

# NORTH CAMPUS OPEN SPACE RESTORATION PROJECT DETAILED PROJECT PROGRAM

Prepared for  
The University of California at Santa Barbara  
Office of Budget and Planning

25 September 2015  
Revised 22 December 2015





**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.

## Contents

Acknowledgements.....	1
EXECUTIVE SUMMARY .....	4
Document purpose .....	4
Site .....	4
Project overview .....	4
Project process.....	5
Project summary.....	5
Project program .....	6
Additional information.....	6
PART I INTRODUCTION.....	7
1.1 Report Organization.....	7
1.2 Background .....	8
1.3 Site Description .....	8
1.4 Process .....	14
1.5 Restoration Goals and Objectives.....	14
1.6 Historic, Existing, and Future Conditions .....	14
1.6.1 Site History .....	15
1.6.2 Current Site Conditions.....	17
1.6.3 Future (No Project) Conditions with Sea Level Rise.....	28
1.7 Opportunities and Constraints.....	30
1.7.1 Estuarine Hydrology.....	30
1.7.2 Stream Inflows .....	32
1.7.3 Sea Level Rise Effects .....	32
1.7.4 Groundwater Levels.....	32
1.7.5 Soils .....	33
1.7.6 Elevation and Coverage Targets for Establishment of Salt Marsh Vegetation .....	36
1.7.7 Western Snowy Plover Nesting Habitat.....	39
1.7.8 Tidewater Goby Habitat.....	39
1.7.9 Existing Native Habitats .....	39
1.7.10 Utilities and Other Built Assets .....	41

1.8	Data Gaps and Recommendations for Stage 2 Studies.....	41
1.9	Development of Conceptual Alternatives.....	42
1.9.1	Description of Conceptual Alternatives .....	43
1.9	Evaluation of Alternatives and Selection of the Project .....	51
PART II PROJECT PROGRAM.....		53
2.1	Project Concept.....	53
2.2	Grading/Topography.....	54
2.3	Hydrology.....	55
2.4	Habitats .....	63
2.4.1	Species Benefits .....	65
2.5	Public Access .....	71
PART III IMPLEMENTATION.....		74
3.1	Pre-construction Collection and Propagation of Plant Materials .....	74
3.2	Construction.....	74
3.2.1	Mobilization .....	74
3.2.2	Site Preparation .....	75
3.2.3	Bulk Earthwork and Fine Grading .....	76
3.2.4	Stream Stabilization and Scour Protection .....	77
3.2.5	Stormwater Drainage Improvements .....	78
3.2.6	Public Access .....	78
3.2.7	Revegetation .....	78
3.3	Maintenance and Monitoring.....	82
3.3.1	Maintenance .....	82
3.3.2	Monitoring and Adaptive Management .....	83
3.4	PROJECT SCHEDULE AND PHASING.....	84
3.4.1	Project Stages.....	84
3.4.2	Construction.....	86
3.4.3	Post-Construction Monitoring .....	91
3.5	Engineer’s Estimate of Construction Costs .....	92
REFERENCES.....		93



## Figures

Figure 1. Project Vicinity .....	9
Figure 2. Regional Location .....	10
Figure 3. Devereux Slough Watershed .....	11
Figure 4. Project Site Map .....	12
Figure 5. Sill at Venoco Road Crossing .....	13
Figure 6. Devereux Slough Historic Extent .....	16
Figure 7. Soil Conductivity versus Depth .....	20
Figure 8. Frequency Distribution of Soil Samples by % Clay .....	21
Figure 9. Distribution of Native Habitats within the Project Site .....	24
Figure 10. Site Infrastructure .....	27
Figure 11. Simulated Time Series of Slough Water Level without the Project .....	29
Figure 12. Time Series of Modeled Slough Water Levels versus Observed .....	31
Figure 13. Groundwater Elevations on the Project Site .....	34
Figure 14. Elevation Distribution of Salt Marsh Vegetation in the Lower Slough .....	38
Figure 15. Snowy Plover Nests in Devereux Slough 2009 – 2014 .....	40
Figure 16. Alternative 1 Max Grading .....	44
Figure 17. Alternative 2 Reduced Grading .....	47
Figure 18. Phelps Creek Connection .....	48
Figure 19. Project Grading Plan .....	56
Figure 20. Monthly Occurrence Frequency of Slough Water Levels .....	58
Figure 21. Slough Water Level Frequencies (2000-2014) .....	60
Figure 22. Slough Water Level Cumulative Frequencies (2000- 2014) .....	61
Figure 23. Modeled Slough Water Level vs Measured Surface Salinity .....	62
Figure 24. Project Habitat Plan .....	64
Figure 25. Public Access Plan .....	72
Figure 26. Trail Types .....	73
Figure 27. Project Schedule .....	88

## Tables

Table 1. Distribution of Native Habitats on the Project Site.....	23
Table 2. Vegetation by Percent Cover and Elevation in Lower Devereux Slough.....	37
Table 3. Alternative 1 Max Grading Habitats.....	45
Table 4. Alternative 2 Reduced Grading Habitats.....	49
Table 5. Habitats Comparison between Alternatives 1 and 2 .....	50
Table 6. Project Habitat: Existing, Impacted, Created and Preserved .....	63
Table 7. Federally Listed Species that May Benefit from the Project.....	65
Table 8. CDFW Endangered and Species of Special Concern that may Benefit from the Project .....	67
Table 9. CNPS Listed Plant Species and Plant Species of Local Concern that may Benefit from the Project .....	69
Table 10. Preliminary Revegetation Species List .....	79
Table 11. Preliminary Estimate of Construction Costs for the NCOS Restoration Project, September, 2015 .....	92

## APPENDICES

A - Historic Conditions
B - Existing Conditions
C - Goals, Objectives and Design Criteria
D - Alternatives Evaluation
E – Quantified Conceptual Model (QCM) Report
F - TPL Public Access Survey Report
G - Engineer’s Estimate of Construction Costs
H - Project Meeting Summaries
I - Project Library Index

## Acknowledgements

---

We wish to thank and recognize the contributions of the following individuals in the development of this Detailed Project Program.

### **North Campus Open Space Project Committee**

**John Melack, Chair**, Professor, Bren School of Environmental Science & Management; Professor, Ecology, Evolution & Marine Biology

**Derek Booth**, Adjunct Professor, Bren School of Environmental Science & Management

**Carla D'Antonio**, Chair and Schuyler Professor, Environmental Studies; Professor, Ecology, Evolution & Marine Biology

**Frank Davis**, Professor, Bren School of Environmental Science & Management; Director, National Center for Ecological Analysis & Synthesis

**Jeff Hoelle**, Assistant Professor, Anthropology

**Juan Lupi**, Assistant Professor, Spanish and Portuguese

**Cris Sandoval**, Director, Coal Oil Point Reserve

**Joshua Schimel**, Professor, Environmental Studies; Professor, Ecology, Evolution & Marine Biology

**Alexander Simms**, Associate Professor, Earth Science

**Lisa Stratton**, Director, Ecosystem Management, Cheadle Center for Biodiversity & Ecological Restoration

**Jennifer Thorsch**, Katherine Esau Director, Cheadle Center for Biodiversity & Ecological Restoration

**Kevin Koo**, Associated Students representative

**Rachel O'Connor**, Graduate Student Association representative

#### *Staff Support:*

**Chuck Haines**, Director, Capital Development, Office of Budget and Planning

**Marc Fisher**, Vice Chancellor, Administrative Services

**Shari Hammond**, Principal Planner, Office of Campus Planning and Design

**Michael McGrogan**, Analyst, Office of Budget & Planning

**Ed Schmittgen**, Associate Director, Design & Construction Services

**Dennis Whelan**, Associate Campus Architect, Campus Planning and Design

## **North Campus Open Space Science Advisory Board**

**John Melack, Chair**, Professor, Bren School of Environmental Science & Management; Professor, Ecology, Evolution & Marine Biology

**Derek Booth**, Adjunct Professor, Bren School of Environmental Science & Management

**Carla D’Antonio**, Chair and Schuyler Professor of Environmental Studies; Professor, Ecology, Evolution & Marine Biology

**Frank Davis**, Professor, Bren School of Environmental Science & Management; Director, National Center for Ecological Analysis & Synthesis

**Joshua Schimel**, Professor, Environmental Studies; Professor, Ecology, Evolution & Marine Biology

**Alexander Simms**, Associate Professor, Earth Science

*Ex officio:*

**Marc Fisher**, Vice Chancellor, Administrative Services

**Chuck Haines**, Director, Capital Development, Office of Budget and Planning

**John Longbrake**, Associate Vice Chancellor, Public Affairs & Communications

**Lisa Stratton**, Director, Ecosystem Management, Cheadle Center for Biodiversity & Ecological Restoration

ESA Team members who have contributed to preparation of this DPP.

**Bob Battalio, PE, ESA**

**Dane Behrens, PhD, PE, ESA**

**Stephanie Bishop, ESA**

**Melissa Carter, PE, ESA**

**Eddie Divita, PE, ESA**

**Eve Pier Kieli, ESA**

**Scott Stoller, PE, ESA**

**Steve Wang, PE, Stantec**

**Craig Steward, PE, Stantec**

**Doug Dunham, PE, GE, Earth Systems, Inc**

**Steve Campbell, RG, CEG, CH, Campbell-Geo**

**Kimberly True, MLA, True Nature Design**

**Jon True, True Nature Design**

**Matt James, Independent Consultant**

**David Revell, PhD, Revell Coastal**



## EXECUTIVE SUMMARY

### Document purpose

This document is the Detailed Project Program (DPP) for implementation of the North Campus Open Space (NCOS) Restoration Project by the University of California, Santa Barbara (UCSB). The NCOS is located east of Ellwood Mesa, west of Storke Road and south of the City of Goleta (34°25'12" N, 119°52'34" W). Coal Oil Point Reserve (COPR) lies adjacent to the site to its immediate south.

### Site

The North Campus Open Space (NCOS), (136.4 acres) which includes properties previously called 'South Parcel' (68.9 acres), 'Whittier parcel' (3.7 acres) and 'Ocean Meadows Golf Course' (63.8 acres), is part of the 652-acre Ellwood-Devereux Joint Management Area, created in 2005. The project site includes the low-elevation lands of the former Ocean Meadows Golf Course (golf course) and Whittier Parcel, and the predominantly higher-elevation South Parcel. Drainages from the west (Devereux Creek), north (Phelps Creek) and east (unnamed drainages) drain through the golf course to the Devereux Slough in the COPR (the lower Slough). With the exception of two remaining private parcels on the eastern project perimeter, the area is owned and managed by UCSB. There are easements on the site associated with an underground sanitary line, the Phelps Creek floodway and requirements to conform to perimeter drainage and roadways.

### Project overview

The restoration project is being undertaken by UCSB in collaboration with multiple local, state and federal agencies. This project is designed to enhance wetland and associated upland habitats characteristic of the historic Devereux Slough ecosystem. The overall project vision is to restore the opportunity for tidal connection to the site, enhance the expression and complexity of brackish and freshwater wetland features and restore upland and wetland habitats, with the following overarching goals:

(1) Ecosystem Restoration: Enhance wetland and associated upland habitats characteristic of the Devereux Slough ecosystem, requiring expansion of estuarine wetlands consistent with the larger historic lagoon estuary that is also likely to provide habitat for threatened and endangered species, and result in resilient ecosystem structure and function (2) Provide Social Values: Maintain open space and develop opportunities for passive recreation, research and educational use that are compatible with the environmentally sensitive resources of the area.

The project is being undertaken in a two-stage process. The development of this Detailed Project Program (DPP) represents the first stage of the project. Guidelines and parameters described herein will serve as the basis of project design, which will be refined and finalized in Stage 2, prior to commencement of construction.

## Project process

Based upon prior work by UCSB, Environmental Science Associates (ESA) drafted refined project goals and objectives and documented the intent to achieve substantial restoration of wetland habitat as well as provision of passive recreation, flood management and aesthetic benefits to the Campus. The Project Goals and Objectives are presented in Appendix C.

ESA conducted an investigation of existing conditions on the project site that was developed within the limited scope of this study and relying upon data presented in previous studies conducted on the golf course, South Parcel and Whittier Parcel. The Existing Conditions Memorandum is presented in Appendix B. Following this work, existing conditions were analyzed relative to the project goals and objectives, and restoration opportunities and constraints were identified. Technical analyses were accomplished collaboratively with UCSB to bolster understanding of physical conditions and processes that affect the feasibility of habitat creation and achievement of other project objectives. The NCOS Science Advisory Board (SAB), Project Committee (PC), and ESA met in a series of working meetings between April and August 2015. At these meetings, ESA presented the results of focused studies, and UCSB provided direction for subsequent actions to inform project development. Meeting summaries are presented in Appendix H.

The results of the technical analyses were used to develop two project alternatives: Alternative 1 - called *Maximum Grading*, and Alternative 2 - called *Reduced Grading*. Both alternatives met the project objectives, but differed in the extent and manner in which particular objectives would be achieved. The Alternatives Evaluation is presented in Appendix E. The NCOS Restoration SAB and PC selected Alternative 2 as the proposed project.

## Project summary

The project will expand estuarine slough and wetland habitats, along with transitional and upland habitats, provide public access and passive recreational amenities and promote educational opportunities. Approximately 350,000 cubic yards of earth will be excavated, primarily from the golf course (but also from portions of South Parcel and Whittier Parcel), and placed on site generally in the South Parcel uplands. This earthwork essentially reverses the actions taken in the mid-1900s when upper Devereux Slough was filled with earth from the South Parcel mesa and other adjacent lands to form the golf course, leaving only a ditch-like Devereux Creek channel to convey drainage through the site. The project will remove a water control structure, a sheet pile sill and armoring, from Devereux Creek just upstream of the Venoco Road crossing, to create a functional hydrologic connection between the restored estuarine habitats and the existing lower Slough. The site will be revegetated with native species to form a diverse array of habitats surrounding the estuary, which will connect to and expand important native habitats of the existing lower Slough and the Coal Oil Point Reserve (COPR).

The cost of construction cost is estimated to be \$20.65 Million. More detailed information about how this cost estimate was derived is provided in Section 3.5 and Appendix G.



The project will convert the existing aquatic and wetland habitats on the project site channel to estuarine slough habitat. In total the project will expand 12 acres of existing wetlands to about 40 acres. The project will also create and/or enhance other wetlands, transitional and upland habitats on the project site. The project will be resilient to sea level rise because it includes space for migration of the estuary wetlands with sea level rise. The project includes 3 miles of public access trails, bridges and a viewing platform.

### **Project program**

Construction is scheduled to begin in 2016 in order to utilize available grant funds previously secured by UCSB. Design, environmental review and permitting will begin as soon as practicable and be completed in 2016, with the first construction phase being limited to a few months prior to the onset of the rainy season. This first phase will focus on the north and east perimeter of the site. The remainder of the project will be constructed in the dry season of 2017, and, if necessary a third season in 2018. The need for a third season will depend on the complexity of earthmoving activities (e.g. on the extent of sorting and/or stockpiling, selective placement of excavated materials, etc.) and other factors that may affect the duration of earthwork. The third season, if needed, will allow additional time for finish grading (the final shaping of the land and trail surfaces, preparation of the soil base or the seed bed for completion) and for areas to be planted. Vegetation maintenance is anticipated to last five years after planting.

The next stage of this project, Stage 2 Design, is scheduled to commence immediately following completion of the DPP. Stage 2 will include data collection and analysis identified in Stage 1 as necessary to complete an adequate basis of design. The Stage 2 process will serve to refine design elements of the project program presented in this DPP, for example, the extent and distribution of created habitats; soil conditions and treatments; final design specifications for bridges, boardwalks and grade control structures; etc. The CEQA compliance and permitting processes will occur in parallel with the Stage 2 Design.

### **Additional information**

Contributors to this document are listed in the Acknowledgement section. Supporting information is included in the Appendices.



## **PART I INTRODUCTION**

The University of California at Santa Barbara (UCSB)'s North Campus Open Space (NCOS) Restoration Project entails restoration of portions of the historic northern extent of Devereux Slough, north of Venoco Road (the 'upper Slough') and of portions of the adjacent South Parcel mesa, as well as implementation of a range of people-serving elements consistent with UCSB's mission. Restoration is to be accomplished in terms of ecological functions consistent with historic slough conditions, modified by existing opportunities and constraints, with consideration of climate change. The project is being undertaken in a two-stage process. Under Stage 1 Detailed Project Program (DPP), Environmental Science Associates (ESA), in collaboration with UCSB, has developed guidelines and parameters for the basis of the restoration project. The project concept will be refined and construction documents completed in Stage 2 Design. It is anticipated that Stage 2 Design will commence immediately upon approval of the DPP.

In developing this DPP, ESA has worked with UCSB to evaluate existing conditions, and identify site opportunities and constraints; develop concept-level project alternatives; evaluate these alternatives; and provide assistance to UCSB in selection of a preferred project. The preferred project is presented in this DPP, and will be refined in the subsequent design, environmental review and regulatory approval processes. ESA, assisted by a team of consultants, is working closely with UCSB's North Campus Open Space Science Advisory Board (SAB) and Project Committee (PC) to develop the project described herein.

### **1.1 Report Organization**

This Detailed Project Program has been prepared to describe the parameters and elements of the proposed North Campus Open Space Restoration Project. The document is organized as follows:

Part I Describes the project background (Section 1.2), site description (Section 1.3) and the process by which the work to define the project has been undertaken (Section 1.4); restoration goals and objectives (Section 1.5); the site history, existing site conditions, and projected future conditions with sea level rise (Section 1.6); opportunities and constraints analyses (Section 1.7); development of conceptual alternatives (Section 1.8); evaluation of those alternatives and selection of the preferred project (Section 1.9).

Part II of the DPP is focused on description of the selected project, including project concept and design features (Section 2.1), effects of the project on site conditions and anticipated benefits, and anticipated conditions with future climate change and associated sea level rise (Sections 2.2- 2.5).

Part III outlines the anticipated actions necessary to construct the project (Sections 3.1 and 3.2), recommended components of post construction maintenance and monitoring programs (Section 3.3), and provides a project schedule and phasing plan (Section 3.4) and preliminary cost estimate (Section 3.5).

The Appendices to this document contain the detailed information produced and/or assembled in the process of evaluating site conditions and opportunities/constraints, developing conceptual alternatives and evaluating those alternatives.

## 1.2 Background

The North Campus Open Space (NCOS, 136.4 acres) includes properties previously called ‘South Parcel’ (68.9 acres), ‘Whittier Parcel’ (3.70 acres) and ‘Ocean Meadows Golf Course’ (63.8 acres). The NCOS is part of the 652.3-acre Ellwood-Devereux Joint Management Area, which was created in 2005 (Figure 1). The NCOS Restoration Project is being undertaken by UCSB in collaboration with the State Coastal Conservancy and the Trust for Public Land (TPL), and multiple local, state and federal agencies (e.g. Land Trust for Santa Barbara County, County of SB, State Coastal Conservancy, CalTrans, DWR, CDFW, and USFWS). The project is designed to “enhance wetland and associated upland habitats characteristic of the Devereux Slough ecosystem” in accordance with the goals and objectives adopted by the NCOS Science Advisory Board (SAB), which was established in September 2013, after the land occupied by the former Ocean Meadows Golf Course (golf course) was purchased by TPL and donated to UCSB in May 2013.

## 1.3 Site Description

The project site is located along the South Coast region of California, near the city of Goleta (Figure 2) at the downstream end of a 3.5-square mile watershed which includes Devereux Creek, Phelps Creek and several unnamed tributaries. Figure 3 shows the location of the project within the Devereux Slough Watershed. The site includes portions of 3 parcels, each owned by UCSB (Figure 4). The Whittier Parcel, located at the northeast corner of the project site, is an undeveloped property that contains marginal quality freshwater wetland and vernal pool habitats which will be enhanced by the proposed project.

The Ocean Meadows Golf Course Parcel (golf course) is the location of the former nine-hole Ocean Meadows Golf Course. The golf course was created in 1965 by filling the historic northern extent of Devereux Slough with soils removed from adjacent lands, including the South Parcel mesa. The Ocean Meadows Golf Course has been closed since 2013, when the parcel was purchased by the Trust for Public Land. Current management of the property consists of occasional irrigation with reclaimed water and annual mowing. Grades on golf course range from 0 to 10 percent, and elevations range from 5 to 15 feet above sea level. Vegetation consists primarily of non-native turf grasses, with non-native landscape trees, annual non-native weeds, native wetland and riparian plants, and bare ground. Devereux Creek traverses the golf course property, connecting to Devereux Slough on the Coil Oil Point Reserve (the lower Slough) at the southern golf course property boundary. This reach of Devereux Creek exhibits a well-defined channel, with steeply sloped banks and dense patches of freshwater marsh and riparian scrub vegetation. Ponded water is often present in this reach of the creek. The hydrologic connection between Devereux Creek and the lower Slough is limited by a sheet pile sill located just upstream of the Venoco Road bridge crossing (Figure 5). The golf course is crossed by formal (former golf cart paths) and informal trails (dirt tracks worn into the landscape) and is heavily used by local residents, students and the public for walking, cycling and dog-walking.

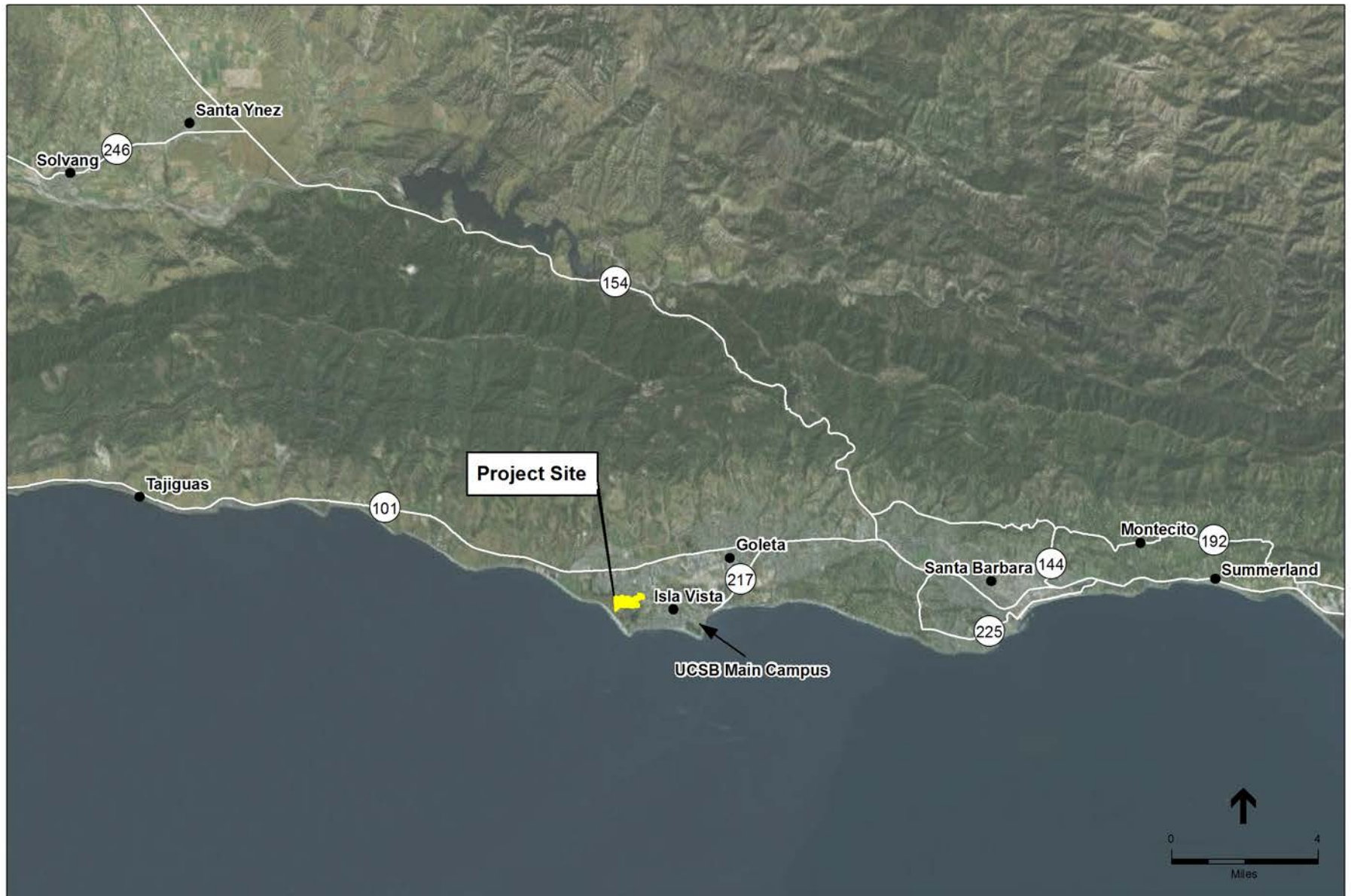


SOURCE: Aerial (ESRI); Parcels (City of Goleta, UCSB); Project Site (ESA 2015)

UCSB NCOS Restoration Project . D140769

**Figure 1**  
Project Site and Surrounding Area





SOURCE: Aerial, Roads, Cities (ESRI); Project Site (ESA 2015)

UCSB NCOS Restoration Project . D140769

**Figure 2**  
Regional Location





SOURCE: ESRI, USGS Stream Stats Website (Accessed June 2015)

UCSB NCOS Restoration Project . D140769.00

**Figure 3**  
Devereux Slough Watershed





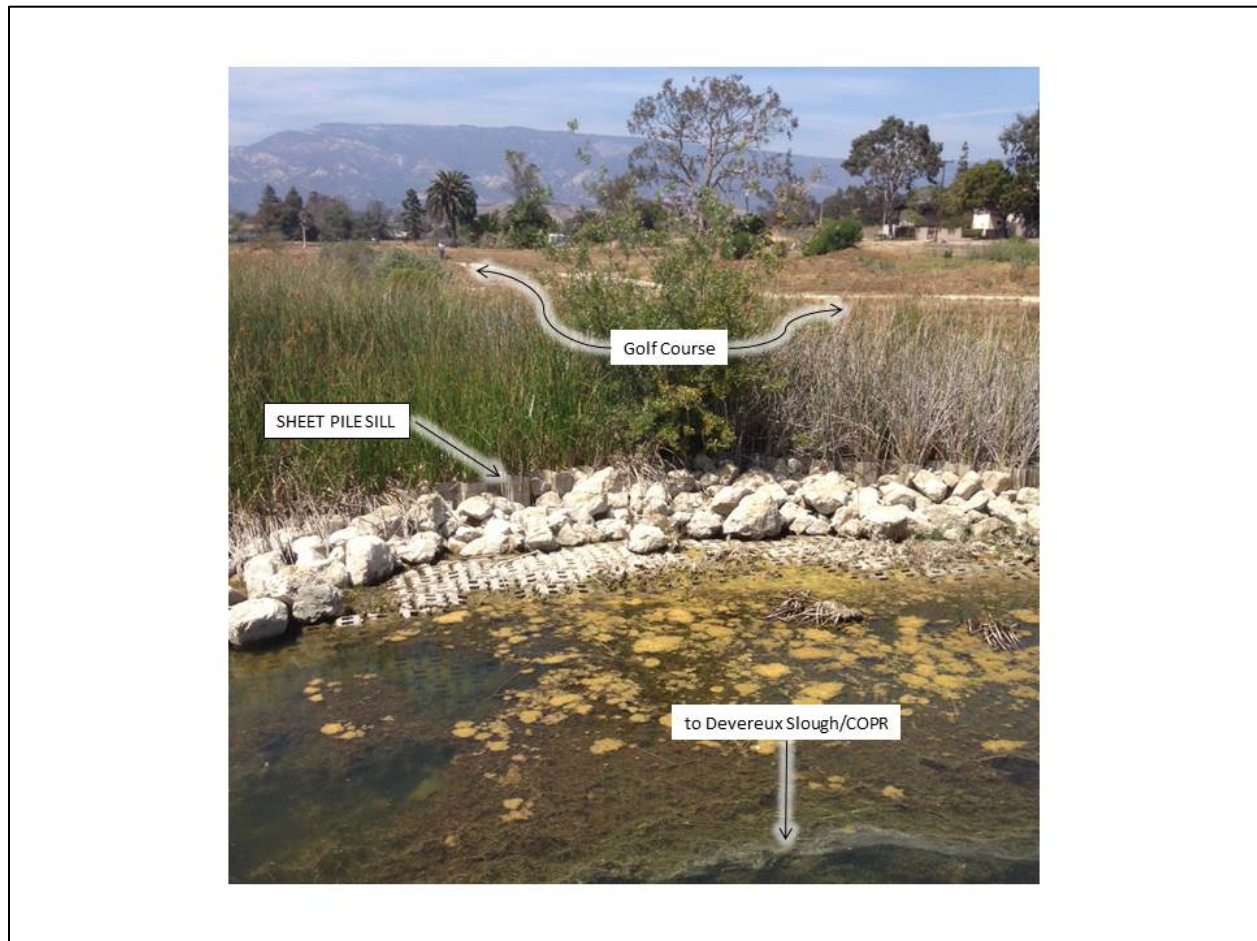


SOURCE: Aerial (ESRI); Parcels (City of Goleta); Project Site (ESA 2015)

UCSB NCOS Restoration Project . D140769  
**Figure 4**  
Project Site Map







**Figure 5. Sill at Venoco Road Crossing**

The South Parcel is located at the western boundary of the UCSB North Campus, southwest of the golf course. The Coal Oil Point Reserve (COPR) is located to the south, and Ellwood Mesa and undeveloped property in the city of Goleta's jurisdiction are located to the west. The South Parcel property slopes generally to the southeast, and ranges in elevation from approximately 8 feet above sea level at the southwest corner to 72 feet above sea level along the southwestern parcel boundary. Average slopes range between 5 and 30 percent. Soils on the site are composed of fine sandy loams that have historically been altered by agricultural manipulation and/or removal of topsoil to provide fill for the Ocean Meadows Golf Course. Four east-west trending man-made drainage swales confined by long, earthen berms traverse the site, direct rainfall runoff to the eastern edge of the property and eventually to Devereux Slough. A north-south trending eucalyptus windrow is present along the western boundary of the South Parcel, within the adjacent Ellwood Mesa area. Venoco Road and a cart path along the golf course edge provide vehicle access along the entire northern and southern boundaries of the site. The

South Parcel contains numerous dirt trails, eroded areas, and dirt bicycle jumps, and currently is used for walking, jogging, off-road bicycling, beach access, and similar recreational purposes.

#### **1.4 Process**

Preparation of an alternatives study and project design has been conducted in collaboration with a broad committee of UCSB representatives (the NCOS Restoration Project Committee and Science Advisory Board). The process for preparation of the DPP has consisted of the following steps:

- Review and refinement of UCSB Project Goals and Objectives
- Review and summary of historic and existing conditions data
- Identification and analysis of site opportunities and constraints
- Development of conceptual project alternatives
- Evaluation of alternatives and selection of the proposed project

This work is summarized in the sections 1.5 through 1.9 below. Additional detail and information that was developed in this process is provided in the Appendices to this report.

#### **1.5 Restoration Goals and Objectives**

The goals of this restoration project are to implement a restoration plan consistent with the goals and objectives established by the NCOS Science Advisory Board (SAB), which represent a balancing of ecosystem restoration and enhancements with provision of social values, as follows:

(1) Ecosystem Restoration: Enhance wetland and associated upland habitats characteristic of Devereux Slough ecosystem. To do so will require expansion of wetland area, improved hydrological connectivity, enhancement of habitats for threatened and endangered species and improving resiliency of ecosystem structure and function.

(2) Provide Social Values: Maintain open space and develop opportunities for passive recreation, research and educational use that are compatible with the environmentally sensitive resources of the area.

ESA worked collaboratively with UCSB to refine the SAB goals and further develop objectives and design criteria by which to guide project development. The full text of the Project Goals, Objectives and Design Criteria are presented in Appendix C.

#### **1.6 Historic, Existing, and Future Conditions**

This section presents a summary of historic and existing conditions documentation assembled and reviewed by ESA, and a summary of a Quantified Conceptual Modeling analysis of projected future Devereux Slough conditions with sea level rise (with no project). A more complete description of existing conditions on and adjacent to the project site is presented in Appendix B. The Quantified Conceptual Modeling (QCM) analysis is further described in section 2.3 and Appendix E.

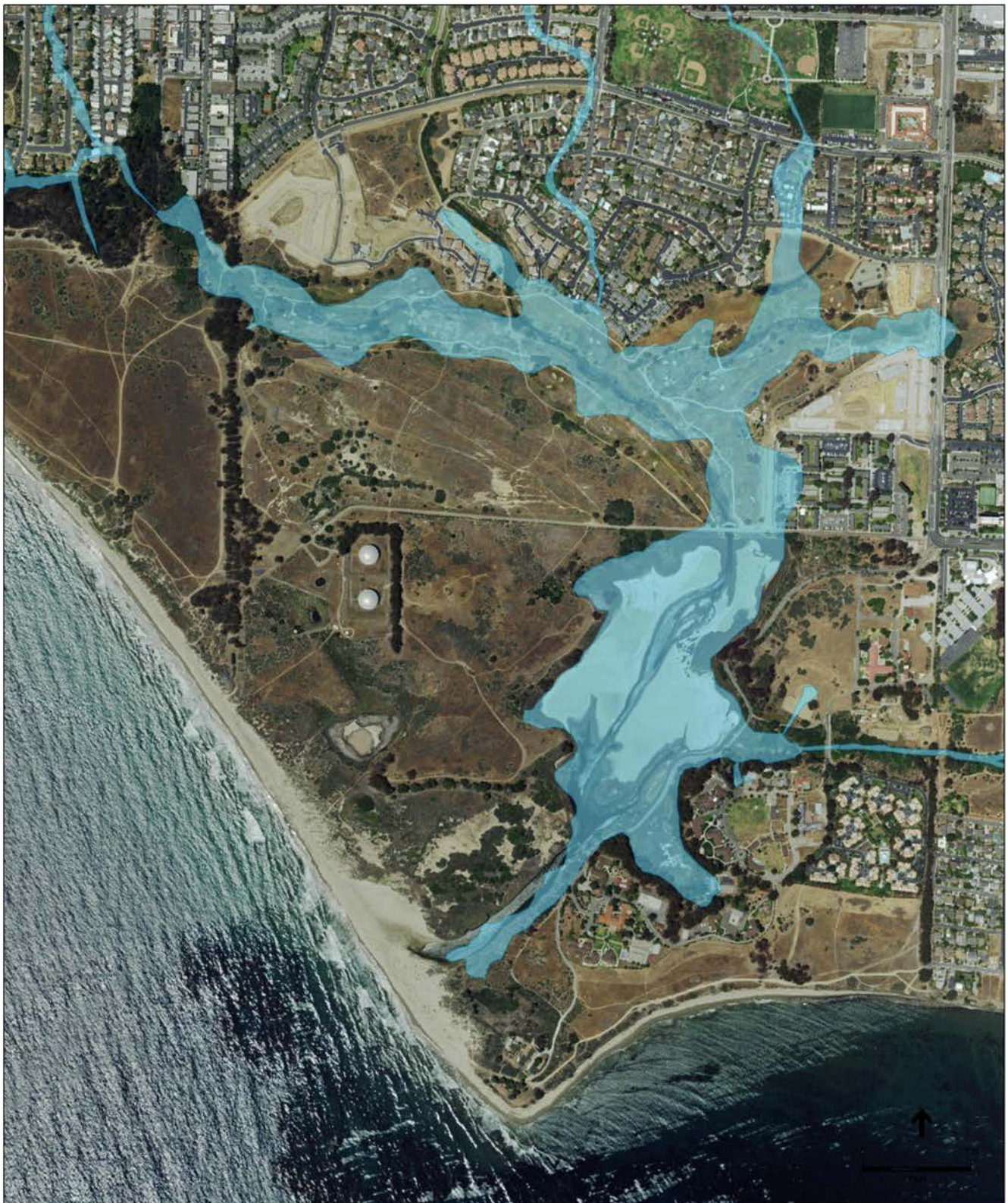
### 1.6.1 Site History

Devereux Slough has been greatly impacted by land use changes within the watershed and by construction within the slough itself. Historically, the project site supported a significant portion of the Devereux Slough coastal estuary system (Figure 6). Records from the 1870s show that the slough was already impacted at that time by agriculture and grazing in the upland watershed. Aerial photos of the slough, the earliest taken in the 1920s, reveal a pattern of agricultural and urban development encroaching into the historic slough footprint. Today the estuarine region of Devereux Slough is only 38% of the size of its historic area, and the associated vernal wetland complex is only 15% of its historic extent. Appendix A provides further detail about the sequence of land use changes that have caused this loss of habitat area, and includes discussion of the implications for the physical function of the slough and shoreline.

In 1965, the wetlands of the upper Slough were filled to create the nine-hole Ocean Meadows Golf Course. Soil was moved from adjacent lands to fill the estuary, causing severe degradation of the borrow sites and raising the elevations on the golf course property between six and 10 feet. This action significantly reduced habitat for wetland dependent wildlife, including mammals, fish, birds and insects of concern, and reduced flood conveyance capacity in the system (Campopiano et. al 2000). The impacts of this action were not limited to the upper area of the slough; sedimentation resulting from erosion of the graded areas reduced the capacity of the area of Devereux Slough below the golf course (the lower Slough), by 50% (Goodman 2008). While in operation, the golf course delivered irrigation runoff carrying excessive nutrients to the lower Slough. The Ocean Meadows Golf Course was closed in 2013.

In 2013, the Trust for Public Land (TPL) purchased 64 acres of the golf course with grant funding from several federal, state, and local agencies. TPL subsequently gifted the property to The Regents of the University of California, which will serve as the long-term steward of the site.





SOURCE: 1871 U.S. Coastal Survey T-Sheet; 2014 NAIP

UCSB NCOS Restoration Project . D140769

**Figure 6**  
Devereux Slough Historic Extent

### 1.6.2 Current Site Conditions

This section presents a summary of existing conditions with particular relevance for restoration of native wetland, transitional and upland habitats to the project site. A more complete description of documented conditions on and adjacent to the project site is presented in Appendix B.

#### *Hydrology, Hydraulics and Geomorphology*

Hydrology and geomorphology of the Devereux Slough system are influenced by its geological setting, highly urbanized watershed and tidal dynamics. Watershed inputs and intermittent tidal inundation dictate the seasonal and long-term behavior of the site. The existing (lower) slough empties into the Pacific Ocean through a channel that is frequently closed (obstructed by a sand berm at the beach). The berm periodically breaks and is rebuilt by wave action over the course of a few to several weeks. During periods when the slough mouth is open, the slough is tidal (ocean waters flow into and out of the slough with the tides).

#### Freshwater hydrology

Devereux and Phelps Creeks are the main sources of flow to the site and drain directly into the project site along with unnamed tributaries from under Whittier and Storke roads. Urbanization has led to a shift toward higher peak and annual runoff as development within the watershed has continued. From 2004-2007, runoff to the system ranged from a low of 80 acre-feet in 2007 to a high of 2,035 acre-feet in 2005, and averaged 900 acre-feet. The freshwater hydrology of the system is characterized by a net gain of freshwater in winter and spring, and a net loss in the drier months, due to a combination of evapotranspiration and seepage of slough waters to the ocean through the sand berm at the beach (Davis et al. 1990). This seasonal pattern typically leads to higher water levels in the slough during the wet season, as inflows are trapped behind the closed slough mouth at the beach.

#### Stormwater inflows

Stormwater enters the project site from adjacent residential areas and through a number of swales and culverts that lead into Devereux Creek and its tributaries. Storm drains contribute freshwater to Devereux Creek through culverts under Hwy 101 and the Southern Pacific Railroad tracks. To the west, URS (2004) noted that storm flows may at times pass through Sandpiper Golf Course and residential developments via a series of natural drainage channels.

#### Tidal inlet dynamics

The Devereux Slough is (and historically has been) an intermittently open coastal estuary. When the slough is open to the ocean, waves breaking on the beach face continually deposit sand in the slough mouth (the open channel connection to the ocean), causing the mouth to fill with sand and eventually close. Because currents in the mouth are typically weak (which is attributable to the small volumetric area of the slough that is subject to tidal inundation when the slough mouth is open), this sand deposition from waves occurs at a faster rate than erosion of that sand by outflow currents in the mouth, preventing the mouth from remaining open for more than several weeks at a time. The mouth of the slough is typically closed for most of the year, but sometimes breaches (re-opens to the ocean) after large rainfall events (Collins and Melack 2014). Breach events result when trapped runoff behind the beach raises the slough stage (water surface elevation) to the height of the beach berm, causing a



drainage outlet to form between the slough and ocean. If the trapped volume of water behind the beach berm is large, or if runoff volume is large, the outlet of the slough erodes the beach barrier to form a tidal inlet (Davis et al. 1990, Collins and Melack 2014). In wet years, such as in 1988 and 2005, the slough mouth tends to be open more often (Davis et al. 1990, Collins and Melack 2014). In dry years, such as 2007, the slough mouth may remain closed throughout the year (Collins and Melack 2014).

#### Flooding conditions

Flooding of the project site is influenced both by runoff and by the state of the slough mouth (Ferren et al. 1987; Davis et al. 1990). Flood events are generally high rainfall events, when freshwater runoff inundates parts of the project site. In the lower Slough, these events correspond to drowning of the flats adjacent to the main slough channel. In the project site, storm flows may exceed the capacity of Devereux Creek, flooding portions of the golf course. The site is subject to fluvial (stream related) flood events in the winter and spring months of most years. Because much of the watershed is developed, rainstorms lead to rapid flooding which quickly subsides again after storm events to low flows (Collins and Melack 2014). As the rainy season progresses and soil saturation increases, more runoff is produced for a given amount of rainfall (e.g. Beighley et al. 2003). Flooding is exacerbated by the closed slough mouth, which blocks outflows to the ocean. When waters within the slough rise to the beach berm elevation, slough mouth breaching abates flooding by allowing drainage to the ocean.

#### Groundwater

Groundwater levels have been measured within the project area since the 1980s (Davis et al. 1990, Fugro West 2003, CCBER 2015). Groundwater levels vary seasonally in response to rainfall and runoff (Fugro West 2003, CCBER 2015). More recent groundwater measurements collected by CCBER (2015) in the project area generally show a roughly annual pattern driven by episodic rainfall events, with higher groundwater levels immediately after rainfall and a slow decline of groundwater levels after the last rainfall event of the year. At the northwestern corner of the project area, there is persistent and steep gradient in groundwater levels between the mesa to the south and the creek bed. This gradient may be a source of higher soil moisture levels in this corner of the site throughout the dry season.

#### Topography

The present-day topography of the project site was strongly influenced by the construction of the golf course. Construction involved removal of large amounts of topsoil from the South Parcel mesa and lands surrounding the site. Gully erosion has occurred on the mesa following this construction and sediment has deposited on the northwestern corner of the salt flats adjacent to Venoco Road. In current conditions, the low lying areas of the project site experience sediment deposition during winter floods, but overall, suspended sediment delivery to the site is limited (Ferren et al. 1987, Davis et al. 1990, Schaaf and Wheeler 2006).

#### Soils

As described above, to construct the golf course, parts of the adjoining uplands were cut and the upper Slough was filled with the excavated material. Maximum cuts were concentrated in the South Parcel uplands. The areas north of the golf course also were disturbed. The soils that remain on South Parcel are constituted of subsoils. Whittier Parcel soils are also characterized by disturbance. The fill areas on



the golf course have poorly developed and poorly drained soils with predominantly clay loam textures (URS 2004).

#### **Golf Course Soils:**

CCBER conducted soil sampling (see Daumal 2013) at 34 locations throughout the former golf course. Multiple samples were taken at depths up to about 2.5m at each site. A total of 221 samples were analyzed for texture, pH and conductivity (also commonly referred to as salinity). At the time of this analysis, the golf course was still in operation and was regularly irrigated. With cessation of golf course maintenance (reduction of irrigation in particular), soil characteristics, especially salinity, may have changed since that time.

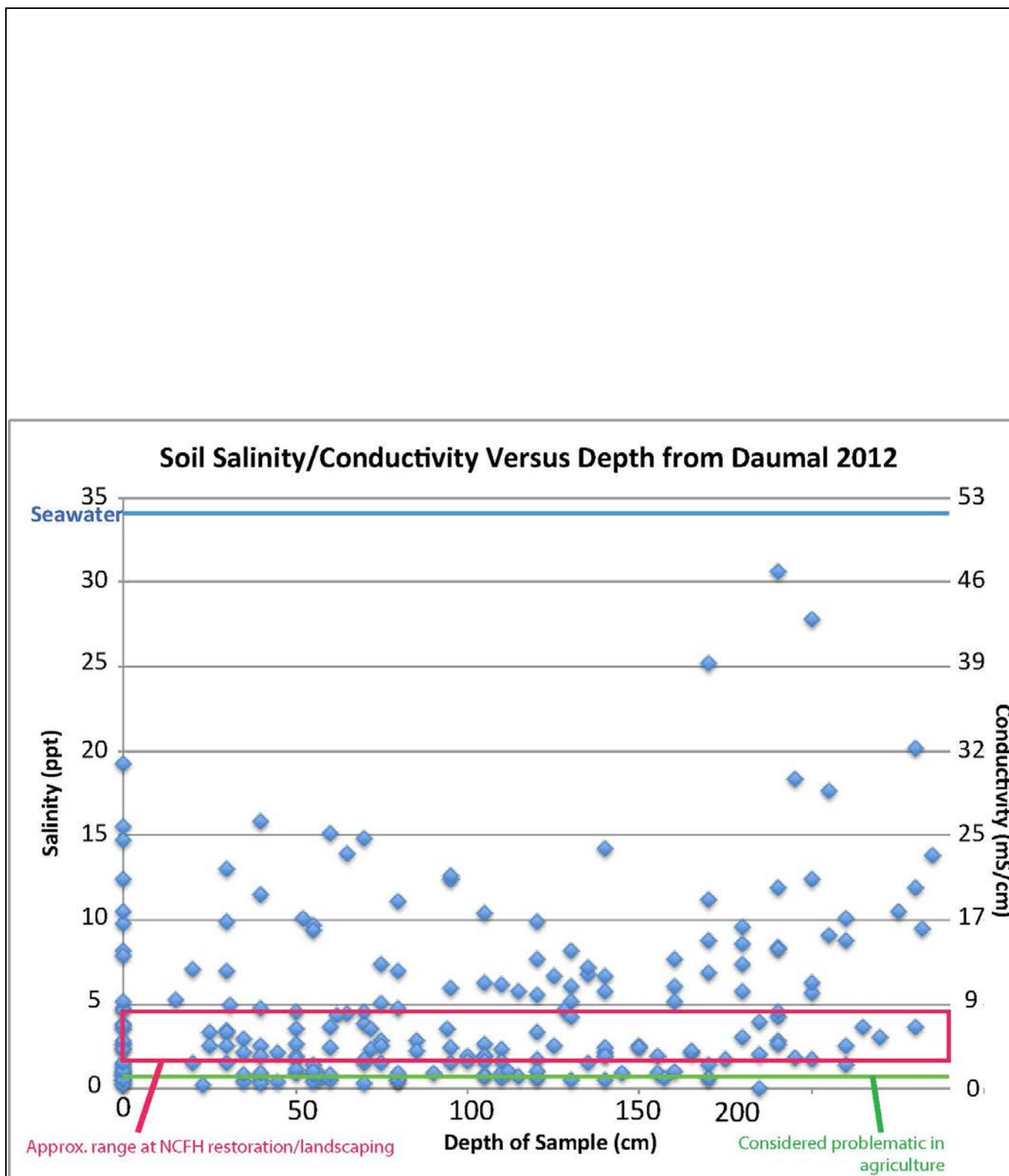
Salinity. Soil sampling conducted in 2012 by CCBER (Daumal 2013) and analyzed by the ESA team, indicate that soils in this area have moderate to high salinities (Figure 7). Plants that occur in salt marshes (known as halophytes) are adapted to deal with extremely high levels of salt. Most native upland plants, however, have low tolerance to salty soil, though some coastal bluff and dune species tolerate moderate to high levels of salt (such species are sometimes referred to as facultative halophytes). Further investigation of the extent and distribution of high salinity levels in golf course soils will be necessary to inform project design in Stage 2.

Soil acidity. The majority of soil samples in the Daumal (2013) study had relatively low pH (average 7.6; maximum 8.6; minimum 5.7). These pH levels are considered suitable for salt marsh or upland restoration.

Soil texture. The relative amount of sand, silt and clay in surface soils plays an important role in determining the types of vegetation a restoration site can support. The soil texture analyses by Daumal (2013) indicate that the majority of the soil in the former golf course is fairly sandy in nature. Clay levels are moderate. Only 6 of 215 samples contained 40% or higher clay (Figure 8). Forty percent is generally considered the minimum clay content required for vernal pool creation/restoration (Zedler 1987).

#### **South Parcel Mesa Soils:**

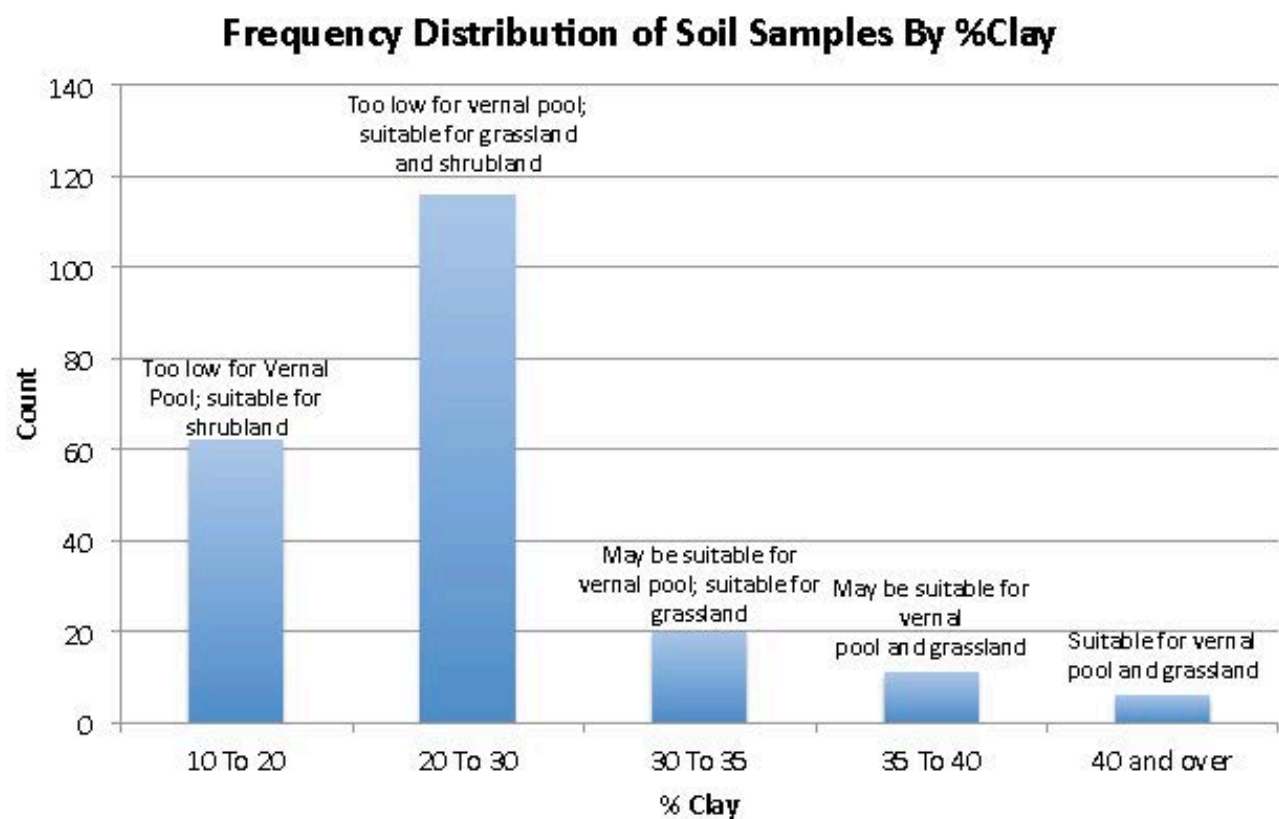
Most of the surface soil on the South Parcel mesa is sub-soil that was exposed when the area was used as a borrow site for fill material to build the golf course. As a result, this soil has very little structure and is not an ideal growing medium for most native plants. This fact, combined with the fact that there is a significant invasive non-native seed bank on and near the soil surface, may mean that soils from the South Parcel will not be suitable for use as planting substrate.



UCSB NCOS Restoration Project . D140769

SOURCE:  
Daumal, 2012

**Figure 7**  
Soil Conductivity vs Depth



## Habitat

The former golf course is a mosaic of primarily non-native turf grasses, annual non-native weeds, native wetland and riparian plants and bare ground. There are non-native trees scattered throughout the site as well. Current management of the site involves occasional irrigation with reclaimed water and annual mowing. The vegetation distribution is strongly influenced by year-round surface water inflows, high groundwater and localized areas of moderate to high soil salinity (see Soils discussion above). Coastal freshwater marsh occurs within Devereux Creek through the golf course, within a tributary to the creek south of the golf course clubhouse, and within a channel and ditch on the Whittier Parcel. Dominant wetland plants within Whittier Parcel and golf course freshwater marsh habitat include California bulrush (*Schoenoplectus californicus*), salt marsh bulrush (*Bolboschoenus maritimus*) and cattail (*Typha latifolia*) in the drainages and ponds, while willows (*Salix* spp.) and coyote brush (*Baccharis pilularis*) are also common along the banks and edges of this habitat (Campopiano et al. 2000).

Non-native lawn grasses dominate the former greens and fairways of the golf course, while several native and non-native trees dominate the rough along the course, including pine, sycamore, juniper, and palm species. The rare southern tarplant (*Centromedusa parryi* ssp. *australis*) has also been documented on the golf course site (Campopiano et al. 2000). Most of the vertebrate species that inhabit the golf course utilize the emergent wetland habitats, including waterfowl, passerines, and frogs. Wildlife potentially inhabits the open space of the golf course for breeding, shelter, and foraging. Mammals also likely use the golf course to migrate from Phelp's Creek to lower Devereux Slough. Phelp's Creek is also known to contain the rare Santa Barbara honeysuckle (*Lonicera subspicata* var. *subspicata*). In addition to birds and mammals, the Baja California chorus frog (*Pseudacris hypochondriaca*) and western toad (*Anaxyrus boreas*) are found within the drainages and ponds of the golf course. Other vertebrates may inhabit the site; however, no systematic survey has been conducted.

The Whittier Parcel, located in the north east portion of the site is comprised primarily of non-native annual grassland. A small drainage channel runs through the center of the parcel. A ditch on the property receives urban runoff from a culvert under Whittier Drive and is vegetated by several arroyo willows with relatively little herbaceous understory. The southern portion of the ditch, which flows into the golf course, is densely vegetated with California bulrush. Two low grade vernal pools in the parcel are dominated by non-native species including Italian ryegrass (*Lolium multiflorum*), Mediterranean barley (*Hordeum marinum* ssp. *gussoneanum*) and vetch (*Vicia* spp.), with curly dock (*Rumex crispus*), bristly oxtongue (*Helminthotheca echioides*), prickly sow thistle (*Sonchus asper*) and fennel (*Foeniculum vulgare*) as subdominants. Alkali heath (*Frankenia salina*) is also present (WRA 2004). Southern tarplant was documented in three small patches in south west corner of Whittier Parcel in 2004 (WRA 2004).

The area of the South Parcel within the project site is mostly upland habitat dominated by non-native annual grassland, but also contains a variety of natural plant communities and habitat types including southern vernal pools, coastal salt marsh, native grasslands, riparian scrub, coastal scrub, and eroded/disturbed areas. The South Parcel contains a large contingent of invasive exotic plants including fennel and pampas grass (*Cortaderia jubata*). Scattered occurrences of escaped ornamental plants are also present on the site (Morro Group, Inc. 2006). Of the natural habitat types present, southern riparian scrub, freshwater wetland, and southern vernal pools typically meet California Coastal

Commission (CCC) wetland criteria, and native grasslands are considered environmentally sensitive habitat areas (ESHAs). Special-status species that have been observed within the South Parcel include: red-tailed hawk (*Buteo jamaicensis*), white-tailed kite (*Elanus leucurus*), yellow warbler (*Setophaga petechia*), and southern tarplant.

Figure 9 shows existing habitats documented on the project site.

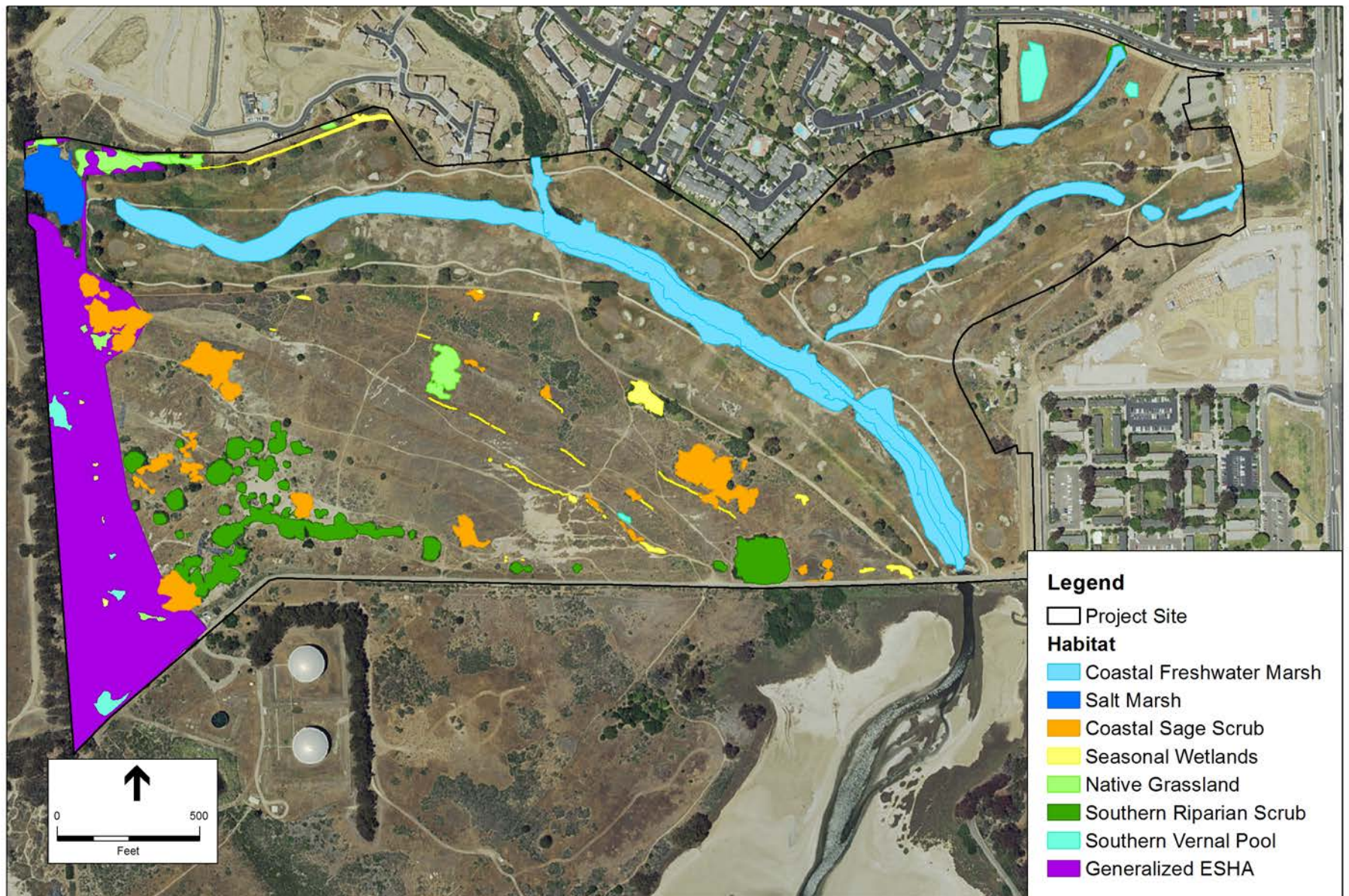
Table 1 presents a summary of existing native habitats and their locations within the project site.

**Table 1. Distribution of Native Habitats on the Project Site**

Habitat Type	Approximate Acreage	Dominant spp.	Details/location
Coastal Freshwater Marsh	9.5	tule, cattail	Devereux Creek, detention basin at Phelps Creek Tributary, drainage and basin at Whittier Parcel
Coastal Salt Marsh	0.9	pickweed, saltgrass	Northwest corner of South Parcel at Devereux Creek
Southern Vernal Pool	0.7	common spike rush, meadow barley	Western margin of South Parcel; eastern half of South Parcel in drainage swales, Whittier Parcel
Southern Riparian scrub	3.1	arroyo willow, seep willow	South Parcel, small area at Whittier Parcel
Southern Coastal Sage Scrub	2.7	coyote brush, California sagebrush	South Parcel
Native grassland	0.9	purple needlegrass, creeping wild rye	South parcel: northwest, southwest, northeast; golf course: northwest

<sup>1</sup> This data has been compiled from studies conducted between 2000 and 2007. A current wetland delineation and vegetation survey will be necessary to accurately characterize habitats on the project site.





SOURCE: Habitats (Watershed Environmental 2003, URS 2004, WRA 2006, Morro Group 2006, 2007), Project Site (ESA 2015), Aerial (NAIP 2014)

UCSB NCOS Restoration Project . D140769

**Figure 9**  
Distribution of Native Habitat within the Project Site

### Habitats on Adjacent Lands:

The Coal Oil Point Reserve includes Devereux Slough and is located just south and east of the project site. Devereux Creek maintains a limited connection to the slough. Devereux Slough is impounded most of each year by a natural sand barrier and following months of dry season evaporation, winter storm runoff fills the main portion of the slough. Salinities range from near freshwater on the surface during maximum flooding to 80 parts per thousand (ppt) and above in channels during periods of maximum desiccation (Ferren et al. 1995). The dynamic physical environment of Devereux Slough plays a major role in determining the distribution and composition of the biotic communities within the project area.

The UCSB North Parcel Site is just north of the western portion of the golf course. The east part of the North Parcel was restored in 2008 when the east bank of Phelps Creek was laid back and a riparian corridor was restored by UCSB. Willow, sycamore, cottonwood, and alder trees were planted with an understory of wetland plants along the creek edge and coastal sage scrub on the upper banks (CCBER 2012). This is an important riparian corridor connection to the golf course property. Riparian trees and shrubs on Phelps Creek consist primarily of arroyo willow (*Salix lasiolepis*), with a few cottonwood (*Populus fremontii*), and mulefat (*Baccharis salicifolia*). California blackberry (*Rubus ursinus*), non-native Himalayan blackberry (*R. discolor*), and California wild rose (*Rosa californica*) are the dominant understory species.

### Wildlife

Wildlife habitats of the project area can be discussed in terms of habitats present and the animal species that typically inhabit or utilize those communities. However, many wildlife species are not restricted to a single habitat type and are likely to utilize various portions of the site as forage areas or migration corridors on a seasonal or infrequent basis.

The project area supports a variety of wildlife species typical of coastal ecosystems. Avian resources are diverse -- woodland habitats provide perching, nesting, and roosting habitat, and grasslands provide foraging resources for a number of bird species. The expanse of open grassland supports small mammals and birds, creating prime foraging territory for birds of prey. Reptile and amphibian diversity is comparatively limited but is typical of disturbed coastal plains (URS 2004).

Reptiles and amphibians are present in all vegetated habitats within the project area, including Baja California chorus frog, southern alligator lizard (*Gerrhonotus multicarinatus*), western skink (*Eumeces skiltonianus*), and western fence lizard (*Sceloporus occidentalis*). Western pond turtle (*Actinemys marmorata*) is a California Species of Special Concern that potentially occurs in Devereux Creek on the golf course.

Common avian species found in upland habitats include black phoebe (*Sayornis nigricans*), American crow (*Corvus brachyrhynchos*), California towhee (*Melospiza crissalis*), and northern mockingbird (*Mimus polyglottos*) (Stahlheber 2015). The patches of freshwater marsh in Devereux Creek provide habitat for marsh birds such as house wren (*Troglodytes aedon*), warblers, and American goldfinch (*Carduelis tristis*). Riparian habitats and estuarine habitats within Devereux Slough provide foraging and breeding



areas for a diversity of species, such as great blue heron (*Ardea herodias*), snowy egret (*Egretta thula*), and warblers. Although not restricted to this habitat, many raptor species such as turkey vulture (*Cathartes aura*), white-tailed kite (*Elanus leucurus*) and red-tailed hawk (*Buteo jamaicensis*), forage within the grassland habitats in the project area. Belding's savannah sparrow (*Passerculus sandwichensis beldingi*), designated as an endangered species in California, has been documented breeding in Devereux Slough salt marsh habitat. The western snowy plover (*Charadrius alexandrinus nivosus*), designated as threatened by the federal government, over-winters and nests on the beach near the mouth of Devereux Slough and in salt flats within Devereux Slough, and California least tern (*Sterna antillarum browni*) has also been observed foraging near the mouth the slough.

Common mammal species known to occur throughout the project area include Virginia opossum (*Didelphis virginianus*), striped skunk (*Mephitis mephitis*) and raccoon (*Procyon lotor*). Small mammal fauna occurring in all habitats, including the coastal bluffs and grasslands, include Botta's pocket gopher (*Thomomys bottae*), California ground squirrel (*Spermophilus beecheyi*) and California vole (*Microtus californicus*).

The three most abundant fish species caught during 2005 - 2007 surveys in the Devereux Slough were native California killifish (*Fundulus parvipinnis*) and topsmelt (*Atherinops affinis*), and non-native mosquitofish (*Gambusia affinis*) (Goodman 2008). The endangered tidewater goby (*Eucyclogobius newberryi*) was also captured during surveys from 2005 - 2013, however it was not found during surveys in 2014 (Goodman 2008, pers. comm. K. Lafferty and T. Longwell).

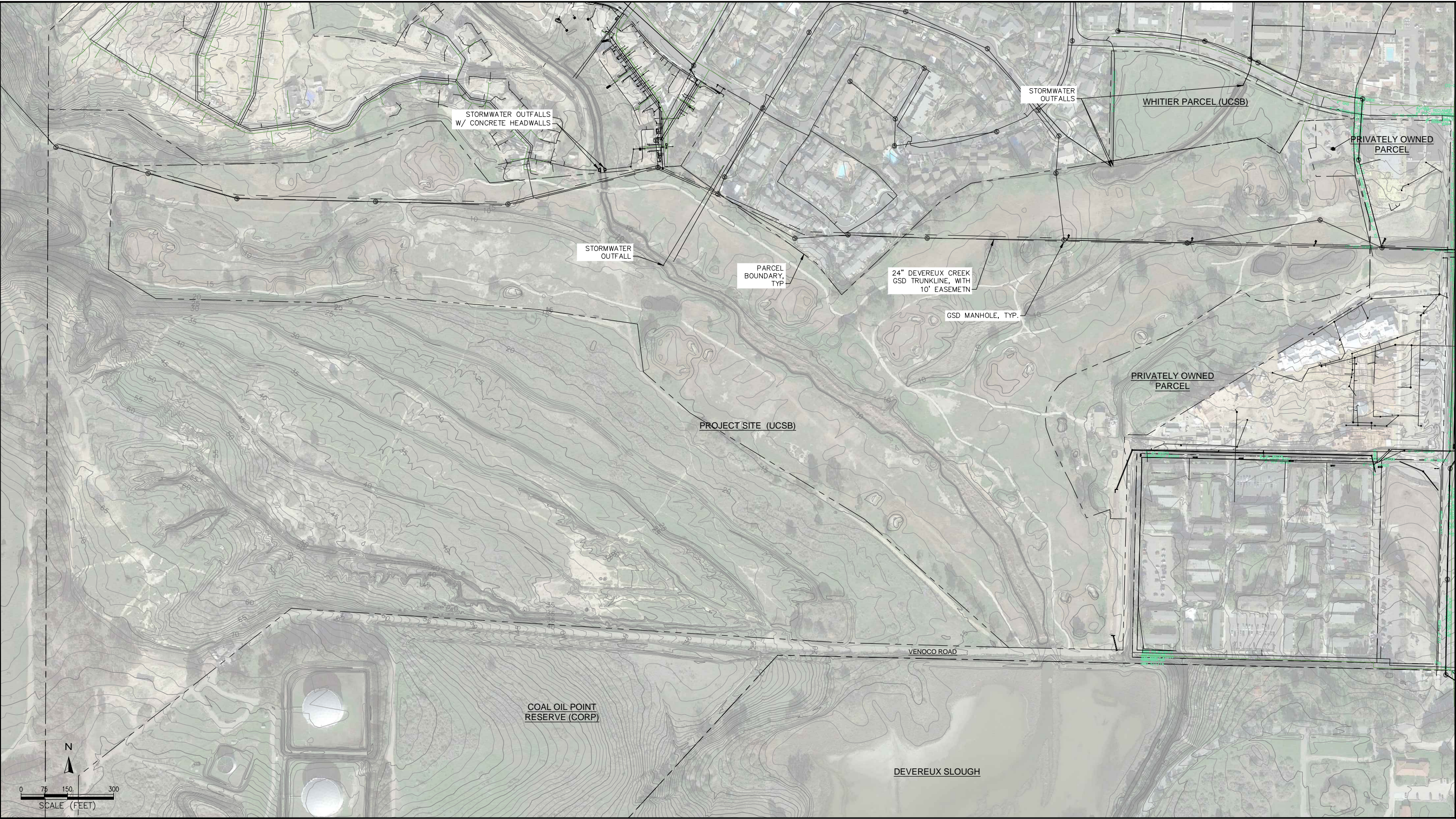
### **Infrastructure**

Infrastructure in the golf course area consists of a series of stormwater outfalls and drains, and an underground Goleta Sanitary District (GSD) sewer main line (Figure 10). Stormwater outfalls enter Phelps Creek from the east and west just upstream of its confluence with Devereux Creek on the golf course. A storm drain flows from the western segment of Scripps Crescent Street to Devereux Creek. Storm drains from the eastern length of Scripps Crescent Street and from Whittier Drive convey runoff to an isolated wetland in the northeastern portion of the golf course, and a culvert under Whittier Drive delivers storm flows to this wetland also, via an open ditch. Stormflows from West Campus Married Student Housing flow in a storm drain to an outlet on the SE wingwall of the Venoco Bridge, directly into Devereux Slough.

A Goleta Sanitary District sewer main line traverses the golf course property for most of its length before extending under Storke Road. Now defunct golf course facilities include a clubhouse, parking lot, cart paths, and culverts/footbridges at several Devereux Creek crossings. Overhead power lines and buried natural gas lines provide utility service to the clubhouse.

Two abandoned oil well heads are within the project site (Campbell Geo 2011). The location and depth of the capped wells will need to be a considered during the final design of the proposed project.





SOURCE: Aerial Photo: Google Earth, 2015. Topography: Aerial Photogrammetry June 13, 2006 by Arrowhead Mapping Corporation

UCSB NCOS Restoration Project . D140769





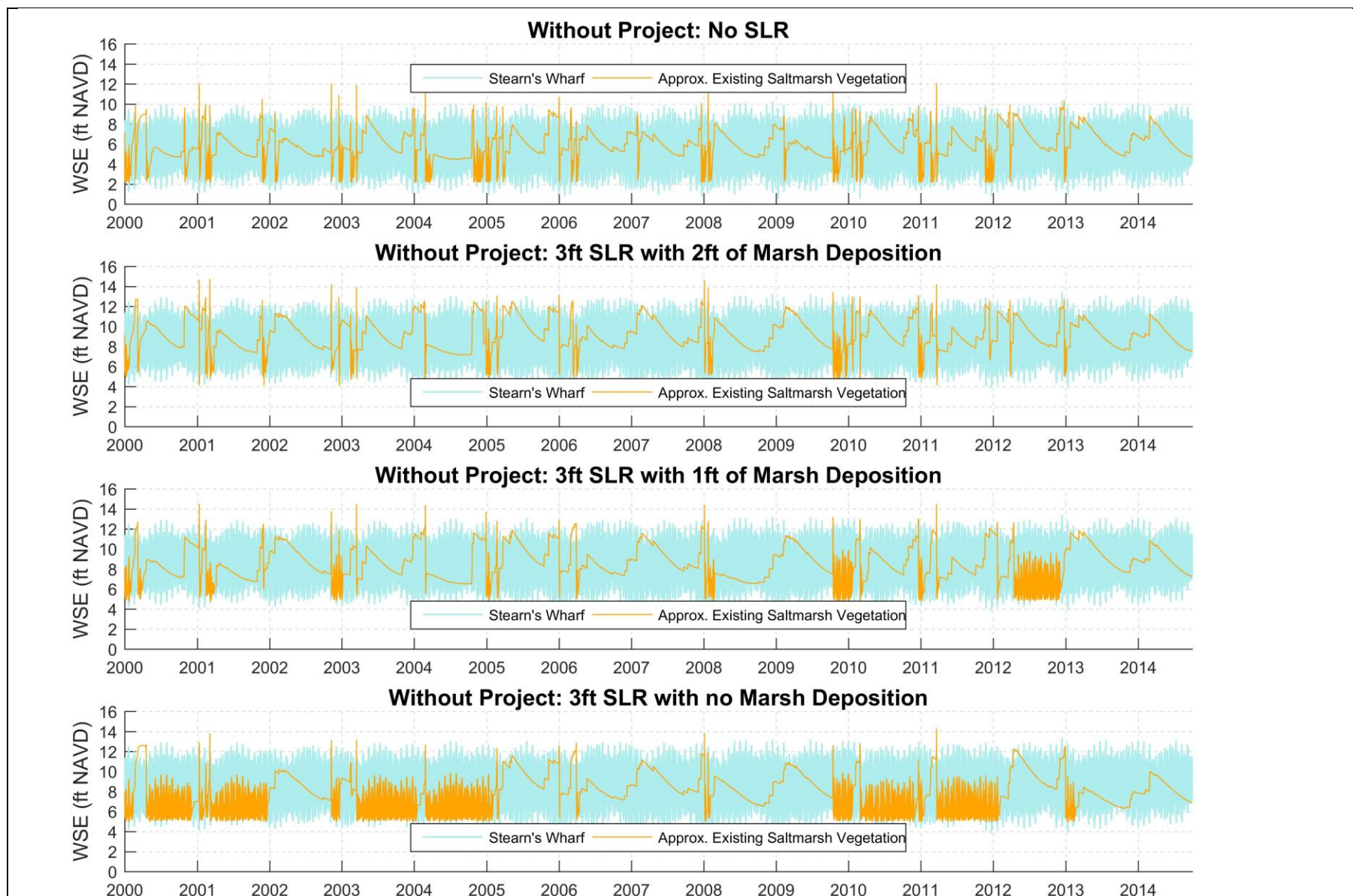


### 1.6.3 Future (No Project) Conditions with Sea Level Rise

The main effect of sea level rise (SLR) is to shift tides upward relative to the site topography, so that typical tides will drown existing mudflat and salt flat areas more frequently if marsh accretion cannot keep pace with the rise in water levels. (Marsh accretion is the process of gradual rise in the elevation of a marsh plain caused by deposition of sediment and/or organic material over time). Currently, oceanic high tide levels are below most of the salt flats in the lower Slough, and are blocked by the sill at the Venoco Road Bridge. With SLR of 3 feet by 2100, the intertidal volume of the site is expected to increase by roughly 100 to 350 percent (double to quadruple the existing volume), more frequently drowning the salt flats and the project site upstream of the sill. This range incorporates uncertainty associated with variable marsh accretion rates, which would partially mitigate the increased intertidal volume with SLR. The larger intertidal volume would lead to longer open-mouth conditions after mouth breaches occurred, but larger inflows would be needed for breaches to occur because the site would hold more runoff.

Within the project site, long-term tectonic activity, especially within the vicinity of the More Ranch Fault (pers. comm. A. Simms), and marsh accretion have the potential to alter these projected changes with SLR. ESA considered potential marsh accretion using a one-dimensional model that accounts for gradual deposition of sediment as well as decay and buildup of organic material in vegetated areas (see Krone 1985). Considering both subsidence and marsh accretion, it was found that three feet of SLR by 2100 would potentially be met with 0-2 feet of accretion, given high variability in sedimentation rates. In this analysis, low suspended sediment concentrations of 30-100 milligrams per liter (mg/L) and organic deposition of 1-3 millimeters per year (mm/yr.) were assumed, consistent with values associated with saltmarsh vegetation (Stralberg et al. 2011).

ESA considered the above points using a tool called the Quantified Conceptual Model (QCM), described in section 2.3 and Appendix E. In this analysis it was assumed that the beach would shift upward at a pace equal to SLR. Figure 11 shows that with three feet of SLR and zero feet of accretion, prolonged periods of open-mouth tidal conditions and prolonged mouth closures are expected in the lower Slough. Prolonged closures are expected in dry years because of the larger volume of the slough below the higher beach berm, which would mean more water is required to fill the slough to a breach elevation. In wet years, the QCM predicted that breaches would occur despite the larger volume of the slough, and the large intertidal volume would maintain an open mouth for several months at a time (compared to less than 20 days at a time at present). With 1-2 feet of marsh accretion, the relative increase in slough volume with SLR is partly mitigated by the loss of volume associated with the accretion. With one foot of accretion, the slough mouth behavior is similar to the no-accretion case. With two feet of accretion, the effect of three feet of SLR on mouth conditions is largely mitigated, and the slough remains primarily closed, similar to existing conditions (Figure 11).



SOURCE: ESA QCM model

UCSB NCOS Restoration Project . D140769

**Figure 11**

Simulated Time Series of Slough Water Level without the Project

## 1.7 Opportunities and Constraints

The ESA team worked closely with the UCSB Science Advisory Board (SAB) and Project Committee (PC) to identify and investigate opportunities and constraints for the restoration project. A series of meetings occurred between April and August 2015. At these meetings, the results of focused studies were presented for review by the SAB, which then provided direction for subsequent action. Meeting summaries are presented in Appendix H. The pertinent aspects of these focused studies are included in this Detailed Project Program, with the appendices containing detailed information organized by category.

This effort was supported by the plethora of site data and analysis results amassed by UCSB, largely due to work by the Cheadle Center for Biodiversity and Ecological Restoration (CCBER). Prior work by ESA (and its predecessor name, PWA) for the project was also important to development of project alternatives. These data were instrumental in the development of an understanding of existing conditions and identification of opportunities and constraints. The data and studies assembled for the project have been organized into a digital library for further expansion and use. The Project Library Index is provided in Appendix I.

The following items were addressed and are summarized below:

- Estuary hydrology, and associated water balance and slough mouth (ocean boundary) condition;
- Stream inflows conveyed by tributary Phelps Creek under flood and typical conditions;
- Sea level rise effects to estuarine water levels and mouth conditions and habitats;
- Groundwater levels;
- Salinity levels in and soils texture in project site soils;
- Estuarine habitat elevations and vegetative cover;
- Sediment flats for western snowy plover habitat;
- Grade control and backwater for tidewater goby habitat;
- Existing native habitats; and,
- Utilities and other built assets including public access requirements.

### 1.7.1 Estuarine Hydrology

Estuarine hydrology varies depending on the condition, or “state” of the mouth of Devereux Slough, as well as on inflows to the site, which vary with the seasons as well as over multi-year periods. Depending on the balance of several parameters as well as preceding conditions, the slough mouth is either closed, open or in transition between these states. The hydrology in turn influences wetland vegetation and habitats directly and via related parameters such as soil moisture and salinity. ESA applied the Quantified Conceptual Model (QCM) to extend existing data to generate a statistical description of mouth states and slough hydrology (Figure12). The QCM was previously developed by ESA and was improved during this application. A report describing the QCM analysis is provided in Appendix E.



**Figure 12**  
Time Series of Modeled Devereux Slough Water Levels,  
Compared Against Observed Water Levels, Streamflow, and  
Nearshore Wave Power



### 1.7.2 Stream Inflows

Stream inflows were investigated in order to address flood and typical conditions.

Prior analysis by ESA identified that removal of the sill at the Venoco Road crossing would reduce water levels during extreme rainfall runoff events. This analysis was revisited to confirm that the methods and data used were appropriate to address the effect of excavation for a restoration project on flood levels and to inform project development. It was confirmed that the excavation of the upper Slough and removal of the sill upstream of the Venoco Road crossing would reduce the 100-year flood level associated with high flows from the major tributaries, Devereux and Phelps Creeks. Also, it was confirmed that all other drainages would be maintained and that no increase in flood hazards would result from restoration of the upper Slough. These other drainages are primarily local flows to the western arm (Devereux Creek), the eastern arm (from the vicinity of Storke Road and the Whittier Parcel), and local discharges from north campus housing and roads.

ESA investigated the watershed runoff that enters Devereux Slough under typical conditions as part of the assessment of estuary hydrology and to determine whether additional analysis is warranted as part of project design. These efforts resulted in improved estimates of historic watershed inflows entering the slough. The amount of freshwater inflow to the slough is an important factor in establishment of wetland habitats and affects breaching and closure patterns at the slough mouth. However, the critical aspect of water supply and its inherent variability led the SAB to recommend that watershed hydrology modeling be conducted in Stage 2 to support project design.

It is expected that the results of the Stage 2 analysis will be used primarily to confirm and/or refine the design of project elements that are directly related to the creek hydraulics and slough water levels (e.g. grading elevations, bridges, channel dimensions). However there is a possibility that a refined watershed hydrology analysis may indicate unanticipated changes in expected future water levels and breaching/closing patterns at the slough mouth. In such a case it may be necessary to adjust site grading in areas intended for the establishment of marsh vegetation in order to best achieve the project's objectives for habitat outcomes.

### 1.7.3 Sea Level Rise Effects

Sea level rise scenarios were developed to be consistent with the County's draft coastal resilience study and also the California Coastal Commission's draft guidance on consideration of sea level rise for coastal development permits. The hazard mapping developed in the County study was reviewed for existing and future conditions, including the range of restored slough grades. It was concluded that these projected future water levels were likely higher than what might be expected for a given sea level rise, owing to the presumption that the slough water levels would match the beach berm elevation without breaching. Further, it was determined that restoration of estuary habitat to the project site would not increase these projected levels.

### 1.7.4 Groundwater Levels

Groundwater levels are close to surface grades and directly contribute to surface soil moisture in some locations within the project site, resulting in wetland habitats. The project goals include objectives to

maintain, improve and/or expand existing wetland features, and hence high groundwater and existing drainage patterns present opportunities. As high groundwater levels near the top of the South Parcel mesa result from natural groundwater flows interacting with the local geology, they are expected to persist. Monitoring well data provided a basis for water levels (Figure 13). Surveys proposed for Stage 2 will enhance the data interpretation by providing accurate locations and spatial representation. Installing additional wells could also help to refine understanding of existing conditions and the project design.

### 1.7.5 Soils

#### *Soil Salinity*

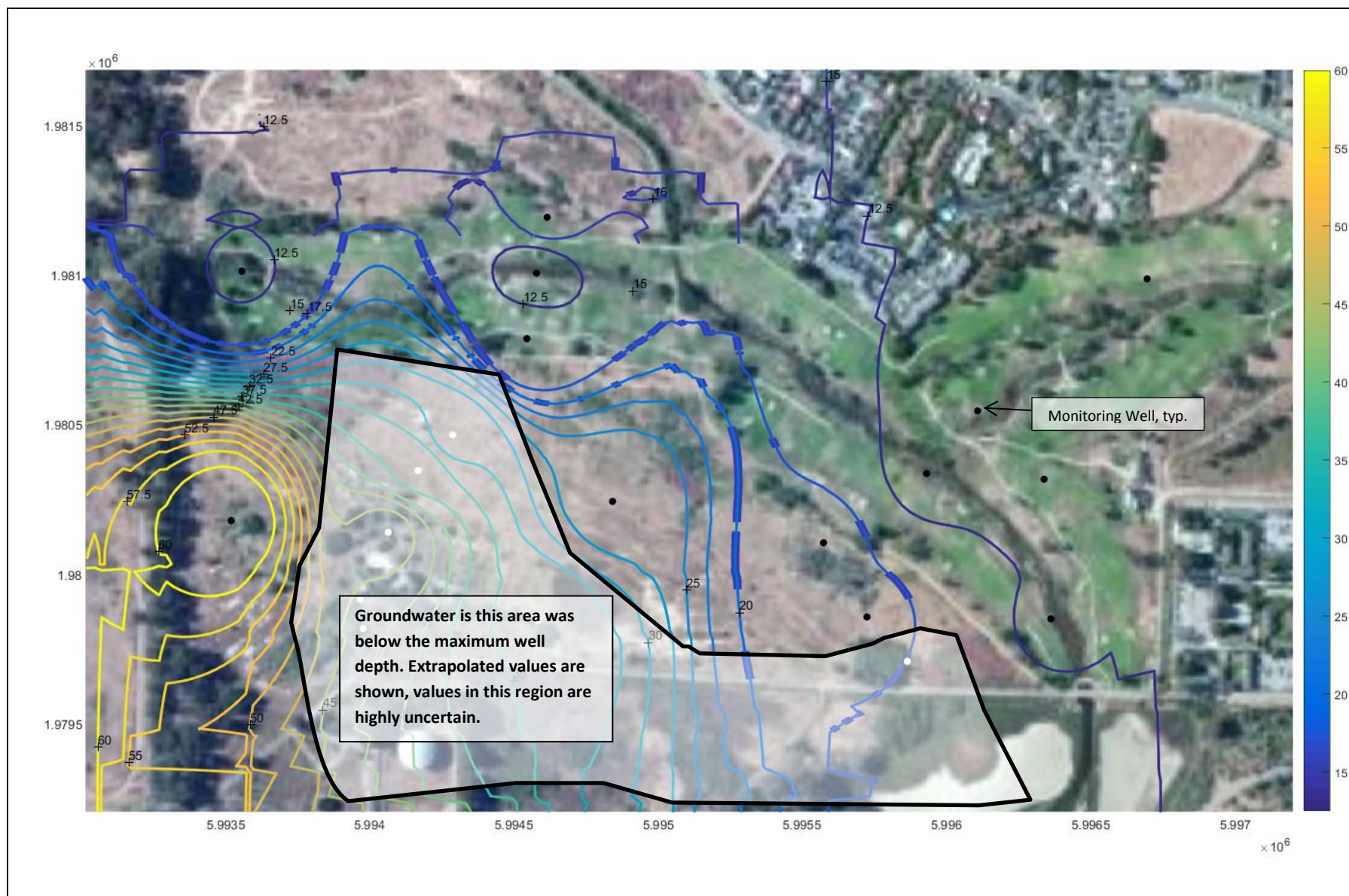
Soils sampling conducted by CCBER reveals high salinity levels in the former golf course area. In some instances salinities exceed levels tolerated even by native salt marsh vegetation. Patches of bare ground and salt-tolerant plants in the golf course are attributed to these conditions. It is not clear the extent to which the high soil salinity levels are associated with historic estuarine soils, groundwater salinity or prior management practices associated with operation of the golf course. Analysis of potential to leach salts from the soils was conducted in order to assess the feasibility of upland plant establishment on the soils that would be excavated from the golf course.<sup>1</sup> The analysis confirmed experience gained elsewhere in the north campus area that revegetation is feasible. Upland planting feasibility can be enhanced by leaching salts from the soils, is especially effective with loamy soils with sufficient permeability and can be further enhanced with additives typically used in agricultural applications. Salt marsh vegetation establishment can be enhanced by supply of fresh water, either through irrigation or by proximity to groundwater expressions.

A one-dimensional groundwater transport model was used to assess the potential rate of leaching of salts from proposed upland habitat (fill soil). This model showed that the rate of salt flushing is highly sensitive to the soil's porosity and conductivity. Salt flushes rapidly from well-draining soils (e.g. soils with higher sand and organic content) while it may persist for 10+ years in soils which have very high silt and clay content. These results suggest that the selective placement of well-draining soils within the top layers of fill placement could mitigate for higher salt concentrations in the fill material.

However, soil salinity was identified as a key constraint requiring further attention as part of Stage 2 design.

---

<sup>1</sup> Given the high costs and potential air quality and traffic impacts associated with export of a large volume of excavated material, it has been assumed that balancing cut and fill on the project site will be desirable. Therefore the ability to establish native upland vegetation on fill soils native plants on soils excavated to create estuarine habitat after replacing these soils as fill material on portions of the site is an important consideration.



SOURCE: CCBER 2015

UCSB NCOS Restoration Project . D140769

**Figure 13**  
Groundwater Elevations (ft NAVD) within Project Site  
Fall 2014

### *Soil Textures*

CCBER 2012 data indicate that soil texture on the former golf course varies with depth within different sampled soil cores. It is not yet clear what the soil texture will be at the surface in the restored slough. Typical salt marsh soil is generally higher in clay and silt than most of the soils found within the sampled areas of the former golf course. It is not clear what effect this might have on plant growth (due to potentially different nutrient cycling) and the elevation distributions of species (due to potentially different soil moisture patterns). Where tidal salt marsh habitats have been restored on sandier soils (*e.g.*, Sweetwater Marsh in San Diego Bay), studies have shown that the sandy soil retains less nitrogen than natural tidal marsh soils (due to the continual ebb and flow of tides flushing nutrients out of the sandier soil). This phenomenon may not be a problem in Devereux Slough, as it is rarely tidal. Further, pickleweed grows well at the Sweetwater Marsh project, which suggests that this plant may not be as sensitive to lower nutrient levels as other tidal marsh species (*e.g.*, cordgrass, which does not exist in Devereux Slough). Sandier soil drains faster than the high clay/silt content soils typical of salt marshes, leading to different soil moisture dynamics as water levels change. This may affect the tail ends of the elevational distribution of some species that are sensitive to soil moisture; however it should not pose a barrier to re-vegetation in general.

The presence of very high sand content soils on the South Parcel fill site was identified as a potential opportunity for creation of high percolation zones within the fill to sustain and enhance the groundwater gradient that appears to support higher elevation freshwater wetlands on the South Parcel and golf course. These soils could also present opportunities for expansion of dune scrub/woodland habitat on the restored mesa (fill), contiguous to existing areas of this habitat to be preserved on the South Parcel.

The 2012 soils analyses should be supplemented with further soil sampling and analysis in Stage 2, to address questions about quality control, potential for changes in soil conditions in the time period that has passed since the study was done and to describe appropriate selective grading/soil sorting/soil treatment measures for project implementation. Recommendations for Stage 2 analyses include:

- *Re-test soils at several locations on the former golf course.* Analysis of CCBER soils data identified the need for follow-up investigation to verify and expand on the reported results. Management of the golf course has changed significantly since the 2012 soils testing was conducted, and soil characteristics, especially salinity, may have changed since that time. ESA recommends repeat testing at a few locations tested in 2012 using similar methodologies to corroborate findings in the 2012 study, and to confirm this data as an appropriate basis for planning. In addition, new sampling may reveal important changes in soil salinities since 2012 due to, for example, changes in irrigation and fertilization regimes and the subsequent dry years.
- *Test soil salinity and texture more broadly in the former golf course.* Based on available data, it currently appears that selective grading will be needed to attain habitat creation goals on the fill site. As such, additional soil sampling will be needed in order to accurately characterize the extent and distribution of soils based up on salinities and textural characteristics. This may include first testing more broadly (geographically and by depth) to look for broad scale patterns.



Next, more focused testing will be needed to confirm the extent of the areas where the highest and lowest salinities are concentrated and where there are areas of clay soil. This testing is required to determine the extent of selective grading can be used to accomplish project habitat goals, or if other actions are potentially feasible.

- *Determine volume of sandy soil available for salvage on the mesa.* Testing is required to determine the extent of sandy soils on the South Parcel mesa that may be available for salvage and re-use in the restoration.

### 1.7.6 Elevation and Coverage Targets for Establishment of Salt Marsh Vegetation

In coastal marshes with full tidal exchange (systems that are open to the tides at all times), pickleweed usually occupies an elevation zone from mean high water level to the level of the highest high tides (Josselyn 1983). The elevation distribution of habitats in intermittently tidal sloughs like Devereux Slough, however, is not well studied or understood. It is likely that the same physical parameters that control habitat distributions in fully tidal systems (inundation frequency, extreme high water events and salinity) are also important in controls in intermittently tidal systems. While these parameter are fairly predictable in tidal systems (especially inundation frequency and salinity), in intermittently tidal systems they are much more variable in space and time, which leads to difficulty in predicting how plants will respond. In fact, it is likely that because every intermittently tidal slough in has a unique hydrologic regime, which includes different periods of tidal influence, different surface and sub-surface freshwater inputs, etc., each system probably has a slightly differing elevational distribution of salt/mud flats, salt marsh, brackish marsh and upland plants. Nevertheless, it is important to be able to predict with some confidence which habitats will occur at which elevations in a restored upper Devereux Slough system. In order to predict this, data on water levels and salinity (actual and modeled) need to be compared to existing habitat distributions in the lower slough.

Devereux Slough within the Coal Oil Point Reserve (COPR) (the lower Slough) was investigated as a reference site for establishment of target elevations and surface conditions such as percent vegetative cover for the restoration of estuarine vegetation types to the project site. Available data for the lower Slough provide a range of elevations strongly associated with marsh vegetation elevations between 6 and 8 feet NAVD (North American Vertical Datum of 1988<sup>2</sup>, Figure 14) and indicate that only about 56% of this elevation range is vegetated (Table 2). This limited vegetation cover may be attributed to high salinities that occur in the late summer and fall, especially as water levels lower and salinity increases with evaporation.

---

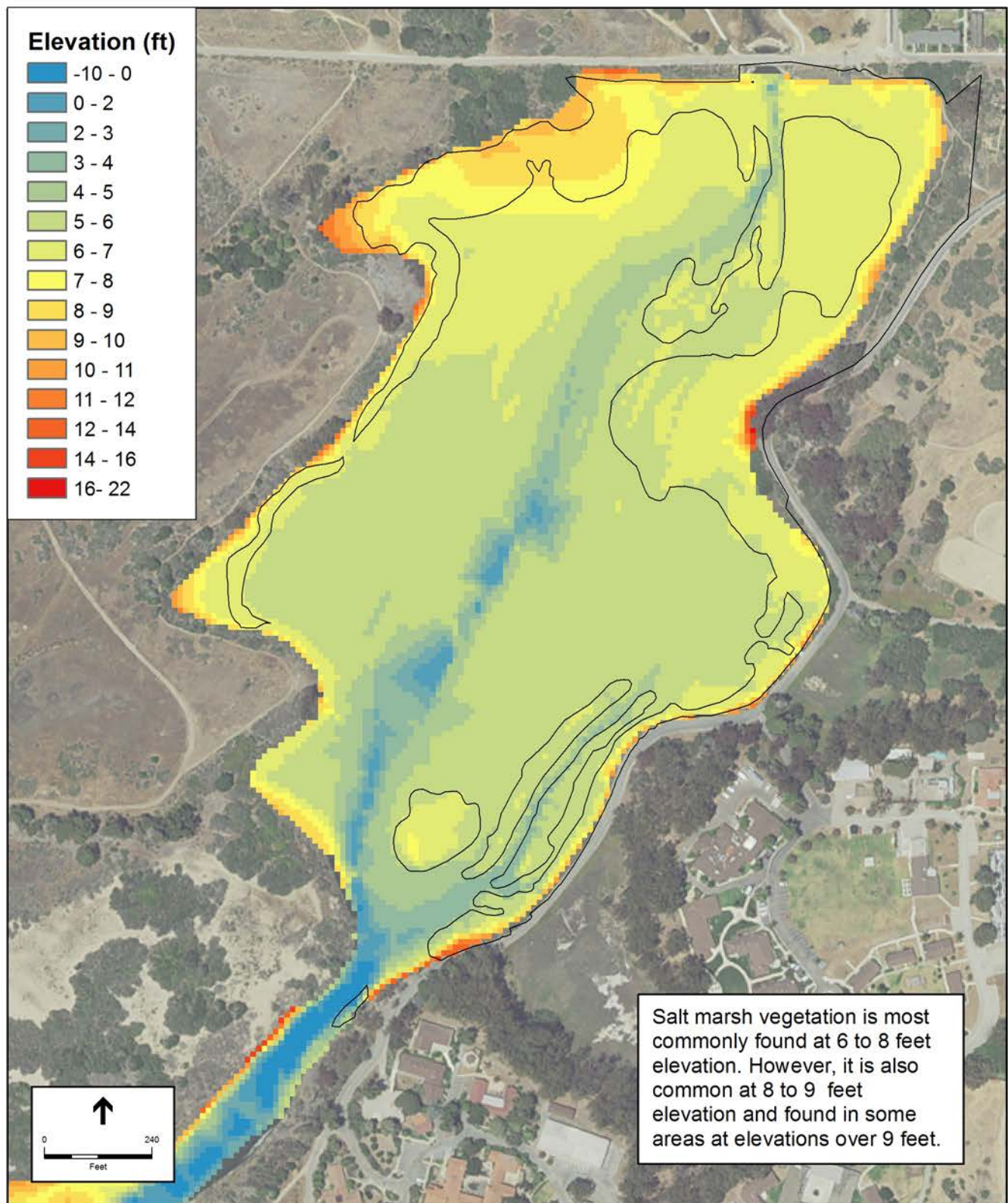
<sup>2</sup> The **North American Vertical Datum of 1988 (NAVD88)** is the vertical control datum of orthometric height established for vertical control surveying in the United States of America based upon the General Adjustment of the North American Datum of 1988.

**Table 2. Vegetation by Percent Cover and Elevation in Lower Devereux Slough**

<b><i>Elevation (Ft. NAVD)</i></b>	<b><i>Veg Area (sq. ft.)</i></b>	<b><i>Total Area (sq. ft.)</i></b>	<b><i>Percent Vegetated cover within each elevation band</i></b>
-10 - 0	398.938	8614.05	4.6
0 - 2	252.473	21175.7	1.2
2 - 3	904.871	29807.1	3.0
3 - 4	5985.91	80224.7	7.5
4 - 5	14864.3	167909	8.9
5 - 6	119545	827060	14.5
6 - 7	236845	516345	45.9
7 - 8	72483.6	108696	66.7
8 - 9	66060.6	86580.4	76.3
9 - 10	15915.1	34036.1	46.8
10 - 11	3070.83	10508.9	29.2
11 - 12	1130.44	6248.51	18.1
12 - 14	1736.12	3607.52	48.1
14 - 16	563.736	941.091	59.9
16 - 22	156.849	156.849	100.0

Observations in the northwestern extent of the project site, in the Devereux Creek arm, indicate that salt marsh vegetation exists at higher elevations in this area (8 to 12 feet NAVD), in isolated locations. These higher-elevation, ‘perched’ salt marsh patches are likely attributable to high soil salinities, local fresh water supply from the tributary flows and high groundwater. The existence of these higher elevation patches of salt marsh vegetation may indicate potential for establishment of salt marsh and/or high marsh transitional habitats in a greater elevation range in this portion of the project site, if supporting conditions and processes can be maintained with excavation of much of the site to restore the upper Slough.

Accurate elevation surveys and vegetation mapping to document the lower and upper limits of different plant species (*e.g.*, pickleweed) and habitats (*e.g.*, salt/mud flat, salt marsh, transitional and upland) should be carried out in lower Devereux Slough in Stage 2 to refine project design. Areas where vegetation distributions may be influenced by unnatural features or phenomena (such as altered landforms, altered hydrology due to roads or culverts, etc.) should be avoided. Similarly, elevation and vegetation distribution surveys combined with groundwater data collection for the Devereux Creek arm of the project site, would serve to illuminate conditions/processes that support the higher elevation salt marsh and other wetlands habitats in this area of the project site. Combined with projections of hydrologic conditions in the restored system, these data can be used to predict habitat distributions and guide design refinements.



SOURCE: Aerial (NAIP 2014); Salt Marsh (URS 2003); Elevations (ESA 2015)

UCSB NCOS Restoration Project . D140769

**Figure 14**

Elevations of Salt Marsh Vegetation in Lower Devereux Slough

### **1.7.7 Western Snowy Plover Nesting Habitat**

Consultation with the SAB identified an area of the COPR where federally threatened western snowy plover have been nesting and foraging. This area is located immediately south of the project site boundary, just south of the Venoco Road crossing, on the west side of the lower Slough channel. The area has been monitored by COPR, and its conditions were documented by the team as a reference site for the restoration project. This feature exhibits very gently sloping, unvegetated sandy sediment flats, in the 5- to 8-foot NAVD elevation range, with access to shallow slough waters and a clear buffer from adjacent shrubs and trees that may harbor predators (Figure 15). Documentation of conditions favored by snowy plovers on the COPR provides an opportunity to include replication of such conditions with project design to provide additional plover nesting habitat.

### **1.7.8 Tidewater Goby Habitat**

Available data indicate that tidewater goby, a federally endangered species, has been observed in Devereux Slough in the COPR and also upstream in Devereux Creek on the project site. In the project site, tidewater goby are documented to have been found within an excavated depression along the creek channel, near the confluence with Phelps Creek. Although tidewater goby was not found in Devereux Slough during surveys in 2014, they were found in Devereux Slough during surveys in 2004-2010, 2012, and 2013 (Goodman 2008, pers. comm. K. Lafferty and T. Longwell). Tidewater goby are also documented to be present in watersheds to the west and in other similar features tributary to Goleta Slough, (both features are in-channel depressions resulting from sediment removal practices associated with flood control). These features were characterized by the team to investigate potential opportunities for creation of project elements that may provide favorable conditions for tidewater goby, should the species return to a restored Devereux Slough system.

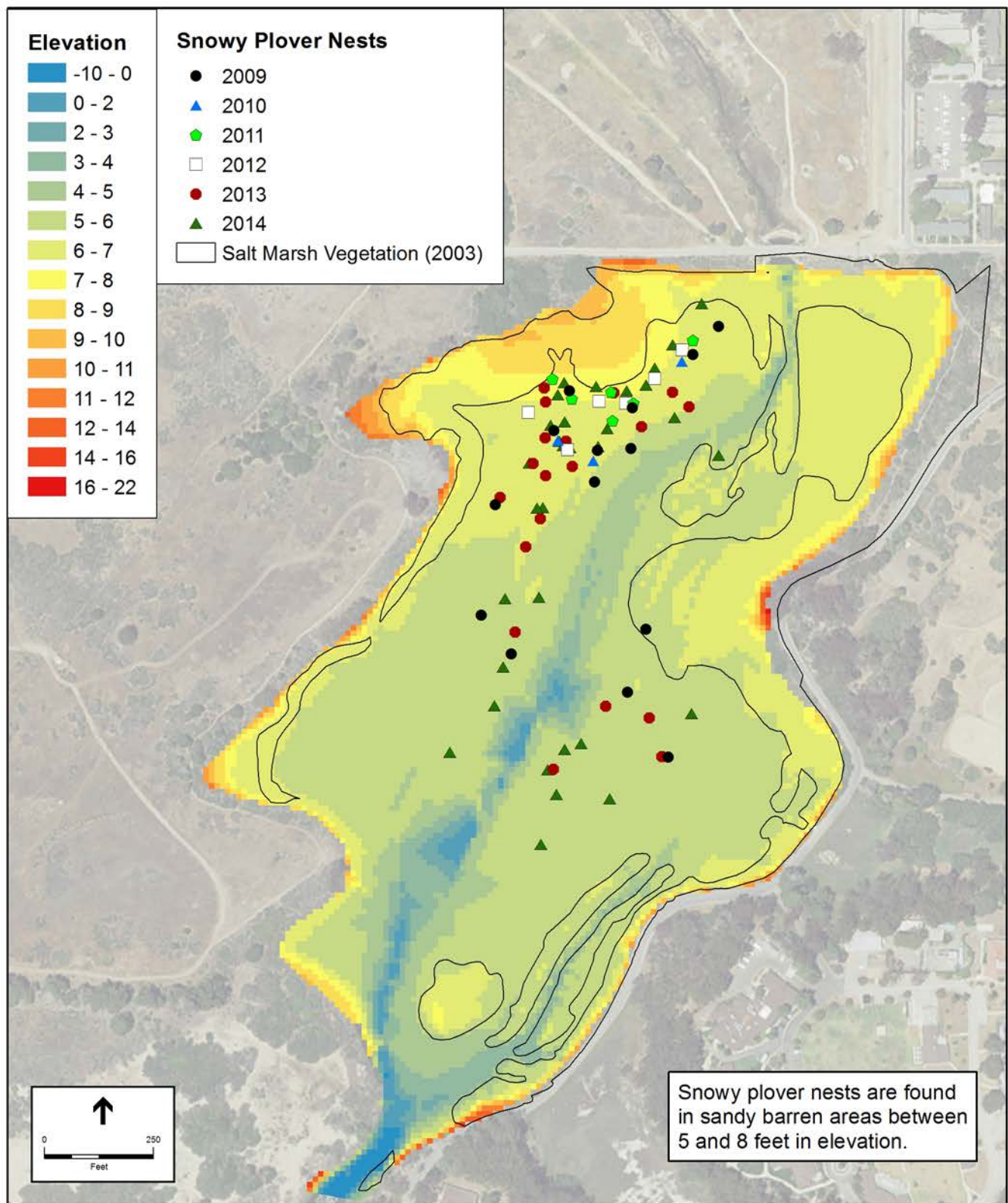
Further consultation with agency/UCSB personnel conducting tidewater goby monitoring locally should be pursued in Stage 2 to refine design criteria for project design features that may support tidewater goby habitat in the restored upper Slough.

### **1.7.9 Existing Native Habitats**

The existing habitats on the project site were inventoried and mapped as a part of several past unrelated projects. While not necessarily accurately representative of current existing conditions, these documents indicate a range of sensitive habitats scattered throughout the South Parcel and, to a lesser extent, within the golf course and Whittier properties. Many of these habitats are considered to have marginal function and quality. In contrast, the COPR, directly adjacent to the project site is comprised of a range high functioning habitats. These together present opportunities to increase, enhance and connect much needed habitat for no less than 20 state listed special-status species.

Updated habitat mapping should be conducted in Stage 2 to accurately characterize project baseline conditions and to refine project design.





SOURCE: Aerial (NAIP 2014); Salt Marsh (URS 2003);  
Elevations (ESA 2015); SNPL nest locations (CCBER 2015)

UCSB NCOS Restoration Project . D140769

**Figure 15**

Snowy Plover Nests in Lower Devereux Slough 2009-2014

### **1.7.10 Utilities and Other Built Assets**

The project site lies within a largely developed north campus and therefore needs to conform to conditions along its perimeter. However, these built conditions do not pose significant constraints beyond limiting the project footprint. Drainages are readily accommodated with a restored slough, and storm drainage performance can be maintained or improved. A sewer trunk line traverses the northern portion of the site along an east-west alignment: Access to manholes must be accommodated in project design.

Private property exists near campus housing east side of the project site. Deed restrictions require that the project must maintain specific setbacks from the private property.

Venoco Road crosses the connection between Devereux Creek and Devereux Slough and prevents restoration of a contiguous slough consistent with historic conditions. The road is presently needed for vehicular access to storage tanks at the Venoco Ellwood Marine Terminal, and is also heavily used for public access (pedestrian and bicycle). Prior work conducted by ESA indicates that the existing bridge is wide enough to facilitate restoration of a hydrologic connection that will support ecological functions. Therefore, it was decided in conjunction with the SAB and PC that modification of the bridge and earth approaches would not be part of this project, while future relaxation of the crossing (e.g. removal) would also be consistent if only marginally beneficial. However, it was confirmed that the sill – in channel grade control located just upstream of the bridge (Figure 5) is a hydrological barrier and must be removed to meet restoration project objectives. Prior study indicates that it may be necessary to install scour protection (riprap) along the expanded channel banks and/or bottom in the vicinity of the Venoco Road Bridge to limit scour following the removal of the sill. Without riprap or other protection, scour caused by the concentration of flow at the bridge may pose a risk to critical structural elements including the abutments and pilings. The scour protection would be placed along the bridge abutments and channel bottom in the vicinity of the bridge to protect against excessive scour that might threaten the bridge structure. The sizing and extent of riprap placement will be based on hydraulic and engineering analysis consistent with established guidelines published by the Federal Highway Administration (FHWA). This analysis will be conducted as part of Phase 2 Design.

Two abandoned oil wells exist on the project site (Campbell Geo 2011). The well heads were likely capped 5 to 15 feet below existing grades. These wells should be located to confirm they are buried far enough below proposed project grades, or identify other appropriate actions. A geophysical survey, in conjunction with test pit exploration would allow the exposure of those well heads and a precise horizontal/vertical survey to factor into grading plans.

### **1.8 Data Gaps and Recommendations for Stage 2 Studies**

Investigations and analyses conducted to elucidate project opportunities and constraints also informed identification of key areas where further investigation will be needed to complete scientific bases and refinements for project design. These needs, as discussed in section 1.7, above, include:

- *Conduct watershed hydrology modeling* to confirm and/or refine the design of project elements that are directly related to inflows and slough water levels (e.g. marsh grading elevations, bridges, channel dimensions).
- *Refine modeling of lagoon hydrology for restored conditions, with future sea level rise, to confirm or refine grades selected for emergent marsh. Also use QCM to address salinity to further inform design of restoration features.*
- *Conduct further groundwater investigation* to confirm groundwater data and *salinity, using new wells and geo-referencing existing wells and data.*
- *Test soil salinity and texture more broadly in the former golf course* to accurately characterize current soils conditions including the extents and distribution of high salinity and clay content soils. This understanding will inform refinement of earth handling and possible soil treatment operations for project construction planning.
- *Determine volume of sandy soil available for salvage on the mesa* to inform South Parcel fill (selective grading/placement) and distribution of restored habitats on the mesa.
- *Collect baseline biological data sufficient* to inform planning process. A biological assessment and wetland delineation should be prepared for the entire project area. The results of this study should be used to inform the restoration design so that sensitive habitats and resources can be avoided where feasible. Also, where avoidance is not feasible, the project should be self-mitigating. Understanding the current resources is key to avoiding and mitigating impacts.
- *Document elevation distributions of target plant species and habitats in the lower Slough* to predict habitat distributions and guide planting in the restored slough.
- *Compare observed plant and habitat distributions to actual and modeled hydrologic conditions in the lower Slough* to confirm the appropriate elevations for each habitat class under the restored hydrologic regime.
- *A range of engineering-design related activities including specifically updated topography and base map and soil borings and geotechnical analyses.*
- *Consult with agency/UCSB staff/students conducting local tidewater goby monitoring* to refine design criteria for project design features that may support tidewater goby habitat in the restored Slough
- *Conduct site visit with agency representatives* to gain input from the agencies as to issues and concerns that must be addressed in CEQA compliance and permitting processes for the project.
- *Integration with others to utilize wetland delineation and other pertinent data to be collected by others.*

## 1.9 Development of Conceptual Alternatives

ESA reviewed existing conditions relative to project goals and objectives, and identified restoration opportunities and constraints, discussed above. Technical analyses were accomplished collaboratively with UCSB to bolster our understanding of physical conditions and processes that affect the feasibility of habitat creation and achievement of other project objectives. The results were used to develop two conceptual project alternatives: Alternative 1, called *Maximum Grading*, and Alternative 2, called *Reduced Grading*.

Alternative 1 *Maximum Grading* was refined from prior work that was focused on assessing whether earthwork to restore the upper Slough could be balanced on site. ESA confirmed that restoration of the upper Slough to the maximum practical excavation limits could be accomplished by placing excavated material on the degraded South Parcel mesa to avoid substantial offhaul of earth. This prior “rough grading plan” was refined to achieve restoration project objectives, while maximizing the extent of restored estuarine habitat. Alternative 1 was developed by adjusting this prior rough grading plan to conform with existing conditions, opportunities and constraints and specifically existing land uses, proposed public access, and existing habitats, while maintaining maximum practical restoration of the historic slough basin.

Alternative 2 *Reduced Grading* was further refined from Alternative 1 in order to achieve a greater diversity of habitats by preserving more of the existing habitats surrounding the excavation area for the restored estuary, and to provide space for future transgression of estuarine habitat in anticipated response to sea level rise. This Alternative entailed reduced excavation and a smaller slough basin, and less fill in the South Parcel.

Alternatives 1 and 2 are described briefly below and in greater detail in Appendix D.

### **1.9.1 Description of Conceptual Alternatives**

#### **Alternative 1 Max Grading**

This design would restore the maximum feasible extent of the upper Devereux Slough to estuarine habitats. The design would feature conversion of most of the low lying lands of the site to estuarine aquatic and wetland habitats, with limited fresh to brackish wetland features at the Phelps Creek and Storke Road wetlands entry points (Figure 16).

This alternative targets restoration of the upper Slough footprint, to the extent practicable without encroaching on developed areas and without exporting excavated material from the site. Elevations in the restored slough would favor creation of predominantly subtidal/aquatic and mudflat/salt flat (unvegetated) habitats. While habitat zonation in tidal estuaries is generally predictable based upon known inundation regimes (diurnal inundation with the tides) and salinity gradients (salinities generally at or near that of seawater), the widely fluctuating conditions of Devereux Slough, which is only episodically open to the tides for short time periods, are much more complex, and therefore are difficult to predict. ESA developed the projected habitat distributions presented below via opportunities and constraints analyses described in section 1.7, including:

- Application of a Quantified Conceptual Model
- Subsurface well and soils information collected by UCSB
- Characterization of habitat distribution in the Lower Devereux Slough (data provided by UCSB), which we believe is the best available reference site





SOURCE: Aerial Photo: Google Earth, 2015. Topography: Aerial Photogrammetry June 13, 2006 by Arrowhead Mapping Corporation



UCSB NCOS Restoration Project . D140769  
**FIGURE 16**  
 Alternative 1 - Maximum Grading Habitats





On the areas of the project site to be excavated, target elevation bands and plan-view locations, were selected to produce conditions conducive to establishment and sustainability of subtidal aquatic habitat, mudflats/saltflats, marsh plain (vegetated marsh and unvegetated sediment plains), high marsh/transitional ecotone, and upland habitats. On the fill site, restoration efforts would focus on creation of locally rare, site appropriate habitats, including vernal pools, seasonal wetlands, native grassland, coastal sage scrub, back dune woodland/scrub, and sandy dune annual vegetation. Table 3, below, presents estimated areas of existing habitat, projected impacts and habitats to be created and preserved with Alternative 1.

**Table 3. Alternative 1 Max Grading Habitats**

Habitat Type	Acres Total Existing Habitats <sup>4</sup>	Acres Created <sup>1</sup>	Acres Impacted	Acres Preserved	Total Acres With Project
		Alternative 1 Maximum Grading			
Subtidal/Aquatic	0.0	8.2	0	0.0	8.2
Mudflat/Salt Flat	0.0	19.0	0	0.0	19.0
Marsh Plain <sup>2</sup>	0.9	15.1	0	0.9	16.0
Freshwater/Brackish Wetland	9.5	0.5	9.3	0.2	0.7
High Marsh/Transition	0.0	9.9	0	0.0	9.9
Southern Riparian Scrub <sup>3</sup>	3.1	4	2.2	0.9	4.9
Native grassland	0.9	35.1	0.7	0.2	35.3
Vernal Pool/Native Grass complex	0.7	4.1	0	0.7	4.8
Coastal Sage Scrub	2.7	10.1	1.7	1.0	11.1
Seasonal Wetland	0.4	0.0	0.4	0.0	0.0
Semi-Perennial Wetland	0.2	0.0	0.2	0.0	0.0
Sandy Dune Annuals	0.0	0.3	0	0.0	0.3
TOTAL	18.4	106.3	14.5	4.0	110.3

<sup>1</sup> Distribution and extents of habitats would be determined based upon further soils testing and analyses and final grading. Acres of created habitats category does not include existing habitats to be preserved on the site (these are shown in the 'acres preserved' category).

<sup>2</sup> Based upon distribution and extent of vegetated salt marsh present within the Lower Devereux Slough, we project that approximately 50% of the acres indicated for this habitat would be vegetated and the remainder would be unvegetated sediment flats

<sup>3</sup> Southern riparian scrub includes back dune woodland/scrub

<sup>4</sup> Sources for existing habitats: Watershed Environmental 2003, URS 2004, WRA 2006, Morro Group 2006, 2007

Approximately 550,000 CY of fill would be excavated to create grades suitable for estuarine habitats. Excavated soils would be placed onto portions of the South Parcel to re-form the mesa to topography similar to existing natural landforms in the vicinity. The land form would be contoured such that drainage would flow toward the northwest toward the restored upper Slough, to support existing and future vernal and seep-fed wetlands.

Revegetation would be undertaken as soils tests determined the planting substrate was suitable to target native plant species. Final plant palette and habitat selection, distribution and extents would be determined based upon further investigation of site soils characteristics and subsurface conditions on the South Parcel fill site. Marsh plain habitat would be actively revegetated with pickleweed and other salt marsh species, as natural recruitment (generally good in fully tidal marsh restorations) would be expected to be minimal and/or very slow due to the intermittent tidal inundation of the Devereux Slough system.

### **Alternative 2 – Reduced Excavation**

This design would restore a lesser extent of the historic upper Slough to subtidal/aquatic and mudflat/saltflat habitats in favor of preservation of more existing wetland habitats and creation of a greater diversity of habitat types and features (Figure 17). Reduced grading in the northwestern (Devereux Creek) arm of the upper Slough was proposed to create conditions conducive to preservation and continued function of adjacent salt marsh and on-site seep-fed wetland habitats.

The reduced excavation along the western, Devereux Creek arm would allow construction of special habitat features. The features included in Alternative 2 are targeted toward fresh and brackish wetlands, as described below, at two locations, the Devereux Creek arm (northwest area of site) and the eastern arm (adjacent to the Whittier Parcel). Also, reduced slough construction would provide space for potential shore bird habitat designed for the downstream (southern) part of the restoration site, near Venoco Road.

#### *Seasonal Wetlands and Freshwater Expression in the Devereux Creek arm*

A large seasonally ponded feature would be created at the northern site boundary, west of the Phelps Creek tributary connection. At Phelps Creek, grade control and backwater feature would be created to connect the creek to the restored estuary, targeting conditions that may provide suitable habitat for tidewater goby, should a population reenter the restored estuary system (Figure 18). While the feasibility of supporting a goby population with this feature is uncertain, there are indications that habitat has been created inadvertently in depressions excavated for sediment removal in Devereux Creek and Goleta Slough. This feature would also be designed to preserve freshwater expression to the grade control location, maintaining conditions that support recent riparian restoration projects implemented on Phelps Creek, just upstream of the project site boundary.

#### *Riparian Habitat on East Arm*

At the Whittier Parcel, the banks of a ditch currently carrying fresh water inflows through the site would be graded back to create riparian and wetland habitat and a fresh-to-brackish transitional connection to the restored estuary. To the south of this feature, existing wetlands fed by drainage to the site from a culvert that flows under Storke Road would be preserved and enhanced within the design.



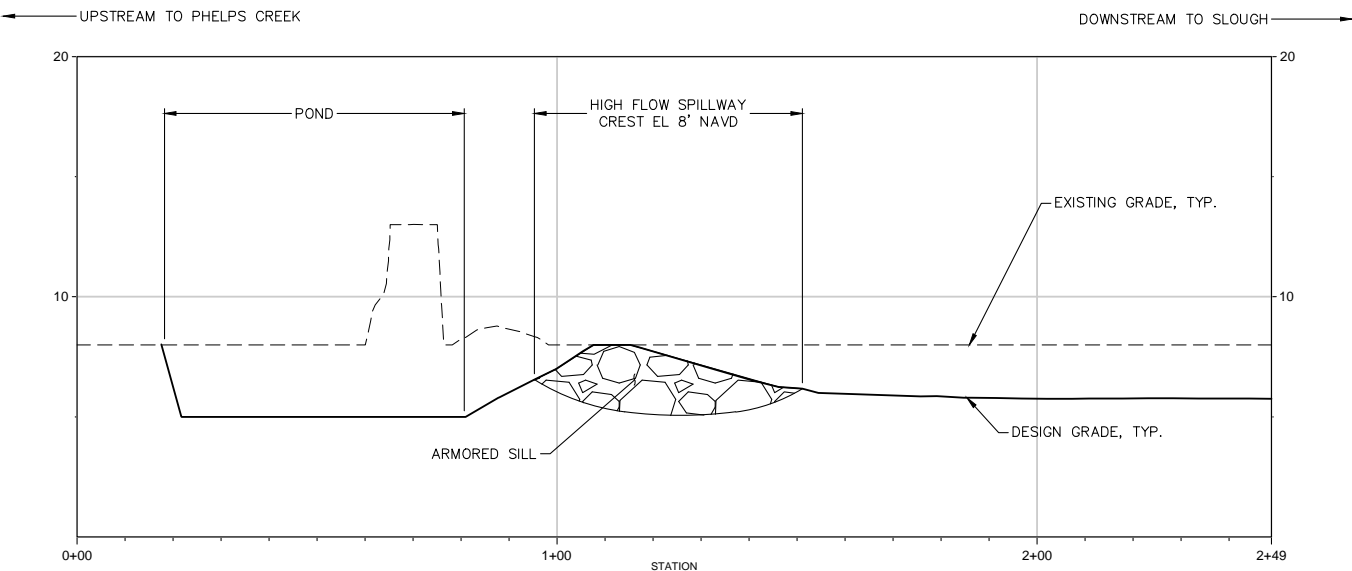


SOURCE: Aerial Photo: Google Earth, 2015. Topography: Aerial Photogrammetry June 13, 2006 by Arrowhead Mapping Corporation

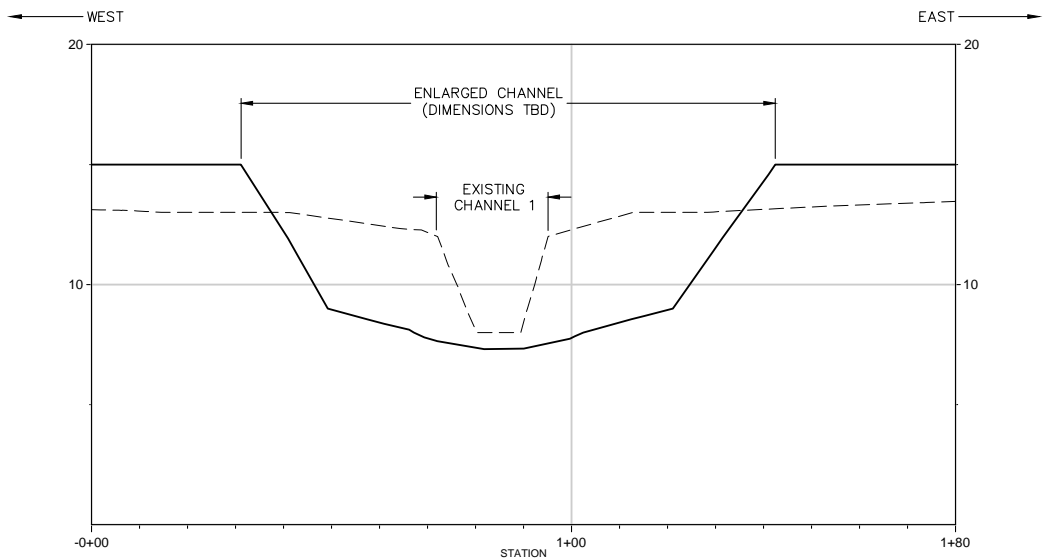


UCSB NCOS RESTORATION PROJECT . D140769  
**FIGURE 17**  
North Campus Open Space Restoration  
Project Habitat Plan





**A**  
PHELPS CREEK HIGH FLOW CHANNEL  
Alt 2: Reduced Grading  
SCALE:  
HORIZ: 1"=20'  
VERT: 1"=4'



**B**  
ENLARGED PHELPS CREEK CHANNEL NEAR BRIDGE D  
Alt 2 - Reduced Grading  
SCALE:  
HORIZ: 1"=20'  
VERT: 1"=4'

SOURCE: Aerial Photo: Google Earth, 2015. Topography: Aerial Photogrammetry June 13, 2006 by Arrowhead Mapping Corporation



UCSB Devereux Slough .D140769.00  
**FIGURE 18**  
Phelps Ck. Connection Cross Sections

### *Shorebird Habitat adjacent to COPR*

In the southeastern area of the site, straddling the golf course / South Parcel property boundary, a large extent (approximately 2.75 acres) of marsh plain elevation lands would be created and augmented with sandy soils, and be left unvegetated, in order to provide conditions that may be suitable for nesting

western snowy plover. This feature was designed to mimic conditions that occur in a 2- 3 acre area of the lower Slough, located just across Venoco Road, which is currently used by snowy plovers as a nesting site.

As described above for Alternative 1, the fluctuating conditions of intermittently tidal slough systems such as Devereux Slough are complex, and, therefore, difficult to predict. ESA developed the projected habitat distributions presented below via the analyses described in section 1.7 and listed for Alternative 1, above.

For the excavation area, target elevation bands and plan-view locations were selected to produce conditions conducive to establishment and sustainability of subtidal aquatic habitat, mudflats/saltflats, marsh plain (vegetated marsh and unvegetated sediment plains), high marsh/transitional ecotone, 'perched' seasonal wetland and upland habitats. On the fill site, restoration efforts would focus on creation of locally rare, site appropriate habitats, including vernal pools, seasonal wetlands, native grassland, coastal sage scrub, back dune woodland/scrub, and sandy dune annual vegetation. Table 4, below, presents projected areas of habitat to be created and/or restored with Alternative 2.

**Table 4. Alternative 2 Reduced Grading Habitats**

Habitat Type	Acres Total Existing Habitats <sup>4</sup>	Acres Created <sup>1</sup>	Acres Impacted	Acres Preserved	Total Acres With Project
		Alternative 2 Reduced Grading			
Subtidal/Aquatic	0.0	5.5	0.0	0.0	5.5
Mudflat/Salt Flat	0.0	9.5	0.0	0.0	9.5
Marsh Plain <sup>2</sup>	0.9	17.4	0.0	0.9	18.3
Freshwater/Brackish Wetland	9.5	0.5	9.5	0.0	0.5
High Marsh/Transition	0.0	13.1	0.0	0.0	13.1
Southern Riparian Scrub <sup>3</sup>	3.1	4.1	0.4	2.7	6.8
Native grassland	0.9	29.7	0.4	0.5	30.2
Vernal Pool/Native Grass complex	0.7	4.1	0.0	0.7	4.8
Coastal Sage Scrub	2.7	14.9	1.5	1.2	16.1
Seasonal Wetland	0.4	0.9	0.4	0.0	0.9
Semi-Perennial Wetland	0.2	0.0	0.2	0.0	0.0
Sandy Dune Annuals	0.0	0.3	0.0	0.0	0.3
TOTAL	18.4	100.0	12.4	6.0	106.0

<sup>1</sup> Distribution and extents of habitats would be determined based upon further soils testing and analyses and final grading. Acres of created habitats does not include existing habitats to be preserved on the site (these are shown in the 'acres preserved' category).

<sup>2</sup> Based upon distribution and extent of vegetated salt marsh present within the Lower Devereux Slough, we project that approximately 50% of the acres indicated for this habitat would be vegetated and the remainder would be unvegetated sediment flats

<sup>3</sup> Southern riparian scrub includes back dune woodlands

<sup>4</sup> Sources for existing habitats: Watershed Environmental 2003, URS 2004, WRA 2006, Morro Group 2006, 2007

In the Reduced Grading Alternative, approximately 350,000 CY of fill would be excavated. Placement of excavated material on South Parcel would occur as described for Alternative 1. However the reduced volume of material generated in excavation for this Alternative would result in a smaller fill footprint on South Parcel and facilitate preservation of a greater extent of wetland and dune scrub habitats existing on the site. The finished fill land form would be contoured such that drainage would flow toward the northwest, to support existing and future vernal and seep-fed wetlands on and adjacent to the restoration project site.

Revegetation would be undertaken as described for Alternative 1.

#### **Alternatives 1 and 2 -- Comparative Jurisdictional Impacts:**

Table 5, below, presents a summary comparison of overall habitat effects of the two project alternatives. It should be noted that the estimates of impacts to and preservation of existing habitats provided below are based up on earlier studies that may not accurately reflect current habitat conditions and/or distribution on the project site. A current wetland delineation and vegetation survey will be needed in Stage 2 to accurately characterize baseline conditions and evaluate potential project impacts.

**Table 5. Habitats Comparison between Alternatives 1 and 2**

Habitat Type	Acres Total Existing Habitats <sup>4</sup>	Acres Impacted	Acres Created <sup>1</sup>	Acres Preserved	Total Acres With Project	Acres Impacted	Acres Created <sup>1</sup>	Acres Preserved	Total Acres With Project
		Alternative 1 Maximum Grading				Alternative 2 Reduced Grading			
Subtidal/ Aquatic	0.0	0	8.2	0.0	8.2	0.0	5.5	0.0	5.5
Mudflat/ Salt Flat	0.0	0	19	0.0	19.0	0.0	9.5	0.0	9.5
Marsh Plain <sup>2</sup>	0.9	0	15.1	0.9	16.0	0.0	17.4	0.9	18.3
Freshwater / Brackish Wetland	9.5	9.3	0.5	0.2	0.7	9.5	0.5	0.0	0.5
High Marsh/ Transition	0.0	0	9.9	0.0	9.9	0.0	13.1	0.0	13.1
Southern Riparian Scrub <sup>3</sup>	3.1	2.2	4	0.9	4.9	0.4	4.1	2.7	6.8
Native grassland	0.9	0.7	35.1	0.2	35.3	0.4	29.7	0.5	30.2



Habitat Type	Acres Total Existing Habitats <sup>4</sup>	Acres Impacted	Acres Created <sup>1</sup>	Acres Preserved	Total Acres With Project	Acres Impacted	Acres Created <sup>1</sup>	Acres Preserved	Total Acres With Project
Vernal Pool/ Native Grass complex	0.7	0	4.1	0.7	4.8	0.0	4.1	0.7	4.8
Coastal Sage Scrub	2.7	1.7	10.1	1.0	11.1	1.5	14.9	1.2	16.1
Seasonal Wetland	0.4	0.4	0	0.0	0.0	0.4	0.9	0.0	0.9
Semi-Perennial Wetland	0.2	0.2	0	0.0	0.0	0.2	0.0	0.0	0.0
Sandy Dune Annuals	0.0	0	0.3	0.0	0.3	0.0	0.3	0.0	0.3
TOTAL	18.4	14.5	106.3	4.0	110.3	12.4	100.0	6.0	106.0

<sup>1</sup> Distribution and extents of habitats would be determined based upon further soils testing and analyses and final grading

<sup>2</sup> Based upon distribution and extent of vegetated salt marsh present within the Lower Devereux Slough, we project that approximately 50% of the acres indicated for this habitat would be vegetated and the remainder would be unvegetated sediment flats

<sup>3</sup> Southern riparian scrub includes back dune woodland/scrub

<sup>4</sup> Sources for existing habitats: Watershed Environmental 2003, URS 2004, WRA 2006, Morro Group 2006, 2007

## 1.9 Evaluation of Alternatives and Selection of the Project

The Science Advisory Board (SAB) and Project Committee (PC) met with ESA on July 31, 2015 to review the Alternatives Evaluation and select the preferred alternative to move forward as the proposed project. The Alternatives Evaluation document is presented in Appendix D, and summarized in this section.

The alternatives were evaluated based upon quantitative metrics (presented in the tables in section 1.8 above) and on their performance relative to project goals and objectives. Alternative 2 *Reduced Grading* was selected as the preferred project for implementation. The following are considerations that led to selection of Alternative 2:

- Resilience:** Alternative 2 has greater potential habitat resiliency owing to its provision of a greater area of space for migration of estuarine wetland habitat in response to sea level rise. While Alternative 1 provides a greater extent of estuarine wetland immediately following construction (42 acres compared to 33 acres for Alternative 2), future conditions driven by sea level rise are expected to result in a conversion of much of the emergent and transitional wetland to submerged aquatic habitat, reducing habitat diversity. With future sea level rise, Alternative 2 maintains a mix of habitats. The higher elevation high marsh transitional habitat (13 acres vs. 10 acres for Alternative 1) is expected covert to vegetated marsh habitat with higher inundation frequencies. Three feet of sea level rise was assumed for this analysis.

- **Cost:** Alternative 2 requires less excavation and earth moving (350,000 vs 550,000 cubic yards, a 36% decrease), indicating lower earth moving and construction costs.
- **Impact:** The reduced earthwork volume associated with Alternative 2 results in slightly lesser area of impact to existing habitats (2.0 acres) owing to a reduced fill footprint in the South Parcel. In addition, Alternative 2 was configured with reduced excavation in the (northwest) Devereux arm to avoid lowering groundwater levels and soil moisture that sustain existing wetlands.
- **Diversity:** By reducing the extent of excavation, Alternative 2 allows more space for transitional area (13 acres for Alternative 2 vs. 10 acres for Alternative 1; 3 acres and 30% more than Alternative 1) and fresh-brackish and seasonal wetland (1.4 acres for Alternative 2 vs. 0.7 acres for Alternative 1; 0.7 acres and 50% more than Alternative 1). The reduced excavation also allows space for habitat creation opportunities targeted toward snowy plover (just north of Venoco Road) and bird foraging (seasonal wetland feature on the northern project area west of Phelps Creek confluence). Alternative 1 habitat enhancement is 62% estuarine (42 acres of aquatic, flats and marsh of 68 acres graded) versus 52% (33 acres of 64 acres graded) for Alternative 2. With sea level rise, the percentage of aquatic habitat expands for Alternatives 1 and 2, but Alternative 2 maintains more marsh while flats and submerged habitat are dominant in Alternative 1.

## PART II PROJECT PROGRAM

The selected project proposes removal of the sill structure in Devereux Creek at the Venoco Road Bridge to restore hydrologic connectivity to the lower Devereux Slough, and grading of the site to restore subtidal estuarine habitat to portions of the historic estuary footprint in the upper Slough. Careful preservation of existing habitats and extensive planting with appropriate native plant species will help to restore and enhance natural habitat functions including the quality of the area as a wildlife corridor. Trails and interpretive elements will provide public access, educational opportunities and aesthetic enhancement. This project, as it evolves from pre-construction baseline studies through future adaptations to changes in climate and sea level rise, will provide unique opportunities for research and developing understanding of an increasingly rare estuarine environment.

### 2.1 Project Concept

The proposed restoration will entail modifying the form of the golf course, Whittier and South Parcel properties to restore the upper Slough and adjacent mesa to a more natural geomorphic configuration, hydrologic regime and habitat mosaic. The restoration area will be graded and planted with appropriate native species to restore a diversity of wetland habitats characteristic of the Devereux Slough system, including estuarine and palustrine (freshwater) habitat types, and to provide enhanced habitat values and connections to the larger 652-acre Ellwood Devereux Coastal Open Space which includes the project site. The design will preserve and expand estuarine, seasonal wetland, riparian, vernal pool, and native upland habitats, create conditions that may support special status species, including southern tarplant, tidewater goby, Belding's savannah sparrow and western snowy plover, and maintain genetic integrity on the project site and COPR. Public access and passive recreational opportunities will be provided with trails, interpretive and viewing elements and regional trail connections.

Features of the proposed project design include the following:

- Create conditions conducive to preservation and continued function of adjacent salt marsh and wetland habitats.
- A large seasonally ponded feature would be created at the northern site boundary, west of the Phelps Creek tributary connection, with potential benefits to migratory shorebirds and other wildlife.
- At Phelps Creek, grade control and backwater feature would be created to connect the creek to the restored estuary, targeting conditions that could provide suitable habitat for tidewater goby, should a population reenter the restored estuary system. This feature would also be designed to preserve freshwater expression to the grade control location, maintaining conditions that support recent riparian restoration projects implemented on Phelps Creek just upstream of the project boundary.
- At the Whittier Parcel, a ditch carrying fresh water inflows would be graded to create expanded and enhanced riparian and wetland habitats and a fresh to brackish ecotonal connection to the restored estuary.

- In the southeastern area of the site, a large extent (approximately 2.75 acres) of marsh plain habitat would be graded, augmented with sand, and not be revegetated, in order to provide conditions suitable for nesting snowy plovers. This design mimics conditions that occur in a 2- 3 acre area of the lower Slough, located just across Venoco Road, which is currently used by snowy plovers as a nesting site.
- Removal of the sheet pile sill at the Venoco Road Bridge, to restore hydrologic connectivity between the lower and restored upper Devereux Slough.
- Revegetation of the restored landscape with native salt marsh, fresh and/or brackish wetland, high marsh/transitional, seasonal wetland, vernal pool, riparian, back dune woodland/scrub, coastal sage scrub, native grassland, and sandy dune annual species, according to their physiological requirements, to create natural zonation and structural diversity within the restored habitat.
  - Salt marsh species would be planted on 65% of the marsh plain elevation, with the remainder of the marsh plain surface to be unvegetated sediments.
  - Riparian vegetation will be planted at the confluence of Phelps Creek with the Upper Devereux Slough. Once established, riparian canopy will shade portions of the stream, lowering water temperatures and enhancing aquatic habitat conditions.
  - Existing canopy trees that currently serve as roosting, nesting, and forage sites for Cooper's hawk and a variety of avian species will be preserved on site.
  - Plantings will include species such as California blackberry and blue elderberry (*Sambucus nigra* ssp. *caerulea*), which have cover and forage value for birds and other wildlife.
  - To the extent possible, plant materials will be salvaged from the site or collected and grown from local sources, in order to preserve local genotypic integrity.
- The restored project area will provide enhanced cover, resting and forage areas and an enhanced corridor for wildlife, as well as enhanced aesthetic and recreational values for local residents.
- The project, as it evolves over time from construction through establishment, through adaptations with changes in climate and sea level rise will provide rich opportunities for research and education.
- The proposed design will include provision for substantial wildlife viewing opportunities, a hierarchy of networked trails to accommodate trail use, and create varied experiences with near-trail plantings to enhance the sense of solitude and relaxation that many users desire.
  - Primary trails will be located at elevations above the projected 100-year flood water surface elevation, on the north and east sides of the project area, with connections to local trails adjacent to the site.

## 2.2 Grading/Topography

The reshaping of the upper Devereux Slough will begin immediately upstream of the Venoco Bridge crossing. The golf course fill will be removed and the site will be excavated to elevations of 3.5 – 5 ft. NAVD to create a subtidal slough channel, surrounding mudflats and marsh plain (vegetated salt marsh and unvegetated sediments) terraces, and gradual transitional areas (high marsh to upland habitats).



Approximately 350,000 cubic yards (CY) of fill will be excavated and placed to re-form portions of the South Parcel mesa to topography similar to existing natural landforms in the vicinity. Design grades and cross-sections are provided on the grading plan depicted in Figures 19a and 19 b.

## 2.3 Hydrology

The project site and lower Devereux Slough experience a seasonal cycle of inundation controlled by the local freshwater hydrology, slough mouth dynamics, and the long-term effects of the golf course construction on site topography. Although several comprehensive data collection efforts have taken place (Collins and Melack 2014; CCBER 2015; UCSB 2015), there are gaps in the records of slough water levels and watershed runoff to the project site. Because of this, ESA developed a number of tools to assess the hydrology and hydraulics of the site. These include a synthetic runoff time series, and the Quantified Conceptual Model (QCM) described in Appendix E.

ESA found that inundation of lower Devereux Slough varies strongly from month to month and between years. Lower Devereux Slough water levels tend to reach heights of 8-10 feet NAVD in the winter months prior to mouth breach events, and lows of 4-6 feet during the late summer and fall after beach seepage and evapotranspiration deplete water trapped behind the beach berm at the slough mouth.

To assess the effects of the proposed project (i.e. after restoration) on this cycle, ESA simulated slough conditions at roughly a six-minute time step with the QCM from 2000-2014 and examined the wettest and driest seven years of the period 2000-2014 in detail. The choice of a six-minute time step is based on prior experience in coastal lagoons (Behrens et al. 2015). The time required to model a 15-year period increases greatly for smaller time steps. However, since water levels in the slough and the coastal zone vary continuously, time steps need to be small enough that sudden changes in water level are appropriately resolved, and so the model results are independent of the time step. ESA (2015) and Behrens et al. (2015) have found in the past that 10-minute time steps and lower were sufficient to model tidal conditions both at the nearby Goleta Slough and at the Russian River in Sonoma County, which is the focus of a long-term estuary management program.

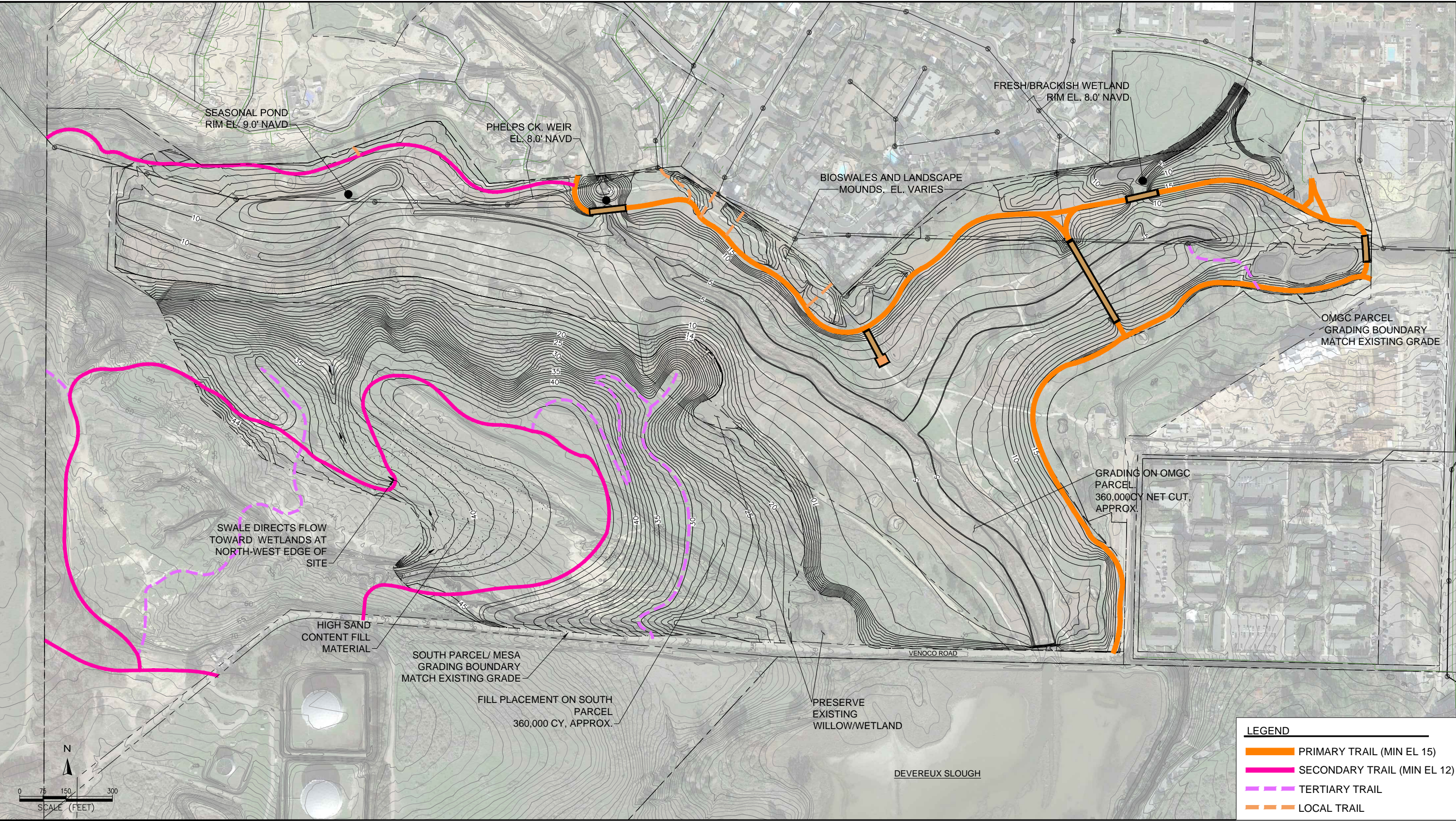
For present-day conditions (no sea level rise), Figure 20 summarizes the monthly expected inundation with and without the project. The project has two main effects:

- Open-mouth conditions are slightly extended as added intertidal volume leads to stronger currents (and thus increased scour) in the slough mouth, and
- Mouth breaching is delayed in wet years and prevented in some dry years, because the added slough volume requires more runoff to fill to levels that would cause the slough to breach. This increases the likelihood of winter water levels reaching roughly 8 ft. NAVD and higher. As mudflats will occur at a range of habitats, this will lead to more frequent mudflat inundation.

When sea level rise is not considered, the added intertidal volume resulting from the project is only about a 25 percent increase. The predicted increase in the periods of open-mouth conditions is small, as this increase does not amount to significantly higher flows in the slough mouth. As a result, the overall predicted shift is toward fewer breaches, and thus slightly higher water levels in the slough. With and







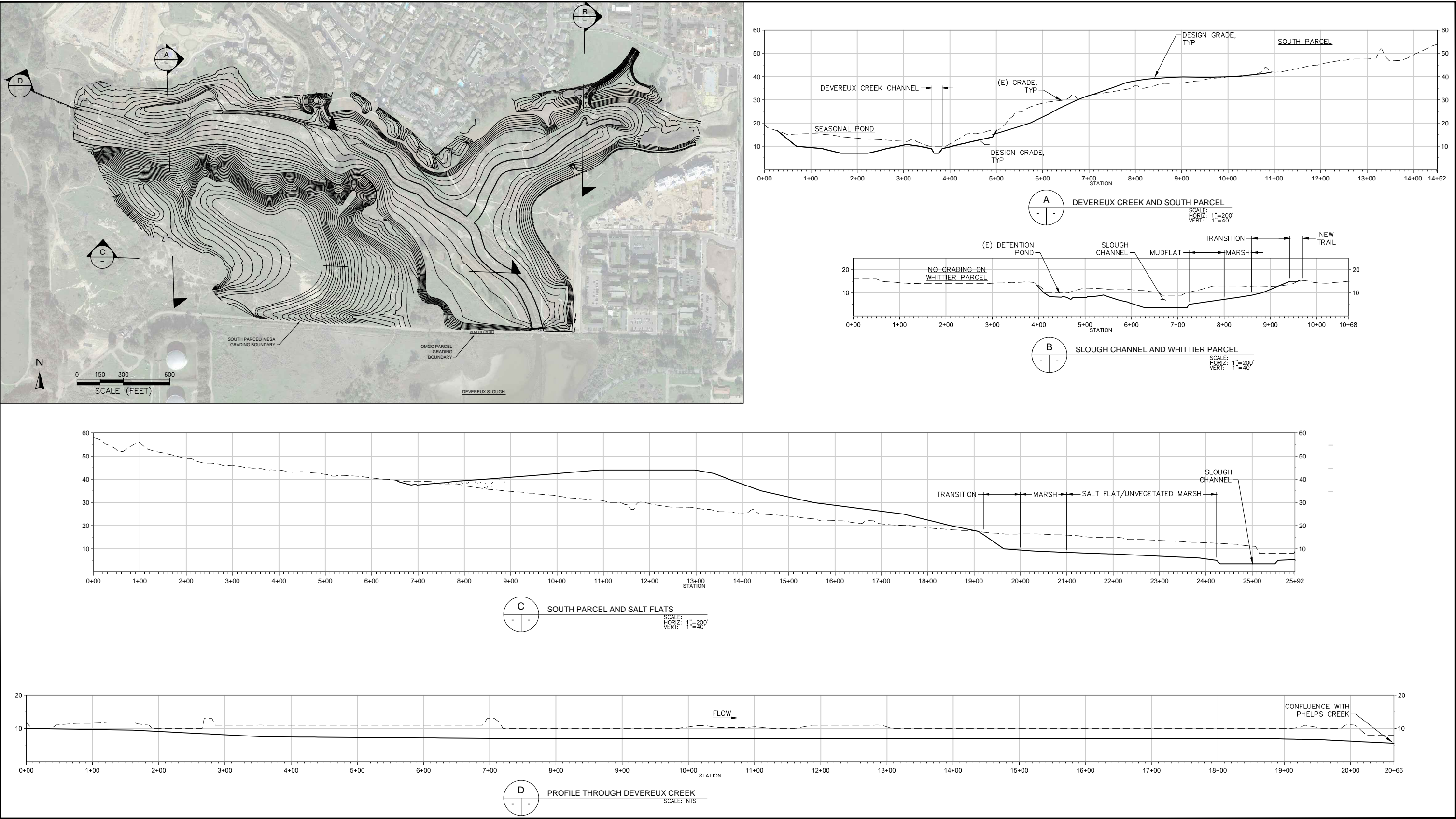
SOURCE: Aerial Photo: Google Earth, 2015. Topography: Aerial Photogrammetry June 13, 2006 by Arrowhead Mapping Corporation



UCSB NCOS Restoration Project . D140769

**FIGURE 19a**  
Project Grading Plan





SOURCE: Aerial Photo: Google Earth, 2015. Topography: Aerial Photogrammetry June 13, 2006 by Arrowhead Mapping Corporation

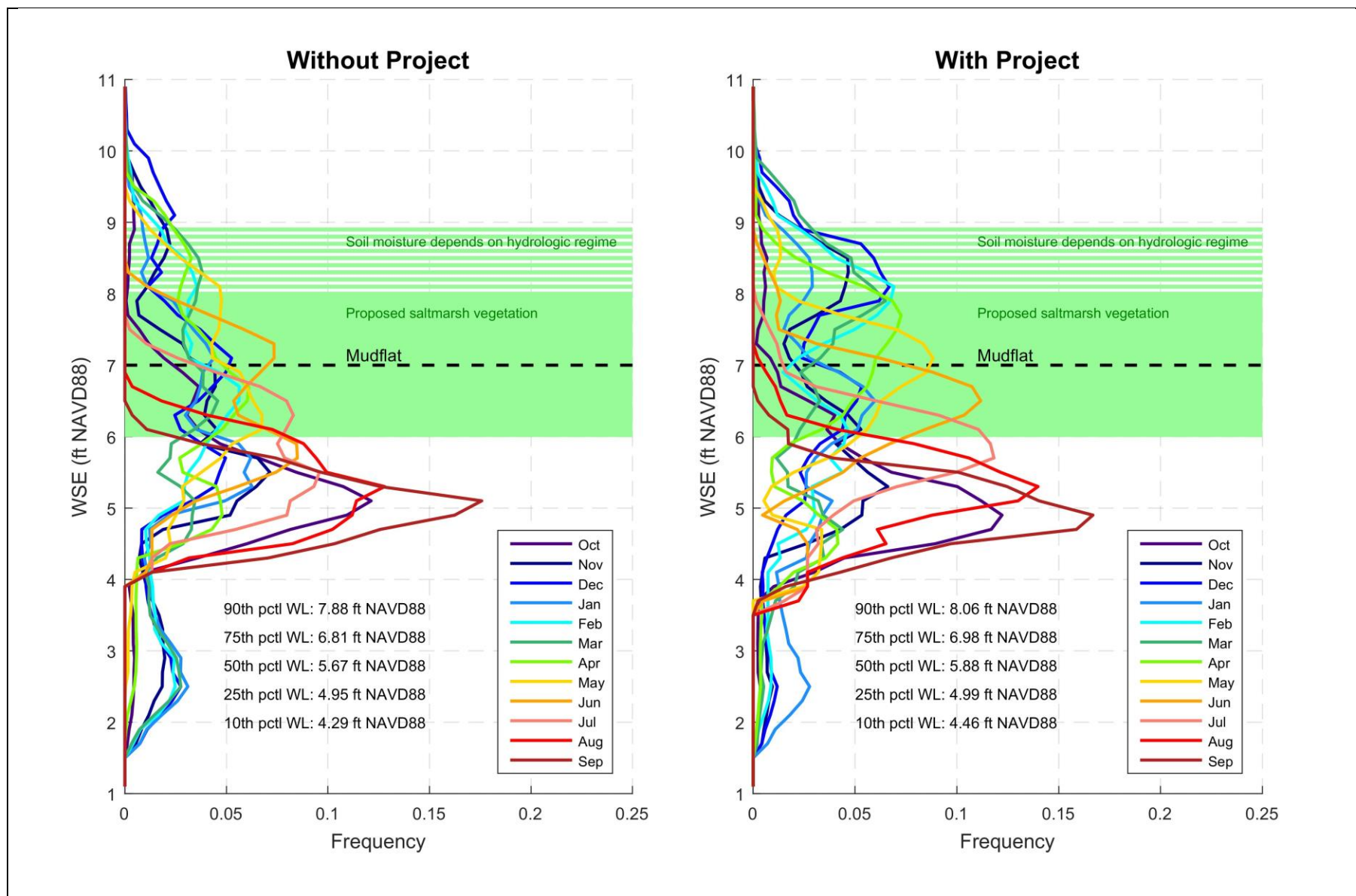
UCSB NCOS RESTORATION PROJECT . D140769

**FIGURE 19b**

Project Grading Cross Sections







SOURCE: ESA QCM model  
NOTE: A linear box filter was used to smooth curves

UCSB NCOS Restoration Project . D140769

**Figure 20**  
Monthly Occurrence Frequency of Slough Water Levels **(left)** without the project and **(right)** with the project.

without the project, it is expected that the mudflats at the site will be inundated 20 and 15 percent of the time, respectively.

Figures 21 and 22 look more closely at the influence of the project on site inundation. Under present-day conditions with no SLR (Figure 21, 22 upper panels), QCM analysis showed:

- The project has more influence in prolonging mouth closures than in extending open-mouth tidal conditions.
- Overall, the expected range of slough water levels is similar in wetter and drier years, but mean levels were slightly higher for dry years due to fewer breach events. Slough stage was most often in the range from 5.5-7.5 ft. NAVD for both wet and dry years.

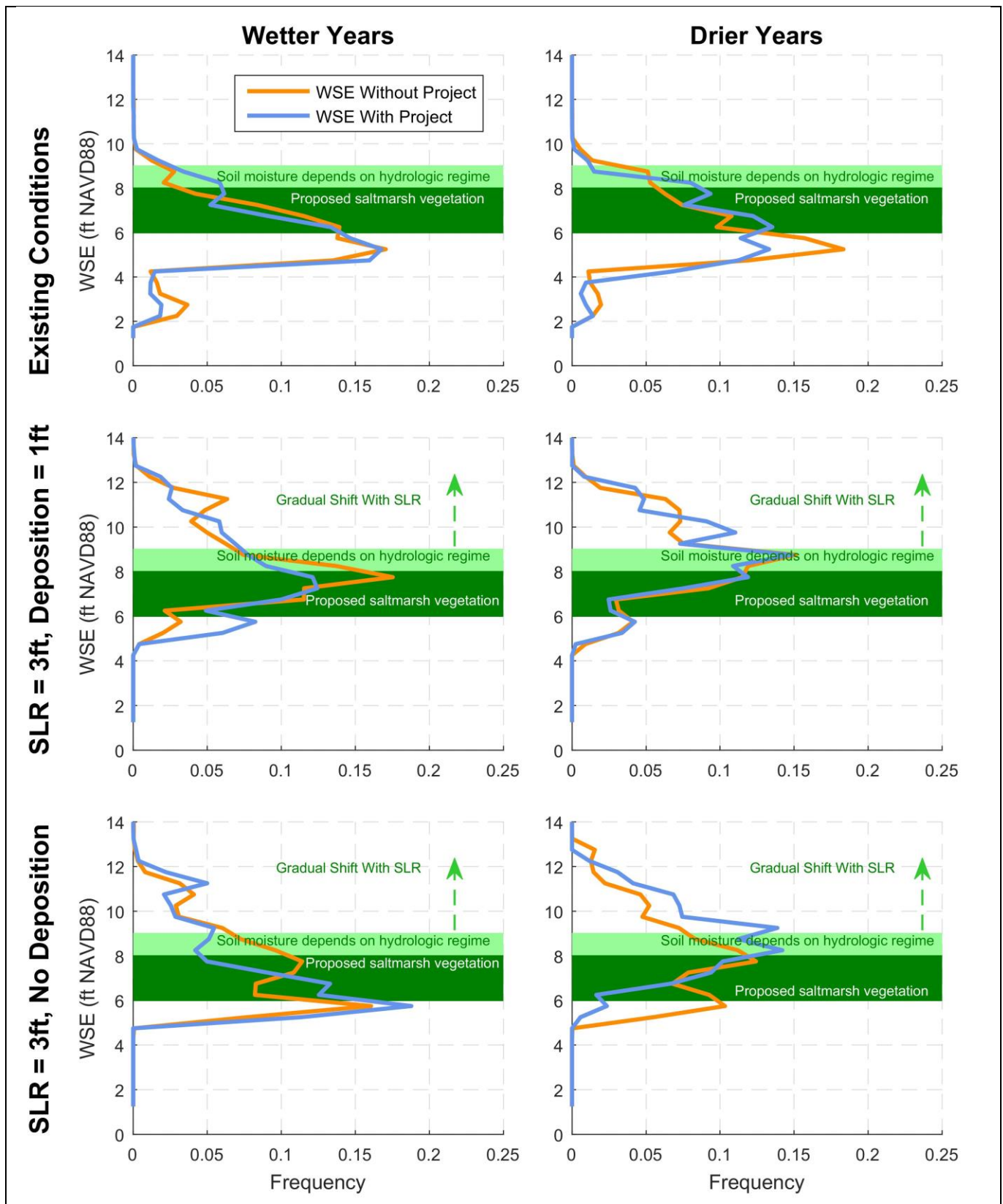
The project design sets the primary trail system elevations at +15 ft. NAVD to be above sea level rise for high sea levels projected through 2050, and for the midrange projection for 2100. The elevation selected for secondary trails is +12 ft. NAVD. These trails are intended to provide an experience that requires following the terrain close to the water and habitat, and can be readily adapted to future higher water levels.

Slough water salinity is influenced by the seasonal inundation regime, which has implications for the proposed revegetation on constructed mudflats and upland areas. ESA compared bottom and surface water column salinity data collected by Collins and Melack (2014) from 2004 to 2007 against modeled water levels during the same time period. Slough surface elevation, surface salinity, and frequency of occurrence of elevation are illustrated in Figure 23. The slough surface water salinity tends to be lowest during high inundation, as stormwater runoff is captured behind the beach barrier at the mouth. After this time, surface salinity usually follows one of the following routes:

- In wet years, the mouth breaches and introduces oceanic salinities, which are typically limited to tidal elevations below 6 ft. NAVD during tidal conditions. After subsequent mouth closure, evaporation and berm seepage lower the slough water level in summer and fall, leading to hypersalinity (salinity > 35 ppt) in the Slough waters, which is also mostly limited to elevations below 6 ft. NAVD.
- In dry years, the slough may not breach during rainfall events. Without introduction of oceanic saltwater, the slough remains fresh even after evaporation and seepage lower the water level throughout the remainder of the year, as it did in 2007 (Collins and Melack 2014).

Since the slough only reaches water levels above 6 ft. NAVD as a result of stormwater runoff events, surface water tends to be brackish to fresh for elevations from 6-10 ft. NAVD. Oceanic salinity and hypersalinity levels in the slough are likely limited to the lower elevations as a result of open-mouth tidal conditions or prolonged periods of net water loss from seepage and evaporation.

The effect of higher estuary water levels resulting from higher sea levels on future habitats was identified as an important constraint to sustained ecology. The project grading was developed to sustain estuarine wetlands by providing space for migration up and inland with rising water levels.

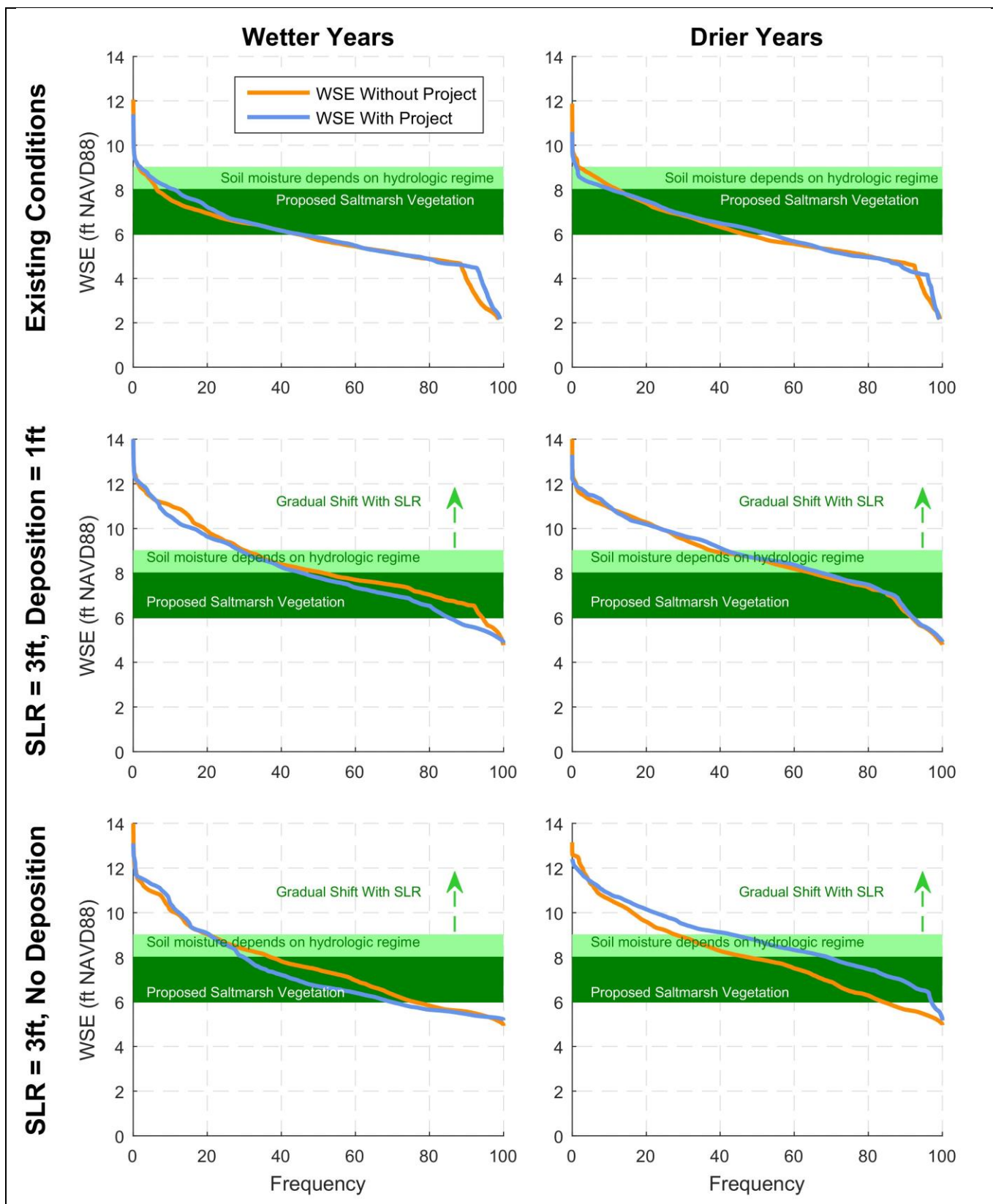


SOURCE: ESA model

UCSB NCOS Restoration Project . D140769

**Figure 21**

Slough Water Level Frequencies (2000-2014) for existing and project conditions, with and without sea level rise.



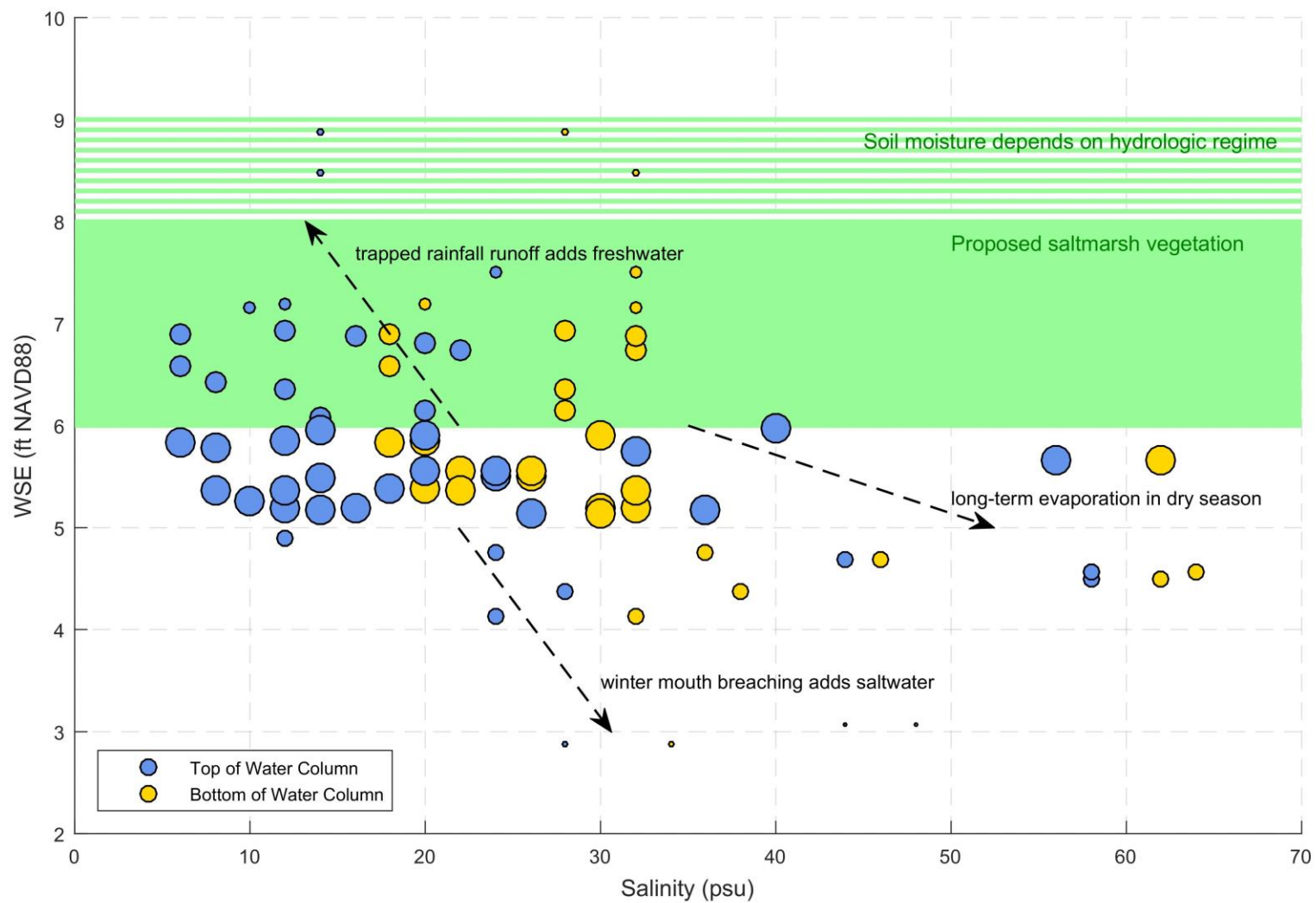
SOURCE: ESA model

UCSB NCOS Restoration Project . D140769

**Figure 22**

Slough Water Level Cumulative Frequencies  
(2000- 2014) for existing and project conditions,  
with and without sea level rise.





SOURCE: Collins and Melack (2014) salinity data paired with ESA QCM model water level results  
 NOTE: dot size represents frequency of occurrence.

UCSB NCOS Restoration Project . D140769

**Figure 23**  
 Modeled Slough Water Level vs Measured Surface Salinity for  
 2004- 2007. Dot size represents relative frequency of occurrence.

## 2.4 Habitats

While the majority of the project area has suffered from disturbance and/or development, there are sensitive habitats scattered throughout the South Parcel and to a lesser extent within the golf course and Whittier Parcel (Figure 9). Freshwater marsh occurs within Devereux Creek through the golf course, within a tributary drainage to the creek south of the golf course clubhouse, and within a channel and ditch on the Whittier Parcel. Low grade vernal wetlands have also been identified on the Whittier Parcel. Many of these habitats are considered to have marginal function and quality. Project earthwork will impact some of the existing habitats. The design will preserve and expand estuarine, riparian, vernal pool, and native upland habitats (Figure 24). Table 6 provides the types and areas of habitats that would be impacted, preserved and created with the project.

**Table 6. Project Habitat: Existing, Impacted, Created and Preserved**

Existing Habitats	Habitat Type	Acres Impacted	Acres Created <sup>1</sup>	Acres Preserved	Total Acres With Project
0.0	Subtidal/Aquatic	0.0	5.5	0.0	5.5
0.0	Mudflat/Salt Flat	0.0	9.5	0.0	9.5
0.9	Marsh Plain <sup>2</sup>	0.0	17.4	0.9	18.3
9.5	Freshwater/Brackish Wetland	9.5	0.5	0.0	0.5
0.0	High Marsh/Transition	0.0	13.1	0.0	13.1
3.1	Southern Riparian Scrub <sup>3</sup>	0.4	4.1	2.7	6.8
0.9	Native grassland	0.4	29.7	0.5	30.2
0.7	Vernal Pool/Native Grass	0.0	4.1	0.7	4.8
2.7	Coastal Sage Scrub	1.5	14.9	1.2	16.1
0.4	Seasonal Wetland	0.4	0.9	0.0	0.9
0.2	Semi-Perennial Wetland	0.2	0.0	0.0	0.0
0.0	Sandy Dunes	0.0	0.3	0.0	0.3
18.4	TOTAL	12.4	100.0	6.0	106.0

<sup>1</sup> Distribution and extents of habitats would be determined based upon further soils testing and analyses and final grading. Does NOT include existing habitats preserved within the project site.

<sup>2</sup> Based upon distribution and extent of vegetated salt marsh present within the Lower Devereux Slough, we project that approximately 50% of the acres indicated for this habitat would be vegetated and the remainder would be unvegetated sediment flats

<sup>3</sup> Southern riparian scrub includes back dune woodlands

<sup>4</sup> Sources for existing habitats: Watershed Environmental 2003, URS 2004, WRA 2006, Morro Group 2006, 2007





SOURCE: Aerial Photo: Google Earth, 2015. Topography: Aerial Photogrammetry June 13, 2006 by Arrowhead Mapping Corporation

UCSB NCOS RESTORATION PROJECT . D140769

FIGURE 24





### 2.4.1 Species Benefits

It is anticipated that the project will benefit a wide range of plant and animal species, including five federally listed species: the federally endangered tidewater goby, California least tern, Ventura marsh milk-vetch and the federally threatened western snowy plover and the California red-legged frog; as well as two state listed endangered species, Belding's savannah sparrow and peregrine falcon, which are found on, or in close proximity, to the site. Benefits will derive from the expansion and enhancement of habitat for these species, many of which are currently found on or in close proximity to the project site. Special status species anticipated to benefit from the project are listed in Tables 7, 8 and 9, below.

**Table 7. Federally Listed Species that May Benefit from the Project**

Common and Scientific Name	Status/Relation to Project Site	Habitat	Project benefits
Ventura Marsh Milk-vetch  <i>Astragalus pycnostachyus</i> var. <i>lanosissimus</i>	Federally Endangered;  State Endangered  <b>Present in COPR</b>	High marsh transition  Dune scrub	Ventura marsh milk-vetch has been planted in portions of Coal Oil Point Reserve as part of an effort to recover the species after 30 years of presumed extinction. Devereux Slough area provides one of the most successful reintroduction sites for this species. Restoration of high marsh transition and dune scrub habitats on the project site will increase the habitat available for continued recovery efforts for this endangered plant.
California Least Tern  <i>Sterna antillarum browni</i>	Federal Endangered Species; State Endangered Species; CA Dept. of Fish and Wildlife "Fully Protected Species"  <b>Present in in COPR</b>	Estuarine aquatic	Expansion of aquatic estuarine open water habitat near beach nesting grounds of COPR will expand habitat suitable for foraging
Tidewater Goby  <i>Eucyclogobius newberryi</i>	Federally Endangered; CA Dept. of Fish and Wildlife Species of Special Concern; IUCN Vulnerable Species; American Fisheries Society Vulnerable Species  <b>Present in Goleta Slough; Documented in Devereux Slough in 2012</b> (monitoring in Devereux Slough has not recorded this species in the last 2 years)	Estuarine aquatic/freshwater aquatic interface	Suitable habitat would be enhanced through restoration of estuarine and palustrine interface. Project feature at Phelps Creek confluence would create protected backwater that could provide refuge for gobies in high flow events.

Common and Scientific Name	Status/Relation to Project Site	Habitat	Project benefits
California Red-legged Frog <i>Rana aurora draytonii</i>	Federally Threatened ; CA Dept. of Fish and Wildlife Species of Special Concern; IUCN Vulnerable Species  <b>Occurrence within the known dispersal distance</b>	Freshwater wetlands and adjacent riparian and upland areas	Project will enhance the quality of habitat through restoration of wetlands and adjacent upland habitats.
Western Snowy Plover <i>Charadrius alexandrinus nivosus</i>	Federally Threatened; USFWS Bird of Conservation Concern; CA Dept. of Fish and Wildlife Species of Special Concern  <b>Present in Devereux Slough and at beach in COPR</b>	Estuarine aquatic Mud flat/salt flat Marsh plain	The project site is located adjacent to designated critical habitat for the western snowy plover. Project will expand nesting and forage habitat. Project includes sand flat feature designed to mimic directly adjacent area in COPR currently used as nesting habitat.
Peregrine falcon <i>Falco peregrinus anatum</i>	Federally delisted species; State delisted species; USFWS Bird of Conservation Concern; US Forest Service Sensitive Species; CA Dept. of Forestry Sensitive Species; CA Dept. of Fish and Wildlife "Fully Protected" Species  <b>Occurs on site and in adjacent lands</b>	All	The larger wetland and associated upland habitats support lower levels of the food chain (primarily birds) which provide greater prey resources for Peregrine falcon and other raptors.
Long- billed curlew <i>Numenius americanus</i>	USFWS Bird of Conservation Concern; CA Dept. of Fish and Wildlife "Watch List" species  <b>Occurs in Devereux Slough and at beach in COPR</b>	Mud flat/salt flat	Project provides for enhanced forage habitat
Southwestern pond turtle <i>Actinemys marmorata pallida</i>	US Forest Service Sensitive Species; Bureau of Land Management Sensitive Species; CA Dept. of Fish and Wildlife Species of Special Concern  <b>Present in Devereux Creek in project area</b>	Estuarine aquatic Fresh-brackish wetland Riparian Adjacent upland habitats	Project provides enhanced forage and refuge habitat for this species.



Common and Scientific Name	Status/Relation to Project Site	Habitat	Project benefits
Tricolored Blackbird <i>Agelaius tricolor</i>	USFWS Bird of Conservation Concern; Bureau of Land Management Sensitive Species: CA Dept. of Fish and Wildlife Species of Special Concern  <b>Present in COPR</b>	Fresh-Brackish wetland  Native grassland	Project provides for enhanced nesting and forage habitat
Burrowing owl <i>Athene cunicularia</i>	USFWS Bird of Conservation Concern; Bureau of Land Management Sensitive Species: CA Dept. of Fish and Wildlife Species of Special Concern  <b>Present on South Parcel in project area</b>	Native grassland  Coastal sage scrub	Project provides for enhanced nesting and forage habitat

**Table 8. CDFW Endangered and Species of Special Concern that may Benefit from the Project**

Common and Scientific Name	Status/Relation to Project Site	Habitat	Project benefits
Belding's savannah sparrow  <i>Passerculus sandwichensis beldingi</i>	California Endangered Species  <b>Occurs on project site</b>	Marsh Plain (vegetated)  High marsh transition	Project provides expanded nesting/breeding and forage habitat
Burrowing owl	See table above		
California least tern	See table above		
California Red-legged frog	See table above		
Cooper's hawk <i>Accipiter cooperi</i>	CA Dept. of Fish and Wildlife "Watch List" species  <b>Nests in woodland areas adjacent to project site</b>	Riparian	The larger wetland and associated upland habitats support lower levels of the food chain (primarily birds) which provide greater prey resources Project may provide enhanced nesting habitat in riparian areas

Common and Scientific Name	Status/Relation to Project Site	Habitat	Project benefits
Loggerhead Shrike <i>Lanius ludovicianus</i>	CA Dept. of Fish and Wildlife Species of Special Concern  <b>Occurs on site</b>  <b>Occurs in Devereux Slough on COPR</b>	Coastal sage scrub  Native grassland	Project provides enhanced breeding and forage habitat
Long-billed curlew	See table above		
Northern Harrier <i>Circus cyaneus</i>	CA Dept. of Fish and Wildlife Species of Special Concern	Fresh-brackish wetland	Project provides for enhanced and expanded breeding and forage habitat.
Peregrine falcon	See table above		
Sharp-shinned hawk <i>Accipiter striatus</i>	CA Dept. of Fish and Wildlife "Watch List" species  <b>Occurs on project site</b>	Riparian	Project provides for enhanced and expanded forage habitat
Southwestern pond turtle	See table above		
Tidewater Goby	See table above		
Tricolored blackbird	See table above		
Ventura Salt Marsh Milkvetch	See table above		
Western Snowy Plover	See table above		
White-tailed Kite <i>Elanus caeruleus</i>	California "Fully Protected Species"; Local Concern (Santa Barbara County)  <b>Occurs on project site</b>	Fresh-brackish wetland  Riparian	Project provides for enhanced and expanded nesting and forage habitat
Yellow warbler <i>Dendroica petechia</i>	CA Dept. of Fish and Wildlife Species of Special Concern	Fresh-brackish wetland	Project provides for enhanced nesting and forage habitat

Finally, the restoration may provide habitat benefits for plants species listed as rare by the California Native Plant Society (CNPS) or plant species of local concern (Table 9).

**Table 9. CNPS Listed Plant Species and Plant Species of Local Concern that may Benefit from the Project**

Common and Scientific Name	Status (see footnote) /Relation to Project Site	Habitat	Project Benefits
CNPS Listed Plant Species			
Coulter Goldfields <i>Lasthenia glabrata</i> <i>ssp. coulteri</i>	CNPS List 1B.1; RP; SP; SLC; FSSMC; Wilkowski  <b>Occurs in COPR</b>	Vernal pool	Project will create areas suitable for establishment
Southern Tarplant <i>Centromadia parryi</i> <i>ssp. Australis</i> ( <i>Hemizonia</i> )	CNPS List 1B.1; RP; SP; SLC; FSSMC; SLC <sub>wetland</sub> ; PRC; Wilkowski  <b>Occurs on South Parcel, Phelps Creek and COPR</b>	Riparian (scrub)  Coastal sage scrub  High marsh transition	Project will expand and enhance areas suitable for establishment.
Santa Barbara Honeysuckle <i>Lonicera subspicata</i> <i>subspicata</i>	CNPS List 1B.2; RP; SP; endemic; Wilkowski. Considered by CNPS to be rare and endangered in California.  <b>Occurs on South Parcel</b>	Riparian  Coastal sage scrub	Restoration will include planting of this species and expand and enhance suitable habitat conditions.
Locally Rare Plant Species			
Meadow Barley <i>Hordeum</i> <i>brachyantherum</i>	SLC; SLC <sub>wetland</sub> ; Wilkowski  <b>Occurs in project area</b>	Fresh-brackish wetland  Seasonal wetland	Project will create areas suitable for establishment and this species will be planted on site
Parish's Glasswort <i>Arthrocnemum</i> <i>subterminale</i> ( <i>Salicornia subterminalis</i> )	RP; SLC; SLC <sub>wetland</sub> ; PRC; Wilkowski  <b>Occurs in Devereux Slough in COPR</b>	Salt marsh  High marsh transition	Project will include planting of this species and expand/enhance suitable habitat.
Tall Stephanomeria <i>Stephanomeria elata</i>	SLC wetland; PRC; Wilkowski  <b>Occurs in Devereux Slough in COPR</b>	High marsh transition Native grassland Coastal sage scrub	Project will expand and enhance areas suitable for establishment
Wooly Seablite <i>Suaeda taxifolia</i>	RP; SP; LSC  <b>Occurs in Devereux Slough in COPR</b>	Salt marsh  High marsh transition	Project will expand and enhance habitat conditions.



Common and Scientific Name	Status (see footnote) /Relation to Project Site	Habitat	Project Benefits
Yerba Mansa <i>Anemopsis californica</i>	RP; SLC; SLC <sub>wetland</sub> ; PRC; Wilkowski <b>Occurs on Phelps Creek and Devereux Slough in COPR</b>	Fresh-brackish wetland  Riparian	Restoration will include planting of this species and will enhance habitat conditions.

#### References for abbreviations

CNPS = California Native Plant Society, Rare Plant Rank

1B: Rare, Threatened, or Endangered in California and elsewhere

An extension reflecting the level of threat to each species is appended to each rarity category as follows:

.1 = Seriously endangered in California.

.2 = Fairly endangered in California.

*Final Program EIR for Santa Barbara County Flood Control Routine Maintenance Activities, 90-EIR-7. Ralph Philbrick, principal.*

PRC = Plants of Regional Concern

*Goleta Slough Ecosystem Management Plan, DRAFT. December 1997.*

SLC = Species of Local Concern

CNPS List 1B = rare throughout range

FSSMC = Federal Species of Special Management Concern

*Plants of Local Concern: Wetland habitats of Coastal Santa Barbara and Ventura Counties and Adjacent Portion of San Luis Obispo County. Wayne R. Ferren and Clifton Smith. Santa Barbara Botanic Garden. 1988.*

SLC wetland = Species of Local Concern-wetland.

*Rare Plants of Santa Barbara County. Central Coast Center for Plant Conservation. Santa Barbara Botanic Garden. August 2004.*

RP = Rare Plant list.

SP = California Natural Diversity Database Special Plant List.

Endemic = endemic to Santa Barbara County

*Sensitive Plants of Santa Barbara County. Tara Wiskowski, for Division of Environmental Review, Resource Management Department, County of Santa Barbara, 1988.*

## 2.5 Public Access

The NCOS Public Access Concept Plan builds upon the Public Access community outreach work previously performed by the University and TPL (see Appendix B. Existing Conditions Report and Appendix G. TPL Public Access Survey Report for more details on this process and outcomes), and adapts the main features of that plan to the proposed project (Figure 25).

A series of hierarchical trails are proposed (Figure 26). These trail types were initially proposed in the Ellwood-Devereux Coast Open Space and Habitat Management Plan, and were refined during the TPL planning process. The trails are sited based on anticipated levels of use, proposed grading, known soil and grade constraints, and proximity to sensitive habitats.

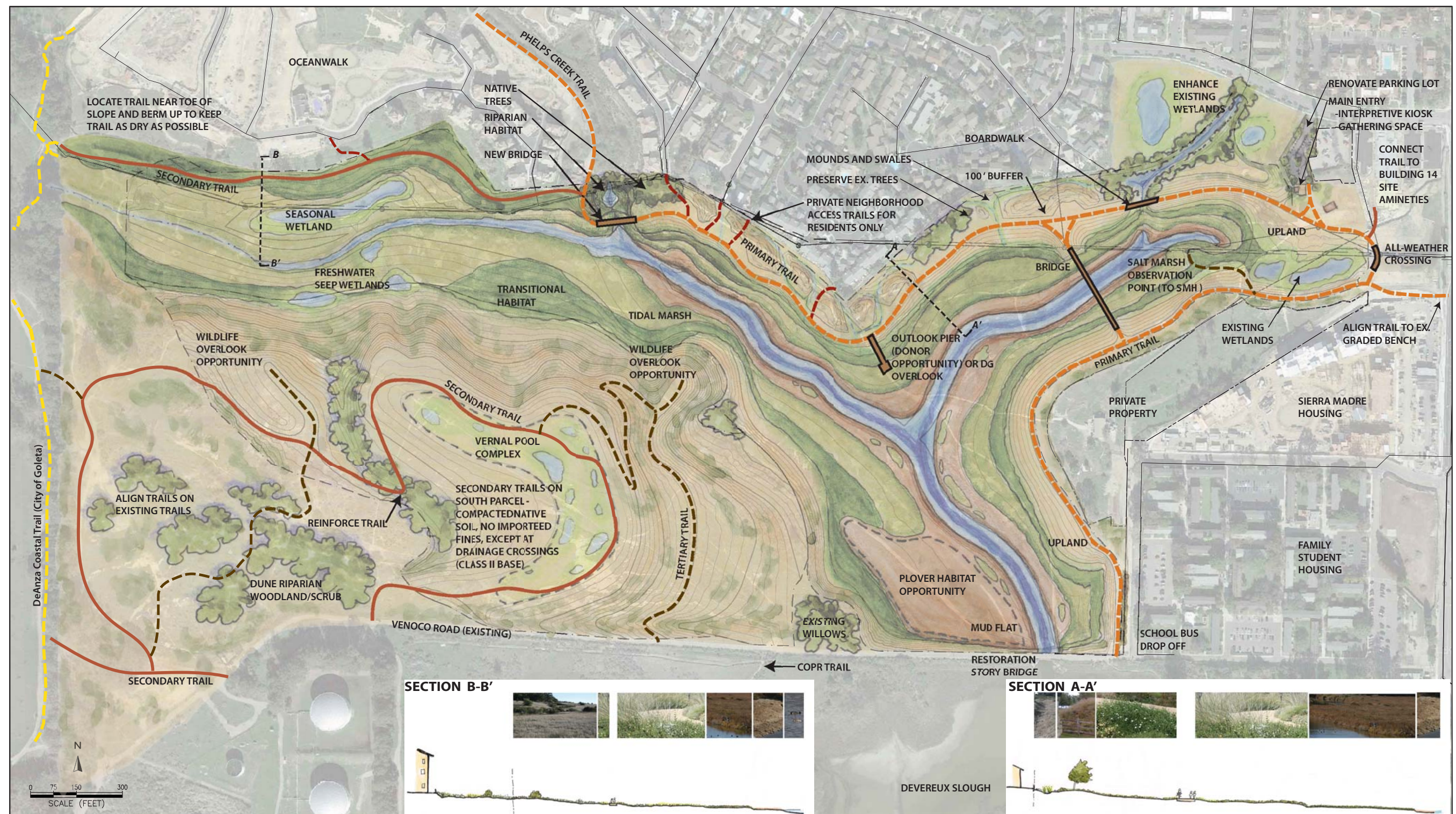
One mile of primary trails are planned for the project. A Primary Trail loop will connect the Phelps Creek Trail west to the project entry and further to Storke Road, and continues south along the West Campus Apartments and privately owned properties toward Venoco Road to provide access to the lower Slough, student housing, Isla Vista School, and the University. A boardwalk/bridge crosses at the center to provide a loop trail, improved access, and wildlife and habitat viewing opportunities. Two smaller bridges provide dry access across the eastern incoming drainage and the drainage from the Whittier Parcel. These dry crossings will provide habitat and wildlife viewing and interpretive / educational opportunities while reducing site disturbance by keeping the trails dry.

Two main sections of secondary trails, totaling 1.25 miles, are proposed. One section of trail connects the Phelps Trail, the Ocean Walk development, and the northern reach of the DeAnza / Ellwood Coastal Trail. This section will provide overlook opportunities to the upper reach of the restored slough and a seasonal wetland. It is proposed at a higher elevation than the current trail to reduce impacts to habitat and erosion potential. Another network of secondary trails is proposed on the South Parcel. The trail connects on an eastern edge of Venoco Road and traverses the perimeter of the newly proposed mesa created by the fill soils. This relatively flat trail would be constructed of compacted native soils, except where it crosses a proposed swale (where it will be made of compacted imported aggregates and fines). The trail provides viewing opportunities across the site, and experiences of a vernal pool complex, native grassland habitat, coastal sage scrub habitat, and rare dune riparian woodland and scrub habitats. The trail connects to the western edge of the site to the DeAnza Coastal Trail and Venoco Road. These trails will provide the solitude and nature experience many community members requested, along with numerous opportunities for environmental education and university research.

A small network of Tertiary trails, totaling 0.75 miles, is also proposed on South Parcel. An eastern-most trail traverses on contour from Venoco Road across the gentle south parcel slope which will be revegetated with native grassland and drifts of coastal sage scrub.







SOURCE: Aerial Photo: Google Earth, 2015. Topography: Aerial Photogrammetry June 13, 2006 by Arrowhead Mapping Corporation

UCSB NCOS RESTORATION PROJECT . D140769

**FIGURE 25**  
Public Access Plan



**PRIMARY TRAILS**

- Improved trail with uniform compacted fines
- 10' wide
- Year-round trails
- Multi-use
- Periodic interpretive signage
- Grass mounds & swales at north perimeter to buffer open space
- Provide seating, boulders & places to rest
- Observation points
- Bridges over wetland
- Dog waste receptacles

**SECONDARY TRAILS**

- Improved existing surface with imported compacted fines in select areas
- 5'-6" wide
- Relaxing, slower-paced spur routes
- Surrounded by native vegetation to provide a peaceful experience in nature
- No signage or trail amenities

**TERTIARY TRAILS**

- Improved native trail, compact existing surfaces
- Primitive natural character to provide sense of solitude & reflection.
- 3'-4' wide
- Creates loops off of secondary trails
- Connects to existing off-site trails
- Some intended for seasonal use as conditions allow
- Two or three bird blinds
- No signage or trail amenities

**NEIGHBORHOOD TRAILS**

- Informal simple trails for local residents only
- 3' wide, compacted native soil

**MAIN ENTRY**

- Seatwall
- Gathering Space
- Educational material

12-22-15

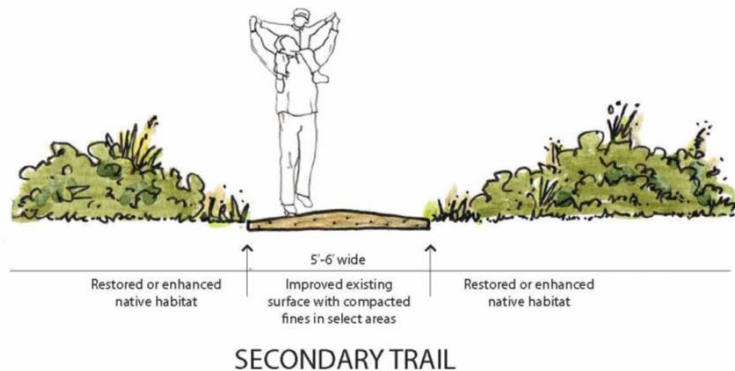








Tertiary trail: “nature experience trail”



Secondary trail: improved aggregate surface, moderate use, pedestrians, some bicycles



Primary trail: improved aggregate surface, highest use, bicycles & pedestrians, baby carriages, dogs, etc.





## PART III IMPLEMENTATION

Implementation of the project will be accomplished in three “programmatic” phases: 1) pre-construction collection and propagation of plant materials; 2) construction of the project; and 3) establishment maintenance and monitoring of the project. Details for each of these phases are provided below, followed by a proposed implementation schedule and estimate of the construction cost. Construction Phasing, which is expected to occur over two to three years, is described elsewhere.

### 3.1 Pre-construction Collection and Propagation of Plant Materials

To the extent feasible, seeds, rooted cuttings, and container plants for the restoration area will be obtained on or near the project site. These materials, as well as any materials not available from the project site, will be collected and grown by CCBER and/or a contract grower with qualifications and experience in the propagation of native plants. Native plants that can be salvaged from the project site, such as salt grass (*Distichlis spicata*) will be collected and prepared for replanting.

Seeds and cuttings will be collected during the appropriate seasons, and propagated or stored for later installation on the restoration site. Live cuttings for wattles and pole plantings in riparian areas will be collected immediately prior to installation. The timing of collection and preparation of plants to be salvaged will be determined based on detailed construction plans and by cultural requirements of each species. Seed will be collected from as many on-site species and as many individuals as feasible. Seed from individual species will be cleaned and stored separately until planting. Purchased seed, if any, will be from local or similar ecotypic sources, or sterile grasses for use in erosion control. The resulting variety of plant propagules will allow for the development of habitats with more immediate natural diversity and genetic integrity.

In anticipation of project implementation, CCBER has been collecting seed since December 2014, and has established a contract with a local grower for 300,000 salt marsh, grassland and coastal sage scrub plantings to be ready by December 2016. CCBER plans to begin growing plants for this project beginning in December 2015, and is planning for an additional contract with the grower for a second round of plants to be ready for installation in March 2017.

### 3.2 Construction

Construction of the project will include mobilization, site preparation, bulk earthwork and fine grading, installation of grade control/scour protection, improvements to stormwater drainage, installation of public access features, and revegetation.

#### 3.2.1 Mobilization

Work included under mobilization includes establishment of access, staging, and stockpile areas within the project site, preparation and implementation of a storm water pollution prevention plan (SWPPP), establishment of survey control and any necessary pre-construction topographic surveys, and implementation of all habitat protection measures in compliance with project permits and CEQA findings.

### ***Environmental Protection Measures***

Environmental protection measures likely to be required during construction of the project include fencing to both exclude sensitive wildlife species from entering the project site and to protect existing wetland and riparian habitats to remain within and adjacent to the site. Prior to the commencement of site preparation and earthwork, the construction boundary adjacent to existing habitats to be preserved will be clearly marked with fencing and flagged to prevent accidental maneuvering in these areas. Such fencing and flagging will extend a minimum of 15 feet outside the edge of habitat (in the case of riparian habitat on Phelps Creek and South Parcel this zone will be established 15 feet outside the dripline of riparian trees). Native plant materials to be salvaged from the site will be identified and marked off for protection prior to removal and relocation to a growing ground or planting site.

Construction equipment, debris, building materials, excess soil, and employee or other vehicles will not be parked or stored within 15 feet of any protected area. Construction plans and specifications will include fines to ensure that no damage is done to the habitat to be preserved within the construction area.

Except in situations where public safety or flood protection concerns prohibit, dead or dying trees may be retained in place, as they serve important habitat functions in providing nesting and breeding habitat areas for wildlife.

### **3.2.2 Site Preparation**

Prior to commencement of the bulk earthwork for the project, existing golf course infrastructure (including cart paths, irrigation system components, and the club house) will be demolished and removed, culverts along Devereux Creek will be removed, plant material to be salvaged will be collected and reallocated and the construction site will be cleared of all vegetation.

### ***Vegetation Clearing and Grubbing***

Vegetation will be cleared from all areas to be graded. Within the South Parcel fill area, vegetation will be cleared and all stumps, roots, and root clusters that have a diameter of 1 inch or larger shall be grubbed out to a depth of at least 1 foot below grade.

### ***Debris Removal***

Debris has been dumped or left at various locations within the project site and includes concrete rubble, metal posts, and trash. Where rubble exists in portions of the site to be filled, it may be buried in place, as deemed appropriate by the project engineer. All debris which may affect water or soil quality, or is hazardous, such as asphalt, or auto parts, will be removed from the site. Some organic debris, such as thatch from dead exotic vegetation, will be removed and disposed of off-site, to avoid further invasion of the site by seed or propagules of undesirable vegetation. All debris not incorporated into the project design will be removed and disposed of properly in a landfill or other approved receiving site.

### ***Golf Course Infrastructure Removal***

A 6-foot wide concrete golf cart path remains within the golf course portion of the project site. This path will be removed and disposed of off-site. The existing buried irrigation system will also be removed and disposed of off-site.



### *Devereux Creek Culverts and Bridge*

The existing golf cart path crosses Devereux Creek seven times within the project areas. These culvert crossings will be removed and the associated piping and concrete debris will be disposed of off-site. In addition the existing timber bridge across Phelps Creek in the central, northern portion of the golf course portion of the site will be removed and disposed of off-site.

### **3.2.3 Bulk Earthwork and Fine Grading**

#### *Excavation and Fill Placement*

Following site preparation, areas of the project site that lie within the proposed upper Slough footprint will be graded in order to restore the landform to elevations suitable for establishment of subtidal aquatic habitat, mudflats/salt flats, marsh plain (vegetated marsh/wetlands and unvegetated sediment plains), high marsh/transitional ecotone, and upland habitats. Approximately 355,000 CY of fill will be excavated. High groundwater conditions exist on site, and therefore wet or saturated soils conditions are likely to be encountered during excavation. Soils at and above elevation 6 feet NAVD, roughly 260,000 CY, are likely to be drier and have acceptable moisture content to facilitate fill placement and compaction. Soils excavated from below 6 feet NAVD, roughly 95,000 CY, may be wet and require additional time for aeration and drying before they can be placed and compacted.

Excavated material will be placed onto the South Parcel to re-form the mesa to topography similar to existing natural landforms in the vicinity. Prior to placement of fill material and following clearing and grubbing, portions of the South Parcel mesa fill placement site containing sandy soils will be over excavated and these sandy soils set aside for replacement in the South Parcel back dune woodland/scrub and sandy dune annual habitats, areas as well as on the sediment flat feature designed to emulate COPR snowy plover nesting habitat. This overexcavation work will be undertaken to create more stable fill-to-base soils contact within the fill area, and to promote infiltration – which will, in turn, promote groundwater conditions that support existing wetlands and back dune woodland/scrub habitats to be preserved on the South Parcel. The mesa fill will be contoured such that drainage will flow toward the northwest, to support existing and future vernal and seep-fed wetlands. Fill will be placed in lifts and recompacted, with topsoils placed in the final lift. Erosion control measures and best management practices (BMPs) will be implemented to stabilize finished fill slopes. These measures may include hydroseeding with native or sterile non-native seed mix, and/or application of biotechnical materials containing no plastics, such as jute or coir fabric or wattles. The proposed grading layout and typical finished cross-sections are illustrated on Figures 19a and 19b.

#### *Fine Grading*

Following the bulk excavation within the project site, fine grading will take place to achieve the desired contours, grades, and slopes. Fine grading refers to achieving finished elevations within stricter tolerances than mass graded areas, to serve specific hydrologic and habitat functions; using specific soil materials, compaction densities, and other requirements that are unique to the features being graded. Within the excavation area, all surfaces above elevation 8 feet NAVD will be fine graded, including the seasonal pond feature near the northwestern project boundary, stormwater bioswales, the Whittier channel riparian enhancement, the side channel (potential goby habitat) ponds at Phelps Creek, and the

potential snowy plover nesting feature in the southern project area. The entire South Parcel fill site will be fine graded, with additional select grading of the high sand content areas and the vernal pool complex.

#### **Soil Testing Sorting, and Stockpiling**

In order to provide conditions favorable to the establishment of restoration plantings, excavation will include a soil testing, sorting, and temporary stockpiling operation to serve selected soils placement in the fill site. Some golf course soils have salinities that are too high to serve as suitable planting substrate for vernal pool or upland plant species. Soils testing will be used to identify the distribution of these high salinity soils across the golf course. Excavated high salinity soils will be sorted for placement in the lower lifts for the fill (buried below the level of rooting) in order that salinity levels not negatively affect revegetation of the fill site on South Parcel. Lowest salinity soils will be sorted and salvaged for use in placement for the top layer of fill. Similarly, soils with clay content of 30% or more will be selected for use in vernal pool creation on the fill site.

If immediate transport and application of salvaged soils is not feasible during a particular construction season, the retained soils may be stored, but will be stored as briefly as possible to prevent anaerobic conditions from developing. Temporary seeding of stockpiled soils may be performed to prevent erosion during the storage period. Plantain (*Plantago insularis*) is a suitable species for this purpose as it is non-persistent and will not compete with establishing native plantings.

Soil tests will be performed at the time of stockpiling, and again at the time of redistribution over the restoration area if the soils have been stored for longer than 2 months. These tests will serve to determine whether any adverse changes (such as changes in pH levels) have occurred during storage. Measures will be taken to remedy any adverse changes in soil chemistry.

Once final grading (including re-application of salvaged soils) has been completed, soils tests will be performed to identify any difficult soils and formulate appropriate soil treatments, detect variations in the soils throughout the restoration site, make any necessary adjustments to the planting plan, and determine cultural regimes for establishment maintenance. The soils samples will be sent to a qualified soils laboratory for agricultural suitability tests and analyses.

#### **3.2.4 Stream Stabilization and Scour Protection**

Excavation and grading of the restored slough and channel could result in erosion and incision along the Phelps Creek profile where it will join the restored (lowered) slough. In order to transition from the higher existing grade in the Phelps Creek channel to the lower design grade of the restored slough, seven in-grade control structures (rock ramps) will be installed in Phelps Creek.

At the Venoco Road Bridge, the existing sheet pile sill and armoring will be removed to provide improved tidal connection to the site. Rock scour protection will be installed for the existing pile supports of the bridge.

### 3.2.5 Stormwater Drainage Improvements

A shallow drainage swale exists along the north-eastern boundary of the golf course portion of the project site, adjacent to the housing development. Bioswales and mounds will be created in this area to continue to provide the existing drainage function while also improving habitat. Nine culverts will be installed along this area to facilitate drainage under the public access trail to the restored slough.

### 3.2.6 Public Access

Following the bulk earthwork and fine grading, public access components will be installed within both the site. Public access components include installation of the following:

- Primary Trail – 1-mile long, 10- to 12-ft wide trail surfaced with Class 2 rock base
- Secondary Trail – 1.25-mile long, 6-ft wide trail surfaced with Class 2 rock base along south side of North Campus Housing and near creek crossing in southwestern portion of site and XX mile long, 12-ft wide trail surfaced with native soils along southwestern portion of the project site
- Tertiary Trail - 0.75-mile long, 4-ft wide trail surfaced with native soils
- Bridge A – 85-ft long by 12-ft wide, multi-use (pedestrian, bicycle, emergency vehicle) crossing of a drainage; pile supported
- Bridge B – 100-ft long by 12-ft wide, multi-use (pedestrian, bicycle, emergency vehicle) crossing of a drainage; pile supported
- Bridge C – 300-ft long by 12-ft wide, multi-use (pedestrian, bicycle, maintenance vehicle) crossing providing crossing of eastern arm, pile supported
- Bridge D – 200-ft long by 12-ft wide, multi-use (pedestrian, bicycle, maintenance vehicle) crossing Phelps Creek, pile supported
- Bridge Da – 50-ft long by 12-ft wide, multi-use (pedestrian, bicycle, maintenance vehicle) crossing Phelps Creek side channel
- Viewing Platform – 100ft long by 12-ft wide
- Interpretative Signs
- Rehabilitation of existing parking lots
- Gathering Area

### 3.2.7 Revegetation

The habitat concept presented in Figure 24 is based upon plant species composition and distribution observed in local habitats exhibiting the similar conditions to those which will result from the reconfiguration of the Upper Devereux Slough and South Parcel mesa. The restoration area will be planted in native species, including those listed in Table 10, in accordance with their physical requirements.



Table 10. Preliminary Revegetation Species List

Species	Common Name
<b>Marsh Plain Salt Marsh</b>	
<i>Salicornia pacifica</i>	Pickleweed
<i>Distichlis spicata</i>	Salt grass
<i>Frankenia salina</i>	Alkali heath
<i>Jaumea carnosa</i>	Marsh jaumea
<b>High Marsh - Transition</b>	
<i>Salicornia pacifica</i>	Pickleweed
<i>Frankenia salina</i>	Alkali heath
<i>Jaumea carnosa</i>	Jaumea
<i>Limonium californicum</i>	Marsh rosemary
<i>Atriplex californica</i>	California saltbush
<i>Distichlis spicata</i>	Salt grass
<i>Arthrocnemum subterminale</i>	Parish's glasswort
<i>Suaeda calceoliformis</i>	Horned seablite
<i>Spergularia marina</i>	Salt marsh sand-spurrey
<i>Monanthechloe littoralis</i>	Shore grass
<i>Leymus triticoides</i>	Creeping wild rye
<b>Riparian</b>	
<i>Salix lasiolepis</i>	Arroyo willow
<i>Salix laevigata</i>	Red willow
<i>Salix exigua</i>	Sandbar willow
<i>Quercus agrifolia</i>	Coast live oak
<i>Populus trichocarpa</i>	Black cottonwood
<i>Alnus rhombifolia</i>	White alder
<i>Platanus racemosa</i>	California sycamore
<i>Sambucus nigra</i> ssp. <i>caerulea</i>	Blue elderberry
<i>Baccharis salicifolia</i>	Seep willow
<i>Frangula californica</i>	California coffeeberry
<i>Rosa californica</i>	California wild rose
<i>Anemopsis californica</i>	Yerba mansa
<i>Rubus ursinus</i>	California blackberry
<i>Clematis ligusticifolia</i>	Creek clematis
<b>Fresh- Brackish Wetland/Seasonal Wetland</b>	
<i>Schoenoplectus californicus</i>	California bulrush
<i>S. americanus</i>	American bulrush
<i>Bolboschoenus maritimus</i>	River bulrush
<i>Typha latifolia</i>	Narrow-leaved cattail
<i>Juncus textilis</i>	Basket rush
<i>Juncus phaeocephalus</i>	Brown-headed rush
<i>Hordeum brachyantherum</i>	Meadow barley

Species	Common Name
<i>Baccharis salicifolia</i>	Seep willow
<i>Rosa californica</i>	California wild rose
<i>Salix exigua</i>	Sandbar willow
<i>Anemopsis californica</i>	Yerba mansa
<i>Baccharis douglasii</i>	Salt marsh baccharis
<b>Coastal Sage Scrub</b>	
<i>Artemisia californica</i>	California sagebrush
<i>Atriplex lentiformis</i> ssp. <i>breweri</i>	Quail bush
<i>Encelia californica</i>	California sunflower
<i>Epilobium canum</i>	California fuchsia
<i>Eriophyllum confertiflorum</i>	Golden yarrow
<i>Eriogonum parvifolium</i>	Sea cliff buckwheat
<i>Isocoma menziesii</i>	Coast goldenbush
<i>Elymus condensatus</i>	Giant Wild Rye
<i>Lonicera subspicata</i>	Santa Barbara honeysuckle
<i>Malacothrix saxatilis</i>	Seacliff daisy
<i>Mimulus aurantiacus</i>	Monkeyflower
<i>Scrophularia californica</i>	Figwort
<b>Native Grassland</b>	
<i>Nassella pulchra</i>	Purple needle grass
<i>Bromus carinatus</i>	California brome
<i>Elymus glaucus</i>	Blue wildrye
<i>Hordeum brachyantherum</i> ssp. <i>californicum</i>	California barley
<i>Dudleya lanceolata</i>	Live forever
<i>Distichlis spicata</i>	Salt grass
<i>Eschscholzia californica</i>	California poppy
<i>Gnaphalium californicum</i>	Everlasting
<i>Hazardia squarrosa</i>	Prickly goldenbush
<i>Deinandra fasciculata</i>	Fascicled tarplant
<i>Dichelostemma capitatum</i>	Blue dicks
<i>Lessingia filaginifolia</i>	California aster
<i>Lupinus bicolor</i>	Miniature lupine
<i>Sisyrinchium bellum</i>	Blue-eyed grass
<b>Vernal Pool</b>	
<i>Alopecurus saccatus</i>	Pacific foxtail
<i>Atriplex coulteri</i>	Coulter's saltbush
<i>Brodiaea jolonensis</i>	Jolon brodiaea
<i>Castilleja densiflora</i>	Denseflower owl's clover
<i>Centunculus minimus</i>	Chaffweed
<i>Crassula aquatica</i>	Pigmy weed
<i>Elatine brachysperma</i>	Short seed waterwort
<i>Eleocharis macrostachya</i>	Creeping spike rush
<i>Epilobium pygmaeum</i>	Smooth boisduvalia

Species	Common Name
<i>Eryngium vaseyi</i>	Coyote thistle
<i>Eryngium armatum</i>	Prickly coyote thistle
<i>Grindelia camporum</i>	Common gumplant
<i>Isolepis cernua</i>	Low bulrush
<i>Juncus bufonius</i>	Toad rush
<i>Pilularia americana</i>	Pillwort
<i>Plagiobothrys undulates</i>	Coast allocarya
<i>Plantago elongata</i>	Coastal plantain
<i>Phalaris lemmonii</i>	Lemmon's canarygrass
<i>Psilocarphus brevissimus</i>	Short woolyheads
<i>Psilocarphus tennelus</i>	Slender woolyheads
<i>Hordeum brachyantherum</i> ssp. <i>brachyantherum</i>	Meadow barley
<i>Eleocharis acicularis</i>	Needle spike rush
<b>Sand Dune Annuals</b>	
<i>Cammisoniopsis micrantha</i>	Spenser primrose
<i>Cryptantha clevelandii</i>	Cleveland's cryptantha
<i>Plantago erecta</i>	California plantain
<i>Lupinus bicolor</i>	Bicolored lupine
<i>Stebbinsoseris heterocarpa</i>	Grassland stebbinsoseris
<i>Cirsium occidentale</i>	Cobweb thistle
<i>Eschscholzia californica</i>	California poppy
<i>Sanicula arguta</i>	Sharp-toothed snakeroot
<i>Acmispon americanus</i>	Acmispon
<i>Pseudognaphalium beneolens</i>	Cudweed
<i>Hazardia squarrosa</i>	Sawtooth goldenbush
<i>Amsinckia intermedia</i>	Common fiddleneck

Subtidal and mudflat/salt flat elevation terraces will remain unplanted, as these habitats are generally unvegetated in natural conditions.

### **Planting Procedures**

All planting on the restoration site will be supervised by a restoration ecologist having demonstrated knowledge and experience in native plant revegetation. To the extent feasible, planting will be performed during the cooler, wetter months, between November 15 and March 31; preferably, immediately following a rainfall of one to one and one-half inches. If seasonal rainfall is low, or does not coincide with the desired planting dates, both the plant materials and the receiving ground surface will be thoroughly irrigated prior to planting.

Following the planting of salvaged plants, container stock, cuttings, and willow wattles, the specified amounts of seed will be hydroseeded, broadcast, and/or drill/imprint seeded over the designated areas. If seed is not applied until just before the onset of winter rains, the seeded areas will be covered with straw mulch, tacked down and monitored throughout the first rainy season. If seed is applied earlier, it



will be irrigated such that vegetation is sufficiently established to protect against erosion of channel banks by the onset of winter rains.

### ***Installation of Temporary Irrigation System***

A temporary irrigation system will be installed at the restoration site to ensure the establishment of native vegetation. The system will be designed to provide periodic deep irrigation (versus frequent light irrigation customarily provided for ornamental landscapes) in order to promote deep root growth.

The irrigation system will consist of primarily above-ground components and lines. The above-ground components can be removed upon completion of the establishment period without disturbing plant life.

Restoration plantings will be irrigated using low-volume, low-pressure drip irrigation and impact spray heads. Quick-coupling valves will be located throughout the site to accommodate incidental watering needs.

## **3.3 Maintenance and Monitoring**

### **3.3.1 Maintenance**

Periodic maintenance will be required during the establishment of the restoration area. Maintenance will be performed by qualified personnel having demonstrated experience in maintenance of natural habitat areas and of native revegetation projects. At minimum, maintenance visits will consist of a thorough walk-through of the entire restoration site, inspection of the condition of all plantings and seeded areas, irrigation system function checks (see section 3.6.1 below) and checks for proper irrigation coverage, weed control, and replanting, as necessary. Maintenance personnel will communicate directly with the project monitor to ensure prompt and appropriate response to any problems or unanticipated conditions encountered.

### ***Plantings***

Any unsuccessful plantings will be replaced as needed to bring the restoration site into compliance with the minimum success criteria (vegetation success criteria will be developed with the monitoring and adaptive management plan). The species planted within the restoration area will not be fertilized or pruned, unless such pruning is required in case of emergency.

Maintenance visits will be performed weekly for the first three months of the establishment period; and every two weeks thereafter for the first year.

The maintenance schedule for the remainder of the establishment period will be determined in coordination with the project monitor, based upon the level of success achieved after completion of the first year. At a minimum, maintenance will be performed monthly for the second year and quarterly thereafter, for the duration of the 5- year monitoring period.

### ***Irrigation***

Temporary irrigation will be provided for approximately one year, to help ensure successful establishment of the restoration plantings.

Irrigation rates will be determined based upon individual species requirements and zonation of ecotypes, and will be adjusted to provide the minimum necessary for rapid, healthy growth. In order to limit the growth of invasive, weedy species, seeded areas will receive the minimum amount of irrigation that is required to establish the target species.

The irrigation system will consist of a combination of low-pressure, low-volume drip components, with flexible lateral and feeder lines and impact spray heads. Periodic maintenance will be required to inspect and repair any problems with the system and its components. Irrigation system checks will consist of separate operation of each valve and verification of functioning condition of each irrigation head and emitter. Remedial measures required to correct irrigation system malfunctions will be performed immediately upon detection.

In order to minimize damage to irrigation tubing caused by rodents and other wildlife, wildlife guzzlers will be installed at several locations within the project site to provide an alternate water source.

During the last 6 months of the (one-year) establishment period, irrigation will be gradually curtailed so that vegetation may adapt to a natural precipitation regime. If drought stress is detected in the plantings or in areas of the restoration site following this "weaning" process, irrigation will be continued to affected portions of the site for an additional year.

### **Weed Control**

Construction and site modifications will create open areas that are prime sites for opportunistic weedy exotics. Some of these weeds will be naturally suppressed, as native plants mature. Others, however, if allowed to become established, can out-compete the desired native species. Given the urbanizing setting and constant exposure to exotic seed sources, complete eradication of weeds is not realistic. For these reasons, in order to re-establish a native plant community on the project site, exotics will be completely removed from the site prior to the planting phase of construction. Exotic weeds may then be kept in check with periodic maintenance throughout the establishment period. Native plants within the restoration area will be protected during weed eradication efforts.

Of particular concern in the restoration area are yellow fennel, wild mustard, and pampas grass. The restoration area will be closely monitored for the presence of these and other invasive species. These weedy plants will be removed by hand or mechanical means, and if necessary, with minimum effective amounts of appropriate herbicides, as they appear.

Construction drawings and specifications will include a detailed Exotics Eradication Plan prescribing specific methods, timing, number of applications, and precautions for protection of native vegetation.

### **3.3.2 Monitoring and Adaptive Management**

Regular monitoring will be conducted following the completion of construction in order to document the evolution of ecological and geomorphic conditions at the project site. Monitoring results will inform the adaptive management of the project site, which may include actions such as additional planting or alterations to the original planting and irrigation plan, control of invasive plant species, installation or

removal of temporary erosion control measures, maintenance of public access infrastructure and public outreach efforts.

A monitoring and adaptive management plan will be completed as part of final project design. This plan may include permitting and or granting agencies required elements and/or conditions. Monitoring protocols and project performance/success criteria may be developed in consultation with said agencies. It is anticipated that the monitoring may be performed to evaluate vegetation establishment, wildlife utilization, physical processes, and site conditions related to potential development of hazards such as slope stability and flood capacity. The monitoring plan will likely include the following elements:

- Recording of as-built Conditions
- Establishment of permanent monitoring stations (e.g. cross-sections, photo points, transects)
- Monitoring schedule
- Monitoring protocols (standardized for consistency in data collection and documentation)
- Reporting requirements
- Success Criteria
- Corrective /adaptive management measures or process



## REFERENCES

- Beighley, R. E., Melack, J. M., and Dunne, T. 2003. Impacts of California's Climatic Regimes and Coastal Land Use Change on Streamflow Characteristics. *JAWRA Journal of the American Water Resources Association*, 39: 1419–1433.
- Campbell Geo, Inc. 2011. Phase I Environmental Investigation Limited Portion of Ocean Meadows Golf Course 6925 Whittier Drive (APN 073-090-062) Goleta, California. Prepared for The Trust for Public Land.
- Campopiano, M, C. M. Denn, E. Miller, S. D. Pratt, R. Smyk-Newton, and J. Yi. 2000. Enhancement Alternatives for the Ocean Meadows Golf Course Site: Goleta, California. University of California - Santa Barbara.
- Cheadle Center for Biodiversity and Ecological Restoration (CCBER). 2012. UCSB Phelps Creek Bank Layback and Bridge Habitat Restoration Program 2007-2012 Report, Year 5, Final Report. University of California, Santa Barbara.
- CCBER. 2015. Devereux Slough Water Quality Monitoring 2014. University of California, Santa Barbara.
- Collins, D. G. and J. M. Melack. 2014. Biological and chemical responses in a temporarily open/closed estuary to variable freshwater inputs. *Hydrobiologia* 734: 97-113.
- Daumal, M. 2013. Soil Analysis as a basis for the restoration of a wetland on the Ocean Meadows Golf Course in Goleta, California, USA. Bachelor Thesis. University of Applied Sciences Bremen, Germany in cooperation with the University of California - Santa Barbara, USA.
- Davis, F.W, D. Theobald, R. Harrington, and A. Parikh. 1990. University of California Santa Barbara Campus Wetlands Management Plan - Part 2: Technical Report on Hydrology and Water Quality of West and Storke Campus Wetlands. A Report to the California Coastal Conservancy and UCSB Campus Wetlands Committee.
- Environmental Science Associates (ESA). 2015. Goleta Slough Inlet Modeling Study. Technical memorandum provided for City of Santa Barbara. 37 p.
- Ferren, Jr., W. R. D. G. Capralis, and D. Hickson. 1987. University of California, Santa Barbara Campus Wetlands Management Plan: Part I – Technical Report on the Botanical Resources of West and Storke Campuses. University of California, Santa Barbara.
- Ferren Jr., W. R., P. L. Fiedler, and R. A. Leidy. 1995. Wetlands of the Central and Southern California Coast and Coastal Watersheds: A Methodology for Their Classification and Description.
- Fugro West, Inc. 2003. Preliminary Geotechnical Engineering Report, Ocean Meadows Housing Development. Goleta, California. Prepared for Bermant Development Company, 18 pp.

Goodman, D. 2008. Effective Estuarine Management: A Case Study of a California Estuary and its Ecological and Political Characteristics. Dissertation. University of California - Santa Barbara.

Krone, R.B. 1985. Simulation of marsh growth under rising sea levels. Proceedings of the Conference on Hydraulics and Hydrology in the Small Computer Age. ASCE, New York, pp106-115.

Long Term Ecological Research Project (LTER). 2015. Precipitation and streamflow data for Devereux Slough. <http://sbc.lternet.edu/>.

Morro Group, Inc. 2006. Biological Resources Survey Report: UCSB South Parcel Santa Barbara, California. Prepared for Shari Hammond: UCSB Office of Campus Planning and Design.

Schaaf & Wheeler. 2006. Hydrologic and Sediment Study - Impacts of Proposed Housing Developments & Bridge Construction Over Devereux Slough - University of California, Santa Barbara. Prepared for Pentfield & Smith.

Stahlheber, K. A. 2015. Summary of Bird Survey Data. Prepared for Cheadle Center for Biodiversity and Ecological Restoration and Santa Barbara Land Trust.

Stralberg, D., M. Brennan, J. C. Callaway, J. K. Wood, L. M. Schile et al. 2011. Evaluating Tidal Marsh Sustainability in the Face of Sea-Level Rise: A Hybrid Modeling Approach Applied to San Francisco Bay. Plos One 6(11): e27388.

URS Corporation. 2004. 2004 Ellwood-Devereux Coast Open Space and Habitat Management Plan. Prepared for City of Goleta, County of Santa Barbara, and University of California - Santa Barbara.

Watershed Environmental. 2003. Wetland Delineation Report - Ocean Meadows Golf Course, Goleta, California. Prepared for BDC/Devereux Creek Properties, Inc.

WRA, Inc. 2004. Wetland Functional Assessment – University of California, Santa Barbara (North and Storke-Whittier Parcels) Goleta, California. Prepared for Office of Campus Planning and Design, UCSB.

WRA, Inc. 2006. Wetlands Delineation Subject to the California Coastal Act - UCSB South Parcel, Santa Barbara County, California. Prepared for Tye Simpson, University of California - Santa Barbara.

Wiskowski, T. 1988. Sensitive Plants of Santa Barbara County. Division of Environmental Review, Resource Management Department, County of Santa Barbara. 101 pp.

Zedler, P. H. 1987. The Ecology of Southern California Vernal Pools: A Community Profile. U.S. Fish and Wildlife Service, Biology Report 85(7.11).