to encourage users to stay on the trail and reduce conflicts with agricultural activities. A trail providing access to the beach at the center of the Project Area, at the east end of the lagoon, would require consideration of existing sensitive bird habitat fencing, and would possibly require realignment of the fencing to accommodate the trail and provide habitat buffers.

PAO #4: Use adjacent existing creek channel corridors and green belts (i.e., Bubbling Springs Green Belt) to lead visitors from neighboring areas to the Project Area by providing trail connections in the Project Area.

Many of the existing adjacent drainages have proposed bike paths per community General Plans or Bicycle Master Plans (Port Hueneme, City of Oxnard, and County of Ventura). Utilizing these proposed trails along creeks and drainages or greenways would encourage walking and biking to the Project Area from adjacent neighborhoods.

As the OBRAP design is developed, the Project Partners can coordinate with local agencies to understand how they propose to align these trails so that trails within the Project Area can connect to them, creating low-impact access points. Alternative transportation grants could potentially be used to fund some of these trails or alignment studies.

PAO #5: Provide new and/or enhanced public entrances to the Project Area.

Several opportunities for new and enhanced entrances are discussed below and will be considered further and selected from for the development of alternatives. The existing Perkins Road entrance is discussed within the northwest entrance below. The existing Arnold Road entrance is discussed in PAC #5.

- *Northwest entrance could utilize existing parking lots at Hueneme beach and Perkins Road, and use the adjacent Bubbling Springs Drain and Green Belt to lead visitors to the Project Area.*

  The existing entrance at Perkins Road provides limited access opportunities to the lagoon, but does not provide access to the beach. The Perkins Road entrance could potentially be incorporated into a new enhanced northwest entrance that provides beach access. A trail from Perkins Road leading northwest to tšumaš Creek and a new bridge over tšumaš Creek could provide an access path to the beach (Figure 4-1). This northwest entrance would also connect to the Bubbling Springs Drain and Green Belt path. Enhancing the northwest entrance would require coordination with the VCWPD and the City of Port Hueneme for a tšumaš Creek bridge.

- *Hueneme Road entrance through TNC's property, which extends to Hueneme Road.*

  A new entrance to the Project Area could be created at East Hueneme Road. TNC's parcel extends to East Hueneme Road between the Ventura County Railroad and the OLW (Figure 4-1). The portion of TNC's parcel between East Hueneme Road, Ventura County Railroad, and the OLW could be used as an entrance with parking and other features. A pedestrian crossing over the OLW and a controlled railroad crossing could be installed to bring visitors to trails heading south through the Project Area. The OLW crossing could potentially use the existing railroad bridge/culvert, or a new pedestrian bridge could be constructed. The railroad crossing could potentially be a signaled at-grade crossing, similar to the signaled crossing at Hueneme Road, or an elevated over-crossing. Fencing could be installed at the entrance in conjunction with the railroad crossing to encourage visitors to use the crossing and discourage visitors from crossing the railroad in other locations.

- *East McWane Blvd. entrance.*

  Public and/or maintenance entrances to TNC parcel via East McWane Blvd. could be created either at the west end of East McWane Blvd. or through the agricultural field, once it is restored. These entrances would require crossing the Ventura County Railroad. A crossing would likely be required and fencing would likely be more complicated than at a Hueneme Road entrance. East McWane Blvd. entrances would also be farther and more remote from the South Oxnard community. The existing gate at the end of East McWane Blvd. could be used as an entrance for maintenance and/or emergency service vehicles to access trails on the west side of the railroad.

- *West McWane Blvd. entrance.*

  Public access and maintenance entrance to TNC parcel via West McWane Blvd. could be created on the West McWane Blvd. road, which is owned by the City of Oxnard. A gate currently exists between the West McWane Blvd. portion of the road which is paved and the undeveloped dirt portion of the road. An existing dirt road is located on the private TNC parcel which connects to this gate. There is also an existing dirt trail and double track dirt road on TNC property north of the Halaco properties which could be connected to West McWane Blvd. by use of boardwalks and/or a bridge.

PAO #6: Involve neighboring schools in stewardship programs.

Several local school teachers attended the first Public Meeting to provide input on the OBRAP. The input received indicated that there is strong interest from local science and environmental studies teachers to incorporate site visits and field studies into their class curriculum. The nearby CSUCI provides an opportunity to dovetail restoration studies and stewardship programs with local college student curriculum.

An outreach program could be developed to include local educators in the OBRAP design, so that trails and public access amenities can support school activities. In the long term, Project Partners could include long-term partnerships with local schools into their management programs.

PAO #7: Stimulate Ecotourism in Port Hueneme and Oxnard by providing a variety of activities for local residents and attracting tourists, which can drive opportunities for the local economy.

The pristine nature and abundant opportunities for birding is a natural draw to the Project Area. By simply providing safe, clean, secure, easy access to trails, and promoting the Project Area, it should become a draw for locals and tourists alike. Amenities such as boardwalks, bird overlooks, raised viewing areas, and safe nature trails will make accessing the site easier, thus promoting visitation. Local entrepreneurs can take advantage of this by providing guided hikes to birding sites, and inform visitors about the plants and birds, hydrology, ecology, and evolution of the site. Improving the real and perceived sense of safety at access points will be important to promoting tourism. Parking, entry features, and trail design should consider enhancing visitor experience of nature.

PAO #8: Inspire and inform a diverse community that is actively engaged in using, enjoying, and protecting Ormond Beach.

Providing improved visitor services such as safe parking areas or trail head entrances, interpretive elements, and preserved open space with ocean views and beach access could attract many visitors to the Project Area. By educating visitors, perhaps with informational kiosks or a visitor's center where informational presentations could be made or where school groups could gather to learn from site docents, a new generation and group of community members could be inspired to use and protect the Project Area. A docent program could engage the public through programs, walks, talks, or demonstrations, so that the public could learn about the rich history and ecology of the Project Area and be motivated to protect it. Local youth have already participated in, and

should continue to be encouraged to engage in, restoration activities through the Oxnard City Corps and other similar programs (State grants may also facilitate these efforts).

This opportunity could be realized through a long-term management plan.

PAO #9: Extend the Oxnard, Camarillo, and Ventura Greenbelt to the Project Area.

The Feasibility Study (Aspen 2009) identifies extending the Oxnard, Camarillo, and Ventura Greenbelt as an opportunity for the OBRAP. In 1984, the City of Oxnard, City of Camarillo, and County of Ventura entered into an agreement establishing a greenbelt, defined as "an area consisting of prime agricultural or other open space land…which is preserved in agricultural or other open space uses." The Camarillo-Oxnard Greenbelt was established in an effort to conserve open space as a means of "providing community identity, definition, and character in keeping with the objective of controlling urban sprawl." The OBRAP Project Area could be included in an amended version of the Agreement between these agencies, which would further protect it from future development or urbanization. Since the City of Oxnard's 2030 General Plan includes a change in Sphere of Influence to cover agricultural lands east toward Arnold Road, those lands could potentially be included in the Camarillo-Oxnard Greenbelt. NBVC–Point Mugu's contiguous habitat area combined with OBRAP would effectively create a contiguous open space area from the beach to the existing Oxnard-Camarillo Greenbelt.

PAO #10: Complete the Ormond Beach section of the California Coastal Trail.

The Feasibility Study (Aspen 2009) identifies creating a trail system to serve as the California Coastal Trail as an opportunity for the OBRAP.

PAO #11: Create bike trails within the Project Area that are incorporated into the City of Oxnard's Bicycle Facilities Master Plan.

The Feasibility Study (Aspen 2009) identifies creating bike trails within the Project Area and incorporating them into the City of Oxnard's Bicycle Facilities Master Plan as an opportunity for the OBRAP. This plan was completed in 2012, and the only relevant recommendation was extending a bike lane on Perkins Road to the Project Area.

PAO #12: Construct a future visitor center

The Feasibility Study (Aspen 2009) identifies creating a visitor center and/or cultural center as an opportunity for the OBRAP. A visitor center could include natural and cultural interpretation and education programs for neighborhood schools and other visitors.

PAO #13: Provide public safety elements and access for fire department, security and law enforcement.

The Oxnard Fire Department recommended consideration of additional hydrants and fire roads to allow easier access for fire control. Roads should consider accessibility by police and private

security companies. The design of safety elements (e.g., hydrants and water lines, security lighting at trailheads compatible with habitat) would be elaborated upon in final design.

PAO #14: Address the scarcity of overnight accommodations for lower and middle-income individuals and families on the coast.

The State of California Coastal Conservancy in the draft document, Explore the Coast Overnight; (November 2018), identified barriers to coastal access including a lack of lower-cost accommodations. Project Partners can consider locations in or near the Ormond Beach Project Area for lower cost overnight accommodations (e.g., camping) that would be compatible with the restored ecosystem.

4.2.2 Public Access Constraints (PACs)

PAC #1: Public transportation options for visitors to the Project Area are limited.

Both research into existing public transportation networks and input gained from public outreach efforts (Public Meeting #1 and Survey results) show that public transportation to the Project Area is very limited. Residents who do not drive or do not have cars have a difficult time reaching the Project Area. Challenges include:

- Existing bus network does not reach all neighborhoods in Oxnard.
- Must take 2 or 3 buses to reach Ormond Beach.
- Bus stop at Perkins Road does not ultimately lead to beach access, only north side of the lagoon.
- Need more efficient transportation.

While this is a larger planning concern, which is not in the purview of the OBRAP, it would be advantageous to OBRAP's success to have easy public access to the Project Area. Future development and land use changes outlined in the Oxnard 2030 General Plan may result in future increased public transportation to the area as required in the General Plan. It is uncertain when this would be implemented. Design for the Project Area can consider facilities for future bus or shuttle route access and circulation to key visitor access points to the Project Area. Site planning should include outreach to public transportation providers.

PAC #2: Existing and potential new entrances to the Project Area are remote and should therefore consider safety and vagrancy issues.

As discussed in PAO #8, there is a real and perceived concern for safety due to the remote location of the Project Area. Current concerns regarding safety and security at existing access points and in more remote parts of the Project Area due to transient populations was a reason cited for not visiting the Project Area by some attendees at Public Meeting #1 and survey respondents. Potential improvements include eliminating trash and debris dumping at access points, and providing security, rangers, or police patrols to discourage vagrancy, camping, and

illicit activities. Access points can also be designed to be open and promote visibility. An increase in visitation alone may discourage activities like dumping or camping, so that the access points would no longer be isolated.

PAC #3: Future sea-level rise could cause inundation of low elevation public access features.

Public access features at lower elevations may be inundated in the future with sea-level rise. Public access planning will therefore consider life spans for public access features and corresponding projections of sea-level rise. Public access features can be assessed to identify whether features should be built at higher elevations with an allowance for future sea-level rise or if features can be moved in the future as an adaptive management response to future sea level. Trails may require seasonal closures due to inundation during major storms or high tide events.

PAC #4: Options for Parking Lot expansion constrained at Arnold Road.

The existing head-in parking along the east side of Arnold Road will need to be removed to comply with Navy policy, which calls for a 20-foot unobstructed zone at the fence line for security purposes. The Project Partners could consider pursuing an exception with Navy command as allowed for in Navy policy, such as raising the existing fence to improve security and allowing the existing parking to remain, but it is highly unlikely to be granted since such exceptions are only intended for use in constrained areas. The Navy owns this land; the OBRAP cannot rely on Navy property to serve as a public parking area. Parallel parking may be made available on the west side of Arnold Road; however, opportunities to provide a parking area are constrained by the NBVC–Point Mugu to the East and private property to the west side of Arnold Road. OBRAP alternatives consider reconfigured and alternative means of access via Arnold Road, including as an entrance for pedestrians, cyclists, and emergency vehicles. As discussed for PAC #5, the Arnold Road entry point is one of only two current beach access points and should also be considered with that in mind.

PAC #5: Limited parking, vehicular, and pedestrian (e.g., trail) access.

Currently there are two recognized public access points. The Arnold Road parking area, which has 20 parking stalls, and which does not comply with Navy regulations, is the only vehicular parking area which provides beach access. This parking lot is subject to flooding after heavy rains. The lot size does not always accommodate visitor demand (Walter Fuller, pers. Comm. September 21, 2016). The pedestrian access from the Arnold Road parking lot is limited to an old, degraded partially-paved road subject to flooding which extends to the sand, and a compacted dirt trail along a levee of ODD #3 leading to the dunes and beach. Neither of these pedestrian trails currently provides Americans with Disabilities Act (ADA) access. The Perkins Road parking lot, which provides 50 parking stalls, is the only other access point. It contains limited trails and a footbridge leading out to trails on an islet in the lagoon. There is no beach access here. There are no other public access locations or formal trails, which is a constraint to public access of the Project Area.

PAC #6: Physical barriers to pedestrian access such as channels and property line fences (as well as the Ventura County Railroad).

As discussed previously, the Ventura County Railroad spur runs through the Project Area from Hueneme Road to the OBGS. Public access across the railroad could possibly be provided at controlled crossings, such as a signaled at-grade crossing or an elevated over-crossing. Based on Ventura County Railroad's experience, an elevated over-crossing would need to be installed in conjunction with fencing along the railroad to prevent people from walking across the tracks instead of using the over-crossing. A crossing could potentially be installed in conjunction with a new entrance at Hueneme Road.

PAC #7: Public use disturbance of existing and newly restored sensitive species and their habitat or nesting areas, such as the western snowy plover and California least tern.

Protective measures for habitats and species, including western snowy plover and California least tern may constrain public access. A major goal of the OBRAP is to provide public access features that are compatible with and limit disturbance to sensitive habitats. There are a number of these habitats and associated species that will be evaluated when considering access features, such as the lagoon, listed species nesting sites, wetlands that become seasonally inundated and are impassable, and sections of coastal dunes that contain fragile plant associations, processes, and nesting sites. For example, locating trails on existing disturbed locations or on existing roads, berms, or trails around the perimeters of habitats can provide areas of contiguous habitats and concentrate uses into perimeter buffer areas, which are adjacent to other land uses, thus potentially limiting disturbance to wildlife.

PAC #8: Prominent industrial uses (e.g., the Ormond Beach Generating Station, its associated transmission lines, the Oxnard Wastewater Treatment Plant and the Halaco properties), which diminish visual quality and the public's perceived recreational/outdoor "experience."

These large-scale industrial facilities loom over the pristine wetland landscapes one can experience in the Project Area. The tall smoke stacks of the OBGS diminish the visual quality of the landscape and contrast starkly with sense of wild nature and open views afforded by the Project Area. The Halaco slag pile rises above the landscape, surrounded by a graffiti-clad fence, which reduces the visual quality and sense of pristine habitat one could otherwise experience at the lagoon. While these facilities are a reality of the Project Area, they do pose a challenge to public access experience by creating barriers to trail networks and diminishing the visual quality of the visitor's experience.

SECTION 5
Project Elements

The Project Alternatives are assembled from a set of ecological elements (habitat types). This section describes these elements to guide the reader's interpretation of the alternative design maps in Section 6. The ecological elements are characterized according to the dominant vegetation community, with typical or special-status species mentioned. The habitat types are intentionally broad in order to simplify the maps, and to acknowledge uncertainty in predicting the habitat outcomes at a finer resolution of detail. In reality, these habitats will grade into each other, and will likely move up and down slope across years where there are broad, relatively flat ecotones (a transition zone between two biological communities). Public access elements are described in Section 6.

5.1 Habitat Elements

5.1.1 Beach/Coastal Strand

The most seaward habitat on the Project Area is the beach. It consists mostly of marine intertidal wetland. Directly behind and landward edge of the beach is the coastal strand, an important habitat and plant community. Beach and coastal strand is currently found in Areas 1, 7, 8, and 9, and totals 28.5 acres (4 percent of the Project Area). These habitats fluctuate with the seasons and between years, in response to seasonal wave climate and large wave events (causing erosion). The beach is generally unvegetated but the coastal strand can support beach saltbush (*Atriplex leucophylla*) and red sand verbena, which play important roles in dune building.

Beach and coastal strand habitats support a diversity of invertebrates that are a food source for over-wintering and migrating shorebirds. Western snowy plovers (*Charadrius nivosus*) forage year-round in beach and coastal strand habitats, and can nest in coastal strand areas. Other special-status species that use these habitats include hairy-necked tiger beetles, globose dune beetles, and many kinds of birds. As the sea level rises, the beach and coastal strand habitats will migrate landward and upward and therefore persist.

5.1.2 Coastal Dunes

Inland of the coastal strand are coastal dunes. This habitat is currently found in Areas 1, 7, 8, and 9, and totals 128.4 acres (20 percent of the Project Area). Coastal dunes include large unvegetated areas of open sand with hummocks and dunes, which form when plants such as red sand verbena, pink sand verbena (*Abronia umbellata*) and beach bur (*Ambrosia chamissonis*) trap blowing sand. Further back in the dunes where the sand is more stable, other dune species may be found such as

beach evening primrose (*Camissoniopsis cheiranthifolia*) and beach morning glory (*Calystegia soldanella*). Most dune plants rely on long taproots to access moisture trapped deep in the dunes where a freshwater lens (a pocket of freshwater fed by percolating rainwater that remains separate from an underlying water table due to density) is found on top of the salty watertable (supported by the ocean). Further landward, shrubs such as coyote brush (*Baccharis pilularis*) and coast goldenbush can establish a habitat often called back dune scrub.

Both western snowy plover and California least tern nest in coastal dunes, especially in areas with low vegetative cover. Other ground-nesting birds such as killdeer (*Charadrius vociferus*) and northern harrier (*Circus cyaneus*) can nest in coastal dune and back dune habitats. The silvery legless lizard (*Anniella pulchra*) is a burrowing reptile that lives primarily in dunes. As the sea level rises and the beach and strand habitats retreat landward, the area of dunes in the Project Area will decrease. Eventually, with enough coastal retreat, the dunes may be eroded and also begin to migrate inland into wetland habitats.

5.1.3 Dune Swale Wetlands

Dune swale wetlands occur in coastal dunes where dry sand gets scoured away by wind, exposing moist sand associated with the dunes' freshwater lens. The wind is not able to move the wet sand, which supports a range of wetland plants, including arctic rush (*Juncus arcticus*), salt grass (*Distichlis spicata*), spiny rush, field sedge (*Carex praegracilis*) and sandbar willow (*Salix exigua*). There is very little dune swale wetland habitat in the Project Area now, but nearby areas such as McGrath State Beach still support dune swale wetlands that range in size from a few hundred square feet to many acres in size.

Dune swale wetlands add considerable habitat heterogeneity to the coastal dune system. They support much denser and taller vegetation than the rest of the dune areas and therefore probably play an important role is supporting wildlife. The critically endangered Ventura marsh milk vetch (*Astragalus pycnostachyus* var. *lanosissimus*) could be introduced experimentally in dune swale wetlands at the Project Area. As the dune system narrows due to coastal retreat, dune swale wetlands might be lost. Dune swales constructed toward the back of the dunes would be expected to last longer.

5.1.4 Lagoon and Open Water

Open brackish water habitats are more or less permanently flooded areas that are too deep for emergent vegetation (wetland plants that project above the water surface, such as cattails). Open water is currently found in Area 1 at Ormond Lagoon, which totals 27.1 acres (4 percent of the Project Area). In general, where water salinities are low (less than 5 parts per thousand [ppt]), cattail can grow in water up to about 3 feet deep. In saltier water (generally 5 to 20 ppt), tule (*Schoenoplectus californicus*) can grow in water up to about 2 feet deep. Other factors also affect plant distribution, such as scouring and seasonal variations in water levels. Because most of the water on-site is brackish, we expect almost all of the open water habitats on-site to be at least about 2 feet deep as emergent vegetation is not present (the exception being the area of the lagoon

on the beach where conditions other than depth likely impede emergent vegetation). Open water areas can support algae and aquatic plants such as sea lettuce (*Ulva lactuca* and *U. intestinalis*) and spiral ditch grass (*Ruppia cirrhosa*).

Open water areas support both aquatic and terrestrial wildlife. The endangered tidewater goby is a small fish that lives almost exclusively in seasonally closed lagoon and low-salinity estuarine habitats. Many bird species forage in open water areas including terns (e.g., California least tern), herons, egrets and waterfowl. These species feed on fish, invertebrates and vegetation. As the sea level rises, open water areas will get deeper and expand throughout the Project Area.

5.1.5 Salt Panne

Salt panne habitats occur in shallow basins that are seasonally flooded and hypersaline (saltier than seawater). The source of the salt may be from saline surface water and/or groundwater, or from ocean water washing over the beach and dunes. In either case, the water then evaporates (as opposed to flowing off-site or percolating in to the soil) and leaves an increasing amount of salt on the soil surface over time. The high salinity precludes all plants, though algae such as sea lettuce can occur seasonally. This habitat is currently found in Areas 3b and 6, and totals 25.9 acres (4 percent of the Project Area). Salt pannes are a rare habitat type that contributes to habitat complexity (SCWRP 2018).

Salt panne habitats support many bird species, including nesting and/or foraging areas for American avocet (*Recurvirostra americana*), California least tern, western snowy plover, killdeer and black-necked stilt (*Himantopus mexicanus*). Western snowy plover fathers are consistently seen bringing recently fledged chicks to the salt panne habitat at the Arnold Road end of the Project Area to forage on the abundant brine flies (*Ephydridae* spp.). Salt panne habitat occurs in the lowest elevations at the Project Area and as the sea level rises, increasing groundwater levels will eventually lead to year-round ponding and eventual conversion of these areas to open water, salt or brackish marsh.

During the 19th century, 80 percent of salt panne habitats were lost in Southern California (SCWRP 2018). The Regional Strategy recommends an objective of protecting 100 percent of existing natural salt pannes and their supporting hydrological regime.

5.1.6 Salt Marsh

The salt marsh habitats at Ormond Beach are all non-tidal and have salinity levels high enough to exclude brackish species, but lower salinities and less ponding than occurs in salt panne areas. Salt marsh is currently found in Areas 1, 3a, 3b, 4, 5, and 6, and totals 107.8 acres (17 percent of the Project Area). Only the southern-most salt marsh area (Area 6) still receives direct seawater influence in the form of occasional wave overwash events. Salts from brackish ground or surface water and poor drainage off-site are probably important factors in sustaining salt marsh in other areas of the Project Area. Salt marsh plants do not occur in permanently flooded areas but they can tolerate some seasonal flooding. Salt marsh habits are dominated by pickleweed (*Salicornia*

pacifica), salt grass and fleshy jaumea (*Jaumea carnosa*), which all have broad tolerance to different salinity and flooding regimes including hypersalinity (i.e., >40 ppt). Other salt marsh halophytes that are more limited in distribution in the Project Area include sea lavender (*Limonium californicum*), alkali heath (*Frankenia salina*), arrow grass (*Triglochin concinna*), shore grass (*Distichlis littoralis*), Parish's glasswort (*Arthrocnemum subterminale*), Coulter's goldfields and salt marsh bird's beak—all of which are typically only found in tidal systems. These higher diversity salt marsh areas mostly occur directly behind the dunes in Areas 6 and 3b, where some influence from the freshwater lens in the dunes may be keeping soil conditions in a "sweet spot" for species less tolerant of salinity extremes. The non-tidal salt marsh habitats are unlikely to support a high diversity or abundance of bivalves, snails, crabs, or shrimp that are found in tidal salt marshes, and therefore the predators that depend on theses food sources are not expected either.

Despite being non-tidal, the salt marsh habitats in the Project Area might be expected to support some salt marsh-dependent wildlife species, including Belding's savannah sparrow, documented in the Project Area, and wandering skipper (*Panoquina errans*), a butterfly. As the sea level rises, salt marsh habitats will be more strongly influenced by groundwater. This might convert some areas to salt panne and others to brackish marsh. Based on current modeling, there is no strong evidence that regular tidal influence will come in the future (a few decades) with increasing sea levels.

5.1.7 Seasonal Wetlands

Seasonal wetlands occur where rainfall or seasonal fluctuations in surface or groundwater levels lead to seasonal ponding or seasonally saturated soils in the rooting zone. This habitat is currently found in Areas 2, 4, and 5, and totals 78.8 acres (12 percent of the Project Area). Seasonal wetlands might occur in depressions that pond water or on flats with clay soils that retain moisture and salt after rainfall. Seasonal wetlands near the coast that are influenced by salt are uncommon today in southern California but can support a wide range of regionally and globally rare plant species, including Virginia pickleweed (*Salicornia depressa*), Coulter's saltbush (*Atriplex coulteri*), Pacific saltbush (*A. pacifica*), Davidson's saltbush (*A. serenana* var. *davidsonii*), horned sea blite (*Suaeda calceoliformis*) and Ventura marsh milk vetch. Some other common species expected in these habitats include salt grass, pickleweed and alkali heath. All the different species will have somewhat different tolerances to different levels of salinity, depths and durations of inundation, and dry-season drought stress.

Saline-affected seasonal wetlands might support some of the same wildlife species as salt marsh and salt panne habitats. As the sea level rises, the seasonal wetlands will evolve in to other habitats. Depressional areas, where water could pool and evaporate, are expected to evolve toward salt marsh and salt panne or brackish marsh in the future. Non-depressional areas are expected to evolve toward salt marsh and brackish marsh in the future.

Restoring wetland area, size, distribution, habitat diversity, and condition are objectives in the Regional Strategy (SCWRP 2018).

5.1.8 Fresh-Brackish Wetland

Brackish marshes occur where water salinities are typically lower than seawater but have some amount of salt. Fresh-brackish marsh is currently found in Areas 2 and 3a, and totals 24.5 acres (4 percent of the Project Area). Brackish marsh can occur in permanently or seasonally flooded areas and in areas that are not flooded but have a water table close to the surface. Flooding can be caused by groundwater rising above the soil surface, rainfall, or watershed inputs (i.e., the lagoon). Salts come from brackish groundwater or overwash from the ocean. The flooded areas of brackish marsh on the Project Area are typically dominated by tule and cattail. Species found in rarely flooded areas include saltmarsh bulrush (*Bolboschoenus maritimus*), spiny rush, salt marsh baccharis (*Baccharis glutinosa*), and pickleweed.

Tule and cattail stands provide important nesting habitat for many species of birds, including red winged blackbird (*Agelaius phoeniceus*), marsh wren (*Cistothorus palustris*), common yellowthroat (*Geothlypis trichas*) and several species of rail. The endangered light-footed clapper rail (*Rallus longirostris levipes*) almost always nests in tidal salt marshes, but can occasionally nest in brackish marshes. As the sea level rises, brackish marsh will generally convert toward open water habitats.

As noted above, restoring wetland area, size, distribution, habitat diversity and condition are objectives in the Regional Strategy (SCWRP 2018).

5.1.9 Riparian

Riparian habitat primarily occurs along creeks, rivers and freshwater wetlands in coastal southern California. The Project Area does not currently support riparian habitat, though it might be feasible to establish sandbar and arroyo willow (*Salix exigua* and *S. lasiolepis*) along OLW in Area 2. This area is probably too salty for most other typical riparian tree species. Test plantings would be useful in assessing feasibility. Riparian habitat can support foraging and nesting for many bird species. As the sea level rises, the riparian areas would likely become too wet and salty to support willows and would convert to brackish marsh.

5.1.10 Wetland-Upland Transition

Wetland-upland transition habitats (also known as wetland-upland ecotones) occur at intermediate elevations between marsh habitats (salt and brackish) and uplands. This transition zone is found in Areas 1, 2, 3a, 4, and 5. Growing conditions in this zone are dynamic in space and time. Different characteristics of both adjacent habitats are expressed at different times in the transition zone. Rare flooding events can inundate plants with salty, brackish or fresh water. This can stress or kill most typical upland species. These flooding events can be followed by the heat and drought stress associated with upland habitats that make these elevations unsuitable for wetland species. The extreme events that affect the transition zone occur on impossible to predict time scales. There are several native species that are tolerant of the extremes found in the transition zone, including shrubs like Brewer's saltbush (*Atriplex lentiformis* ssp. *lentiformis*),

horned sea blite, woolly sea blite (*Suaeda taxifolia*), bush seepweed (*Suaeda nigra*), coyote brush, and coast goldenbush.

Wetland-upland transition habitat supports a similar range of wildlife compared to uplands and is especially important as a refugia for terrestrial species when water levels are high in adjacent wetland habitats. Wetland-upland transition habitat on the Project Area will be a crucial resource for upslope movement of wetland habitats as sea-level rise pushes existing resources out of their current locations and up slope.

The Regional Strategy recognizes the importance of such transition zones with four specific objectives focused on protecting and increasing wetland/upland transitions zones (SCWRP 2018).

5.1.11 Bioswales

Bioswales are constructed wetlands. As discussed under Restoration Opportunity #6 (Section 4.1.1), bioswales are an example of BMPs that can enhance water quality. Bioswales may be designed for different purposes, but depending on their size and location in catchment they can: (1) trap sediment, (2) retain stormwater that can then percolate and evaporate rather than flow in to habitat areas, and (3) help clean up contaminated water (allow sediments to settle, allow plants to take up excess nutrients, let microbes break down toxic compounds, etc.). If bioswales are planted with native plants such as cattail, tule and bulrush, and are well designed, they can provide valuable habitat for foraging and nesting birds and other wildlife. In some cases, especially where sediment is expected to be a problem, constructed wetlands may include a forebay that traps most of the sediment and can be cleaned out as needed without damaging vegetation in the rest of the wetland.

The proposed bioswales are all schematic at this design stage. Eventually, they would need to be engineered to perform adequately given the expected amount of runoff they would be designed to catch, and the potential pollutant loads they would be expected to affect (both runoff volumes/ velocities and pollutant loads are currently unknown). As the sea level rises, the bioswale areas are expected to convert to other wetland types, such as brackish marsh, salt marsh, and perhaps salt panne.

This habitat is not yet present at the Project Area but is proposed in Alternative 2.

5.1.12 Upland

Upland areas are expected at elevations above areas that flood, even if the flooded areas are very rarely inundated. This habitat is currently found in Areas 1, 2, 3a, 4, and 5, and totals 96.6 acres (12 percent of the Project Area). The type of vegetation supported in upland areas will depend on several factors, with soil texture probably being the most important. If soils are relatively high in clay and poorly drained, they might be expected to support native grassland habitats dominated by perennial grasses such as purple needle grass (*Nassella pulchra*), California brome (*Bromus carinatus*), meadow barley (*Hordeum brachyantherum*), and blue wild rye (*Elymus glaucus*), with

a mix of annual and small perennial broad leaved species such as California poppy (*Eschscholzia californica*), arroyo lupine (*Lupinus succulentus*), miniature lupine (L. bicolor) and deer weed (*Acmispon glaber*). Better-drained soils would likely support coastal sage scrub, with species such as California sagebrush (*Artemisia californica*), Brewers saltbush, coyote brush, California encelia (*Encelia californica*), California buckwheat (*Eriogonum fasciculatum*), coast goldenbush, sticky monkey flower (*Mimulus aurantiacus*), purple sage (*Salvia leucophylla*), and black sage (*S. mellifera*).

Both of these types of upland provide habitat for a wide range of wildlife and might be especially important to terrestrial species as refugia when water levels are extremely high in adjacent wetland and transition zone habitats. Upland habitat on the Project Area will be a crucial resource for upslope movement of wetland habitats as sea-level rise pushes existing resources out of their current locations and up slope.

5.2 Public Access Elements

The potential trail types and amenities included in the alternatives are described below.

5.2.1 Trails

Developed (Primary) Trails form the backbone of the access system through the Project Area. Developed trails are generally intended to accommodate larger groups, more active uses, and are designed for more intensive use. Developed trails would be constructed of class II base, decomposed granite, or improved and graded natural soil depending on their location and adjacent or projected future or seasonal hydrologic conditions. These trails are sited in projected high-use areas, provide ADA access, room for school or tour groups, and can be multi-modal to serve both pedestrians and mountain bikers, in addition to maintenance and emergency vehicles. They would be approximately 10–12 feet wide with 1- to 2-foot shoulders, and may be site or California Coastal Trail sections. These trails provide emergency access for fire, law enforcement, private security, and rescue, as well as access for maintenance staff, and can be used to align any required utilities. Site amenity elements would include boardwalks, bridges, turn-outs, overlooks with bird blinds, benches, viewpoints, and edge control (fencing or edging) in sensitive areas, signage (directional, interpretive), culverts or footbridges, limited wildlife-friendly lighting from bollards at trailheads for safety, and viewing platforms. The trail surface would be set at elevation of 12 feet NAVD88, except for Alternative 3 where they are proposed at elevation 15 feet NAVD88.

Rustic (Secondary) Trails are designed access through habitats where an immersion in nature experience can be provided. Rustic trails are generally intended to accommodate two people walking side by side comfortably, in areas where moderate use is anticipated. Rustic trails would be graded natural soil or class II base in wet areas. They are designed for pedestrian use only to serve activities such as walking and nature observation. They would be 4 to 6 feet wide with 2 feet clear of tall vegetation on perimeters. They would contain elements such as footbridges, boardwalks, overlooks, benches, viewpoints, turn-outs, and signage, and edge control at sensitive

habitat areas. Trail elevations may vary to sit on native grade elevations or between elevation of 11 to 12 feet NAVD88.

Primitive (Tertiary) Trails are single-track, narrow earthen tread, with limited gravel or class II base only in wet areas, with mowed or cleared edges 1-foot wide maximum. Primitive trails are designed to provide solitude and a quiet nature experience in more sensitive areas with lower use. Many of these trails could be seasonal. They are designed to serve pedestrians only, focus on birding or nature observation, slow nature-based activities, nature immersion, and would have benches or platforms for birding, or small trails leading to water's edge with overlooks.

Beach Trails provide access on the beach sand, or on the sensitive back dune areas via boardwalks. They are for pedestrian use only along the shore or through the most active areas of the dune complex. The width is viable from the entire beach strand to 50- or 100-foot buffer areas near bird habitat fencing. Bird fencing can be symbolic bird fencing composed of metal posts and wire or cable, or exclusion fencing comprised of a mesh such as cintoflex to protect the most sensitive areas. Boardwalks would be 6 feet wide with occasional turnouts for wheel chair pull-outs or passing where applicable. Boardwalk sections of beach trails overlooking sensitive Tern nesting colonies would be shielded by bird blinds where necessary to minimize disturbance to nesting birds.

Bike or Multi-Modal Trails would either be Class I or Class II bike ways. Class II striped bike lanes are proposed on the edges of existing roads leading to the Project Area from adjacent neighborhoods and are envisioned to be spurs of the California Coastal Trail. The striping of Class II bike lanes would need to be coordinated with local jurisdictions. Class I bike paths leading through the Project Area are proposed only in limited areas, and would be made of Class II base, or striped two-way paths of pervious asphalt or concrete, wide enough for emergency responders or wildlife rescues. Class I bike paths may be combined with Primary trails, and may be bifurcated for more active and passive uses.

5.2.2 Site Amenities

Site amenities are features to enhance, guide, and complement the visitor experience at Ormond Beach. Common amenities include signage (directional, interpretive, or access control), edge control (rails on boardwalks, rustic fencing, agricultural fencing, bird area fencing of nets or symbolic cable rail fences), access nodes (major trail heads with parking lots and visitor services at high-use areas, minor trailheads with small, ADA, or no parking, bike parking, interpretive signage only, community-focused entries), bike amenities (bike parking racks, limited lockers, a bike service station in one alternate), boardwalks, bridges, and benches (**Table 5-1**). Amenities may be phased in over time as funding is procured and/or restoration plan components are implemented.

TABLE 5-1
SITE AMENITIES

Site Amenity	Description
Signage	**Tell people where to go, and educate them regarding their environment.**
Directional	Series of trail signs noting trail name for location and route identification on the Project Area. Each section of trail can be named after a bird, animal, or plant, and the name and icon of that element can universally identify the trails. This would make the directional signage and maps understandable by visitors who may speak many different languages. Text on directional signs to be both English and Spanish. A color code system can be developed to denote trail usage, such as multi-modal (bike and pedestrian), pedestrian only, seasonal, rustic, etc.
Interpretive	Interpretive signage is proposed at trail heads, and is suggested at certain overlooks. Each interpretive sign can tell the story of a particular topic related to the Project Area, such as endangered birds, how salt pannes form, what a salt marsh is, etc. These signs should be durable, UV resistant, contain ample clear graphics, and in English and Spanish. If signs have numbers or QR codes, a smartphone app can be developed to provide additional audio information for visitors. This option could be developed in concert with or to support school curriculum in partnership with local grade schools, high schools, or colleges.
Access Control	Signs that encourage or discourage entry to certain areas. Access control signs can be posted on bird nesting fences along with interpretive signage explaining the life-cycle and limited habitat availability of those birds. Seasonal trails should all be posted with access control signs.
Symbolic Bird Fencing	T-bar posts with two strands of wire or cable between them. They provide a symbolic barrier between the trail and sensitive habitat areas but allow wildlife to pass through them. Symbolic fencing is good for lining trails which move through dunes as they do not impede the process of dune formation and sand migration while clearly defining the trail for visitors. Symbolic fences may also be used to define seasonal closures of trails; cable fences may have hooks which allow them to be open or closed to allow or prevent access due to nesting season, high water levels from inundation or high tides, etc.
Exclusionary Bird Fencing	T-bar posts with wire mesh between them. They provide a physical barrier between the trail and sensitive habitat areas. Birds and very small mammals may pass through them, but larger predators, dogs, and people cannot easily pass through them. Exclusionary fences may be used in the most sensitive seasonal nesting areas, areas with high visitorship, or as an adaptive management strategy to convert symbolic bird fencing in locations where visitors are not staying on trails.
Edge Control	**Keep visitors on trails**
Rails on boardwalks	Low symbolic edges on flat boardwalks, or guard-rail (42”) or railing (36”) height railing that prevent or signal that visitors need to stay on the trail. These may be for safety or to provide a steady surface for birding glasses.
Rustic Fencing	Rustic fencing such as lodgepole, split rail, or wood post and cable fences meant to restrict access to certain areas at more developed locations such as trailheads or locations where people are not welcome (i.e., active railroad tracks).
Agricultural Fencing	T-bar post or wood post with hog-wire mesh or horizontal cable to provide a physical barrier between a farm and trail.
Access Node	**Locations where the public can enter Ormond Beach**
Major Trailhead	Large parking lot (20–50+ stalls) visitor services such as docents, security, restrooms, maps, for high-use areas
Minor Trailhead	Small parking area (2–15 stalls) or ADA-only parking (or no car parking), drop-off area, bike parking, interpretive signage only, community focused entries.

TABLE 5-1
SITE AMENITIES

Site Amenity	Description
Visitor Services	
Visitor Center	A physical building with interpretive elements, books or goods for sale, docents to answer questions, security center. A portable visitor's center could be made from an RV-type trailer and could be open to the public on weekends or during summer. Visitor Center can be geared to school groups, designed to support and provide research facilities for college/university involvement in long-term monitoring and data collection to inform adaptive management planning, serve as a hub to arrange ecotourism services, and to provide information for the active local birding community regarding recent species sightings.
Visitor Kiosk	A portable trailer or small covered structure (posts only, no walls or doors) with information for visitors, such as trail conditions, recent bird sightings, interpretive displays, fish guides, interactive displays. Visitor Kiosks may be staffed by docents during busy times or when school groups or tours are scheduled, but interpretive displays would be available at all times.
Restrooms	Restrooms could be included in a visitor center or kiosk. Initial restrooms could be portable trailer restrooms provided by a local waste management company; rental on these units typically includes service and can be very reasonably priced. Later phases could implement restrooms with sewer connections, water, and electrical at a visitor's center or Major Trailhead. Restrooms would ideally be provided where school groups stage and begin or end their visit.
Bike Services	
Bike Parking	Metal bike racks secured to the ground either by bolting to a concrete pad or bolting to below-ground footings in a D.G. or earthen parking area.
Bike Lockers	Large "boxes" where visitors who are regional Coastal Trail riders can store and lock their bike and camping gear while visiting the Project Area.
Bike Service	Small pre-fab public bike repair stations that have tools, air, clamps, etc. to allow visitors to perform minor services such as pumping tires, fixing brakes, patching tires, or other minor repairs.
Trail Amenities	
Bridge	Bridges would be prefabricated drop-in structures supported by concrete abutments, pile, or other means. Bridge deck elevations should be set at an elevation of 15.0 to allow water passage below. Bridges are proposed at major water crossings (OLW).
Floating Boardwalk	A floating structure suspended over water to facilitate wildlife viewing. The deck elevation can raise and lower with tidal influence or hydrological cycles, and should be far enough above the water to allow passage of birds beneath.
Boardwalk	Wood or metal frame structures with recycled lumber decks, elevated above substrates such as seasonal or perennially wet land, shifting sands, or shallow water (pools, seasonal wetlands, flooded marsh, etc.). Boardwalk elevations to be at set at an approximate elevation of 13 feet. Boardwalks would be elevated high enough to allow bird and wildlife passage beneath, and discourage rodent nesting.
Overlook Platform	An overlook platform is a flat surface with benches and railings to support wildlife viewing. They are located so that trail circulation is not blocked.
Trash / Recycle	Trash and recycling receptacles to be designed to exclude foraging birds and will be located at major and minor trailheads.
Picnic Tables	Both ADA and standard picnic tables for picnics or school group gathering. No barbeques. At least one table should have a shade structure or shade sails.
Benches	Benches can be used by visitors to rest, bird watch, or commune with nature. Benches should be rustic in style, durable, and could have recycled plastic lumber or ipe slats, and can be donor opportunities.
Overlook	Overlook may be an Overlook Platform, bump-out in a bridge or boardwalk, or raised earthen feature to provide visitors with views over the Project Area or into specific habitat areas. Due to the extremely flat nature of the Project Area, these elevated features help visitors orient themselves on-site and take in views of vast natural habitats.
Bird Blinds	Structures that conceal humans from birds to promote high-quality bird viewing while minimizing disturbance to birds. Overlooks or Platforms may include bird blinds.

5.2.3 Design Considerations

Design Themes

Community input and goals developed by the Project Partners suggest that the most important characteristic of the Project Area is the sense of wild nature and solitude that it offers. This implies that rather than proposing heavily developed access infrastructure with large architectural features, a more appropriate approach would be to provide more naturalistic integrated access features, compatible with a rustic, wild site.

Development of the public access alternatives by the Consultant Team took into consideration a set of design principles developed by True Nature to meet the Project's goals and objectives. Each design guidelines stems directly from a project goal (Section 3.2) and is meant to guide design decisions to meet project goals. Specific input received from the community is woven into these guidelines, which are:

1. Habitats: Create ability to experience multiple habitat types.
2. Processes: Create ability to observe natural processes.
3. Processes: Trails and access features should not interrupt or impede natural processes.
4. Resilience: Trails or boardwalks should be planned to accommodate sea-level rise and habitat migration.
5. Connectivity: Trails or access points should connect to existing or planned trail routes adjacent to the site to facilitate access by neighboring communities, including non-automobile forms of transportation for local residents.
6. Coastal Trail: Traverses site, is multi-modal, and should connect to the southeast and northwest planned Coastal Trail routes at Project Area boundaries.
7. Recreation: Enhance opportunities for passive recreation (e.g., bird watching, walking, bike riding, picnicking, beach enjoyment).
8. Sensitive: Trails and access features should be sited and aligned so as to minimize impacts to sensitive plants or wildlife by using buffers or avoiding sensitive areas. When competing ecological concerns overlap, elements should seek to minimize impacts.
9. Community: Encourage community involvement.
10. Education: Include interpretive elements and access for school groups and visitors.
11. Sensitive: Parking areas should be provided to discourage on-street parking and trespass over agricultural fields or though industrial areas; trails should be aligned to discourage trespass onto adjacent properties, and parking areas, trails, and public areas should ensure compatibility with security and safety criteria of the adjacent military installation.
12. Amenities: Provide public access amenities (trails, staging areas, interpretive signs, viewing areas, restrooms, shade structures, picnic tables, benches, trash cans, parking) for community members and visitors.

Choice of Materials

In keeping with the nature-based goals and design character suggested for the Project Area, site amenities should blend with the natural surroundings and be sited in ways that support a positive visitor experience. It is suggested that colors be muted, natural tones, and materials balance natural look with longevity. An example would be recycled lumber which has a natural wood-grain pattern but is resistant to rot, important in a coastal site with multiple types of wetlands.

Seasonal Inundation and Sea Level Rise

Public access feature design and proposed location take SLR into consideration. Future SLR models were reviewed to understand likely impacts to the site. Primary trails are proposed at an elevation of 12.0 NAVD88 (or 15.0 NAVD88 for Alternative 3) to minimize the likelihood of flooding or inundation for approximately the next 50 to 75 years. Primary trails are proposed to be constructed of a sturdy compacted Class II base material which holds up during wet weather, even for emergency or security vehicular access. Bicycle and pedestrian use should not damage them when they are wet, such as during heavy storms or extreme high tides. Many proposed trail locations run through areas which are seasonally wet or which may become wetter with SLR. Boardwalks are proposed in those areas. The boardwalks would be constructed of a weather-resistant material, and can be designed to float, like boat docks, during the wet season and under future SLR scenarios. Rustic trails and Primitive trails, which are proposed with natural earthen surfaces, may require seasonal closure. Rustic trails may need to be surfaced with Class II base or other similar materials in the future should wetland levels rise and the trails become wetter. Boardwalks and bridges proposed for Rustic and Primitive trails were sited to anticipate areas of current or future inundation. Some of the Rustic and Primitive trails may need to be abandoned if the 2100 SLR model predictions become reality.

Public access amenities such as interpretive kiosks and docent stations are proposed to be semi-permanent, meaning they can be surface mounted and unbolted and relocated to higher elevations further inland on the Project Area as required should SLR occur faster than predicted, or high tide events prove to be too damaging to them. The main Visitor's Center was proposed in Area 4 due to the current high elevation, and it would not require relocation under current SLR models. The proximity to roads and future planned neighborhoods was also taken under consideration.

Habitat and Species Considerations

Public access features such as trails, boardwalks, and overlooks were also sited to allow natural hydrologic function to occur, and were sited to be sensitive to habitat areas. In addition to accommodating SLR, boardwalks allow water to flow evenly across the Project Area, without providing barriers for migration of water, plants, and animals. Trail and boardwalk alignments were adjusted and refined to avoid sensitive plant populations and known bird nesting sites.

Boardwalks will be constructed at an elevation above ground level which will allow species migration below them, and which will discourage rodent pests which can prey on eggs and hatchlings. Boardwalks also function to clearly define the trails and serve to keep people on them,

limiting off-trail disturbance to wildlife and sensitive plant species. Boardwalks in dune areas allow some sand migration, and limit foot traffic onto sensitive dune plants and nesting birds.

Beach trails are proposed to have symbolic fencing aligning them. Since a beach trail exists on sand, which migrates and can obscure previous footprints which would help visitors find the trail, these symbolic fences serve to define the trail route and protect bird species nesting in the coastal dune environments. Additional exclusionary bird fencing will be added to as needed along the backdune boardwalks. Bird blinds are proposed along the back dune boardwalk adjacent to existing sensitive bird nesting sites for Western Snowy Plover and California Least Tern so that visitors may observe them or use the trail without disturbing the birds. Locations of exclusionary and symbolic bird fencing can be adjusted in the future as an adaptive management strategy to protect wildlife and define preferred access routes.

This page intentionally left blank

SECTION 6
Description of Project Alternatives

The Preliminary Restoration Plan includes three refined Project Alternatives, each of which provides a different range of outcomes related to the Project's overall goals and objectives and across a range of complexity related to hydromodification and earth moving. Each alternative seeks to restore natural ecosystem processes with a focus on self-sustaining habitats typical of coastal southern California wetland systems. This chapter:

- Describes three alternatives that are expected to provide a different range of ecological outcomes using varying intensities of landscape modification and management.
- Depicts a variety of public access trails and amenities for each alternative that is compatible with proposed restoration outcomes.
- Analyzes each alternative and compares how well each alternative meets Project goals and objectives using quantitative and qualitative criteria.
- Presents a preferred "hybrid" alternative that is composed of elements selected primarily from Alternatives 2 and 3 as recommended by the SAC and the Project Partners.

This Section 6.1 provides an overview of the three alternatives that were developed, analyzed and evaluated. Development of the alternatives is described in Section 6.1. Each of the three alternatives is described in detail, analyzed and evaluated in Section 6.3. The preferred alternative is described in Section 6.4.

The three alternatives are designed around three ecological themes. Alternative 1 focuses on restoring salt marsh (the "Salt Marsh Theme") (**Figure 6-1**), Alternative 2 focuses on restoring a wider diversity of habitats (the "Habitat Diversity Theme") (**Figure 6-2**), and Alternative 3 focuses on removing man-made barriers between habitats (the "Habitat Connectivity Theme") (**Figure 6-3**). The amount of modification and intervention increases from Alternative 1 (minimal intervention) through Alternative 3 (greater intervention).

Table 6-1 presents a comparison of major actions and outcomes among the three alternatives. Various public access improvements were developed concurrently and matched to each restoration alternative. These public access features are presented for each alternative concept design (Figures 6-1, 6-2, and 6-3) to show the interrelation between restored habitats and access elements. Public access elements are not restricted to the restoration alternative they are paired with in the tables and figures. Development of a preferred alternative may include combining of elements from among the restoration and public access alternatives.

6.1 Alternatives Development

Three alternatives were developed to meet project goals and objectives, based on our understanding of historical and existing site conditions, expected future conditions, and opportunities and constraints. The alternatives are consistent with the objectives of the Regional Strategy (SCWRP 2018). Surveys, modeling, and technical studies (as summarized in Section 2 and Section 6.3 and detailed in the appendices) were conducted to bolster understanding of present and future physical processes that may affect the feasibility and sustainability of ecosystem restoration.

6.1.1 Ecological Basis

Three restoration alternatives were developed and refined primarily to present a range of ecological outcomes to the Project Partners and SAC for consideration in the eventual development of the preferred alternative. The target habitats presented are appropriate for the Project Area within the context of what we know about historical conditions. There are still outstanding questions as to the types of interventions that might be needed to sustain some of the depicted habitats, due in part to data gaps. However, the target habitats presented are expected to be feasible within the context of the minimal, moderate and more intensive interventions that characterize the three alternatives. Habitat targets will be achieved by restoration of important physical and biological processes that have been altered.

Alternative 1 is configured to enhance existing habitats through limited intervention, with an emphasis on preservation of salt marsh and salt panne habitats. Alternative 1 recognizes that there are significant existing wetlands resources in the Project Area that can be improved through, enhancement, restoration and improved management. This alternative also provides a lower impact approach with less earth moving. Alterative 1 therefore has a “salt marsh theme” with minimal intervention and is described in Section 6.2.1.

Alternative 2 has a “diversity theme” with moderate intervention. Substantial intervention is proposed to expand a wide diversity of wetland habitats. The wetland types proposed are based on current conditions and are appropriate within the historic context of the region. A major action is the realignment of OLW to create extensive brackish wetlands. This alternative requires substantial earthwork to enhance, restore and create higher functioning habitats. Alternative 2 is described in Section 6.2.2.

Alternative 3 focuses on removing man-made barriers that fragment habitats throughout the site in order to re-create a more contiguous mosaic of habitats connected by broad ecotones. This alternative proposes the most earthwork, and the greatest changes. Hence the alternative has a “connectivity theme” with the greatest degree of intervention. A major action is the creation of a new lagoon connected to a re-routed OLW and with a new intermittently open mouth. The fill generated from the earthwork is used to expand upland and wetland-upland ecotone habitat. These higher areas will allow for wetland habitat transgression with sea-level rise. Alternative 3 is described in Section 6.2.3.

Wetland boardwalk

Overlook Platform

Wetland Bridge & Overlook

Birding

Kiosk with Docents & Signage

Primary Developed Trail

Rustic Trail

Primitive Trail

Beach Trail

Benches and Overlook

Wayfinding Signage

Designated Areas

1. Ormond Lagoon, Including Beach, Dunes, & Perkins Drainage
2. Ormond Lagoon Waterway (OLW)
3a. South-of-Railway, Near Halaco Property
3b. South-of-Railway, Near OBGS
4. Agriculture
5. Tank Farm
6. Salt Marsh / Panne
7. Beach & Dune South of 3
8. Beach & Dune South of 5
9. Beach & Dune South of 6

Access Nodes

- A Perkins Road
- B_1 West McWane Blvd.
- B_2 East McWane Blvd.
- C Edison Road
- D Arnold Road
- E City of Port Hueneme

Vegetation

- Salt Marsh (SM)
- Wetland-upland Transition (WT)
- Seasonal Wetlands (SW)
- Brackish Marsh (BM)
- Open Water
- Salt Panne (SP)
- Bioswale
- Upland (U)
- Coastal Dune (D)
- Beach/Strand (B)
- Riparian (R)

Access Elements

- Primary / Developed Trail
- Secondary / Rustic Trail
- Tertiary / Primitive Trail
- Beach Trail
- Boardwalk
- Bridge
- CA Coastal Bike Trail
- Overlook Platform
- Overlook or View
- Parking
- Major Trailhead
- Minor Trailhead
- Water Control Structure
- Project Boundary
- Railroad

D160447.00 - Ormond Beach Wetlands Restoration\05 Graphics\Illustrator

SOURCE: ESA, 2019

Ormond Beach Restoration and Public Access Plan

Figure 6-1
Alternative 1: Salt Marsh Theme, Light Intervention

ESA

Wetland boardwalk

Overlook

Wetland Bridge

Interpretive Kiosk at Trailhead

Bird Blind

Primary Developed Trail

Rustic Trail

Primitive Trail

Beach Trail

Symbolic Bird Fencing

Interpretive / Educational Sign

Designated Areas

1. Ormond Lagoon, Including Beach, Dunes, & Perkins Drainage
2. Ormond Lagoon Waterway (OLW)
3a. South-of-Railway, Near Halaco Property
3b. South-of-Railway, Near OBGS
4. Agriculture
5. Tank Farm
6. Salt Marsh / Panne
7. Beach & Dune South of 3
8. Beach & Dune South of 5
9. Beach & Dune South of 6

Access Nodes

- A Perkins Road
- B_1 West McWane Blvd.
- B_2 East McWane Blvd.
- C Hueneme Road
- D Arnold Road
- E City of Port Hueneme

Vegetation

- Salt Marsh (SM)
- Wetland-upland Transition (WT)
- Seasonal Wetlands (SW)
- Brackish Marsh (BM)
- Open Water
- Salt Panne (SP)
- Bioswale (BI)
- Upland (U)
- Coastal Dune (D)
- Beach/Strand (B)
- Dune Swale Wetland (DSW)

Access Elements

- Primary / Developed Trail
- Secondary / Rustic Trail
- Tertiary / Primitive Trail
- Beach Trail
- Boardwalk
- Bridge
- CA Coastal Bike Trail
- Overlook Platform
- Overlook or View
- Parking
- Major Trailhead
- Minor Trailhead
- Water Control Structure
- Project Boundary
- Railroad

Bike or Pedestrian Minor Trailhead for neighborhood or CA Coastal Trail Access
At-Grade Railroad Crossing
Primary Developed Multi-modal CA Coastal Trail
Existing Railroad Spur
Constrained Minor Trailhead; weekends or scheduled visits only (trains)
Parallel Parking on existing road during first phase
CA Coastal Trail, Class II Bike, on McWane Road to Edison Road
CA Coastal Trail, Class II Bike, on Perkins Road & Hueneme Road
Overlook at edge of creek on island
Rustic Wetland Loop Trail
Boardwalks between elevated areas
Elevated Overlook
CA Coastal Trail
Bridge with Overlook
Seasonal Primitive Trail
Boardwalk
New Parking & Trailhead
Overlook with Educational Interpretive Elements
Primary Developed ADA Trail for school groups
New Bridge
Rustic Trail to Overlook
Boardwalk through wetland
Boardwalk or Bridge over Ormond Lagoon
Primitive Trail, Seasonal, to Overlook with bench
CA Coastal Trail Beach Trail from City of Port Hueneme
Crosswalk connection to W. McWane Blvd.
Improve & expand Parking Lot, add restrooms, Visitor Kiosk, Bike Racks, Bike Lockers.
New Parking Lot with Trail Maps, Wetland Education Focus Interpretive Signage, Major Trailhead
Existing Railroad Spur
Primary ADA Compliant Trail
Overlook
50' sections of Boardwalks to allow water flow
Wetland Overlook Platform, Bike Racks
Bridge
Birding Overlook Platform, Bird Blinds, viewscope
Boardwalk
Wetland Education Loop Trail: Primitive Trail through wetlands with birding platforms overlooking wetlands, trails may be subject to seasonal closures
Wetland Boardwalks to allow water migration across site
Wetland Boardwalk with Overlook
Existing Railroad Spur
New Culvert
Boardwalks
Wetland Overlooks
At-grade RR crossing
Backdune Boardwalk with Bird Blinds
Dune Swale Overlook
Dune Overlook Platform, Bike Racks
New Bird Fence
Existing Bird Fence
Beach Trail
New Bird Fencing
Beach Trail, CA Coastal Trail
Existing Bird Fence
Beach Trail, CA Coastal Trail
Primitive Trail
Elevated Birding Overlook
Existing Bird Fence
Beach Trail
New Bird Fencing
CA Coastal Trail, Class II Bike on Arnold Road
Close existing Parking at Navy fence. New parallel Parking at west side of Arnold Road to be Navy Compliant. Drop-off and turn-around, Emergency and Wildlife Rescue Beach access. Bike Racks and four Bike Lockers.
Elevated Birding Overlook
Keep existing interpretive signs, raise and improve Primary Trail
HUENEME ROAD
ORMOND LAGOON WATERWAY
PERKINS ROAD
W. McWANE BLVD
PERKINS DRAINAGE
ISHIMS CREEK
AGRICULTURAL DITCH
E. McWANE BLVD
EDISON ROAD
PROJECT BOUNDARY
ARNOLD ROAD
OXNARD DRAINAGE DITCH #3
SCALE: 1"=400'-0"
0 200' 400' 800'

SOURCE: ESA, 2019

Ormond Beach Restoration and Public Access Plan

Figure 6-2
Alternative 2: Habitat Diversity Theme, Moderate Intervention

ESA

D160447.00 - Ormond Beach Wetlands Restoration\05 Graphics\Illustrator

Wetland Boardwalk

Wetland Overlook Pier

Wetland Bridge with Overlook

Wetland-Dune Boardwalk

Bike Service and Racks

Primary Developed Trail

Rustic Trail

Primitive Trail

Beach Trail

Bird Fencing (Exclusionary)

Bike Lockers

Designated Areas

1. Ormond Lagoon, Including Beach, Dunes, & Perkins Drainage
2. Ormond Lagoon Waterway (OLW)
3a. South-of-Railway, Near Halaco Property
3b. South-of-Railway, Near OBGS
4. Agriculture
5. Tank Farm
6. Salt Marsh / Panne
7. Beach & Dune South of 3
8. Beach & Dune South of 5
9. Beach & Dune South of 6

Access Nodes

- A Perkins Road
- B_1 West McWane Blvd.
- B_2 East McWane Blvd.
- C Edison Road
- D Arnold Road
- E City of Port Hueneme

Vegetation

- Salt Marsh (SM)
- Wetland-upland Transition (WT)
- Seasonal Wetlands (SW)
- Brackish Marsh (BM)
- Open Water
- Salt Panne (SP)
- Bioswale
- Upland (U)
- Coastal Dune (D)
- Beach/Strand (B)

Access Elements

- Primary / Developed Trail
- Secondary / Rustic Trail
- Tertiary / Primitive Trail
- Beach Trail
- Boardwalk
- Bridge
- CA Coastal Bike Trail
- Overlook Platform
- Overlook or View
- Parking
- Major Trailhead
- Minor Trailhead
- Water Control Structure
- Project Boundary
- Railroad

SOURCE: ESA, 2019

Ormond Beach Restoration and Public Access Plan

Figure 6-3
Alternative 3: Habitat Connectivity Theme, Greater Intervention

ESA

D160047.00 - Ormond Beach Wetlands Restoration\05 Graphics\Illustrator

This page intentionally left blank

TABLE 6-1
OVERVIEW OF ALTERNATIVES WITH RESTORATION AND PUBLIC ACCESS ELEMENTS

Area	Design Element	Alternative 1 **Salt Marsh Theme** Minimal Intervention	Alternative 2 **Habitat Diversity** Moderate Intervention	Alternative 3 **Habitat Connectivity** Greater Intervention
1	Restoration	• Weeding and planting in upland areas • Surface connection between lagoon and Area 3a blocked by fill configured and planted to form a stabilized dune • Lagoon volume may decrease slightly	• Weeding and planting in upland areas • Lagoon connection to OLW moved to the east of Halaco properties • Lagoon connection to marsh in Area 3a increases capacity and leads to less frequent manual breaching	• Convert upland areas to brackish marsh by grading • OLW diverted to second lagoon in Area 3a • Decreased inflows lead to less manual breaching of existing lagoon
	Public Access	• All primary trails at 12.0 elevation, rustic trails at 11.0-12.0 elevation where feasible, boardwalks at 13.0 • New bridge over tšumaš Creek • Primary trail on OLW "island", primitive loop trail with footbridges and birding overlooks • Overlook pier/platform at OLW • Expand Perkins Road parking lot footprint, adding 24 spaces. • Visitor Services - ±120 SF docent kiosk with interpretive elements, security, wildlife-friendly lighting at Perkins	• All Primary trails at 12.0 elevation, rustic trails at 11.0 -12.0 elevation where feasible, boardwalks at 13.0, bridges at 15.0 • Boardwalk, floating boardwalk, or bridge over OLW from island to beach • Primitive seasonal trail to overlook at OLW • Rustic trail to overlook and boardwalks • New bridge between Perkins and OLW • Expand Perkins parking lot footprint, adding 24 spaces • Restrooms, interpretive kiosk, and docent station (±100 SF for school group focus) • Bike racks and bike lockers (rental) • Primary trail in wetlands north of Perkins Road parking leading to West McWane Blvd.	• All primary trails 15.0, rustic and primitive trails at 13.0 elevation, pier/boardwalks at 15.0 • Bridge over tšumaš Creek • Elevated boardwalk from tšumaš Creek bridge to Perkins parking lot • Elevated boardwalk to an overlook pier • Rustic trail to overlook at OLW • Primary developed multi-modal trail from Perkins across wetlands, leading to West McWane Blvd trailhead • Expand Perkins Parking Lot footprint, adding 50 spaces • Visitor's Center (Future), bike racks, bike lockers, interpretive and educational signage, docent staff, security, lighting
2	Restoration	• Maintain brackish marsh west of OLW • Close culvert in eastern levee of OLW to enhance salinity, and rebuild southern section of OLW levee-berm to reduce freshwater flows from OLW to Area 3a via southern Area 2 • Enhance seasonal wetlands with weeding and planting • Enhance and restore upland areas with weeding and planting • Eliminate berms and ditch between Area 2 and 3a • Create bioswale to capture freshwater runoff from McWane Blvd to maintain higher salinity in salt marsh	• Re-align OLW and grade to allow engagement with floodplain and brackish marsh • Minor grading to create gently sloping brackish marsh plain along new channel • Balance cut-fill within the area by filling old channel and adding flood protection around edges of property • Create smooth transition between Areas 2 and 3a • Create bioswale to capture nutrients in runoff from McWane Blvd.	• Re-align OLW and grade to allow engagement with floodplain and brackish marsh • Fill old channel and add flood protection around edges of property • Place fill from newly excavated lagoon in 3a on edges of property to create upland habitats • Create smooth transition between Areas 2 and 3a • Create bioswale to capture nutrients in runoff from McWane Blvd.

TABLE 6-1
OVERVIEW OF ALTERNATIVES WITH RESTORATION AND PUBLIC ACCESS ELEMENTS

Area	Design Element	Alternative 1 **Salt Marsh Theme** Minimal Intervention	Alternative 2 **Habitat Diversity** Moderate Intervention	Alternative 3 **Habitat Connectivity** Greater Intervention
2 (cont.)	Public Access	• New Parking at extended West McWane Blvd., parallel on road with ADA parking at end (±15 spaces) • New trailhead with primary developed trail, seasonal primitive trail loop, creek overlooks • Bridge over OLW and primary developed trail/ CA Coastal Trail to East McWane Blvd. elevated overlook. • Constrained, scheduled, minor access point at East McWane Blvd. (at-grade train crossing and frequent train parking on track)	• New Major trailhead with 25+ parking spaces and interpretive signage • New primary developed trail and boardwalk, CA Coastal Trail • Rustic wetland loop trail with boardwalks, creek overlook on island • Bridge over OLW with birding overlook • Elevated overlook near East McWane • Minor pedestrian and bike trailhead at Hueneme Road • Primary multi-modal trail at Hueneme Road (at-grade railroad crossing) to East McWane Blvd., CA Coastal Trail	• New Major trailhead with 25+ parking spaces and interpretive signage • New multi-modal primary developed trail and CA Coastal Trail • Elevated wetland boardwalk to rustic loop trail • Elevated overlook • Bridge over OLW with overlook • No access at East McWane Blvd.
3	Restoration	• Limit off-site surface drainage to retain salts, sustain and expand salt marsh and salt panne habitats • Eliminate berms and ditch between Areas 2 and 3a • Weeding and planting in upland areas • Expand existing small population of salt marsh bird's beak	• Re-align OLW and grade to allow engagement with floodplain and brackish marsh • Minor grading to create gently sloping brackish marsh plain along new channel • Let habitat naturally convert from salt marsh to brackish marsh • Establish additional Coulter's goldfield populations in other areas on-site by collecting seed and distributing in appropriate areas • Weeding and planting in upland areas • Water control structure (culvert) under the railroad	• Excavate new lagoon with open water habitats and an intermittently open (un-managed) mouth through the dunes to the ocean • Place excavated material in Area 2 and edges of Area 3A to protect neighbors from flooding • Revegetate as needed with upland, transition and brackish marsh species • Allow for future channel to connect the new lagoon to Area 4 as Area 4 becomes wetter with sea-level rise • Water control structure (culvert) under the railroad • Construct berm between Area 3a and 3b to prevent second lagoon from flooding Area 3b to maintain salt marsh there • Establish additional Coulter's goldfield populations in other areas on-site by collecting seed and distributing in appropriate areas

TABLE 6-1
OVERVIEW OF ALTERNATIVES WITH RESTORATION AND PUBLIC ACCESS ELEMENTS

Area	Design Element	Alternative 1 **Salt Marsh Theme** Minimal Intervention	Alternative 2 **Habitat Diversity** Moderate Intervention	Alternative 3 **Habitat Connectivity** Greater Intervention
3 (cont.)	Public Access	• Primary Developed CA Coastal Trail from East McWane Blvd. to beach though Area 3a • Wetland boardwalk behind back dunes • Wetland birding overlook	• Primary multi-modal trail, CA Coastal Trail • Overlook platforms • Wetland boardwalk behind back dunes • Birding overlook with platforms and viewing scope (into OLW Area 1) • Boardwalks through back dunes and wetlands • Beach overlook platform with bike racks • Back dune boardwalks with bird fencing	• Primary multi-modal trail, CA Coastal Trail • Overlook Platforms • Bridge over OLW/Agricultural ditch creek • Wetland boardwalks • Birding overlook platform with bird blinds • Backdune boardwalks • Elevated boardwalks through Area 3b • At-grade railroad crossing
4	Restoration	• Cease farming and do minor grading to eliminate roads, ditches and any tile drains • Assess need for soil amendments to create appropriate salt marsh soils (relatively high silt and clay content) • Fill in diagonal drainage ditch; capture inflows in bioswale located adjacent to McWane Blvd. • Plant salt marsh species below about 9 feet NAVD88 and consider irrigating with brackish water or saltwater • Establish transition zone habitat above about 9 feet NAVD88 with planting and weeding as needed	• Cease farming and excavate a series of shallow basins at increasing elevations from south to north • Water control structure (culvert) under the railroad to allow hydraulic connectivity between Areas 4 and 3 may be installed, to be determined. • Basins will undergo type changes as the sea level rises • Lower basin expected to support salt panne habitat at about 5 feet NAVD88 in the short term and evolve in to open water with moderate sea-level rise • Middle basin(s) expected to support seasonal saline-effected wetlands at about 7 feet NAVD88 and evolve in to salt marsh and salt panne with moderate sea-level rise • Upper basin(s) expected to support seasonal wetlands and act as a bioswale at about 9 feet NAVD88 and evolve in to salt marsh and salt panne with greater sea-level rise • Establish salt marsh (below about 9 feet NAVD88) and transition zone vegetation (above about 9 feet) around basins	• Cease farming and excavate a large shallow basin to about 5 feet NAVD88 to create a large salt panne • Place excavated material in the northern areas and revegetate with upland (above 11 feet NAVD88) and transition (between 9 and 11 feet NAVD88) species • Restore salt marsh around the salt panne between about 6 and 9 feet NAVD88 • Fill in the diagonal ditch between McWane Blvd. and ODD # 3 and remove levees between Areas 3b and 4 • Water control structure (culvert) under the railroad to allow hydraulic connectivity between Areas 4 and 3, hydraulic criteria to be determined during design

TABLE 6-1
OVERVIEW OF ALTERNATIVES WITH RESTORATION AND PUBLIC ACCESS ELEMENTS

Area	Design Element	Alternative 1 **Salt Marsh Theme** Minimal Intervention	Alternative 2 **Habitat Diversity** Moderate Intervention	Alternative 3 **Habitat Connectivity** Greater Intervention
4 (cont.)	Public Access	• Major trailhead with new parking lot (±25 stalls, ADA stalls) • Interpretive signage • Farm exclusion fencing along rustic trail	• Parallel parking on East McWane for McWane east access (constrained, first phase) • Major trail head and parking lot (±25 spaces + ADA) with interpretive and educational exhibits, trail maps (future phase) • Wetland Education Loop Trail: primitive trail through wetlands with birding platforms, overlooks, boardwalks, observation nodes, subject to seasonal closures when flooded in major events (future phase), at grade railroad crossing to Area 3	• Major trailhead and ±50 stall parking lot at McWane Blvd. and Edison intersection (Future, high point of site) • Bike services for CA Coastal Trail riders, including racks, lockers, minor repair station. • New Community Wetland Center (future) • Multi-modal primary elevated trail, CA Coastal Trail
5	Restoration	• Modify culverts between Area 5 and ODD #3 to retain salts on-site and support more ponding and salt marsh and salt panne habitat, and to support existing Mugu hydrology; monitor to assure no polluted waters/sediments are impacting restoration sites. • Plant salt marsh below about 7.5 feet NAVD88 and transition species above 7.5 feet NAVD88 • Expect salt panne below about 5 feet NAVD88 • Consider irrigating with brackish water or saltwater	• Leave culverts between the northern part of Area 5 and ODD #3 as is to minimize changes to hydrology in the western arm of Mugu Lagoon • Expand salt marsh in southern portion of Area 5 by removing some roads/levees and building a berm eliminate drainage (and removal of salts) toward ODD #3 • Weeding and planting to restore saline seasonal wetlands where highly degraded wetlands currently occur • Weeding and planting to restore upland habitats where weedy uplands currently occur • Planting to restore salt marsh in south eastern area with possible brackish water/saltwater irrigation	• Eliminate culverts between Area 5 and ODD #3 (or reduce connectivity with berms, similar to Alternative 1) • Remove levees and fill the ditch of ODD #3 between Areas 5 and 6 (the dead end channel) to create continuous marsh plain • Remove all old roads and building pads • Create series of shallow basins at increasing elevation • Lowest basin expected to support salt panne in the near term at about 5 feet and open water habitats with moderate sea-level rise • Middle basin expected to support seasonal saline-effected wetlands at about 6 feet NAVD88 and evolve in to salt marsh and salt panne with moderate sea-level rise • Upper basin expected to support seasonal wetlands at about 8 feet NAVD88 and evolve in to salt marsh and salt panne with greater sea-level rise • Establish salt marsh (below about 7.5 feet NAVD88) and transition zone vegetation (above about 7.5 feet NAVD88) around basins
	Public Access	• No proposed access	• No proposed access	• Rustic trail to birding platform with wetland overlook • Opportunity for future connection to Edison Road for loop trail

TABLE 6-1
OVERVIEW OF ALTERNATIVES WITH RESTORATION AND PUBLIC ACCESS ELEMENTS

Area	Design Element	Alternative 1 **Salt Marsh Theme** Minimal Intervention	Alternative 2 **Habitat Diversity** Moderate Intervention	Alternative 3 **Habitat Connectivity** Greater Intervention
6	Restoration	• Maintain salt panne and salt marsh habitats with some weeding and revegetation as needed on higher spots • Restore upland habitats along ODD #3 levee	• Maintain salt panne and salt marsh habitats with some weeding and revegetation as needed on higher spots • Restore upland habitats along ODD #3 levee	• Maintain salt panne and salt marsh habitats with some weeding and revegetation as needed on higher spots • Restore upland habitats along ODD #3 levee • Remove levees and fill the ditch of ODD #3 between Areas 5 and 6 (the dead end channel) to create continuous marsh plain (in coordination with Oxnard Drainage District No. 2)
	Public Access	• Arnold Road closed to public traffic; emergency, maintenance, and public works access only	• Close existing parking lot at Arnold Road abutting Navy fence (non-compliant) • Future parallel parking along west side of Arnold Road • Drop-off and turn-around at Arnold Road, Emergency access, bike racks and bike lockers (rentals) • Elevated birding overlooks to salt panne • Raise and improve primary trail to beach • Primitive trail along ODD #3 (formalize existing trail) • Birding overlook in back dunes	• CA Coastal trail Class II bike trail on Arnold Road (future) • Close existing Arnold parking, provide only ADA parking stalls, drop-off and turn-around space for cars • Bike focused trailhead with bike lockers and bike racks • Elevated wetland overlook • Primitive trail along ODD #3 to Area 5 and beach • Birding overlook in back dunes • Rustic seasonal trail from trailhead to beach
7, 8, 9	Restoration	• Weeding and planting to restore back dune scrub habitat and expand foredune scrub habitat • Excavate series of shallow depression between dune ridges and vegetate with dune swale wetland species • Conduct minimal management of the dunes at the southern end to facilitate occasional (+/decadal) wave overwash events	• Weeding and planting to restore back dune scrub habitat and expand foredune scrub habitat • Excavate series of shallow depression between dune ridges and vegetate with dune swale wetland species • Excavate new connection between OLW and the lagoon through the dunes	• Weeding and planting to restore back dune scrub habitat and expand foredune scrub habitat • Excavate series of shallow depression between dune ridges and vegetate with dune swale wetland species • Add sand fencing and seed native dune species to facilitate wind-driven sand capture anddune building
	Public Access	• Area 7: New bird fencing • Beach trail from Dunes Area 3a and beach in front of power plant • Area 8: Beach spur trail to elevated birding overlook in backdunes (for birding views into Area 6) • CA Coastal Trail along beach strand	• Area 7: New bird fencing • Beach trail from dunes Area 3a and beach in front of Area 3b • Area 8: Beach trail to Arnold primitive trail • CA Coastal Trail along beach strand	• Area 7: New bird fencing • Backdune boardwalk • Dune Overlook platform with bike racks • CA Coastal Trail along beach strand

6.1.2 Public Access

The three alternatives for public access were developed to meet project goals and objectives for public access (Section 3.2).

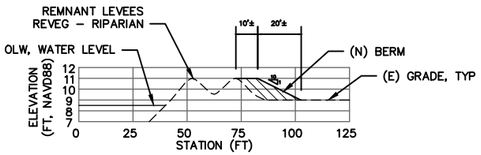
Information gained through public input also informed the character of the proposed access features in the alternatives, including areas the community is interested in visiting and the types of activities they would like to do. The Project Partners held a public meeting on June 21, 2017. In addition, the Project Partners gathered input from individual surveys conducted by the Central Coast Alliance United for a Sustainable Economy (CAUSE) (322 door-to-door in-person oral surveys with local South Oxnard residents, including Mixteco residents). One of the major themes that emerged at the public meeting was a desire to preserve the unique and rare coastal habitats found at Ormond Beach. Many community members expressed interest in viewing birds and other wildlife, connecting with nature, enjoying the beach, and facilitating use of the site for education by local schools. Survey results identified a desire for low-impact and free access activities or amenities such as picnic tables, beach access, walking paths, learning about nature, biking, and fishing. Multi-modal bicycle and walking paths with safe and easy neighborhood connections were commonly requested. The community also expressed desire for clean, safe, well-lit family-friendly experiences where children and adults alike could experience nature and relax.

In the design of public access for each alternative, the ecological restoration theme of the associated alternative was considered and built upon to develop an appropriate design approach. The types of habitat, the physical implications of the interventions proposed for the Project Area (hydrologic modifications leading to wetter environments, etc.), and the level of intervention was considered to develop the access plans so that the proposed access features are compatible with the proposed habitat and desired hydrologic conditions. Design of the public access elements also considered the potential to “mix and match” components of different alternatives into the Preferred Alternative.

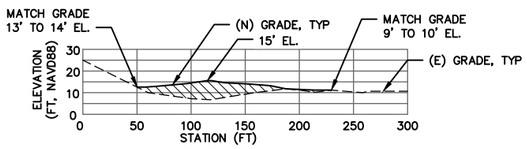
6.2 Description of Alternatives

Alternatives 1, 2, and 3 are described in Sections 6.2.1, 6.2.2, and 6.2.3, and shown in Figures 6-1, 6-2, and 6-3, respectively. Table 6-1 provides a summary of restoration actions and public access improvements for each alternative, by area. More detail for each alternative is provided below, including restoration actions and estimated acreages by habitat type within each of the nine areas. Typical earthwork cross sections are provided in **Figure 6-4a** and **Figure 6-4b**. The locations of earthwork sections are shown in the plan views in **Figure 6-5** (Alternative 1), **Figure 6-6** (Alternative 2), and **Figure 6-7** (Alternative 3). These plan views also show the habitats used to initiate the habitat evolution modeling described in Section 6.3.1. The distribution of habitat areas for each alternative is quantified in **Figure 6-8**.

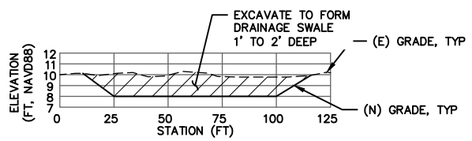
ALTERNATIVE 1



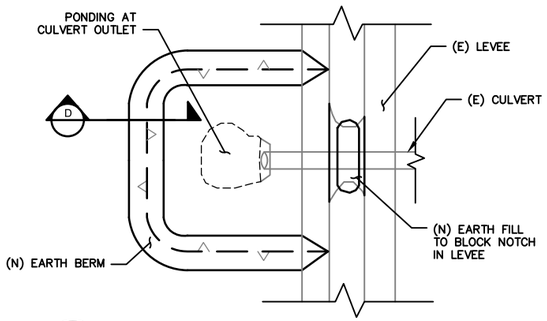
A / ALT 1 — ORMOND LAGOON WATERWAY SECTION, TYP



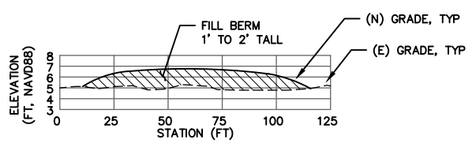
B / ALT 1 — BEACH LAGOON SECTION, TYP



C / ALT 1 — DRAINAGE SWALE SECTION, TYP

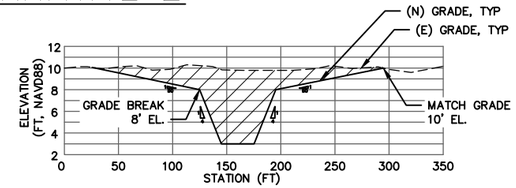


1 / ALT 1 — DRAINAGE CONTROL PLAN, TYP

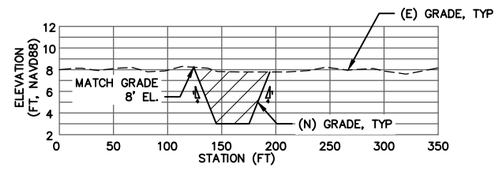


D / ALT 1 — DRAINAGE CONTROL BERM SECTION, TYP

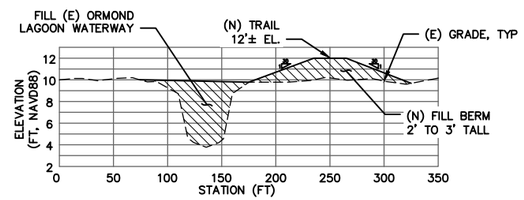
ALTERNATIVE 2



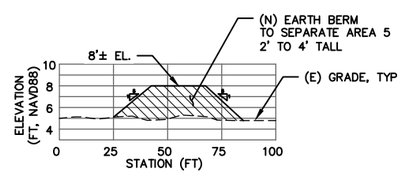
A / ALT 2 — (N) CHANNEL EXCAVATION SECTION, AREA 2, TYP



B / ALT 2 — (N) CHANNEL EXCAVATION SECTION, AREA 3A, TYP

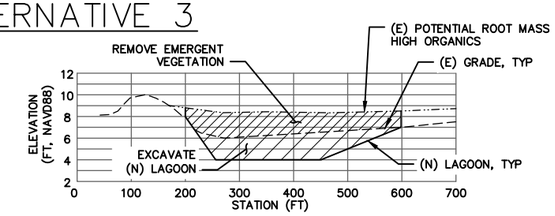


C / ALT 2 — (E) CHANNEL AND (N) BERM SECTION, TYP



D / ALT 2 — (N) BERM SECTION, AREA 5, TYP

ALTERNATIVE 3



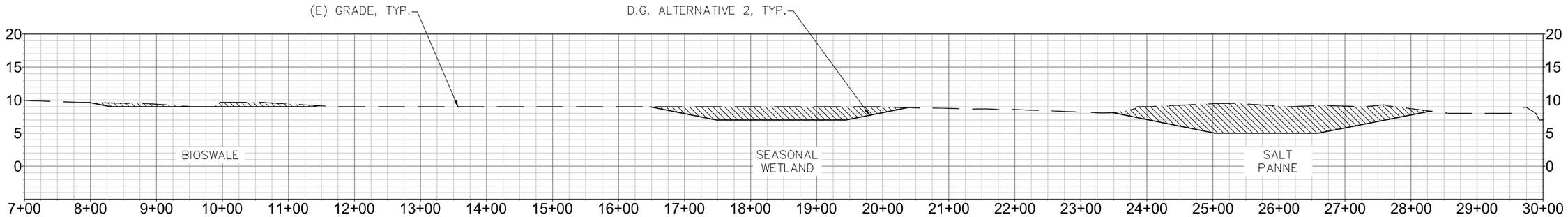
A / ALT 3 — (N) LAGOON SECTION, TYP

SOURCE: ESA, 2019

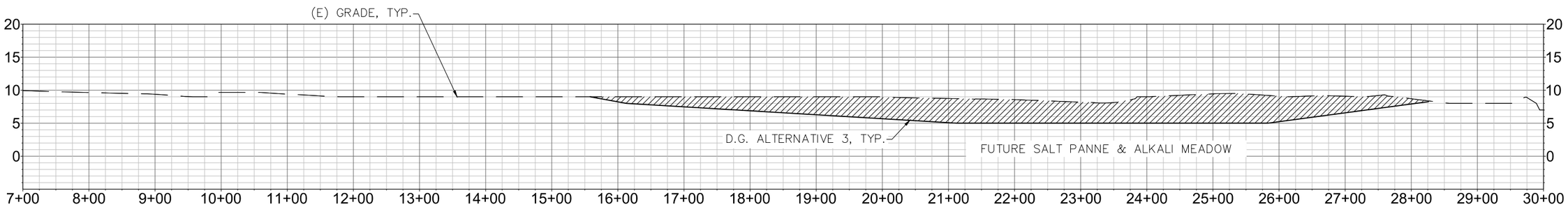
Ormond Beach Restoration and Public Access Plan

Figure 6-4a
Cross Sections for Project Alternatives

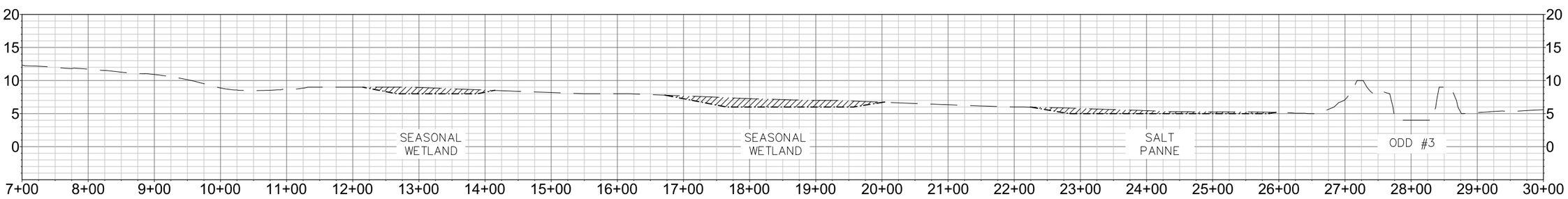
D160447.00 - Ormond Beach Wetlands Restoration\05 Graphics\Illustrator



E
Alt 2
AREA 4
CROSS SECTION
SCALE
h:
v:



B
Alt 3
AREA 4
CROSS SECTION
SCALE
h:
v:



C
Alt 3
AREA 5
CROSS SECTION
SCALE
h:
v:

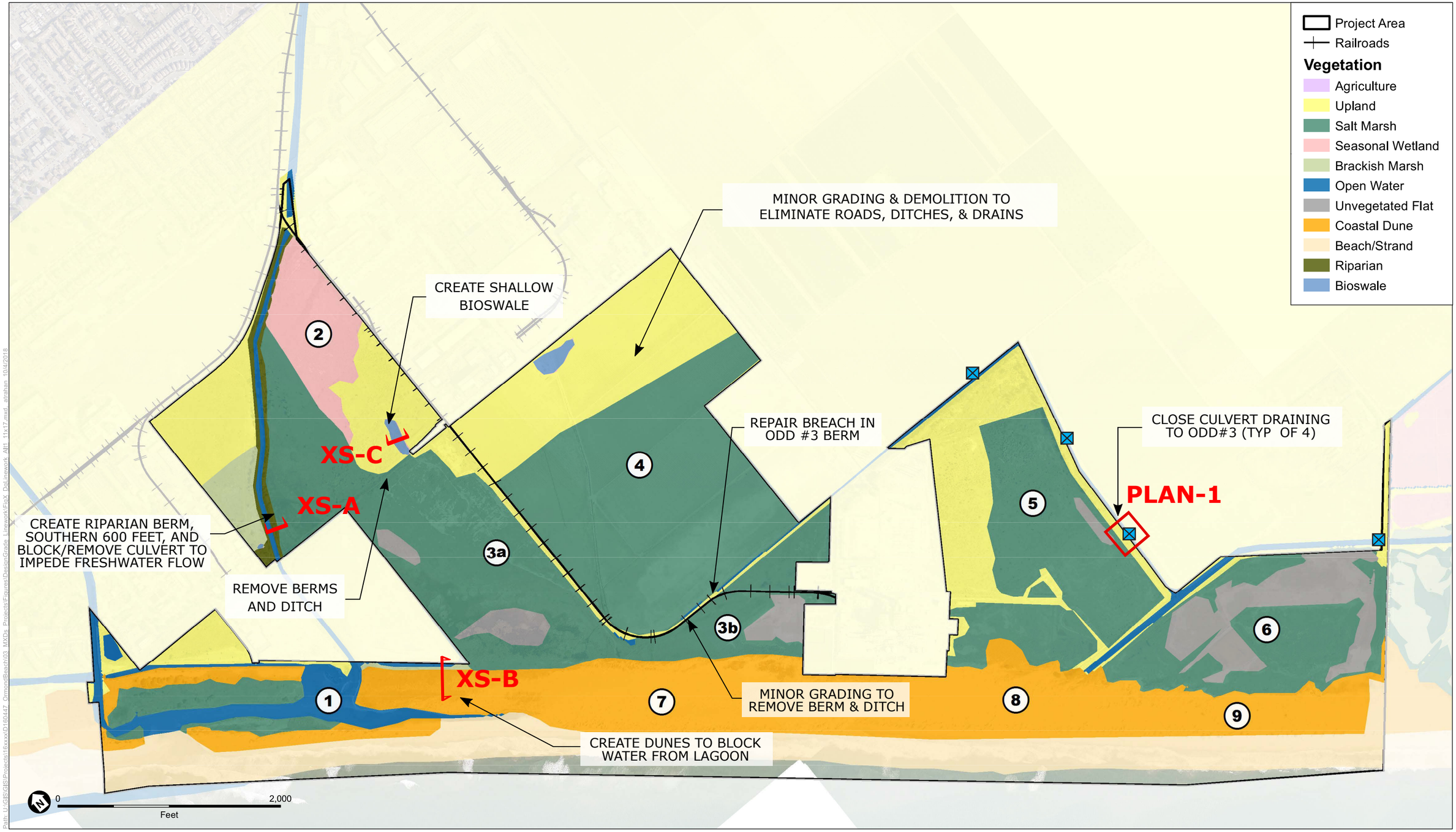
D160447.00 - Ormond Beach Wetlands Restoration\05 Graphics\Illustrator

SOURCE: ESA, 2019

Ormond Beach Restoration and Public Access Plan

Figure 6-4b
Cross Sections for Project Alternatives

ESA

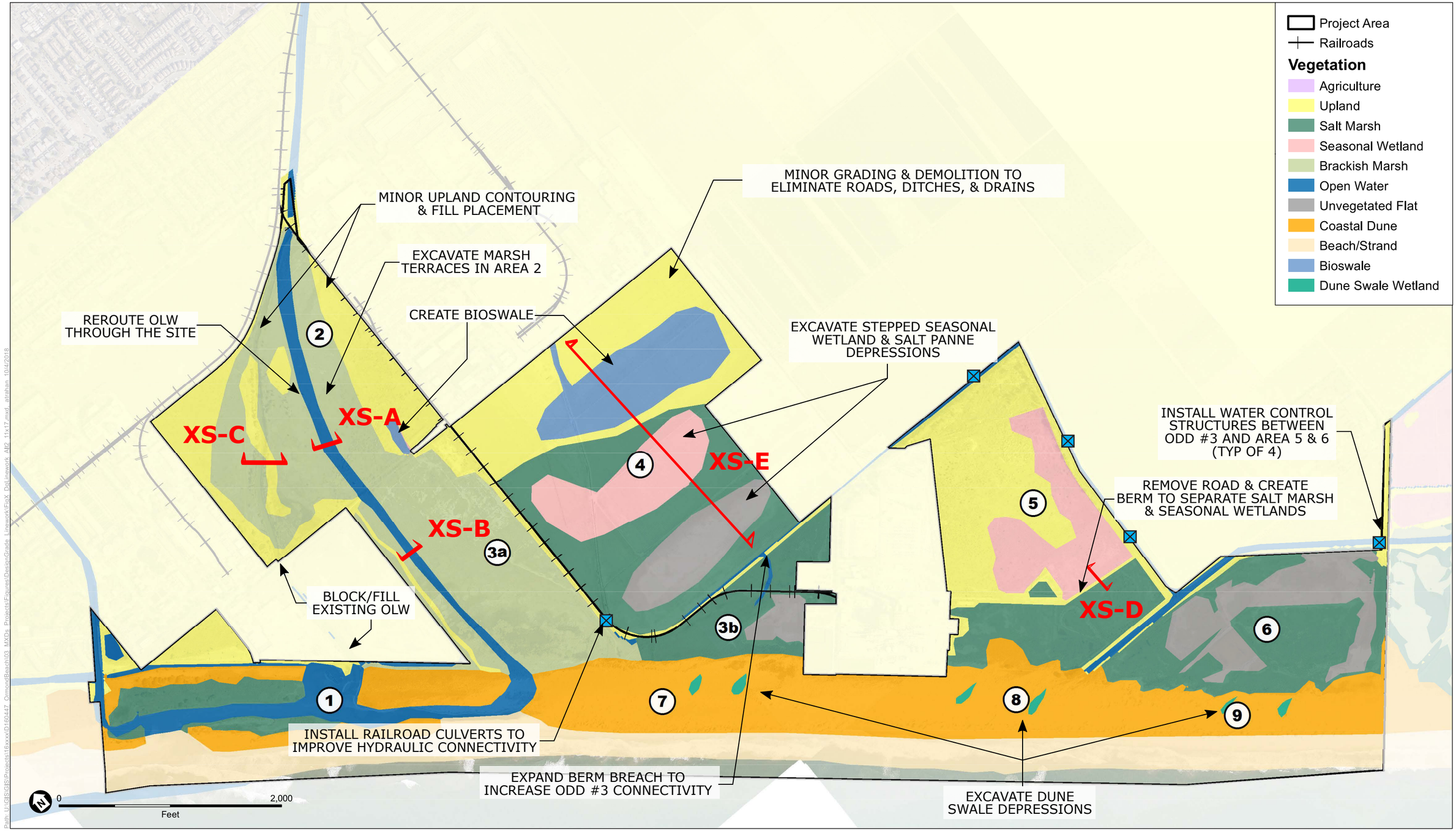


SOURCE: ESA (2017), CA Coastal Conservancy LiDAR (2011)

Ormond Beach Restoration and Public Access Plan

Figure 6-5
Alternative 1 Cross Section Locations

ESA

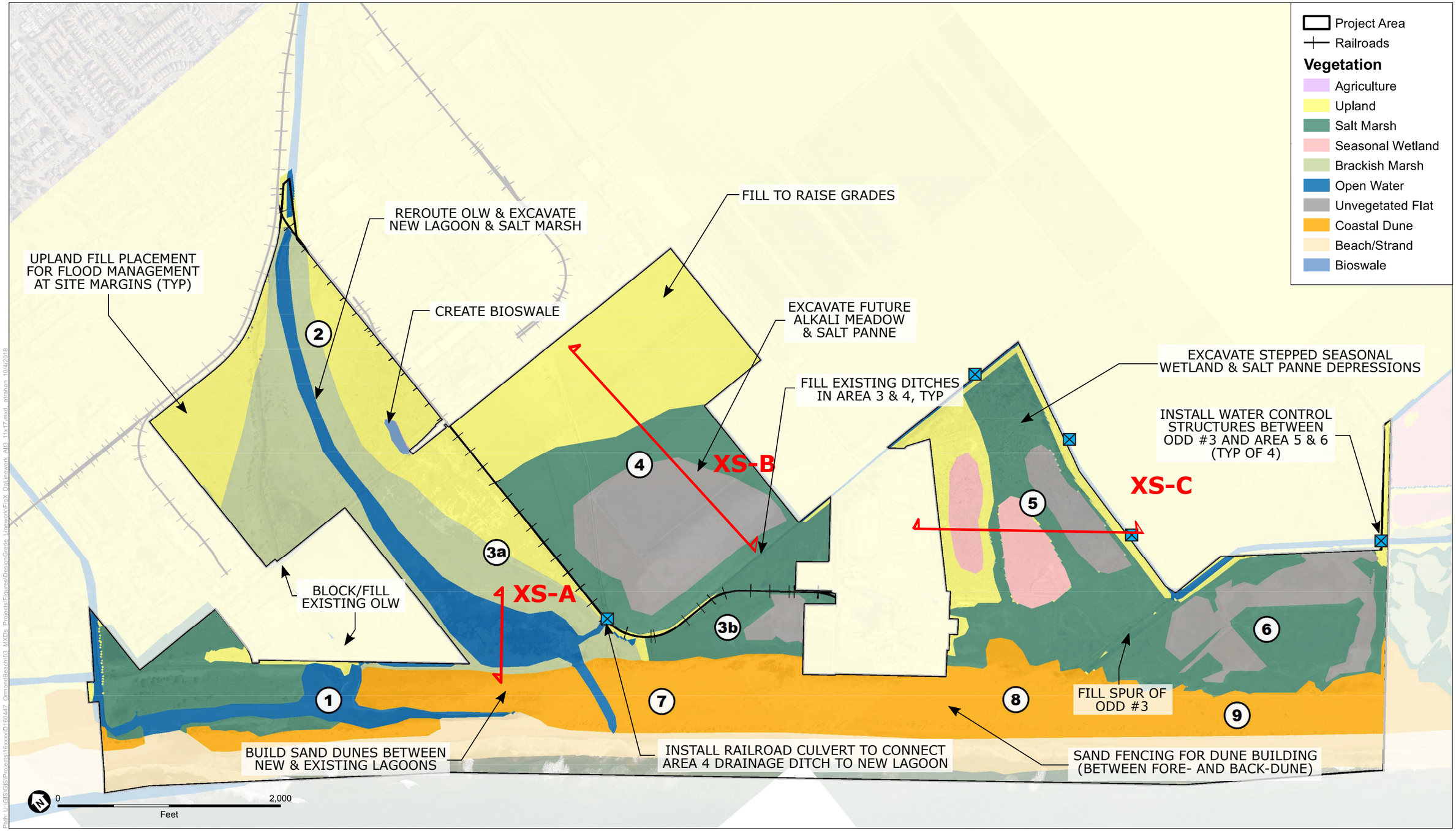


SOURCE: ESA (2017), CA Coastal Conservancy LiDAR (2011)

Ormond Beach Restoration and Public Access Plan

Figure 6-6
Alternative 2 Cross Section Locations

ESA



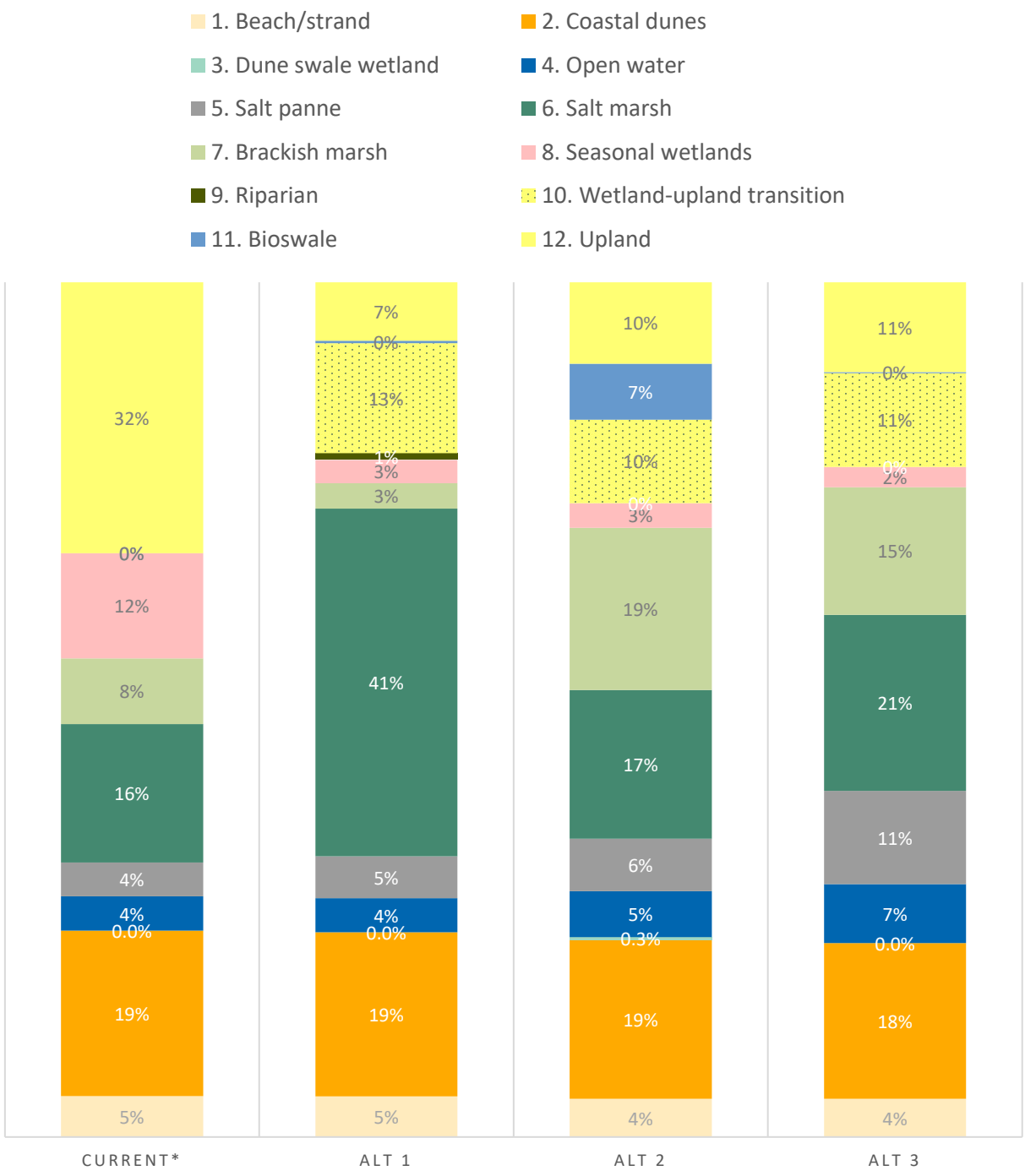
SOURCE: ESA (2017), CA Coastal Conservancy LiDAR (2011)

Ormond Beach Restoration and Public Access Plan

Figure 6-7
Alternative 3 Cross Section Locations

ESA

This page intentionally left blank



* Agricultural area (106 ac) and coyote brush scrub (30 ac) were grouped into "uplands". Willow scrub (<1 acre) was grouped with surrounding "seasonal wetlands".
* Wetland/Upland Transition is yellow in SLAMM figures and green in public access figures, so it is stippled in this figure.

D160447.00 - Ormond Beach Wetlands Restoration\05 Graphics\Illustrator

SOURCE: SFEI 2011, CRC 2018

Ormond Beach Restoration and Public Access Plan

Figure 6-8
Habitat Distribution by Alternative

ESA

6.2.1 Alternative 1

Overview

Alternative 1 emphasizes salt marsh and limited intervention (Figure 6-1).

Most of the Project Area was historically salt marsh habitat, but much of it has been lost due to soil disturbance and hydrologic alterations. This alternative seeks to restore salt marsh habitats through minor alterations to small channels, culverts and land forms with minimal earth moving. Local point source runoff will be directed to bioswales and away from core habitat areas to limit freshwater inputs and encourage retention or buildup of salts to support salt marsh and salt panne, instead of brackish and freshwater marsh. Resilience to sea-level rise is built into the design by preserving higher-elevation upland and transitional areas to accommodate up-slope migration of salt marsh (Areas 2 and 4) habitat. Existing high-value habitats in Areas 3b, 5, and 6 would be preserved. There would be minimal actions taken in the dunes.

The public access features proposed for Alternative 1 could be implemented with limited grading or other disturbance. This access alternative focuses on utilizing existing infrastructure (such as roads, trails, parking lots, etc.), largely preserving existing conditions. It provides three new entry points to the site and shifts the concentration of public use to the west. This alternative provides the least number of access points and trails, in effect preserving vast contiguous areas of the site for habitat. The trails and access elements can largely be implemented immediately, with options for phased boardwalks to accommodate sea-level rise and habitat migration in the future (i.e., wetland expansion inland).

Actions

Overview by Areas

The ecological restoration will consist mostly of enhancement, defined as improving existing habitats based on limited earthwork, planting and vegetation management.

More extensive grading is proposed for the areas north and south of the Halaco properties, to block surface water flow from OLW and Ormond Lagoon to the area north and east of the Halaco properties slag pile (primarily Area 3a).

The banks of OLW (Area 2) and the north banks of Ormond Lagoon (Area 1) will be mostly maintained as-is, and enhanced with some weeding and planting for riparian vegetation (depending on salinity) and brackish marsh, respectively. An exception entails modification east bank of OLW, where the southern 600 linear will be regraded on the landside of the eroded levee-berm to provide a contiguous berm crest: the purpose is to reduce fresh water supply to Area 3a via southern Area 2. Also, an existing culvert in this area will be plugged or removed for the same purpose (it is believed to be a conduit for freshwater “back-flowing” into Areas 2 and 3a). A cross section of this action is shown in Section A, Figure 6-4a. The upland areas will also be enhanced by weeding and planting, with limited to no earthwork, with the exception that some selective fine grading to enhance wetlands.

In Areas 3a and 3b, salt marsh and salt panne habitats will be enhanced. Special-status plants would be maintained, and potentially expanded or provided with inland expansion pathways via grading, planting and vegetation management actions.

The agricultural area (Area 4) will be taken out of agriculture and transitioned into wetland. Conceptually, the conversion from agriculture to natural area could progress from south to north, and occur in several steps associated with the existing site drainage divisions, or as part of a single effort. One or more drainage swale features would capture stormwater runoff from adjacent pavements, increase residence time, and facilitate breakdown of organics and cycling of nutrients prior to flows entering the perennial wetland areas.

Areas 5 and 6 will be enhanced as salt marsh and salt panne. Localized earthwork will be employed to reduce site drainage to ODD #3, and to enhance salt accumulation on the site. Continued salt input from the ocean, ditch backwater, and groundwater, together with evaporation, will increase salinity and thus maintain salt marsh and salt panne.

Weeding and planting of beach-dune Areas 7, 8, and 9 is included subject to funding for ongoing maintenance activities (such funding may not be available, or these actions may be accomplished by others). Special consideration to Area 9 (adjacent to Area 6) is recommended so that wave overtopping is maintained. Management activities could target plant management to limit high-dune relief that blocks wave run-up while maintaining low hummocks, similar to existing conditions, though these actions are not expected as part of this project.

More details on area-specific actions and expected outcomes is provided in **Table 6-2**.

Grading

Typical earthwork cross sections are provided in Figures 6-4a and 6.4b, with corresponding locations marked on the Alternative 1 Plan (Figure 6-5). Excavated soil will be reused beneficially on-site as practicable.

Earthwork will be limited to that needed to enhance existing habitats, and will include removal of legacy structures such as irrigation channels and pavement, flattening of banks, and localized creation of swales (shallow depressions). Grading will be limited and targeted with the goal of reducing freshwater inflows that are altering the marsh in Area 3a. Grading will reduce surface water flows into 3a but will not block groundwater and direct precipitation.

TABLE 6-2
ALTERNATIVE 1 ACTIONS BY AREA

Area	Sub-area	Habitat Type	Actions/Expected Outcomes			Projected changes with sea-level rise
			Earth moving	Vegetation	Hydrology/Salinity	
1	1.1	Brackish marsh	None	Non-native species control	As-is	Conversion toward open water
	1.2	Open water	None	N/A	As-is	Lagoon will retreat landward
	1.3	Coastal dune	None	Non-native species control	N/A	Conversion to beach/strand as the shoreline retreats & marsh/open water as the lagoon migrates landward
	1.4	Upland	None	Non-native species control. Planting grassland & coastal sage scrub	N/A	Conversion toward salt marsh then brackish marsh as water table nears surface
	1.5	Beach/strand	Continued mouth management	None	As-is	Conversion to intertidal beach & surf zone
2	2.1	Salt marsh	• Minor grading to eliminate berms & ditch between Areas 2 & 3a • Restore berm along east bank, of OLW, southern 600 feet, to reduce overtopping and fresh water supply to salt marsh in 3a	• Tule marsh expected to convert to salt marsh with increasing salinity • Weed & plant as needed • Expect salt marsh up to about 9.5' contour	• Reduce surface connection to OLW by restoring berm crest, southern 600 feet east bank, and blocking existing culvert that is flowing “backwards” into Areas 2 and then 3a • Salinity should increase with decreased drainage • Sewer trunk line is dewatering the area & may preclude desired habitat conversion	Conversion to brackish marsh as water table reaches surface & eventually to open water as growing-season water depth exceeds about 2'
	2.2	Brackish marsh	None	Non-native species control & planting brackish marsh species to increase diversity	As-is	Conversion toward open water
	2.3	Riparian	None	• Eliminate non-native trees & shrubs • Control other non-natives • Plant willows & mulefat (depending on salinity)	Soil & groundwater salinity may be too high for riparian so suggest pilot plantings	Conversion to brackish marsh with increasing salinity
	2.4	Upland	None	Non-native species control, planting grassland & coastal sage scrub	N/A	Conversion toward brackish marsh as water table nears surface

TABLE 6-2
ALTERNATIVE 1 ACTIONS BY AREA

Area	Sub-area	Habitat Type	Actions/Expected Outcomes			Projected changes with sea-level rise
			Earth moving	Vegetation	Hydrology/Salinity	
2 (cont.)	2.5	Seasonal wetland	None	• Control non-natives & plant salt-tolerant natives that tolerate wet winter & dry summer conditions • Consider introducing locally & regionally rare species such as *Salicornia depressa, Atriplex coulteri, A. pacifica, A. serenana var. davidsonii, Lasthenia glabrata ssp. coulteri, Suaeda calceoliformis, Astragalus pycnostachyus var. lanosissimus,* etc.	• Rare seasonal flooding primarily by rainfall • Saline groundwater generally below the rooting zone • Salts transported in to the rooting zone, generally pushed deeper & diluted in the winter with rainfall & closer to the surface & more concentrated in the summer	Conversion toward brackish marsh as water table nears surface
	2.6	Bioswale	• Create shallow basin of sufficient volume to capture dry-season runoff from McWane Blvd • Consider including forebay that traps sediment & can be cleaned out occasionally • Direct outflow toward seasonal wetland area	Plant with cattail & tule	• Basin will capture surface flows & allow plants to uptake water, nutrients & other pollutants • Encourage percolation with coarse soil & large area • Expect slightly brackish conditions	As the water table rises, water will percolate less efficiently & when the water table reaches the surface, the basin will begin to lose capacity
	2.7	Open water	None	Tule on the edges of the channel will remain	As-is	Water will get deeper & tule fringe will move up the banks
3a	3a.1	Salt marsh	• Minor grading to eliminate berms & ditch between Areas 2 & 3a • Minor grading to eliminate drainage to the lagoon by creating a berm to about 10ft NAVD88	• Let pickleweed & other salt marsh species recolonize areas as cattail & tule die of due to higher salinity soils over time • Consider options to expand salt marsh bird's beak population • Consider weeding in high marsh areas & replanting with rare salt-tolerant natives (see subarea 2.5 above for list)	• Lower areas will pond with rainfall but drainage off-site will be limited • Decreased off-site drainage should lead to increased salinity over time • The water level in the lagoon is probably driving groundwater elevations in this area	Rising groundwater will eventually lead to wetter & less salty year-round conditions & eventual conversion to brackish marsh & open water

TABLE 6-2
ALTERNATIVE 1 ACTIONS BY AREA

Area	Sub-area	Habitat Type	Actions/Expected Outcomes			Projected changes with sea-level rise
			Earth moving	Vegetation	Hydrology/Salinity	
3a (cont.)	3a.2	Salt panne	None	None	• Ponding with rainfall but drainage off-site will be limited & salt concentrations should build up over time • Soils & surface water should eventually become hypersaline • The water level in the lagoon is probably driving groundwater elevations in this area	Rising groundwater will eventually lead to wetter year-round conditions & eventual conversion to brackish marsh & open water
	3a.3	Upland	None	Non-native species control & planting grassland & coastal sage scrub	N/A	Conversion toward salt marsh then brackish marsh as water table nears surface
3b	3b.1	Salt marsh	Minor grading to eliminate breach in berm that allows the site to drain to ODD #3	Some salt marsh may convert to salt panne as ponding increases & salts build up	• Expect salinity to rise over time with decreased drainage • Expect longer-duration ponding from rainfall • This area probably has less brackish groundwater influence from the lagoon & more salty groundwater influence from the ocean than Area 3a	Assuming limited influence on groundwater from the lagoon, rising salty groundwater from the ocean will cause conversion to salt panne & then open water
	3b.2	Salt panne	None	N/A	• Expect salinity to rise over time with decreased drainage • Expect longer-duration ponding from rainfall • This area probably has less brackish groundwater influence from the lagoon & more salty groundwater influence from the ocean than Area 3a	Assuming limited influence on groundwater from the lagoon, rising salty groundwater from the ocean will cause conversion to open water
	3b.3	Upland	Minor grading to eliminate breach in berm that allows the site to drain to ODD #3	Non-native species control & planting grassland & coastal sage scrub	N/A	Conversion toward salt marsh as the water table nears surface
	3b.4	Open water	None	Tule on the edges of the channel will remain	As-is	Water will get deeper & tule fringe will move up the banks

TABLE 6-2
ALTERNATIVE 1 ACTIONS BY AREA

Area	Sub-area	Habitat Type	Actions/Expected Outcomes			Projected changes with sea-level rise
			Earth moving	Vegetation	Hydrology/Salinity	
4	4.1	Salt marsh	• Minor grading to eliminate roads, ditches & any tile drains • Area could be a broad almost flat plain gently sloping southwest or could contain shallow basins & higher areas • Soil texture should be studied & appropriate amendments added (e.g., bentonite) to mimic salt marsh soil	• Area will need revegetation & possibly short-term weed control • Expect salt marsh below about 9 feet NAVD88 • Consider options such as irrigating with salt or brackish water to control weeds & favor salt marsh species • Dominant species would include *Salicornia pacifica, Distichlis spicata & Jaumea carnosa*	• The brackish water table is expected to be within a couple feet of the surface once ditches & drains are removed • If basins are excavated, the area might pond water also	Rising salty groundwater from the ocean will cause conversion to salt panne & then open water
	4.2	Wetland-upland transition	• Minor grading to eliminate roads, ditches & any tile drains • Area should be a broad almost flat plain gently sloping toward the salt marsh	• The area will need revegetation & probably short-term weed control • Expect transition zone above about 9 feet NAVD88 • Typical species would include shrubs that can tolerate some salinity & occasional flooding such as *Atriplex lentiformis, Suaeda calceoliformis, S. taxifolia & Isocoma menziesii*	• Very rare flooding for short durations with brackish water • Some buildup of salts in soil • Water table below the rooting zone	Conversion toward salt marsh as the water table nears the surface
	4.3	Bioswale	• Create shallow basin of sufficient volume to capture dry-season runoff from McWane Blvd • Consider including forebay that traps sediment & can be cleaned out occasionally	Plant with cattail & tule	• Basin will capture surface flows & allow plants to uptake water, nutrients & other pollutants • Encourage percolation with coarse soil & large area • Expect slightly brackish conditions	As the water table rises, water will percolate less efficiently & when the water table reaches the surface, the basin will begin to lose capacity
	4.4	Open water	None	None	As-is	Water will get deeper & tule fringe will move up the banks
5	5.1	Salt marsh	Close culverts draining the area to ODD #3	• No actions in existing salt marsh area • Plant new salt marsh with appropriate salt marsh species	• Salt marsh areas would pond with rainfall & retain salts (similar to other salt marsh habitats on-site) • Expect salt marsh between about 5 &7.5 feet NAVD88	Rising salty groundwater from the ocean will cause conversion to salt panne & then open water

TABLE 6-2
ALTERNATIVE 1 ACTIONS BY AREA

Area	Sub-area	Habitat Type	Actions/Expected Outcomes			Projected changes with sea-level rise
			Earth moving	Vegetation	Hydrology/Salinity	
5 (cont.)	5.2	Salt panne	Salt panne habitat could be expanded by creating a low shallow basin	N/A	• Salt panne areas would pond with rainfall & retain salts (similar to other salt panne habitats on-site) • Expect salt panne below about 5 feet NAVD88	Rising salty groundwater from the ocean will cause conversion to open water
	5.3	Wetland-upland transition	None	• Eliminate iceplant & non-native trees • Expect transition zone above about 7.5 feet NAVD88 • Typical species would include shrubs that can tolerate some salinity & occasional flooding such as *Atriplex lentiformis, Suaeda calceoliformis, S. taxifolia & Isocoma menziesii*	• Very rare flooding for short durations with brackish water • Some buildup of salts in soil • Water table below the rooting zone	Rising salty groundwater from the ocean will cause conversion to salt marsh
	5.4	Upland	None	Non-native species control & planting coastal sage scrub	N/A	Rising water in ODD #3 will lead to conversion to brackish or salt marsh
	5.5	Open water	None	Tule on the edges of the channel will remain	As-is	Water will get deeper & tule fringe will move up the banks
6	6.1	Salt marsh	None	Non-native species control	As-is	• Conversion to salt panne & open water as groundwater level rises • Dunes will migrate landward & bury salt marsh
	6.2	Salt panne	None	None	As-is	Conversion to open water as groundwater level rises
	6.3	Upland	None	Non-native species control	N/A	Conversion to salt marsh habitat as groundwater level rises
	6.4	Open water	None	Tule on the edges of the channel will remain	As-is	Water will get deeper & tule fringe will move up the banks

TABLE 6-2
ALTERNATIVE 1 ACTIONS BY AREA

Area	Sub-area	Habitat Type	Actions/Expected Outcomes			Projected changes with sea-level rise
			Earth moving	Vegetation	Hydrology/Salinity	
7, 8, 9	7, 8, 9.1	Coastal dune	Optional occasional lowering of dune berm at southern end	• Optional planting of dune species • Maintain low cover at southern end to discourage dune building	Encourage rare (~decadal) overwash into Area 6 at southern end during large wave events	Conversion to strand & beach as the coast retreats
	7, 8, 9.2	Beach/strand	None	None	As-is	Conversion to intertidal & surf zone as the beach retreats

One exception is fill placement to block surface water flows from the OLW to the area near the Halaco properties and McWane corridor (southeastern Area 2 and northwestern Area 3a), and south of the Halaco properties, between Ormond Lagoon and Area 3a. This earthwork is expected to consist of fill in existing channels, mounded above existing elevations. Typical earthwork cross-sections A and B show the earthwork to block surface flow (cross sections are drawn in Figure 6-4a and located in the plan view in Figure 6-5). Cross-section A shows the placement of earth fill on the east side of OLW for a length of 600 feet, on the land side of the remnant levee, to form a barrier to surface flow; we anticipate that this new earth would be graded and planted to mimic a brackish-riparian channel berm. Cross-section B shows fill placement to block the channel-swale just south of the Halaco properties. We anticipate that this earth would be graded and planted to resemble a high-relief dune, with crest elevation between 10 and 15 feet NAVD88.

The grading to reduce surface water flows from Areas 1 and 2 to Area 3 is not expected to increase flooding along Ormond Lagoon and OLW based on modeling of lagoon hydrology (see Section 6.4 Alternative Evaluation and Appendix C).

Shallow drainage swales would be excavated to capture runoff from paved areas, as shown schematically in cross-section C.

More intensive earthwork is also targeted to mute the draining of the Area 5 and 6 to drainage ditches, including where deteriorating culverts and levee erosion have increased the drainage from the wetlands. Detailed Plan 1 and Section D on Figure 6-4a show the treatment at each of the four culverts between Areas 5 and 6 and the ODD #3. Earth would be used to reconstruct degraded levee crests and a berm would inhibit drainage from the sites. The berm would be low enough that the effect would be limited, but enough to pond water to depths up to 2 feet.

Infrastructure Modification

Existing infrastructure will be removed where it interferes with habitat establishment, adversely affects drainage or intersects desired grades. The primary infrastructure modification will be removal of drainage works in the agriculture parcel (Area 4).

An existing culvert that conveys water from OLW to the southeast portion of Area 2 will be removed and the levee locally regraded to block freshening of the brackish marsh in the vicinity.

A breach in the levee between Area 3b and the remnant drainage ditch (western extension of ODD #3) will be filled and locally regraded to inhibit drainage and enhance salt concentration via evaporation in the salt panne area.

The existing, deteriorating drainage culverts between Areas 5 and 6 and ODD #3 may be removed and replaced, along with grading, to increase area ponding and salt accumulation.

Public Access, Trails, and Site Amenities

The trails and amenities in Alternative 1 are focused near the existing western entry points; this alternative proposes additional trailheads at the western edge of the site in an effort to concentrate

visitors near existing neighborhoods, public transportation routes, existing or proposed bike trails, and the Port Hueneme Beach (Figure 6-1 Alternative 1). Alternative 1 modifies the eastern parking lot and public entry point at Arnold Road, limiting entry for emergency, natural resource management, and security. Alternative 1 trails and public amenities would be site-wide and primarily based on existing roads and trails, resulting in larger amounts of contiguous habitat areas. A discussion of specific elements in each area follows.

The existing Perkins Road parking lot (Access Node A in Area 1) would be expanded to accommodate visitor services such as security, a docent kiosk, and interpretive elements by using fill soil obtained from grading activities to create more level area at the same grade as the existing parking lot. A bridge is proposed over tšumaš Creek, with a primary trail leading from Hueneme Beach Park to Perkins Road, and to an overlook platform at Ormond Lagoon. A small loop trail is proposed with primitive and rustic trails, foot-bridges, an overlook platform, and tranquil viewing areas with benches to offer visitors a peaceful nature experience.

A new trailhead is proposed at West McWane Blvd. (Access Node B1) with parking on the existing road right-of-way owned by the City of Oxnard, which would be improved and reconfigured for this purpose. A new trail loop is proposed in the west side of Area 2, and a CA Coastal Trail primary route runs east-west to East McWane Blvd. (Access Node B2, a constrained access point due to railway spur train parking). This East McWane Blvd. primary trail heads south to the ocean from East McWane Blvd. roughly following the railroad corridor through Area 3a, to a set of wetland boardwalks (which can be implemented in a future phase) and ultimately to a dune overlook platform with benches and bike racks located in Area 7. The trail heads east through Area 7 along the un-vegetated section of the dunes toward the power plant, and then connects to the Beach (California Coastal Trail). A new small parking area, which can be implemented in the future, is proposed at Edison Road (Area 4, Access Node C). A rustic trail can be aligned to the edge of the existing agricultural fields (Area 4) with farm exclusion fencing and interpretive signage about the importance of local agriculture, sea-level rise, etc. The proposed trail may be kept in this alignment upon conversion of the agricultural area to habitat areas.

The public parking lot and public entry at Arnold Road (Area 6, Access Node D) would be closed, except for natural resource management, Navy maintenance, large mammal rescue, and emergency and security purposes consistent with Ormond Beach Ordinance. The public could continue to access Areas 6 and 9 from the beach. A small spur trail is proposed in the dunes between Areas 8 and 9 to provide a seasonal birding overlook to Areas 5 and 6.

Outcomes

Physical

Minor grading and modifications to culverts will change soil moisture and salinity dynamics in order to favor the expansion of salt marsh vegetation. Minor grading will provide more natural transitions between the wetland and upland areas. Over time, as sea levels rise, groundwater and ponding levels will also rise, and wetland habitats will migrate into upland areas. The project is not expected to affect the hydrology of adjacent lands.

Ecological/habitat

The expected habitat types and acres are compiled in **Table 6-3**, and shown in Figure 6-1. Figure 6-8 shows the expected acreage of post-project habitats, compared to existing conditions. Some existing habitats will be enhanced through planting of natives and controlling non-native vegetation. Limited earth moving will expand contiguous habitat areas and provide more natural transitions and ecotones.

This alternative would favor some salt marsh dependent wildlife, especially Belding's savannah sparrow. Existing populations of rare plants (Coulter's goldfields and salt marsh bird's beak) could be expanded to new areas and rare species adapted to non-tidal saline habitats might be introduced (e.g., Ventura marsh milk vetch).

TABLE 6-3
ALTERNATIVE 1: SALT MARSH THEME HABITAT PROJECTIONS

	Area (acres)								
Habitat Type	**1**	**2**	**3a**	**3b**	**4**	**5**	**6**	**7-9**	**TOTAL**
Beach/strand	12							19	31
Coastal dunes	24							102	126
Dune swale wetland									0
Open water	17	3	0	1		2	4		26
Salt panne			5	4		1	22		32
Salt marsh		23	53	20	88	51	33		268
Brackish marsh	14	6							19
Seasonal wetlands		18							18
Riparian		5							5
Wetland-upland transition		15			45	25			85
Bioswale		1			1				2
Upland	9	19	5	1		9	2		45
TOTAL	**76**	**89**	**64**	**25**	**135**	**87**	**60**	**121**	**658**

NOTE:
Habitat estimates rounded to nearest acre. Habitat projections are post-construction under current sea level.

SOURCE: CRC

Public Access

Access is generally concentrated toward areas with existing roads, trails, and similar infrastructure. Access in the western portion of the Project Area is increased, with the addition of new parking, new entry via Perkins Road over tšumaš Creek around Ormond Lagoon and mid-beach, and several loop trails of varying size. Large areas of the site are also left as undisturbed habitat areas, particularly in the eastern Project Area. This alternative could be implemented immediately while funding is secured for greater interventions and bolder actions proposed by some of the other alternatives.

6.2.2 Alternative 2

Overview

Alternative 2 enhances and expands the range of existing habitats and modifies site hydrology (Figure 6-2).

The Project Area's large size and complex hydrology make it feasible to create and restore a wide range of wetland types. This alternative uses some earth moving and other moderate interventions to create a broader mosaic of wetland types on the site. The greater diversity of wetlands might be expected to support a wider array of species. Realignment of the OLW would significantly alter hydrological processes in Area 2 and 3a, increasing year-round inundation by brackish water. Resilience to sea-level rise is built in with some water control structures (Area 5) and by allowing wetland types to convert over time (Area 4). Existing high-value habitats in Areas 3b, 5, and 6 would be preserved. A series of dune swale wetlands would be excavated to increase biodiversity in the dunes. Upland areas will be restored, as will broad transitions between wetland and upland habitats. These transitional and upland areas will also provide space to accommodate wetland migration in response to sea-level rise.

The public access plan for Alternative 2 immerses the visitor in the ecology and diversity of Ormond Beach. Trail alignments showcase the diversity of wetland types wetlands and provide opportunities to see seasonal fluctuations in water levels and wildlife (bird) interactions with site. With the realignment of OLW and the increase in wetland areas and diversity, the access features focus on boardwalks, elevated structures, birding overlooks, and all-season trails graded at higher elevations or on elevated boardwalks. Bridges cross waterways with overlooks, and boardwalks wind through wetlands to increase visibility and access to the site. The public access features and amenities are distributed evenly across the site. Alternative 2 provides a multi-modal connection directly to the South Oxnard neighborhoods so that locals can easily walk or bike to visit the site. Direct beach access is provided at Perkins Road via a new floating boardwalk or bridge across Ormond Lagoon.

Actions

Overview by Areas

Site hydrology will be modified by way of earthwork and modification of surface water conveyance. The banks of OLW (Area 2) and the north banks of Ormond Lagoon (Area 1) will be graded and planted to expand wetlands and transition to upland. OLW will be routed through Area 3a and connected to the existing Ormond Lagoon on the eastern side of the lagoon. The new channel would bypass the Halaco properties in favor of a more natural channel and expanded wetlands within the project area. The existing OLW channel segment between the two Halaco properties would be blocked and potentially filled, pending coordination with EPA. The design includes an expansion of the Ormond Lagoon into Areas 7 and 3a. A pedestrian access bridge would be installed across this channel along McWane Blvd., from Perkins Street, and a trail would be constructed to the beach. We anticipate expansion of brackish marsh and open water habitats in Areas 2 and 3a. Flood waters would be partly diverted into the restoration area and the expanded lagoon, thereby incrementally lowering the water level in the lagoon and reducing flood

risk and management effort. Routing flows through the wetlands is expected to remove nutrients and improve the lagoon water quality.

A series of shallow basins will be created in Area 4 at different elevations as the area transitions out of agriculture. The lowest basin would support salt panne habitat, and higher basins would be seasonal wetlands and/or bioswales. The higher basins would convert to salt panne habitat as the sea level rises.

Drainage from Area 4 in to ODD #3 will be reduced to retain more water on-site. Hydraulic connectivity between ODD #3 and Areas 3b, 5, and 6, will be maintained as they are. The existing connections include a mix of open culverts, culverts with gates, and breached berms. If further evaluation of these connections in the future indicates they are deteriorating, intervention may be needed to stabilize these connections. Intervention would likely consist of maintenance or reconstruction to maintain the existing hydrology, or modification in case hydrologic changes are desired including potentially removal of culverts.

The southern, seaward portion of Area 5 would be segregated from the rest of Area 5 by a low berm. This would limit drainage to ODD #3 and allow salts to concentrate in the soils, allowing for the expansion of salt marsh and salt panne habitats. North of the new berm existing upland and seasonal wetland habitats would be enhanced.

The beach (Areas 7, 8, and 9) will be enhanced by weeding and planting to restore back dune scrub habitat and expand foredune scrub habitat. In addition, several shallow depressions will be excavated between dune ridges and planted with dune swale wetland species.

More details on area–specific actions and expected outcomes are provided in **Table 6-4**.

Grading

Typical earthwork cross sections are provided in Figures 6-4a and 6.4b, with corresponding locations marked on the Alternative 2 Plan (Figure 6-6). Excavated soil will be reused beneficially on-site as practicable.

A new OLW channel will be excavated, and the existing lagoon expanded, resulting in significant earthwork. Much of the earth will be used to fill the existing OLW and to fill and block ODD #3. Excess earth will be placed to form uplands and for access trail elements. Surface water connectivity between Area 1 and 3a will be increased by excavation of a lagoon deep enough to support tidewater goby habitat. Cross-sections A and B show the new OLW channel through Areas 2 and 3, respectively. In Area 2, the existing grades are higher, and a wetland terrace is excavated above elevation 8 feet NAVD88 to provide for emergent marsh. An emergent marsh terrace is not included in Area 3a, where existing grades are lower. Both sections show the thalweg (low point) of the channel at elevation 3 feet NAVD88, which approximately matches the existing OLW. Section C shows the filled existing OLW, as well as additional fill to form a raised area. The raised area is shaped to resemble an abandoned natural river levee, and largely follows the existing remnant levees originally constructed as part of the OLW. This raised land will be planted with a riparian palette, and support a path for public access.

TABLE 6-4
ALTERNATIVE 2 ACTIONS BY AREA

Area	Sub-area	Habitat Type	Actions/Outcomes			Projected changes with sea-level rise
			Earth Moving	Vegetation	Hydrology/Salinity	
1	1.1	Brackish marsh	None	Non-native species control	As-is	Conversion toward open water
	1.2	Open water	None	N/A	As-is	Lagoon will retreat landward
	1.3	Coastal dune	• Minor excavation through dunes to enhance connection to re-aligned OLW	Non-native species control	N/A	Conversion to beach/ strand as the shoreline retreats & marsh/open water as the lagoon migrates landward
	1.4	Upland	Fill in old OLW	Non-native species control. Planting grassland & coastal sage scrub	N/A	Conversion toward salt marsh then brackish marsh as water table nears surface
	1.5	Beach/strand	Continued mouth management	None	None	Conversion to intertidal beach & surf zone
2	2.1	Brackish marsh	• OLW re-aligned & allowed to overtop its banks in high water conditions & flood the brackish marsh • Fill in old channel & remove most of the existing levees • Create a marsh plain that slopes gently toward the new channel to support riparian vegetation along channel levees • Topographic heterogeneity (e.g., depressions or higher areas) would support greater spatial vegetation diversity within the marsh	• Non-native species control as needed • Plant a wide diversity of brackish marsh species • Highest elevations within the marsh may get salty enough to support salt marsh species	• Brackish marsh would occur down to elevations that are regularly flooded to depths less than about 2 feet • Brackish marsh will occur up to elevations where the soil is saturated in the rooting zone during the growing season • Highest areas of the marsh might get salty enough to support salt marsh species where evaporation at the soil surface concentrates salts	Conversion toward open water

TABLE 6-4
ALTERNATIVE 2 ACTIONS BY AREA

Area	Sub-area	Habitat Type	Actions/Outcomes			Projected changes with sea-level rise
			Earth Moving	Vegetation	Hydrology/Salinity	
2 (cont.)	2.2	Wetland-upland transition	• Minor contouring & possible location to spoil any excess material dredged during creation of the brackish marsh • Area should be a broad plain gently sloping toward the brackish marsh to the east • Highest areas at the edges of the property should be tall enough to protect neighbors from flooding	• The area will need revegetation & probably short-term weed control • Expect transition zone above about 11 feet NAVD88 • Typical species would include shrubs that can tolerate some salinity & occasional flooding such as *Atriplex lentiformis, Suaeda calceoliformis*, *S. taxifolia* & *Isocoma menziesii*	• Very rare flooding for short durations with brackish water • Some buildup of salts in soil • Water table below the rooting zone	Conversion toward salt marsh & then brackish marsh as the water table nears the surface
	2.3	Bioswale	• Create shallow basin of sufficient volume to capture dry-season runoff from McWane Blvd • Consider including forebay that traps sediment & can be cleaned out occasionally • Direct outflow toward seasonal wetland area	Plant with cattail & tule	• Basin will capture surface flows & allow plants to uptake water, nutrients & other pollutants • Encourage percolation with coarse soil & large area • Expect slightly brackish conditions	As the water table rises, water will percolate less efficiently; when the water table reaches the surface, the basin will begin to lose capacity
	2.4	Open water	A new channel will be excavated	N/A	Permanently flooded with brackish water	Water will get deeper
3a	3a.1	Brackish marsh	• OLW re-aligned & allowed to overtop its banks in high water conditions & flood the brackish marsh • Create a marsh plain that slopes gently toward the new channel with micro-topography to support wetland and riparian habitats (tbd) • Topographic heterogeneity (e.g., depressions or higher areas) would support greater spatial vegetation diversity within the marsh • New culvert(s) potentially with water control (e.g., gates) to allow adjustment of hydraulic connectivity across railway	• Non-native species control as needed • Plant a wide diversity of brackish marsh species • Highest elevations within the marsh may get salty enough to support salt marsh species	• Brackish marsh would occur down to elevations that are regularly flooded to depths less than about 2 feet • Brackish marsh will occur up to elevations where the soil is saturated in the rooting zone during the growing season • Highest areas of the marsh might get salty enough to support salt marsh species where evaporation at the soil surface concentrates salts • Culvert beneath railroad provides hydraulic connectivity to Area 4	Conversion toward open water

TABLE 6-4
ALTERNATIVE 2 ACTIONS BY AREA

Area	Sub-area	Habitat Type	Actions/Outcomes			Projected changes with sea-level rise
			Earth Moving	Vegetation	Hydrology/Salinity	
3a (cont.)	3a.2	Open water	A new channel will be excavated	N/A	Permanently flooded with brackish water	Water will get deeper
	3a.3	Upland	• Existing upland areas will receive fill from excavated areas • Wetland-upland transition expected to be relatively steep	Non-native species control & planting grassland & coastal sage scrub	N/A	Conversion toward salt marsh & then brackish marsh as the water table nears the surface
3b	3b.1	Salt marsh	Minor enhancement of berm breach & channel to increase connectivity to ODD #3	Weed control as needed	• Little change from current conditions • Hydrology would be more closely tied to that of ODD #3, mainly north of railroad tracks • Realignment of OLW in Area 3a might raise/freshen groundwater in this area & could lead to conversion to brackish marsh	Assuming limited influence on groundwater from the lagoon, rising salty groundwater from the ocean will cause conversion to salt panne & then open water
	3b.2	Salt panne	None	N/A	• Little change from current conditions • Realignment of OLW in Area 3a might raise/freshen groundwater in this area & could lead to conversion to brackish marsh	Assuming limited influence on groundwater from the lagoon, rising salty groundwater from the ocean will cause conversion to open water
	3b.3	Upland	None	Planting coastal sage scrub along railroad and berms	N/A	Conversion toward salt marsh as the water table nears surface
	3b.4	Open water	Lengthen existing channel off of ODD #3 toward railroad tracks	Expand existing bulrush on the edges of the channel	As-is	Water will get deeper & bulrush fringe will move up the banks

TABLE 6-4
ALTERNATIVE 2 ACTIONS BY AREA

Area	Sub-area	Habitat Type	Actions/Outcomes			Projected changes with sea-level rise
			Earth Moving	Vegetation	Hydrology/Salinity	
4	4.1	Salt marsh	• Minor grading to eliminate roads, ditches & any tile drains • Area could be a broad almost flat plain gently sloping southwest with two or more shallow basins at increasing elevations • Soil texture should be studied & appropriate amendments added (e.g., bentonite) to mimic salt marsh soil	• The area will need revegetation & possibly short-term weed control • Expect salt marsh below about 9 feet NAVD88 • Consider options such as irrigating with salt or brackish water to control weeds & favor salt marsh species • Dominant species would include pickleweed, salt grass & fleshy jaumea	• The brackish water table would presumably be within a couple feet of the surface once ditches & drains are removed • New location of OLW might raise the water table enough that wetlands establish above the estimated 9-foot NAVD88 contour & might lower salinities • Limiting off-site drainage would help keep salts on-site & favor salt marsh species	Rising groundwater will cause conversion to salt panne & then open water
	4.2	Salt panne	• Create a shallow basin • Soil may need to be amended with clay to encourage ponding • Water control structure(s) (culvert) under the railroad to allow hydraulic connectivity between Areas 4 and 3	N/A	• Salt panne areas would pond with rainfall & retain salts from evaporating groundwater (similar to other salt panne habitats on-site) • Expect salt panne below about 5 feet NAVD88 • water control structure to allow hydraulic connectivity across railway and adjust water balance and salt balance	The lowest of a series of stepped basins would convert to open water
	4.3	Seasonal wetland	• Create a shallow basin • Soil may need to be amended with clay to encourage ponding • Water control structure(s) (culvert) under the railroad to allow hydraulic connectivity between Areas 4 and 3	• Control non-natives & plant salt-tolerant natives that tolerate wet winter & dry summer conditions • Consider introducing locally & regionally rare species such as *Salicornia depressa, Atriplex coulteri, A. pacifica, A. serenana* var. *davidsonii, Lasthenia glabrata* ssp. *coulteri, Suaeda calceoliformis, Astragalus pycnostachyus* var. *lanosissimus,* etc.	• Rare seasonal flooding primarily by rainfall • Saline groundwater generally below the rooting zone • Salts transported in to the rooting zone, generally pushed deeper & diluted in the winter with rainfall & closer to the surface & more concentrated in the summer • water control structure to allow hydraulic connectivity across railway and adjust water balance	The middle of a series of stepped basins would convert to salt panne & eventually open water

TABLE 6-4
ALTERNATIVE 2 ACTIONS BY AREA

Area	Sub-area	Habitat Type	Actions/Outcomes			Projected changes with sea-level rise
			Earth Moving	Vegetation	Hydrology/Salinity	
4 (cont.)	4.4	Wetland-upland transition	• Minor grading to eliminate roads, ditches & any tile drains • Area should be a broad almost flat plain gently sloping toward the salt marsh	• The area will need r-vegetation & probably short-term weed control • Expect transition zone above about 9 feet NAVD88 • Typical species would include shrubs that can tolerate some salinity & occasional flooding such as *Atriplex lentiformis, Suaeda calceoliformis, S. taxifolia & Isocoma menziesii*	• Very rare flooding for short durations with brackish water • Some buildup of salts in soil • Water table below the rooting zone • New location of OLW might raise the water table enough that wetlands establish above the estimated 9-foot NAVD88 contour	Conversion toward salt marsh as the water table nears the surface
	4.5	Bioswale	• Create a large shallow basin to capture dry & wet-season runoff from McWane Blvd • Consider including forebay that traps sediment & can be cleaned out occasionally	Plant with cattail & tule	• Basin will capture surface flows & allow plants to uptake water, nutrients & other pollutants • Encourage percolation with coarse soil & large area • Expect slightly brackish conditions	As the highest of a series of stepped basins, expect conversion to brackish marsh or, if inflows from the street are diverted elsewhere, salt marsh & then salt panne
	4.6	Open water	None	None	As-is	Water will get deeper & tule fringe will move up the banks
5	5.1	Salt marsh	• Remove some abandoned roads & create a berm to separate salt marsh from seasonal wetlands to the north • Optional basins could be created in new salt marsh area to support salt panne	• No actions in existing salt marsh area • Plant new salt marsh with appropriate salt marsh species	• Salt marsh areas would pond with rainfall & retain salts (similar to other salt marsh habitats on-site) • Expect salt marsh between about 5 &7.5 feet NAVD88	Rising salty groundwater from the ocean will cause conversion to salt panne & then open water

TABLE 6-4
ALTERNATIVE 2 ACTIONS BY AREA

Area	Sub-area	Habitat Type	Actions/Outcomes			Projected changes with sea-level rise
			Earth Moving	Vegetation	Hydrology/Salinity	
5 (cont.)	5.2	Seasonal wetland	None	• Control non-natives & plant salt-tolerant natives that tolerate wet winter & dry summer conditions • Consider introducing locally & regionally rare species such as *Salicornia depressa, Atriplex coulteri, A. pacifica, A. serenana var. davidsonii, Lasthenia glabrata ssp. coulteri, Suaeda calceoliformis, Astragalus pycnostachyus var. lanosissimus,* etc.	• Maintain existing drainage of area to ODD #3 • Seasonally wet from rainfall & possibly water backing up from ODD #3 • Saline groundwater generally below the rooting zone • Salts transported in to the rooting zone, generally pushed deeper & diluted in the winter with rainfall & closer to the surface & more concentrated in the summer	Conversion toward brackish marsh as water table nears surface
	5.3	Upland	None	Non-native species control & planting coastal sage scrub	N/A	Rising water in ODD #3 &/or groundwater will lead to conversion to brackish or salt marsh
	5.4	Open water	None	Tule on the edges of the channel will remain	As-is	Water will get deeper & tule fringe will move up the banks
6	6.1	Salt marsh	None	Non-native species control	As-is	• Conversion to salt panne & open water as groundwater level rises • Dunes will migrate landward & bury salt marsh
	6.2	Salt panne	None	None	As-is	Conversion to open water as groundwater level rises
	6.3	Upland	None	Non-native species control	N/A	Conversion to salt marsh habitat as groundwater level rises
	6.4	Open water	None	Tule on the edges of the channel will remain	As-is	Water will get deeper & tule fringe will move up the banks

TABLE 6-4
ALTERNATIVE 2 ACTIONS BY AREA

Area	Sub-area	Habitat Type	Actions/Outcomes			Projected changes with sea-level rise
			Earth Moving	Vegetation	Hydrology/Salinity	
7, 8, 9	7, 8, 9.1	Coastal dune	None	Dune planting could include reintroduction or introduction of rare, threatened & endangered endemic dune species	N/A	Conversion to strand & beach as the coast retreats
	7, 8, 9.2	Beach/strand	None	None	Occasional wave overwash at south end	Conversion to intertidal & surf zone as the beach retreats
	7,8,9.3	Open water	• Excavate new connection between re-aligned OLW and existing lagoon	N/A	The connection will designed to keep the two waterways connected and convey flood waters	As the beach retreats, the connection would eventually be lost and OLW would have its own mouth
	7,8,9.4	Dune swale wetland	• Excavate multiple depressions between the dune ridges • Depressions should be deep enough to expose damp sand	Plant dune swale species such as *Juncus arcticus, Distichlis spicata, Juncus acutus*, and *Carex praegracilis*	Depressions will intersect the capillary fringe above the dunes' freshwater lens	Conversion to dunes, strand & beach as the coast retreats

Area 4 will be excavated and graded to form shallow seasonally flooded basins. The elevations and depths of the basins will be designed to support different hydrology and salinity dynamics. The basins will be higher with distance northward, to allow for habitat conversion with sea level-rise.

Area 5 will be segregated into a salt marsh-panne area by a fill embankment (Section D), and the remainder of the site will be maintained at existing grades, or filled (existing uplands only) to balance cut and fill on-site. Upland habitat can accommodate wetland migration with future sea-level rise. Grading will occur in beach-dune Areas 7, 8, and 9 to form wetland swales and to provide limited access.

Infrastructure Modification

One or more culverts may be installed to provide the opportunity for hydraulic connectivity across the railway. The water and salt balance of the salt panne and seasonal wetlands for existing and future conditions will inform the design of culverts and whether they will be open or have gates to control and adjust water conveyance. Note that the culverts can be used to drain Area 4 to Area 3b, and allow flow from Areas 3b into 4 when water levels are high. Water control structures will be installed between the ODD #3 and Area 5, to modify and control the flow of water between the two areas. These structures and changes will be designed to be reversible, in case the changes have adverse effects on sensitive habitats at Ormond Beach or NBVC–Point Mugu. Irrigation and drainage systems in Area 4 will be removed. Finally, OLW will be blocked in the vicinity of the Halaco properties, and ideally filled, pending coordination with EPA.

Access, Trails, and Site Amenities

Alternative 2 provides a diverse visitor experience in which many habitat types can be experienced and appreciated. Trails are evenly distributed throughout the site and traverse through many of the newly created wetlands. This alterative provides a large amount of primitive and rustic trails, and may be expected to provide a more tranquil nature experience for visitors. Alternatives 1 and 3 largely keep trails to the perimeters or to areas which are adjacent to developed areas. Alternative 2 also creates the closest link with South Oxnard neighborhoods, providing direct access for walking and biking from Hueneme Road.

Alternative 2 (Figure 6-2, Area 1) provides direct beach access via a proposed primary ADA accessible trail and boardwalk system leading from the Perkins Road parking lot to a bridge or floating boardwalk crossing Ormond Lagoon (Access Node A). The floating boardwalk can be designed with sea-level rise in mind. A rustic trail loop leads from the new bridge at Perkins Road parking to the Ormond Lagoon island and a lagoon overlook platform, and connects back to the floating boardwalk. A primitive seasonal trail runs along the south side of the Ormond Lagoon island to an overlook. Boardwalks are proposed over wetlands on the OLW island. A new primary developed, Ormond Lagoon compliant trail weaves through the wetland north of the Perkins Road parking lot, designed specifically to accommodate school groups and provide educational opportunities for students. The trail terminates with an overlook platform. One can cross Perkins Road at this point to West McWane Blvd.

A new trailhead at West McWane Blvd. (Access Node B1) is served by a new parking lot in the reconfigured West McWane Blvd. right-of-way. The McWane Blvd. east trailhead (Access Node B2, constrained by an at-grade railroad crossing and train parking) provides parking and trails leading west through Areas 2 and 3a over a new bridge crossing the realigned OLW. This primary, all-season trails adjoins a north-south primary spur of the CA Coastal Trail. This trail provides bicycle and pedestrian access at Hueneme Road (Access Node C), leading through restored habitats to a network of boardwalks between Areas 3a, 3b, and 7, where cyclists can secure their bikes and continue the adventure on foot. Several birding overlooks on platforms and boardwalks provide birding opportunities, and lead to a beach trail lined with bird fencing through the back dunes and to the beach at Area 7. A possible future seasonal loop is provided in Area 3a along the Halaco properties, which could be implemented after cleanup.

A wetland discovery loop can be implemented in the future in Area 4, with new primitive trails and boardwalks with birding platforms and overlooks providing views of the newly created wetlands and salt panne area. The new (future) parking lot proposed at the end of eastern McWane Blvd. (Access Node B2) is sited conveniently for visitors to complete larger trail loops when the train is not parked on the tracks at the western end of East McWane Blvd.

The existing parking adjacent the Navy fence would be removed, and a smaller parallel parking area (Access Node D) along the west side of at Arnold Road, a drop-off area, and turn-around area would be provided, limiting the number of visitors to this sensitive area of the site (Area 6). Emergency, wildlife rescue, and maintenance beach access would still remain south of ODD #3 via Arnold Road. This would be enhanced and improved by elevating this section of primary trail so it is above the flood zone, and the existing interpretive signs could be retained. Elevated birding overlooks, oriented into Area 6 (and not into NBVC–Point Mugu), are provided off of a primitive trail which borders ODD #3 and leads to the beach. The CA Coastal Trail runs east west along the beach. The CA Coastal Trail runs east west along the beach, and connects to a future Class II bike path spur of the California Coastal Trail identified in the County of Ventura Local Coastal Plan.

Outcomes

Physical/Geomorphic

The hydrology of Areas 2 and 3a will be markedly changed due to the rerouting of the OLW. The capacity of Ormond Lagoon will be expanded to about twice its existing volume through connectivity to Area 3a. The lack of berms directly along the new OLW will allow for more regular inundation of the expanded floodplain wetlands. Flood management actions are expected to be unchanged or reduced owing to the reduced frequency of higher lagoon water levels during intermediate-flowrate conditions. The expansion of the lagoon will reduce the area of open sandy strand and dune. In Areas 4 and 5, grading and modification of culverts will be used to enhance hydrology and salinity dynamics to support salt marsh, salt panne, and seasonal wetland habitats.

The significant alterations to drainage channels raises the risk of effects (primarily flooding) on tributary areas of site. We anticipate that these changes will be neutral to beneficial, either

causing no change in the areas surrounding the project or improving conveyance. However, analysis will likely be required to quantify the effects and inform stakeholders.

Ecological/habitat

The post-construction habitat types and acres are compiled in **Table 6-5**, and shown in Figure 6-8. The area of wetlands within the site will be increased overall. Salt marsh habitats in Areas 2 and 3a will be converted to brackish marsh or open water and existing open water will be converted to brackish marsh. Some uplands will be converted to brackish marsh while others will be maintained and restored. Riparian habitat along OLW will not be sustainable in Area 2 because the shallow groundwater is too brackish for most riparian vegetation species. Salt marsh and salt panne are expanded in Areas 4 and 5. Regionally rare dune swale wetlands would be excavated Areas 6-9. Areas 1 and 6 would remain largely unchanged.

TABLE 6-5
ALTERNATIVE 2: WETLAND DIVERSITY THEME HABITAT PROJECTIONS

Habitat Type	Area (acres)								
	1	2	3a	3b	4	5	6	7-9	TOTAL
Beach/strand	12							18	30
Coastal dunes	23							100	123
Dune swale wetland								2	2
Open water	18	6	4	1		2	4	2	36
Salt panne				4	15		22		40
Salt marsh				19	41	22	33		115
Brackish marsh	14	56	56						125
Seasonal wetlands					19				19
Riparian									0
Wetland-upland transition		27			37				64
Bioswale		1			23	20			43
Upland	10		5	1		44	2		63
TOTAL	76	89	65	25	135	88	60	121	660

NOTES: Habitat estimates rounded to nearest acre. Habitat estimates rounded to nearest acre. Habitat projections are post-construction under current sea level.

SOURCE: CRC

Expanded salt panne habitats could provide potential new nesting areas for California least tern and western snowy plover. Area 4 could support these functions as the sea level rises and converts existing salt panne areas to open water. The expanded lagoon will increase available tidewater goby and California least tern foraging habitat. An enlarged lagoon would generally benefit California least tern; however; this expanded design would eliminate their current (2017–2018) nesting colony in Area 7. The design's effect on nesting habitat in the dunes would need to be studied in more detail. Existing habitat for Belding's savannah sparrow would be eliminated in Area 3a but new salt marsh habitats in Areas 4 and 5 could support this species. The expansion of

brackish marsh and open water would benefit a large suite of avian species, especially ducks and rails. The only existing population of Coulter's goldfields in the project area and a small population of salt marsh bird's beak in Area 3a would be eliminated. Restored saline habitats in Areas 4 and 5 and existing habitat in Area 6 might support new populations of these species. Regionally and globally rare species adapted to non-tidal saline habitats might be introduced (e.g., Ventura marsh milk vetch) in Areas 4 and 5 as well.

Public Access

A diverse array of access features is provided which generally improve access to the Project Area and beach, especially for neighboring communities. Numerous loop trails provide the public with the opportunity to experience every habitat type proposed, with ample opportunities to experience nature and view birds and other wildlife. The varied trails provide frequent visitors the opportunity to have a different experience with each visit.

6.2.3 Alternative 3

Overview

Alternative 3 emphasizes connectivity of habitat and restoration of historical processes (Figure 6-3).

The project area is currently highly fragmented by levees, channels, roads, railroads, and other industrial infrastructure. This alternative focuses on earth moving and manipulations to increase hydrologic and ecological connectivity within the site and between the site and neighboring habitats. A new lagoon would be excavated with its own intermittently open mouth to allow unmanaged connectivity with the ocean. All unnecessary berms and channels would be filled to create large swaths of contiguous habitat (Areas 5 and 6, Areas 3b and 4, Areas 3a and 2). Wetlands around Ormond Lagoon would be expanded landward to facilitate lagoon retreat with sea-level rise. Existing high-value habitats in Areas 3b, 5, and 6 would be preserved. Actions such as planting and/or installing sand fencing would be taken to facilitate continued dune building, which might protect the wetlands from sea-level rise. Excavated material would be used on-site to create more upland habitat to provide wetland to upland connectivity.

Alternative 3 supports more active use of the site with an interconnected network of multi-modal trails. Due to the expanded and projected higher elevations of wet areas and movement of waterways inland, public access features are primarily located on the periphery of the Project Area at higher elevations to support the enhanced hydrologic connectivity. Access points remain concentrated at McWane Blvd. and Perkins and Arnold Roads. This alternative has the most amount of developed trails and boardwalks of all of the alternatives, creating year-round access and looped trail experiences for visitors. This alternative provides the strongest connection to the regional California Coastal Trail for cyclists. The more active trail types are focused to the west, while primitive trails are focused on the east for birding and quiet contemplation. These trails invite regional visitors using the California Coastal Trail by bike to traverse the Project Area and enjoy the coastal and natural environment. Extensive boardwalks and bridges provide views of seasonal fluctuations in water and thus bird species.

Actions

Overview by Areas

Upland areas to the north of the current lagoon in Area 1 would be excavated to expand brackish marsh habitat. The existing lagoon would no longer have a surface connection to the OLW.

OLW will be rerouted through Areas 2 and 3a to a new lagoon, and the existing OLW channel (the portion through the Halaco properties) would be blocked and filled pending coordination with EPA). Fill would be placed to separate the new lagoon (Area 3a) from the existing Ormond Lagoon (Area 1). The new lagoon would not be subject to flood management, and it will pond to higher levels, estimated to be 1 to 3 feet higher than Ormond Lagoon management elevation of 9 feet NAVD88. The new lagoon would provide many of the functions provided by historical lagoon habitats, once present between Hueneme and Mugu but since lost or severely reduced. The existing Ormond Lagoon would receive less water after diversion of the OLW to the new lagoon, resulting in a lower water level. As a result, estimates of the typical lagoon water level in Ormond Lagoon would be about 1 foot lower. While this lower water level is expected to reduce flood potential, management of the mouth to prevent flooding will need to continue.

Salt marsh habitats in Areas 3b and 4 will be connected hydrologically and restored. Area 4 would be graded to create a large basin that will support salt panne habitat. Excavated soil would be placed in the northern part of Area 4 and would support upland and transition habitats. The drainage ditches in Areas 3b and 4 would be filled and hence water would no longer drain from the area as efficiently. Small culverts may be desired to create greater hydraulic connectivity under the railway within Area 3b.

Salt marsh and salt panne habitat will be restored in Area 5 and it will be connected to Area 6. Excavated soil would be placed in the northern part of Area 5 and would support upland and transition habitats. Additional shallow basins would be excavated in Area 5 at elevations that would allow them to convert from seasonal wetlands to salt panne habitat as the sea level rises. The ODD #3 would be disconnected from the site, and the spur between Areas 5 and 6 would be filled. Water control structures may be required to allow reconnection of Areas 5 and 6 to the ODD #3 if adverse effects develop in the Mugu wetlands or if the loss of flood water storage increases flood levels on adjacent lands.

Beach Areas 7, 8, and 9 will be enhanced by weeding and planting to restore back dune scrub habitat and expand foredune scrub habitat. Dune building will be facilitated in selected locations with sand fencing and seeding with native dune species to capture wind-driven sand.

Further detail on actions and expected outcomes by Area and habitat is provided in **Table 6-6**.

Grading

Alternative 3 proposes the greatest amount of earthwork and will result in a greater change in the landscape than the other alternatives. Typical earthwork cross sections are provided in

Figure 6-4a and 6-4b, with corresponding locations marked on the Alternative 3 Plan (Figure 6-7). Excavated soil will be reused beneficially on-site as practicable.

The upland areas north of Ormond Lagoon in Area 1 will be excavated to a lower elevation to establish brackish marsh.

A second, new lagoon will be constructed in Area 3a, as depicted in cross-section A. The lagoon will be connected to the new OLW, similar to that depicted in cross-sections A and B for Alternative 2. An outlet channel will be excavated through the dunes and beach, to the shore. The excavation of the lagoon and outlet channel will extend down to elevation 4 feet NAVD88, which is similar to the elevation of the existing Ormond Lagoon.

Fill will be placed around the perimeter of Area 2 and Area 3a to form upland that will also serve a barrier between the higher lagoon water and adjacent land and infrastructure. Fill will also be placed between Areas 3a and 3b, to maintain the salt marsh and panne in 3b. Excavation will connect the agricultural ditch of other feature(s) in Area 4 to the lagoon in 3a, with a new culvert facility installed under the existing railway. The hydraulic criteria for this culvert have not been defined at this point in the project development. Actual configuration will depend on further understanding of the water salt balance.

Earthwork on the beach in Areas 1 and 7 will be substantial. A raised area of vegetated dunes will be built with sand excavated from the new lagoon mouth channel. The new dune ridge will keep the two lagoon segregated. The anticipated geometry is similar to the dune fill shown in cross-section B for Alternative 1, but a large footprint is envisioned, to extend the barrier out to the existing elongated lagoon.

Area 4 will be excavated and graded to form one large, shallow basin to support salt panne habitat. Excavated material will be placed to raise the northern perimeter of Area 4. ODD #3 between Areas 3b and 4 will be eliminated to restore a flat, contiguous marsh plain and limit surface drainage from these areas.

A series of shallow basins and increasing elevations would be excavated in Area 5. The fill would be placed in existing upland areas. The stub of ODD #3 between Areas 5 and 6 would be eliminated to restore a contiguous marsh plain.

Dune formation will be encouraged via sand fences and planting, but grading of the sand dunes is not proposed except to form the boundary between the existing and new lagoon.

TABLE 6-6
ALTERNATIVE 3 ACTIONS BY AREA

Area	Sub-area	Habitat Type	Actions/Outcomes			Projected Changes with sea-level rise
			Earth Moving	Vegetation	Hydrology/Salinity	
1	1.1	Brackish marsh	• Excavate upland areas down to marsh elevation • Use excavated material to fill existing landward channel to marsh elevation • Additional fill might be placed in Area 2 or exported off-site	• Non-native species control in existing marsh • Planting in newly excavated marsh • Marsh elevation range may adjust once OLW is no longer connected the lagoon if hydrology/salinity change	Without inflows/connection to OLW, hydrology & salinity may change but will likely stay in the brackish range	Conversion toward open water as lagoon migrates landward
	1.2	Open water	None	N/A	Without inflows/connection to OLW, water levels & salinity may change	Lagoon will retreat landward
	1.3	Coastal dune	None	Non-native species control	N/A	Conversion to beach/strand as the shoreline retreats & marsh/open water as the lagoon migrates landward
	1.4	Upland	Fill in old Perkins drain by lagoon	Non-native species control. Planting grassland & coastal sage scrub	N/A	Conversion toward salt marsh then brackish marsh as water table nears the surface
	1.5	Beach/strand	Continued mouth management	None	None	Conversion to intertidal beach & surf zone
2	2.1	Brackish marsh	• OLW re-aligned & allowed to overtop its banks in high water conditions & flood the brackish marsh • Fill in old channel & remove the existing levees • Create a marsh plain that slopes gently toward the new channel • Topographic heterogeneity (e.g., depressions or higher areas) would support greater spatial vegetation diversity within the marsh	• Non-native species control as needed • Plant a wide diversity of brackish marsh species • Highest elevations within the marsh may get salty enough to support salt marsh species	• Brackish marsh would occur down to elevations that are regularly flooded to depths less than about 2 feet • Brackish marsh will occur up to elevations where the soil is saturated in the rooting zone during the growing season • Highest areas of the marsh might get salty enough to support salt marsh species where evaporation at the soil surface concentrates salts	Conversion toward open water

TABLE 6-6
ALTERNATIVE 3 ACTIONS BY AREA

Area	Sub-area	Habitat Type	Actions/Outcomes			Projected Changes with sea-level rise
			Earth Moving	Vegetation	Hydrology/Salinity	
2 (cont.)	2.2	Wetland-upland transition	• Fill material from new channel & lagoon placed in existing upland & seasonal wetland areas • Excavated soil may be saline • Saline soils would not support most transition species so leaching & soil amendments may be needed	• The area will need revegetation & probably short-term weed control • Expect transition zone above about 11 feet NAVD88 • Typical species would include shrubs that can tolerate some salinity & occasional flooding such as *Atriplex lentiformis, Suaeda calceoliformis, S. taxifolia & Isocoma menziesii*	• Very rare flooding for short durations with brackish water • Some buildup of salts in soil • Water table below the rooting zone	Conversion toward salt marsh & then brackish marsh as the water table nears the surface
	2.3	Upland	• Fill material from new channel & lagoon placed in existing upland & seasonal wetland areas • Highest areas at the edges of the property should be tall enough to protect neighbors from flooding • Excavated soil may be saline • Saline soils would not support most upland species so leaching & soil amendments may be needed • The slope created between the wetland to upland is expected to be fairly steep	Non-native species control & planting grassland & coastal sage scrub	N/A	Conversion toward transition zone & brackish marsh as occasional flooding occurs & the water table nears the surface
	2.4	Bioswale	• Create shallow basin of sufficient volume to capture dry-season runoff from McWane Blvd • Consider including forebay that traps sediment & can be cleaned out occasionally • Direct outflow toward seasonal wetland area	Plant with cattail & tule	• Basin will capture surface flows & allow plants to uptake water, nutrients & other pollutants • Encourage percolation with coarse soil & large area • Expect slightly brackish conditions	As the water table rises, water will percolate less efficiently; when the water table reaches the surface, the basin will begin to lose capacity
	2.5	Open water	A new channel will be excavated	N/A	Permanently flooded with brackish water	Water will get deeper

TABLE 6-6
ALTERNATIVE 3 ACTIONS BY AREA

Area	Sub-area	Habitat Type	Actions/Outcomes			Projected Changes with sea-level rise
			Earth Moving	Vegetation	Hydrology/Salinity	
3a	3a.1	Brackish marsh	• OLW re-aligned & allowed to overtop its banks in high water conditions & flood the brackish marsh • Create a new lagoon with a large area of open water • Create a marsh plain that slopes gently toward the new channel & lagoon • Topographic heterogeneity (e.g., depressions or higher areas) would support greater spatial vegetation diversity within the marsh	• Non-native species control as needed • Plant a wide diversity of brackish marsh species • Highest elevations within the marsh may get salty enough to support salt marsh species	• Brackish marsh would occur down to elevations that are regularly flooded to depths less than about 2 feet • Brackish marsh will occur up to elevations where the soil is saturated in the rooting zone during the growing season • Highest areas of the marsh might get salty enough to support salt marsh species where evaporation at the soil surface concentrates salts	Conversion toward open water
	3a.2	Wetland-upland transition	• Fill material from new channel & lagoon placed in existing upland & salt marsh areas • Excavated soil may be saline • Saline soils would not support most transition species so leaching & soil amendments may be needed	• The area will need revegetation & probably short-term weed control • Expect transition zone above about 11 feet NAVD88 • Typical species would include shrubs that can tolerate some salinity & occasional flooding such as *Atriplex lentiformis, Suaeda calceoliformis, S. taxifolia & Isocoma menziesii*	• Very rare flooding for short durations with brackish water • Some buildup of salts in soil • Water table below the rooting zone	Conversion toward salt marsh & then brackish marsh as the water table nears the surface
	3a.3	Open water	A new channel & lagoon will be excavated	N/A	Permanently flooded with brackish water	Water will get deeper

TABLE 6-6
ALTERNATIVE 3 ACTIONS BY AREA

Area	Sub-area	Habitat Type	Actions/Outcomes			Projected Changes with sea-level rise
			Earth Moving	Vegetation	Hydrology/Salinity	
3a (cont.)	3a.4	Upland	• Existing upland areas will receive fill from excavated areas • The slope created between the wetland to upland is expected to be fairly steep • Place fill strategically to protect neighbors and railroad from flooding • Excavated soil may be saline • Saline soils would not support most upland species so leaching & soil amendments may be needed	Non-native species control & planting grassland & coastal sage scrub	N/A	Conversion toward salt marsh & then brackish marsh as the water table nears the surface
3b	3b.1	Salt marsh	Removal of ODD #3 would allow restoration of salt marsh	Plant salt marsh species	• Little change from current conditions • Hydrology would no longer be influenced by ODD #3 • Filling of ODD #3 might raise the water table & lead to conversion of lowest areas of salt marsh to salt panne • Creation of lagoon in Area 3a might raise/freshen groundwater in this area & could lead to conversion to brackish marsh	Assuming limited influence on groundwater from the new lagoon, rising salty groundwater from the ocean will cause conversion to salt panne & then open water
	3b.2	Salt panne	None	N/A	• Little change from current conditions • Creation of lagoon in Area 3a might raise/freshen groundwater in this area & could lead to conversion to brackish marsh	Assuming limited influence on groundwater from the new lagoon, rising salty groundwater from the ocean will cause conversion to open water
	3b.3	Upland	None	Non-native species control & planting grassland & coastal sage scrub along railroad berm	N/A	Conversion toward salt marsh as the water table nears surface

TABLE 6-6
ALTERNATIVE 3 ACTIONS BY AREA

Area	Sub-area	Habitat Type	Actions/Outcomes			Projected Changes with sea-level rise
			Earth Moving	Vegetation	Hydrology/Salinity	
4	4.1	Salt marsh	• Minor grading to eliminate roads, ditches & any tile drains • Area could be a broad almost flat plain gently sloping southwest • Soil texture should be studied & appropriate amendments added (e.g., bentonite) to mimic salt marsh soil • Water control structure and culvert under the railroad to allow managed hydraulic connectivity between Areas 4 and 3	• The area will need revegetation & possibly short-term weed control • Expect salt marsh below about 9 feet NAVD88 • Consider options such as irrigating with salt or brackish water to control weeds & favor salt marsh species • Dominant species would include pickleweed, salt grass & fleshy jaumea	• The brackish water table would presumably be within a couple feet of the surface once ditches & drains are removed • New lagoon in 3a might raise the water table enough that wetlands establish above the estimated 9-foot NAVD88 contour & might lower salinities • Limiting off-site drainage would help keep salts on-site & favor salt marsh species • a culvert with water control across the railway is included as a placeholder for subsequent analysis of need to discharge from Area 4 and potential for water supply from Area 3.	Rising groundwater will cause conversion to salt panne & then open water
	4.2	Salt panne	• Create a large shallow basin • Soil may need to be amended with clay to encourage ponding	N/A	• Salt panne areas would pond with rainfall & retain salts from evaporating groundwater (similar to other salt panne habitats on-site) • Expect salt panne below about 5 feet NAVD88	Conversion to open water as groundwater level rises
	4.3	Wetland-upland transition	• Spoil site for soil excavated in 3a • Area should be gently sloping toward the salt marsh	• The area will need revegetation & probably short-term weed control • Expect transition zone at about 11 feet NAVD88 • Typical species would include shrubs that can tolerate some salinity & occasional flooding such as *Atriplex lentiformis, Suaeda calceoliformis, S. taxifolia & Isocoma menziesii*	• Very rare flooding for short durations with brackish water • Some buildup of salts in soil • Water table below the rooting zone • New location of OLW might raise the water table enough that wetlands establish above the estimated 9-foot NAVD88 contour	Conversion toward salt marsh & then brackish marsh as the water table nears the surface

TABLE 6-6
ALTERNATIVE 3 ACTIONS BY AREA

Area	Sub-area	Habitat Type	Actions/Outcomes			Projected Changes with sea-level rise
			Earth Moving	Vegetation	Hydrology/Salinity	
4 (cont.)	4.4	Upland	• Spoil site for soil excavated in 3a • The slope toward the transition zone may need to be fairly steep • Excavated soil may be saline • Saline soils would not support most upland species so leaching & soil amendments may be needed	Non-native species control & planting grassland & coastal sage scrub	N/A	Conversion toward transition zone & then salt marsh as flooding occurs & the water table nears the surface
5	5.1	Salt marsh	• Remove all the abandoned roads & create a broad salt marsh plain • Optional basins could be created in new salt marsh area to support salt panne	• No actions in existing salt marsh area • Plant new salt marsh with appropriate salt marsh species	• Salt marsh areas would pond with rainfall & retain salts from evaporating groundwater (similar to other salt marsh habitats on-site) • Expect salt marsh between about 5 & 7.5 feet NAVD88 • Block culverts to eliminate drainage of area to ODD #3	Rising salty groundwater from the ocean will cause conversion to salt panne & then open water
	5.2	Seasonal wetland	Shallow basins would be excavated at multiple elevations	• Control non-natives & plant salt-tolerant natives that tolerate wet winter & dry summer conditions in upper basin(s) • Consider introducing locally & regionally rare species such as *Salicornia depressa, Atriplex coulteri, A. pacifica, A. serenana var. davidsonii, Lasthenia glabrata* ssp. *coulteri, Suaeda calceoliformis, Astragalus pycnostachyus* var. *lanosissimus,* etc. • Lower basin would likely support salt marsh habitat	• Seasonally flooded from rainfall • Saline groundwater generally below the rooting zone • Salts transported in to the rooting zone, generally pushed deeper & diluted in the winter with rainfall & closer to the surface & more concentrated in the summer	Conversion toward salt marsh & salt panne as water table nears surface
	5.3	Upland	None	Non-native species control & planting coastal sage scrub	N/A	Rising water in ODD #3 &/or groundwater will lead to conversion to brackish or salt marsh
	5.4	Open water	None	Tule on the edges of the channel will remain	As-is	Water will get deeper & tule fringe will move up the banks

TABLE 6-6
ALTERNATIVE 3 ACTIONS BY AREA

Area	Sub-area	Habitat Type	Actions/Outcomes			Projected Changes with sea-level rise
			Earth Moving	Vegetation	Hydrology/Salinity	
6	6.1	Salt marsh	• Remove levees & fill in the stub of ODD #3 between Areas 5 & 6 • Create contiguous salt marsh plain between Areas 5 & 6	• Non-native species control • Planting in new salt marsh areas	As-is	• Conversion to salt panne & open water as groundwater level rises • Dunes will migrate landward & bury salt marsh
	6.2	Salt panne	None	None	As-is	Conversion to open water as groundwater level rises
	6.3	Upland	None	Non-native species control	N/A	Conversion to salt marsh habitat as groundwater level rises
	6.4	Open water	None	Tule on the edges of the channel will remain	As-is	Water will get deeper & tule fringe will move up the banks
7, 8, 9	7, 8, 9.1	Coastal dune	Add sand fencing between fore & back dune ridges to encourage dune building	• Extensive planting between fore & back dune ridges to encourage natural dune building • Dune planting could include reintroduction or introduction of rare, threatened & endangered endemic dune species	N/A	• Conversion to strand & beach as the coast retreats • Additional sand in expanded dunes might slow rate of retreat
	7, 8, 9.2	Open water	• Create sand berm between existing lagoon and the mouth of the new lagoon • Excavate channel through dunes to create a mouth for the new lagoon	N/A	• Mouth of new lagoon would breech occasionally and receive wave overwash rarely • Mouth would be allowed to open and close naturally • A back beach swale may form naturally (as seen at the current lagoon)	As the beach retreats, there will be more opportunities for a back beach swale to form
	7, 8, 9.3	Beach/strand	None	None	Occasional wave overwash at south end	Conversion to intertidal & surf zone as the beach retreats

Infrastructure Modification

The new lagoon water level will result in water ponding higher than the existing lagoon, and hence may impact the railway between Areas 3a and 4. The potential for increased water levels farther upstream near Hueneme Road will be evaluated relative to the local flood thresholds. Modifications to the railway will be required sooner because site water levels will be higher sooner, due to the new lagoon. A culvert under the railway will be constructed to allow backwater from the new lagoon to fill the agricultural ditch in Area 4 and or to limit drainage in order to concentrate salts via evaporation, and to allow draining of Area 4 if needed: The hydraulic criteria for the culvert and potential water control elements (e.g., gate) have not been developed at this stage of design and would depend on an analysis of water and salt balance.

Filling the existing OLW in Area 2 and at the Halaco properties is required to form two lagoons (pending coordination with EPA). The existing Ormond Lagoon will have reduced water supply and water levels, but will still require beach excavation to prevent flooding.

Drainage ditches will be removed by filling. Connection to the ODD #3 will be accomplished by water control structures so that any adverse effects to downstream habitats and adjacent properties can be reversed and otherwise the hydrology can be adaptively managed. This modification is similar to Alternative 2, but the target hydrology is different.

Access, Trails, and Site Amenities

Alternative 3 (Figure 6-3) features more developed trails and boardwalks and opportunities for looped trail experiences, as well as a bicycle route traversing the site (as opposed to “out and back”). Although the trails are more developed and can accommodate more intensive usage, the alignments create contiguous habitat areas, thus contributing to less potential wildlife disturbance.

A new bridge at tšumaš Creek (Area 1, Access Node E) provides a multi-modal connection between the project area and Hueneme Beach, and the multi-modal boardwalk leading through the Ormond Lagoon island connects to the Perkins Road trail. The improved and expanded parking lot at Perkins (Access Node A) can accommodate more visitors, who can then take the elevated boardwalk trail to the overlook at Ormond Lagoon, head to the Beach via the Hueneme Beach trail, or head east to the heart of the site through the West McWane Blvd. trailhead (Access Node B1). A clearly signed and connected sidewalk or site trail is proposed between Perkins and West McWane to facilitate a larger loop trail experience. An elevated boardwalk leads from West McWane (Access Node B1) north to Area 2 and a rustic wetland loop trail. The primary multi-modal trail heads east across a new bridge with overlook at OLW (Area 2 and 3a). The trail continues west, and then south toward the beach via a multi-modal trail with overlooks (Area 3a). This trail then becomes a boardwalk through wetlands and back dunes, creating the opportunity for visitors to head north east to complete a large loop and head back to Hueneme Road along McWane Blvd. (Area 4), or walk along the beach (Area 7 and 1) to return to the Perkins Road or McWane Blvd. East trailhead.

A new trailhead access proposed at the corner of Edison and East McWane Blvd. (Area 4, Access Node C) is sited to accommodate both local and regional visitors, including cyclists. This node would have bike services, and due to its location, could be implemented either while the Area 4 agriculture is occurring or after conversion to wetland. A community visitor's center is envisioned to provide school groups and community groups with a place to gather and learn about the Project Area, and to facilitate community involvement in direct hands-on restoration activities such as planting, weeding, and monitoring. Maintenance facilities could be located here to facilitate volunteer inclusion, tool storage, and staging area for example.

This alternative focuses access to the western portion of the site while still providing limited access on primitive and rustic trails to the more sensitive eastern portion of the site. The existing Arnold Road parking lot (Access Node D) would be reconfigured to have only ADA parking sites, and a drop-off or turn-around area, and focus on bike parking for access. Bike racks and a limited number of bike lockers allow cyclists to secure their bikes or camping gear and explore Areas 5, 6, and 9 on foot. The filling of the ODD #3 (pending agreement with Oxnard Drainage District No. 2) allows an easy access through a new upland band proposed in Area 5, where visitors can view birds and habitats from a new overlook platform. This is the only alternative providing access within Area 5.

Outcomes

Physical/Geomorphic

A separate lagoon will be created in Areas 2, 3a and 7 that will be fed by the OLW, with a new mouth intermittently connecting it to the ocean. The new lagoon would have permanently flooded areas but water levels would vary with rainfall and with the opening and closing of the mouth. At current sea levels, the mouth would remain closed the majority of the time. Seawater ingress could occur during mouth-open conditions. Light rainfall events that do not deliver enough water to cause a breach of the beach berm would lead to high water levels (up to 3 feet higher than the maximum levels in the current lagoon). Overall, water levels in the lagoon will fluctuate between about 2 and 12 feet NAVD88. The existing Ormond Lagoon is expected to attain a lower water level (typically about a foot lower), based on the analysis in Section 6.4.1 Technical Studies (see Water Balance/Lagoon Inlet Modeling, including figure 6-14). Substantial grading in Area 4 will create a shallow basin that will fill with rainwater, have very low percolation rates, and drain only when the basin is over full. This will facilitate a buildup of salts on and near the surface as water evaporates. Similar basins will be constructed in Area 5 at multiple elevations. The lowest will provide salt panne conditions at current sea levels and the higher basins will convert to salt panne conditions with sea-level rise.

Ecological/habitat

The overall shift in habitats in Alternative 3 is similar to Alternative 2. The post-construction habitat types and acres are compiled in **Table 6-7**, and shown in Figure 6-8. The area of wetlands within the site will be increased overall. Salt marsh habitats in Areas 2 and 3a will be converted to brackish marsh or open water, and existing open water will be converted to brackish marsh.

Some uplands will be converted to brackish marsh while others will be maintained and restored. Riparian habitat along OLW in Area 2 will not be sustainable due to existing brackish ground water. Salt marsh and salt panne are expanded in Areas 4 and 5. There would be some conversion of dune habitat in Area 7; however, the affected area would remain valuable habitat. Dune topography would be increased and back dune areas would be more vegetated than they are currently.

TABLE 6-7
ALTERNATIVE 3: CONNECTIVITY THEME HABITAT PROJECTIONS

Habitat Type	Area (acres)								
	1	2	3a	3b	4	5	6	7-9	TOTAL
Beach/strand	12							18	30
Coastal dunes	18							102	120
Dune swale wetland									0
Salt panne				4	37	9	22		72
Salt marsh				19	39	43	34		136
Brackish marsh	30	42	28						99
Seasonal wetlands					16				16
Riparian									0
Open water	15	6	19			2	2	1	46
Wetland-upland transition		13	8		39	13			73
Bioswale		1							1
Upland	2	27	9	1	22	6	2		69
TOTAL	77	89	64	24	137	88	60	121	660

NOTE:
Habitat estimates rounded to nearest acre. Habitat projections are post-construction under current sea level.

SOURCE: CRC

New open water and brackish marsh habitats would support various species of ducks and rails as well as songbirds. Open water areas would provide foraging habitat for California least tern. However, the new mouth location would eliminate the currently active (2017–2018) nesting colony in Area 7 and could also affect a currently productive western snowy plover nesting area. The new lagoon could support a separate population of tidewater goby and therefore decrease the likelihood that the species might be extirpated from the Project Area if there were some major disturbance in one lagoon or the other. The existing lagoon would have lower water levels owing to the diversion of OLW, which could reduce habitat area (but may be offset by the gain in area with a second lagoon). Further analysis of the dynamics and net change in habitat area and quality of a two-lagoon system, and the potential effect on tidewater goby in the existing Ormond Lagoon and new lagoon is needed if this Alternative is advanced.

Existing habitat for Belding's savannah sparrow would be eliminated in Area 3a but new salt marsh habitats in Areas 4 and 5 could support this species. The only existing population of

Coulter's goldfields in the project area and a small population of salt marsh bird's beak in Area 3a would be eliminated. Restored saline habitats in Areas 4 and 5 might support new populations these species. Regionally and globally rare species adapted to non-tidal saline habitats might be introduced (e.g., Ventura marsh milk vetch) in Areas 4 and 5 as well.

Public Access

This alternative balances access to each of the designated Project Areas while maintaining large contiguous, connected habitat areas. Due to the expanded and projected higher elevations of wet areas, and movement of waterways inland, public access features are primarily located on the periphery of the Project Area to support the hydrologic connectivity. Access points remain concentrated at McWane Blvd., and Perkins Road, and Arnold Road. A number of large loop trails are created to support cycling and long nature hikes. The network of boardwalks clearly define walking paths and help encourage visitors to stay on the trails, while allowing hydrologic connectivity and wildlife movement to be unrestricted.

6.3 Alternatives Evaluation

The alternatives were analyzed using SLAMM habitat evolution modeling and the lagoon QCM for future performance, and then scored on the basis of how well they met the project objectives. The shore response to sea-level rise was modeled separately and superimposed on the SLAMM model outputs, and is explained in Appendix B – Shore Migration and Overtopping (Beach QCM). Future sea-level rise used for this study is explained in Appendix A – Sea-Level Rise. These analyses are addressed in detail for the no-project future conditions in Chapter 2 Site Conditions of this report. Please note that the lagoon QCM includes a water balance model and therefore accounts for water supply and the effects of modifying the Ormond Lagoon basin (Alternative 2) and a creating a new lagoon (Alternative 3). Chapter 7 Data Gaps and Uncertainties of this report addresses data gaps and uncertainties, including the need for hydrology data to better quantify water supply. However, based on available data and modeling, all three alternatives considered herein are considered feasible from a physical processes perspective.

6.3.1 Technical Studies

SLAMM Modeling

SLAMM was used to evaluate the habitat evolution of the proposed restoration alternatives. For each alternative, the ground elevations in the digital elevation model (DEM) were modified to represent the proposed grading and the initial habitat map was revised to reflect the target habitats. Then SLAMM was run using all the same configuration as for the No Project scenario, except for the altered DEMs and habitat maps. Differences from the No Project scenario and between the alternatives are summarized in the sections below. Additional details can be found in Appendix D – Wetlands Habitat Evolution Modeling (SLAMM).

Alternative 1

Since Alternative 1 proposes mostly enhancements to existing habitats and relatively mild grading, its initial conditions are very similar to existing conditions in the No Project scenario. Because of the similarity to No Project's initial conditions, the resulting habitat evolution is also similar to the No Project scenario. The habitats entered into the SLAMM model are shown in Figure 6-5.

At 2060 (**Figure 6-9**), with 2 feet of sea-level rise, the most prominent change is open water in Area 6. At 2080 (**Figure 6-10**), with 3 feet of sea-level rise, inundation spreads to a substantial fraction of the project area, and the reduced connectivity to ODD #3 results in larger open water and unvegetated areas in the western portion of Area 5. At 2100, the majority of the Project Area is inundated (see Appendix D – Wetlands Habitat Evolution Modeling (SLAMM)).

Alternative 2

The proposed grading in Alternative 2, notably the realignment of OLW in Areas 2 and 3a, and the wetland swales in Area 4, modify this alternative's initial habitat conditions.

At 2060 (**Figure 6-11**), with 2 feet of sea-level rise, the southern-most wetland swale in Area 4 become permanently inundated. Because of the better connectivity via the OLW realignment, Area 3a has more vegetated wetlands rather than the unvegetated flats predicted for this area for No Project and Alternative 1. The lower portion of the re-aligned channel also provides connectivity between OLW and the lagoon across a wider swath of Area 1.

At 2080 (**Figure 6-12**), with 3 feet of sea-level rise, inundation from OLW spills out across Area 3a, re-creating lagoonal conditions which would be displaced at the original Ormond Lagoon by beach transgression. In Area 4, the landward transgression of inundation progresses, deepening the water in the southern swale and activating the next swale north with permanent inundation. In Area 5, the proposed embankment will slow the encroachment of inundation in the northeast part of the site as compared to the No Project scenario.

At 2100, with almost 5 feet of sea-level rise, the majority of the Project Area is inundated, with slight variation in the inundation's distribution due to this alternative's proposed grading (Appendix D – Wetlands Habitat Evolution Modeling (SLAMM)).

Alternative 3

Alternative 3 proposes more extensive grading to re-align OLW, excavate a lagoon at its downstream end, and create wetland depressions in Area 4 and Area 5.

At 2060 (**Figure 6-13**), with 2 feet of sea-level rise, all of major grading areas become inundated. Conditions are similar to Alternative 2, except the more extensive excavation increases the inundated extents.

At 2080 (**Figure 6-14**), with 3 feet of sea-level rise, the rising inundation spills out from the excavated areas onto adjacent properties. The combination of the grading and increased

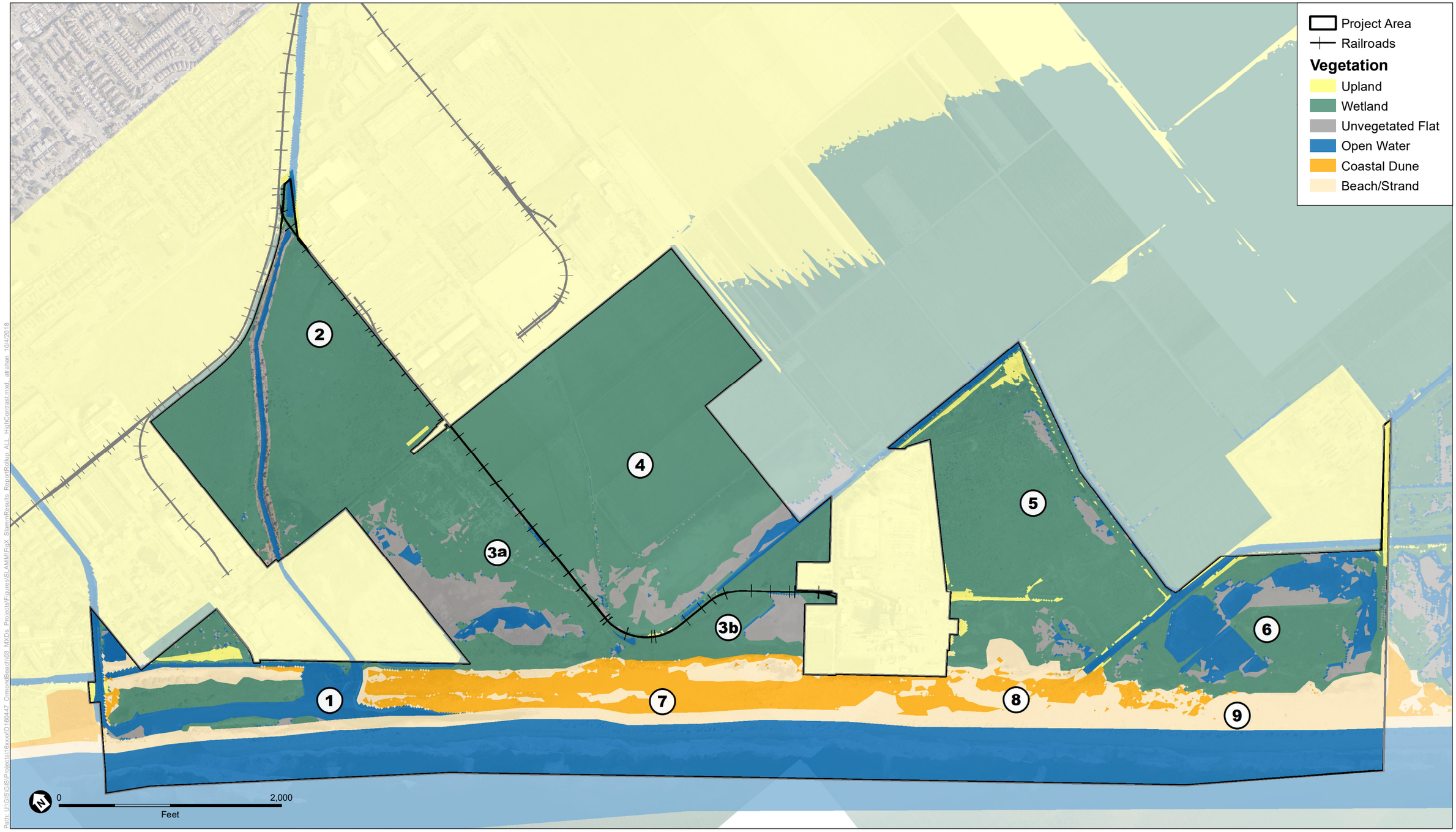
connectivity yields more contiguous wetlands across Area 3a and Area 4. Inundation in Area 5 is largest for this alternative.

At 2100, with almost 5 feet of sea-level rise, the majority of the Project Area is inundated, with slight variation in the inundation's distribution due to this alternative's proposed grading (Appendix D – Wetlands Habitat Evolution Modeling (SLAMM)).

Water Balance/Lagoon Inlet Modeling

In general, the Lagoon QCM model found that the alternatives that expanded the lagoon volume (Alternatives 2 and 3) tended to accumulate more water on the site (by prolonging seasonal lagoon mouth closure events and/or adding additional storage volume for ponded inflows) than maintaining open-mouth conditions during the wet season. Alternative 1 would likely provide the least additional wetted area and water volume, but would provide more brackish and saline habitat (see Section 2.4.3). With 3 feet of sea-level rise, the model generally predicted that the site would tend to be closed to tidal influence for longer periods of time for all alternatives, along with a shift toward higher average water levels and a greater amount of ponded brackish habitat.

Figure 6-15 condenses the modeled water levels for the various alternatives into probability density function (pdf) curves. These curves represent the relative number of times that lagoon water levels were predicted within certain bands of elevation. As an example, a pdf curve of oceanic tides would show high density of occurrences between mean lower low water (MLLW) and mean higher high water (MHHW). For Ormond Lagoon, water levels are typically much higher, so the pdf curves show a higher density above MHHW. The goal of this plot is to show subtle changes in water level between the alternatives. Figure 6-15 also shows pdf curves for wetted area and lagoon volume, which were calculated from the water levels by relating them to the hypsometry (volume vs elevation) relationships for each case.

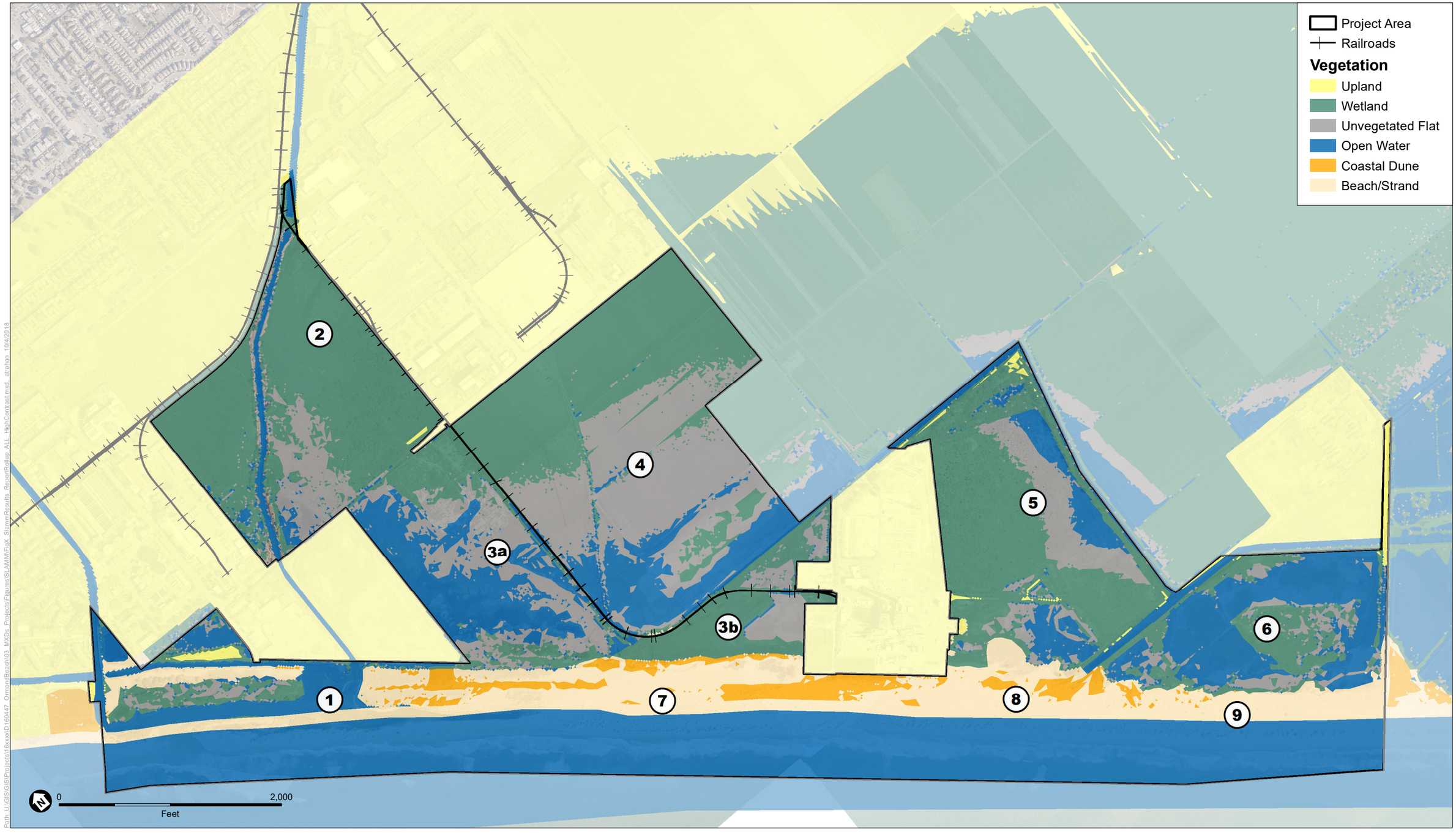


SOURCE: ESA (2017), CA Coastal Conservancy LiDAR (2011)

Ormond Beach Restoration and Public Access Plan

Figure 6-9
SLAMM Results with Beach Transgression
Alternative 1, 2060, +2.1 ft SLR

ESA



SOURCE: ESA (2017), CA Coastal Conservancy LiDAR (2011)

Ormond Beach Restoration and Public Access Plan

Figure 6-10
SLAMM Results with Beach Transgression
Alternative 1, 2080, +3.4 ft SLR

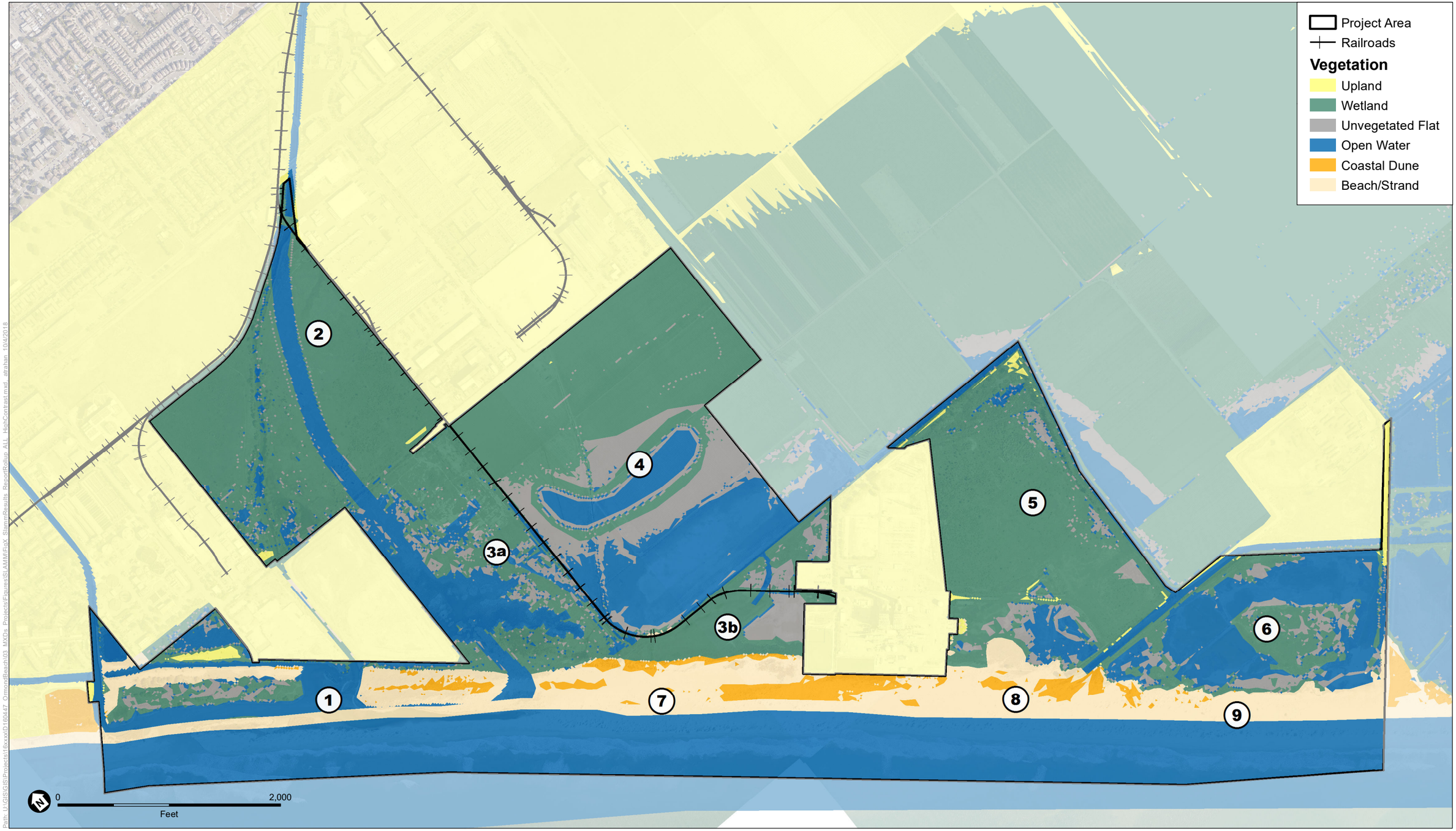
ESA

SOURCE: ESA (2017), CA Coastal Conservancy LiDAR (2011)

Ormond Beach Restoration and Public Access Plan

Figure 6-11
SLAMM Results with Beach Transgression
Alternative 2, 2060, +2.1 ft SLR

ESA

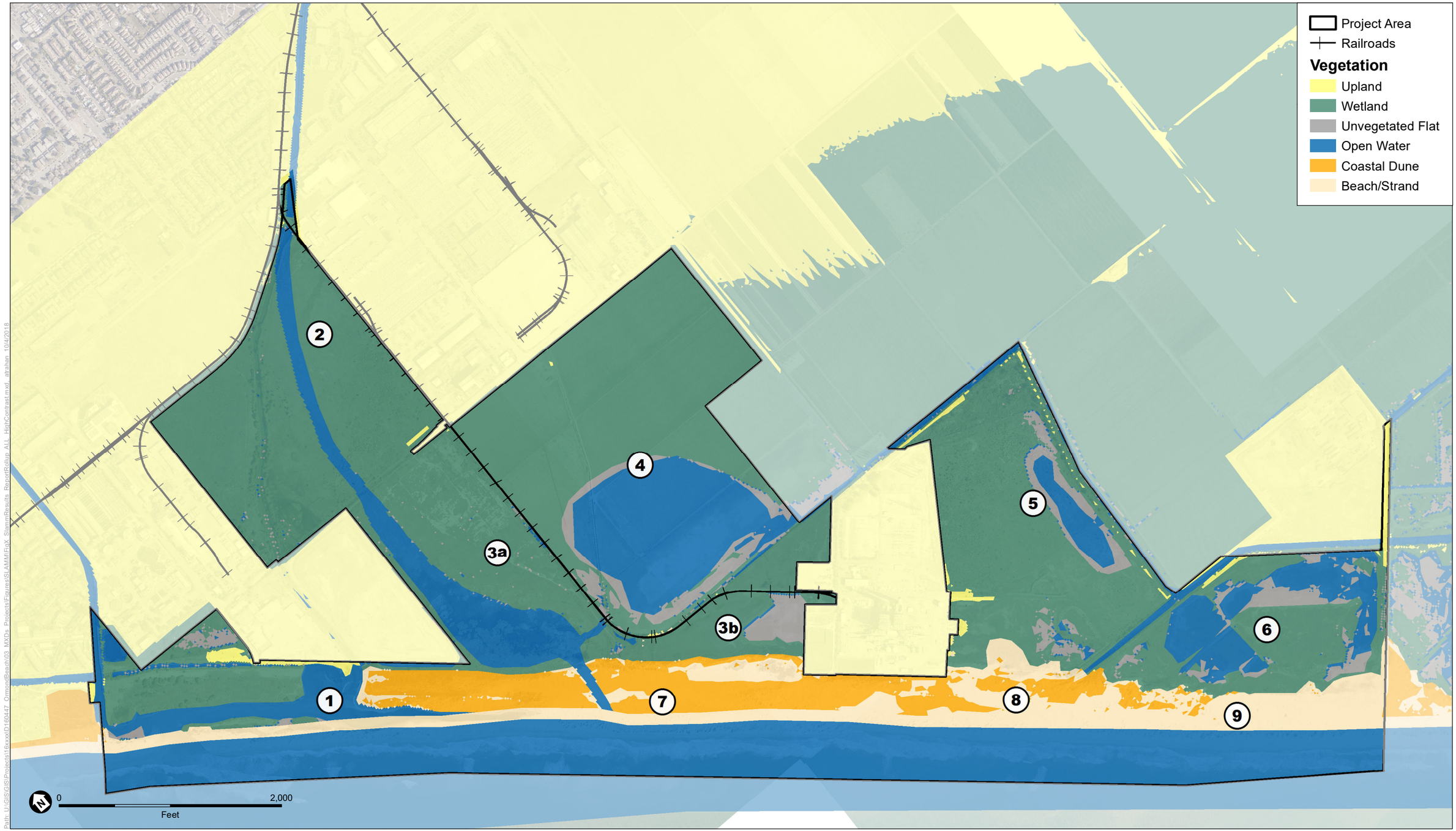


SOURCE: ESA (2017), CA Coastal Conservancy LiDAR (2011)

Ormond Beach Restoration and Public Access Plan

Figure 6-12
SLAMM Results with Beach Transgression
Alternative 2, 2080, +3.4 ft SLR

ESA



SOURCE: ESA (2017), CA Coastal Conservancy LiDAR (2011)

Ormond Beach Restoration and Public Access Plan

Figure 6-13
SLAMM Results with Beach Transgression
Alternative 3, 2060, +2.1 ft SLR

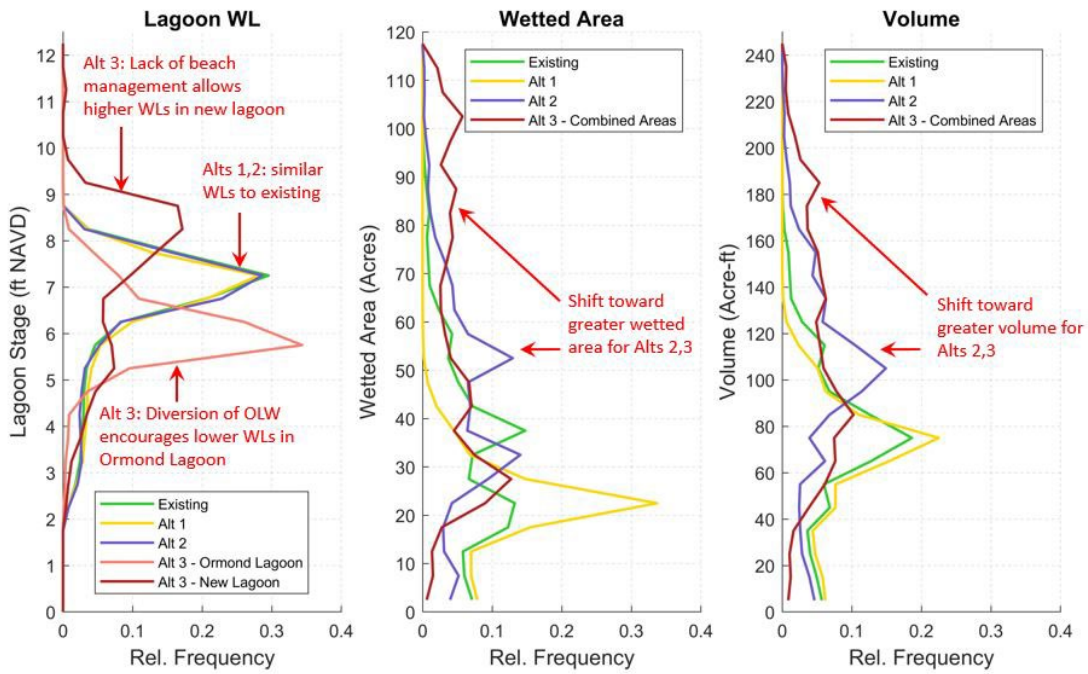
ESA

SOURCE: ESA (2017), CA Coastal Conservancy LiDAR (2011)

Ormond Beach Restoration and Public Access Plan

Figure 6-14
SLAMM Results with Beach Transgression
Alternative 3, 2080, +3.4 ft SLR

ESA



Ormond Beach Wetlands Restoration / D160447.00

SOURCE: ESA QCM model

Figure 6-15
Modeled Lagoon Stage (Water Level) (left), Area (middle), & Volume (right) Probability Distributions for 2007-2017.

Alternative 1

The lagoon model was setup to include a portion of 3a as part of the Ormond Lagoon basin to represent the existing hydraulic connectivity between the largely open water area on the beach Area 1 (this is what most people refer to as Ormond Lagoon) and the often flooded area in Area 3a (part of Ormond Lagoon hydraulically) which is freshening due to inundation during high lagoon levels. Alternative 1 is configured to block the surface water connection to Area 3a at the fresh-brackish area east of the Halaco properties, which is represented by a smaller Ormond Lagoon in the model. Since Alternative 1 would effectively reduce the volume of the lagoon (by isolating the ponded area east of the Halaco properties), the model showed that water levels would likely be slightly higher than in existing conditions during seasonal lagoon mouth closure events. The higher water levels would exist in the open water in Area 1, typically called Ormond Lagoon. The increased water level is attributed to a reducing backwater into Area 3a, essentially making a smaller lagoon, as there would be less storage capacity to hold the inflows. However, this higher water level would also cause the lagoon to breach earlier, as shown by the model. The earlier breaching would occur because the water level would rise higher and faster for a given inflow rate, and therefore would overflow and scour the beach, discharging to the ocean sooner than occurs with the existing, larger lagoon, and sooner than would occur with the other alternatives because it would take less time for inflows to pool and rise to the beach crest elevation and erode a new mouth. The predicted change in number of days of lagoon closure per year was a decrease of less than 1 percent, which is small relative to variations we expect to occur year to year. This means that under Alternative 1, the lagoon drained slightly earlier and more

frequently than the other alternatives, and overall, the resulting surface area and volume of the lagoon were smaller throughout the modeled time period of 2007–2017 (Figure 6-15).

Alternative 2

Alternative 2 would enlarge Ormond Lagoon. This alternative was modeled by doubling the current Ormond Lagoon storage volume. Modeled water levels under Alternative 2 were similar to existing conditions, but the added lagoon volume east of the Halaco properties added a significant amount of wetted area and freshwater volume (Figures 6-15). Overall, the model predicted that the added wetland/lagoon areas constructed east of the Halaco properties would act more to store water entering the site than to change the seasonal mouth morphology. The model predicted a slight increase in closure duration (less than 1 percent) which is small relative to the variations we expect year to year.

Alternative 3

Modeling of Alternative 3 analyzed the impact of adding lagoon storage east of the Halaco properties, and blocking the surface water connection with the existing Ormond Lagoon. The model assumed flows from OLW to the new lagoon in the existing wetland area. The new lagoon was modeled separately from Ormond Lagoon. Alternative 3 resulted in the most marked changes in lagoon water levels and mouth closure frequency, and showed a similar effect as that of Alternative 2 with respect to increasing total lagoon wetted area and volume. The new lagoon under Alternative 3 was predicted to experience higher water levels than for Ormond Lagoon under existing conditions. This is a result of:

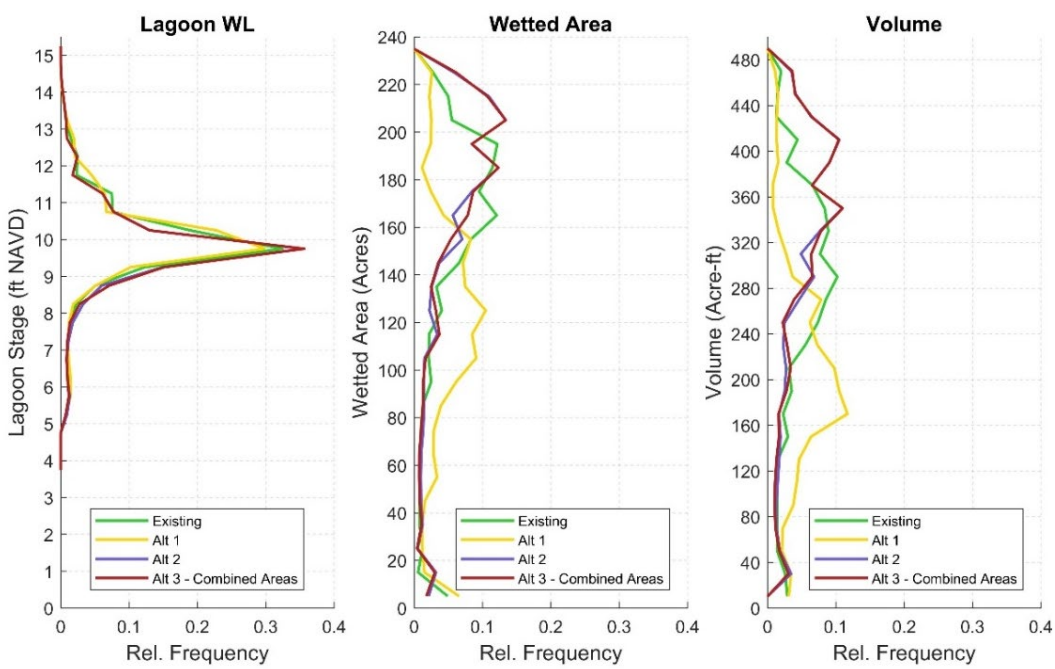
- Smaller storage capacity as compared to the capacity of the entire existing system,
- Reduced seepage toward the ocean given that the new lagoon would mostly be situated behind the dune line, rather than open to the beach, and
- Lack of beach management, allowing the beach crest to reach equilibrium levels of 9 to11 feet NAVD88 during seasonal lagoon mouth closures. This would allow higher water levels to occur in the new lagoon and hold more water behind the beach berm.

These modeled changes contributed to significant gains in water volume east of the Halaco properties, despite the fact that a portion of the inflows (from tšumaš Creek and Bubbling Springs) were directed to Ormond Lagoon. In contrast, the Ormond Lagoon experienced a reduction of 1 to 2 feet in water levels, since its storage capacity remained the same and the OLW would be diverted to the new lagoon. This is anticipated to have a net benefit on flood management in the bypassed portion of OLW and Ormond Lagoon, as it would delay ponding during floods and reduce the number of times that peak water levels would reach the grooming elevation. Water levels would be higher in Areas 3 however and may impact the railway. A flood-hydraulics assessment of Alternative 3 is needed as part of subsequent project development. Given these predicted changes in hydrology, we presume an ecological impact analysis is required for Alternative 3.

Despite the separation of inflows, when combined, the new lagoon and Ormond Lagoon segments are predicted to provide a net increase in overall brackish habitat in the system as indicated by the curves for wetted area and volume in Figure 6-15. The increase is similar in magnitude to Alternative 2.

Sea-level Rise

With 3 feet of sea-level rise, the model predicted that water levels would likely be similar across all alternatives, owing to the expansion of the lagoons into inland lowlands (**Figure 6-16**). The similar water levels result because the progressive (increasing with sea-level rise over time) inundation of back-barrier low-lying areas would eventually compensate for the reduction of lagoon on the beach from beach transgression, and eventually increase the lagoon volumes to exceed the existing and post-construction lagoon volumes. With 3 feet of sea-level rise, all alternatives experienced a shift toward longer seasonal closure events, rather than longer periods of open-mouth conditions. Note that Appendix C – Ormond Lagoon Hydrology and Morphology (Lagoon QCM) distinguishes models run with sea-level rise as "b" alternatives and alternatives without sea-level rise as "a" alternatives. The model set up varied somewhat for sea-level rise cases; details of the modeling conditions are presented in Appendix C.



Ormond Beach Wetlands Restoration / D160447.00

SOURCE: ESA QCM model

Figure 6-16
Modeled Lagoon Stage (Water Level) (left), Area (middle), & Volume (right) Probability Distributions for 2007–2017. With 3 feet of Sea-Level Rise

6.3.2 Comparative Evaluation

The three Project Alternatives were scored relative to existing conditions based on how well each meet the restoration objectives (**Table 6-8**), the public access objectives (**Table 6-9**).

The scoring protocol is:

= the alternative performance is equivalent to existing conditions

+ the alternative is expected to perform better than existing conditions; multiple "+" symbols indicates higher performance

- the alternative is expected to perform worse that existing conditions; multiple "-" indicates lower performance

Each sub-objective was qualitatively scored per above. Scoring can be achieved by comparing the number of "+" scores, which indicates positive outcomes, and noting the number of "-" scores, which indicates negative outcomes. The scoring indicates that the alternatives with more intervention are expected to provide greater ecological benefits (higher score relative to restoration objectives): Alternative 3 scores higher than 2 Alternative, and Alternative 2 scores higher than Alterative 1. Alternatives 2 and 3 have similar scores relative to access objectives, and scored higher than Alternative 1.

In addition to scoring performance relative objectives, the relative feasibility for implementation was comparatively evaluated (**Table 6-10**). Criteria considered include amount of earthwork, amount of disturbance of existing habitats and wetlands, complexity of new infrastructure, future water flows and water quality, permitting requirements, cost feasibility, dependency on other plans and projects, and ongoing maintenance and management requirements. Alternative 1 scored as the most relatively feasible, due to the minimal interventions inherent in this alternative. Alternative 3 scored the least relatively feasible, due to its more extensive earthwork and disturbance with a new second lagoon, and concomitant greater cost.

Note that the above "scoring" presumes equal weight is given to each sub-objective, and a change in weighting could change the overall assessment. Additional data to address data gaps and uncertainties may affect rankings, weightings, and judgments. Negatives may constitute "fatal-flaws" if, for example, impact to adjacent property or protected species cannot be mitigated by design or other action. Cost may also be a consideration. Hence, alternative selection is a judgment that requires the Project Partners decision.

TABLE 6-8
COMPARATIVE EVALUATION OF ALTERNATIVES RELATIVE TO RESTORATION OBJECTIVES

Restoration Objective	Restoration Sub-objective	Metric	Criterion description	Alternative 1		Alternative 2		Alternative 3	
				Rank	Description	Rank	Description	Rank	Description
1. Restore diverse, interconnected native habitats that considers the historical, current, and future landscape context.	1.1 Enhance and restore habitats including: beach; dune; coastal lagoon; seasonally ponded saline wetland and salt flat; high marsh and wetland-upland transition zone; upland; and riparian	Habitat (acres) post-construction estimates	Habitat acres and diversity estimated for historical (SFEI), current (2017 mapping), and post-construction projections (acres) for total project area. (Figure 6-8) Habitats interconnected, with fewer barriers.	+ + + +	Native habitat increased, particularly salt marsh. See Table 6-3 for habitat acres. Diversity increased from current Interconnected – some improvement from current Historic	+ +++ + +	See Table 6-5 for habitat acres Diverse Interconnected Historic	+ ++ ++ ++	See Table 6-7 for habitat acres Diverse Interconnected Historic
	1.2 Enhance and restore habitat for Project Area special-status, rare, and extirpated species where feasible	Species-specific habitat acreage	Salt marsh bird's beak – protect existing and enhance suitable salt marsh habitat near existing patches. Manage for multiple patches on-site. Coulter's goldfields – salt marsh and salt panne California least tern – dune habitat in Areas 8 and 9 Western snowy plover – dunes and salt panne habitats in Areas 6, 8, 9 Tidewater goby – lagoon/open water Belding's Savannah sparrow - salt marsh, wetland-upland transition Ridgway's rail – tidal salt marsh with tall vegetation	++ ++ = = = + =	Salt marsh bird's beak – expands salt marsh that could support Coulter's goldfields – could expand to other salt marsh or salt panne areas California least tern – maintain existing habitat Western snowy plover – maintain existing habitat that will be lost with sea-level rise Tidewater goby – lagoon similar Belding's Savannah sparrow – enhance marsh habitat Ridgway's rail – no appropriate habitat	= - = + + + =	Salt marsh bird's beak loss in Area 3a, could expand elsewhere Coulter's goldfields loss in Area 3a, could expand elsewhere California least tern – current nesting colony lost; benefits of expanded lagoon for foraging Western snowy plover – will use the salt panne Tidewater goby – more channel less channelized, connected with marshplain, not through Halaco Belding's Savannah sparrow - enhance marsh habitat Ridgway's rail – no appropriate habitat	= - = ++ + + =	Salt marsh bird's beak loss in Area 3a, could expand elsewhere Coulter's goldfields loss in Area 3a, could expand elsewhere California least tern – current nesting colony lost; benefits of expanded lagoon for foraging. Western Snowy Plover – will use the new big salt panne Tidewater goby – new channel bypass Halaco, add 2nd lagoon, but both shallower and smaller, persistence uncertain Belding's Savannah sparrow - enhance marsh habitat Ridgway's rail – no appropriate habitat

TABLE 6-8
COMPARATIVE EVALUATION OF ALTERNATIVES RELATIVE TO RESTORATION OBJECTIVES

Restoration Objective	Restoration Sub-objective	Metric	Criterion description	Alternative 1		Alternative 2		Alternative 3	
				Rank	Description	Rank	Description	Rank	Description
2. Restore physical and biological processes that sustain native habitats and ecosystems	2.1 Restore physical processes, such as hydrology, sediment dynamics, and water quality.	Geomorphology - channel location and form relative to marsh and lagoon Water quality Beach crest and lagoon mouth morphology	Linear feet of unconfined channel that can be hydrologically connected to its floodplain Reduction of pollutant levels (nutrients, sediment, pesticides, other urban runoff constituents). Lagoon mouth dynamics responsive to natural versus managed drivers	+ +	Lowest score, some light grading of channel Bioswale will reduce pollutants delivered to lagoon	+ + +	New OLW channel will (1) allow more hydrological connection between marshplain and channel, and (2) will improve downstream water quality by reducing flow through Halaco properties. Bioswale (greater extent) will reduce pollutants delivered to lagoon	+ + + ++	New OLW channel will (1) allow more hydrological connection between marshplain and channel, and (2) will improve downstream water quality by reducing flow through Halaco properties. Bioswale will reduce more pollutants delivered to lagoon New lagoon will function with its own mouth hydro-dynamics, increase hydrologic connectivity
	2.2 Restore biological processes, such as vegetation composition and structure and food web dynamics.	Vegetation Food web Geomorphology	"Composition" – native versus exotic species "Condition" – health and vigor Structure" – more natural pattern	+	Weed management and revegetation will enhance existing habitats	+ +	Weed management and revegetation will enhance existing habitats Reconfigure site to create conditions for expanded aquatic and wetland habitat	+ ++	Weed management and revegetation will enhance existing habitats Reconfigure site with new lagoon with ocean connection to create expanded aquatic and wetland habitat, enhanced tidal/freshwater mixing and access to wetland habitats

TABLE 6-8
COMPARATIVE EVALUATION OF ALTERNATIVES RELATIVE TO RESTORATION OBJECTIVES

Restoration Objective	Restoration Sub-objective	Metric	Criterion description	Alternative 1		Alternative 2		Alternative 3	
				Rank	Description	Rank	Description	Rank	Description
2. Restore physical and biological processes that sustain native habitats and ecosystems (continued)	2.3 Allow for a mosaic of self-sustaining habitats that are **naturally dynamic**, which change and move over time in response to physical processes (e.g., inundation during storm events, wave over-washing, and dune migration and change driven by winds)	Vegetation distribution	Mosaic of viable minimum patch size, in suitable landscape assemblage.	=	Maintain existing high-functioning wetland habitats	+	Less dynamic with existing lagoon mouth.	++	Dynamic with unmanaged lagoon mouth
				+	Enhance habitat conditions with weeding and revegetation	++	Realign OLW and grade to create engagement with floodplain and marsh	+++	More barriers have been removed, to allow dynamic processes and increased hydrologic connectivity, including tidal influence
				+	Enhance salt marsh conditions with blocking of freshwater/urban runoff flows	+	Excavate to create dune/swale morphology and back dune wetland habitat		
				+	Conduct minimal management of dunes at south end to facilitate episodic wave overwash events	+	Excavate new connection between OLW and Ormond Lagoon through the dunes		
	2.4 Create large areas of interconnected habitat with broad transition zones (i.e., ecotones)	Vegetation Topography	Transition zones that transgress upslope across +5 feet, +10 feet, and +15 feet elevation gradient	=	Establish transition zone habitat where elevations are above ~ 9 feet NAVD88	+	Reconfigure site to create 'ramped' series of basins that will facilitate wetland habitat transgression	++	Especially Area 4 Connecting uplands to wetlands in a more definitive way
	2.5 Provide and enhance ecological and hydrological connectivity within the site and with the site's watershed, the coast, and, if feasible, Mugu Lagoon	Hydrology Geomorphology	ODD #3 manipulations with water control structures and connections to Mugu Lagoon Removal of artificial barriers (berms) 2nd lagoon with connection to coast (Alt 3)	+	Remove berms and ditches between Areas 2 and 3a	+	Realign and reconfigure OLW to reconnect with floodplain and marsh	+	Realign and reconfigure OLW to reconnect with floodplain and marsh
						++	Lagoon connection to Area 3 increases capacity and natural mouth breach events (reduced need for managed breaching)	++	Fill ditches and remove artificial barriers (berms) to enhance connectivity within the site
						++	Excavate new connection between OLW and Ormond Lagoon through dunes	+++	2nd lagoon with connection to coast

TABLE 6-8
COMPARATIVE EVALUATION OF ALTERNATIVES RELATIVE TO RESTORATION OBJECTIVES

Restoration Objective	Restoration Sub-objective	Metric	Criterion description	Alternative 1		Alternative 2		Alternative 3	
				Rank	Description	Rank	Description	Rank	Description
3. Restore an ecosystem that is naturally resilient (i.e., able to respond, recover, and adapt) to climate change and sea-level rise	3.1 Promote resiliency to projected future climate change, including accelerated sea-level rise, extreme coastal storms, precipitation variability and extremes (i.e., drought and flood cycles and magnitudes), saline groundwater intrusion, and temperature.		Existing habitat connected to transition zones that progress upslope. Continuous transgression area to maintain species use and allow upslope migration. A connected gradient across expected future elevation changes, based on visual interpretation of elevation patterns in SLAMM for +1, +3 and +5 feet SLR Findings: beach and dune system is already wide, so inherently protected. The big loss will be existing lagoon squeezed, existing panne more inundation become more like a lagoon. Therefore, Alts that create salt panne seasonal pond areas are configured to accommodate pannes with sea-level rise	=	Maintain and slight expansion of existing salt pane habitat See Table 6-2 for habitat acres	+	Creates greater area of salt panne habitat See Table 6-4 for habitat acres Creates diversity of habitats that can transition in response to sea-level rise Large bioswales in Area 4 capture freshwater high flows during extreme storm events predicted with global climate change	++	Creates greatest area of salt panne habitat See Table 6-6 for habitat acres Creates diversity of habitats that can transition in response to sea-level rise
	3.2 As the sea level rises, allow for dunes to migrate landward, wetland types to change within the site, and upland and transition zone habitats to convert to wetlands			=	Maintains 'elevation capital' with minimal grading	+ +	Expands lagoon. Creates tiered basins to accommodate wetland habitat transgression in Area 4.	++ +	Creates new lagoon. Creates tiered basins to accommodate wetland habitat transgression in Areas 4 and 5.
	3.3 Consider local and regional changes in species distributions due to climate change and the potential for assisted migration of imperiled species to or from the site	Vegetation Wildlife	Does the Alternative provide habitats that are especially at risk regionally?		See rating for Sub-objective 1.2		See rating for Sub-objective 1.2		See rating for Sub-objective 1.2

TABLE 6-8
COMPARATIVE EVALUATION OF ALTERNATIVES RELATIVE TO RESTORATION OBJECTIVES

Restoration Objective	Restoration Sub-objective	Metric	Criterion description	Alternative 1		Alternative 2		Alternative 3	
				Rank	Description	Rank	Description	Rank	Description
3. Restore an ecosystem that is naturally resilient (i.e., able to respond, recover, and adapt) to climate change and sea-level rise. (continued)	3.4 Employ restoration as a nature-based climate change adaptation approach that provides co-benefits (such as reducing flood and erosion hazards) and promotes natural habitat as protection to developed areas ("green infrastructure") as an alternative to human-built structures such as concrete channels and seawalls ("grey infrastructure")		Number/acreage of habitat features that have capacity to function as stormwater basins (wetlands, basins, channels connected to waterways, sufficient area/topography to accommodate winter flooding) If compared to Existing conditions (with infrastructure like railroad). When model routes OLW and separates the channel… there is a flood benefit by increasing flood storage in the lagoon.	+	Create bioswale in Area 2	+ ++	Create bioswales in Areas 2 & 4 Greater capacity for floodwater with new OLW channel Lower water level in Ormond Lagoon	+ + -	Create bioswale in Area 2 Allows water levels to go higher upslope Lower water level in Ormond Lagoon but potentially more frequent flooding of railway.
4. Restore habitats that contribute to regional ecological wetland recovery goals.	4.1 Implement the WRP Regional Strategy goals and principles		WRP needs for salt pannes Also WRP emphasis on salt marsh over brackish/FW	+	Native wetland habitat increased, particularly salt marsh – minor increase in salt panne See Table 6-3 for habitat acres	+	Native wetland habitat increased- greater increase in salt panne See Table 6-5 for habitat acres	++	Greatest increase in salt panne, more salt marsh than Alt 2 See Table 6-7 for habitat acres
	4.2 Enhance the site's ecological function as a part of an interconnected system of wetland and upland habitats along the coast, the Pacific flyway, and inland (e.g., by enhancing wildlife corridors; conditions that support migrating birds; and connectivity with Mugu Lagoon, the Santa Monica Mountains, and Los Padres National Forest)		Hydrologic connectivity with Mugu Lagoon (via ODD #3) Wildlife corridors (not sure how to depict, except as sea-level rise wetland-upland transition areas) Which Alt has more open water (for migratory waterbirds on Flyway).	=	Maintains existing high-functioning nesting and forage habitats	+	Realign and reconfigure OLW to reconnect with floodplain and marsh	++ ++	More grading on OLW for lagoon and marsh Expect this to have higher water levels and larger amounts of desirable shallow water habitat for migratory shorebirds at new lagoon. Expect more flats between water and vegetated marsh (unless vegetation encroaches)

TABLE 6-8
COMPARATIVE EVALUATION OF ALTERNATIVES RELATIVE TO RESTORATION OBJECTIVES

Restoration Objective	Restoration Sub-objective	Metric	Criterion description	Alternative 1		Alternative 2		Alternative 3	
				Rank	Description	Rank	Description	Rank	Description
4. Restore habitats that contribute to regional ecological wetland recovery goals. (continued)	4.3 Consider opportunities to accommodate certain coastal wetland habitats and species that have experienced disproportionate loss at local and regional scales		Lagoon and salt panne were more prevalent historically, and are contemporarily rarer. So we are considering this in design by looking to incorporate	+	Maintains and enhances existing wetland habitats; slight increase in salt panne habitat	+	Increased lagoonal and salt panne habitats over Alt 1	++	Greatest increase in salt panne, more salt marsh than Alt 2. Creates new lagoon and create increase in open water habitat

TABLE 6-9
COMPARATIVE EVALUATION OF ALTERNATIVES RELATIVE TO ACCESS OBJECTIVES

Access Objective	Access Sub-objective	Metric	Criterion description	Alternative 1		Alternative 2		Alternative 3	
				Rank	Description	Rank	Description	Rank	Description
1. Provide improved access features … consistent with preserving natural ecosystems and minimizing disruption to natural processes, habitats and associated species, and ecological functions.	1.1 Provide improved access features, such as staging areas, trails, interpretive signs, viewing opportunities, restrooms, shade structures, picnic tables, benches, trash cans, and safe parking consistent with preserving natural ecosystems and minimizing disruption to natural processes, habitats and associated species, and ecological functions (e.g., that do not conflict with sand dune formation and lagoon hydrology).	Trails do not block water migration or prevent habitat transgression Trails and amenities located at appropriate elevations	Processes: Trails and access features should not interrupt or impede natural processes Processes: Ability to observe natural processes (assumes they are preserved or improved if they are observable) Resilient: Trails or boardwalks planned for sea-level rise and habitat transgression Amenities: Provides public access amenities (trails, staging areas, interpretive signs, viewing areas, restrooms, shade structures, picnic tables, benches, trash cans, parking) for community members and visitors	+ + +	Least amount of boardwalk proposed to allow water/ plant migration (see 5) Least number of trails and habitats/ processes to view 18 Site Amenity Elements proposed	++ +++ +++	Medium number of sections of boardwalk and bridges proposed along elevated trails to allow water flow through site Most number of trails and habitat types/ processes to view 26 Site Amenity Elements proposed	+++ ++ ++	Most linear feet of boardwalk proposed to allow water flow; and reduce blockage; works in concert with habitat connectivity theme. Most contiguous habitat and hydrologic connectivity through boardwalks. Medium number of habitat types/processes to view 18 Site Amenity Elements proposed (though they are more robust than Alt 1)
2. Enhance opportunities for recreation, including walking/ hiking, wildlife viewing and bird watching, picnicking, fishing, and surfing	N/A	Number of access points, number of trails, number of overlooks, amenities, habitat types to view or access	Habitats: Ability to experience multiple habitat types Recreation: Enhances opportunities for recreation	+	Least number of trails, trails mostly through salt marsh, coastal dune, or coastal strand	+++	Highest number of trails through highest diversity of habitat types	++	Medium number of trails through diverse number of habitat types

TABLE 6-9
COMPARATIVE EVALUATION OF ALTERNATIVES RELATIVE TO ACCESS OBJECTIVES

Access Objective	Access Sub-objective	Metric	Criterion description	Alternative 1		Alternative 2		Alternative 3	
				Rank	Description	Rank	Description	Rank	Description
3. Improve local community connectivity to Ormond Beach.	3.1 Connect regional and local bicycle and/or multi-use trails to the Ormond Beach trail networks	Number of trail heads and trailhead types (pedestrian, multi-modal, parking lots) and adjacency to neighborhoods.	Connectivity: Trails or access points connect to existing or planned trail routes adjacent to the site to facilitate access by neighboring communities	+	tšumaš Creek Greenway & Bubbling Springs trails, Hueneme Beach Park Pedestrian beach connection (seasonal) and pedestrian bridge connection (year-round). Coastal Trail alignment connects bus stop at Perkins and Hueneme Roads (pedestrian or bike) along Perkins Road to site.	+++	Highest number of access points closest to existing neighborhoods. Pedestrian beach connection to tšumaš Creek Greenway & Bubbling Springs at Hueneme Beach Park (seasonal). Coastal Trail alignment connects bus stop at Perkins and Hueneme Roads (pedestrian or bike) along Perkins Road to site. Multi-modal connection at Hueneme Road to neighborhoods. McWane Blvd. & Arnold Road access points.	++	Multi-modal connection to tšumaš Creek Greenway & Bubbling Springs, Hueneme Beach Park. Coastal Trail alignment connects bus stop at Perkins and Hueneme Roads (pedestrian or bike) along Perkins Road to site. Edison and Arnold Roads access points.
	3.2 Provide directional and informational signs at local public transportation stops or entry points	Provide way-finding and interpretive signage	Connectivity: Way-finding signage proposed. Education: Includes interpretive elements and access for school groups and visitors.	+	All alternatives propose way-finding and interpretive signage	+	All alternatives propose way-finding and interpretive signage	+	All alternatives propose way-finding and interpretive signage
4. Identify the segment of the California Coastal Trail through Ormond Beach, with connections to the proposed trail alignment to the SE and NW	N/A		Coastal Trail: Traverses site and connects to the southeast and northwest planned routes at site.	+	Two bike routes from Hueneme Road to Perkins Road, Edison Road to McWane Blvd., "out and back" access. Beach strand trail "out and back" only. One pedestrian loop from B1, through 3a to Area 7 dunes.	+++	Four bike route connections; two are "out and back" (Perkins A, Arnold Road D); three access points offer multi-modal trail loops through site. Six Pedestrian access points include bifurcated trails and loops. Coastal strand connected at both ends.	++	Four bike route connections; One is "out and back," three provide loop opportunities. Six pedestrian access points. Coastal strand connected at both ends.

TABLE 6-9
COMPARATIVE EVALUATION OF ALTERNATIVES RELATIVE TO ACCESS OBJECTIVES

Access Objective	Access Sub-objective	Metric	Criterion description	Alternative 1		Alternative 2		Alternative 3	
				Rank	Description	Rank	Description	Rank	Description
5. Establish buffers to protect sensitive species while allowing visitors to view these habitats in a manner consistent with their protection (e.g., maintaining adequate distances between public access features and sensitive habitats and use of bird blinds).	N/A	100' buffer established from concentrated nesting sites based on data obtained from Audubon 2017. Trails sited away from seaside bird's beak mapped populations, etc.	Sensitive: Trails and access features are sited and aligned in a way which reduces impacts to sensitive plants or wildlife by utilizing buffers or avoiding sensitive areas. When competing ecological concerns overlap, elements seek to balance and minimize impacts. Habitats: Ability to experience multiple habitat types	+	Least amount of boardwalk proposed. Raised trail from B1 to B2 has the potential to limit habitat transgression with sea-level rise. Backdune trail is aligned through dunes, thus has the least amount of definition and highest potential for users to go "off trail" into bird nest areas.	++	Sections of boardwalk and bridges proposed along elevated trails to allow water flow through site. Perimeter trails sited to consider habitat transgression. Largest number of trails near backdunes, but they are sited with buffers, additional fencing proposed. No trails purposed in largest seaside bird's beak population.	+++	Many linear feet of boardwalk proposed to allow water flow; works in concert with habitat connectivity theme. Perimeter trails pulled back furthest to the perimeter to allow internal habitat transgression. Dune boardwalks sited with buffers. Boardwalk proposed near but not on largest seaside bird's beak population.
6. Ensure compatibility with and minimize disturbance to adjacent land uses	N/A		Sensitive: Parking areas provided to discourage on street parking and trespass over agricultural fields or though industrial areas; trails aligned to discourage trespass to adjacent properties.	+++	No access at Arnold Road reduces potential neighbor conflicts and trespass to Mugu. Lowest number of trails aligned adjacent to dis-similar land uses.	+	Provides the most access at Arnold Road, thus highest potential neighbor conflicts and trespass to Mugu. Highest number of trails aligned adjacent to dis-similar land uses.	++	Provides limited access at Arnold Road, thus moderate potential neighbor conflicts and trespass to Mugu. Medium number of trails aligned adjacent to dis-similar land uses.
7. Encourage community involvement and participation in restoration and/or management activities	N/A		Community: Encourages community involvement. Education: Includes interpretive elements and access for school groups and visitors.	+	Least number of amenities and lowest number of habitat types to view and learn about.	+++	The diversity of habitats provides the most opportunity for learning about them. The largest number of interpretive elements, overlooks, and opportunities for site engagement.	++	Proposes future location for community wetland center geared to including community in propagation and restoration planting efforts.

TABLE 6-10
COMPARATIVE EVALUATION OF ALTERNATIVES RELATIVE TO IMPLEMENTATION FEASIBILITY

Factor	Criterion description	Ranking	Alternative 1		Alternative 2		Alternative 3	
			Rank	Description	Rank	Description	Rank	Description
1. Amount of Earthwork	Based on amount of earthwork expected	1 = Extensive earthwork 3 = Minimal earthwork	3	Minor, localized earthwork	2	Rerouting OLW requires significant earthwork	1	New Lagoon requires extensive earthwork
2. Amount of disturbance of existing habitats and wetlands	Based on extent of existing habitats and wetlands that overlap with planned access infrastructure and earthwork	1 = Significant disturbance 3 = Minimal disturbance	3	Most wetlands maintained as-is	2	Significant disturbance in Area 2	1	Re-routing OLW and new lagoon changes Areas 2 and 3 significantly with some change to the lagoon in Area 1
3. Complexity of new infrastructure	Based on large built infrastructure, primarily bridges and over-water platforms	1 = Many/complex built features 3 = Few built features	3	Bridge over tšumaš Creek	1	Two bridges over OLW Overlook platforms Bridge over lagoon	2	Two bridges over OLW Overlook platform on lagoon
4. Future water flows in lagoon	Based on potential water supply concerns	1 = Lagoon inflows most altered 3 = Lagoon inflow minimally altered	3	No major rerouting of flow	2	Potential for low water levels with expanded lagoon system	1	Potential for low water levels in existing Ormond Lagoon with new lagoon
5. Future water quality in OLW and lagoon	Based on potential WQ issues	1 = All flow into lagoon(s) continues to flow past Halaco 3 = Lagoon inflow bypasses Halaco site	1	OLW still flows through Halaco properties into lagoon	3	Flow avoids Halaco properties	3	Flow avoids Halaco properties but reduced water supply to existing Ormond Lagoon may affect water quality
6. Permitting Requirements	Based on expected permitting challenges for earthwork and construction in wetland areas and sensitive habitats	1 = More extensive potential impacts to resources 3 = Limited impacts to resources	3	Limited earthwork in wetland areas Little infrastructure in habitat areas	2	Significant earthwork in wetland areas Complex infrastructure in wetland areas	1	Extensive earthwork in wetland areas Moderate infrastructure in wetland areas
7. Cost feasibility	Based on Ormond Beach Wetland Restoration Feasibility Study (Aspen 2009) Alternatives 1–3	1 = Higher costs 3 = Lower costs	3	Similar to 2009 Alternative 3 Enhance Existing Habitat	2	Less extensive than 2009 Alternative 2 Restore Seasonally Open Wetlands	1	Similar to 2009 Alternative 1 Create New Lagoon
8. Dependency on other plans and projects	Based on other projects whose outcomes affect this one (Halaco and TNC properties cleanup)	1 = Highly dependent on other plans or actions 3 = Not dependent on other actions	2	No other plans with major influence	2	Contingent on actions on Halaco properties	2	Contingent on actions on Halaco properties
9. Ongoing maintenance and management requirements	Based on level of maintenance for public access infrastructure and adaptive management requirements of target habitats	1 = Extensive maintenance, complex management 3 = Standard maintenance	3	No change due to project alternative	2	Extensive public access infrastructure Adaptive management of stepped habitats (Area 4)	2	Extensive public access infrastructure Adaptive management of stepped habitats (Areas 4 and 5)
Total Score		Low score = less feasible High score = more feasible	**25**	Greatest relative feasibility	**18**	Medium relative feasibility	**14**	Lowest relative feasibility

6.3.3 OBRAP Science Advisory Committee

SCC and TNC convened five SAC meetings between 2016 and 2018 to review the priorities and desired outcomes for the OBRAP. Meetings in 2017 and 2018 discussed and reviewed options for restoration and public access alternatives. On the May 29, 2018, SAC meeting, the three alternatives presented in this section were reviewed and the SAC discussed several issues and recommendations related to technical feasibility; rare, sensitive, threatened, and endangered species and their habitats; and permitting considerations. The Project Partners considered this feedback in selecting the Preferred Alternative identified in Section 6.4.

Significant SAC recommendations are summarized below.

SAC General Recommendations for Restoration

- The restored area should be a self-sufficient ecosystem with minimal active management or maintenance (such as dredging, grading, or dune management).
- Rerouting Ormond Lagoon Waterway away from the Halaco properties is important to improve water quality and to support additional habitat with a more natural channel that would be subject to natural flooding and bank overtopping; therefore, consensus is that Alternatives 2 or 3 are preferred.
- With sea-level rise and other natural processes, Alternative 3 may well be the end point even without intervention; Alternative 2 is an intermediate-range solution that will not have the costs and impacts associated with Alternative 3.
- There is uncertainty whether the Oxnard Plain will drain enough water to Ormond to sustain two lagoons, especially as periods of drought may become more frequent and longer and water recycling is increased and water use is decreased in the communities upstream of the wetlands, which facilitates a leaning toward Alternative 2.
- Hydrologic connectivity between Areas 3a (wetlands on TNC/SCC properties to the west) and 4 (current agricultural area) is important; this needs further examination to ensure that if the OLW is re-aligned there will not be too much freshwater to support the desired salt marsh habitat.
- In general, salt marsh is favored over salt pannes, although salt pannes are a desired habitat type for protection and recovery from the WRP Regional Strategy; salt marsh, salt pannes, dunes, and dune swales are relatively rare in Southern California and should be emphasized; freshwater and brackish wetlands are more common.
- Heterogeneity is important in the face of uncertainty; larger patches of continuous habitat are favored over smaller less-resilient patches.
- Adaptive management, adaptive restoration and pilot projects can inform the final project design in the face of uncertainty; specifically, adjustments to the flows in ODD #3 should not negatively impact habitat or operations at NBVC–Point Mugu or for the channel's owners Oxnard Drainage District No. 2; features that may not take hold in the such as dune swale features from Alternative 3; err on the side of caution and phase implementation to learn how the system will respond; protect what is working well (e.g., non-tidal salt marsh).

- Facilitate habitat migration in response to sea-level rise, particularly allowing for increased salt marsh at Ormond Beach as salt marsh at Mugu Lagoon is lost; allow for beach and dune migration inland.

- Alternatives that consider grading or rerouting of the OLW have the potential to impact rare plants and wildlife habitat; careful consideration must be taken on how to minimize these impacts.

SAC General Recommendations for Public Access

- Consensus is that more perimeter trails are better; more multi-use trails will bring a different kind of users to the area and increase visitation/ecotourism.

- Minimize trails through the middle—the consensus is for a "natural experience" where habitat is not broken up by trails, where you do not see a lot of people in the middle, where wildlife can have more room to move.

- A family loop (i.e., short, easily accessible walking path) at Ormond Lagoon is a good idea, maybe also in Area 2 on the west side of OLW; include spur trails, bird blinds and overlooks for birding and views, and educational kiosks.

- Site security is important to protect natural resources, including sensitive habitats and tern and plover nesting and foraging areas; multi-use trails can be used by car security patrols, VAS, etc.; enforcement would be needed for seasonal trails.

- Install seasonal symbolic fences along dunes to keep people on the strand and away from sensitive habitats.

- Provide access at Arnold Road, but emphasis on western side of the Project Area will better serve the local community and spread out the concentration of visitors.

- Amenities for school children and multiple school buses is important.

- A bridge over tšumaš Creek and a bridge or floating dock over Ormond Lagoon as well as Lagoon Overlook will provide needed access to the beach for the local community (note: a solid bridge structure over Ormond Lagoon may be difficult to permit; a floating dock on piers may be easier to permit).

- A bike path starting at entry point C in Alternative 2 should be included with viewing nodes off the main line.

- Provide amenities and ease of access to the beach for local residents as described in the CAUSE survey results.

6.4 Preferred Alternative

The Project Partners have selected a preliminary Preferred Alternative that best meets their identified restoration and public access objectives. The Preferred Alternative will be developed in greater detail in the next phase of the OBRAP planning process. The Preferred Alternative reflects the Project Partners' consideration of input from the Ormond Beach SAC and the public.

The Project Partners also met with the following entities to discuss potential opportunities and constraints and inform development of the OBRAP:

- NBVC to discuss adjacent NBVC-Point Mugu.
- VCWPD, to discuss areas of VCWPD jurisdiction (including Ormond Lagoon Waterway, Ormond Lagoon, and tšumaš Creek).
- Port of Hueneme and Ventura County Railway (Port of Hueneme), to discuss the railroad line in the OBRAP area. .
- Oxnard Drainage District No. 2, to discuss flows in ODD #3, which drains Areas 3 and 4 to Mugu Lagoon through NBVC.
- EPA to discuss Halaco Superfund Site.

6.4.1 Overview

The Preferred Alternative combines elements of Alternative 2 and Alternative 3 to enhance and expand the range of existing habitats while emphasizing connectivity with modified hydrology (**Figure 6-17** and **Figure 6-18**).

This alternative uses earth moving and other moderate interventions to create a broader mosaic of wetland types on the site. The greater diversity of wetlands might be expected to support a wider array of species. Realignment of the OLW would alter hydrological processes to Areas 2 and 3a, creating more extensive brackish wetlands and open water in the place of brackish salt marsh and upland. Resilience to sea-level rise is built in with some water control structures (Area 5) and by allowing wetland types to convert over time (Areas 4 and 5). Unnecessary berms and channels in the east of the Project Area (Areas 5 and 6) would be removed or modified to improve connectivity while preserving existing high-value habitats in the east of the site. A series of dune swale wetlands would be excavated to increase biodiversity in the dunes. Upland areas will be restored, as will broad transitions between wetland and upland habitats. These transitional and upland areas will also provide space to accommodate wetland migration in response to sea-level rise.

Evaluation of the Preferred Alternative for habitat can be derived from Section 6.3.2 Comparative Evaluation using Alternative 2 for all areas except using Alternative 3 for Areas 5 and 6. Evaluation of the Preferred Alternative for public access can be based primarily on Alternative 3.

6.4.2 Actions

Overview by Areas

Site hydrology will be modified by way of earthwork and modification of surface water conveyance. Higher elevation areas will be enhanced to form a gradient of habitat that transitions from wetlands to uplands and perimeter infrastructure. These transitional and upland areas will also provide space to accommodate wetland migration in response to sea-level rise.

The banks of OLW (Area 2) and the north banks of Ormond Lagoon (Area 1) will be graded and planted to expand wetlands and transition habitats. OLW will be routed through Area 3a and connected to the existing Ormond Lagoon on the eastern side of the lagoon. The new channel would bypass the Halaco properties in favor of a more natural channel and expanded wetlands within the project area. The existing OLW channel segment between the two Halaco parcels would be blocked and potentially filled, pending coordination with EPA. The design includes an expansion of the Ormond Lagoon into Areas 7 and 3a. A pedestrian access bridge would be installed across the newly aligned OLW connecting the east and west portions of McWane Blvd. (Area 2, Access nodes B1 and B2), and a primary multi-modal trail would be constructed leading south through Area 3 to connect with boardwalks leading to the beach (Area 7). We anticipate expansion of brackish marsh in Areas 2 and 3a owing to brackish shallow groundwater, as measured in 2017 (6 – 16 ppt). Plants typically associated with riparian habitat may establish in some locations but we do not expect substantive riparian habitat. Additional analysis of potential vegetation and habitat based on soils and water-salt balance considerations may clarify the likely outcomes. Flood waters would be partly diverted into the restoration area and the expanded lagoon, thereby incrementally lowering the water level in the lagoon and reducing flood risk and management effort. Routing flows through the wetlands is expected to remove nutrients and improve the lagoon water quality.

A series of shallow basins will be created in Areas 4 at different elevations as the area transitions out of agriculture. The lowest basin would support salt panne habitat and higher basins would be seasonal wetlands and/or bioswales. The higher basins would convert to salt panne habitat as the sea level rises. One or more culverts under the railway may be added, based on a further evaluation of the desired hydraulic connectivity between Areas 4 and 3.

Hydraulic connectivity between ODD #3 and Areas 3b and 6 will be maintained as they are. Drainage from Area 5 to ODD #3 will be blocked or reduced in order to retain limited water supply and emphasize evaporation: Earth berms or other means will be used to block drainage rather than removal of the existing culverts and flap gates (similar to the Alterative 1 concept). If further evaluation of these connections in the future indicates they are deteriorating, intervention may be needed to stabilize these connections.

Salt marsh and salt panne habitat will be restored in Area 5 and it will be connected to Area 6. Excavated soil would be placed in the northern part of Area 5 and would support upland and transition habitats. Additional shallow basins would be excavated in Area 5 at elevations that would allow them to convert from seasonal wetlands to salt panne habitat as the sea level rises.

Drainage to ODD #3 from Area 5 and potentially Area 6 would be blocked or reduced, and the spur between Areas 5 and 6 would be filled. This would be the only modification to Area 6.

Beach Areas 7, 8, and 9 will be enhanced by weeding and planting to restore back dune scrub habitat and expand foredune scrub habitat. In addition, several shallow depressions will be excavated between dune ridges and planted with dune swale wetland species.

Wetland Boardwalk

Wetland Bridge with Overlook

Wetland-Dune Boardwalk

Bike Service and Racks

Bike Lockers

Primary Developed Trail

Rustic Trail

Primitive Trail

Beach Trail

Exclusionary Bird Fencing (Netting)

Symbolic Bird Fencing

Designated Areas

1. Ormond Lagoon, Including Beach, Dunes, & Perkins Drainage
2. Ormond Lagoon Waterway (OLW)
3a. South-of-Railway, Near Halaco Property
3b. South-of-Railway, Near OBGS
4. Agriculture
5. Tank Farm
6. Salt Marsh / Panne
7. Beach & Dune South of 3
8. Beach & Dune South of 5
9. Beach & Dune South of 6

Vegetation

- Salt Marsh (SM)
- Wetland-upland Transition (WT)
- Seasonal Wetlands (SW)
- Brackish Marsh (BM)
- Open Water
- Salt Panne (SP)
- Bioswale (BI)
- Upland (U)
- Coastal Dune (D)
- Beach/Strand (B)
- Dune Swale Wetland (DSW)

Access Nodes

- A Perkins Road
- B_1 West McWane Blvd.
- B_2 East McWane Blvd.
- C Hueneme Road
- D Arnold Road
- E City of Port Hueneme
- F Edison Road

Access Elements

- Primary / Developed Trail
- Secondary / Rustic Trail
- Tertiary / Primitive Trail
- Beach Trail
- Boardwalk
- Bridge
- CA Coastal Bike Trail
- Overlook Platform
- Overlook or View
- Parking
- Major Trailhead
- Minor Trailhead
- Water Control Structure
- Project Boundary
- Railroad

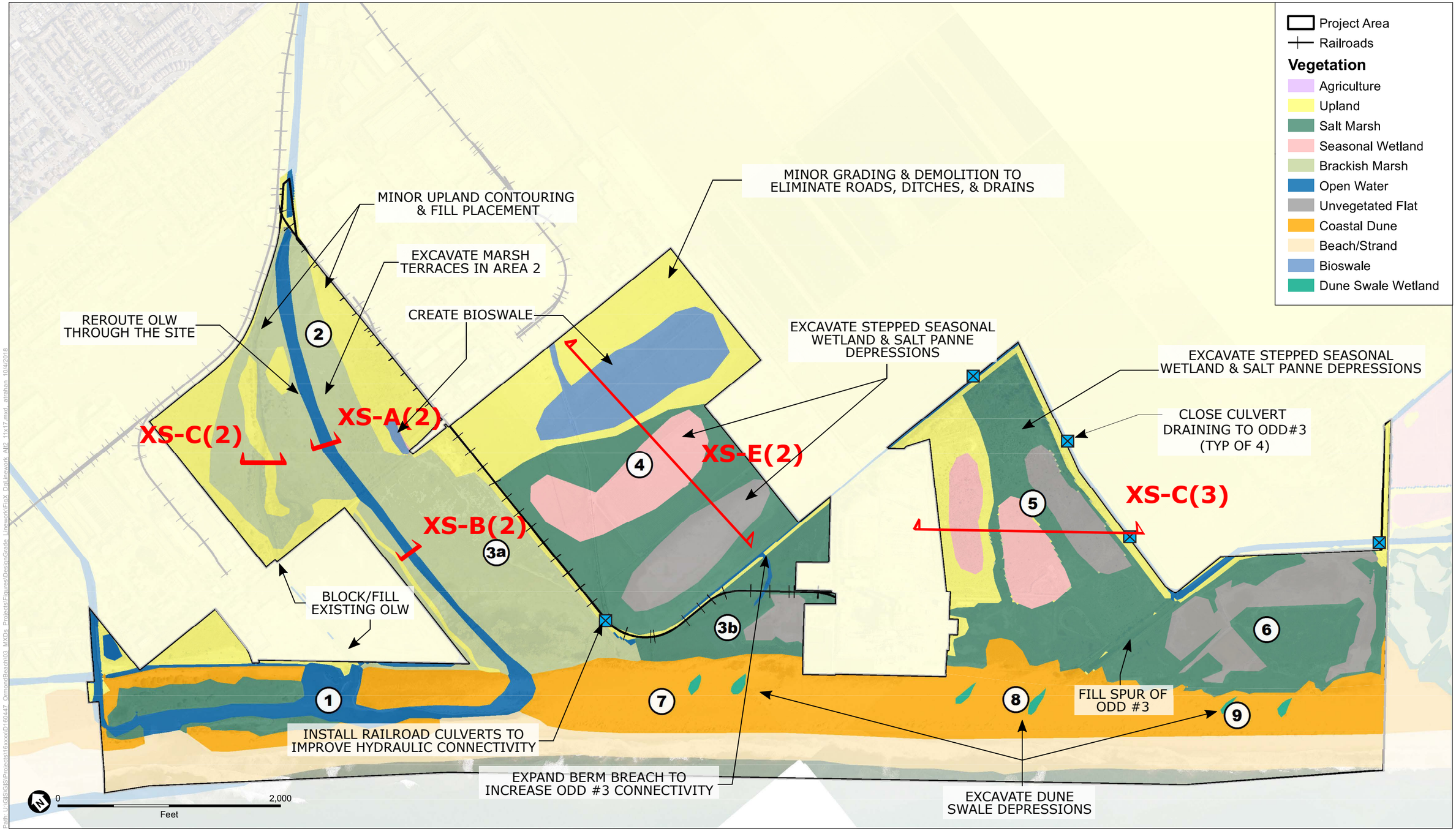
SOURCE: ESA, 2019

Ormond Beach Restoration and Public Access Plan

Figure 6-17
Preferred Alternative of Ormond Beach Restoration and Public Access Plan

D160447.00 - Ormond Beach Wetlands Restoration\05 Graphics\Illustrator

ESA



SOURCE: ESA (2017), CA Coastal Conservancy LiDAR (2011)

Ormond Beach Restoration and Public Access Project

Figure 6-18
Preferred Alternative Cross Section Locations

ESA

More details on area-specific actions and expected outcomes are provided in **Table 6-11**.

Grading

Typical earthwork cross sections are provided in Figures 6-4a and 6-4b, with corresponding locations marked on the Preferred Alternative Plan (Figure 6-18). Excavated soil will be reused beneficially on-site as practicable.

A new OLW channel will be excavated, and the existing lagoon expanded, resulting in significant earthwork excavation. Much of the earth will be used to fill the existing OLW and to fill and block ODD #3. Excess earth will be placed to form uplands and for access trail elements. Surface water connectivity between Area 1 and 3a will be increased by excavation of a lagoon deep enough to support tidewater goby habitat. Cross-sections A (Alt 2) and B (Alt 2) on Figure 6-4a show the new OLW channel through Areas 2 and 3, respectively. In Area 2, the existing grades are higher, and a wetland terrace is excavated above elevation 8 feet NAVD88 to provide for emergent marsh. An emergent marsh terrace is not included in Area 3a, where existing grades are lower. Both sections show the thalweg (low point) of the channel at elevation 3 feet NAVD88, which approximately matches the existing OLW. Section C shows the filled existing OLW, as well as additional fill to form a raised area. The raised area is shaped to resemble an abandoned natural river levee, and largely follows the existing remnant levees originally constructed as part of the OLW. This raised land will be planted with a riparian palette, and support a path for public access.

Area 4 will be excavated and graded to form shallow seasonally flooded basins. The elevations and depths of the basins will be designed to support different hydrology and salinity dynamics. The basins will be higher with distance northward, to allow for habitat conversion with sea-level rise.

A series of shallow basins and increasing elevations would be excavated in Area 5, as shown by Section C (Alt 3) on Figure 6-4b. The fill would be placed in existing upland areas. The stub of ODD #3 between Areas 5 and 6 would be eliminated to restore a contiguous marsh plain.

Grading will occur in beach-dune Areas 7, 8, and 9 to form wetland swales and to provide limited access.

Infrastructure Modification

Irrigation and drainage systems in Area 4 will be removed. A culvert with water control across the railway is included as a placeholder for subsequent analysis of need to discharge from Area 4 and desire for water supply to Area 3. Earth berms or other method will be used to block or reduce drainage from Area 5 to ODD #3 via the existing culverts: The conceptual design for the blockages is similar to that detailed for Alternative 1. Similar actions may be taken at Areas 6 at the existing culvert to ODD #3. The intent is to leave the existing culverts in place to provide the capacity to adapt the restoration. Finally, OLW will be blocked in the vicinity of the Halaco properties, and ideally filled, pending coordination with EPA.

TABLE 6-11
PREFERRED ALTERNATIVE RESTORATION ACTIONS BY AREA

Area	Sub-area	Habitat Type	Actions/Outcomes			Projected changes with sea-level rise
			Earth Moving	Vegetation	Hydrology/Salinity	
1	1.1	Brackish marsh	None	Non-native species control	As-is	Conversion toward open water
	1.2	Open water	None	N/A	As-is	Lagoon will retreat landward
	1.3	Coastal dune	• Minor excavation through dunes to enhance connection to re-aligned OLW	Non-native species control	N/A	Conversion to beach/strand as the shoreline retreats & marsh/open water as the lagoon migrates landward
	1.4	Upland	Fill in existing OLW channel	Non-native species control; Planting grassland & coastal sage scrub	N/A	Conversion toward salt marsh then brackish marsh as water table nears surface
	1.5	Beach/strand	Continued mouth management	None	None	Conversion to intertidal beach & surf zone
2	2.1	Brackish marsh and Upland Transition	• OLW re-aligned & allowed to overtop its banks in high water conditions & flood the brackish marsh • Fill in existing channel & remove most of the existing levees • Create a marsh plain that slopes gently toward the new channel • Topographic heterogeneity (e.g., depressions or higher areas) would support greater spatial vegetation diversity within the marsh	• Non-native species control as needed • Plant a wide diversity of brackish marsh species • Highest elevations within the marsh may get salty enough to support salt marsh species	• Brackish marsh would occur down to elevations that are regularly flooded to depths less than about 2 feet • Brackish marsh will occur up to elevations where the soil is saturated in the rooting zone during the growing season • Highest areas of the marsh might get salty enough to support salt marsh species where evaporation at the soil surface concentrates salts	Conversion toward brackish marsh and then open water
	2.2	Wetland-upland transition	• Minor contouring & possible location to spoil any excess material dredged during creation of the brackish marsh • Area should be a broad plain gently sloping toward the brackish marsh to the east • Highest areas at the edges of the property should be tall enough to protect neighbors from flooding	• The area will need revegetation & probably short-term weed control • Expect transition zone above about 11 feet NAVD88 • Typical species would include shrubs that can tolerate some salinity & occasional flooding such as *Atriplex lentiformis*, *Suaeda calceoliformis*, *S. taxifolia* & *Isocoma menziesii*	• Very rare flooding for short durations with brackish water • Some buildup of salts in soil • Water table below the rooting zone	Conversion toward salt marsh & then brackish marsh as the water table nears the surface

TABLE 6-11
PREFERRED ALTERNATIVE RESTORATION ACTIONS BY AREA

Area	Sub-area	Habitat Type	Actions/Outcomes			Projected changes with sea-level rise
			Earth Moving	Vegetation	Hydrology/Salinity	
2 (cont.)	2.3	Bioswale	• Create shallow basin of sufficient volume to capture dry-season runoff from McWane Blvd • Consider including forebay that traps sediment & can be cleaned out occasionally • Direct outflow toward seasonal wetland area	Plant with cattail & tule	• Basin will capture surface flows & allow plants to uptake water, nutrients & other pollutants • Encourage percolation with coarse soil & large area • Expect slightly brackish conditions	As the water table rises, water will percolate less efficiently; when the water table reaches the surface, the basin will begin to lose capacity
	2.4	Open water	A new channel will be excavated	N/A	Permanently flooded with brackish water	Water will get deeper
3a	3a.1	Brackish marsh	• OLW re-aligned & allowed to overtop its banks in high water conditions & flood the brackish marsh • Create a marsh plain that slopes gently toward the new channel • Topographic heterogeneity (e.g., depressions or higher areas) would support greater spatial vegetation diversity within the marsh	• Non-native species control as needed • Plant a wide diversity of brackish marsh species • Highest elevations within the marsh may get salty enough to support salt marsh species • Consider options to expand salt marsh bird's beak population • Consider weeding in high marsh areas & replanting with rare salt-tolerant natives (see subarea 2.5 above for list)	• Brackish marsh would occur down to elevations that are regularly flooded to depths less than about 2 feet • Brackish marsh will occur up to elevations where the soil is saturated in the rooting zone during the growing season • Highest areas of the marsh might get salty enough to support salt marsh species where evaporation at the soil surface concentrates salts	Conversion toward open water
	3a.2	Open water	A new channel will be excavated	N/A	Permanently flooded with brackish water	Water will get deeper
	3a.3	Upland	• Existing upland areas will receive fill from excavated areas • Wetland-upland transition expected to be steep	Non-native species control & planting grassland & coastal sage scrub	N/A	Conversion toward salt marsh & then brackish marsh as the water table nears the surface

TABLE 6-11
PREFERRED ALTERNATIVE RESTORATION ACTIONS BY AREA

Area	Sub-area	Habitat Type	Actions/Outcomes			Projected changes with sea-level rise
			Earth Moving	Vegetation	Hydrology/Salinity	
3b	3b.1	Salt marsh	Minor enhancement of berm breach & channel to increase connectivity to ODD #3	Weed control as needed	• Little change from current conditions • Hydrology would be more closely tied to that of ODD #3, mainly north of railroad tracks • Realignment of OLW in Area 3a might raise/freshen groundwater in this area & could lead to conversion to brackish marsh	Assuming limited influence on groundwater from the lagoon, rising salty groundwater from the ocean will cause conversion to salt panne & then open water
	3b.2	Salt panne	None	N/A	• Little change from current conditions • Realignment of OLW in Area 3a might raise/freshen groundwater in this area & could lead to conversion to brackish marsh	Assuming limited influence on groundwater from the lagoon, rising salty groundwater from the ocean will cause conversion to open water
	3b.3	Upland	None	N/A	N/A	Conversion toward salt marsh as the water table nears surface
	3b.4	Open water	Lengthen existing channel off of ODD #3 toward railroad tracks	Expand existing bulrush on the edges of the channel	As-is	Water will get deeper & bulrush fringe will move up the banks
4	4.1	Salt marsh	• Minor grading to eliminate roads, ditches & any tile drains • Area could be a broad almost flat plain gently sloping southwest with two or more shallow basins at increasing elevations • Soil texture should be studied & appropriate amendments added (e.g., bentonite) to mimic salt marsh soil • Water control structure and culvert under the railroad to allow hydraulic connectivity between Areas 4 and 3.	• The area will need revegetation & possibly short-term weed control • Expect salt marsh below about 9 feet NAVD88 • Consider options such as irrigating with salt or brackish water to control weeds & favor salt marsh species; consider use of Calleguas Brine Line discharge • Dominant species would include pickleweed, salt grass & fleshy jaumea	• The brackish water table would presumably be within a couple feet of the surface once ditches & drains are removed • New location of OLW might raise the water table enough that wetlands establish above the estimated 9-foot NAVD88 contour & might lower salinities • Limiting off-site drainage would help keep salts on-site & favor salt marsh species • a culvert with water control across the railway is included as a placeholder for subsequent analysis of need to discharge from Area 4 and desire for water supply from Area 3.	Rising groundwater will cause conversion to salt panne & then open water

TABLE 6-11
PREFERRED ALTERNATIVE RESTORATION ACTIONS BY AREA

Area	Sub-area	Habitat Type	Actions/Outcomes			Projected changes with sea-level rise
			Earth Moving	Vegetation	Hydrology/Salinity	
4 (cont.)	4.2	Salt panne	• Create a shallow basin • Soil may need to be amended with clay to encourage ponding	N/A	• Salt panne areas would pond with rainfall & retain salts from evaporating groundwater (similar to other salt panne habitats on-site) • Expect salt panne below about 5 feet NAVD88	The lowest of a series of stepped basins would convert to open water
	4.3	Seasonal wetland	• Create a shallow basin • Soil may need to be amended with clay to encourage ponding	• -Control non-natives & plant salt-tolerant natives that tolerate wet winter & dry summer conditions • Consider introducing locally & regionally rare species such as *Salicornia depressa*, *Atriplex coulteri*, *A. pacifica*, *A. serenana* var. *davidsonii*, *Lasthenia glabrata* ssp. *coulteri*, *Suaeda calceoliformis*, *Astragalus pycnostachyus* var. *lanosissimus*, etc.	• Rare seasonal flooding primarily by rainfall • Saline groundwater generally below the rooting zone • Salts transported in to the rooting zone, generally pushed deeper & diluted in the winter with rainfall & closer to the surface & more concentrated in the summer	The middle of a series of stepped basins would convert to salt panne & eventually open water
	4.4	Wetland-upland transition	• Minor grading to eliminate roads, ditches & any tile drains • Area should be a broad almost flat plain gently sloping toward the salt marsh	• The area will need revegetation & probably short-term weed control • Expect transition zone above about 9 feet NAVD88 • Typical species would include shrubs that can tolerate some salinity & occasional flooding such as *Atriplex lentiformis, Suaeda calceoliformis, S. taxifolia & Isocoma menziesii*	• Very rare flooding for short durations with brackish water • Some buildup of salts in soil • Water table below the rooting zone • New location of OLW might raise the water table enough that wetlands establish above the estimated 9-foot NAVD88 contour	Conversion toward salt marsh as the water table nears the surface
	4.5	Bioswale	• Create a large shallow basin to capture dry- & wet-season runoff from McWane Blvd • Consider including forebay that traps sediment & can be cleaned out occasionally	Plant with cattail & tule	• Basin will capture surface flows & allow plants to uptake water, nutrients & other pollutants • Encourage percolation with coarse soil & large area • Expect slightly brackish conditions	As the highest of a series of stepped basins, expect conversion to brackish marsh or, if inflows from the street are diverted elsewhere, salt marsh & then salt panne

TABLE 6-11
PREFERRED ALTERNATIVE RESTORATION ACTIONS BY AREA

Area	Sub-area	Habitat Type	Actions/Outcomes			Projected changes with sea-level rise
			Earth Moving	Vegetation	Hydrology/Salinity	
4 (cont.)	4.6	Open water	None	None	As-is	Water will get deeper & tule fringe will move up the banks
5	5.1	Salt marsh	• Remove all the abandoned roads & create a broad salt marsh plain • Optional basins could be created in new salt marsh area to support salt panne	• No actions in existing salt marsh area • Plant new salt marsh with appropriate salt marsh species	• Salt marsh areas would pond with rainfall & retain salts from evaporating groundwater (similar to other salt marsh habitats on-site) • Expect salt marsh between about 5 & 7.5 feet NAVD88 • Block culverts to eliminate or reduce drainage of area to ODD #3	Rising salty groundwater from the ocean will cause conversion to salt panne & then open water
	5.2	Seasonal wetland	Shallow basins would be excavated at multiple elevations	• Control non-natives & plant salt-tolerant natives that tolerate wet winter & dry summer conditions in upper basin(s) • Consider introducing locally & regionally rare species such as *Salicornia depressa*, *Atriplex coulteri*, *A. pacifica*, *A. serenana* var. *davidsonii*, *Lasthenia glabrata* ssp. *coulteri*, *Suaeda calceoliformis*, *Astragalus pycnostachyus* var. *lanosissimus*, etc. • Lower basin would likely support salt marsh habitat	• Seasonally flooded from rainfall • Saline groundwater generally below the rooting zone • Salts transported in to the rooting zone, generally pushed deeper & diluted in the winter with rainfall & closer to the surface & more concentrated in the summer	Conversion toward salt marsh & salt panne as water table nears surface
	5.3	Upland	None	Non-native species control & planting coastal sage scrub	N/A	Rising water in ODD #3 &/or groundwater will lead to conversion to brackish or salt marsh
	5.4	Open water	None	Tule on the edges of the channel will remain	As-is	Water will get deeper & tule fringe will move up the banks

TABLE 6-11
PREFERRED ALTERNATIVE RESTORATION ACTIONS BY AREA

Area	Sub-area	Habitat Type	Actions/Outcomes			Projected changes with sea-level rise
			Earth Moving	Vegetation	Hydrology/Salinity	
6	6.1	Salt marsh	• Remove levees & fill in the stub of ODD #3 between Areas 5 & 6 • Create contiguous salt marsh plain between Areas 5 & 6	• Non-native species control • Planting in new salt marsh areas	As-is	• Conversion to salt panne & open water as groundwater level rises • Dunes will migrate landward & bury salt marsh
	6.2	Salt panne	None	None	As-is	Conversion to open water as groundwater level rises
	6.3	Upland	None	Non-native species control	N/A	Conversion to salt marsh habitat as groundwater level rises
	6.4	Open water	None	Tule on the edges of the channel will remain	As-is	Water will get deeper & tule fringe will move up the banks
7, 8, 9	7, 8, 9.1	Coastal dune	Add sand fencing between fore & back dune ridges to encourage dune building	• Extensive planting between fore & back dune ridges to encourage natural dune building • Dune planting could include reintroduction or introduction of rare, threatened & endangered endemic dune species	N/A	Conversion to strand & beach as the coast retreats
	7, 8, 9.2	Beach/strand	None	None	Occasional wave overwash at south end	Conversion to intertidal & surf zone as the beach retreats
	7,8,9.3	Open water	• Excavate new connection between re-aligned OLW and existing lagoon	N/A	The connection will designed to keep the two waterways connected and convey flood waters	As the beach retreats, the connection would eventually be lost and OLW would have its own mouth
	7,8,9.4	Dune swale wetland	• Excavate multiple depressions between the dune ridges • Depressions should be deep enough to expose damp sand	Plant dune swale species such as *Juncus arcticus, Distichlis spicata, Juncus acutus, & Carex praegracilis*	Depressions will intersect the capillary fringe above the dunes' freshwater lens	Conversion to dunes, strand & beach as the coast retreats

Access, Trails, and Site Amenities

The Preferred Alternative (Figure 6-17, **Table 6-12**) combines the public access components from Alternative 3, with a few components from Alternative 2, including the bridge or boardwalk at Ormond Lagoon and the Minor Trailhead and primary trail at Hueneme Blvd. The resulting plan highlights primary trail connections and reduces the number of rustic and primitive trails. This creates a trail network which arranges trails largely to the perimeter of the Project Area, leaving contiguous internal habitat areas. This approach is reinforced by the additional trails in Area 5. Because of the numerous habitat types and the way they are distributed, this configuration allows visitors to experience and appreciate many habitats while minimizing human disturbance with the perimeter trails. A multi-modal primary trail connection at Hueneme Road facilitates access for residents of South Oxnard to enjoy Ormond Beach. Small spur trails leading to overlooks provides a nature immersion experience and the solitude many community members say they treasure about Ormond Beach.

The Preferred Alternative (Figure 6-17, Area 1) provides direct beach access via a proposed primary ADA accessible trail and boardwalk system leading from the Perkins Road parking lot to a bridge or floating boardwalk crossing Ormond Lagoon (Access Node A). The bridge or floating boardwalk can be designed with sea-level rise in mind. An ADA compliant multi-modal boardwalk trail loop connects a new bridge at tšumaš Creek (Access Node E), the new Perkins Road Parking (Access Node A) bridge to the Ormond Lagoon island, and the floating boardwalk over Ormond Lagoon to create a small, easily traversed trail system. A rustic trail runs along the east side of the Ormond Lagoon island to an overlook to provide a quiet nature and birding experience. The floating boardwalk (or pile-supported, to be determined) and tšumaš Creek bridge can also provide a beach loop by traversing the California Coastal Trail and Port Hueneme Beach Park along the beach. The existing Perkins Road parking lot (Access Node A in Area 1) would be expanded to accommodate visitor services such as security, a docent kiosk, and interpretive elements. A primary trail with a wetland overlook heads north to West McWane Blvd.

A new trailhead is proposed at - West McWane Blvd. (Access Node B1) near Perkins Road, with parking on the existing road right-of-way owned by the City of Oxnard, which would be improved and reconfigured for this purpose. A new trail loop is proposed in the west side of Area 2, and a primary route runs east-west to East McWane Blvd. (Access Node B2, a constrained access point due to railway spur train parking). This primary, all-season trail adjoins a north-south primary spur of the California Coastal Trail. This trail provides bicycle and pedestrian access at Hueneme Road (Access Node C) to residents of South Oxnard and users of the California Coastal Trail bike path, leading through restored habitats to a network of boardwalks between Areas 3a, 3b, and 7, where cyclists can secure their bikes and continue the adventure on foot. Several birding overlooks on platforms and boardwalks provide birding opportunities, and lead to a beach trail lined with bird fencing through the back dunes and to the beach at Area 7. Bird blinds would be installed where necessary to minimize disturbance to nesting California least tern colonies.

TABLE 6-12
PREFERRED ALTERNATIVE RESTORATION AND PUBLIC ACCESS ELEMENTS BY AREA

Area	Design Element	Preferred Alternative
1	Restoration	• Weeding and planting in upland areas • Lagoon connection to OLW moved to the east of Halaco properties • Lagoon connection to marsh in Area 3a increases capacity and leads to less frequent manual breaching
	Public Access	• All Primary trails at 12.0 elevation, rustic trails at 11.0 -12.0 elevation where feasible, boardwalks at 13.0, bridges at 15.0 • Bridge over tšumaš Creek • Bridge or boardwalk over Ormond Lagoon from island to beach • Boardwalk to overlook at Ormond Lagoon • Rustic trail to overlook • New bridge between Perkins and Ormond Lagoon • Expand Perkins Parking Lot footprint, adding 24 spaces • Restrooms, interpretive kiosk and docent station (±1,000 SF for school group focus), which can be relocated to accommodate sea-level rise (SLR) • Bike racks and bike lockers (rental) • Primary trail in wetlands north of Perkins Road parking leading to West McWane Blvd.
2	Restoration	• Re-align OLW and grade to allow engagement with floodplain and brackish marsh • Grading to create gently sloping brackish marsh plain along new channel • Balance cut-fill within the area by filling old channel and adding flood protection around edges of property • Create smooth transition between Areas 2 and 3a • Create bioswale to capture nutrients in runoff from McWane Blvd.
	Public Access	• New Major trailhead with 25+ parking spaces at West McWane Blvd. • Interpretive signage • New primary developed CA Coastal Trail heading east • Elevated wetland boardwalk to rustic loop trail • Bridge over OLW with birding overlook • Elevated overlook near East McWane Blvd. • Minor pedestrian and bike trailhead at Hueneme Road • Primary multi-modal trail at Hueneme Road (at-grade railroad crossing) to East McWane Blvd., CA Coastal Trail

TABLE 6-12
PREFERRED ALTERNATIVE RESTORATION AND PUBLIC ACCESS ELEMENTS BY AREA

Area	Design Element	Preferred Alternative
3	Restoration	• Re-align OLW and grade to allow engagement with floodplain and brackish marsh • Minor grading to create gently sloping brackish marsh plain along new channel • Let habitat naturally convert from salt marsh to brackish marsh • Establish additional Coulter's goldfield populations in other areas on the Project Area by collecting seed and distributing in appropriate areas • Weeding and planting in upland areas • Water control structure (culvert) under the railroad
	Public Access	• Primary multi-modal trail, CA Coastal Trail • Overlook platforms • Bridge over OLW/agricultural ditch creek • Wetland boardwalks • Birding overlook platform with bird blinds • Elevated boardwalks through Area 3b • At-grade railroad crossing
4	Restoration	• Cease farming and excavate a series of shallow basins at increasing elevations from south to north • Water control structure (culvert) under the railroad • Basins will undergo type changes as the sea level rises • Lower basin expected to support salt panne habitat at about 5 feet NAVD88[1] in the short term and evolve in to open water with moderate sea-level rise • Middle basin(s) expected to support seasonal saline-affected wetlands at about 7 feet NAVD88 and evolve in to salt marsh and salt panne with moderate sea-level rise • Upper basin(s) expected to support seasonal wetlands and act as a bioswale at about 9 feet NAVD88 and evolve in to salt marsh and salt panne with greater sea-level rise • Establish salt marsh (below about 9 feet NAVD88) and transition zone vegetation (above about 9 feet) around basins
	Public Access	• Major trailhead and ±50 stall parking lot at East McWane Blvd. and Edison intersection (Future, high point of site) • Bike services for CA Coastal Trail riders, including racks, lockers, minor repair station. • Visitor Center • Multi-modal primary elevated trail at 12 feet NAVD88, CA Coastal Trail

TABLE 6-12
PREFERRED ALTERNATIVE RESTORATION AND PUBLIC ACCESS ELEMENTS BY AREA

Area	Design Element	Preferred Alternative
5	Restoration	• Block or reduce drainage through culverts between Area 5 and Oxnard Drainage Ditch (ODD)#3 • Remove levees and fill the ditch of ODD #3 between Areas 5 and 6 (the dead end channel) to create continuous marsh plain • Remove all old roads and building pads • Create series of shallow basins at increasing elevation • Lowest basin expected to support salt panne in the near term at about 5 feet and open water habitats with moderate sea-level rise • Middle basin expected to support seasonal saline-affected wetlands at about 6 feet NAVD88 and evolve into salt marsh and salt panne with moderate sea-level rise • Upper basin expected to support seasonal wetlands at about 8 feet NAVD88 and evolve in to salt marsh and salt panne with greater sea-level rise • Establish salt marsh (below about 7.5 feet NAVD88) and transition zone vegetation (above about 7.5 feet NAVD88) around basins
	Public Access	• Rustic trail to birding platform with wetland overlook
6	Restoration	• Maintain salt panne and salt marsh habitats with some weeding and revegetation as needed on higher spots • Restore upland habitats along ODD #3 levee • Remove levees and fill the ditch of ODD #3 between Areas 5 and 6 (the dead end channel) to create continuous marsh plain (in coordination with Oxnard Drainage District No. 2)
	Public Access	• CA Coastal trail Class II bike trail on Arnold Road per County of Ventura Local Coastal Plan • Reconfigure Arnold parking for drop-off/turnaround only and ADA parking, Bike focused trailhead with bike lockers and bike racks • Elevated wetland overlook • Primitive trail along ODD #3 to Area 5 and beach or along rustic trail to Area 6 and Beach • Birding overlook in back dunes • Rustic seasonal trail from trailhead to beach (closed during nesting season or if inundated in winter)
7, 8, 9	Restoration	• Weeding and planting to restore back dune scrub habitat and expand foredune scrub habitat • Excavate series of shallow depression between dune ridges and vegetate with dune swale wetland species • Add sand fencing and seed native dune species to facilitate wind-driven sand capture and dune building
	Public Access	• Area 7: New and existing bird fencing • Area 7-9: Continue to maintain CA Coastal Trail along beach strand (includes Area 1) • Area 7: Primitive beach strand trail connects to backdune boardwalks in Area 3a and Area 3b • Area 7: Bike racks near Area 3b overlook • Area 8: Beach strand trail connects to Arnold primitive trail, dune overlook area • Area 9: Beach strand trail connects to Rustic trail at Arnold Road

NOTE:
1 All elevations are in North American Vertical Datum of 1988 (NAVD88)

A new trailhead access proposed at the corner of Edison and East McWane (Area 4, Access Node F) is sited. This node would have bike services, and due to its location, could be implemented either while the Area 4 agriculture is occurring or after conversion to wetland. A visitor center is envisioned to provide school groups and community groups with a place to gather and learn about the Project Area, and to facilitate community involvement in direct hands-on restoration activities such as planting, weeding, and monitoring. A loop trail is created via multi-modal trails around the north and east side of Area 4, which connects to the multi-modal trail in Area 3a and the boardwalks in Area 3b.

Backdune boardwalks are proposed along area 7. The boardwalks would have bird blinds to allow visitors to observe birds without disturbing nesting birds such as Western snowy plover and California least tern. The boardwalks would be elevated to allow wildlife to safely pass below, and configured and maintained such that they will not provide refuge for nest predators. The existing exclusionary fencing would be augmented with additional exclusionary fencing offset from the boardwalk. New symbolic bird fencing will line the boardwalk past the bike lock and dune overlook platform, and line the beach trail leading to the coastal strand. The California Coastal Trail runs east –west along beach. The existing bird fencing in area 8 will remain.

The existing Arnold Road parking lot (Access Node D) would be reconfigured for ADA parking, limited parallel parking along the west side of Arnold Road, and a drop-off or turn-around area. Bike racks and a limited number of bike lockers would be provided to allow cyclists to secure their bikes or camping gear and explore Areas 5, 6, and 9 on foot. A rustic seasonal trail leading from Arnold road to the beach will follow the current alignment, providing pedestrian and emergency access to the beach. This section of trail would require seasonal closure based on winter rain patterns and inundation. The filling of the ODD #3 (pending agreement with Oxnard Drainage District No. 2) allows an easy access through a new upland band proposed in Area 5, where visitors can view birds and habitats from a new overlook platform. A primitive trail continues west from the Arnold Road trailhead past area 5 to a dune overlook which provides views of the salt panne, salt marsh, dunes, and beach. This section of rustic trail from Arnold Road to areas 5 and 8 can be closed during nesting season to limit disturbance to birds. A beach trail lined with symbolic fencing leads from the wetland overlook to the beach, allowing visitors to make a loop back to Arnold Road or explore the western portion of the Project Area.

6.4.3 Outcomes

Physical/Geomorphic

The hydrology of Areas 2 and 3a will be markedly changed due to the rerouting of the OLW. The capacity of Ormond Lagoon will be expanded to about twice its existing volume through connectivity to Area 3a. The lack of berms directly along the new OLW will allow for more regular inundation of the expanded floodplain wetlands. Flood management actions are expected to be unchanged or reduced owing to the reduced frequency of higher lagoon water levels during intermediate-flowrate conditions. The expansion of the lagoon will reduce the area of open sandy strand and dune. In Areas 4 and 5, grading and modification of culverts will be used to enhance

hydrology and salinity dynamics to support salt marsh, salt panne, and seasonal wetland habitats. Physical processes and landscapes at the site will be restored and designed to allow habitat transgression with sea-level rise.

The significant alterations to drainage channels raises the risk of effects (primarily flooding) on tributary areas of site. We anticipate that these changes will be neutral to beneficial, either causing no change in the areas surrounding the project or improving conveyance. However, analysis will likely be required to quantify the effects and inform stakeholders.

Ecological/habitat

The post-construction habitat types and acres are compiled in **Table 6-13**. The area of wetlands within the site will be increased overall. Salt marsh habitats in Areas 2 and 3a will be converted to brackish marsh or open water and existing open water will be converted to brackish marsh. Some uplands will be converted to brackish marsh while others will be maintained and restored. Salt marsh and salt panne are expanded in Areas 4 and 5. Regionally rare dune swale wetlands would be excavated in Areas 6–9. Areas 1 and 6 would remain largely unchanged.

TABLE 6-13
PREFERRED ALTERNATIVE HABITAT PROJECTIONS

Habitat Type	Area (acres)								
	1	2	3a	3b	4	5	6	7-9	TOTAL
Beach/strand	12							18	30
Coastal dunes	23							100	123
Dune swale wetland								2	2
Open water	18	6	4	1		2	4	2	36
Salt panne				4	15		22		40
Salt marsh				19	41	22	33		115
Brackish marsh	14	56	56						125
Seasonal wetlands					19				19
Riparian									0
Wetland-upland transition		27			37				64
Bioswale		1			23	20			43
Upland	10		5	1		44	2		63
TOTAL	76	89	65	25	135	88	60	121	660

NOTES: Habitat estimates rounded to nearest acre. Habitat estimates rounded to nearest acre. Habitat projections are post-construction under current sea level.

SOURCE: CRC

Expanded salt panne habitats could provide potential new nesting areas for California least tern and western snowy plover. Area 4 and 5 could support these functions as the sea level rises and converts existing salt panne areas to open water. The expanded lagoon will increase available tidewater goby and California least tern foraging habitat. An enlarged lagoon would generally

benefit California least tern; however, this expanded design would eliminate their current (2017–2018) nesting colony in Area 7. The designs effect on nesting habitat in the dunes would need to be studied in more detail. Existing habitat for Belding's savannah sparrow would be eliminated in Area 3a but new salt marsh habitats in Areas 4 and 5 could support this species. The expansion of brackish marsh and open water would benefit a large suite of avian species, especially ducks and rails. The only existing population of Coulter's goldfields in the project area and a small population of salt marsh bird's beak in Area 3a would be eliminated. Restored saline habitats in Areas 4 and 5 and existing habitat in Area 6 might support new populations of these species. Regionally and globally rare species adapted to non-tidal saline habitats might be introduced (e.g., Ventura marsh milk vetch) in Areas 4 and 5 as well.

Public Access

A diverse array of access features is provided which generally improve access to the Project Area and beach, especially for neighboring communities. Numerous loop trails provide the public with the opportunity to experience every habitat type proposed, with ample opportunities to experience nature and view birds and other wildlife. The varied trails provide frequent visitors the opportunity to have a different experience with each visit. Enhanced visitor services provide opportunity for community involvement and environmental education. Visitors using the California Coastal Trail by bicycle have services and opportunities to explore the wetlands and relax on the beach. The network of boardwalks clearly define walking paths and help encourage visitors to stay on the trails, while allowing hydrologic connectivity and wildlife movement to be unrestricted.

SECTION 7
Data Gaps and Adaptive Management

The OBRAP alternatives in this Preliminary Restoration Plan were developed and evaluated using the best available data on current and historical conditions, projected future conditions, local and regional needs, and opportunities and constraints. The data came from existing sources (Aspen 2009, Beller et al. 2011) and new studies conducted for this effort in 2017, including a general assessment of biological status and needs, collection of hydrologic and topographic data, modeling of water balance and lagoon inlet morphology, and assessment of sea-level rise resiliency. However, important data gaps remain. There are also uncertainties regarding processes, future conditions and expected project outcomes. In general estuaries and coasts face uncertainties on two fronts: altered flows and contaminants from urban and agricultural watersheds, and rising sea levels (Zedler 2016). Furthermore, precise outcomes of restoration actions can be unpredictable (McDonald et al. 2016, Zedler 2016). We seek to differentiate between *data gaps*, which can be addressed by data collection and analyses, and *uncertainties*, which are more effectively addressed via "adaptive management" and "adaptive restoration" (as defined by Zedler 2016 and described below and in Section 7.4). In practice, the distinction between data gaps and uncertainties is not discrete, especially in highly variable natural systems where it is rarely feasible to have enough data to eliminate uncertainty for some important parameters, even with significant data collection.

The Project Area provides opportunities to employ "adaptive management" and "adaptive restoration" to reduce uncertainties through phased restoration. Adaptive management provides a science-based decision-making framework for deliberate learning (Williams et al. 2009). It is an iterative approach that uses targeted studies, monitoring, and assessments to evaluate progress toward Project objectives and make adjustments in the course of implementing the project to help assure those objectives are met. This is more systematic than a trial-and-error approach. Monitoring data collected early in the project's implementation is used to assess progress, reduce uncertainty, and adjust actions as-needed to achieve project goals. This knowledge is also shared to improve long-term management and future projects (Williams et al. 2009; Zedler 2016). Adaptive restoration is a process of "learning while restoring" using field experiments of selected approaches (Zedler 2016). The goal is to achieve on-the-ground ecological goals, fill data gaps and reduce uncertainty, while also improving strategies for future restoration.

The Project Area supports a mosaic of habitats with a complex history of disturbance, including high-functioning habitats, areas in various states of recovery from severe disturbance, and areas that are not currently managed for habitat (the agricultural lease area). High-functioning areas should be studied to inform design of target habitats elsewhere. These areas, in addition to other

high-functioning habitats elsewhere on the coast, should also serve as reference sites for evaluating the performance of restoration projects. Recovering areas could be used to implement small-scale restoration pilot projects or experiments that test various techniques and hypotheses, using an "adaptive restoration" approach. The lessons learned through monitoring existing habitats and small-scale implementation projects would then be "scaled up" when restoration occurs, for example, on the agricultural parcel or potential future adjacent lands (e.g., the sod farm, Halaco properties, or the power plant site), giving those large, complex, and expensive projects a greater likelihood of achieving their goals.

This section identifies: (1) data gaps and how to address them, (2) key uncertainties about how potential Project alternatives may perform, (3) status of data gaps identified in the Feasibility Study (Aspen 2009), and (4) a framework for incorporating adaptive management and adaptive restoration as plans are refined and on-the-ground projects begin.

7.1 Data Gaps

Gaps in information regarding current site conditions, physical and biological processes, management practices, existing infrastructure and CEQA-specific needs will need to be addressed in order to facilitate refinement of the alternatives, development of the preferred restoration plan, and CEQA review. We recommend the following additional field data collection and analysis:

- Hydrology monitoring
  - Stream gaging in the main waterways that provide runoff and/or drain the Project Area, such as OLW, ODD #3, and other creeks entering the site. Stream gauging was accomplished historically, but not presently, and the site shows signs of changing conditions.
  - Surface water level recording in Ormond Lagoon. While the County monitors water levels, they do not store the data.
  - Salinity (seasonal dynamics).
  - Effects of neighbors discharging to and withdrawing from ODD #3.
  - Project site hydraulic connectivity with ODD #3.
- Groundwater monitoring
  - Water levels and salinity data collection through a range of seasons and throughout the site confirm general pattern of slope (flow) in shallow groundwater.
- Monitor seasonal patterns in surface water ponding.
- Soils testing
  - Surface texture and texture at depth where grading is proposed.
  - Presence of perching layer-hard pan depth/presence for salt panne, compare existing salt marsh areas to agricultural and tank farm areas (Areas 4, 5, and 6).
  - Soil salinity to assess suitability for upland restoration in spoil areas.

- Water quality monitoring
  - Nutrients, sediment, and agricultural and urban runoff constituents.
- Contaminants
  - Arnold Road dump location and degree of contaminants in Areas 6 and 9.
  - Assess areas of potential contamination which may exist due to prior land uses (Aspen 2009).
  - Water quality in OLW and ODD #3 and surface flow into Area 4.
- Agricultural drainage and water management practices
  - Documentation of inflows/outflows, salinities, culverts, tile drains, and other water management practices, to understand contributions to surface and groundwater levels.
  - Irrigation and drainage facilities in Area 4, which are likely to be removed and would affect restoration design.
- Topographic data collection in areas where LiDAR data accuracy is not adequate, to characterize habitat distribution relative to elevation and to supply data necessary to design public access features.
- Vegetation mapping (high resolution) and monitoring of target habitats and species.
- Wetland assessment (not a full delineation) to map areas that are under potential state and federal jurisdiction as wetlands or waters.
- Photo documentation and seasonal and inter-annual measurements of the beach crest and lagoon mouth morphology.
- Property boundary survey and easements.
  - Locations and tolerances of buried infrastructure.
  - Property lines.
- Cultural resources survey.

7.2 Restoration Uncertainties

Some data gaps are straightforward to fill, while others will remain sources of uncertainty even with years of monitoring. For the latter type, it will be important to acquire sufficient data to provide support for refining plans, conducting environmental review and permitting, finalizing design, and guiding implementation. New data will also likely reveal further data gaps and uncertainties that could affect projected outcomes. Virtually all restoration projects must be built with some degree of uncertainty. Decreasing uncertainty through a combination of adaptive management and adaptive restoration (Section 7.4) will give the project the best chance of meeting its goals and objectives in a timely and cost-effective manner. The implementation of a phased restoration may be the preferred way to move forward in light of continuing uncertainty.

Uncertainties regarding site conditions and processes that can determine habitat development and potential ecological responses are identified so that monitoring and/or management actions may be targeted to inform expected outcomes of restoration actions. This will guide project planning

and design development of future project phases, as well as inform mid-course corrections, interim site management and post construction adaptive management actions.

Some key uncertainties for understanding the range of outcomes that may be expected from Project implementation are listed below.

Physical and Hydrological

- Sea-Level Rise – The actual rate at which sea-level rise will occur is unknowable. After +3 feet sea-level rise (approximately mid-century by current predictions), the site will be largely inundated. How high do upland habitats need to be to persist with sea-level rise? Will groundwater or surface water or some combination of both be the main drivers of habitat changes with sea-level rise? How will sea-level rise drive land use and management changes on neighboring parcels and will they be compatible with restoration at the site?

- Hydrology – Relationships between surface water, groundwater, and tidally-influenced groundwater, as well as dune hydrology are complex, variable, and not likely to be fully quantified. Monitoring results of current conditions will be complicated by ever-changing land alterations and practices by neighbors (e.g., culverts, sewer line, drainage ditches, agricultural pumping practices, sewer line, vegetation management). The hydrologic connections between channels and surrounding lands will need to be better understood in order to design and predict hydrologic processes and ecological outcomes (i.e., what kind of wetland may be supported).

  – What is the effect of the existing leaky wastewater trunk line near Ormond Lagoon Waterway north of Halaco properties on groundwater and what are future implications?

  – The water/salt balance can be better understood via data collection and analysis, but responses may still differ from expectations owing to the multi-variate processes and uncertain future conditions. Can restoration actions reverse the ‘freshening’ trend and enhance salinity to support saline wetland habitats over brackish wetlands (to what degree is trajectory controlled by surface water versus groundwater – how do these conditions intergrade across the site?

  – Existing hydrology of ODD #3 and effects on restoration site, and effects of project on ODD #3 hydrology and tributary areas.

  – Quantify flowrates in OLW and water balance in Ormond Lagoon in order to assess effects of proposed restoration actions and in particular check to see if there is sufficient water supply to support habitat with expanded lagoon basin volumes.

- Soils – The available data indicate correlations between soil texture (e.g., amount of sand, silt, and clay) and other area-specific parameters (groundwater elevation, salinity). Data collection and analysis can better characterize the existing conditions, and responses to changes in drivers (water level, salinity) during the data collection period. However, uncertainties are likely to remain and adaptive management to respond to future conditions should be contemplated.

- Water Quality and Soil Contamination – Does contamination affect habitats, plants and animals at the site? Coordinate with other projects and programs in the area. How will the

Project be impacted by the EPA Halaco Superfund Site cleanup? How can the Project be coordinated with the EPA Halaco Superfund Site cleanup?

- Beach/Dune Morphology – What lagoon-dune shape will occur and persist? How will the beach and dunes respond with climate change and sea-level rise? To what degree will the dunes transgress inland? What is the impact of beach nourishment activities, will these continue, and will the practice affect shore response to sea-level rise?

- Lagoon Dynamics – The lagoon hydrology and beach face/mouth closure relationship is partially documented for Ormond Lagoon. Will the mouth management for flood control change? Will flowrates to the lagoon change?

  – Will the lagoon blow out at a different location under Alternative 2?

  – Is there enough dry-season flow (now and in the future as urban and agricultural runoff is likely to decline) to support two lagoons under Alternative 3?

  – How will changes in water conservation and reuse in the upper watershed change water levels in the lagoon over the next 20 years?

Biological

- What is minimum sustainable patch size for each target habitat?

- Salt marsh bird's beak - Can we create habitat for the population to migrate with sea-level rise? Pollinators (bees) need upland or transition zone areas for nesting. While uplands and transition zones are part of restored landscape, sea-level rise could squeeze them out. How much freshwater influence is needed for seed germination?

- Coulter's goldfields – If the existing population is extirpated in due to rerouting of OLW (Alternatives 2 and 3), how and where can new populations be established elsewhere in the Project Area?

- Western snowy plover and California least tern – Will nesting be impacted by expanded lagoon (Alternative 2) or construction of a second lagoon (Alternative 3)? Will the trail and boardwalk setbacks effectively buffer nesting tern colonies and nesting shorebirds from disturbance attributable to humans using trails and boardwalks? Will predators use public access features and increase predation losses of eggs and chicks?

- Tidewater goby – Will gobies persist in the existing lagoon and/or colonize the new lagoon (Alternative 3)? Will non-native fish invade new habitat and cause decline of gobies? Will water quality conditions in lagoon(s) continue to be suitable for gobies? Will contaminants from watershed runoff and Halaco properties affect gobies in restored habitat?

- Ridgway's rail – Will new habitats increase the expansion of Ridgway's rail from Mugu Lagoon?

- Invasive plants – Will weeds overtake restored areas? What planting practices and control measures are most effective?

Stakeholder and Regulatory

In addition to the physical, hydrological, and ecological uncertainties, there are questions related to local land and water use and regulations.

- Sewer line interactions with groundwater hydrology – How might the sewer line be changed in the future, and how would that affect local hydrology, salinity, and resulting wetland type in Area 2 and 3a on TNC property? How will the Project affect the existing sewer line infrastructure?

- Railway – What are the Port's long-term plans for the railway in the face of sea-level rise? How would restoration elements to improve hydrologic connectivity (e.g., culverts under railroad) affect drainage and hydrological regime in this area? How will wetlands respond?

- Future agriculture – How will a change or cessation of farming alter irrigation water pumping and drainage through the removal of tiles drains (if they exist), and how would that affect local resultant surface water and groundwater hydrology?

- Land acquisition – What adjoining parcels are most suitable for preserving options for upland migration of the full gradient of habitats? Which parcels may be available for future acquisition and incorporation into the OBRAP (e.g., sod farm, generating station property, Halaco Properties)?

- Permitting for wetland and special-status species – What avoidance and mitigation requirements will there be for potential impacts from construction and long-term restored habitat trajectory? Will short-term impacts on salt marsh bird's beak from habitat construction require plantings to mitigate?

- Vector risk- Will there be increased risks from mosquitoes at restored areas?

- What is EPA's remediation plan for the Halaco Superfund Site at TNC and City of Oxnard properties? What is EPA's funding and timeline? How can these dovetail with OBRAP implementation on TNC and City property?

7.3 Feasibility Study Recommended Activities

The earlier Feasibility Study (Aspen 2009) recommended activities and studies to inform project development (**Table 7-1**). Some of the short-term studies were undertaken as part of this effort, but many are either highly focused research projects, or will be more relevant for later phases after a preferred alternative is selected and environmental document preparation commences. We have added a column to this table to indicate current status of those recommended activities.

TABLE 7-1
SUMMARY OF RECOMMENDATIONS TO FILL PROJECT DATA GAPS (2009 FEASIBILITY STUDY)

Recommendation	Description	Project Phase	Priority in 2009	Status in 2018
Short-Term Recommendations				
Biological Resources				
Prepare Species-Specific Pre-Restoration Studies	Implement studies to understand biological attributes and relationships, refine species-specific restoration techniques, and develop success criteria for specific habitats and species. • Belding's savannah sparrow surveys • Pollinator study for salt marsh bird's beak • Wandering skipper studies • Salt marsh goldfields studies • Surveys for globose dune beetles, ciliate dune beetles, and silvery legless lizards • Determine distribution of *Juncus acutus* • Survey for three common salt marsh snail species • Survey for staphylinid beetles • Monitor New Zealand mudsnails and evaluate eradication methods • Survey small mammal populations • Experimental studies of habitat parameters of salt marsh goldfields and salt marsh bird's beak • Restoration experiments to understand design and implementation of wetland transition and upland habitat restoration	Prior to refinement and optimization of the conceptual alternatives	Critical to Advanta-geous	Not initiated.
Prepare Analysis of Environmentally Sensitive Habitat Areas (ESHAs)	Identify ESHAs in the project area	Prior to refinement and optimization of the conceptual alternatives	High	Initiated (City of Oxnard)
Prepare Essential Fish Habitat (EFH) Analysis	Identify EFH within the project area including analysis of tidewater goby habitat	Prior to refinement and optimization of the conceptual alternatives	Critical	Not initiated. EFH is for marine fish species, not applicable to goby. Intermittently open lagoon may provide limited nursery habitat.
Environmental Resources and Physical Processes				
Prepare Ecological Gaps Analysis	Identify gaps in the regional ecological functions of the project area to maximize opportunities that support weak or mission functions.	Prior to refinement and optimization of the conceptual alternatives	High	Initiated (ESA)
Complete Cross Sections	Complete two-dimensional cross sections of each of the project's conceptual alternatives in order to evaluate and compare alternatives	Prior to refinement and optimization of the conceptual alternatives	Critical	Completed (ESA)
Complete Regional Littoral Sediment Budget Analysis	Prepare a sediment budget analysis from Port Hueneme to Point Mugu to improve current predictions for inlet resistance to closure, thereby increasing the level of confidence in creating sustainable habitats for some of the project's alternatives.	Prior to refinement and optimization of the conceptual alternatives	Critical to High	No longer applicable because the project does not include a tidal inlet

TABLE 7-1
SUMMARY OF RECOMMENDATIONS TO FILL PROJECT DATA GAPS (2009 FEASIBILITY STUDY)

Recommendation	Description	Project Phase	Priority in 2009	Status in 2018
***Environmental Resources and Physical Processes* (cont.)**				
Complete Nearshore Wave Monitoring	Develop monitoring program to assess local nearshore wave patterns to further refine and improve predictions for inlet stability and resistance to closure, which would improve the degree of confidence in developing long-term, viable wetland habitats.	Prior to refinement and optimization of the conceptual alternatives	Critical to High	No longer applicable
Complete Morphological Modeling of Inlet	Morphological modeling for conceptual alternatives that involve an inlet, in terms of location, migration, ebb and flood shoals bathymetry, and influence on their respective lagoon's tidal range, would help refine decisions related to the need for, and geometry of, jetties. The modeling would also assist with the development of site grading plans and infrastructure protection requirements.	Prior to refinement and optimization of the conceptual alternatives	Critical	No longer applicable
Prepare Agricultural Drainage Study	Assess the project area's agricultural drainage connectivity, discharge and conveyance capacity. The study should include assessment of subsurface drains and limiting culvert capacity of the duck club property to ensure that the water supply needed for the project is sufficient.	Prior to refinement and optimization of the conceptual alternatives	Critical	Not initiated
Prepare Sea-Level Rise and Coastal Flood Inundation Study	Predict changes to the project area's coastline in response to anticipated sea-level rise and assess the project area's coastal flood inundation zones as they relate to sea-level rise. The results of the Study would be useful for land acquisition strategies, as well as establishment of final engineering and design plans as well as grading plans.	Prior to or during refinement and optimization of the conceptual alternatives	Critical	Completed (ESA and TNC CRV)
Prepare Groundwater Study	The groundwater study would assess the hydraulic conductivity and groundwater flow rates in the project area's semi-perched surface aquifer and examine the connectivity between semi-perched and deep aquifers to assess potential salinity intrusion. Identification of the potential location of seeps and springs fed from shallow groundwater sources for each alternative also is important for potential establishment of brackish marsh habitat and non-tidal palustrine marshes on the margins of estuary.	Prior to preparation of the project's environmental review document	Critical	Initiated
Prepare a Subsidence Feasibility Analysis	Assess of the feasibility and costs of pumping groundwater to cause managed subsidence of the project area to reduce the need for excavation and provide a water source for the project. If this analysis concludes that managed subsidence is a viable option for one or more alternatives, it would likely lessen project implementation costs due to reduced excavation costs.	Prior to or during refinement and optimization of the conceptual alternatives	Critical	No longer applicable
Complete Water Quality Monitoring and Sampling Program	The program would ensure that the quality of the water sources required for the long-term sustainability of the project is adequate. The program should include a wide range of sampling locations and be undertaken over multiple seasons.	Initiated prior to or during refinement and optimization of the conceptual alternatives	Critical	Not initiated.

TABLE 7-1
SUMMARY OF RECOMMENDATIONS TO FILL PROJECT DATA GAPS (2009 FEASIBILITY STUDY)

Recommendation	Description	Project Phase	Priority in 2009	Status in 2018
***Environmental Resources and Physical Processes* (cont.)**				
Prepare Ecological Risk Analysis	Analysis would further evaluate the historic and existing contaminant sources within and surrounding the project area to determine: (1) the volume of excavated soil that could be reused on-site versus the volume of excavated soil that would need to be transported and disposed of off-site; and (2) the potential effects of these contaminant sources on the habitats created. The archived soil samples that were collected during the project's Site-Wide Soil/Surface Water Investigation are recommended for this analysis.	Prior to or during refinement and optimization of the conceptual alternatives	Critical	Not initiated
Integrate Public Access and Recreation Plans into Project Design Plans	Integrate the "Access Vision Plan" into the conceptual alternatives that have been developed for the project. The process would require careful consideration of the project's habitat restoration goals and objectives versus public access and use and the restrictions that may be necessary for habitat protection.	During refinement and optimization of the conceptual alternatives	Critical	Completed (ESA)
Regulatory Processes				
Identify Proposed Project	Establish which alternative is the "proposed project" for completion of the environmental review and decision making process.	Prior to preparation of the project's environmental review document	Critical	Not initiated
Identify and Coordinate with the Federal Lead Agency	Verify that the project's environmental review requires consideration under NEPA and that the USACE will act at the federal Lead Agency.	Prior to preparation of the project's environmental review document	Critical	Not initiated
Initiate Public and Involvement and Participation Program	Facilitate the public's understanding, acceptance and support of the project. This program would also assist with the early resolution of possible issues of concern and controversy that could hinder the environmental review process.	Prior to preparation of the project's environmental review document	Very High	Initiated
Initiate Informal Agency Consultations	Facilitate the project's regulatory permit acquisition process and ensure that agency concerns are appropriately addressed in the project's environmental review document.	Prior to preparation of the project's environmental review document	Very High	Not initiated
Complete Formal Wetland Delineation	A formal wetland delineation of the project area is needed to support regulatory permitting with federal agencies including the USACE and USFWS, and State agencies including the CDFG and CCC.	Prior to preparation of the project's environmental review document	Critical	Not initiated
Complete Cultural Resources Phase I or Phase II Investigation	Ascertain if significant cultural resources would be affected by project implementation so that a Section 106 consultation process can be initiated as soon as possible.	Prior to preparation of the project's environmental review document	Very High	Not initiated
Complete Environmental Review and Permit Acquisition Processes	Ensure that all regulatory review processes and approvals are complete prior to project implementation. Some permits may not be issued until final design is complete.	Initiate during the preparation of the project's environmental review document	Critical	Not initiated
Prepare Wetland Restoration Management and Monitoring Plan	The Management and Monitoring Plan (MAMP) will guide all future phases of the project once the proposed project has been established.	Complete draft plan prior to preparation of the project's environmental review document	Critical	Initiated (ESA)

TABLE 7-1
SUMMARY OF RECOMMENDATIONS TO FILL PROJECT DATA GAPS (2009 FEASIBILITY STUDY)

Recommendation	Description	Project Phase	Priority in 2009	Status in 2018
Economics				
Complete Cost Feasibility Analysis	Complete a detailed cost feasibility analysis of the project's refined and optimized alternatives to determine if any of them are too costly to pursue. This analysis would help "pare down" those alternatives that were ultimately considered infeasible, and would provide information for pursuit of potential funding sources.	Prior to preparation of the project's environmental review document	Critical	Not initiated
Assess Funding Potential Under the Calleguas Creek In-Lieu Fee Program	Ascertain if the project is a candidate for funding under the in-lieu fee program for Calleguas Creek	Prior to or during preparation of the project's environmental review document	Very High	Unknown
Complete Carbon Sequestering Analysis	Estimate and compare carbon sequestration potential of the project's refined and optimized alternatives (tidal marsh vegetation). Partial project funding may be available from the sale of carbon credits for carbon sequestered as a result of project implementation.	During (as part of) preparation of the project's environmental review document	High	Initiated (ESA and TNC CRV)
Long-Term Recommendations				
Biological Resources				
Develop and Implement Seed Collection Program	Program would collect seed on-site and the propagate plant materials for long-term use within the project area. Implementation of the program would help maintain local genotype and may be the only viable method of providing the required plantings necessary for full restoration.	Initiate soon after the approved project has been identified and all properties for project implementation have been secured.	Very High	Not initiated
Environmental Resources and Physical Processes				
Implement Wetland Restoration Management and Monitoring Plan	Implementation of the Wetland Restoration Management and Monitoring Plan will be the primary mechanism for the project's short- and long-term success. Regular evaluation and revision to the MAMP will help achieve a long-term management strategy that is flexible and adaptive to resource/issue specific site conditions as they evolve.	Implement as first task of any pre-construction activities. Evaluate and revise every 5 years or as warranted by the Project Area conditions	Critical	Not initiated
Regulatory Processes				
Develop and Implement Permit Compliance Plan	The Compliance Plan is to ensure that all conditions of the project's regulatory permits and approvals are implemented, including any required reporting.	Development of the Plan's organization and structure should begin during the project's regulatory permit acquisition process and completed immediately upon receipt of all of the project's regulatory permits and approvals	Very High	Not initiated
Economics				
Develop Long-Term Funding Program	Develop and implement a strategy that would ensure a funding source (or sources) for the project's long-term management and monitoring	The program should be developed and implemented as soon as the approved project is established and the properties necessary for its implementation are secured	Critical	Initiated

SOURCE: Aspen 2009

A list of priority studies recommended to support design is provided in **Table 7-2**. This list is informed by recent analysis leading to and including evaluation of alternatives, and is intended to support refinement of the Project Description and scoping of the environmental review. The list in Table 7-2 is based upon:

- Data Gaps (Section 7.1) and Uncertainties (Section 7.2)
- Data Gaps from the prior Feasibility Study (Section 7.3, Table 7-1) pertinent to project design and environmental review: Specifically, those included from Table 7-1 are:
  - Biological Resources
  - Environmental Resources and Physical Processes
- Studies desired to initiate CEQA and listed in Table 7-1 under:
  - Regulatory Processes
  - Economics

The list of priority studies should be updated as new information is generated and needs are reassessed. A new priority action is to coordinate the OBRAP with the WRP Restoration Project List. The SCWRP will be updating its list of restoration projects that are in alignment with the 2018 Regional Strategy Update. Projects that are not currently on the list must complete a project application. This action is not listed in Table 7-2 because it is a not a OBRAP study.

TABLE 7-2
LIST OF PRIORITY STUDIES

Priority	Study	Comments
1.	Hydrology: Surface and Groundwater Characterization	This study addresses the Hydrology Surface and Groundwater characterization identified in Section 7.1, including data collection. Install instrumentation to record water levels and salinity at selected locations. Extend the data collection period to include periods of rainfall and elevated water runoff and water levels, including flooding of the site and discharge from the Ormond Lagoon. Include a time-lapse camera to record Ormond Lagoon mouth conditions (open, closed, or intermediate) so that lagoon response to drainage and ocean hydrology is better understood. Establish a stream gauge station on Ormond Lagoon Waterway (OLW) to better characterize flowrates as a function of water level: Coordinate with the Ventura County Watershed Protection District for location and other parameters. A minimum period for the data collection period is 1 year; however, an ongoing program is recommended to both inform restoration as well as site management.
2.	Vegetation Conceptual Model	This study addresses soil conditions for plant establishment and habitat enhancement/ creation as well as partially addressing Surveying and Vegetation Mapping identified in Section 7.1. Conceptual model of habitats will be developed to inform restoration design and assessment of effects/ effectiveness of candidate restoration actions. The conceptual model should look for correlations of surface elevation, soils, groundwater and vegetation overall and by area, with the aim of identifying restoration actions (e.g., change surface elevation, soils and or inundation) to affect vegetation and hence habitat. The analysis should include degraded areas in order to diagnose causes and hence conditions to avoid and correct during restoration. Field data collection is necessary to characterize soils and map vegetation. Soil cores will be analyzed in a laboratory for texture, salinity and chemistry. Vegetation mapping will be improved generally but in particular in the vicinity of other data collection (soil, groundwater, elevations). An adaptive data collection and test-plot program should be considered.

TABLE 7-2
LIST OF PRIORITY STUDIES

Priority	Study	Comments
3.	Soil and water quality	This study addresses the contamination and water quality unknowns identified in Section 7.1. A soil and water quality sampling and testing program is recommended to confirm or refine the proposed restoration project description. A sampling and testing plan will be developed based on a summary of available data and information, and consideration of the limits of earthwork and water sources. Depending on the results, additional sampling and testing may be desired. We envision a Phase 1 Environmental Site Assessment followed by a Phase II Assessment for the areas potentially disturbed by the project and alternatives. This work should utilize information available from the EPA in the vicinity of the Halaco parcels, and other available information for the rest of the site.
4.	Revised Project Description	A project Description is needed for the Environmental Review, as indicated in Table 7-1 under Regulatory Processes. Include cost information per Table 7-2 Economics, need for cost feasibility analysis. Develop a project description with sufficient detail and specificity to support environmental review. The preliminary project description will be refined based on the results of the technical studies including 1, 2 and 3 listed above.
5.	Agricultural drainage and water management Topographic data collection in areas where LiDAR data accuracy is not adequate, to characterize habitat distribution relative to elevation Vegetation mapping (high resolution) and monitoring of target habitats and species Photo documentation and seasonal and inter-annual measurements of the beach crest and lagoon mouth morphology Property boundary survey and easements. Locations and tolerances of buried infrastructure Property lines Cultural resources survey	Priority 5 is assigned to the remaining items in the Data Gaps list in Section 7.1.
6.	Wetland Assessment / Wetland Delineation	A wetland delineation is typically needed for the EIR, as indicated in Table 7-1 under Regulatory Processes. Given the size of the site and extent of wetlands, and the nature of the project (ecological enhancement), we recommend considering an assessment instead of a more formal wetland delineation. The level of detail in the wetland Delineation / Assessment for the EIR and for subsequent permitting should be evaluated. This information may be generated before starting the EIR, and used to establish the baseline.
7.	Biological Resources	This Biological Resources Study would satisfy a need for the CEQA process and the data needs “biological Resources” in Table 7-1. A biological resources technical report is desired for the EIR, and may need to be initiated prior to the EIR in order to complete species surveys at the appropriate time of the year. We anticipate that the some of the information may be available from agencies that monitor species activities. This work should be accomplished just before the EIR as part of the baseline. Additional species surveys may be needed.
8.	Biological Assessments	Biological assessment(s) for USFW and possibly NMFS may be integrated with the CEQA analysis. Strategic planning for the Biological Assessment(s) is recommended early on in the EIR process, with a strategic consideration of future Biological Opinion(s) for endangered species.
9.	Flood Hazard	An assessment of project effects (including alternatives) on flooding will be required during the EIR. Subsequent certification of no-rise in flood level or a flood Map Revision may be required in subsequent design and permitting.

7.4 Adaptive Management and Adaptive Restoration

The Project will use an adaptive management approach and will apply adaptive restoration where appropriate and feasible. The large size of the Project Area, the need for phasing of restoration implementation in different areas over time, and the inherent uncertainty related to existing and future conditions make this an ideal site for employing a combined adaptive approach. Early phases could be installed on relatively small scales. The results of early phases would increase understanding of the site and allow for refinement of plans for subsequent phases. For instance, early projects could be located in disturbed areas where there are opportunities to provide ecological lift with only minor manipulations to hydrology with revegetation. Planting experiments could assess which species perform best at different elevations, with different types of soil amendments. Vegetation responses should be compared to data collected on important physical drivers such as soil salinity and hydrology to inform plausible predictions of which species will perform best under different conditions. Experimental dune swales and flow alterations in ODD #3 are also examples of testing and refining methodologies using targeted studies and monitoring over time. This type of small-scale testing and monitoring would allow refinement of restoration actions to support a range of target habitats as large-scale project phases are implemented.

Ideally, adaptive restoration uses controlled, manipulative field experiments that employ a range of approaches (i.e., treatments) in replicated areas (Zedler 2016). Monitoring and statistical analyses can then be applied to assess potential differences in outcomes between the different approaches. The most effective approaches can then be applied on larger scales, in future phases and/or in other areas. For example, at Tijuana Estuary a field test of alternative planting methods found better growth of seedlings planted in tight clusters, near creeks and with soil amendments (O'Brien and Zedler 2006).

Adaptive management/restoration will be especially useful at the Ormond Beach site, where hydrologic, salinity, and soil conditions vary widely both spatially and temporally, and are, at present, only partially understood. Expanded baseline monitoring will document conditions and improve understanding of how proposed manipulations associated with restoration actions can lead to support for target ecosystem functions. Nevertheless, it is expected that even with more data and modeling, there will remain considerable uncertainty as to what plant species will occur at what elevations in different areas of the site. Climate change and sea-level rise will add further complexity.

Learning from past experience is another tool in the adaptive management structure. For instance, the Navy has been implementing wetland and marsh restoration at the adjacent NBVC–Point Mugu for many years. Working with their ecologists to share "lessons learned" can inform restoration methodologies at Ormond Beach. Similarly, efforts under way at the Tijuana Estuary National Estuarine Research Reserve in San Diego County and at Devereux Slough in Santa Barbara County can inform restoration goals and practices at Ormond.

This process of structured learning and decision making is a critical component of successful restoration. Structured learning requires a clear understanding of how monitoring data will be used to make management decisions and achieve objectives. For example, Zedler and Callaway (2000) applied progress-based perspectives to successful wetland restoration, focused on understanding problems at a particular site by identifying cause–effect mechanisms. They recommend experimentation and the evaluation of ecosystem resiliency to unplanned disturbances as the best means to measure restoration success.

As project elements are designed and implemented in future phases, the baseline conditions of the site will change. Long-term data sets characterizing physical and biological drivers will be critical to long-term planning and management of the site, particularly due to the sites' sensitivity to sea-level rise. Continuous monitoring of surface water and groundwater elevations and salinities, establishing permanent transects through restored and existing high-functioning habitats to assess vegetation changes over time, and building on existing data sets of bird use at the site would be extremely advantageous. Ongoing monitoring of the early-phase restoration /pilot projects is indicated in an adaptive restoration approach. Such long-term data sets and monitoring can be implemented through success monitoring associated with grant implementation, citizen science and university undergraduate and graduate studies.

Site-specific knowledge about outcomes of restoration actions targeted to specific species or habitats will greatly increase implementation efficiency and likelihood of success for future restoration efforts in the Project Area as well as among other coastal locations. Documentation of large-scale changes at the site can inform coastal restoration and conservation approaches along the California coast and beyond.

An adaptive management framework for the Project will be developed further after the design of the preferred alternative is fleshed out, with involvement from the SAC. The framework will identify metrics to track progress in meeting OBRAP objectives and evaluate effectiveness of restoration actions, and outline a process to guide management decisions. Management of the restoration site should include opportunities for mid-course corrections as mistakes and/or unexpected benefits are realized. This applies to both ecosystem and public access outcomes.

Ultimately, a monitoring and adaptive management plan (MAMP) will be prepared once the Project has reached a more advanced design and has commenced preparation of environmental documents. The final MAMP will address these uncertainties and other objective-based performance questions in a phased, adaptive approach. Issues that require more in-depth analysis may be referred to separate focused investigations.

SECTION 8
List of Preparers

8.1 Project Partners

Isidro Figueroa, City of Oxnard
Karen Kraus, Pollinate
Christopher Kroll, California Coastal Conservancy
Laura Riege, The Nature Conservancy

8.2 Consultant Team

Environmental Science Associates

Bob Battalio PE
Dane Behrens PE
Matt Brennan PhD PE
Eddie Divita PE
Nick Garrity PE
Eve Pier Kieli
Hannah Snow
Ramona Swenson PhD
Alex Trahan PE

Coastal Restoration Consultants

Dave Hubbard
Matt James

True Nature

Kim True

8.3 Reviewers

Project Partners

Peter Dixon, The Nature Conservancy
Walter Heady, The Nature Conservancy
Kat Selm, The Nature Conservancy

Ormond Beach Science Advisory Committee

Rich Ambrose, UCLA Institute of the Environment and Sustainability
Sean Anderson, California State University, Channel Islands
Shirley Birosik, Regional Water Quality Control Board, Los Angeles
Jeff Crooks, Tijuana River National Estuarine Research Reserve
Chris Dellith, US Fish and Wildlife Service
Jonna Engel, California Coastal Commission
Amanda Fagan, US Navy
Colleen Grant, US Fish and Wildlife Service
Cynthia Hartley, Ventura Audubon Society
Jamie Jackson, California Department of Fish and Wildlife
Spencer MacNeil, USACE
Martin Ruane, US Navy
Eric Stein, Southern California Coastal Water Research Project
Lisa Stratton, University of California, Santa Barbara Cheadle Center for Biodiversity and Ecological Restoration
Valerie Vartanian, US Navy
Joy Zedler, University of Wisconsin

SECTION 9
References

Aspen Environmental Group. 2005. Ormond Beach Wetland Restoration Feasibility Study Project Restoration Goals. Prepared for California State Coastal Conservancy. May 2005.

———. 2009. Ormond Beach Wetland Restoration Feasibility Study. Prepared for California State Coastal Conservancy.

Battalio, R.T., D. Danmeier and P. Williams, 2006. Predicting Closure and Breaching Frequencies of Small Tidal Inlets – A Quantified Conceptual Model, *Proceedings of the 30th International Conference of Coastal Engineering*, ASCE 2007, 4:3937 - 3949.

Behrens, D., Brennan, M., and B. Battalio. 2015. A quantified conceptual model of inlet morphology and associated lagoon hydrology. Shore and Beach 83(3):33-42.

Beller et al. 2011. Historical ecology of the lower Santa Clara River, Ventura River, and Oxnard Plain: an analysis of terrestrial, riverine, and coastal habitats. Prepared for the State Coastal Conservancy. A report of SFEI's Historical Ecology Program, SFEI Publication #641, San Francisco Estuary Institute, Oakland, CA.

Brown, J.S., M. Sutula, C. Stransky, and J Rudolph. 2008. Sediment contaminant chemistry and toxicity of freshwater urban wetlands. pp. 271-287. In: SB Weisberg and K Miller (eds.), Southern California Coastal Water Research Project 2008 Annual Report. Southern California Coastal Water Research Project. Costa Mesa, CA.

Bruun, P. 1962. Sea-Level Rise as a Cause of Shore Erosion: Am. Soc. Civil Engineers Proc., Jour. Waterways and Harbors Div. 88:117-130.

California Coastal Commission, (CCC). 2015. California Coastal Commission Sea-Level Rise Policy Guidance: Interpretive Guidelines for Addressing Sea-Level Rise in Local Coastal Programs and Coastal Development Permits. Adopted on August 12, 2015. Available: http://www.coastal.ca.gov/climate/slrguidance.html.

———. 2018. California Coastal Commission Sea-Level Rise Policy Guidance: Interpretive Guidelines for Addressing Sea-Level Rise in Local Coastal Programs and Coastal Development Permits. Adopted on November 7, 2018. Available: https://documents.coastal.ca.gov/assets/slr/guidance/2018/0_Full_2018AdoptedSLR GuidanceUpdate.pdf.

California Department of Fish and Wildlife (CDFW). 2015. Investigation into cause of fish kill in J Street Drain near Hueneme Road in Port Hueneme. Memorandum to Jenny Marek, U.S. Fish and Wildlife Service. CDFW Wildlife Branch, Wildlife Investigations Laboratory, Pesticide Investigations. Lab Number P-2960. WPCL L-483-15. September 5, 2015.

California Native Plant Society, Rare Plant Program. 2018. Inventory of Rare and Endangered Plants of California (online edition, v8-03 0.39). Website http://www.rareplants.cnps.org. Accessed September 25, 2018.

California State Coastal Conservancy (CSCC). 2016. Staff Recommendation, September 29, 2016, Ormond Beach Acquisition – Southland Sod Farm Project No. 90-048-06, Project Manager: Christopher Kroll.

Cardno. 2014. Annual Report for the Biological Opinion for the J Street Drain Improvement Project. Memo prepared for Padre Associates. March 31, 2014. 11 pp.

———. 2017. Tšumaš Creek Project Post Construction Spring 2017 Tidewater Goby Survey Report. Cardno, Ventura, California. Prepared for the Ventura County Watershed Protection District.

CH2M Hill. 2008. Preliminary Evaluation of the Sources, Nature, Extend and Movement of Contamination in Surface Water and Groundwater, Halaco Site. Prepared for U.S. Environmental Protection Agency. December 2008.

———. 2012. Surface Water and Ground Water Sampling and Analysis Results, Halaco Superfund Site Remedial Investigation, Oxnard, California. Prepared for U.S. Environmental Protection Agency. March 2012.

———. 2015. Baseline Ecological Risk Assessment Remedial Investigation, Halaco Superfund Site, Oxnard, California. Prepared for U.S. Environmental Protection Agency. September 2015.

City of Oxnard. 2010. Ormond Beach Wetlands Gateway Park Grant application. Statewide Park Development and Community Revitalization Program of 2008.

———. 2011. City of Oxnard 2030 General Plan. Oxnard, CA. 286 pp.

Coastal Frontiers. 2008. J Street Drain Coastal Engineering 2008 Beach and Lagoon Monitoring Program. Prepared for HDR Engineering, Inc.

Dean, R.G. 1990, Equilibrium beach profiles: characteristics and applications. Journal of Coastal Research, 7(1): 53-84. Fort Lauderdale (Florida), ISSN 0749-0208.

Environmental Science Associates (ESA). 2015. Santa Barbara County Coastal Hazard Modeling and Vulnerability Assessment. Technical Methods Report. Prepared for County of Santa Barbara.

ESA. 2016. Task Order No. 35 – Los Peñasquitos Lagoon Restoration Strategy, Task 3.1 – Lagoon Inlet Dynamic Modeling and Assessment of Inlet Maintenance. Prepared for the City of San Diego. June 20, 2016.

———. 2016. Draft Lagoon Quantified Conceptual Model Memorandum for Pescadero Creek Lagoon. Prepared for San Mateo County RCD and USFWS. April 10, 2017.

———. 2016. Aliso Creek Estuary Restoration: Lagoon Inlet Dynamics Quantified Conceptual Model (QCM) Memorandum – Draft. Prepared for the Laguna Ocean Foundation. August 4, 2016.

ESA PWA. 2013. Coastal Resilience Ventura: Technical Report for Coastal Hazards Mapping. Prepared by ESA PWA, San Francisco, for The Nature Conservancy. July 2013.

———. 2014. Coastal Resilience Ventura: Technical Report for Sea Level Affecting Marshes Model (SLAMM). Prepared for The Nature Conservancy.

Environmental Science Associates, Coastal Restoration Consultants, True Nature, and Kearns and West. 2017. Ormond Beach Restoration and Public Access Plan: Historical, Existing, and Future Conditions and Restoration Opportunities and Constraints Report. Prepared for California State Coastal Conservancy, the Nature Conservancy, and City of Oxnard. Draft. September 2017.

Everts, C. 1985. Sea Level Rise Effects on Shoreline Position. J. Waterway, Port, Coastal, Ocean Eng., 10.1061/(ASCE)0733-950X(1985)111:6(985):985-999.

Federal Emergency Management Agency (FEMA). 2005. Final Draft Guidelines: Coastal Flood Hazard Analysis and Mapping for the Pacific Coast of the United States. Prepared for the U.S. Department of Homeland Security.

Goodwin, P. 1996. Predicting the stability of tidal inlets for wetland and estuary management. Journal of Coastal Research, Special Issue No. 23, pp. 83-101.

Griggs, et al. 2017. Rising Seas in California an Update on Sea-Level Rise Science, California Ocean Protection Council Science Advisory Team Working Group, California Ocean Science Trust, April 2017.

Hall, L.S. 2016. Final 2016 Ormond Beach Bird Monitoring Study. Western Foundation of Vertebrate Zoology. 25 pp.

Hartley, C. 2017. Ormond Beach, California: Western Snowy Plover and California Least Tern nesting outcome: 2017 Season. Ventura Audubon Society. October 16, 2017. 40 pp.

HDR Inc. 2011. Ormond Beach Lagoon Sand Berm Management Technical Memo. August 8, 2011.

Herron, W.J. and R.L. Harris. 1966. Littoral bypassing and beach restoration in the vicinity of Port Hueneme California. Proceedings of the 10th Conference on Coastal Engineering. Vol. 1, Chapter 38, pp. 651-675.

Hughes, S.A. 2002. Equilibrium cross sectional area at tidal inlets. Journal of Coastal Research, 18(1):160-174.

Jacobs, D., E. Stein, and T. Longcore. 2010. Classification of California Estuaries based on natural closure patterns: templates for restoration and management. Southern California Coastal Wetlands Research Project, Technical Report 619.

Johnson, J.W. 1973. Characteristics and behavior of Pacific coast tidal inlets. Journal of the Waterways, Harbors and Coastal Engineering Division, Proceedings of the American Society of Civil Engineers, Vol. 99, No.WW3, August 1973.

Kraus, N.C. 2002. Barrier breaching processes and barrier spit breach, Stone Lagoon, California. Shore & Beach, Vol. 70, No.4, pp. 21-28. October 2002.

Larry Walker Associates (LWA). 2016. Ventura County Agricultural Irrigated Lands Group (VCAILG), 2015-2016 Annual Monitoring Report, Draft, Submitted to: Los Angeles Water Quality Control Board Prepared By: Larry Walker and Associates On Behalf Of The: Ventura County Agricultural Irrigated Lands Group (VCAILG), December 15, 2016.

Laudier, N.A., E. B. Thornton, J. MacMahan. 2011. Measured and modeled wave overtopping on a natural beach, Coastal Engineering 58 (2011) 815–825.

Lindley, C., J. Liu, M. Patton, A. Prescott, N. Shabol. 2018. Characterizing the ecological risk to the tidewater goby from pyrethroid use in coastal California. A group Project submitted in partial satisfaction of the requirements for the degree of Master of Environmental Science and Management for the Bren School of Environmental Science and Management. University of California Santa Barbara. March 2018.

McDonald T., G.D. Gann, J. Jonson, and K.W. Dixon. 2016. International standards for the practice of ecological restoration – including principles and key concepts. Society for Ecological Restoration, Washington, D.C.

National Resource Council (NRC). 2012. Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future. Prepublication. National Academy Press: Washington, D.C.

NOAA Coastal Services Center (2011). 2009 - 2011 CA Coastal Conservancy Coastal Lidar Project. Accessed: https://coast.noaa.gov/dataviewer/#/lidar/search/. More info here: https://coast.noaa.gov/htdata/lidar1_z/geoid12a/data/1124/supplemental/ca2009_2011_ca_coastal_conservancy_m1124_acquisitionreport.pdf.

Noe, G.B. and J.B. Zedler. 2000. Differential effects of four abiotic factors on the germination of salt marsh annuals. American Journal of Botany. 87:11.

O'Brien, M.P. 1931. Estuary tidal prisms related to entrance area. Civil Engineering, ASCE, Vol. 1, No. 8, 1931, pp. 738-739.

Ocean Protection Council (OPC). 2011. State of California Sea-Level Rise Interim Guidance Document, Developed by the Sea-Level Rise Task Force of the Coastal and Ocean, October 2010.

———. 2013. State of California Sea-Level Rise Guidance Document, developed by the Coastal and Ocean Working Group of the California Climate Action Team (CO-CAT), with science support provided by the Ocean Protection Council's Science Advisory Team and the California Ocean Science Trust, March 2013 update: http://www.opc.ca.gov/webmaster/ftp/pdf/docs/2013_SLR_Guidance_Update_FINAL1.pdf.

———. 2017. State of California Sea-Level Rise Guidance Document – 2018 Updated Draft, November 2017.

———. 2018. State of California Sea-Level Rise Guidance Document – 2018 Updated Final, March 2018.

Phil Williams and Associates (PWA). 2007. Ormond Beach Wetland Restoration Feasibility Plan: Hydrologic and Geomorphic Conditions Report. Report prepared for Aspen Environmental Group, September 26, 2007. 37 p.

Rich, A. and E. Keller. 2013. A hydrologic and geomorphic model of estuary breaching and closure. Geomorphology 19:64-74.

Southern California Wetlands Recovery Project (SCWRP). 2018. Wetlands on the Edge: The Future of Southern California's Wetlands: Regional Strategy 2018 prepared by the California State Coastal Conservancy Oakland, Ca. Draft January 30, 2018.

State Coastal Conservancy (SCC). 2016. Staff Recommendation: Ormond Beach Wetlands Restoration Plan. Oxnard, CA. 9 pp.

Sutula, M. and E.D. Stein. 2003. Habitat value of natural and constructed wetlands used to treat urban runoff: A literature review. Technical Report 388. Southern California Coastal Water Research Project. Westminster, CA.

The Nature Conservancy (TNC). 2008. Conservation Plan for the Lower Santa Clara River Watershed and Surrounding Areas. Ventura, California. 96 pp.

U.S. Army Corps of Engineers (USACE). 2011. Sea-Level Change Considerations for Civil Works Programs. U.S. Army Corps of Engineers, EC 1165-2-212.

U.S. Environmental Protection Agency (EPA). 2004. Constructed Treatment Wetlands. EPA 843-F-03-013. August 2004.

———. 2011. Total Maximum Daily Loads for Pesticides, PCBs, and Sediment Toxicity in Oxnard Drain 3. EPA Region IX. October 6, 2011.

United Water Conservation District. 2018. Ground Water Monitoring Data, 1990-2018, location SW-65. Provided by Dan Detmer, PG, CHG, Supervising Hydrogeologist, United Water Conservation District, June 15, 2018.

U.S. Fish and Wildlife Service (USFWS). 2013. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for Tidewater Goby; Final Rule. 50 CFR Part 17. (78 FR 8746).

U.S. Department of the Navy. Naval Facilities Engineering Command Southwest. 2015. Air Installations Compatible Use Zones Study for Naval Base Ventura County Point Mugu. Final. December 2015.

Ventura County Planning Division. 2017. Ventura County Coastal Area Plan. Amended July 1, 2017. Available: https://docs.vcrma.org/images/pdf/planning/plans/Coastal_Area_Plan_07-01-2017_ver.pdf. Accessed October 2, 2018.

Ventura County Watershed Protection District (VCWPD). 2010. January 18, 2010 Ormond Beach Lagoon Emergency Breach Incident Report, prepared VCWPD.

———. 2010. Ormond Beach Lagoon Emergency Response Action Summary Slides, January 18, 2010.

Ventura Local Agency Formation Commission. 2005. Municipal Service Review. Drainage Services. Special Districts. Oxnard Drainage District No. 1 and Oxnard Drainage District No. 2. Final Report. February 16, 2005.

Warren Pinnacle Consulting, Inc. (WPC). 2016. SLAMM 6.7 Technical Documentation Sea Level Affecting Marshes Model, Version 6.7 beta.

Williams, B.K., R.C. Szaro, and C.D. Shapiro. 2009. Adaptive management: The U.S. Department of the Interior technical guide. Adaptive Management Working Group, U.S. Department of the Interior, Washington, DC.

Williams P.B. and K.C. Cuffe. 1994. The management implications of the potential for closure at Bolinas Lagoon. Shore and Beach, 62(4):3-12, October 1994.

Western Foundation of Vertebrate Zoology (WFVZ). 2013. Ormond Beach Winter Bird Abundance, Habitat Use, and Movement Study, and Bird Restoration-Response Literature Review. May 2013.

———. 2016. Final Ormond Beach Bird Monitoring Study. November 2017.

Wetlands Research Associates (WRA). 2000. South Ormond Beach Edaphic and Water Quality Study, Prepared for USFWS.

Zedler, J. and J. Calloway. 2000. Evaluating the progress of engineered tidal wetlands. Ecological Engineering 15, 211-225.

Zedler, J. 2016. What's new in adaptive management and restoration of coasts and estuaries? Estuaries and Coasts. DOI 10.1007/s12237-016-0162-5.

Zembal, R., S. M. Hoffman, and R.T. Patton. 2015. A survey of the Belding's Savannah sparrow (*Passerculus sandwichensis beldingi*) in California, 2015. California Department of Fish and Wildlife, Wildlife Branch, Nongame Wildlife Program Report, 2015-02, Sacramento, CA 20 pp.

Appendix A
Sea-level Rise

APPENDIX A
Sea Level Rise Policy and Guidance

This appendix summarizes existing federal and state policy and guidance related to sea-level rise planning and describe current sea-level rise projections relevant to Ventura County from various data sources.

Federal

FEMA provides Flood Insurance Rate Maps (FIRM) as part of the National Flood Insurance Program (NFIP), which show coastal and fluvial flood hazards. The maps do not consider future sea-level rise or erosion and only evaluate existing hazards. Additionally, FEMA maps do not present flooding information related to extreme events with a lower probability than the 1% chance of occurrence.

State

As per Executive Order S-13-08 issued by Governor Schwarzenegger, the California Ocean Protection Council (OPC) released a statewide guidance document in 2010 to assist state agencies with incorporating sea-level rise into planning decisions. The subsequent update (OPC 2013) was informed by *Sea Level Rise for the Coasts of California, Oregon, and Washington* by the National Research Council (NRC 2012), which provided new projections of future SLR. An update to the OPC guidance is expected in early 2018 and is outlined in Section 3.3.

The California Coastal Commission (CCC) issued SLR policy guidance in 2015 (CCC 2015). The document outlines a methodology for addressing SLR and adaptation planning in Local Coastal Programs (LCPs) and Coastal Development Permits (CDPs) using "best available science" and specifies climate change scenarios relevant to local risk and vulnerability assessments. The framework for addressing SLR in CDP applications is summarized as follows (CCC 2015, p. 20):

1. Establish the projected sea-level rise range for the proposed project's planning horizon using the best available science, which is currently the 2012 NRC report.
2. Determine how physical impacts from sea-level rise may constrain the project site, including erosion, structural and geologic stability, flooding, and inundation.
3. Determine how the project may impact coastal resources, considering the influence of future sea-level rise upon the landscape as well as potential impacts of sea-level rise adaptation strategies that may be used over the lifetime of the project

4. Identify alternatives to avoid resource impacts and minimize risks throughout the expected life of the development.
5. Finalize project design and submit CDP application.

Both OPC (2013) and CCC (2015) recommend considering a range of scenarios which represent low, medium and high rates of climate change (OPC 2013; CCC 2015), as caused by greenhouse gas emissions and estimates of future rates of ice sheet loss. Scenario-based analysis helps elucidate extent and severity of impacts caused by different amounts of climate change. Recent studies of current greenhouse gas emissions and projections of future loss of ice sheet indicate that the low scenario probably underrepresents future SLR (Rahmstorf et al. 2012; Horton et al. 2014). Also, note that even if SLR does not increase as fast as projected for the High scenario, SLR is projected to continue beyond 2100 under all scenarios. The assumptions that form the basis for the NRC (2012) scenarios are as follows:

Low Scenario – The low scenario assumes population growth that peaks mid-century, high economic growth, and assumes a global economic shift to less energy-intensive industries, significant reduction in fossil fuel use, and development of clean technologies.

Medium Scenario – The medium scenario assumes population growth that peaks mid-century, high economic growth, and development of more efficient technologies, but also assumes that energy would be derived from a balance of sources, thereby reducing greenhouse gas emissions.

High Scenario – The high scenario assumes population growth that peaks mid-century, high economic growth, and development of more efficient technologies. The associated energy demands would be met primarily with fossil-fuel intensive sources.

2018 SLR Guidance Update

The California Natural Resource Agency and Ocean Protection Council released a draft (OPC 2017) and final (OPC 2018) 2018 guidance update to the 2013 State of California guidance document (OPC 2013). The guidance update provides a synthesis of the best available science on SLR in CA, a step-by-step approach for state agencies and local governments to evaluate SLR projections, and preferred coastal adaptation strategies. The key scientific basis for this update was developed by the working group of the California Ocean Protection Council Science Advisory Team (OPC-SAT) titled *Rising Seas in California: An Update on Sea-Level Rise Science* (Griggs et al. 2017). SLR scenarios were selected for the OBRAP prior to the OPC 2018 and CCC 2018 updates were finalized. However, the OBRAP scenarios are generally consistent with the 2018 updates owing to use of the draft guidance update (OPC 2017) and consideration of the science update document (Griggs et. al. 2017). References to the earlier guidance documents (OPC 2017, CCC 2015, and OPC 2013) and science document (NRC 2012) are made for context.

The 2018 guidance update includes the following key changes and additions to the OPC 2013 guidance:

- **For years before 2050, SLR projections are provided only for the high emissions scenario (RCP 8.5).** The world is currently on the RCP 8.5 trajectory, and differences in SLR projections under different scenarios are minor before 2050.
- **Includes new "extreme" SLR projections associated with rapid melting of the West Antarctic ice sheet.**
- **Shifts from scenario-based (deterministic) projections to probabilistic projections of SLR.** The guidance update recommends a range of probabilistic projections for decision makers to select given their acceptable level of risk aversion for a given project.
- **Provides estimated probabilities of when a particular SLR amount will occur.** In addition to SLR projections that are tied to risk acceptability, updated guidance provides information on the likelihood that sea-level rise will meet or exceed a specific height (1 foot increments from 1 to 10 feet) over various timescales.

The guidance update includes significant advances in the scientific understanding of SLR. Compared to the ***scenario-based*** SLR projections in the 2013 version of state guidance, the updated guidance incorporates ***probabilistic*** sea-level rise projections, which associate a likelihood of occurrence (or probability) with various sea-level rise heights and rates into the future and are directly tied to a range of emissions scenarios (described below). Using probabilistic sea-level rise projections is currently the most appropriate scientific approach for policy setting in California, providing decision makers with increased understanding of potential sea-level rise impacts and consequences. The guidance update also includes an extreme SLR scenario that is based on rapid melting of the West Antarctic ice sheet.

The guidance update also provides a range of probabilistic projections of SLR that are based on two Intergovernmental Panel on Climate Change (IPCC) emissions scenarios called representative concentration pathways (RCPs[1]), as well as a non-probabilistic projection associated with rapid West Antarctic ice sheet mass loss. These three climate scenarios are explained below:

- **RCP 2.6 *Scenario* –** This scenario corresponds closely to the aspirational goals of the 2015 Paris Agreement, which calls for limiting mean global warming to 2 degrees Celsius and achieving net-zero greenhouse gas emissions in the second half of the century. This scenario is considered very challenging to achieve, and is analogous to the Low scenario in NRC (2012).
- **RCP 8.5 *Scenario* –** This scenario is consistent with a future where there are no significant global efforts to limit or reduce emissions. This emission scenario is consistent with that used to develop the High SLR scenario in NRC (2012) but the 50th percentile is closer to the Mid SLR rate and amount in NRC (2012).

[1] Named for the associated radiative forcing (heat trapping capacity of the atmosphere) level in 2100 relative to pre-industrial levels.

- **H++ *Scenario*** – This extreme scenario was proposed by the Ocean Protection Council Science Advisory Team in response to recent scientific studies that have projected higher rates of SLR due to the possibility of more rapid melting of ice sheets.

Because differences in SLR projections under the various emissions scenarios are minor before 2050, the update only provides RCP 8.5 projections of SLR up to 2050. **State-recommended projections for use in low, medium-high and extreme risk aversion decisions are outlined by red boxes in Table A-1.**

TABLE A-1
PROJECTED SEA-LEVEL RISE IN FEET (OPC 2017; 2018)

		Probabilistic Projections (in feet) (based on Kopp et al. 2014)					H++ scenario (Sweet et al. 2017) *Single scenario
		Median *50% probability sea-level rise meets or exceeds…*	Likely range *67% probability sea-level rise is between…*		1-in-20 chance *5% probability sea-level rise meets or exceeds…*	1-in-200 chance *0.5% probability sea-level rise meets or exceeds…*	
				Low-risk Aversion		Medium - High risk Aversion	Extreme-risk Aversion
High emissions	2030	0.6	0.5 -	0.7	0.8	1	1.2
	2040	0.9	0.7 -	1.1	1.2	1.6	2.0
	2050	1.2	0.9 -	1.5	1.7	2.3	3.1
Low emissions	2060	1.3	1.0 -	1.7	2	2.8	
High emissions	2060	1.5	1.2 -	1.9	2.2	3.1	4.3
Low emissions	2070	1.6	1.2 -	2	2.4	3.5	
High emissions	2070	1.9	1.4 -	2.4	2.9	4	5.6
Low emissions	2080	1.8	1.4 -	2.4	2.9	4.4	
High emissions	2080	2.3	1.7 -	2.9	3.5	5.1	7.2
Low emissions	2090	2.1	1.5 -	2.7	3.4	5.3	
High emissions	2090	2.7	2.0 -	3.5	4.3	6.2	8.9
Low emissions	2100	2.3	1.7 -	3.1	3.9	6.3	
High emissions	2100	3.1	2.3 -	4.1	5.1	7.6	10.9
Low emissions	2110	2.5	1.9 -	3.3	4.2	7.1	
High emissions	2110	3.3	2.6 -	4.3	5.2	8	12.7
Low emissions	2120	2.7	2.0 -	3.7	4.8	8.2	
High emissions	2120	3.7	2.9 -	4.9	6.1	9.4	15.0
Low emissions	2130	3	2.1 -	4	5.3	9.4	
High emissions	2130	4.2	3.1 -	5.5	6.9	10.9	17.4
Low emissions	2140	3.2	2.3 -	4.4	5.9	10.7	
High emissions	2140	4.6	3.4 -	6.2	7.8	12.5	20.1
Low emissions	2150	3.4	2.3 -	4.8	6.6	12.1	
High emissions	2150	5	3.7 -	6.8	8.7	14.1	23.0

DRAFT

The State suggests using a risk-adverse approach for sea-level rise planning when evaluating projects with a long life span, limited adaptive capacity, and/or medium to high consequences of inundation. In these scenarios, the medium-high sea-level rise projections should be used across the range of emission scenarios. The State further recommends incorporating the H++ scenario in planning and adaptation strategies for projects that could result in threats to public health and

safety, natural resources and critical infrastructure such as large power plants, wastewater treatment, and toxic storage sites.

The H++ projection is a single scenario and does not have an associated likelihood of occurrence as do the probabilistic projections. Probabilistic projections are with respect to a baseline of the year 2000, or more specifically the average relative sea level over 1991 - 2009.

SLR Projections for Ventura

The National Research Council (NRC) performed an analysis of SLR for the coasts of California, Oregon, and Washington (NRC 2012), which was used by the State of California including the CCC's SLR Policy Guidance (CCC 2015, updated 2018). The report evaluates each major contributing component to global sea-level rise and combines these contributions to provide values of sea-level rise at various planning horizons for the West Coast. The report also discusses regional and local contributions to sea-level rise. Four regional sea-level rise estimates are reported for the West Coast. The values for Los Angeles (the closest station to San Diego for which data are available) are reported in **Table A-2**. These values include an estimate for vertical land motion of -1.5 mm/year ± 1.3 mm/year, which NRC uses for all of California south of Cape Mendocino and refers to as the "San Andreas" region. Note that these sea-level rise projections do not account for any local effects of subsidence in the Ventura region; data or evidence of local subsidence is not available or known.

TABLE A-2
NRC 2012 SEA-LEVEL RISE PROJECTIONS[1]

Projection	2030	2050	2100
Low-range	2 in	5 in	17 in (1.4 ft)
Mid-range	6 in	11 in	37 in (3.1 ft)
High-Range	12 in	24 in	66 in (5.5 ft)

NOTE:
1 Inches and feet of sea-level rise since 2000

The 2100 estimates reflect the range in greenhouse gas emission scenarios, with low emissions resulting in 17 inches of sea-level rise and high emissions resulting in 66 inches. To date, emissions have been tracking on the high scenario (Flint and Flint 2012). Assuming continuation of the high emissions trajectory, the higher range of sea-level rise projections would apply.

The State of California and The Nature Conservancy funded an analysis of sea-level rise hazards for Ventura County as part of a program called Coastal Resilience Ventura (CRV). **Table A-3** provides the sea-level rise values used in that study, which were also derived from NRC 2012 and U.S. Army Corps of Engineers (USACE, 2011) guidance. The sea level rise scenarios used in this project are based on recent National Research Council (NRC, 2012). The State of California guidance on sea-level rise in effect at the time (OPC, 2010) prescribed the use of 55 inches of rise

by 2100, the CRV study attempted to combine federal and scientific guidance in anticipation of revised guidance expected to be issued by the state shortly after the completion of this study (ESA PWA, 2013). Hence the CRV values are generally consistent with the existing guidance and are generally consistent with the subsequent OPC (2013) and CCC (2015, updated 2018), and tailored to Ventura County. The USACE medium curve was selected as the low curve because it is the lowest of all the USACE and NRC projections that incorporates future increases in the rate of sea-level rise. The high and medium curves are based on the high and middle range of models discussed in the NRC 2012 report. All curves include an adjustment for local vertical land motion using the Santa Monica tide station (NOAA #9410840). The sea-level rise at each planning horizon is shown in **Table A-3** and marked in **Figure A-1**.

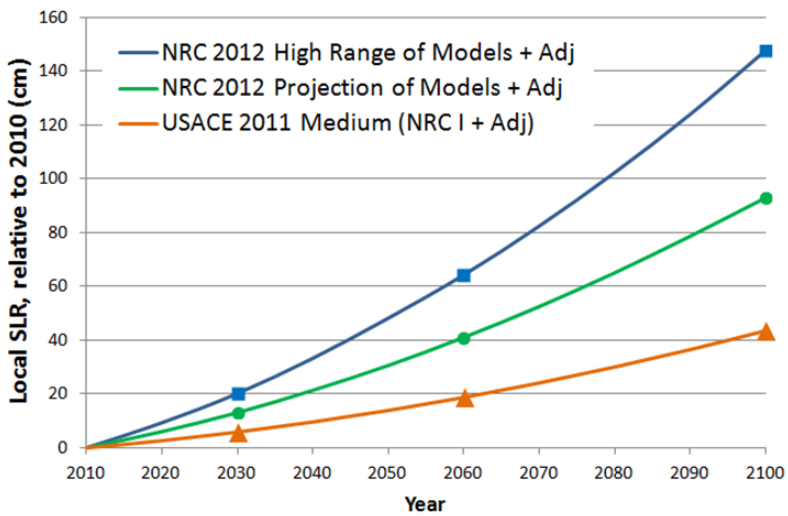
TABLE A-3
CRV SEA-LEVEL RISE PROJECTIONS[1]

Projection	2030	2060	2100
Low-range	2.3 in	7.4 in	17.1 in (1.4 ft)
Mid-range	5.2 in	16.1 in	36.5 in (3.1 ft)
High-Range	8.0 in	25.3 in	58.1 in (4.8 ft)

NOTE:
1 Inches and feet of sea-level rise since 2000

NRC 2012: Global SLR from table 5.2. Polynomial (order 2) fit to obtain global SLR for intermediate years. This curve was shifted by 1.5 mm/year subsidence to get local SLR (Table A.1, Santa Monica).

USACE 2011 Curve: NRC 1987 curve I, adjusted to local SLR by replacing global SLR (1.7 mm/year, IPCC 2007) with local sea level rise for Santa Monica (1.42 mm/yr, Gill/NOAA 2011).



Ormond Beach Restoration and Public Access Plan

Figure A-1
Sea Level Rise Scenarios (Local SLR, relative to 2010)

SLR Projections for OBRAP

The sea-level rise scenarios selected for the OBRAP are a subset of the Ventura County Coastal Resilience Ventura, specifically the mid-century (2060) and end-of-century (2100) Medium and High values (see Table A-3 and Figure A-1). Use of these values will be consistent with the coastal planning underway in Ventura County and the City of Oxnard, who are using the CRV program products.

A comparison of these values with draft updated California Guidance (OPC, 2017, finalized 2018) is provided in Figure A-2 and A-3. Figure A-2 shows that the selected values from CRV are similar to those low-risk aversion and medium-high risk aversion developed from the draft guidance update. The OPC (2017, finalized 2018) and CRV (2013) values are plotted in Figure A-3 for comparison.

Coastal Resilience Ventura (CRV) (as per Ormond Beach Existing Conditions 2017)

TABLE 2-13
SEA LEVEL RISE PROJECTIONS, RELATIVE TO 2010

Year	Low SLR	Medium SLR	High SLR
2030	6 cm (2.3 inches)	13 cm (5.2 inches)	20 cm (8.0 inches)
2060	19 cm (7.4 inches)	41 cm (16.1 inches)	64 cm (25.3 inches)
2100	44 cm (17.1 inches)	93 cm (36.5 inches)	148 cm (58.1 inches)

SOURCE: ESA PWA 2013
SLR = sea level rise

Discontinued

similar

0.5-~2 ft higher

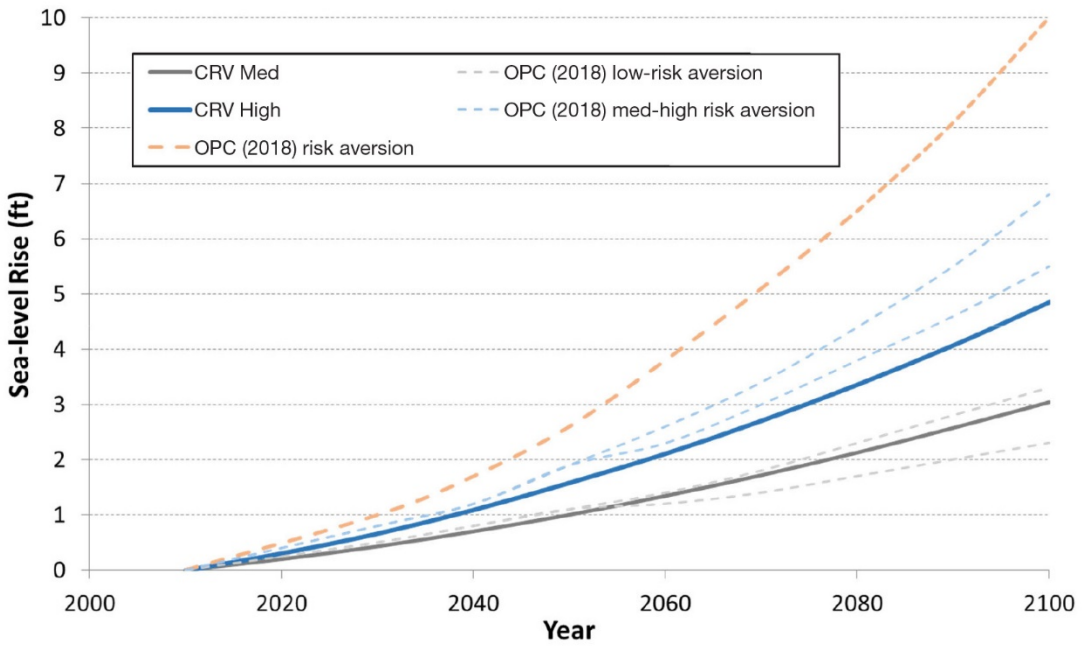
Latest CA Guidance (OPC 2017; Griggs et al. 2017) Table 25: Projected SLR for Santa Monica

Year	Low risk (67% chance)	Med-High Risk (0.5 % chance)	Extreme Risk (~0.1% or less chance)
2050	1.1 ft	1.9 ft	2.6 ft
2100	2.3-3.3 ft	5.5-6.8 ft	10.0 ft*

*Exceeds capacity of models to project erosion and flooding

Ormond Beach Restoration and Public Access Plan

Figure A-2
Comparison of CRV (2013) and OPC (2017) SLR Scenario Tables



Ormond Beach Restoration and Public Access Plan

Figure A-3
Comparison of CRV (2013) and OPC (2017) SLR Scenario Graphs

Appendix B

Shore Migration and Overtopping (Beach QCM)

APPENDIX B
Shore Migration and Wave Overtopping

Introduction

The Ormond Beach Restoration and Public Access Project (OBRAP) project area crosses several coastal habitats, from open beach, to dune, to various types of back-dune marsh and wetland. While habitat modeling examines the effect of changing water levels on the wetlands behind the beach and dunes, it generally overlooks the erosion and transgression of the beach. Ormond beach is expected to transgress inland with rising sea level, as waves propelled by higher water levels push the beach up and inland.

In addition, a critical feature of the wetlands behind the beach and dunes is their salinity, and this is driven by the balance of freshwater from the inland side and saltwater from the coast. Coastal saltwater tends to reach the inboard side of the dunes through groundwater seepage (saltwater intrusion) and by wave overtopping, the latter of which is expected to increase nonlinearly with sea level rise, as higher water levels bring larger waves farther inland during more of the year.

Methods

Shore Migration Methods

Long-term erosion is common on the California coast, and the rate varies along over 800 miles between the Mexican border and the Oregon border. The United States Geologic Survey (USGS) has recorded the location of the coast at irregular intervals for several decades, and this can be used to estimate the long-term erosion rate in different portions of the coast. According to these coastlines, the average trend at Ormond beach is actually one of accretion (beach building); however, this is a regional outlier, and there are local physical processes that are believed to have obscured the actual long-term trend at the beach. Ormond beach has a high annual longshore transport volume (on the order of 800,000 cubic yards of sand moving along the coast each year, Herron and Harris 1966), which travels from northwest to southeast. After the construction of Port Hueneme, much of that transport was disrupted or blocked, rapidly eroding the regional coastline around Ormond beach. Now, about every two years, sand is pumped past the port to offset this erosion. This means that the coast southeast of Port Hueneme (i.e. the Ormond project site) fluctuates a great deal between these sand deposition projects, and the infrequent USGS shoreline measurements are scattered and do not capture an actual annual trend in shore position. In light of this, the average accretion rate was eschewed and the regional erosion rate of 0.5 feet per year was used for the Ormond beach project site.

In addition to the long-term erosion already underway at the site, sea-level rise is expected to drive inland transgression of the beach. This is likely to happen more quickly than wind can rebuild the dunes, meaning that the beach will eat into the existing dunes until it cuts through to the wetlands behind them. Beach transgression with changing sea levels is a common process, and is often modeled using the Bruun method (USACE 2006), which estimates the movement of the beach and dune face up and inland as the sand is eroded from the existing beach face and deposited offshore. The Bruun method migrates an equilibrium beach profile inland based on a representative shore slope. Based on survey and bathymetric data, this slope was determined to be 1:55 in the Ormond beach region. According to the Bruun method, when sea level rises, the beach will rise vertically an equal amount, and it will move inland that distance multiplied by the slope. For example, for one foot of sea-level rise, the beach would move up one foot and inland 55 feet.

The Bruun method assumes that the beach has enough time to reach equilibrium as sea level rises, which is a reasonable assumption for the beach itself, but the dunes behind the beach berm tend to develop and adapt more slowly. As such, they were assumed stationary, as the transgressing beach steadily eroded its way into them. For each analyzed transect (E, H, and I in **Figure B-1**), the representative dune slope was measured from the survey transect, and that was used to connect the berm of the transgressing beach to the existing dune profile. Each time the beach transgressed inland, segments of the dune outboard of the beach berm were removed, and the berm was connected to the closest inland survey point with a line at the representative dune slope. This representative slope varies between transects, but is generally within the range of 10:1 to 20:1 (horizontal to vertical). As the berm erodes through the back side of the dunes, this method generated unrealistic profiles, so they were smoothed into a typical 100-foot back beach area, using a shape consistent with sand transport associated with wave overwash.

This level of beach analysis is not included in the habitat model used in this study (SLAMM), but it was considered important to account for erosion and transgression in analyzing the OBRAP alternatives. To do this, the beach berm positions from each transect were connected at three time horizons, and areas offshore of this line were assumed to be open water. Then, the 100-foot band inland of the beach berm line was assumed to convert to beach/coastal strand to account for the back-beach area. These two regions were overlain on the SLAMM results to represent the coastal processes not captured in the habitat model.

Wave Overtopping Methods

Significant overtopping generally occurs in stormy high-water events, leading to ponded saltwater trapped behind the dunes. These effects are expected to be negligible in the west portion of the site, where lagoon processes dominate, but in the central and east portion of the site (areas 3a, 3b, 5, and 6 in **Figure B-2**), ponding from overtopping events is considered a major source of salt. To assess changes in operational conditions, each of these areas were analyzed for ponded water resulting from overtopping during conditions expected at least once per year.

Ormond Beach Restoration and Public Access Plan

Figure B-1
Beach transects E, H and I were used to represent beach strand areas 1, 7 and 9, respectively

SOURCE: ESA 2018, SCC 2011

Ormond Beach Restoration and Public Access Plan

Figure B-2
Ormond Beach Overtopping and Ponding Regions of Interest

Overtopping volumes were calculated in the same manner as in the Coastal Resilience Ventura (CRV) study (ESA PWA 2013) for consistency. Water levels and wave conditions for a period of approximately 20 years were provided by NOAA, and these were used to generate a rough estimate of the 2% runup elevation using the Stockdon method for natural beaches. While this method is not entirely accurate for long-period waves arriving on beaches with steep backshore profiles (i.e. west-coast, dune-backed beaches), it is considered a reasonable approximation for this level of analysis. As in CRV, overtopping rates were calculated for each record in the 20-year time series based on the European overtopping manual (Pullen et al. 2007), which provides an estimate of overtopping rate (cubic meter per second per linear meter of coast) as a function of crest elevation, water level, runup elevation, and surf similarity parameter (the ratio of the beach slope to the wave slope). From these, annual maximum overtopping rates were identified, and the smallest of these – the maximum overtopping rate reached at least once during each year in the record – was selected to represent annual storm overtopping conditions. It was assumed that this event would last four hours, rising from no overtopping to peak overtopping in two hours, then declining back to zero; integrating over this period gave an overtopping volume per linear meter of beach.

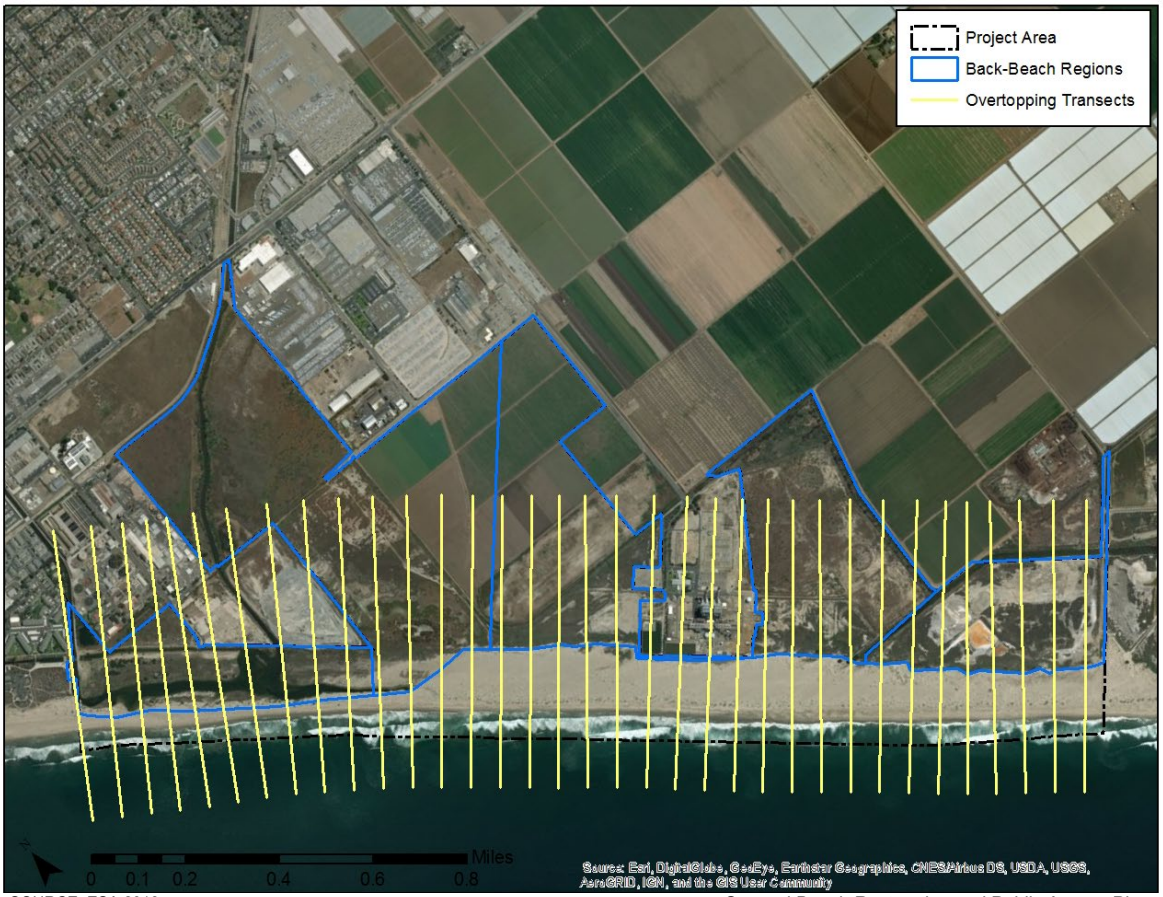
The described analysis was performed on thirty-five cross-shore transects (**Figure B-3**) along the Ormond coastline. These were extracted from LiDAR (SCC 2010) at 120-meter intervals as part of CRV (ESA PWA 2013). The slopes and dune crests on each profile were identified and used in the analysis described above. Nearshore wave conditions at these transects were determined by transformation of waves recorded by NOAA[1] and CDIP[2] at their Santa Barbara offshore buoy. This analysis was performed for CRV, and details can be found in the report from that study. The overtopping analysis, applied to these inputs, resulted in a set of overtopping volumes per linear-meter along the Ormond coast, which was integrated by multiplying by the transect spacing (120 meters) to yield a total volume of water crossing each transect during a large storm event occurring at least once per year. Each transect was linked to a backshore area, resulting in an estimate of the total volume captured by each area. This volume of overtopped water was converted to ponding elevation based on the minimum elevation in the area and a hypsometric curve (elevation vs. volume) generated from the topography for each ponding region (Figure B-2).

Upon inspection of site topography, a few modifications were made to the raw overtopping volumes. First, the overtopping method estimates the volume crossing the first coastal barrier and does not account for additional rows of dunes or an extensive back beach. Since the project is primarily concerned with saltwater reaching and ponding in the wetland areas behind the back beach, a reduction factor of 0.1 was used to account for the backshore distance separating overtopping water from the wetlands of interest (on the order of 700-1000 feet under existing conditions). The beach transgression and dune erosion analysis performed as part of this study indicates that the beach is apt to recede on the order of 300 feet by the end of the century, greatly

1 National Oceanic and Atmospheric Administration, National Data Buoy Center, https://www.ndbc.noaa.gov/. Accessed March 2019.

2 Coastal Data Information Program, http://cdip.ucsd.edu/. Accessed March 2019.

diminishing the backshore buffer between the ocean and the wetlands. To account for this, the reduction factor was weakened linearly to 0.5 by 2100.



SOURCE: ESA 2018

Ormond Beach Restoration and Public Access Plan

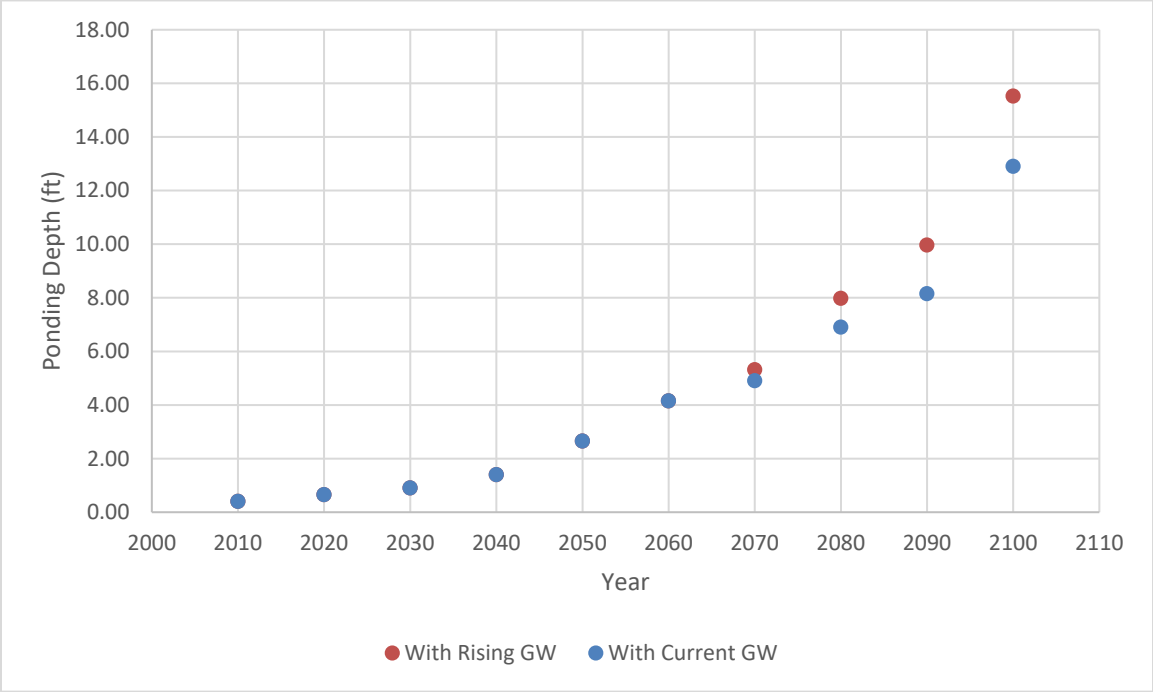
Figure B-3
Ormond Beach Overtopping Transects and Ponding Regions

Second, the central region of the project area – Area 5 – has a wider beach than the east and west ends of the project area. In this area, the beach is backed by two rows of dunes, separated by a shallow swale, before descending into wetlands. To account for this wide backshore, the reduction factors were intensified, beginning at 0.05 and weakening to 0.25 by 2100.

Third, there is a tall set of dunes at the inland edge of Ormond Beach in front of Area 3, but this dune ridge only covers half the coastline contributing overtopping water to Area 3. To account for this, the transects crossing the high dune ridge were not included when summing the overtopping volumes entering Area 3.

Finally, Area 6 is relatively low-lying with a high groundwater table. The area is expected to see an increase in ponded surface water as the groundwater table rises with sea level rise. To account for this, once sea level rises above the current groundwater depth (2 feet), the difference was added to the ponding elevation calculated in the overtopping analysis. The resulting difference

can be seen in **Figure B-4**, though this effect only begins after mid-century, at which point high sea levels and beach transgression may have introduced new physical processes that dominate those analyzed in this study.



SOURCE: ESA 2018

Ormond Beach Restoration and Public Access Plan

Figure B-4
Ponding Depth in Area 6,
With and Without Rising Groundwater

Results

Shore Migration Results

Cross sections for the shore migration transects from Figure B-1 are presented in **Figure B-5**. These three transects represent the dunes in front of Ormond Lagoon (Transect E), the dunes in the center of the beach (Transect H), and the dunes in the east of the beach (Transect I). Including both long-term erosion and beach transgression with sea-level rise, these transects are expected to move inland approximately 300 feet each, with different effects in different parts of the beach.

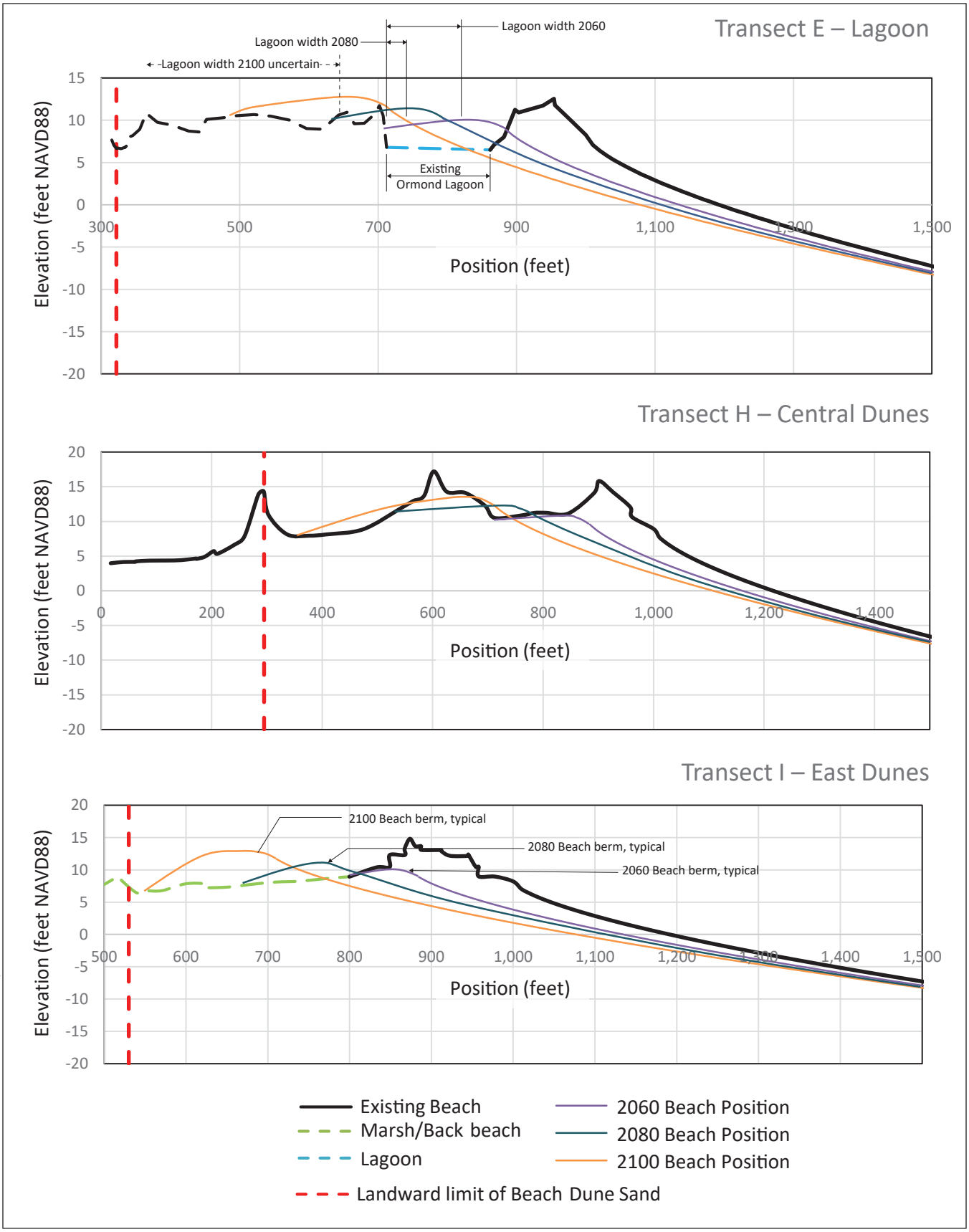
At each of these three locations, the shore geometry is shown in black in Figure B-5. For example, in the top schematic in Figure B-5, the black solid line is based on a survey of ground elevations (beach transect I), the black dashed line is derived from LiDAR, and the blue dashed line is the water surface of Ormond Lagoon at the time of the LiDAR data collection. The vertical red dashed line corresponds to the landward edge of the beach-dune strand and corresponds to the red line in Figure B-1. The horizontal position is a scale in feet with a “zero” location inland of the changes. The width of the existing lagoon is depicted by the blue dashed line. Note that the vertical scale is exaggerated to clarify the relief. Future shore geometries are shown in other

colors, per the figure legend. As sea level rises, the wave-shaped seaward face of the profile responds rapidly by migration, while landward elevations are held steady.

Note that at Transect E, the waves overtop the beach and reach the lagoon, and hence this "overwash" area also migrates with the seaward beach. At Transect E the existing Ormond Lagoon is impacted by shore migration. Note that the lagoon width decreases in 2030 and approaches zero in 2060. By 2100 the beach migrates inland of the existing dune and the extent of lagoon is difficult to predict. Transect E indicates that the lagoon (at least its east end) will be pinched by rising sea level by mid-century; without erosion, the east end will have closed by late-century; and by end-of-century, this half of the lagoon will have basically disappeared. This profile modeling neglects scouring of the backshore, which may happen during breaching events with rapid drainage and high OLW discharge. Therefore, the resulting lagoon footprint may be larger than implied by the beach migration modeling. Also, large expanses of low-elevation areas in Area 3b and 3a are likely to pond during high beach levels, indicating that the lagoon may "shift" location to the north and east.

Transect H indicates that the first row of dunes will erode by mid-century, exposing flat plover habitat between the two dune rows; this area will be steadily eroded through late-century; and entirely gone by end-of century, leaving the second dune ridge exposed. At Transect H, waves are not predicted to overtop the dunes sufficiently to cause the sand deposition in the lee of the dunes, resulting in a reduction of the width of the dune field.

Transect I indicates that the east dunes will be eroded by mid-century, leaving a berm and back-beach transgressing into the salt panne currently behind the dunes; and this process will continue basically unimpeded through late-century and end-of-century.



SOURCE: ESA, 2017

NOTE: Transect E (top) is located at western beach strand Area 1 at Ormond Lagoon; Transect H is located at central beach strand 7 near backshore Area 3 and Transect I is located at eastern beach strand Area 9 near backshore Area 6.

Ormond Beach Restoration and Public Access Plan

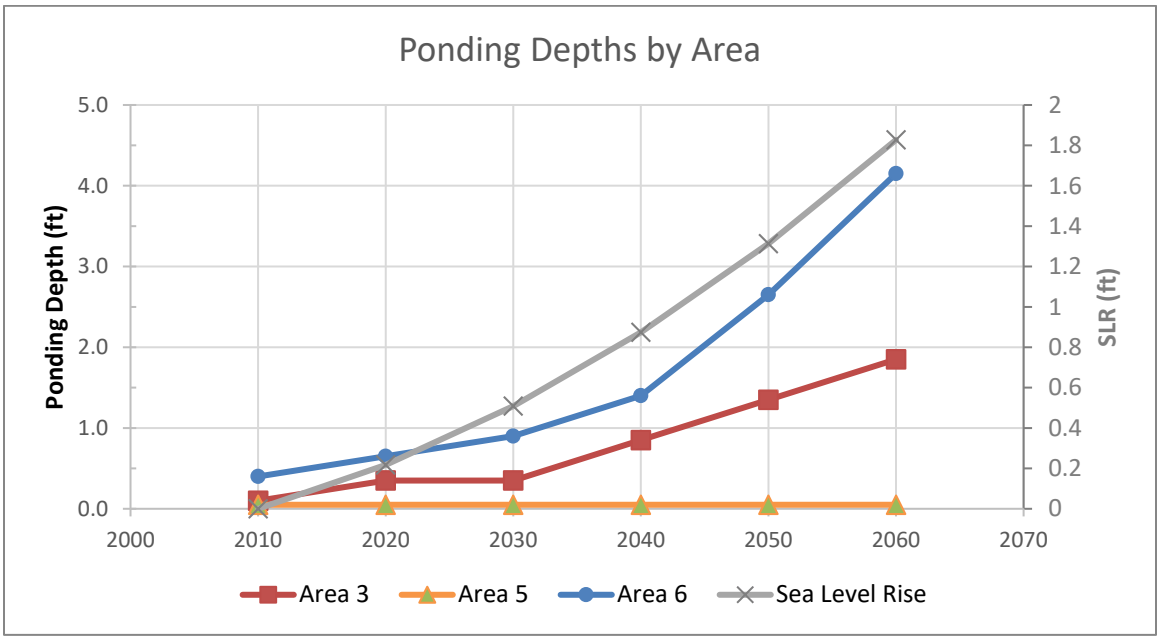
Figure B-5
Beach Transect Elevations

ESA

D160447.00 - Ormond Beach Wetlands Restoration\05 Graphics\Illustrator

Wave Overtopping Results

The wave overtopping analysis led to an estimate of ponding elevation for a relatively common storm ("operational conditions") in Areas 3, 5, and 6, as presented in **Figure B-6**. Area 3 shows a slow but steady increase into mid-century, thanks to the large wetland area that lies behind the gap in the high dune ridge there. Area 5 shows no increase through mid-century due to its second line of dunes, which block most of the overtopping volume until sea levels are even higher and the first row of dunes has eroded, later in the century. Area 6 shows an exponential increase in ponding depth, rising from approximately 0.5 feet to over 4.0 feet by mid-century, even before rising groundwater begins to raise the ponding elevation even more quickly.



SOURCE: ESA 2018

Ormond Beach Restoration and Public Access Plan

Figure B-6
Ponding Depth in Areas 3, 5, and 6
Compared with SLR (right axis)

In this analysis, the areas were assumed to be separate behind the dunes, which is not the case once water reaches higher elevations. This behavior could be harnessed in Areas 5 and 6, where one (Area 6) fills rapidly and the other (Area 5) is relatively resilient to increased overtopping from sea-level rise. The berm and ditch separating the two areas could be flattened to allow water to spread between the two more readily, reducing the nonlinear rise in ponding depth in Area 6 and making Area 5 wetter, promoting certain wetland habitats.

References

ESA PWA. 2013. Coastal Resilience Ventura: Technical Report for Coastal Hazards Mapping. Prepared by ESA PWA, San Francisco, for The Nature Conservancy. July 2013.

Herron, W.J. and Harris, R.L., 1966. "Littoral Bypassing and Beach Restoration in the Vicinity of Port Hueneme, California" Coastal Engineering, Vol. 1, 1966.

Pullen, T., Allsop, N.W.H., Bruce, T., Kortenhaus, A., Schuttrumpf, H., van der Meer, J.W., 2007. EurOtop: Wave Overtopping of Sea Defenses and Related Structures: Assessment Manual. Available: www.overtopping-manual.com.

State Coastal Conservancy (SCC). 2011. California Coastal Conservancy Coastal Lidar Project. Available: https://coast.noaa.gov/dataviewer.

U.S. Army Corps of Engineers (USACE). 2006. Cross-shore sediment transport processes. Chapter 3 of Part III of the Coastal Engineering Manual, EM 1110-2-1100.

Appendix C

Ormond Lagoon Hydrology and Morphology (Lagoon QCM)

APPENDIX C
Lagoon Quantified Conceptual Model

This appendix summarizes modeling of Ormond Lagoon and surrounding areas using a quantified conceptual model (QCM) of Ormond Lagoon's water balance. As described in the main body of the report, the project involves developing restoration concepts to enhance critical habitats, sustainability, and public value of Ormond Lagoon and surrounding areas that are managed by the state Coastal Conservancy, the City of Oxnard, and The Nature Conservancy. Ormond Lagoon is a heavily modified back-barrier lagoon-wetland system at the mouth of an urbanized watershed. Much of the historic Ormond Lagoon and surrounding wetlands have been converted to other uses, while upstream urban and agricultural development has increased the intensity of storm flows (see ESA 2017). The QCM provides an understanding of how Ormond Lagoon's morphology and hydrology could evolve, under the influence of future climate change and the proposed conceptual restoration actions. Interpretation of Ormond Lagoon's evolution can then inform how restoration may affect focal species' future habitat.

Section 1 summarizes the conceptual model lagoon conditions that inform the QCM. Additional details about the site can be found in the Existing Conditions report by ESA (2017). Sections 2 and 3 describe the model approach and data sources, respectively. Section 4 describes the preliminary results, and Section 5 discusses some of the uncertainties resulting from data gaps and future evolution of the site.

1. Conceptual Model of Site Conditions

The Ormond Lagoon is a perched system (see classification of Jacobs et al. 2010) that collects water from the Ormond Lagoon Waterway (OLW), tšumaš Creek, and Bubbling Springs (also called Hueneme Drain). After pooling in Ormond Lagoon, this water drains to the Pacific Ocean over and through a heightened beach berm that typically prevents tides from having a strong influence in Ormond Lagoon. Although the mouth of Ormond Lagoon is groomed prior to significant storms to facilitate natural breaching to alleviate flooding, waves elevate the mouth near or above high tides by delivering more sand than can be removed by stream inputs. The coastal sediment supply and beach morphology is heavily influenced by U.S. Army Corps of Engineers (USACE) dredging and beach nourishment activities west of the site, which involve mechanically bypassing the Port of Hueneme and placing of this sand updrift of Ormond Lagoon approximately every two years (see ESA 2017).

Under present conditions, Ormond Lagoon spills water out to the ocean during the winter months, when runoff from local municipal and agricultural runoff is highest. Flows from the watershed are concentrated into a series of drainage channels, which cause flood flows to rapidly arrive at Ormond Lagoon during rainfall events, and to rapidly tail off after rainfall ceases. The OLW

provides the majority of the runoff to Ormond Lagoon, with smaller amounts arriving from tšumaš Creek and Bubbling Springs. The local groundwater table is influenced by the accumulation of runoff in Ormond Lagoon and by the nearby trunk line for the Oxnard Wastewater Treatment Plant (OWWTP). Because Ormond Lagoon's water surface is perched, water seeps from Ormond Lagoon as groundwater toward the ocean through the sandy beach, northward toward the sewer trunk line and the seasonally ponded area located immediately east of the Halaco Site (ESA 2017).

Even when the mouth is open to the ocean, Ormond Lagoon receives relatively little tidal action, owing to its high elevation on the beach (beach elevations vary around +8 to +12 feet NAVD along Ormond Beach (ESA 2017)). When runoff declines in the spring, wave action closes the mouth seasonally, usually for periods of at least 4-6 months. During these closure periods, residual runoff ponds in the closed Ormond Lagoon, but balances with seepage and evaporative losses, giving relatively stable water levels of about 8-8.5 feet NAVD in the dry season. In drier years, such as 2017, evaporation and seepage may overmatch runoff, leading to a lowering of water levels throughout the dry season, to as low as 6.5 feet NAVD (ESA 2017). Flooding can result when high runoff is initially trapped behind the beach berm during a wet season rainfall event. This occurred on January 18th, 2010, leading to flooding of many of the local roadways and the OWWTP (VCWPD 2010). Following guidance from HDR (2011), the Ventura County Water Protection District (VCWPD) has managed the beach to prevent further flooding events by lowering a portion the beach crest to an elevation of 8.9 feet NAVD88 when a series of water level, beach, and predicted precipitation triggers are met. This allows the mouth to breach at a lower elevation before flooding occurs during the initial flood pulse.

The available brackish habitat in Ormond Lagoon and surrounding areas is mostly governed by the state of the mouth. When it is closed, trapped runoff provides highest water levels, greatest surface area, and greatest volume. When the mouth breaches, Ormond Lagoon drains and tends to have lower water levels and saltier conditions. The existing hydrology and habitat of the system are described in more detail by ESA (2007; 2017).

2. Lagoon Modeling Approach

To provide an understanding of how the Ormond Lagoon would respond to future changes, ESA developed a quantified conceptual model (QCM) for the site, which predicts lagoon mouth morphology and the resulting water levels of the lagoon. The current QCM approach is an adapted and refined version of earlier approaches for tidal conditions from Crissy Field Lagoon (Battalio et al. 2006) and for fluvial conditions for the Carmel River (Rich and Keller 2013), and builds on lessons learned from both approaches. In recent years, ESA has further developed the QCM as a more complete tool to assess systems with both tidal and fluvial characteristics (Behrens et al. 2015). It has been used most recently by ESA at Pescadero Creek (ESA 2017) in northern California, and at Los Peñasquitos Lagoon (ESA 2016) and Devereux Slough (ESA 2015), in southern California.

The QCM approach is centered on a water budget for the lagoon, which is coupled with a sediment budget for the lagoon mouth. The model is based on two core concepts:

- All water flows entering and leaving the lagoon should balance.
- The net erosion/sedimentation of the inlet channel results from a balance of erosive (fluvial and tidal) and constructive/deconstructive (wave) processes.

The model uses time series of nearshore waves and tides, watershed runoff, and evapotranspiration data as boundary conditions. Using these as forcing conditions with the lagoon's topography, the model dynamically simulates time series of lagoon water levels, along with inlet, beach, and lagoon state. With each time step, the net inflows or outflows to the system are estimated, along with the net sedimentation or erosion in the mouth. The flow terms vary depending on whether the mouth of the lagoon is open or closed. During closed conditions, inflows are based on watershed runoff, wave overwash into the lagoon, and while outflows are based from beach berm seepage and evapotranspiration. For more information on how the model resolves different processes, refer to Behrens et al. (2015).

As the model steps forward in time, it continuously transitions the mouth through tidal, perched, and closed conditions. When deposition in the inlet bed exceeds erosion, the bed rises vertically, eventually perching above most tidal elevations and closing. Mouth closure occurs in the model when sediment fills the bed higher than lagoon water levels. Breaching occurs in the model when the lagoon fills from accumulation of either watershed runoff or wave overwash, and water levels overtop the beach berm crest, eroding a new lagoon mouth.

Model accuracy is tested by comparing modeled lagoon water level time series against observed water levels, and by comparing the timing and length of inlet closure events to those of historical records. Closure time series and lagoon water level time series usually provide a good indication of which processes are dominating the system at a given time, such as runoff during floods, or powerful waves prior to closure. Thus, reproducing these time series is taken to mean that the dominant processes are meaningfully represented.

3. Data Sources

Input data for the QCM were obtained from a variety of publically available sources and field data collected by ESA and others. **Table C-1** summarizes the data sources for the model.

TABLE C-1
SOURCES OF HYDROLOGY, CLIMATE, AND TOPOGRAPHIC DATA AT THE PROJECT SITE

Parameter	Source/Location	Availability
Coastal Hydrology		
Offshore Waves	CDIP Harvest Buoy (#071)	1995-present
Nearshore Wave Estimates	ESA (2012)	1992-2012
	CDIP MOP	2000-present
Tide Stage	NOAA Santa Monica Gage (#9413450)	1985-present
Watershed Runoff, Local Climate, and Lagoon Hydrology		
Runoff	VCWPD gage 790	Peak flows 2002-2015, peak daily flows 2002-2005
	USGS Calleguas Creek Gauge (#11106550)	1996-2016
Evapotranspiration	CIMIS #156 (Oxnard)	2001-present
Rainfall	VCWPD gage 17C - Oxnard Sewer Plan	2004-present
	CIMIS #156 (Oxnard)	2001-present
Lagoon Stage	VCWPD (unreferenced OID gage)	2002-2005
	CH2M Hill (2011)	2007-2009
	VCWPD (OID staff gage referenced to NAVD)	2008-2013
	ESA (2018)	June 2017 – December 2017
Groundwater	CH2M Hill (2008)	2006-2012
Morphology		
Beach Topography	Coastal Frontiers: RTK GPS	March 2008
	State Coastal Conservancy LiDAR DEM	2011
	ESA: RTK GPS	2017
Lagoon Topography	HDR: RTK GPS	March 2008

3.1. Coastal Conditions

Hourly wave height, period, and direction near the Ormond Lagoon mouth were obtained from nearshore transformed wave data provided by the Coastal Data Information Program (CDIP) California Coastal Wave Monitoring and Prediction System (O'Reilly et al. 2016) at the CDIP model output point number VE254. VE254 is located approximately 2,000 feet offshore of Ormond Lagoon in approximately 33 ft of water. Model data were downloaded from January 2000 to November 2017. The wave data are a driver of beach elevation, which contributes to establishing the water levels in Ormond Lagoon, and influences the state of Ormond Lagoon (i.e., open, closed, perched overflow, etc.).

These nearshore wave predictions were compared against predictions from ESA PWA (2012), generated as part of the Coastal Resilience Ventura (CRV) project, and were generally found to correlate well. These prior predictions were based on a similar modeling approach that provided wave information from 1992-2012 at the site.

Hourly ocean water level data were obtained from NOAA's Santa Monica Tide Gage Station (NOAA #9413450) from 2005 to 2017. The Santa Monica Station is located approximately 35 miles from the Ormond Lagoon mouth. All data was downloaded in the North American Vertical Datum of 1988.

3.2. Lagoon Hydrology

The hydrology of Ormond Lagoon is summarized in detail by ESA (2017). This includes a description of the watershed conditions, and flows from the three main tributaries to the site.

Only limited observations of inflows to Ormond Lagoon are available. The VCWPD has maintained a gauge approximately 2 miles upstream of Ormond Lagoon that records high flow events. This gauge only captures flows above 50 cubic feet per second (cfs), and was in place from 2002 to 2015. As described in ESA (2017) and HDR (2008), several groups have scaled watershed inflows for the purpose of modeling flood conditions, but these do not provide a complete picture of the seasonal hydrograph or summer/fall base flows, which is critical information for understanding lagoon conditions when the mouth is closed during the dry season. A nearby gauge on Calleguas Creek upstream of Mugu Lagoon (see Table 1) was operated until 2016, and likely provides representative agricultural and municipal runoff conditions.

Runoff to Ormond Lagoon was scaled using information from the VCWPD gauge, the nearby Calleguas Creek gauge (USGS #11106550), and information from prior reports (PWA 2007). Calleguas Creek flows were scaled to the site using a ratio of drainage areas. Flood flows measured on the VCWPD gauge upstream of the site were also scaled to Ormond Lagoon by accounting for the ratio of drainage areas above the gauge and Ormond Lagoon, respectively. The scaled flood flows from both gauges were then compared, and the scaled Calleguas flows were adjusted to fit the scaled VCWPD flood peaks. Lastly, base flows were augmented by adding approximately 2 cubic feet per second to account for consistent urban runoff. Neither of the gauges used to develop this synthetic record had measurements in 2017.

Evaporation and precipitation data were obtained from Oxnard and Camarillo California Irrigation Management Information System (CIMIS) stations (Station #156 and #152, respectively). These stations were assumed to be representative of the rainfall and evaporation in the drainages upstream from Ormond Lagoon. Data were downloaded from the Oxnard Station from January 2002 to May 2016. After May 2016, data from the nearby Camarillo CIMIS Station #152 was appended to the Oxnard record.

Ormond Lagoon water levels collected from 2007 to 2017 were used to calibrate the model and test its accuracy. From October 2007 to September 2009, water level data were collected continuously with a logger by CH2M Hill as part of an EPA study of the Halaco Site (CH2M Hill 2011). Although continuous measurements ended in 2009, spot measurements were taken every two weeks from 2009 to 2011 using a staff gauge at the site referenced to the NAVD88 datum (CH2M Hill 2012). ESA deployed several continuous water level loggers in June through December 2017.

3.3. Beach and Lagoon Morphology

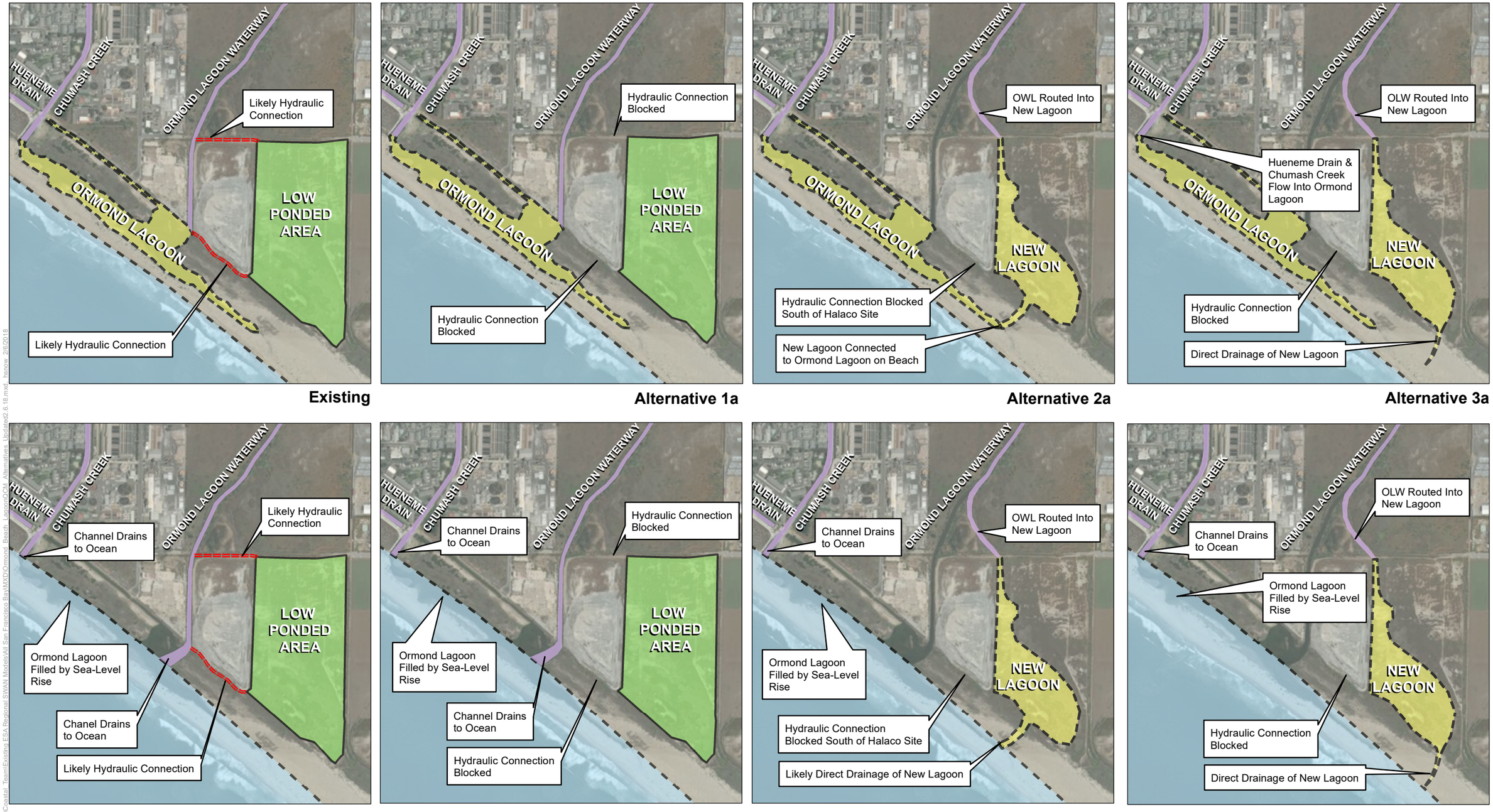
ESA compiled topographic data sources at Ormond Lagoon to create a ground surface elevation basemap. The basemap was used to build a stage-storage curve for Ormond Lagoon. A survey by Coastal Frontiers in 2008 provided elevations on the beach and in Ormond Lagoon. This field data was supplemented with 2009-2011 California Coastal Conservancy LiDAR in upland areas. Elevations within channels draining to Ormond Lagoon were approximated based on the Coastal Frontiers data. Note that the OLW was dredged after the 2008 Coastal Frontiers survey and the increased depth is not represented in the basemap. Additionally, Ormond Lagoon has likely accumulated sand over the past several years of extended drought in California, and thus, volumes in the stage-storage curve may overestimate present Ormond Lagoon storage. ESA also collected several transects of Ormond Lagoon and beach in the summer of 2017, and these were used to check for any changes in lagoon bed elevation between 2008 and 2017. A comparison of the transects showed that the southern arm of Ormond Lagoon which was not fronted by vegetation had partially filled-in with up to approximately 4 feet of sand between 2008 and 2017. This sand was likely deposited by wave overwash and had not scoured out during the low-flow drought years. Survey data from 2017 in other parts of Ormond Lagoon is too limited to make a comparison with the 2008 data.

4. Model Results

ESA ran the QCM from October, 2007 to October, 2017, a period that includes a range of wet and dry years, and a high overlap of available data sets for testing the model. Although the wave and tide data extend back further, the measured water levels are restricted to more recent years. To explore how future changes could influence the behavior of Ormond Lagoon, we ran the same 2007-2017 time series with 3 feet of SLR and with several restoration and management options. These initial restoration/management options are intended to inform the assessment of the restoration alternatives.

The modeled alternatives are summarized in **Table C-2** and shown graphically in **Figure C-1**. Alternatives 0 (existing conditions) through 3 were modeled with and without SLR. The Alternatives were given the suffix label “a” when sea-level rise (SLR) was not added, and the label “b” when 3 feet of SLR was included. The calibration run did not include SLR.

The conceptual restoration alternatives are introduced here for context, but are described in more detail in the main body of the report. Alternative 1 involved isolating the existing brackish habitat immediately east of the Halaco properties. Alternatives 2 and 3 include the creation of a new water system (called “New Lagoon” as it is modeled as a separate body in this lagoon model) in this area (see conceptual depiction in Figures 1). For this analysis, the New Lagoon was considered to be roughly the same volume as the portion of the existing Ormond Lagoon in front of the dune line. For Alternative 2, the New Lagoon (the re-routed OLW and surrounding floodplain) is assumed to be connected hydraulically to the OLW and to the existing Ormond Lagoon. Conversely, the New Lagoon and Ormond Lagoon are disconnected under Alternative 3



Path: K:\pwa\Coastal_Team\Existing ESA Regional SWAN Models\All San Francisco Bay\MXD\Ormond_Beach_LagoonQCM_Alternatives_Updated2.6.18.mxd, hsnow, 2/6/2018

SOURCE:

Ormond Beach Restoration and Public Access Project

Figure C-1
Lagoon QCM Alternatives
Alternatives 1 through 3

ESA

This page intentionally left blank

TABLE C-2
ORMOND LAGOON QCM SCENARIOS

Alternatives	Alt. Description	SLR	Hydrology	Beach Management
Calibration	Existing conditions without beach grooming	0'	Existing conditions	No beach grooming
0a	Existing conditions (do nothing)	0'	Existing conditions	Beach grooming to 8.9'
0b	Existing conditions (do nothing), include SLR	3'	Existing conditions	Partial loss of Ormond Lagoon due to SLR, no beach grooming
1a	Block hydraulic connection between Ormond Lagoon and ponded area east of Halaco slag pile	0'	OWL is disconnected from ponded area, Ormond Lagoon is disconnected from ponded area	Beach grooming to 8.9'
1b	Block hydraulic connection between Ormond Lagoon and ponded area east of slag pile, include SLR	3'	OWL is disconnected from ponded area (Area 3a), Ormond Lagoon is disconnected from ponded area	Partial loss of Ormond Lagoon due to SLR, no beach grooming
2a	Relocate OLW to area east of slag pile, connect to Ormond Lagoon	0'	Ormond Lagoon is hydraulically connected to OLW floodplain	Beach grooming to 8.9'
2b	Relocate OLW to ponded area east of slag pile, connect to Ormond Lagoon, include SLR	3'	Ormond Lagoon is hydraulically connected to OLW floodplain	Partial loss of Ormond Lagoon due to SLR, no beach grooming
3a	Create New Lagoon in ponded area east of slag pile, separate from Ormond Lagoon	0'	OWL is rerouted into New Lagoon. New Lagoon and OWL are blocked from Ormond Lagoon. New Lagoon discharges to ocean southeast of slag pile.	No beach grooming in front of New Lagoon. Beach grooming to 8.9' in front of Ormond Lagoon.
3b	Create New Lagoon in ponded area east of slag pile, separate from Ormond Lagoon, include SLR	3'	OWL is rerouted into New Lagoon. New Lagoon and OWL are blocked from Ormond Lagoon. New Lagoon discharges to ocean southeast of slag pile.	Partial loss of Ormond Lagoon due to SLR, no beach grooming

and were modeled separately with the New Lagoon receiving 80% of the original streamflow and the old Ormond Lagoon receiving the remaining 20% of the flow, to account for diversion of the OLW. Under Alternative 3, we assumed that the New Lagoon will drain directly to the ocean via a new unmanaged ephemeral lagoon outlet (mouth) and will not pond onto the beach between the beach berm and the dune line. The implications of this assumption are discussed later in Section 5.

For the sea level rise “b” cases, we assumed that part of the existing Ormond Lagoon will be filled in by sand as the beach transgresses landward, as described in the main report. For Ormond Lagoon, we predict that the majority of Ormond Lagoon in front of the dune line would be lost under 3 feet of sea level rise, representing a loss of 20-40% of the overall lagoon system storage.

To represent the influence of the current beach grooming practice, we applied a cap of 8.9 feet NAVD for beach berm growth for the “a” Alternatives, effectively assuming that VCWPD would

breach the mouth if water levels ever reached this elevation. This means that if Ormond Lagoon water levels fill to 8.9 feet NAVD during a closure event, the model assumes the beach crest is instantaneously excavated to 8.9 feet, allowing Ormond Lagoon waters to spill over the beach and erode a new mouth. We assumed that the current beach grooming policy would no longer be relevant under 3 feet of sea level rise, and thus, the "b" cases did not include a beach height cap. The 3a alternative also does not include grooming in front of the New Lagoon.

4.1 Existing Conditions – Model Calibration

To train the model, we tested (1) predictions of water levels in the lagoon and (2) predictions of mouth closure and breach timing. We use the period from October 2007 to October 2011 to match water levels in the lagoon, and the mouth closure record interpreted from water level time series.

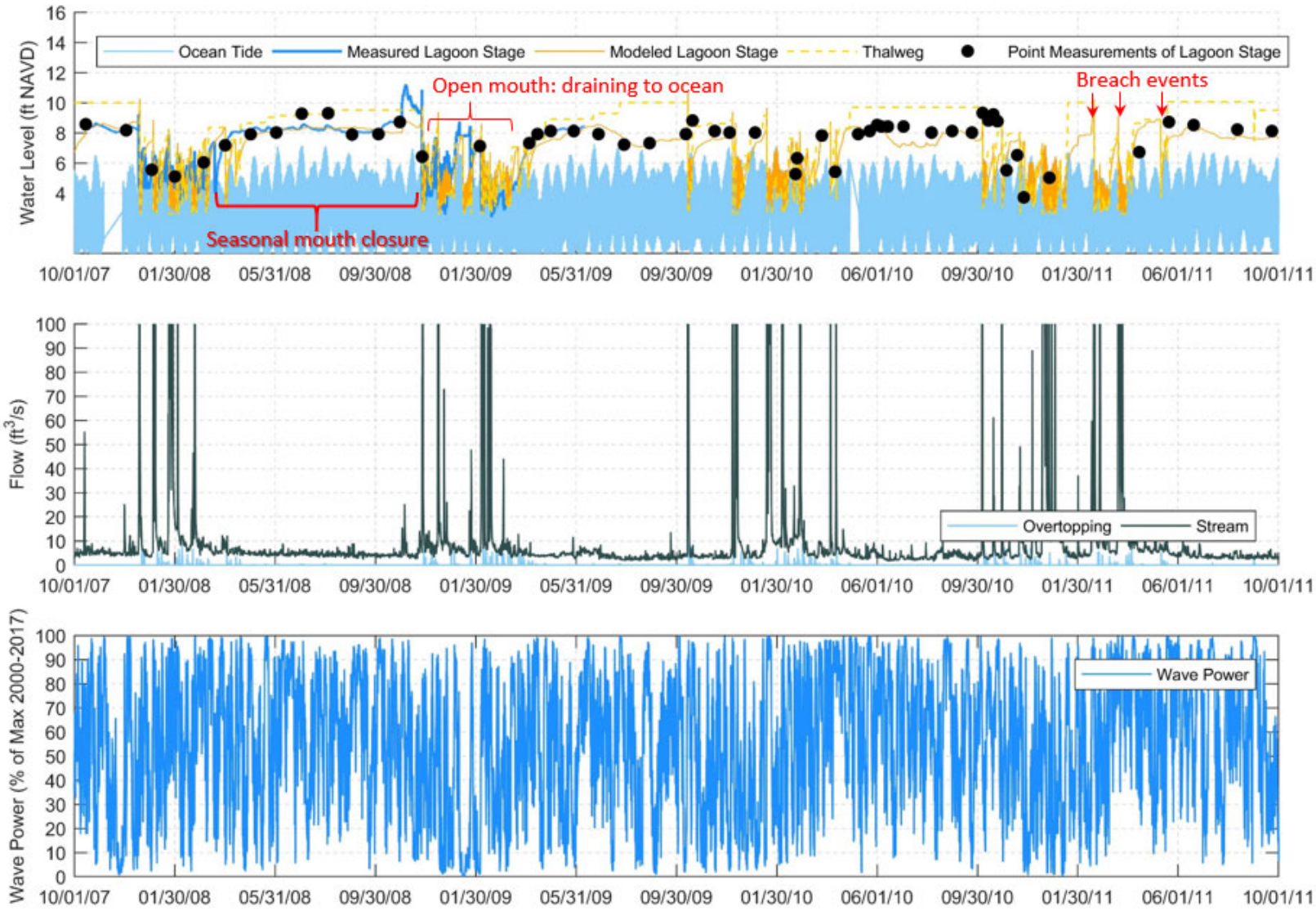
Figures C-2 and C-3 show how the model calibration run compares against the lagoon water level data from October 2007 to October 2011. Although the exact timing of the closure and breaching events are not always captured, the model reproduces a number of important aspects, such as (1) periods of mouth scour during high watershed runoff, (2) mouth closure during high wave events, (3) stabilization of the water level at 8-9 ft NAVD during seasonal closure events, and (4) natural mouth breaching during floods.

Given the complexity of Ormond Lagoon and other similar estuaries, the QCM is best used to reproduce the seasonality of the closures and the expected distribution of water levels in the lagoon, and not the exact timing of closure or breach events. Overall, the model performs well in reproducing the water level exceedance (Figure C-3) in the lagoon and the percentage of days closed (**Figure C-4**). The model correctly predicts the seasonality of closure, although it tended to overpredict mouth closure in late winter and fall. Since the model was driven by a synthetic inflow time series, and water level observations were limited, it is likely that it could be improved significantly as more data are collected.

4.2 Impact of Restoration Alternatives

Table C-2 outlines the conceptual alternatives, and lists the ways that they were represented in the model. The restoration alternative "a" cases are representative of existing sea level, while the "b" cases represent future sea levels, and an absence of mouth management. **Figures C-5 through C-8** provide a summary of model results that highlight the predicted water levels in the lagoon, the changes in the seasonal mouth closure pattern, and the expected changes in the wetted area and volume. These characterize the hydrology of the system, while the SLAMM model described in the main body of the report addresses specific habitat responses.

Figure C-5 shows a time series of modeled water level in the lagoon for each of the alternatives, without SLR (upper panel) and with 3' of SLR (lower panel). For the third alternative, water levels are indicated both for the Ormond Lagoon area, fed by tšumaš Creek and Bubbling Springs, and for the New Lagoon area fed by a redirected OLW. Figure C-6 illustrates the seasonal closure pattern for each of the alternatives, in terms of number of days of mouth closure

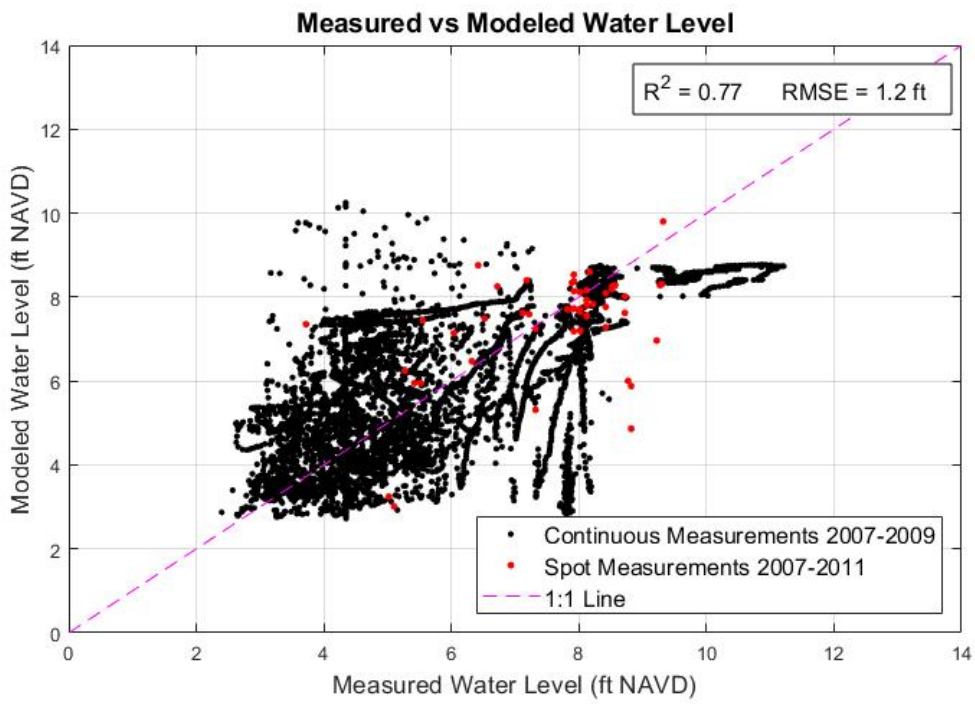


Ormond Beach Wetlands Restoration / D160447.00

SOURCE: ESA

Figure C-2

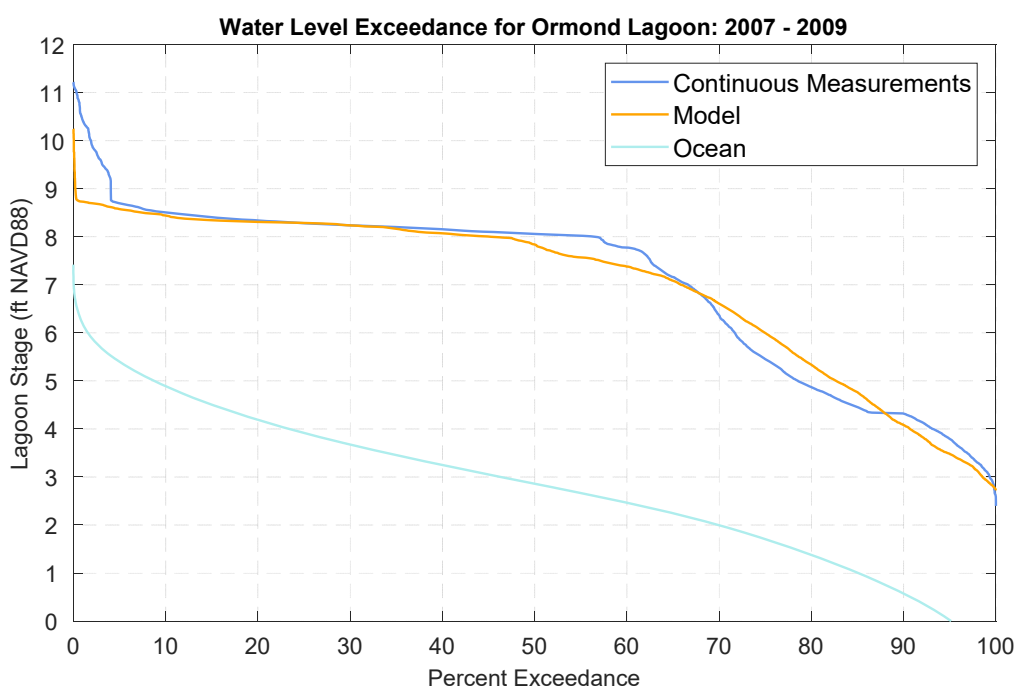
Comparison of **(top)** modeled and observed water levels in Ormond Lagoon, **(middle)** synthetic time series of runoff and predicted wave overwash, and **(bottom)** nearshore wave power.



Ormond Beach Wetlands Restoration / D160447.00

SOURCE: ESA

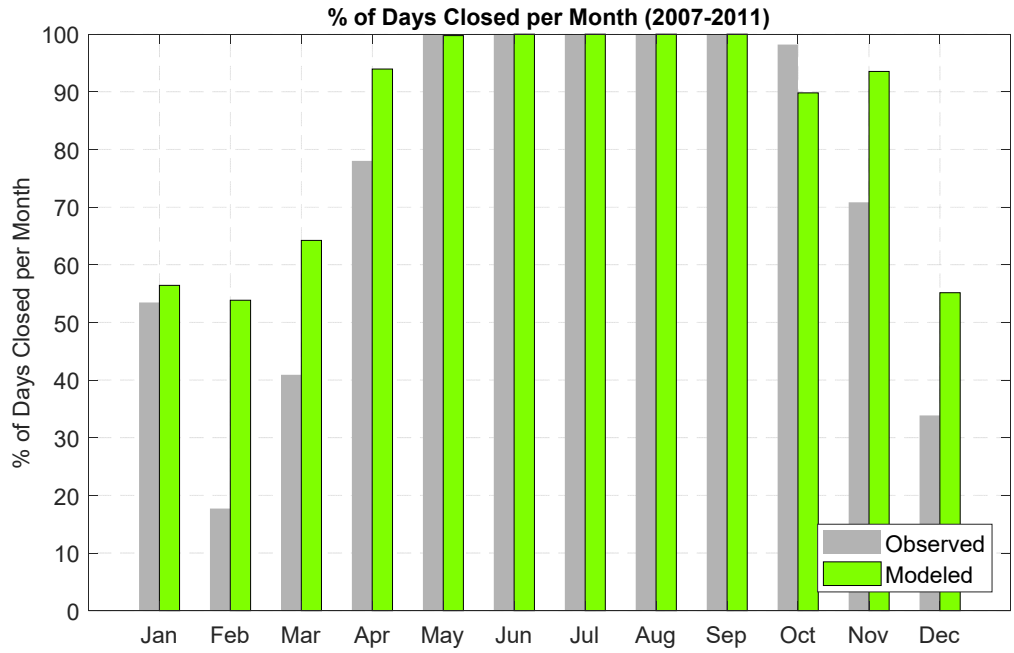
Figure C-3
Comparison of modeled and observed water levels in Ormond Lagoon from 2007 to 2009.



Ormond Beach Wetlands Restoration / D160447.00

SOURCE: ESA QCM model. Water level observations provided by CH2M Hill (2012)

Figure C-4
Comparison of modeled and observed water level exceedance in Ormond Lagoon from 2007 to 2009.



Ormond Beach Wetlands Restoration / D160447.00

SOURCE: ESA

Figure C-5
Comparison of modeled vs observed percentage of days closed per month

for each month of the year over the period from 2007 to 2017. The seasonal closure pattern is apparent in each of the curves from the dip in the number of closure days in winter months (during higher flow conditions) and higher number of closure days in the drier months (when runoff is low and the mouth is more likely to be blocked by sand from wave action).

Figure C-8 condenses the water level time series from Figure C-6 into probability density function (pdf) curves. These curves represent the relative number of times that lagoon water levels were predicted within certain bands of elevation. As an example, a pdf curve of oceanic tides would show high density of occurrences between mean lower low water (MLLW) and mean higher high water (MHHW). For Ormond Lagoon, water levels are typically much higher, so the pdf curves show a higher density above MHHW. The goal of this plot is to show subtle changes in water level between the alternatives more clearly than a time series alone could reveal. Figure C-8 also shows pdf curves for wetted area and lagoon volume, which were calculated from the water levels by relating them to the hypsometry (volume vs elevation) relationships for each case. Figure C-9 is similar to Figure C-8 but illustrates the SLR scenarios.

Alternative 1a was the only alternative to reduce the volume of Ormond Lagoon, since it isolated the ponded area east of the Halaco site. Compared to existing conditions, this alternative resulted in slightly higher water levels during seasonal closure (Figure C-6), but this caused Ormond Lagoon to breach earlier relative to existing conditions (Figure C-7). This meant that Ormond Lagoon drained earlier and more frequently than the other alternatives. Overall, the effects on

water levels were small, although the isolation of part of Ormond Lagoon meant that wetted area and water volume were reduced (Figure C-8).

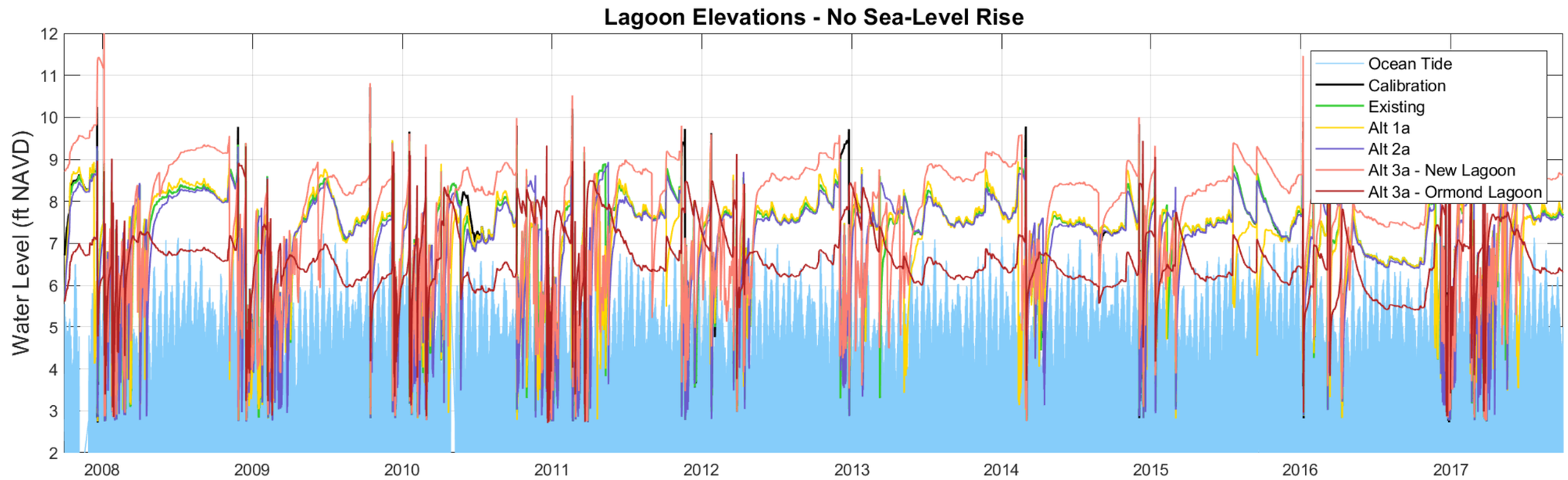
Alternative 2a resulted in slightly lower water levels than for existing conditions, but the added lagoon volume east of the Halaco site added a significant amount of wetted area and volume (Figures C-6 and C-8). Since oceanic tides have a small presence under existing conditions, the added volume had only a small impact on maintaining a longer opening, and relatively larger impact on impounding more water behind the beach during seasonal closure events. In systems that are much lower in elevation, adding volume within the tidal range can increase tidal currents in the mouth and make it harder for waves to deposit sediment and close the mouth (e.g. Behrens et al. 2015). In this case, the impact of the grading was predicted to have a relatively small impact on mouth conditions (Figure C-7).

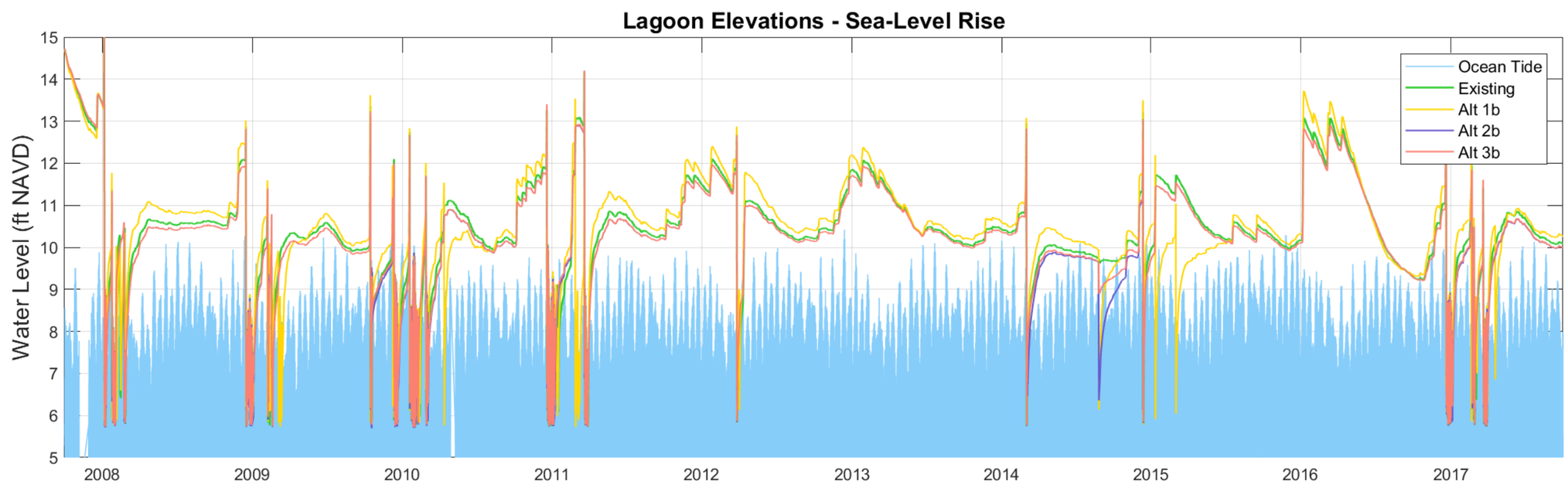
Alternative 3a had the most marked impact on lagoon water levels and mouth closure, and had a similar effect as Alternative 2a with respect to increasing wetted area and volume. The New Lagoon under Alternative 3a was predicted to experience higher water levels than for Ormond Lagoon under existing conditions. This is a result of:

- Smaller storage capacity of inflows when compare to the capacity of the entire existing system,
- Reduced seepage toward the ocean given that the New Lagoon would mostly be situated behind the dune line, rather than on the beach, and
- Lack of beach management, allowing the beach crest to reach equilibrium levels of 9-11 feet NAVD during seasonal closures. This would allow the New Lagoon to hold more water behind the beach berm.

These changes contributed to significant gains in water volume east of the Halaco site, despite the fact that a portion of the inflows (Chumash Creek and Bubbling Springs) were directed to Ormond Lagoon. In contrast, the Ormond Lagoon experienced a reduction of 1-2 feet in water levels, since its storage capacity remained the same and the OLW would be diverted to the New Lagoon. This is anticipated to have a net benefit on flood management, as it delayed ponding during floods and reduced the number of times that peak water levels reached the grooming elevation of 8.9 ft NAVD (Figure C-6).

Despite the separation of inflows, when combined, the New Lagoon and Ormond Lagoon segments are predicted to provide a net increase in overall brackish habitat in the system as indicated by the curves for wetted area and volume in Figure C-8. The increase is similar in magnitude to Alternative 2a. The model also predicted significant changes in mouth closure duration. Despite the assumed continuation of beach grooming by VCWPD in front of Ormond Lagoon in the future, the reduced inflow to Ormond Lagoon meant that closure events lasted significantly longer on average (Figure C-7).





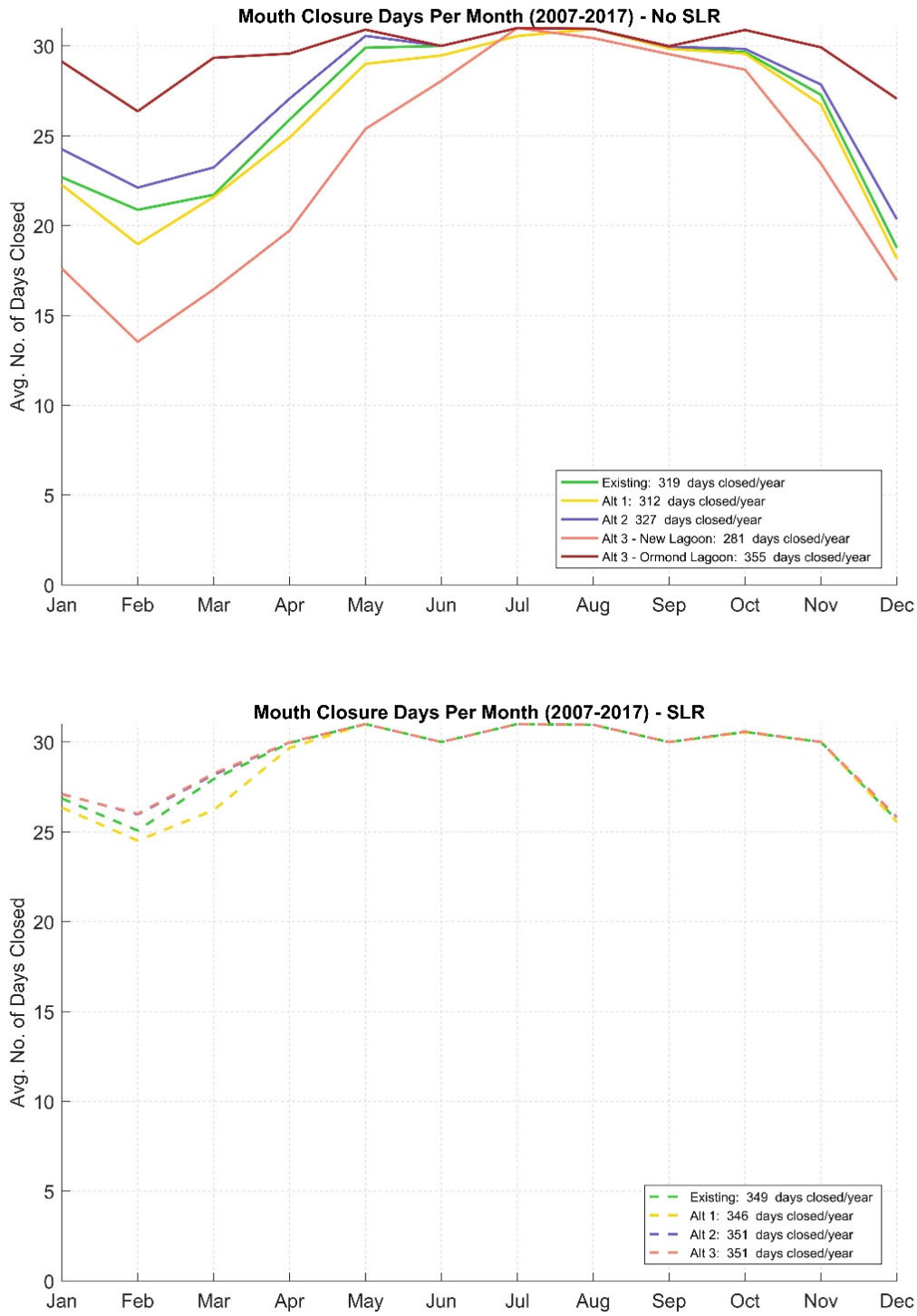
ESA

Ormond Beach Restoration and Public Access Project

Figure C-6

Alternatives Timeseries

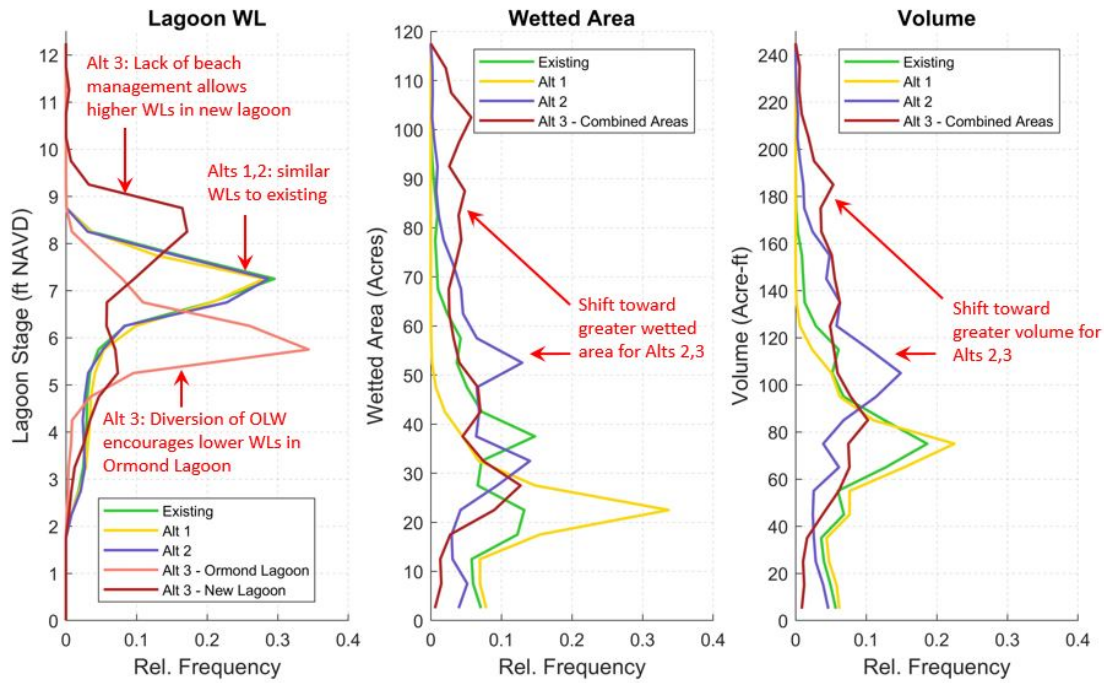
This page intentionally left blank



SOURCE: ESA QCM Model

Ormond Beach Restoration and Public Access Plan

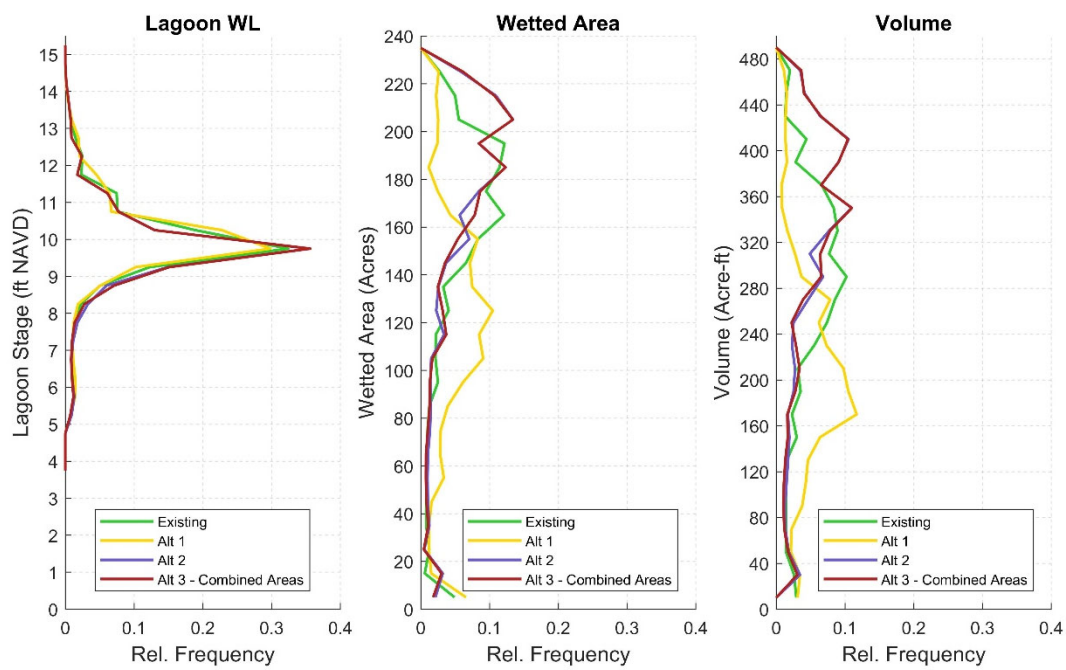
Figure C-7
Lagoon Mouth Closures in Days per Month
No Sea-Level Rise (top) and 3' of Sea-Level Rise (bottom)



SOURCE: ESA QCM model

Ormond Beach Restoration and Public Access Plan

Figure C-8
Modeled Lagoon Stage (Water Level) (left), Area (middle), & Volume (right) Probability Distributions for 2007-2017.



SOURCE: ESA QCM model

Ormond Beach Restoration and Public Access Plan

Figure C-9
Modeled Lagoon Stage (Water Level) (left), Area (middle), & Volume (right) Probability Distributions for 2007-2017. With 3 feet of Sea level Rise

4.3 Impact of Sea Level Rise

Under the sea level rise scenarios ("b" alternatives), water levels are very similar across the alternatives. This is likely because the elevated water levels will fill low areas behind the dune line. The capacity of these areas to store water is higher than the relatively small area of the Ormond Lagoon that would be lost to beach transgression inland. Therefore, the differences in storage capacity between the cases are small relative to the total storage capacity. Figure 7 (bottom) shows that for the SLR cases, the mouth is closed on the majority of the days each month. A similar seasonal pattern with winter and spring breaches is still observed with sea level rise, although the pattern is less pronounced. These results imply that the increase in the extent of inundated areas behind the dune line would contribute more to impoundment of water than to maintaining an open mouth. As SLR increases water levels above 3', more frequent open-mouth conditions may result: This response was predicted for Devereux Slough in Santa Barbara County, for high levels of SLR (ESA 2016). For Ormond Beach area, the very low topography would not constrain the water surface at these higher sea-levels, and a more detailed analysis of the basin hydrology is required to provide meaningful projections.

4.4 Conclusions

In the short- to mid-term time horizon, Alternative 3 provides the greatest wetted area and volume for tidewater goby habitat. Although Alternative 3 can cause elevated water levels in the New Lagoon (which potentially poses a flooding risk), the fraction of time in which water levels are above 10 feet NAVD is small. If Alternative 3 were to be pursued, flooding risks to nearby areas should be assessed. Also note that Alternative 3 is sensitive to input assumptions and thus the results for Alternative 3 include more uncertainty than the other Alternatives. Alternative 2 was found to have a comparable increase in water volume, although water levels were constrained by continued beach management, limiting the allowable gain of lagoon habitat. Alternative 1, provided the least lagoon elevation and area (habitat), but would likely be simpler to implement and would preserve more brackish/saline habitats than the other alternatives.

As sea level rises, the differences between the Alternatives becomes less significant. With 3 feet of sea level rise, Alternative 3 has a smaller advantage over existing conditions in the amount of wetted area and volume provided. However, it is assumed that construction of this alternative would allow formation of critical backbarrier lagoon habitat, that could then transition and adjust inland with SLR, rather than being squeezed and constrained against infrastructure behind the beach. Also, Alternative 3 is more consistent with future conditions with higher sea levels for all of the Alternatives because the proposed New Lagoon location is where a lagoon is predicted to form at higher sea level.

This page intentionally left blank

5. Uncertainties and Restoration Implications

5.1 Data Gaps and model uncertainty.

While the model was able to reproduce seasonal mouth closure conditions and water levels, the short span and limited geographic scope of some of the available data contributed to some of its uncertainty. Model calibration relied heavily on data collected from 2007 to 2011 since this period had the greatest overlap of different data sets required for testing the model. Although this period of time included relatively dry and wet years, year-to-year variability in the California climate is often very high, and 4-5 years of data cannot describe the full breadth of hydrologic conditions that might be expected in the future, with or without restoration.

While data collection by the EPA, CH2M Hill, and others was intensive, and has done much to illustrate the function of the system, there are several data gaps that impacted this modeling study:

- Runoff data into Ormond Lagoon were unavailable. A synthetic record was developed from nearby gauges to attempt to approximate the seasonality if runoff (described in Section 3), but the uncertainty of this synthetic time series is unknown without data to compare against. No runoff data were available from either of these nearby gauges for 2017.
- No water level records were taken in Ormond Lagoon from 2012 to 2016.
- Records of mouth closure periods have not been kept, except for the dates of beach management actions. Timing of mouth closure events was interpreted from water level time series.
- The impact of biennial beach nourishment activities from the USACE, is thought to impact beach growth at the site, but seasonal and inter-annual measurements of the beach crest are not available.
- Groundwater interactions between area 3a and areas to the east are uncertain, which implications all alternatives. Area 3a is thought to have a groundwater connection to OLW and Ormond Lagoon (CH2M Hill 2012), but its connectivity to areas immediately to the east, including the ODD#3 is less certain. Ground water is affected by the existing waste water system, which is connected to the groundwater via pipeline leaks (CH2M Hill, 2012), but the existing and future implications to groundwater are not adequately understood.

Future refinement efforts of the restoration design would benefit greatly from additional data collection that would address these gaps. The goal of this data collection would be to gather information in a wider range of hydrologic conditions than were observed from 2007 to 2011. In particular, water level data collected in Ormond Lagoon and in area 3a would be relatively cost-effective and provide a much broader understanding of how Ormond Lagoon and outlying ponded areas respond to the driest and wettest of years. Runoff measurement near Ormond Lagoon would also provide a large benefit to the restoration design. Since the existing Ormond Lagoon rarely experiences ocean tides, we found that the seasonal runoff pattern has relatively high importance in governing the morphology of Ormond Lagoon mouth and the resulting water levels. This is consistent with other lagoons that whose topography lies mostly above the tide

range, including Scott Creek in central California (ESA 2016) and at Aliso Creek, north of San Diego (ESA year).

5.2 Uncertainties in Site Evolution

For all alternatives, we assumed that beach transgression with sea level rise will impact the available volume on the beach, as the beach begins to squeeze Ormond Lagoon against the hard line of infrastructure immediately landward. Unlike the beach crest fronting Ormond Lagoon, we have assumed that the dune line would be more resilient and would front the Lagoon constructed in area 3a as part of Alternatives 2 and 3.

We have assumed that the New Lagoon created under Alternative 3 would mostly be comprised of the ponded areas behind the dune line, and would have an ephemeral connection to the ocean via a New Lagoon mouth channel on the beach. For simplicity, we assumed that the channel connecting the New Lagoon to the ocean on the beach would not expand to form a seasonally ponded area of its own on the beach (similar to the ponded area that makes up the existing Ormond Lagoon). At several other sites in California, this condition is true, but it requires that vegetation or other environmental constraints prevent the channel from migrating along the beach. The proposed grading for Alterative 3 includes dune creation to inhibit connection to the existing Ormond Lagoon, but pooling along the beach to the east is possible and even likely, and should be considered in reviewing alternatives effects and effectiveness.

While we did not explicitly model this case, the expected result of this lagoon formation on the beach would be:

- A gradual increase in wetted area and volume available (beyond those already predicted for Alternative 3), and
- An increase in seepage losses from the New Lagoon, potentially resulting in lower water levels

6. List of Preparers

Dane Behrens, PhD PE
Hannah Snow, EIT
Matt Brennan, PhD PE
Bob Battalio, PE

7. References

Battalio, R.T., D. Danmeier and P. Williams, 2006. Predicting Closure and Breaching Frequencies of Small Tidal Inlets –A Quantified Conceptual Model, *Proceedings of the 30th International Conference of Coastal Engineering*, ASCE 2007, Vol. 4, 3937 - 3949.

Behrens, D., Brennan, M., and B. Battalio. 2015. A quantified conceptual model of inlet morphology and associated lagoon hydrology. Shore and Beach 83(3):33-42.

CH2M Hill. 2008. Preliminary Evaluation of the Sources, Nature, Extend and Movement of Contamination in Surface Water and Groundwater, Halaco Site. Prepared for U.S. Environmental Protection Agency. December 2008.

CH2M Hill. 2012. Surface Water and Ground Water Sampling and Analysis Results, Halaco Superfund Site Remedial Investigation, Oxnard, California. Prepared for U.S. Environmental Protection Agency. March 2012.

Coastal Frontiers. 2008. J Street Drain Coastal Engineering 2008 Beach and Lagoon Monitoring Program. Prepared for HDR Engineering, Inc. 2008.

ESA 2015. Santa Barbara County Coastal Hazard Modeling and Vulnerability Assessment. Technical Methods Report. Prepared for County of Santa Barbara.

ESA. 2016. Task Order No. 35 – Los Peñasquitos Lagoon Restoration Strategy, Task 3.1 – Lagoon Inlet Dynamic Modeling and Assessment of Inlet Maintenance. Prepared for the City of San Diego. June 20, 2016.

ESA. 2016. Draft Lagoon Quantified Conceptual Model Memorandum for Pescadero Creek Lagoon. Prepared for San Mateo County RCD and USFWS. April 10, 2017.

ESA 2016. Aliso Creek Estuary Restoration: Lagoon Inlet Dynamics Quantified Conceptual Model (QCM) Memorandum – Draft. Prepared for the Laguna Ocean Foundation. August 4, 2016.

Goodwin, P. 1996. Predicting the stability of tidal inlets for wetland and estuary management. Journal of Coastal Research, Special Issue No. 23, pp. 83-101.

HDR Inc., 2011, Ormond Beach Lagoon Sand Berm Management Technical Memo. August 8, 2011.

Hughes, S.A. 2002. Equilibrium cross sectional area at tidal inlets. Journal of Coastal Research, Vol. 18, No. 1, pp 160-174, 2002.

Jacobs, D., Stein, E., and T. Longcore. 2010. Classification of California Estuaries based on natural closure patterns: templates for restoration and management. Southern California Coastal Wetlands Research Project, Technical Report 619.

Johnson, J.W. 1973. Characteristics and behavior of pacific coast tidal inlets. Journal of the Waterways, Harbors and Coastal Engineering Division, Proceedings of the American Society of Civil Engineers, Vol. 99, No.WW3, August 1973.

Kraus, N.C. 2002. Barrier breaching processes and barrier spit breach, Stone Lagoon, California. Shore & Beach, Vol. 70, No.4, pp 21-28. October 2002.

O'Brien, M.P. 1931. Estuary tidal prisms related to entrance area. Civil Engineering, ASCE, Vol. 1, No. 8, 1931, pp. 738-739.

Rich, A. and E. Keller. 2013. A hydrologic and geomorphic model of estuary breaching and closure. Geomorphology 19:64-74.

Ventura County Watershed Protection District (VCWPD), 2010, January 18, 2010 Ormond Beach Lagoon Emergency Breach Incident Report, prepared VCWPD.

VCWPD, 2010, Ormond Beach Lagoon Emergency Response Action Summary Slides, January 18, 2010.

Williams P.B. and K.C. Cuffe. 1994. The management implications of the potential for closure at Bolinas Lagoon. Shore and Beach, Vol. 62 No. 4, pp. 3-12, October 1994.

Appendix D

Wetlands Habitat Evolution Modeling (SLAMM)

APPENDIX D
Wetlands Habitat Evolution Modeling

Introduction

As sea level rises, the beach and wetland habitats at Ormond beach are expected to change due to increasing inundation and geomorphic migration inland. To project habitat changes at the site due to sea-level rise, this study employed the Sea Level Affecting Marshes Model (SLAMM). SLAMM, written and maintained by Warren Pinnacle Consulting, Inc., is a program that simulates wetland conversion and shoreline change due to sea-level rise (WPC 2016). It was developed in the 1980s and has been adapted and updated since, leading to the most recent version 6.7, which includes updates specific to California estuaries and lagoons. In general, SLAMM uses ground elevation and slope, along with an initial habitat map and a sea-level rise curve, to estimate the conversion and migration of habitat areas over large time steps (on the order of years to decades).

For this study, habitat changes under future conditions through 2100 were modeled for the No-Project case and for each of the three alternatives.

Methods

This study was performed with SLAMM version 6.7 because it is the latest iteration of the software and includes some features developed for California estuaries and perched lagoon systems (WPC 2016). Earlier versions of SLAMM were developed for sites and ecosystems on the east coast of the United States, and as such they did not capture the suite of California estuarine habitats and their relationship to perched lagoon hydrology. The latest version includes a separate set of habitat classifications and conversion functions tailored to California. SLAMM v6.7 also introduces a perched lagoon model, which allows estuarine water levels behind a coastal barrier beach to be perched above the ocean water level and to experience a muted tidal range. Lagoon perching is represented by a parameter, beta, and two physical benchmarks, mean tide level and the barrier beach crest elevation. Beta is multiplied by the difference between the barrier beach crest elevation and the mean tide level to represent the perched water level (WPC 2016).

The Coastal Resilience Ventura (CRV) project applied SLAMM v6.2 beta to the stretch of shoreline including both Ormond Beach and Mugu Lagoon to the southeast (ESA PWA 2014). The CRV project was intended as a regional-scale assessment of coastal wetland habitat vulnerability to sea-level rise, whereas the current study is intended as guidance for designing the Ormond Beach restoration. As such, the inputs to these two versions of SLAMM are similar, but

not identical. Overall, the findings from the two studies are similar, particularly in that Ormond Beach will begin to experience significant increase in inundation after two feet of sea-level rise that escalates to affect nearly all the Project Area as sea-level rise approaches five feet.

The key inputs for ground elevations, habitat extents, and sea-level rise for this study's SLAMM model are as follows:

- **Ground elevation** - Over the OBRAP project site, a digital elevation model (DEM) at 1-meter resolution was taken from the SCC California Coastal LiDAR dataset (SCC 2011). Portions of this DEM were updated based on surveying and site observations to correct for LiDAR bias in densely vegetated areas. Outside the project area, the topography from CRV was deemed sufficient, and the two datasets were spliced together to provide a single DEM covering the model domain. The elevation bands can be seen in **Figure D-1**, with the two data source regions outlined. This merged DEM was sampled at 5-meter resolution to serve as input to SLAMM.

- **Existing habitats map** - As part of the OBRAP existing conditions report, habitat surveys were performed at the site, identifying different types of beach, wetland, and upland habitats in the area based on salinity, elevation, existing plant and animal communities, and access to water (ESA 2017, Figure 2-28). The SLAMM California habitat categories for each of these regions were identified to create the SLAMM existing habitats input file. For parts of the model domain outside the surveyed project area, the habitat map from CRV was converted to California categories as indicated by the cross-walk in **Table D-1**. This merged existing habitats map is presented in **Figure D-2**.

- **Sea-level rise** - For this study, the CRV 'High SLR' sea-level rise curve was used. This curve is based on guidance from the National Research Council (NRC 2012) and the US Army Corps of Engineers (USACE 2011) and projects sea-level rise of 4.8 feet at 2100. This elevation was selected based on reviews of prior work and consideration of California guidance and Ventura County planning, as described in more detail in Appendix A.

SLAMM allows the user to define subareas with different hydrologic parameters, and two of these were defined for this model: the Ormond Lagoon Subarea and the Arnold Road Subarea (as outlined in Figure D-2). The Ormond Lagoon Subarea was defined to capture the effects of perched Ormond Lagoon water levels on habitat conversion in the west, and the Arnold Road Subarea was defied to capture the effects of rising groundwater levels on habitat conversion in the east. The rest of the domain includes developed areas, which are assumed to have unchanged land use from their current development, and the exposed beach and dune areas, which directly experience the open ocean tides and waves. The hydrology of each subarea was characterized with a local definition of mean tide level, tide range, and berm crest and beta-parameter. These parameters are summarized in **Table D-2** and described in the following paragraphs.

The part of the domain not contained in either subarea is exposed to the open ocean, so it experiences the full oceanic tidal range (5.4 ft). The mean tide level applied to the model from the open ocean was based on published tidal datums at the NOAA's Santa Barbara gage #9411340. This area has a small perching factor applied via the lagoon module to account for groundwater higher than sea level, which is described in more detail in the description of Arnold Road Subarea below.

TABLE D-1
SLAMM TRADITIONAL TO CALIFORNIA HABITAT CATEGORY CROSS-WALK

Traditional Name	Trad. Code	CA Name	CA Code
Developed Dry Land	1	Developed Dry Land	101
Undeveloped Dry Land	2	Undeveloped Dry Land	102
Swamp *	3		
Cypress Swamp *	4		
Inland-Fresh Marsh	5	Freshwater Marsh	108
Tidal-Fresh Marsh	6	Tidal Fresh Marsh	114
Trans. Salt Marsh	7	Irreg.-Flooded Marsh	115
Regularly-Flooded Marsh	8	Regularly-flooded Marsh	120
Mangrove *	9		
Estuarine Beach	10	Ocean Beach	119
Tidal Flat	11	Tidal Flat and Salt Panne	122
Ocean Beach	12	Ocean Beach	119
Ocean Flat	13	Tidal Flat and Salt Panne	122
Rocky Intertidal	14	Rocky Intertidal	121
Inland Open Water	15	Inland Open Water	106
Riverine Tidal	16	Riverine Tidal	124
Estuarine Open Water	17	Estuarine Open Water	126
Tidal Creek	18	Tidal Channel	125
Open Ocean	19	Open Ocean	127
Irreg.-Flooded Marsh	20	Irreg.-Flooded Marsh	115
Inland Shore	22	Inland Shore	107
Tidal Swamp	23	Tidal Fresh Marsh	114
Flooded Developed Dry Land	25	Flooded Developed	128
		Dunes **	111

NOTES:
* These Traditional Categories to not apply to the California Coast, so they were not mapped.
** There was not a direct cognate in the Traditional Categories. CRV used “Flooded Forest” for this category, but the two are not consistently comparable.

TABLE D-2
DOMAIN HYDRAULIC PARAMETERS

	Model Domain Outside of Subareas	Ormond Lagoon Subarea	Arnold Road Subarea
Mean Tide Level (ft NAVD88)	2.6	2.6	2.6
GT Great Diurnal Tide Range (ft)	5.4	0.3	0.3
Lagoon Beach Crest Elev. (ft, NAVD88)	9.6	9.6	9.6
Lagoon Beta Parameter (-)	0.082	0.5	0.082

The Ormond Lagoon Subarea includes parts of Area 1, the existing lagoon and surrounding beach and marsh areas; Area 2, upstream on the Ormond Lagoon Waterway; and Area 3a, the wetland area potentially connecting the two; and Area 4, the land inland of the existing railroad embankment. These are hydraulically connected via by Ormond Lagoon Waterway, the channel along the south edge of the Halaco site, and the similar ground surface elevations. Tides in the lagoon are damped, and the representative tide range of 0.3 ft was selected based on results from water level observations and the lagoon QCM (Appendix C. Based on water level gauges deployed from June-December 2017 as part of the OBRAP field work, the minimum dry season water level in Ormond Lagoon is expected to be 6.5 feet NAVD. This is about 3.5 feet higher than oceanic mean tide level, so the beach crest elevation and lagoon beta parameter were set to representative values that result in this 6.5-foot NAVD perched elevation.

The Arnold Road Subarea includes the western portion of the OBRAP project area, comprising Area 3b, between the railroad embankment and the beach; Area 5, east of the power plant; and Area 6, the salt panne area at the end of Arnold Road that is between Oxnard Drainage Ditch #3 and the dunes. These areas are lower-lying and exposed to a shallow groundwater table, as indicated by water level gauges deployed from June-December 2017. These observations indicated that the groundwater in this area varied from 3.2 to 4.3 ft NAVD, and had a representative value of 3.7 ft NAVD, slightly higher than oceanic mean tide level. This slight elevation above oceanic mean tide was likely due to the regional groundwater gradient sloping down to the ocean. The groundwater observations exhibit muted fluctuations at periods corresponding to the daily and spring-neap tidal cycle, confirming the groundwater's connectivity to the ocean. To represent this ocean-connected groundwater, the Arnold Road sub area was modeled as a lagoon with a very small beta parameter. A beta parameter of 0.082 raises the water levels by about 0.7 feet under current conditions, aligning with field observations, such as the surface water in ODD #3. For current conditions, this water level is below the surface in most of the subarea, but with sea-level rise, it will rise above the ground surface and become a groundwater-sourced lagoon. The SLAMM tide range parameter was set to be consistent with the tidal fluctuations observed in the groundwater, 0.3 ft.

Using the hydraulic conditions in each subarea, SLAMM begins with the initial-conditions habitats (input) and steps forward in time by raising sea level and calculating changes to the topography – both horizontal recession by erosion, and vertical growth by accretion. Based on the elevation and slope of each cell, SLAMM calculates the new inundation frequency for that cell. SLAMM includes a set of conversion pathways – for example, leading from Irregularly-Flooded Marsh to Regularly-Flooded Marsh, to Tidal Flat/Salt Panne, to Estuarine Open Water – and as the inundation frequency of each cell changes, it shifts toward wetter or drier habitat categories (though wetter is far more frequent as sea level rises). For cells not directly connected to the ocean, SLAMM also considers saturation, assuming groundwater rises with sea level, allowing fresher wetlands to move into upland areas, even if they are not directly inundated.

SLAMM was developed to primarily to examine the effect of changing water levels in estuarine wetlands, and as such, it does not consider coastal processes affecting the beach and dunes

themselves. Sea-level rise will cause landward transgression of water levels and waves, which, in turn, will cause erosion and shift the shoreline itself further inland. These processes were addressed outside SLAMM, and then applied to the SLAMM results. It was assumed that the beach could freely transgress inland and upwards according to the Brunn rule, while the dunes would erode permanently as sea-level rise outpaces aeolian (wind-driven) dune formation. This methodology isdescribed in more detail in Appendix B. The result was a new beach berm location, representingthe inland extent of SLAMM's open ocean habitat category at each time horizon, and a new backbeach extending 100 feet behind that line. These two habitat areas were overlain on the SLAMMhabitat results, representing the inland transgression of the beach overtaking other potentialhabitats with rising sea level.

Results

1.1 No-Project

The SLAMM results for the No-Project case are presented in **Figure D-3**, **Figure D-4**, and **Figure D-5** at three future time horizons.

At 2060 (Figure D-3), projected sea-level rise is about two feet (2.1 ft). In the western side of the project area, water is still generally confined to existing waterways, and the beach is beginning to pinch off the east end of the lagoon, but Ormond Lagoon is generally still intact. In Area 6, on the east end of the project area, much of the salt panne at the end of Arnold Road has converted to open water, with the higher area around that converting from marsh to salt panne and the existing marsh shrinking slightly. Across the site, more saline and wetter influence is projected to move upslope, potentially shifting nearly all the uplands towards brackish wetlands. This is consistent with the project area's existing vegetation distribution (ESA 2017, Figure 2-28), which includes saline wetlands at elevations up to about 10 ft NAVD. With two feet of sea-level rise, the band of potential saline influence is likely to also shift upwards by two feet, to 12 ft NAVD. Nearly all the project area's ground surface falls below 12 ft NAVD (Figure D-1).

At 2080 (Figure D-4), projected sea-level rise is about three feet (3.4 ft). In the west, the marsh in Area 3a has mostly converted to open water, and is anticipated to have perched water levels that function similar to and somewhat connected to Ormond Lagoon. The surrounding areas have converted to a single class containing both unvegetated salt panne and tidal flat. These habitats are primarily differentiated by evaporation and hydraulic connectivity, process for which SLAMM does not account. Since SLAMM habitats are based on only elevation and tidal range, the model does not differentiate between tidal flat and salt panne and instead groups them together into a single category. While the figures in this appendix use more habitat distinctions and refer to those areas as "salt panne," they are generalized as "unvegetated flats" when the habitat areas are summarized into fewer categories for the main report. The beach has transgressed far enough inland to overrun the east side of the lagoon. The low-lying portions Area 2 near Ormond Lagoon Waterway have also converted to salt marsh and begun to show patches of permanent open water. Open water, salt panne, and salt marsh have begun to migrate into Area

4 from the west, and the lower area closer to the ocean is permanently ponded. The eastward extent of this open water, which is attributed to perched lagoon conditions, may be limited by the available freshwater volume and not spread out quite as far as shown, except during wet season runoff evens. In the east, the existing salt panne in Area 6 has been squeezed to the margins of a growing pool of open-water there, which likely acts as a lagoon supplied by a combination of groundwater, channels from Mugu Lagoon, and increasingly frequent wave overwash.

At 2100 (Figure D-5), projected sea-level rise is nearly 5 feet (4.8 ft). By this time, most of the project area is permanently inundated by open water. Groundwater's connectivity to the ocean provides an effectively unlimited water supply to support groundwater inundating the project area in the lower areas, including Areas 5 and 6, and progressing as far west as Area 3b. However, in the western portion of the project area, while the site is expected to be very wet by end-of-century, this figure may overstate the actual inundation. SLAMM does not account for limited water supply, whereas in reality as the western area inundates from Ormond Lagoon and its waterways, more volume would be required to raise the water surface as the water spreads over a wide area. SLAMM assumes that there is enough water to fill any potential space below the inundating water level, thereby likely overestimating inundation in Areas 2, 3a, and 4. Although the western inundation is likely overestimated for 4.8 ft of sea-level rise, higher amounts of sea-level rise, which are projected as possibilities for the end of the 21st century or into the 22nd century, would eventually result in conditions similar to inundation extent in Figure D-5 as the continued increase in groundwater augments the inundation from the watershed and lagoon perching.

1.2 Proposed Restoration Alternatives

SLAMM was also used to evaluate the habitat evolution of the proposed restoration alternatives. For each alternative, described in Section 6 of the preliminary restoration plan, the ground elevations in the DEM were modified to represent the proposed grading and the initial habitat map was revised to reflect the target habitats. Then SLAMM was run for each alternative using all the same configuration as for the No Project scenario, except for the altered DEMs and habitat maps. Unless otherwise stated, the alternatives' habitat evolution in Areas 6-9 are roughly similar to the No Project scenario. Differences from the No Project scenario and between the alternatives are summarized in the sections below.

The alternatives propose a range of management for the dunes, such as vegetation management, grading swales, and dune building. These types of management are not resolved by the approach for coastal erosion (Appendix B) that was applied to the SLAMM results, so projections for beach and dune erosion are mapped the same in all alternatives as for the No-Project scenario.

1.2.1 Alternative 1

Since Alternative 1 proposes mostly enhancements to existing habitats and relatively mild grading, its initial conditions (**Figure D-6**) are very similar to existing conditions in the No

Project scenario. Because of the similarity to No Project's initial conditions, the resulting habitat evolution is also similar to the No Project scenario.

At 2060 (**Figure D-7**), with two feet of sea-level rise, the most prominent change is open water in Area 6.

At 2080 (**Figure D-8**), with three feet of sea-level rise, inundation spreads to a substantial fraction of the project area, and the reduced connectivity to ODD #3 results in larger open water and unvegetated in the western portion of Area 5.

At 2100 (**Figure D-9**), the majority of the site is inundated.

1.2.2 Alternative 2

The proposed grading in Alternative 2, notably the re-alignment of Ormond Lagoon Waterway in Areas 2 and 3a, and the wetland swales in Area 4, modify this alternative's the initial habitat conditions (**Figure D-10**).

At 2060 (**Figure D-11**), with two feet of sea-level rise, the southern-most wetland swale in Area 4 become permanently inundated. Because of the better connectivity via the Waterway's re-alignment, Area 3a has more vegetated wetlands rather than the unvegetated flats predicted for this area for No Project and Alternative 1. The lower portion of the re-aligned channel also provides connectivity between the Waterway and the Lagoon across a wider swath of Area 1.

At 2080 (**Figure D-12**), with three feet of sea-level rise, inundation from the Ormond Lagoon Waterway spills out across Area 3a, re-creating lagoonal conditions which would be displaced at the original Ormond Lagoon by beach transgression. In Area 4, the landward transgression of inundation progresses, deepening the water in the southern swale and activating the next swale north with permanent inundation. In Area 5, the proposed embankment will slow the encroachment of inundation in the northeast part of the site as compared to the No Project scenario.

At 2100 (**Figure D-13**), with almost five feet of sea-level rise, the majority of the site is inundated, with slight variation in the inundation's distribution due to this alternative's proposed grading.

1.2.3 Alternative 3

Alternative 3 proposes more extensive grading to re-align the Ormond Lagoon Waterway, excavate a lagoon at its downstream end, and create wetland depressions in Area 4 and Area 5. These proposed actions result in the initial habitat conditions shown in **Figure D-14**.

At 2060 (**Figure D-15**), with two feet of sea-level rise, all of major grading areas become inundated. Conditions are similar to Alternative 2, except the more extensive excavation increases the inundated extents.

At 2080 (**Figure D-16**), with three feet of sea-level rise, the rising inundation spills out from the excavated areas onto adjacent properties. The combination of the grading and increased connectivity yields more contiguous wetlands across Area 3a and Area 4. Inundation in Area 5 is largest for this alternative.

At 2100 (**Figure D-17**), with almost five feet of sea-level rise, the majority of the site is inundated, with slight variation in the inundation's distribution due to this alternative's proposed grading.

Discussion

SLAMM's predictions of habitat evolution are based on simplifying assumptions and only consider ground surface elevations, sea-level rise, representative water levels, and proximity to preceding habitats. Habitat evolution depends on a broader range of physical processes, including watershed hydrology, evapotranspiration, ground surface slope, groundwater, soils, and salinity. There is not enough available data to fully characterize the project area and watershed conditions that determine these processes. Even if sufficient existing data were available, full deterministic modeling of the processes over nearly a century is not feasible. In spite of these limitations, SLAMM's general trends in projected habitat evolution provide an indication of future site condition for the designated sea-level rise thresholds, even if the thresholds do not arrive exactly at the assumed decade.

Ground survey transects suggest LiDAR elevations may be high by a half a foot to a foot (e.g., southern part of Area 3a, central portion of Area 6) due to the LiDAR observing the vegetation canopy rather than the ground surface. In these areas, inundation would occur sooner than predicted by SLAMM.

The mapped open water areas are based on minimum observed elevations within the project site in 2017. During extended droughts, evaporation and limited watershed could lower these water levels. However, with anticipated wet season precipitation, inflow from the watershed, increased groundwater, and wave overwash, higher water levels and greater extent of inundated area are likely for portions of non-drought years.

Since the focus of this study is restoration, SLAMM was configured so as to not map inundation in the developed areas west and north of Areas 1, 2, 3a, and 4, as well as the power plant. These developed areas are vulnerable to coastal flood and erosion hazards, as evaluated in ESA PWA (2013) and in the County's hazard assessment. As sea-level rise exceeds about two feet, coastal flooding hazard begins to impinge upon developed areas at the southern end of Perkins Road. With five feet of sea-level rise, coastal flood risk extends further northward, extending across McWane Boulevard. As flood management planning for these areas progresses, it can be coordinated with the restoration project.

As the site, its environs, and climate evolve, adaptive management should be supplemented with hydrologic, hydraulic, and geomorphic modeling informed with additional data.

References

State Coastal Conservancy (SCC). 2011. California Coastal Conservancy Coastal Lidar Project. Available: https://coast.noaa.gov/dataviewer.

ESA PWA. 2014. Coastal Resilience Ventura: Technical Report for Sea Level Affecting Marshes Model (SLAMM). Prepared for The Nature Conservancy.

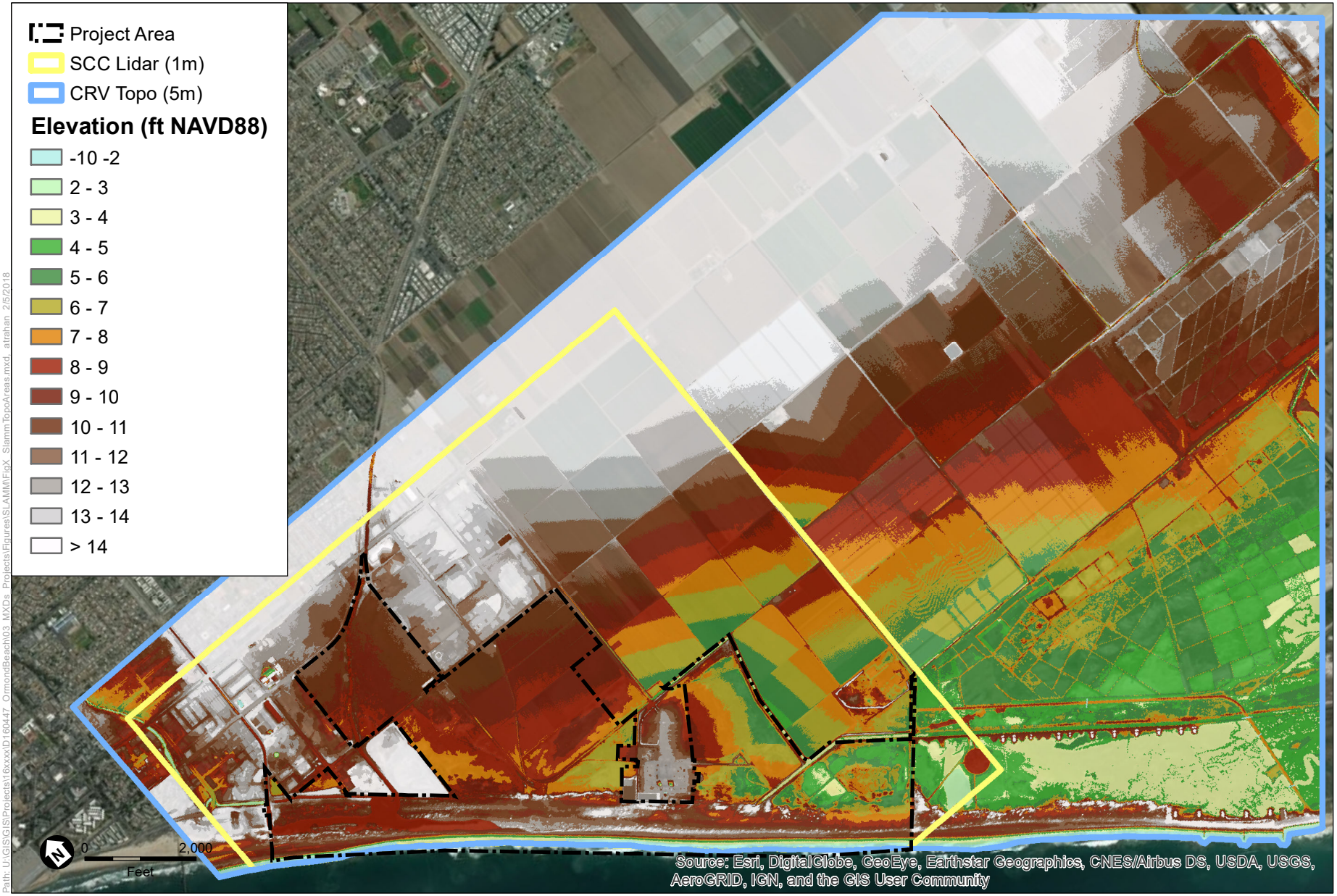
National Research Council (NRC). 2012. Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future. National Academy Press: Washington, D.C.

U.S. Army Corps of Engineers (USACE). 2011. Sea-Level Change Considerations for Civil Works Programs. Engineering Circular 1165-2-212.

Warren Pinnacle Consulting, Inc. (WPC). 2016. SLAMM 6.7 Technical Documentation Sea Level Affecting Marshes Model, Version 6.7 beta.

Figures

Figure D-1. Site Topography and Data Sources
Figure D-2. No-Project Existing Habitats and Subarea Boundaries
Figure D-3. No-Project, 2060, +2.1 ft SLR
Figure D-4. No-Project, 2080, +3.4 ft SLR
Figure D-5. No-Project, 2100, +4.8 ft SLR
Figure D-6. Alternative 1, Initial Conditions
Figure D-7. Alternative 1, 2060, +2.1 ft SLR
Figure D-8. Alternative 1, 2080, +3.4 ft SLR
Figure D-9. Alternative 1, 2100, +4.8 ft SLR
Figure D-10. Alternative 2, Initial Conditions
Figure D-11. Alternative 2, 2060, +2.1 ft SLR
Figure D-12. Alternative 2, 2080, +3.4 ft SLR
Figure D-13. Alternative 2, 2100, +4.8 ft SLR
Figure D-14. Alternative 3, Initial Conditions
Figure D-15. Alternative 3, 2060, +2.1 ft SLR
Figure D-16. Alternative 3, 2080, +3.4 ft SLR
Figure D-17. Alternative 3, 2100, +4.8 ft SLR



SOURCE: SCC 2011, ESA PWA 2014, ESA 2017

Ormond Beach Restoration and Public Access Plan

Figure D-1

Site Topography and Data Sources

ESA

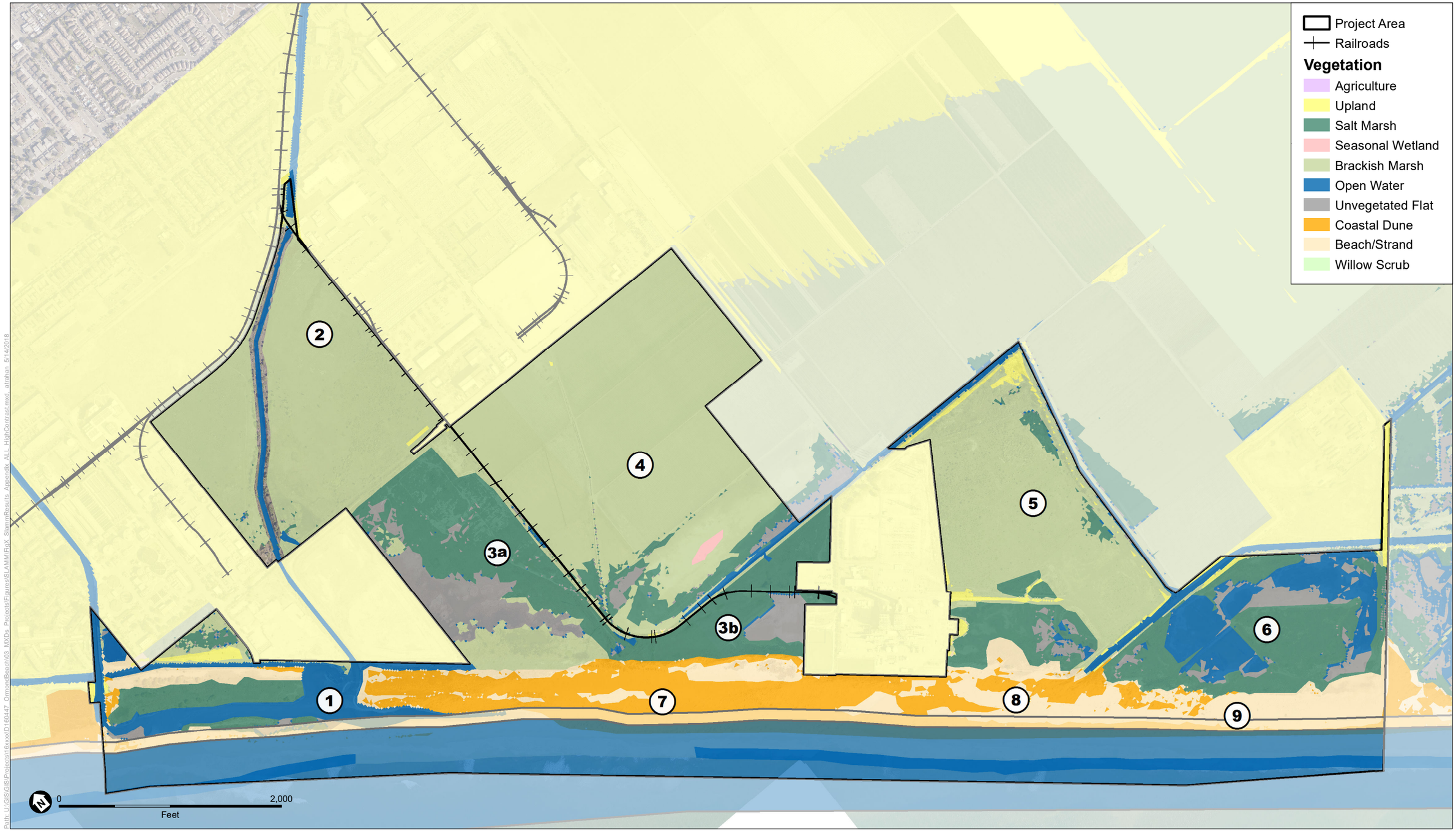
This page intentionally left blank

SOURCE: ESA (2017), CA Coastal Conservancy LiDAR (2011)

Ormond Beach Restoration and Public Access Project

Figure D-2
SLAMM Results wtih Beach Transgression
Existing Conditions, Current-Day

ESA



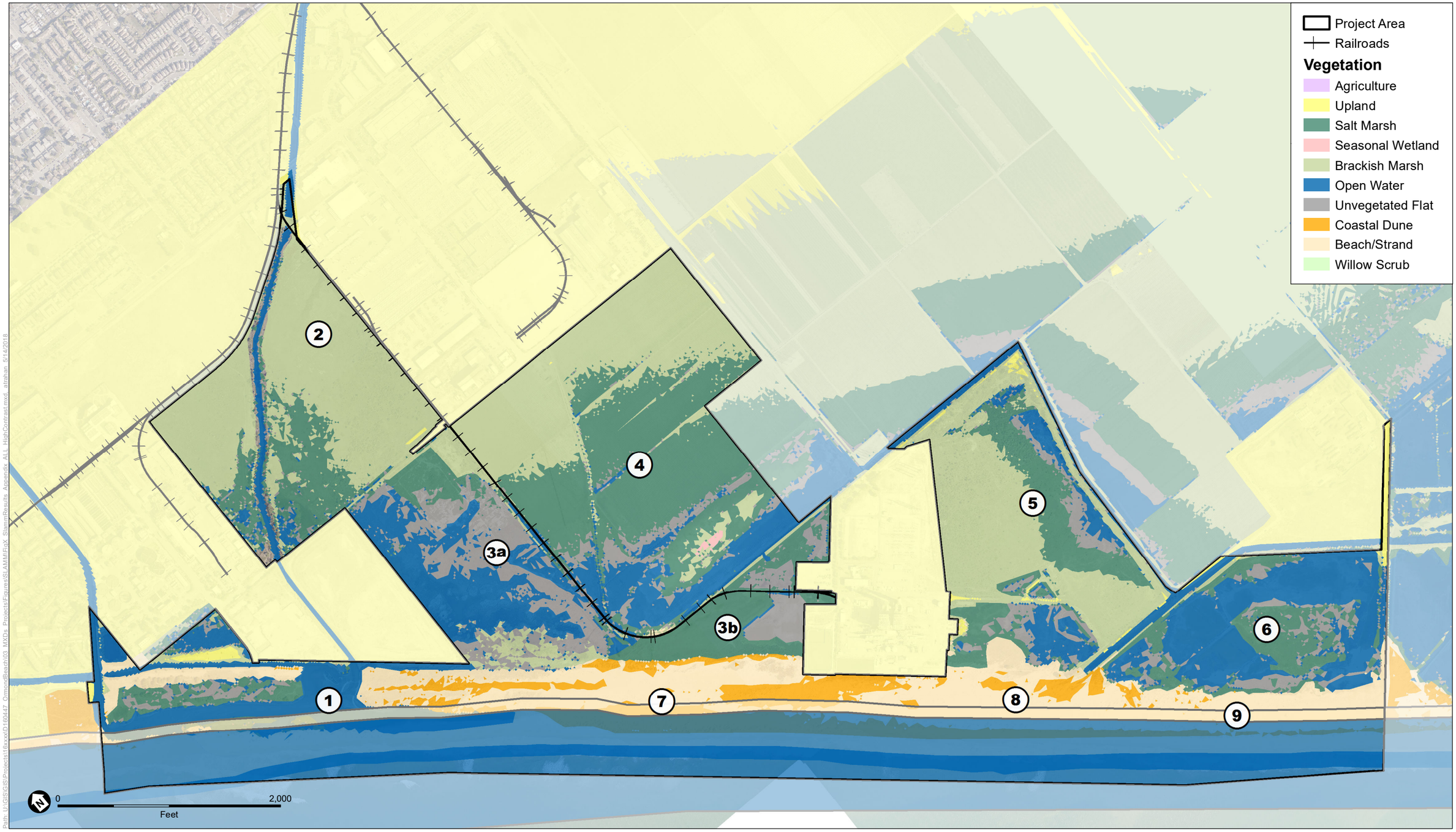
SOURCE: ESA (2017), CA Coastal Conservancy LiDAR (2011)

Ormond Beach Restoration and Public Access Project

Figure D-3
SLAMM Results wtih Beach Transgression
Existing Conditions, 2060 +2.1 ft SLR

ESA

Path: U:\GIS\GIS\Projects\16xxxx\D160047_OrmondBeach\03_MXDs_Projects\Figures\SLAMM\FigX_SlammResults_Appendix_ALL_HighContrast.mxd, atrahan, 5/14/2018

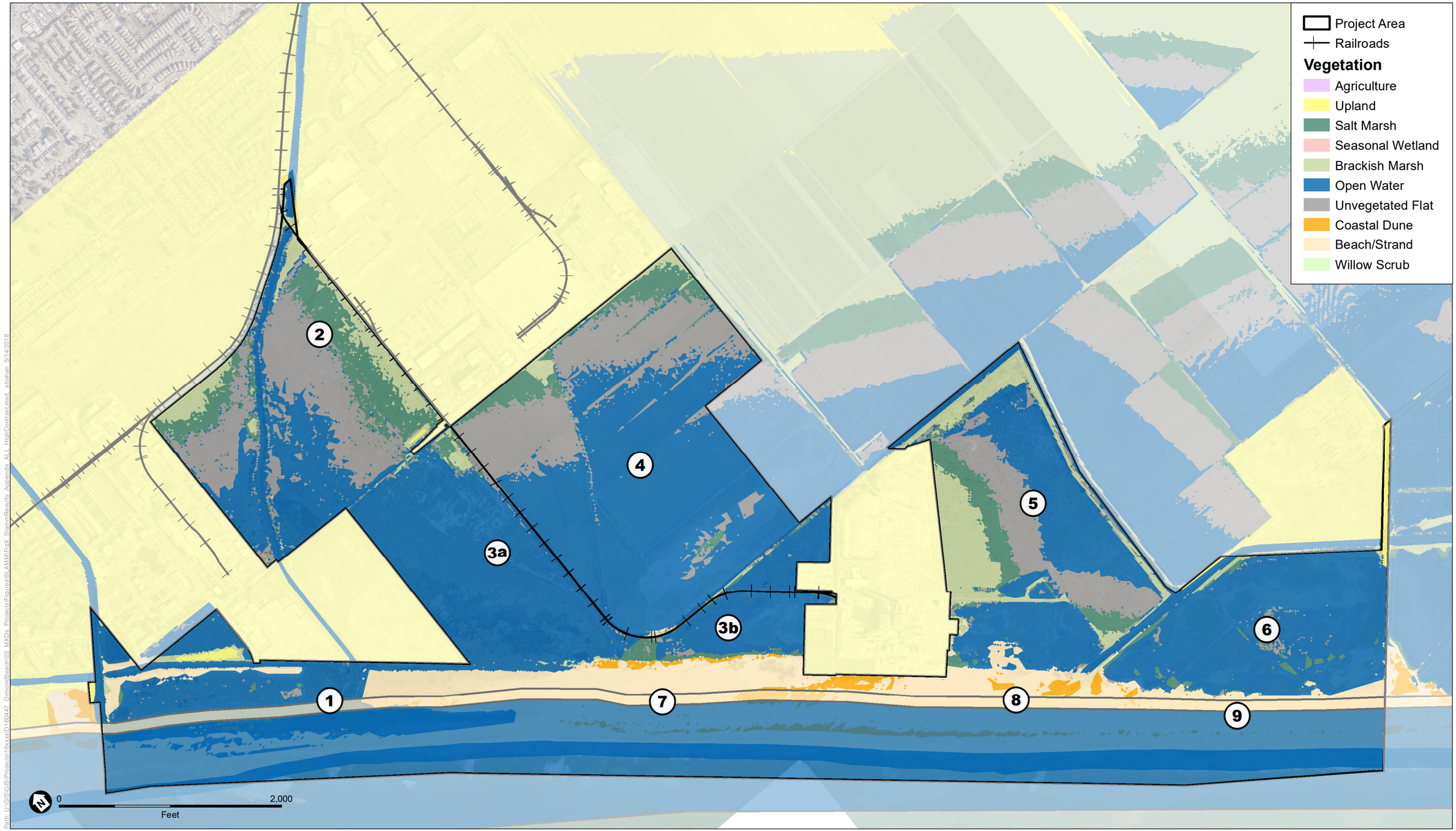


SOURCE: ESA (2017), CA Coastal Conservancy LiDAR (2011)

Ormond Beach Restoration and Public Access Project

Figure D-4
SLAMM Results wtih Beach Transgression
Existing Conditions, 2080 +3.4 ft SLR

ESA



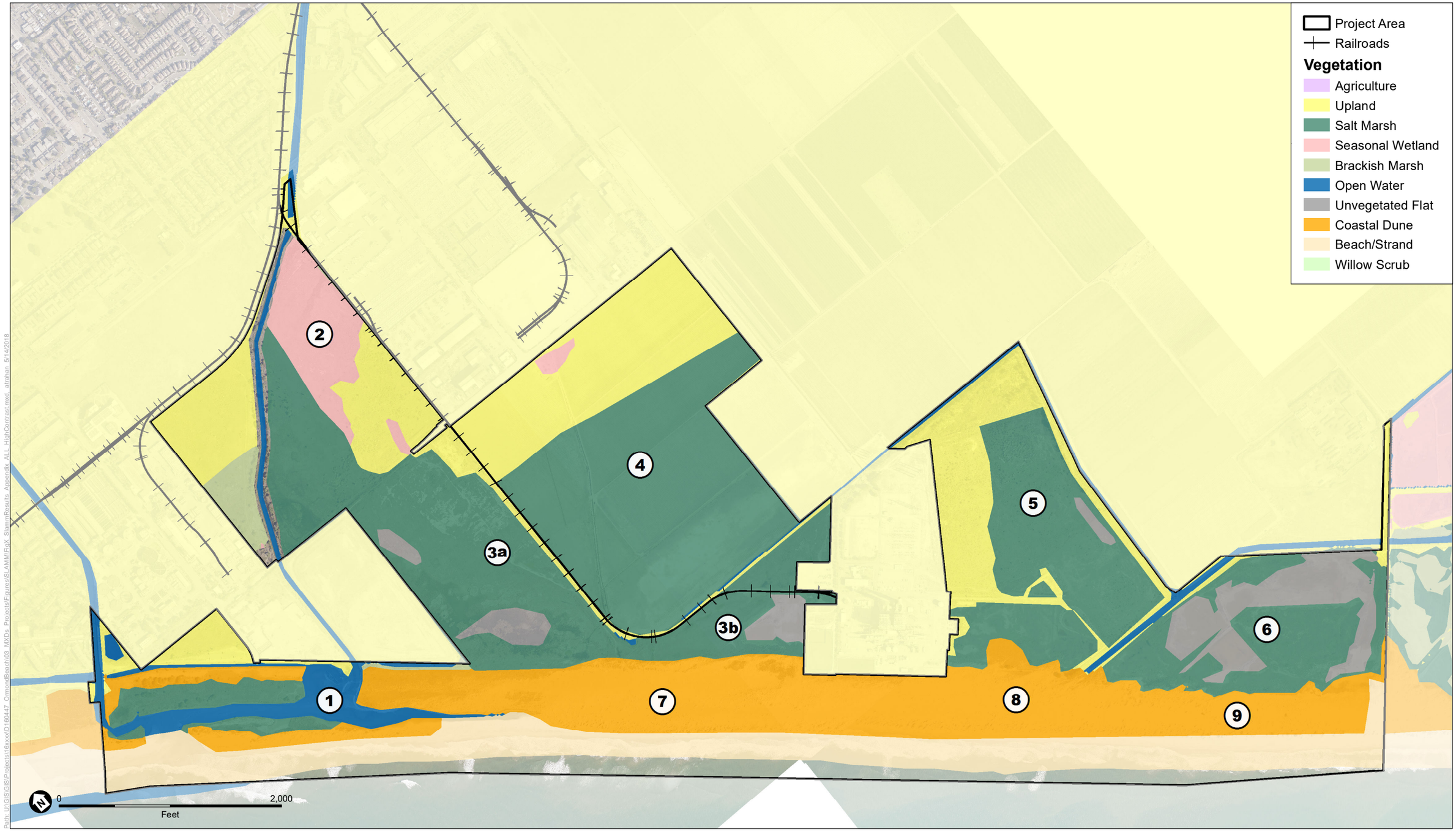
SOURCE: ESA (2017), CA Coastal Conservancy LiDAR (2011)

Ormond Beach Restoration and Public Access Project

Figure D-5
SLAMM Results wtih Beach Transgression
Existing Conditions, 2100 +4.8 ft SLR

ESA

Path: U:\GIS\GIS\Projects\16xxxx\D160447_OrmondBeach\03_MXDs_Projects\Figures\SLAMM\FigX_SlammResults_Appendix_ALL_HighContrast.mxd, atrahan, 5/14/2018

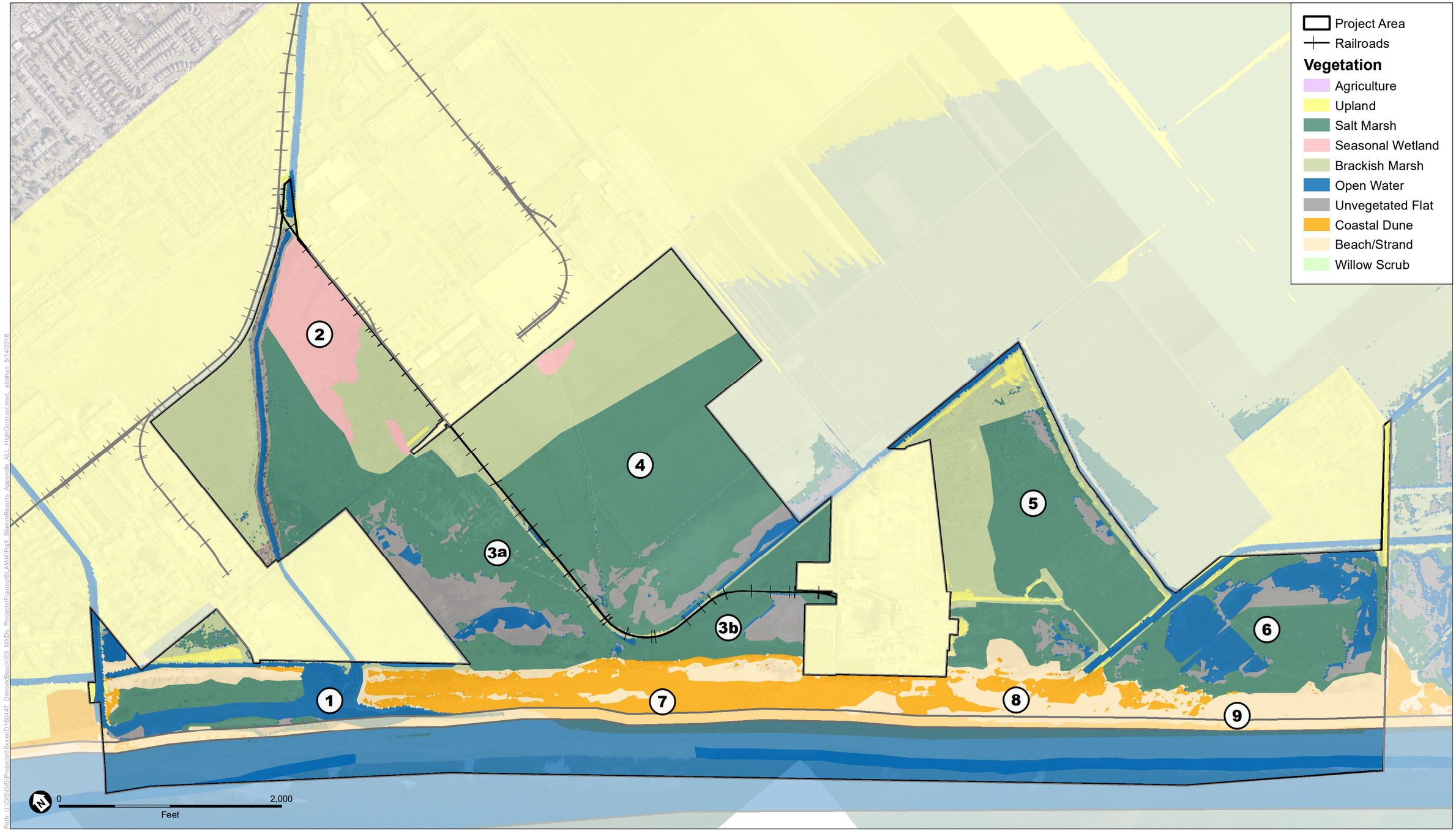


SOURCE: ESA (2017), CA Coastal Conservancy LiDAR (2011)

Ormond Beach Restoration and Public Access Project

Figure D-6
SLAMM Results wtih Beach Transgression
Alternative 1, Current-Day

ESA



SOURCE: ESA (2017), CA Coastal Conservancy LiDAR (2011)

Ormond Beach Restoration and Public Access Project

Figure D-7
SLAMM Results wtih Beach Transgression
Alternative 1, 2060 +2.1 ft SLR

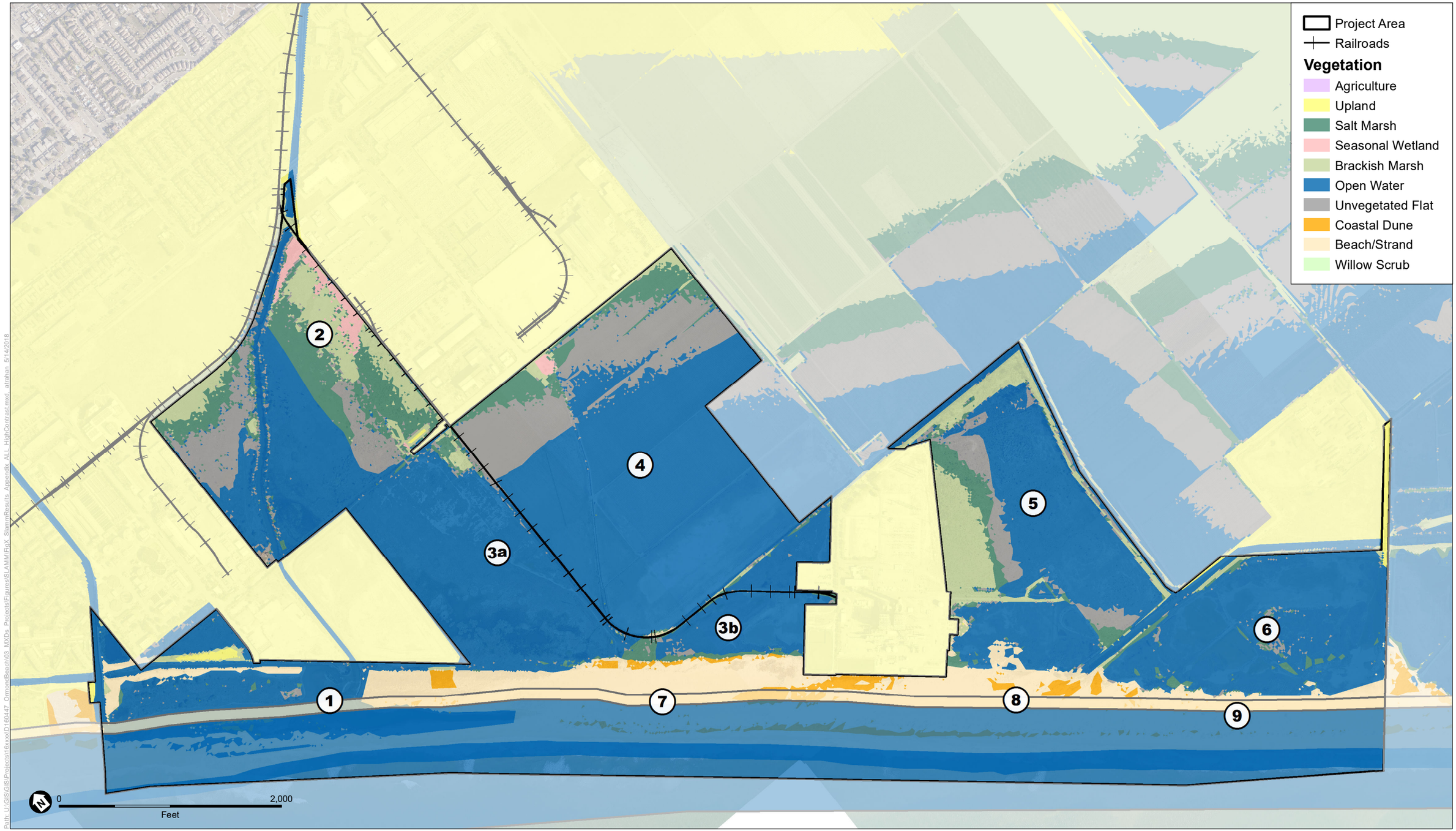
ESA

SOURCE: ESA (2017), CA Coastal Conservancy LiDAR (2011)

Ormond Beach Restoration and Public Access Project

Figure D-8
SLAMM Results wtih Beach Transgression
Alternative 1, 2080 +3.4 ft SLR

ESA



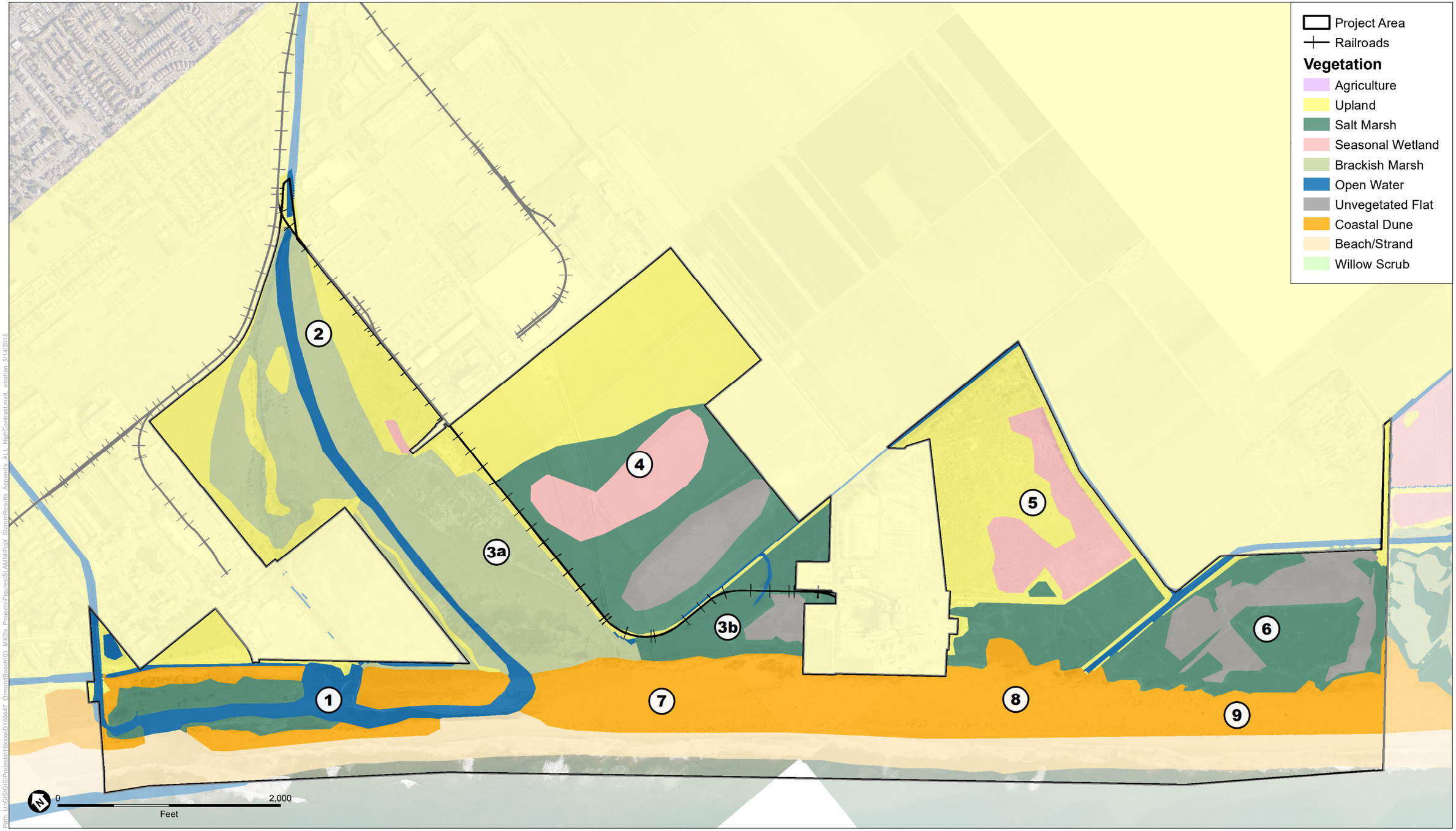
SOURCE: ESA (2017), CA Coastal Conservancy LiDAR (2011)

Ormond Beach Restoration and Public Access Project

Figure D-9
SLAMM Results wtih Beach Transgression
Alternative 1, 2100 +4.8 ft SLR

ESA

Path: U:\GIS\GIS\Projects\16xxxx\D160447_OrmondBeach\03_MXDs_Projects\Figures\SLAMM\FigX_SlammResults_Appendix_ALL_HighContrast.mxd, atrahan 5/14/2018



SOURCE: ESA (2017), CA Coastal Conservancy LiDAR (2011)

Ormond Beach Restoration and Public Access Project

Figure D-10
SLAMM Results wtih Beach Transgression
Alternative 2, Current-Day

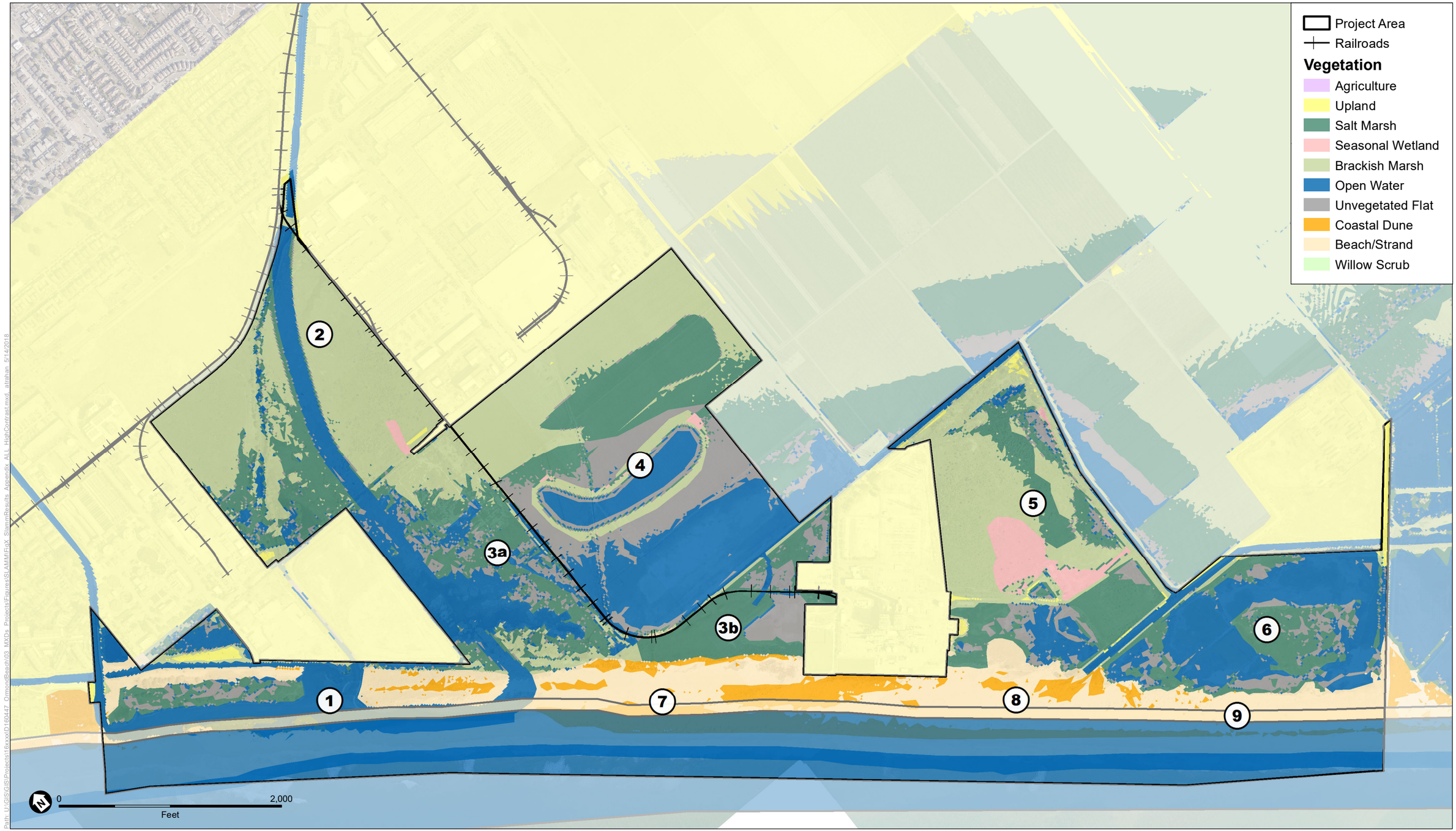
ESA

SOURCE: ESA (2017), CA Coastal Conservancy LiDAR (2011)

Ormond Beach Restoration and Public Access Project

Figure D-11
SLAMM Results wtih Beach Transgression
Alternative 2, 2060 +2.1 ft SLR

ESA

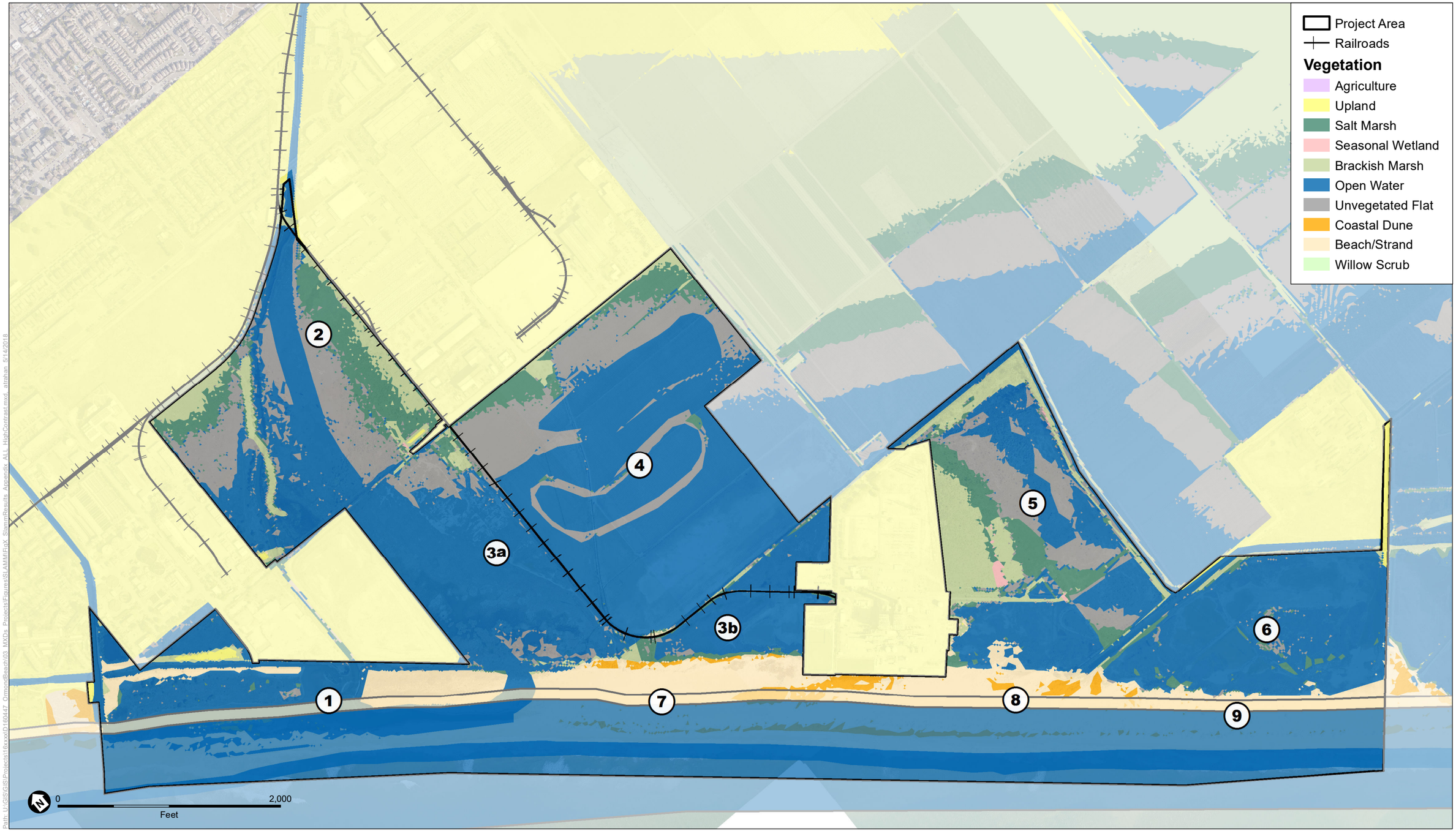


SOURCE: ESA (2017), CA Coastal Conservancy LiDAR (2011)

Ormond Beach Restoration and Public Access Project

Figure D-12
SLAMM Results wtih Beach Transgression
Alternative 2, 2080 +3.4 ft SLR

ESA



SOURCE: ESA (2017), CA Coastal Conservancy LiDAR (2011)

Ormond Beach Restoration and Public Access Project

Figure D-13
SLAMM Results wtih Beach Transgression
Alternative 2, 2100 +4.8 ft SLR

ESA

Path: U:\GIS\GIS\Projects\16xxxx\D160447_OrmondBeach\03_MXDs_Projects\Figures\SLAMM\FigX_SlammResults_Appendix_ALL_HighContrast.mxd, atrahan, 5/14/2018

SOURCE: ESA (2017), CA Coastal Conservancy LiDAR (2011)

Ormond Beach Restoration and Public Access Project

Figure D-14
SLAMM Results wtih Beach Transgression
Alternative 3, Current-Day

ESA

SOURCE: ESA (2017), CA Coastal Conservancy LiDAR (2011)

Ormond Beach Restoration and Public Access Project

Figure D-15
SLAMM Results wtih Beach Transgression
Alternative 3, 2060 +2.1 ft SLR

ESA

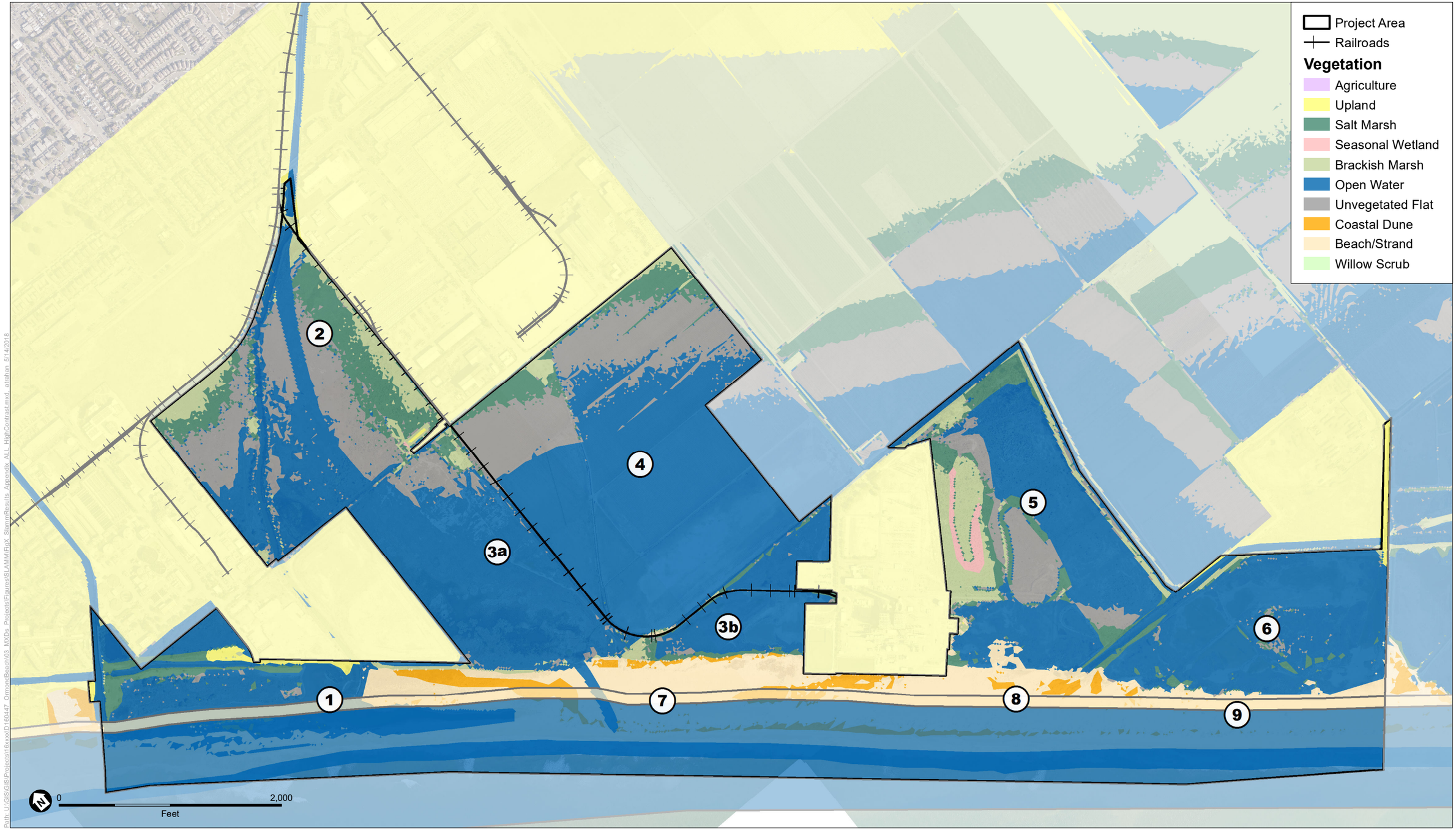
SOURCE: ESA (2017), CA Coastal Conservancy LiDAR (2011)

Ormond Beach Restoration and Public Access Project

Figure D-16
SLAMM Results wtih Beach Transgression
Alternative 3, 2080 +3.4 ft SLR

ESA

Path: U:\GIS\GIS\Projects\16xxxx\D160447_OrmondBeach\03_MXDs_Projects\Figures\SLAMM\FigX_SlammResults_Appendix_ALL_HighContrast.mxd, atrahan, 5/14/2018



SOURCE: ESA (2017), CA Coastal Conservancy LiDAR (2011)

Ormond Beach Restoration and Public Access Project

Figure D-17
SLAMM Results wtih Beach Transgression
Alternative 3, 2100 +4.8 ft SLR

ESA