GOLETA SLOUGH AREA
SEA LEVEL RISE AND MANAGEMENT PLAN

Prepared for
The Goleta Slough Management Committee

August 2015

ESA







GOLETA SLOUGH
Management Committee

Established 1991,
Santa Barbara County, CA

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SEA LEVEL RISE AND MANAGEMENT PLAN

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Special thanks to :

The members of the Goleta Slough Management Committee, the City of Santa Barbara, California Coastal Conservancy, Santa Barbara County, the US Fish and Wildlife Service and the many individuals who participated in focus groups and public meetings in support of this project.

ACKNOWLEDGEMENTS

The Goleta Slough Management Committee (GSMC) would like to express appreciation to the many individuals, agencies and organizations that contributed to the *Goleta Slough Area Sea Level Rise and Management Plan*. First, our appreciation goes to the following agencies and groups that so generously donated funds to the preparation of this Plan:

- US Fish and Wildlife Service, Coastal Program
- California Coastal Conservancy
- County of Santa Barbara, Coastal Resource Enhancement Fund[1]
- City of Santa Barbara, Airport Department
- Goleta West Sanitary District
- Goleta Valley Land Trust
- Associated Students UC Santa Barbara, Coastal Fund

In addition, innumerable hours were contributed by representatives of many agencies and non-profit and interest groups in the area. These people tirelessly offered input to make the plan better and collaborated on many aspects, particularly the possible adaptations to sea level rise and the updated goals, policies and actions.

One key step in the development of this document was the input received at five "focus group" meetings on Goleta Slough habitat and infrastructure vulnerabilities held on February 11th and 12th, 2014. The five focus groups were:

- Environmental Community
- Local/Regional Agencies
- Regulatory Agencies
- Sanitary Districts/Utilities
- Santa Barbara Airport

Each of these focus group meetings included in-depth discussions of the current state of the science and issues associated with sea level rise, as well as detailed discussions regarding vulnerability and adaptation strategies in their particular area of expertise and interest. The participants in the focus groups and GSMC meetings where the Plan was discussed are:

Richard Abrams – Santa Barbara County Office of Emergency Services
Heather Allen – Santa Barbara County Planning & Development Dept., Long Range Planning
Jim Bailard – Beach Erosion Authority for Clean Oceans and Nourishment (BEACON)
Andrew Bermond – City of Santa Barbara, Airport Department
Rick Bush – National Marine Fisheries Service
Hillary Campbell – Santa Barbara County 2nd District Board of Supervisors representative
Trish Chapman – Coastal Conservancy
Gerald Comati - BEACON
Steve Conner – UCSB Campus Planning and Design
Pete Conception – City of Santa Barbara, Airport Department
Scott Cooper – Santa Barbara Audubon Society and UCSB Emeritus Professor
Jenna Driscoll – Santa Barbara Channelkeeper

[1] This plan was financed in part by Santa Barbara County's Coastal Resource Enhancement Fund, a partial mitigation of impacts from the following offshore oil and gas projects: Point Arguello, Point Pedernales, and Santa Ynez Unit.

Rosie Dyste – City of Santa Barbara Planning Division
Rick Frickman – Urban Creeks Council
Amber Geraghty – California Coastal Commission
Steve Greer – City of Santa Barbara, Community Development Department
Katie Hentrich – Santa Barbara County Planning & Development Department
Karin Hodin – Growing Solutions
Mark Holmgren - Ornithologist
Steve Hudson – California Coastal Commission
Peter Imhof - Santa Barbara County Association of Governments
Hazel Johns – City of Santa Barbara, Airport Department
Johanna Kisner – Kisner Environmental
Liz Limon – City of Santa Barbara, Community Development Department
Dennis Lowrey – Southern California Gas Company/Sempra Energy
Jeff Onsted – Florida International University
Brian McCarthy – Goleta West Sanitary District
Jeff McKee – City of Santa Barbara, Airport Department
Mary Meyer – California Department of Fish and Wildlife
Monique Myer – California Sea Grant, Marine Science Institute, UC Santa Barbara
Mark Nation - Goleta West Sanitary District
April Price – UC Santa Barbara, Coal Oil Point Reserve
Karen Ramsdell – City of Santa Barbara, Airport Department
Bruce Reitherman – Land Trust for Santa Barbara County
Leif Reynolds – City of Santa Barbara, Public Works Department
Mary Root – US Fish and Wildlife Service
Chandra Slaven – City of Goleta, Planning and Environmental Review Department
Maureen Spencer – Santa Barbara County Flood Control District
Lisa Stratton – UC Santa Barbara, Cheadle Center for Biodiversity and Ecological Restoration
Owen Thomas – City of Santa Barbara, Public Works Department
Christine Thompson – California Department of Fish and Wildlife
Molly Troup – California Coastal Commission
Steve Wagner – Goleta Sanitary District
Brooke Welch – Goleta Water District
Anne Wells – City of Goleta, Planning and Environmental Review Department
Ed Wiegman – Southern California Gas Company/Sempra Energy

The overall goal of the Goleta Slough Management Committee and the *Goleta Slough Area Sea Level Rise and Management Plan* is to provide coordinated management of the Goleta Slough Ecosystem and to provide for a healthy slough ecosystem by implementing the most beneficial plans, mitigation protection or restoration projects possible. The individuals, agencies and groups listed above contributed to that goal and we thank them.

Finally, several people on the consultant team and representatives of GSMC researched and wrote this Plan and deserve special mention, including:

Andrew Bermond, City of Santa Barbara Airport
Bob Battalio, ESA
Dane Behrens, ESA
Rachel Couch, California Coastal Conservancy
Eddie Divita, ESA
Dave Hubbard, Coastal Restoration Consultants
Jeremy Lowe, SFEI (formerly ESA)
Dave Revell, Revell Coastal (formerly ESA)
Pat Saley, GSMC staff and facilitator

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

GOLETA SLOUGH AREA SEA LEVEL RISE AND MANAGEMENT PLAN

EXECUTIVE SUMMARY

Part 1 - Introduction

Goleta Slough is a coastal wetland located along the central coast of California, a region with high biodiversity in which many species reach their northern and southern limits. Like many tidal wetlands along the Pacific Coast, the Slough has been greatly reduced in size and function over the past two centuries through a combination of natural processes and manmade land uses. The *Goleta Slough Area Sea Level Rise and Management Plan* (Plan) comprises an update of previous Slough management plans and includes new detailed information and analysis of future conditions projected to occur as climate changes over the next century.

The *Goleta Slough Area Sea Level Rise and Management Plan* was initiated by the Goleta Slough Management Committee (GSMC). GSMC was formed in 1991 to serve in an advisory capacity to local governments, state and federal agencies to ensure that the Goleta Slough Ecosystem Management Plan Area, comprised of 2,250 acres of habitat and adjoining lands, are addressed in a comprehensive manner, irrespective of jurisdictional boundaries. This plan area is almost entirely within the Coastal Zone and encompasses the entirety of the Slough, open space areas and creeks that feed into it, as well as the Santa Barbara Airport and developed areas within the City of Goleta, Santa Barbara County and UC Santa Barbara (see Figure 2-4). Portions of the Goleta Slough are designated as an Ecological Reserve and a Marine Conservation Area, both managed by the California Department of Fish and Wildlife.

The ecological significance of the Slough and surrounding area is described and recognized in several management plans that have been prepared since the 1980s, including the *Goleta Slough Ecosystem Management Plan* in 1997 and *Goleta Slough Existing Conditions and Monitoring Report* in 2012. This Plan updates those plans and includes a sea level rise vulnerability analysis. The intent is for this informational plan to serve as the foundation for future projects, plans, research and studies in the area. This Plan will be updated periodically as new information comes available such as ecosystem monitoring results, climate change and sea level rise studies, and new policies adopted by jurisdictions in the Ecosystem. It is important to note that sea level rise is an evolving science and local jurisdictions may conduct sea level rise vulnerability and adaptation assessments that differ from the methods used in this Plan.

Part 2 – Background

The background of the Goleta Slough and its environs is described in this section including the importance of the Ecosystem and its resource functions and values. The jurisdictions within the Goleta Slough Ecosystem are described along with major legislation that affects habitats, land uses, development and restoration in the area. The background on the effects of greenhouse gas emissions, climate change and sea level rise is provided. Historic development and changes over the last 150 years are explained and existing uses are described. The roles that GSMC and state and federal agencies play in the area are also explained. Restoration efforts since the inception of GSMC are described and mapped, including the ground breaking tidal restoration demonstration project implemented by the Santa Barbara Airport to restore tidal action to brackish basins in the Slough.

This section describes the physical aspects of the Ecosystem including its geology, hydrology and climate. The 45-square mile watershed and seven creeks that feed the Slough are described, along with annual rainfall patterns. The flood history of the area is discussed, including devastating floods that filled in much of Goleta Slough in 1861-62 and subsequent El Niño storm events that caused significant damage locally.

Sediment supply and removal in the Slough is described along with the Goleta Slough inlet (or mouth) management practices over the last thirty years. The natural functioning of Goleta Slough is explained along with the role of fluvial processes and tidal influences. Since the mid-1990s, the Slough inlet has been opened an average of twice per year to allow tidal circulation and improved water quality in the Slough and to avoid flooding upstream. In 2013, Federal agency concerns about the effects of mechanical opening the inlet on two federally-listed endangered species (Tidewater goby and Southern steelhead) have resulted in opening the Slough inlet infrequently and only under emergency permits. The habitat change and other implications of the infrequent opening of the Slough inlet are described. This provides important background information for the climate change and sea level rise discussion in the next section of the Plan.

Part 3 – Looking Ahead (2015 and Beyond)

Part 3 provides a summary of projections of climate change for Goleta Slough and the impacts it may have on the natural ecosystem and the built environment. It includes an inventory of the infrastructure and habitats that may experience impacts due to rising Slough water levels and, for each vulnerable infrastructure element or habitat, presents a set of adaptation strategies that could be adopted in order to reduce the risk to that infrastructure or habitat.

The final segment of this section describes the inlet analysis conducted to compare the expected outcomes of different lagoon inlet management strategies under existing conditions and with increasing amounts of sea level rise.

The purpose of this section is to help decision-makers, planners and land managers identify and prioritize adaptation strategies, including infrastructure improvements, policy changes and management actions to adapt to sea level rise related impacts. The goals of these adaptation strategies are twofold:

1. To maintain the Goleta Slough Ecosystem in light of sea level rise, and to enhance habitats where possible; and,
2. To minimize the risk of damage to infrastructure within the Goleta Slough area due to flooding under future sea level rise scenarios.

The following are the key findings related to sea level rise at Goleta Slough:

- Recognize that the future management of the Slough inlet will have a very significant impact on water levels and have a large effect on the distribution of habitats and species within the Slough Ecosystem.
- Manage the Goleta Slough inlet to maintain tidal circulation, water quality, and diversity and resilience of species and habitats.
- Establish provisions for the long-term management of the Slough mouth, including ongoing monitoring with adaptive management to achieve well-defined goals and to allow for compliance with future permitting requirements.

- View sediment as a resource that can be used within the Slough to increase the resiliency of the habitats as sea level rises.
- Deposition of sediment from the watershed onto tidal marshlands and flats within the Slough should be encouraged to maximize marsh accretion relative to sea level rise.
- Improve ecological linkages, increase resiliency and reduce habitat fragmentation by restoring tidal action to diked areas and provide more adjacent upland habitat for transgression.
- Identify and pursue priority projects to protect, enhance and/or expand key habitat areas, taking advantage of existing open space areas that are already near the typical elevation range for these habitats.
- Identify and pursue priority projects to protect the most vulnerable infrastructure so as to increase the threshold water surface elevation at which flood damage becomes likely.
- Require the consideration of future sea level rise and Slough inlet management practices when determining flood risk and identifying flood hazard areas.
- Minimize the construction of new vulnerable infrastructure within flood hazard areas.

Part 4 - Goals, Policies and Actions

When the first *Goleta Slough Ecosystem Management Plan* was developed in the mid-1990s, the goals, policies and actions were derived from those of the local jurisdictions in the area. The goals were in four broad categories: Administrative Framework; Protection and Maintenance of Existing Resources, Functions and Values; Education, Research and Public Access; and Restoration and Enhancement of Historic Resources, Functions and Values. The status of implementation of each goal, policy and action of the 1997 Plan is provided in Table 4-1. Many actions are ongoing, e.g., collaborating with agencies on projects and plan updates, and these actions have generally been carried forward into the updated Plan. Some actions have not yet been completed and these are mostly retained, although with some edits to reflect current and expected future conditions.

The major change to this updated Plan is the addition of the sea level rise vulnerability analysis. Rather than having a separate sea level rise goal with corresponding policies and actions, the issues relating to climate change and sea level rise have been incorporated throughout the policies and actions. GSMC participants agreed that integrating the issues and possible adaptations relating to sea level rise into all relevant policies and actions would increase the likelihood that a comprehensive approach to this important issue would be achieved. The updated goals, policies and actions are included in Section 4.4.

The updated goals of this Plan are:

> **ADMINISTRATIVE FRAMEWORK (Goal A) –** Provide an administrative framework for the adoption, implementation and periodic updates of the GSEMP through cooperative interaction between landowners, public interest groups, responsible agencies and jurisdictions. Consider the evolution of habitats, adaptive management and other changes that are likely to occur over time, including those related to climate change. Compatibility with surrounding land uses must also be considered in the review of plans and projects.
>
> **PROTECTION AND MAINTENANCE OF EXISTING RESOURCES, FUNCTIONS AND VALUES (Goal P)** – Protect and maintain the natural diversity and resilience of species, habitat types

and Ecosystem functions through protection of physical processes that naturally maintain these resources. More deliberate adaptation actions may be necessary as sea level rise accelerates and other climate change impacts become more apparent. These adaptation strategies, when implemented, should, to the maximum extent feasible, avoid further alteration of habitats or physical processes.

RESTORATION AND ENHANCEMENT OF HISTORIC RESOURCES, FUNCTIONS AND VALUES (Goal R) – To the maximum extent possible, enhance and restore the Slough's natural diversity of resources, habitats, physical processes and functions that have been lost or degraded and that are needed to maintain the resilience of the Slough in the light of climate change.

EDUCATION AND RESEARCH (Goal E) – Increase the understanding and awareness of the Goleta Slough Ecosystem and its historic and future functions and values, through providing inventories of resources and supporting research and monitoring to inform decision makers and the public.

Section 4.5 of this Plan summarizes all the actions by specific subject area, e.g.,

- Administration and Management
- Goleta Slough Inlet Management and Tidal Circulation
- Monitoring and Research
- Protection, Enhancement and Restoration of Habitats
- Sedimentation and Beach Nourishment
- Support of Specific Species
- Watershed/Areawide Issues

This grouping should be helpful in implementing the Plan. For example, if funds are needed for restoration, the actions that relate specifically to restoration are grouped and can be reviewed together, and an appropriate project and funding source can be identified. Monitoring actions are particularly important so that the short- and long-term effectiveness of actions can be ascertained.

The Goleta Slough Management Committee also reviewed the summarized actions and initially divided them into 'A' (most important), 'B' (also important), 'C' (need to do eventually) and 'D' (ongoing) priorities. As GSMC intends to begin implementation of the Plan immediately, they also reviewed all 'A' and 'B' priorities and further refined them into A1, A2, A3 and A4 "sub-priorities" based on this hierarchy:

- A1 – Administration and Management
- A2 – Goleta Slough inlet and Inlet Management
- A3 – Monitoring and Research
- A4 – Protection, Enhancement and Restoration

The 'B' priorities follow the same "sub-priority" hierarchy.

Section 4.6 of the Plan discusses monitoring protocols as the amount and quality of baseline monitoring data is limited and should be improved. Existing monitoring protocols are discussed, including the maintenance and monitoring requirements of many projects and plans recently

approved or proposed throughout the Ecosystem. Considerations for future monitoring are discussed in Section 4.6.2.

The final section (4.7) discusses future updates to the Plan. The *Goleta Slough Area SLR and Management Plan* is one of the first comprehensive plans in the area that incorporates climate change and sea level rise. As Local Coastal Plans and other planning documents incorporate sea level rise and adaptations, this Plan may be amended to incorporate those plans directly or by reference. Regardless, the Plan should be updated at least every five years, if funding is available.

PART 1
INTRODUCTION

Goleta Slough is a coastal wetland located along the central coast of California, a region with high biodiversity in which many species reach their northern and southern limits. Like many tidal wetlands along the Pacific Coast, the Slough has been greatly reduced in size and function over the past two centuries through a combination of natural processes, land use changes, and other human activities. The *Goleta Slough Area Sea Level Rise and Management Plan* (Plan) comprises an update to previous Slough management plans and includes new detailed information and analysis of future conditions projected to occur as the climate changes over the next century.

The City of Santa Barbara prepared the *Airport/Goleta Slough Coastal Plan* in 1982. This document, certified by the California Coastal Commission, recognized the importance of the Goleta Slough. In 1984, the City of Santa Barbara prepared an Environmental Impact Report/Environmental Assessment that analyzed the potential impacts associated with the 1980 Airport Master Plan. The EIR/EA found that there would be significant biological impacts in the Slough if all the projects envisioned in the Master Plan were implemented. The EIR/EA recommended that "A Goleta Slough Advisory Committee be organized by the City of Santa Barbara" and that a "Goleta Slough Preserve" be established.

1.1 Goleta Slough Ecological Reserve – 1987

The Goleta Slough Ecological Reserve was established in 1987 and is managed by the California Department of Fish and Wildlife (CDFW). The Ecological Reserve System, authorized by the California Legislature in 1968, is designed to conserve areas for the protection of rare plants, animals and habitats, and to provide areas for education and scientific research. The reserve includes approximately 400 acres located on Santa Barbara Airport property, which is owned by the City of Santa Barbara, and about another 40 acres owned by CDFW (see Figure 2-6). The City-owned portion of the Reserve is also designated as "Goleta Slough Reserve" and "Environmentally Sensitive Habitat Area" in the Coastal Plan and is in the original permit jurisdiction of the Coastal Commission. In 1988, a draft management plan was prepared for the Reserve by Dr. Joy Zedler. This plan was not adopted although it did serve as an important background document for later studies.

1.2 Goleta Slough Management Committee – 1991

In 1991, the City of Santa Barbara began an update to their *Aviation Facilities Plan.* The plan included projects that would encroach into wetlands in the Goleta Slough Ecological Reserve. At that time it was decided that, rather than prepare a plan that focused only on the Ecological Reserve, a more comprehensive plan was needed that addressed ecosystem-wide issues rather than just the habitats within the Reserve. This led to the establishment of the Goleta Slough Management Committee (GSMC) and the beginning of the *Goleta Slough Ecosystem Management Plan* process.

The Goleta Slough Management Committee (GSMC) was established in 1991 in recognition of the importance of the Slough and the challenge of managing it comprehensively.

A number of agencies have regulatory authority in the area including two cities, a county, several special districts, a public university, and several state and federal resource protection agencies (Figure 2-5). The GSMC was formed to work cooperatively with regulatory agencies, property owners and public interest groups to provide for a healthy Goleta Slough, irrespective of jurisdictional or other boundaries.

1.3 *Goleta Slough Ecosystem Management Plan* – 1997

In 1997, GSMC completed the draft *Goleta Slough Ecosystem Management Plan* (GSEMP). The plan addresses 2,250 acres in and around the Slough, including the major creeks that drain into the marsh (see Figure 2-14). The GSEMP provides detailed background and natural history information about the Goleta Slough Ecosystem based on prior studies and planning documents prepared by the City and County of Santa Barbara, UC Santa Barbara, California Department of Fish and Wildlife and other regulatory agencies. Existing policies of those jurisdictions and agencies were synthesized into a list of goals, policies and actions in the GSEMP that addressed the following issue areas:

- Administrative Framework
- Protection and Maintenance
- Restoration and Enhancement
- Education, Research and Public Access

The plan was incorporated into the City of Santa Barbara's Airport/Goleta Slough Coastal Plan and certified by the California Coastal Commission although it has not been formally adopted by any other jurisdictions in the area. Outside the Airport area, the GSEMP serves as an informational document only. Since its adoption in 1997, the GSMC has been guided by the GSEMP as they have provided input to local agencies, restoration groups and property owners on projects, studies and plans that may affect the Goleta Slough Ecosystem (see Figure 2-4).

1.4 *Goleta Slough Marine Conservation Area – 2007*

On September 20, 2007, the approximately 160-acre Goleta Slough State Marine Conservation Area was created by CDFW. This Marine Conservation Area includes the area located below the mean high tide line within Goleta Slough and Atascadero Creek. This area is designated a "no take" zone where no marine life may be taken or caught.

1.5 *Existing Conditions and Monitoring Report* – 2012

In recent years, the GSMC recognized the need to update the GSEMP. The first step in that process was to update the natural resources, policy and other baseline information included in the plan. The GSMC worked with the Land Trust for Santa Barbara County to prepare the *Goleta Slough Ecosystem Existing Conditions and Monitoring Report* using funding from the California Wildlife Conservation Board. The report identified changes in development patterns and infrastructure, and habitat restoration and enhancement projects that had been completed since 1997. It added reference to the new City of Goleta, which was incorporated in 2002. Other legislation and policies applicable to the area were updated, and a new section discussing monitoring protocols was added. The status of implementation of the goals, policies and actions included in the original plan was provided in anticipation of this update to the GSEMP. Updated elevations were provided to serve as the basis for the Sea Level Rise Study that is also incorporated into this update.

1.6 *Sea Level Rise and Vulnerability Assessment* – 2014

The second major task related to the update of the 1997 Management Plan was the preparation of a sea level rise vulnerability assessment to help decision-makers, planners and land managers understand hazards and risks from sea level rise and to identify and prioritize adaptation strategies. These include infrastructure improvements, policy changes and management actions that will assist with adapting to sea level rise related impacts.

The state of California's Ocean Protection Council (www.opc.ca.gov) adopted a resolution in March 2011 based on work done by a task force including state agencies such as Caltrans, Fish and Wildlife, Water Resources and State Water Resources Control Board. The resolution states that sea level rise should be considered in all planning studies and projects. In March 2013, the OPC updated its *Sea Level Rise Guidance*, designed to help state agencies incorporate future sea-level rise impacts into planning decisions, to include the best current science, as summarized in the final report from the National Academy of Sciences, *Sea-Level Rise for the Coasts of California, Oregon, and Washington*. In October 2013, state legislation was adopted (AB 691) requiring that cities, counties and special districts with leased tide lands (i.e., "trustees") whose gross public trust revenues average over $250,000 annually prepare and submit to the Commission assessments of how they propose to address sea level rise. The bill would also permit, but not require, a local trustee whose gross public trust revenues are $250,000 or less to prepare and submit to the commission an assessment. Given the importance of and interest in sea level rise and its potential impact in the Slough area, the GSMC pursued grants and agency funding to prepare a *Sea Level Rise Vulnerability Assessment* to incorporate it into this Plan.

In August 2015, the Coastal Commission finalized its *Sea Level Rise Policy Guidance (available at http://www.coastal.ca.gov/climate/slrguidance.html)*, which provides an overview of best available science on sea level rise for California and recommended steps for addressing sea level rise in Coastal Commission planning and regulatory decisions. The guidance document includes updates to reflect newly developing science, tools, and resources for sea level rise adaptation planning. In drafting the Guidance, Commission staff coordinated with other California state efforts related to climate change and adaptation, that complements the *2014 Safeguarding California*: *Reducing Climate Risk* document produced by the California Natural Resources Agency by addressing issues specific to the Coastal Act, including Local Coastal Programs and Coastal Development Permits.

1.7 Other Studies and Plans in the Goleta Slough Area

As the GSMC is completing its Management Plan update in 2015, several other agencies are preparing similar studies and plan updates including:

- City of Goleta – Drafting a new Local Coastal Program for certification by the California Coastal Commission including preparation of hazard assessments and other technical studies, a Coastal Land Use Plan, and Implementation Plan.

- City of Santa Barbara –The City is preparing an update to their Local Coastal Plan that includes draft sea level rise adaptation policies. The Santa Barbara Airport is preparing an *Airport Master Plan and Draft Environmental Impact Report* and *Goleta Slough Mouth Management Study* relating primarily to the effect of the mechanical opening of the Slough mouth on sensitive fish species (Steelhead trout and Tidewater gobies). The

City also received a grant from Santa Barbara County's Coastal Resources Enhancement Fund (CREF) to conduct hydrologic modeling of the Goleta Slough inlet to further inform future mouth management actions. The hydrologic modeling study is attached as Appendix G.

- County of Santa Barbara – Preparing resource and planning tools databases, coastal hazard modeling, and mapping to conduct an analysis of coastal resource vulnerabilities as part of a process to update to their Local Coastal Program policies.

- California Sea Grant – Preparing the Santa Barbara Area Coastal Ecosystem Vulnerability Assessment (SBA CEVA) that will measure historic and project future daily temperature, precipitation and waves near shore for incorporation into an analysis of potential climate changes.

- University of California at Santa Barbara – In November 2014, the Coastal Commission approved the University's *Long Range Development Plan* that addresses UCSB's anticipated growth through 2025. One of the studies required by that plan is a sea level rise vulnerability and adaptation study.

- The Eastern Goleta Valley Community Plan, which covers the unincorporated area between Goleta and Santa Barbara, including portions of the GESMP area, is scheduled for final approval by the Board of Supervisors in fall, 2015.

One goal of the management plan update is for it to serve as a foundation for other studies in the area and as a platform for sharing of information. The updated Plan will provide "place holders" for these plans and studies so that they may be incorporated into the Plan in the future. Ideally the goals, policies and actions of the new Plan will be updated periodically to incorporate new information derived from these studies and plans.

1.8 *Goleta Slough Area Sea Level Rise and Management Plan* – 2015

The third and final step in updating the 1997 GSEMP is the preparation of this document, the *Goleta Slough Area Sea Level Rise and Management Plan* (Plan). This Plan incorporates information from the 1997 GSEMP, the 2012 *Existing Conditions Report*, the 2014 sea level rise study, the 2015 inlet modeling study, and new information from area studies as it becomes available. The development of the Plan involved many public meetings and focus groups related to infrastructure, environmental considerations, and input from local and regional government. The GSMC, in particular, spent many hours reviewing and providing input on drafts of the document, especially the updated goals, policies and actions, including establishing priorities for implementation.

The *Goleta Slough Area Sea Level Rise and Management Plan* is an informational document. The Plan synthesizes available information related to historic and existing condition of Goleta Slough and discusses current and anticipated future challenges related to the management of the Slough. The Plan concludes with a set of goals and policies that have been developed by the GSMC for the preservation and enhancement of Goleta Slough. The GSMC will encourage local jurisdictions to consider these goals and policies as they update their Local Coastal Programs and undertake new studies in the Goleta Slough area. We look forward to participating in these processes with the local community.

PART 2 – BACKGROUND (THROUGH 2014)

2.1 Location and Relationship to Surrounding Areas

2.1.1 Goleta Slough

Goleta Slough is located in southern Santa Barbara County between the Santa Ynez Mountains and the Pacific Ocean. The Slough is the northernmost example of a large Southern California estuary and represents the northern limit of distribution for several plant and animal species (Zedler, 1982). It includes the Goleta Slough Ecological Reserve and the Goleta Slough State Marine Conservation Area, both of which are managed by the California Department of Fish and Wildlife (CDFW). The general location of the Slough is shown in Figure 2-1, General Location of the GSEMP Area.

In addition to its biological importance, Goleta Slough provides many other functions and values including floodwater storage capacity, filtering of pollutants contained in stormwater runoff, open space, and educational and scientific opportunities. The area is also rich in cultural and historic resources. The Slough is designated an Environmentally Sensitive Habitat Area (ESHA) in planning documents, as are most of the creeks that drain into it.

The Slough's watershed is about 45 square miles and includes the drainages of seven creeks: Atascadero, Carneros, Las Vegas, Maria Ygnacia, San Jose, San Pedro and Tecolotito Creeks (See Figure 2-14, Watersheds). Goleta Slough was historically an embayment of approximately 18 square miles in size. The name "Goleta" means schooner in Spanish, reflecting the history of the area when Goleta Slough was a bay with boats sailing inland close to what is now Hollister Avenue.

2.1.2 Goleta Slough Ecosystem

The 2,250-acre Goleta Slough Ecosystem area was identified by the Goleta Slough Management Committee (GSMC) in the mid-1990s. The primary determinant of what to include in the Ecosystem was if an area was historically within the tidally influenced basin of the Slough. Contiguous freshwater wetland habitats and upland habitats were also included. The Ecosystem includes the Slough and portions of the seven creeks that drain into it. Much of the area lies within the Coastal Zone.

Some of the GSEMP area is developed with urban uses including the Santa Barbara Airport, Goleta Sanitary District plant, Goleta West Sanitary District plant, multi-family housing and commercial and industrial uses. Major features and subareas of the Ecosystem are shown in Figures 2-2W and 2-2E. The western figure includes the subareas or basins in the Slough itself. These terms were first used in the CDFW 1988 *Draft Goleta Slough Ecological Reserve Management Plan* are still used today and throughout this report.

Figure 2-3 shows the existing boundary of the Goleta Slough Ecosystem Management Plan area.

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Figure 2-1 General Location of GSEMP Area

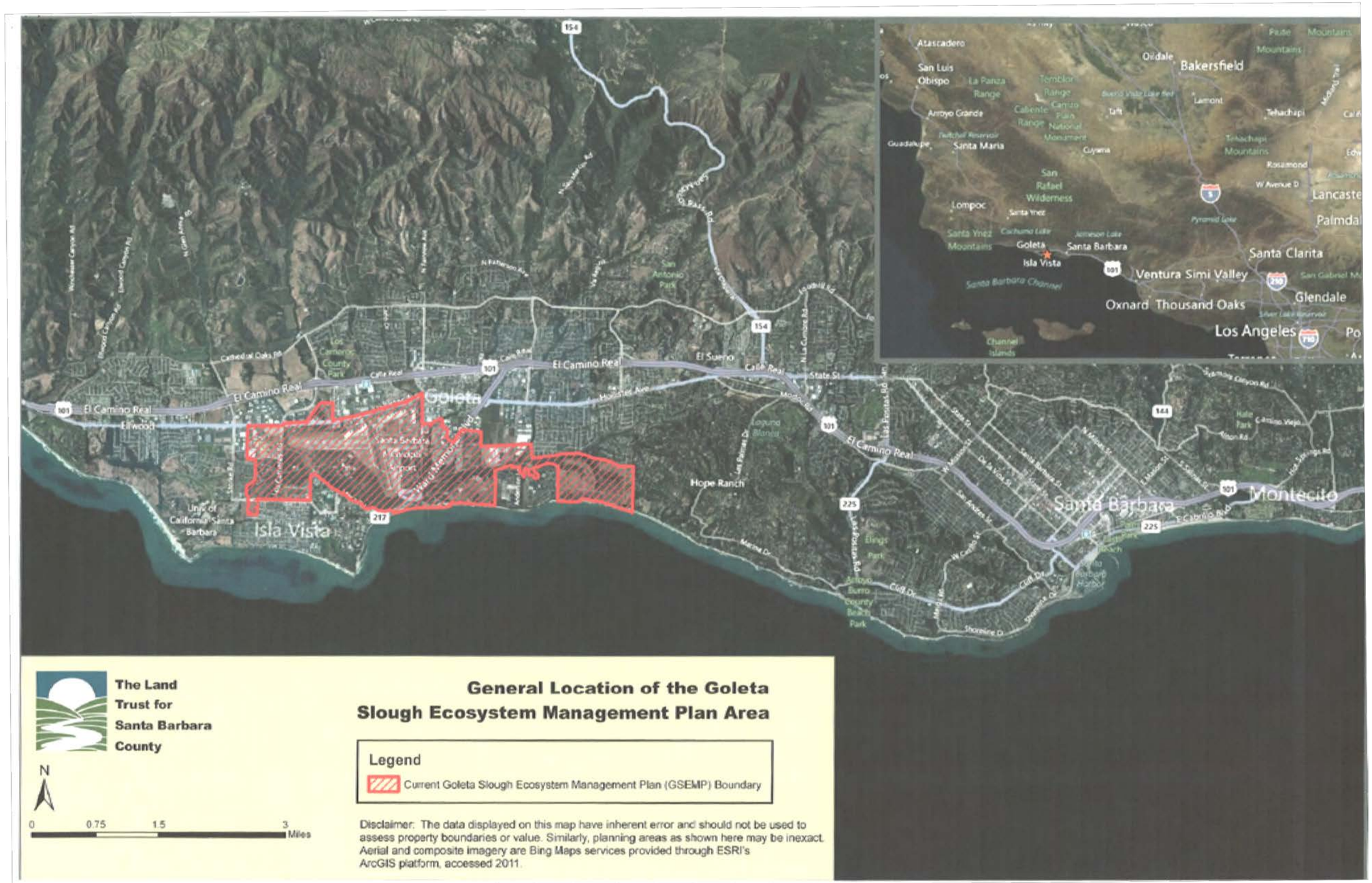

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Figure 2-2W Major Features and Subareas, West

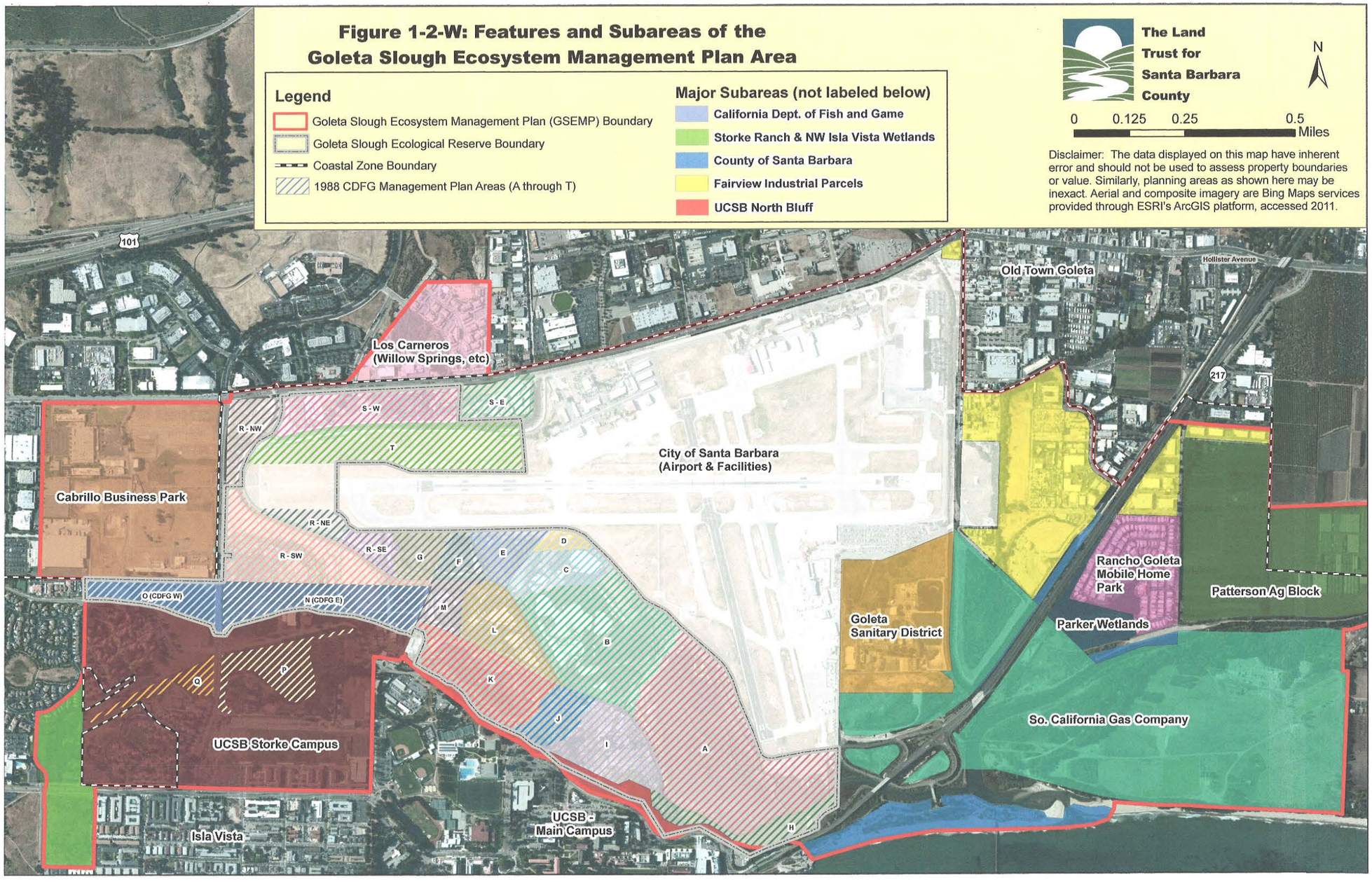

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Figure 2-2E Major Features and Subareas, East

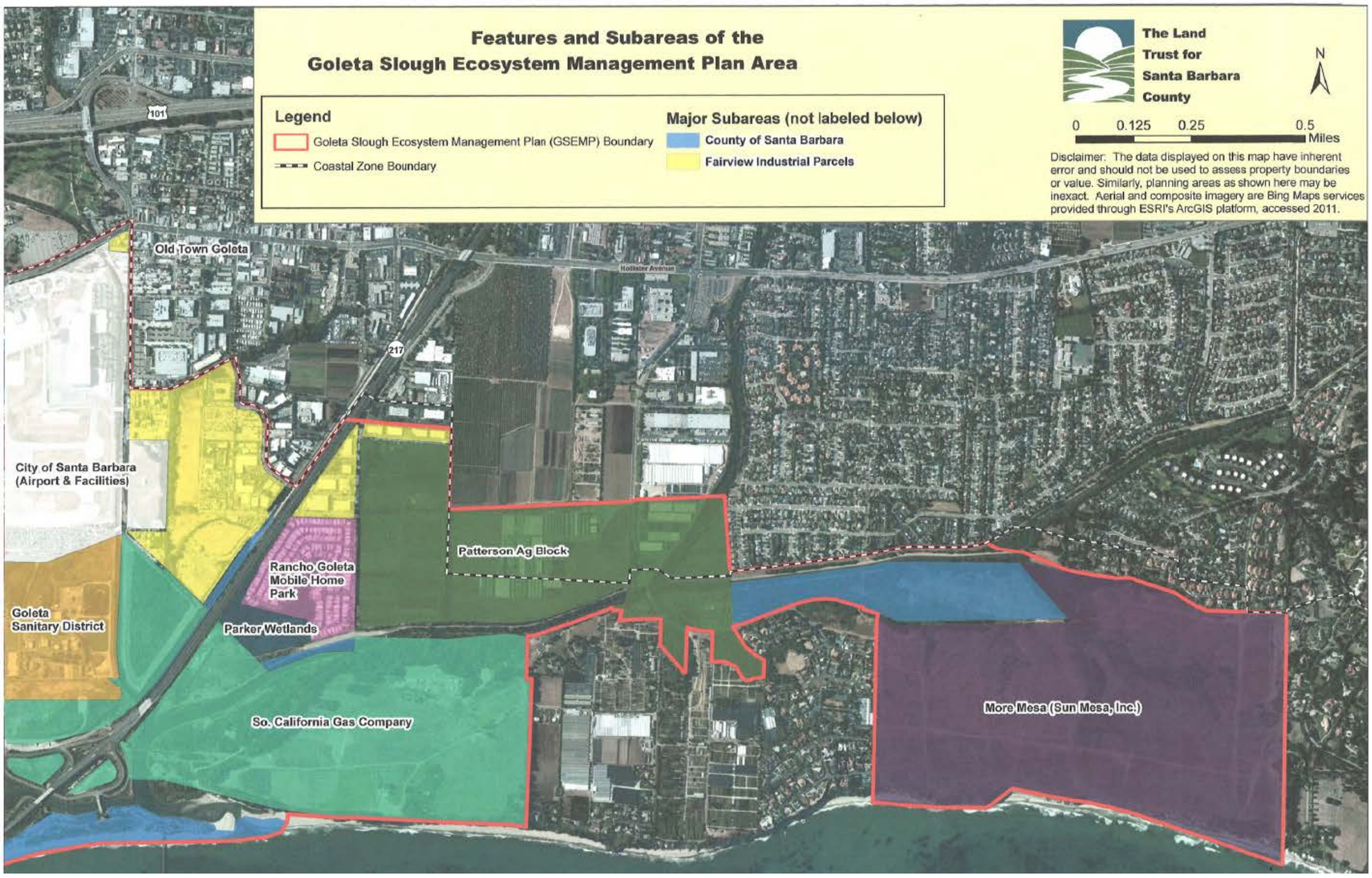

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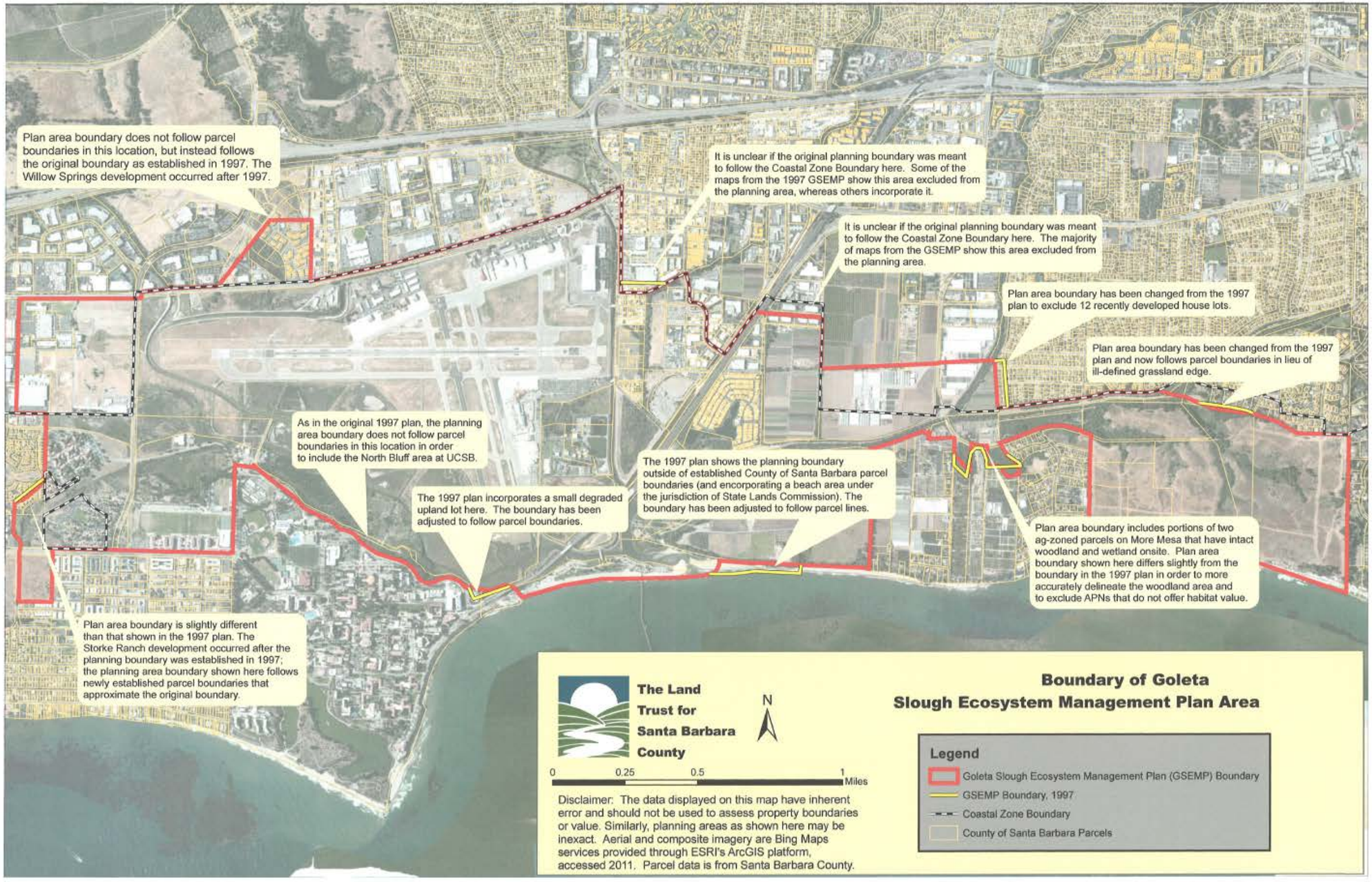
Figure 2-3 Original GSEMP Area Boundary - 1997



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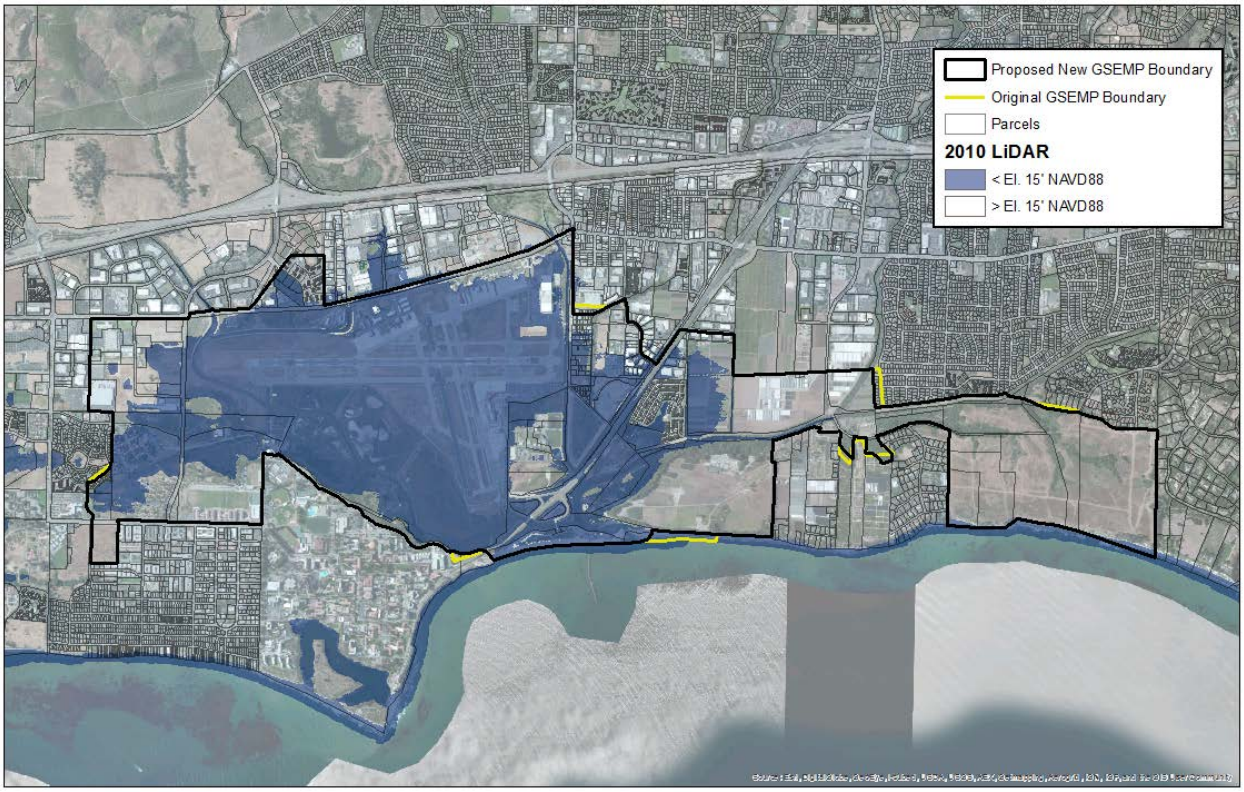
Mapping techniques have improved significantly since the boundary was initially drawn in the early 1990s, revealing several areas where discrepancies exist between the intended boundary and what it now on the ground. Figure 2-4 shows the GSEMP boundary in detail, including areas where there are incongruities, e.g., where the boundary does not follow parcel lines or the Coastal Zone, and where housing tracts and other uses were not intended to be included. The boundary line was revised as part of the 2012 *Existing Conditions and Monitoring Report* and was refined as part of the sea level rise study included in this plan.

Figure 2-4 Revised 2015 GSEMP Area Boundary



2.2 Jurisdictional Boundaries and Ownership

Several jurisdictions are represented within the Ecosystem including two cities (Goleta and Santa Barbara), Santa Barbara County and University of California at Santa Barbara land governed by the U.C. Regents. These jurisdictions are shown in Figure 2-5, Jurisdictional Boundaries of the GSEMP Area.

The relevant policies and other planning considerations relating to these jurisdictions are discussed in Section 2.3, Planning Framework. Local, state and federal agencies that regulate development and restoration projects within the Plan area are also discussed in Section 2.3.

Figures 2-6E and 2-6W, Land Use Designations and Parcels of the GSEMP Area, shows land use designations for parcels within the GSEMP area. Ownership, property address, acreage and land use on each parcel within the GSEMP area is provided in Appendix A, Parcels in the Goleta Slough Ecosystem – 2011.

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Figure 2-5 Jurisdictional Boundaries of the GSEMP Area

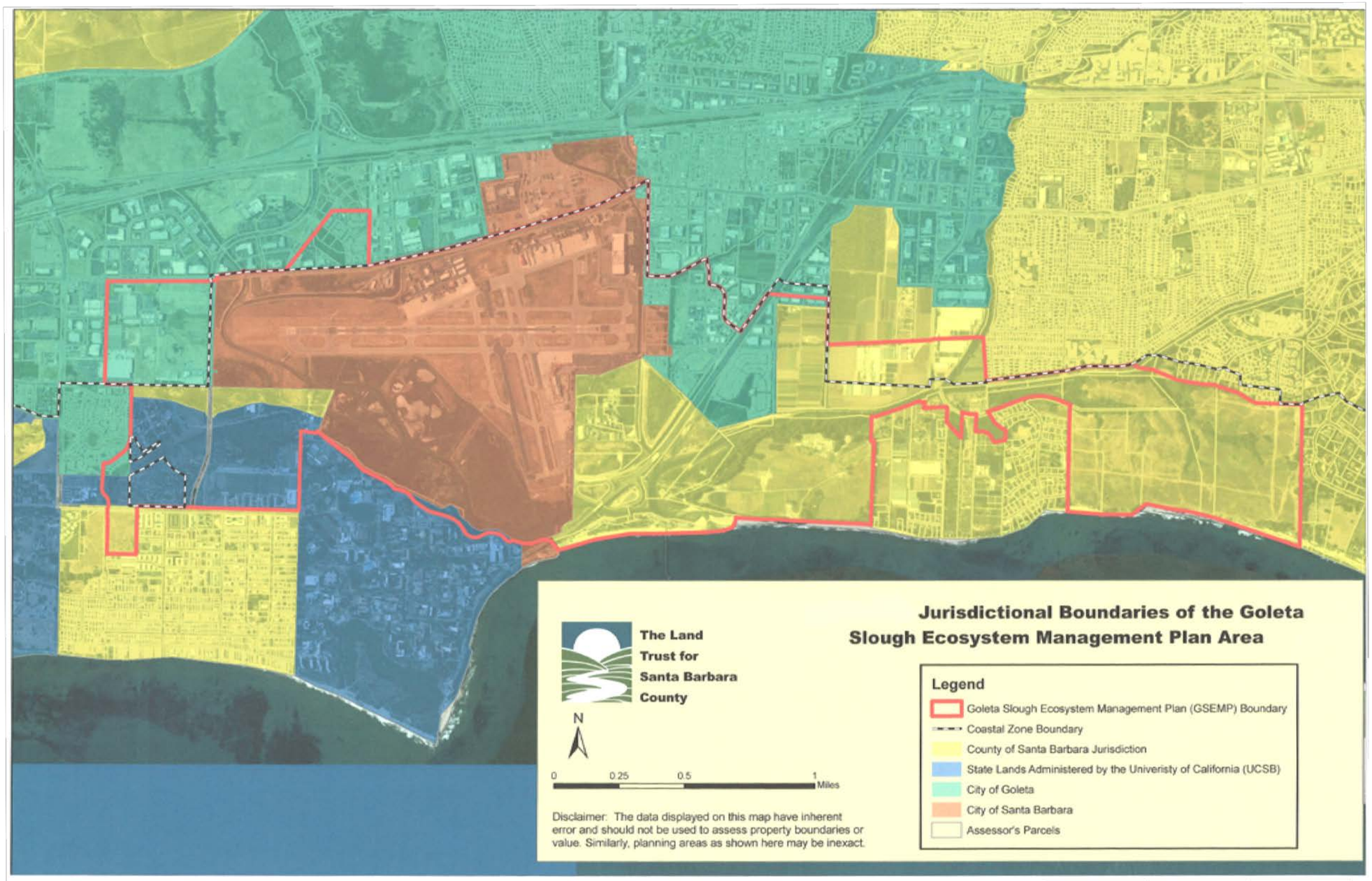

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Figure 2-6W Land Use Designations – West

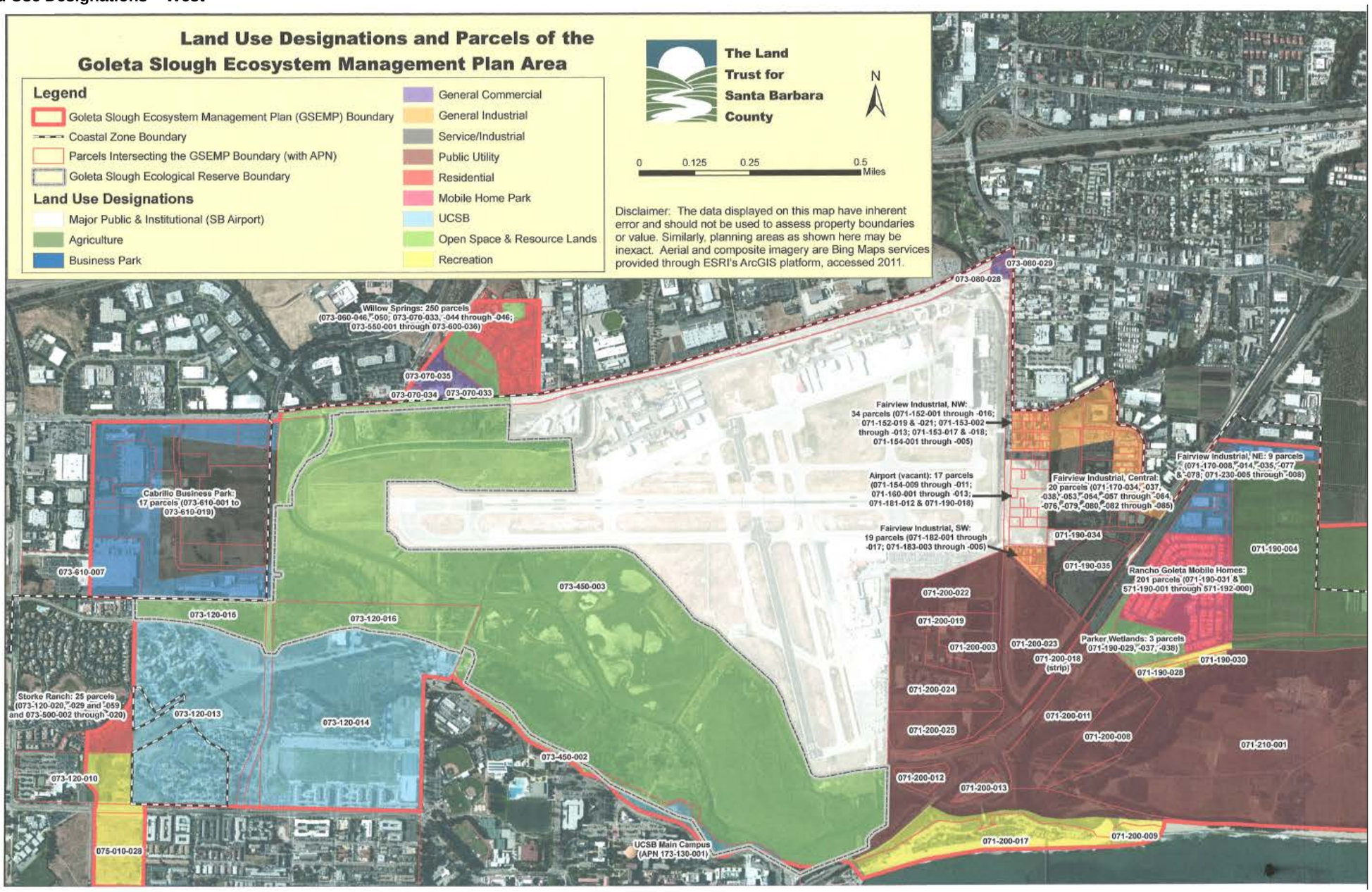

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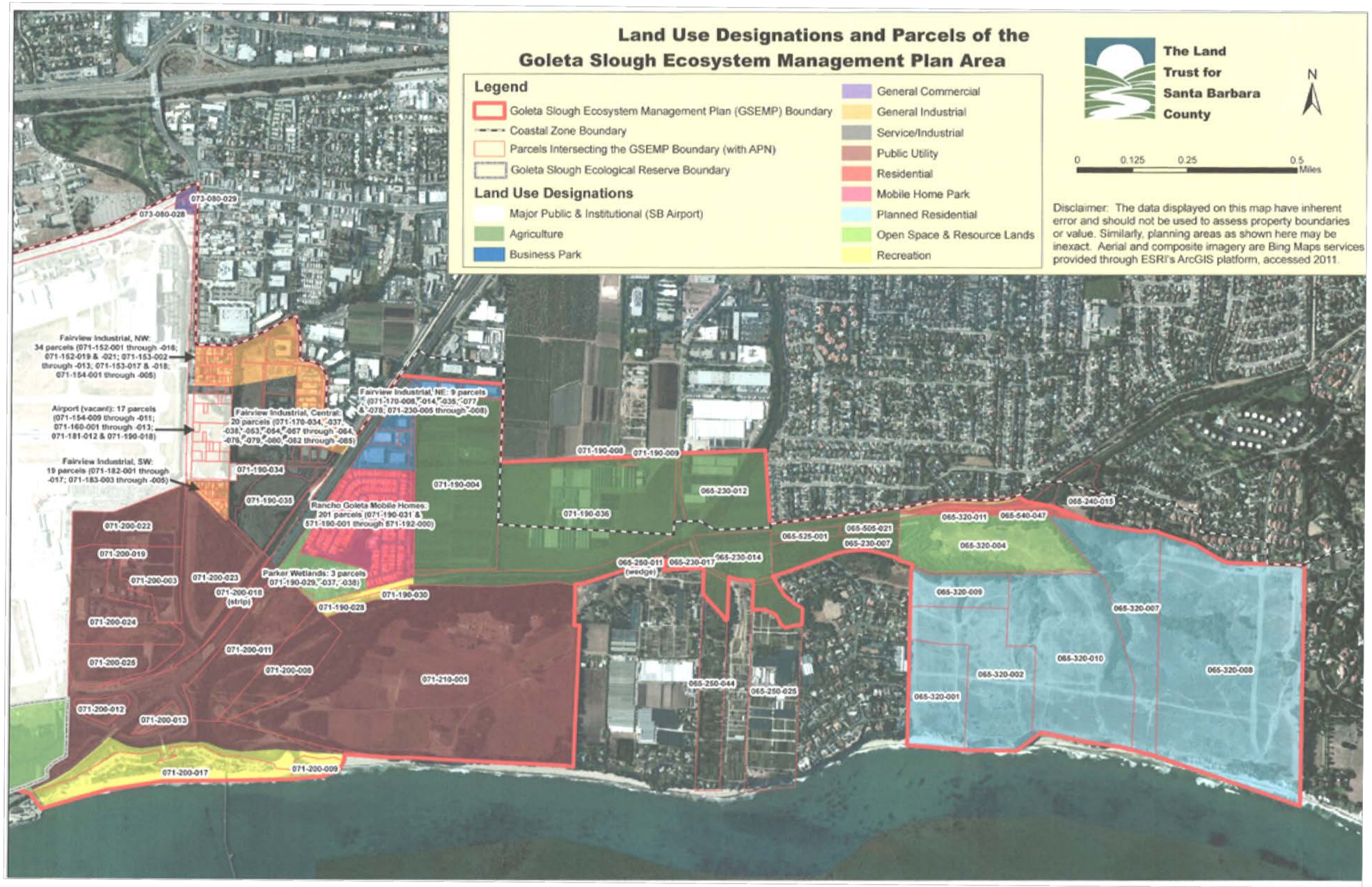
Figure 2-6E Land Use Designations - East



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2.3 Planning Framework

One of the key reasons the Goleta Slough Management Committee was initially formed was to provide a forum for discussion, oversight and management of the Ecosystem irrespective of the jurisdictional boundaries that overlapped with the area. Figure 2-5 shows the jurisdictions in and around the Slough including the Cities of Goleta and Santa Barbara, County of Santa Barbara and the University of California, Santa Barbara (UCSB).

State, federal and local agencies regulate development and restoration projects and conduct or oversee research activities within the Plan area. Regulatory agencies include the Federal Aviation Administration (FAA), Army Corps of Engineers (ACOE), U.S. Fish and Wildlife Service (USFWS), state and regional water quality control boards, the California Department of Fish and Wildlife (CDFW), State Lands Commission (SLC), National Marine Fisheries Service (NMFS), and the California Coastal Commission (CCC). At the County level, special districts such as Flood Control (FCD) and Mosquito and Vector Management District of Santa Barbara County (MVMD) conduct activities in the Slough. Other special districts operating in the Slough are two sanitary districts (Goleta Sanitary District (GSD) and Goleta West Sanitary District (GWSD) and the Goleta Water District (GWD). The authorizing or governing legislation of each relevant agency and a summary of their role and purview are provided at the end of this section in Table 2-1, Major Legislation relating to the Goleta Slough Ecosystem. Key planning issues are discussed further below.

2.3.1 California Coastal Commission

Most of the Goleta Slough Ecosystem is located within the Coastal Zone. The location of the Coastal Zone is shown in detail on Figure 2-7, Coastal Commission Jurisdictional Boundaries within the GSEMP Area. The Coastal Commission retains “original permit jurisdiction” over portions of the Slough itself and along Atascadero Creek as shown in Figure 2-7. They also have two different appeal jurisdictions that, depending on circumstances and the nature of the appeal, could result in a project approved at the local level being appealed to the Coastal Commission. These jurisdictional boundaries may be updated as the City of Goleta and other jurisdictions go through the LCP certification process.

The City of Santa Barbara has a certified Local Coastal Program covering the Airport and Goleta Slough. This plan, originally certified in 1982, was updated in 2003 to incorporate the *Goleta Slough Ecosystem Management Plan.* The County of Santa Barbara also has a certified LCP that will be updated to incorporate climate change and other relevant information. The City of Goleta, incorporated in 2002, has adopted a General Plan/Coastal Land Use Plan but the latter is in the process of consultation with the Coastal Commission. UCSB has a Long Range Development Plan approved by the UC Regents in 2010 and certified by the Coastal Commission in November 2014.

2.3.2 Wetland/Habitat Protection Legislation

State and federal laws that strive to protect wetland and other sensitive habitats were initially passed in the 1970s. Those laws have been amended and augmented since that time. Table 2-1 lists the major environmental legislation that affects the Ecosystem, particularly those laws relating to sensitive and protected species of plants and animals that are discussed in Section 2-10, Natural Resources.

2.3.3 Greenhouse Gas, Climate Change and Sea Level Rise Issues

The related issues of greenhouse gas emissions, climate change and sea level rise have been studied and debated widely in the last two decades. In 2006, AB 32 was passed in California relating to greenhouse gas (GHG) emissions, requiring that by 2020 jurisdictions reduce their communities' GHG emissions to 1990 levels. Since determining 1990 GHG emission levels may be a challenge, some communities are striving to reduce their emissions by a set percentage. In 2008, SB 375 was passed, often called the "anti-sprawl" or "sustainable communities" bill. This bill requires the California Air Resources Board to establish GHG reduction targets. Many communities in the state are preparing climate action plans in response to these laws.

Also in 2008, Governor Schwarzenegger signed Executive Order S-13-2008 that called on state agencies to develop California's first strategy to identify and prepare for expected climate impacts. In March 2011, the State's Ocean Protection Council provided general low, medium and high estimates of sea level rise along the California coast through 2100. In March 2013, the OPC updated its Sea Level Rise Guidance, designed to help state agencies incorporate future sea-level rise impacts into planning decisions, to include the best current science, as summarized in the final report from the National Research Council in 2012, *Sea-Level Rise for the Coasts of California, Oregon, and Washington*. They also recommended that state agencies consider sea level rise in their planning. In October 2013, legislation was adopted in October 2013 (Muratsuchi, AB 691) that would require grantees of public trust tidelands and submerged lands to submit a sea level rise assessments to the State Lands Commission, the agency that has jurisdiction over those lands, by July, 1, 2019. The Coastal Commission adopted guidance to jurisdictions dealing with climate change in August 2015 (http://documents.coastal.ca.gov/assets/slr/guidance/August2015/0_Full_Adopted_Sea_Level_Rise_Policy_Guidance.pdf). It is possible that the coming years will see legislation that would require that coastal cities and counties prepare sea level rise plans.

Table 2-1
Major Legislation Relating to the Goleta Slough Ecosystem

By Issue Area:

Issue/Law	Administered by	Summary
NATURAL RESOURCES		
Endangered Species Act - 1976	• US Fish and Wildlife Service • Nat'l Marine Fisheries Service	• Actions relating to threatened, endangered and candidate species. • Where a species is fully protected, there can be no "take" of the species & no permits to "take" the species.
Fisheries Conservation and Management Act – 1976 [New]	• US Fish and Wildlife Service • Nat'l Marine Fisheries Service	• Mandates the use of annual catch limits and accountability measures to end overfishing • Provides for widespread market-based fishery management through limited access privilege programs • Calls for increased international cooperation.
Calif. Endan-gered Spp Act	• California Dept. of Fish and Wildlife	• Actions related to threatened or endangered species
California Fish & Game Code	• California Dept. of Fish and Game	• Actions that result in alteration of stream bed, bank, channel or riparian vegetation (§1600 et seq)

Issue/Law	Administered by	Summary
California Coastal Act – 1976 and local Coastal Plans	• California Coastal Commission (CCC), Cities and County thru LCPs and UCSB through Long Range Development Plan (LRDP)	• Mission is "To protect, conserve, restore, and enhance the environment of the Calif. coastline"• • "Development" activities are broadly defined to include construction of buildings, divisions of land, and activities that change the intensity of use of land or public access to coastal waters. • Amendments to LCP or LRDP must be found consistent with Coastal Act by CCC.
Draft Eastern Goleta Valley Community Plan – 2011	• Santa Barbara County Planning & Development Long Range Planning Division	• Many policies and actions relating to Community Development and Land Use; General Resources and Constraints; Watershed, Hydrology & Flooding; Biological Resources; ESHA and Riparian Corridor – See Appendix C for text of policies.
City of Goleta General Plan/ Coastal Land Use Plan - 2006	• City of Goleta Advance Planning	• Many policies and actions relating to Community Development and Land Use; General Resources and Constraints; Watershed, Hydrology & Flooding; Biological Resources; ESHA and Riparian Corridor – See Appendix C for text.

City of SB General Plan Update – Env. Resources Element – 2011	• City of Santa Barbara Planning Division & Airport Dept.	• Goals include:
		  • Sustainable resource use including protect and use resources wisely
		  • Reduce Greenhouse Gases including those that contribute to climate change
		  • Climate Change adaptation by, if applicable, incorporating adaptations into new development, redevelopment and public infrastructure.

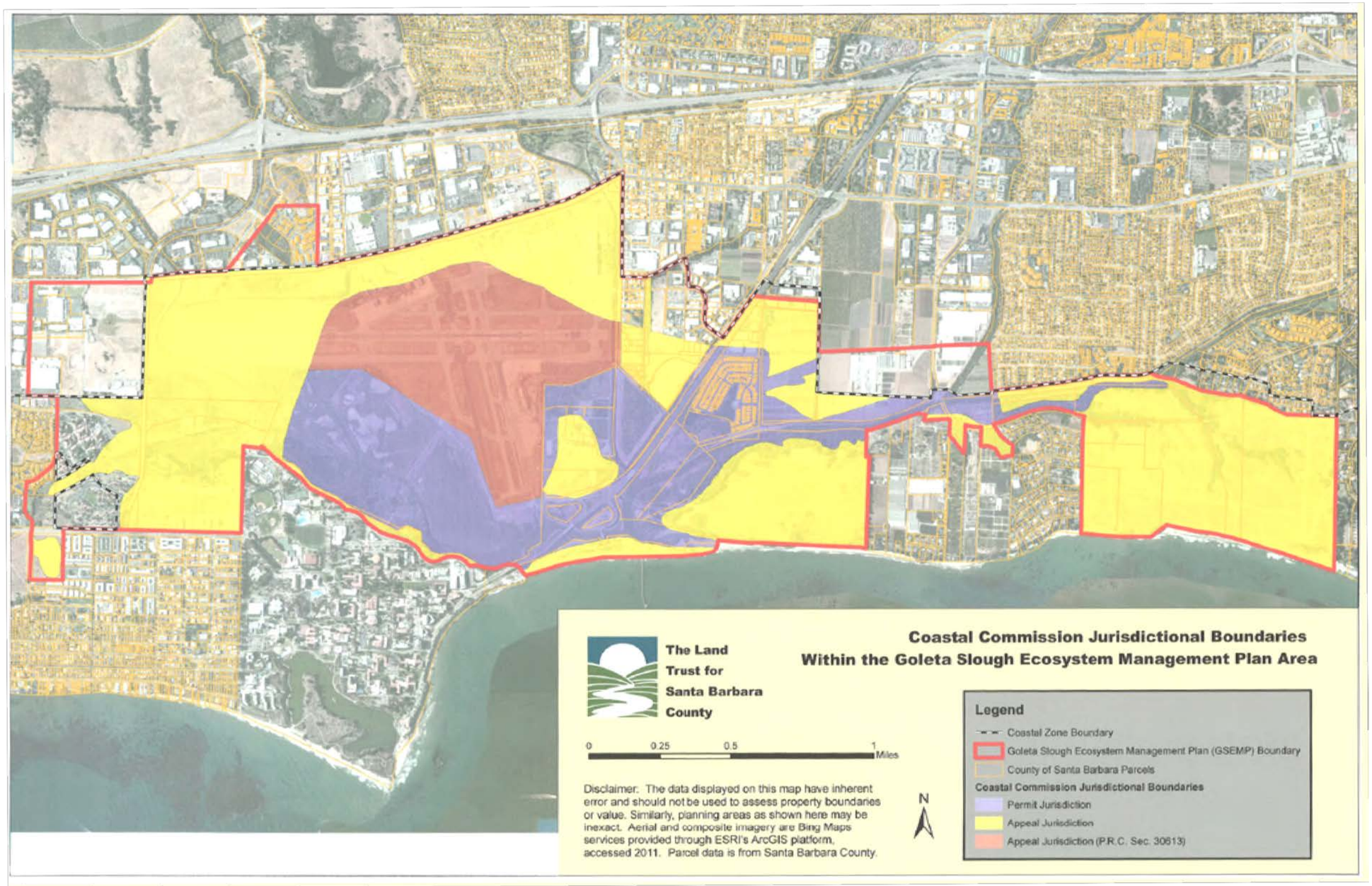
City of SB Coastal Plan – Airport/Goleta Slough – 1982 and 2003	• City of Santa Barbara Planning Division & Airport Dept.	• Many policies and actions relating to Access, Recreation, Mosquito Abatement, Sedimentation, Tidal Action & Wetlands – See Appendix C for text of policies. • GSEMP incorporated as App. G in Airport/GS LCP. Policy C-10 requires that "All development and mitigation of impacts on Goleta Slough shall be consistent with the policies of the Goleta Slough Ecosystem Management Plan."
UCSB Long Range Develop-ment Plan – 2010	• UCSB Office of Campus Planning & Design	• Many policies and actions relating to Land Use; Open Space & Landscaping; ESHAs; Coastal Waters – Water Resources & Erosion; Diking & Filling; Utilities & Infrastructure – See Appendix C for text.
CLIMATE AND SEA LEVEL RISE		
AB 32 (2006)	• Calif. Air Resources Board (CARB)	• Requires CARB develop regulations and market mechanisms to reduce California's GHG emissions back to 1990 levels by 2020.
SB 375 (2007)	• Office of Planning & Research (OPR)	• OPR must develop legal guidelines for analysis and mitigation of GHG emissions, pursuant to the California Environmental Quality Act.
State Exec. Order S-13-2008	• Office of the Governor	• Called on state agencies to develop California's 1st strategy to identify & prepare for expected climate impacts.
Ocean Protection Council Reso 3-11-11	• California Ocean Protection Council	• Provided a range of estimates of sea level rise through 2100 using 2000 as a baseline. • Recommended that state agencies should consider SLR when making funding decisions.
AB 691 (Muratsuchi) - 2013	• State Lands Commission	• Requires lessees of public trust lands to submit to SLC sea level rise assessments by July 1, 2019.
Calif. Coastal Commission Sea Level Rise	• California Coastal Commission	• Provides an overview of best available science on SLR for California and recommended steps for addressing SLR in CCC planning and regulatory decisions.

Issue/Law	Administered by	Summary
Guidance (8/15)		
WATERSHED		
Watershed Protection & Flood Preven-tion Act of 1954	• Natural Resources Conservation Service (NRCS)	• The Act authorizes federal assistance (by the NRCS) to local organizations for planning and carrying out projects in watershed areas for conservation and use of land and water, and flood prevention.
WATER ISSUES – WATER QUALITY, FLOODING, ACCRETION AND EROSION		
Water Quality - Clean Water Act §303	• Regional Water Quality Control Board • Calif. Environmental Protection Agency	• Applied locally through Central Coastal Basin Water Quality Control Plan • Includes Water Quality Standards and Implementation Plans
Clean Water Act – 1964 §401 and 402	• Regional Water Quality Control Board • Army Corps (§404)	• Water quality certif. for §404 (§401); • Regulates discharge into waters of US (§402); NPDES permits (§402)
Clean Water Act – 1964 §404	• Army Corps of Engineers (§404)	• •Water quality certif. for §404 (§401)
Storm Water Management Program	• City of SB	• Under Clean Water Act NPDES Program, Phase II deals with regulations governing discharges for small municipalities that have storm drainage systems.
SBA Storm Water Pollution Prevention Plan	• City of SB	• Under the Airport's Clean Water Act NPDES General Permit for Storm Water Discharges Associated with Industrial Activities
Flood Insurance Reform Act of 2004	• Federal Emergency Management Agency (FEMA)	• This act authorizes the national flood insurance program, which includes provisions for the evaluation and mapping of flood hazard zones.

Regulations Governing Airport, Flood Control and other Special Districts:

Issue/Law	Administered by	Summary
FEDERAL – Santa Barbara Airport		
FAA Regs. Part 77	• Federal Aviation Administration	• This legislation relates to limitations on the height of structures in the vicinity of the runways at the Airport.
Federal Aviation Regs. Part 139 (wildlife hazard mgmt.)	• Federal Aviation Administration	• Provide a safe and efficient airport • Reviews and approves projects proposed on Airport property with respect to wildlife hazards.
LOCAL		
Flood Control Regulations	• SB County Flood Control District	• Provide flood protection (various federal and state laws)
California Health and Safety Code	• Mosquito and Vector Management District of Santa Barbara Co.	• Control existing and future mosquito breeding sources

Figure 2-7 Coastal Commission Jurisdiction



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2.4 Existing Uses, Infrastructure and Development

When the GSEMP was completed in 1997, about one-third of the GSEMP area was in public ownership, just over half was in private hands and about 13 percent was owned by utilities.[1] While the type of ownership in the area has not changed since that time, the land uses within the area have changed. Most notable is the development at the Cabrillo Business Park site immediately west of the main Airport runway as well as the Willow Springs housing development just north of Hollister Avenue near Carneros Creek (see Figure 2-2W, Features and Subareas of GSEMP Area). There has also been a considerable amount of mitigation and restoration work done in the GSEMP area as discussed below. Land use by parcel is provided in Appendix A, Parcels in the Goleta Slough Ecosystem – 2011 with more detailed information available through the County Assessor's Office at http://sbcassessor.com/assessor/AssessorParcelMap.aspx

2.5 Historical Development and Change Since 1860s

For centuries prior to European settlement of California, the Goleta Slough encompassed 18-square miles and was a deep-water harbor. Chumash villages flourished in numerous villages in the area, including on Mescalitan Island and near the confluence of Atascadero, San Jose and San Pedro Creeks. In more recent times, people could sail their boats to just south of what is now Hollister Avenue.

The major changes to the Slough, Airport and to UCSB's Storke Campus area (including wetlands), are summarized in Table 2-2, Major Changes in Goleta Slough Area – 1860s to 2011. Figures 2-8a through 2-8i show the progressive changes in the Goleta Slough area from 1871/73through 2011. The first development at what is now Santa Barbara Airport occurred around 1938 (see Figure 2-8c). Mescalitan Island is visible and intact in this map. By 1943/44 (Figure 2-8d), only a remnant of the island remains and the airfield is considerably more developed. Around this time the nascent Santa Barbara Municipal Airport was conscripted as a Marine Corps Air Station. The air station was deactivated in March 1946 and returned to the City of Santa Barbara.

Table 2-2
Major Changes in Goleta Slough Area – 1860s to 2011

PHOTO DATE	FIGURE # & SOURCE	Area A AIRPORT/GOLETA SLOUGH	Area C UCSB STORKE CAMPUS
1860s and 1870s	**Fig. 2-8a** US Coast Survey	• **GS was altered significantly in 1861-62** when extensive sedimentation occurred as a result of erosion from the watershed during severe storms following fires and overgrazing. • **Goleta Slough (**GS) has extensive salt marsh habitat, sand flats (alluvium) & a small lagoon • **Mescalitan Island** is whole & almost entirely surrounded by marsh habitat & the Slough mouth	• **Storke Campus appears as a grassland** sloping down to the upper portion of the Slough • **Vernal pools** were probably associated with the grasslands near the seeps & were probably associated hydrologically with the seeps

[1] *Draft Goleta Slough Ecosystem Management Plan,* page 1-1 and Figure 3.

PHOTO DATE	FIGURE # & SOURCE	Area A AIRPORT/GOLETA SLOUGH	Area C UCSB STORKE CAMPUS
1903	**Fig. 2-8b** US Geological Survey	• **New development** includes a railroad & new settlement areas (La Patera), fragmentation of the estuary and roads • **Marshlands and lagoon** appear similar to 1871/73 map	• **Western portion** is still intact & not fragmented • **Early roads and berms** are appearing
1938	**Fig. 2-8c** UCSB Map & Imagery Library	• **Extensive salt flats** have developed on the margin of the estuary • **Estuarine wetlands** appear more limited & more fragmentation of habitats has occurred • **GS mouth** appears to be closed • **GS delta** is largest observed in historic record • **Airfield** appears on what is now the Santa Barbara Airport	• **Western GS** has become more fragmented & can see beginnings of West & East Storke Wetlands. • **Additional roads & agricultural development** occur in the upland areas. • **Vernal pools** appear that are large & contiguous (dark soil or wetland vegetation above what is now El Colegio Rd.) • **Storke Ranch** & an early portion of future Los Carneros Rd appear
1943/44	**Fig. 2-8d** UCSB Map & Imagery Library	• **SB Municipal Airport construction began** during fall 1941 by Army Corps of Engineers • **Mescalitan Island** was partially leveled to produce fill for the construction and marsh & salt flat habitats were filled • **Goleta Beach** reaches most eroded state in historic air photo record • **Marine Corps Air Station construction** began in June 1942 & was conscripted for military purposes. MCAS was deactivated in March 1946 & converted back to Santa Barbara Municipal Airport.	• **Major changes** including runoff resulting in the formation of a large pond, called "Storke Lake" • **The current Los Carneros/Mesa Rd. intersection** occurs in the center of this impounded wetland • **Seasonal wetlands** apparently still existed in the vicinity of what is now Storke Field & UCSB housing
1961	**Fig. 2-8e** UCSB Map & Imagery Library	• **Flood control channels** have been excavated within the estuary for the flow of water & sediment from Tecolotito & Carneros Creeks • **Airport** development expanded • **Goleta Sanitary District facilities** expanded including treatment basins • **Construction of US 101** & expansion of residential & commercial development north of the Slough occurred	• **Major changes have occurred** resulting in minimal evidence of seeps, coastal pond & salt marsh vegetation. Storke Wetlands appear more fragmented. • **Extensive western portions** of the GS system appear to be drained, diked, impounded & altered
1967	**Fig. 2-8f**	• **Construction of Ward Memorial Drive** (SR 217) resulted in filling of wetlands,	• **Construction of Harder Stadium** initiated other UCSB development on Storke

PHOTO DATE	FIGURE # & SOURCE	Area A AIRPORT/GOLETA SLOUGH	Area C UCSB STORKE CAMPUS
	UCSB Map & Imagery Library	fragmentation of habitat & perhaps temporary closure of the estuary • **The SW-NE trending runways** appear to have been abandoned	Campus • **Francisco Torres dormitories** appear west of Storke Wetlands & were built on important habitats (including vernal pools?) contiguous to West Storke Wetlands
1975	**Fig. 2-8g** UCSB Map & Imagery Library	• **The main runway is extended 1,000 feet** which necessitated the relocation of Tecolotito Creek (note right angles) • **Sedimentation into the Slough** appears to have accelerated	• **Mesa Road** passes through Storke Campus Wetlands, further altering the natural landscape in the area • **Construction of Married Student Housing** west of Los Carneros Rd. required more filling of wetlands & further isolated habitats of Storke Wetlands
1991	**Fig. 2-8h** UCSB Map & Imagery Library	• **Sediment basins** on Tecolotito & Carneros Creeks are more prominent • **Service roads within the Slough** are more defined	• **Area K** near East Storke Wetlands is visible & provides brackish habitat favored by waterfowl • **Santa Ynez Student Housing** at El Colegio & Los Carneros Road constructed on southern edge of West Storke Wetland.
2011	**Fig. 2-8i** Bing Maps through ESRI's ArcGIS platform	• **The Airport relocated the main runway 800 feet to the west** &Tecolotito & Carneros Creeks were rerouted & have a more curvilinear flow line. Tidewater gobies were discovered in sediment basins in 2006. • **Carneros & Tecolotito sediment basins** expanded • **The Airport restored 80 acres habitat on 12 sites in the Slough** including tidal, creek, wetland and upland habitat restoration	• **UCSB housing has been built on Storke Field** next to El Colegio Rd • **Restoration of West CDFW property** has occurred & work has begun on East CDFW property • **Restoration of 7-acre San Clemente area -** NE corner of Los Carneros/El Colegio intersection treats runoff from new housing on El Colegio.

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Figure 2-8a Historic Map – 1871/1873

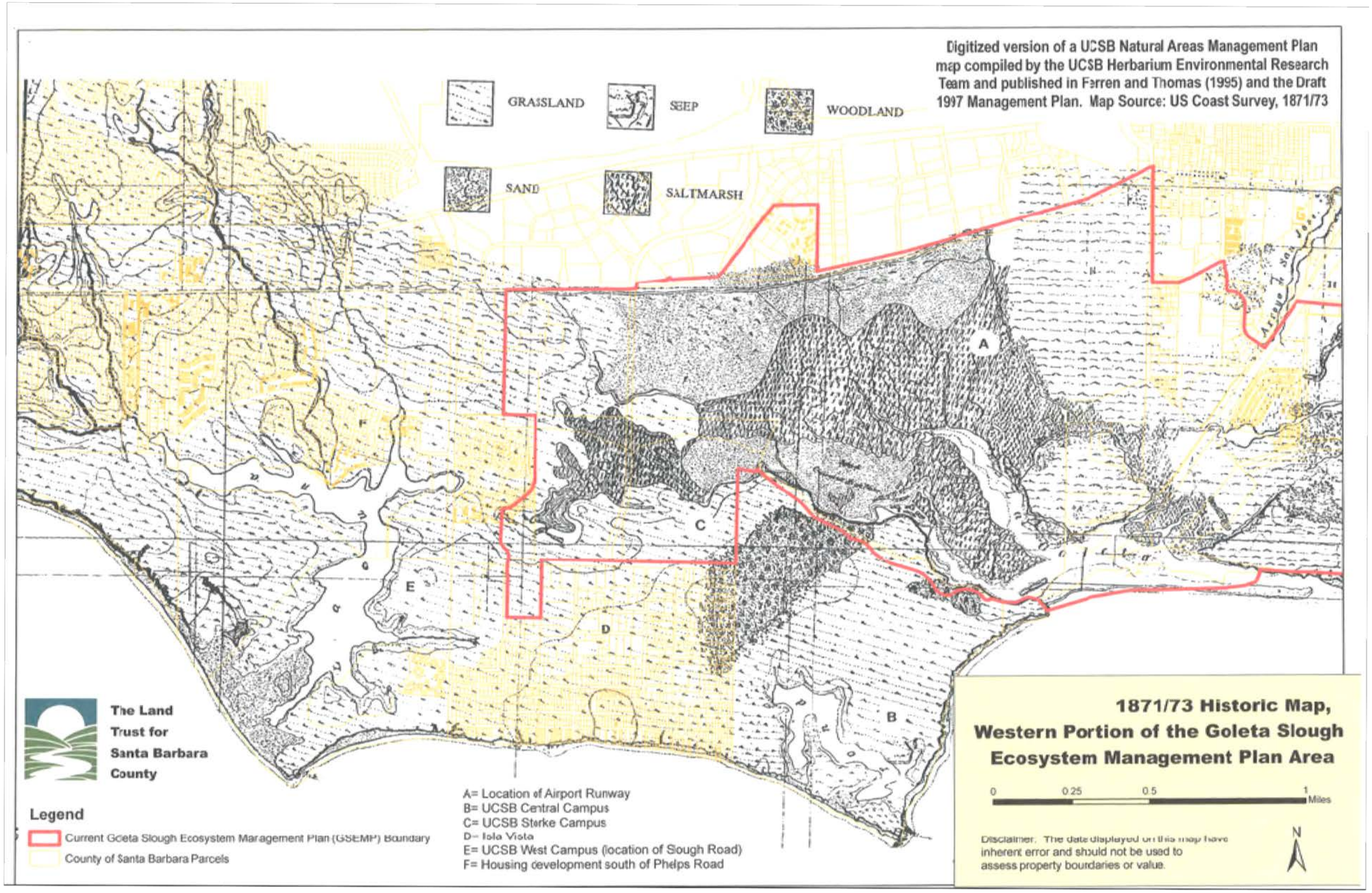

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Figure 2-8b Historic Map – 1903

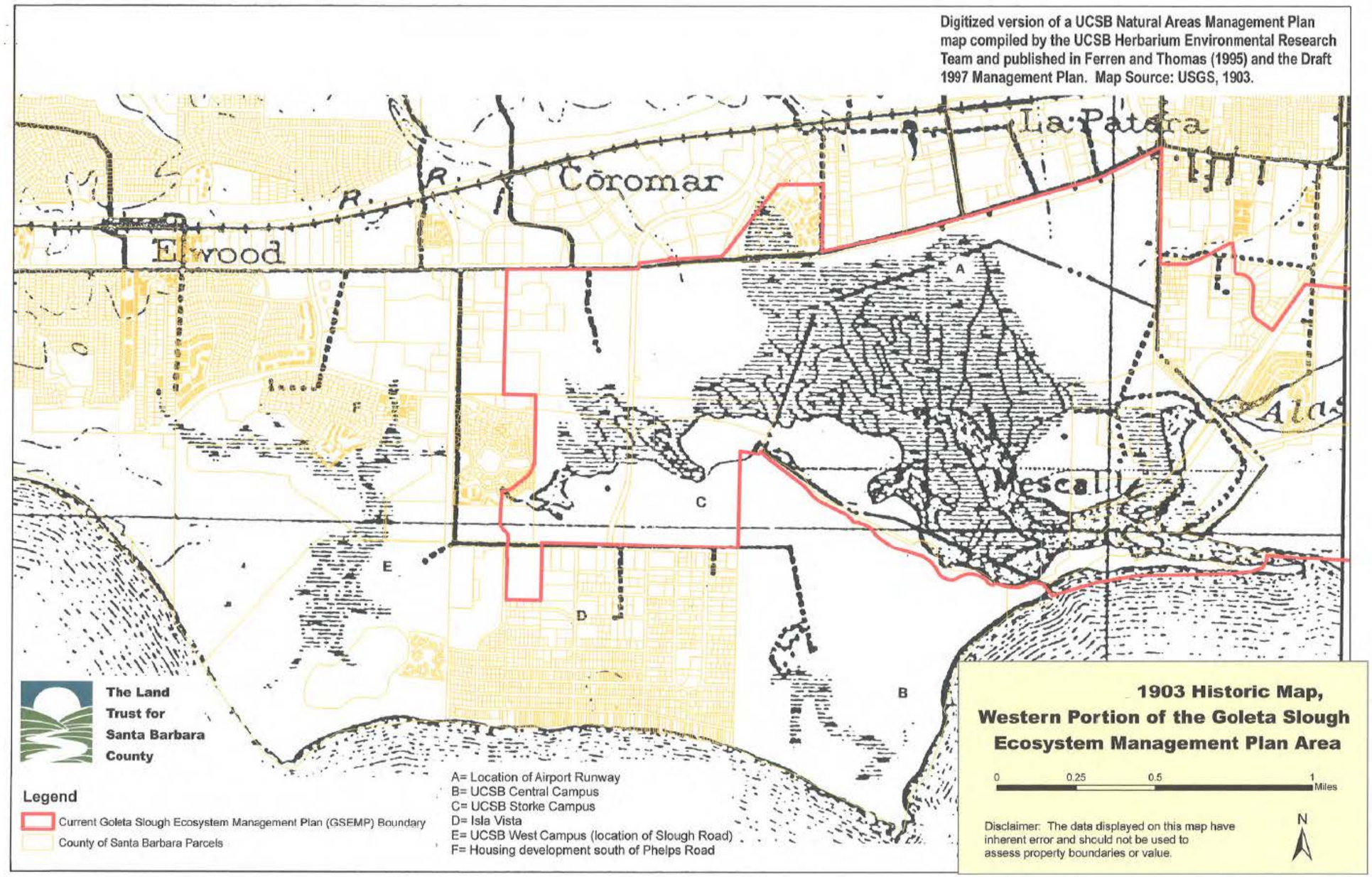

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Figure 2-8c Historic Aerial Photograph - 1938

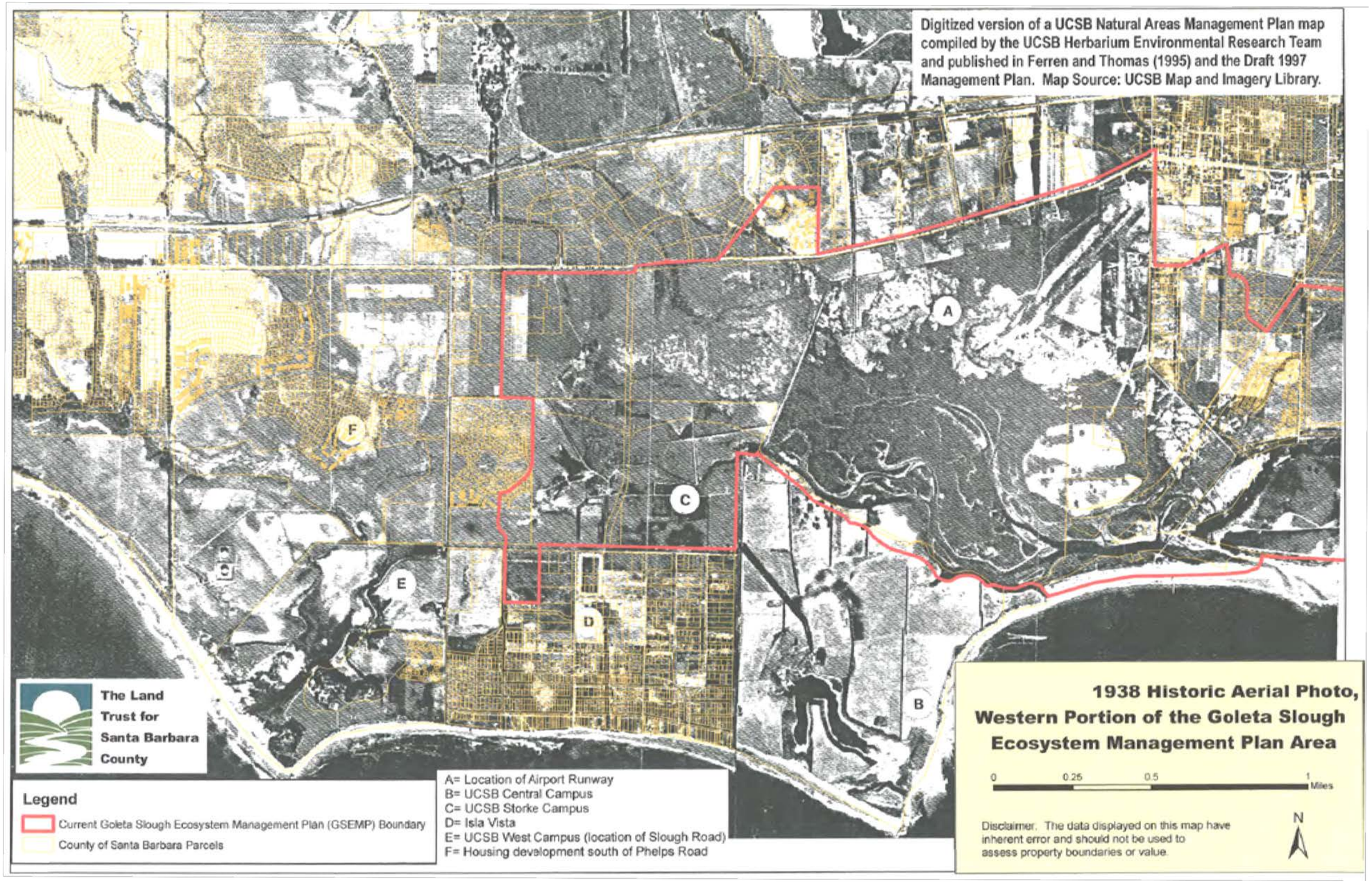

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Figure 2-8d Historic Aerial Photograph – 1943/1944

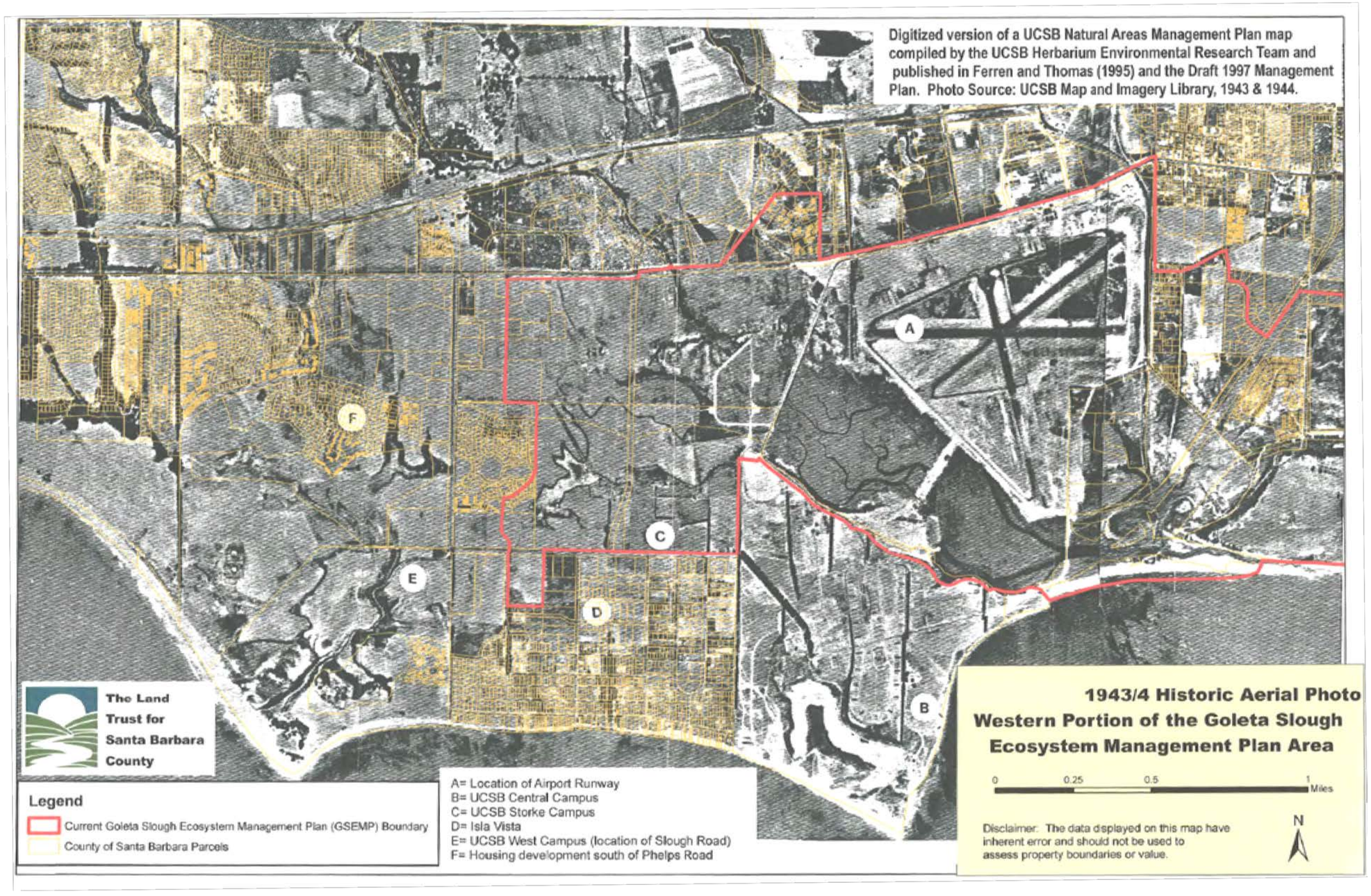

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Figure 2-8e Historic Aerial Photograph – 1961

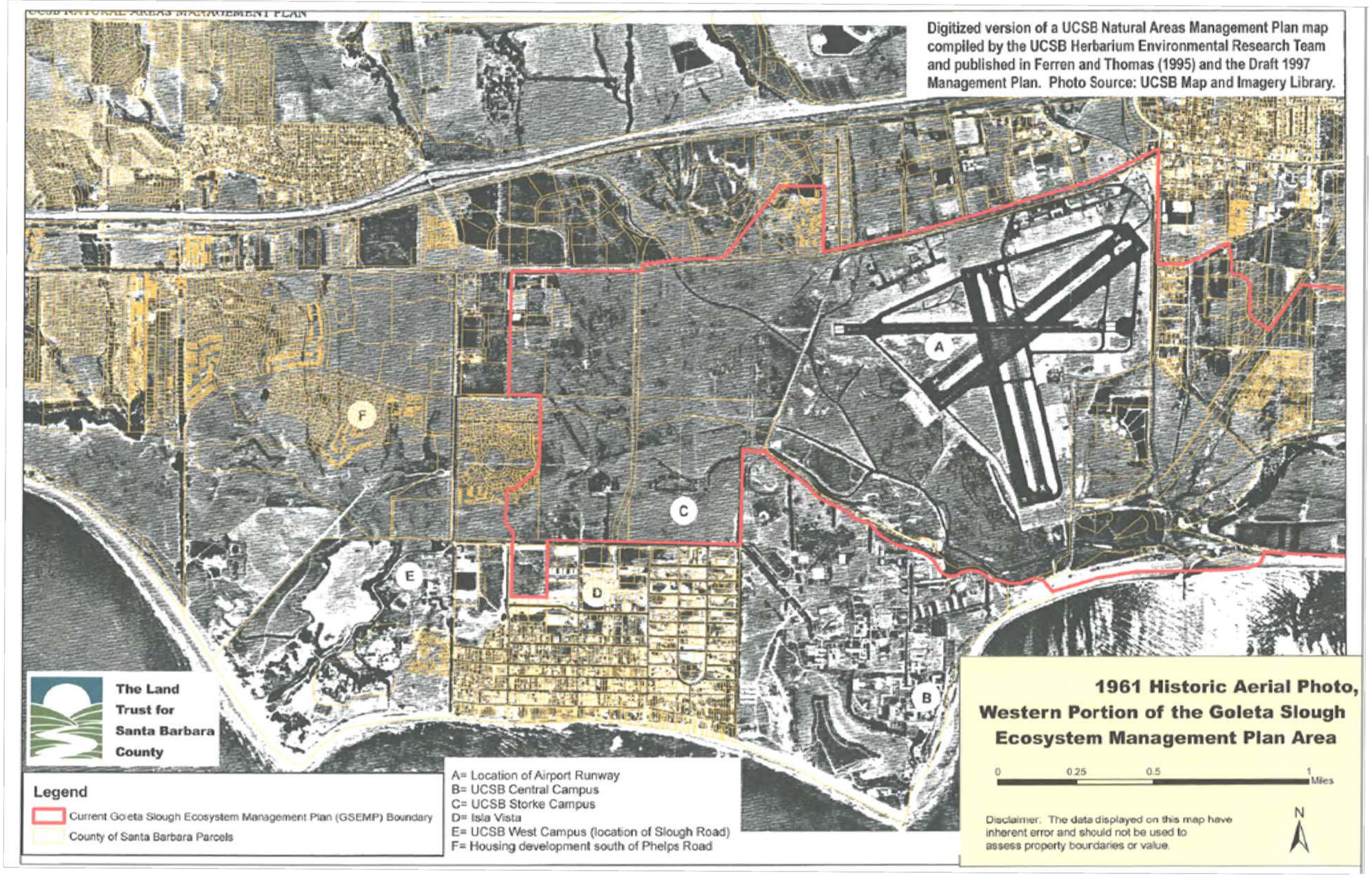

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Figure 2-8f Historic Aerial Photograph – 1967

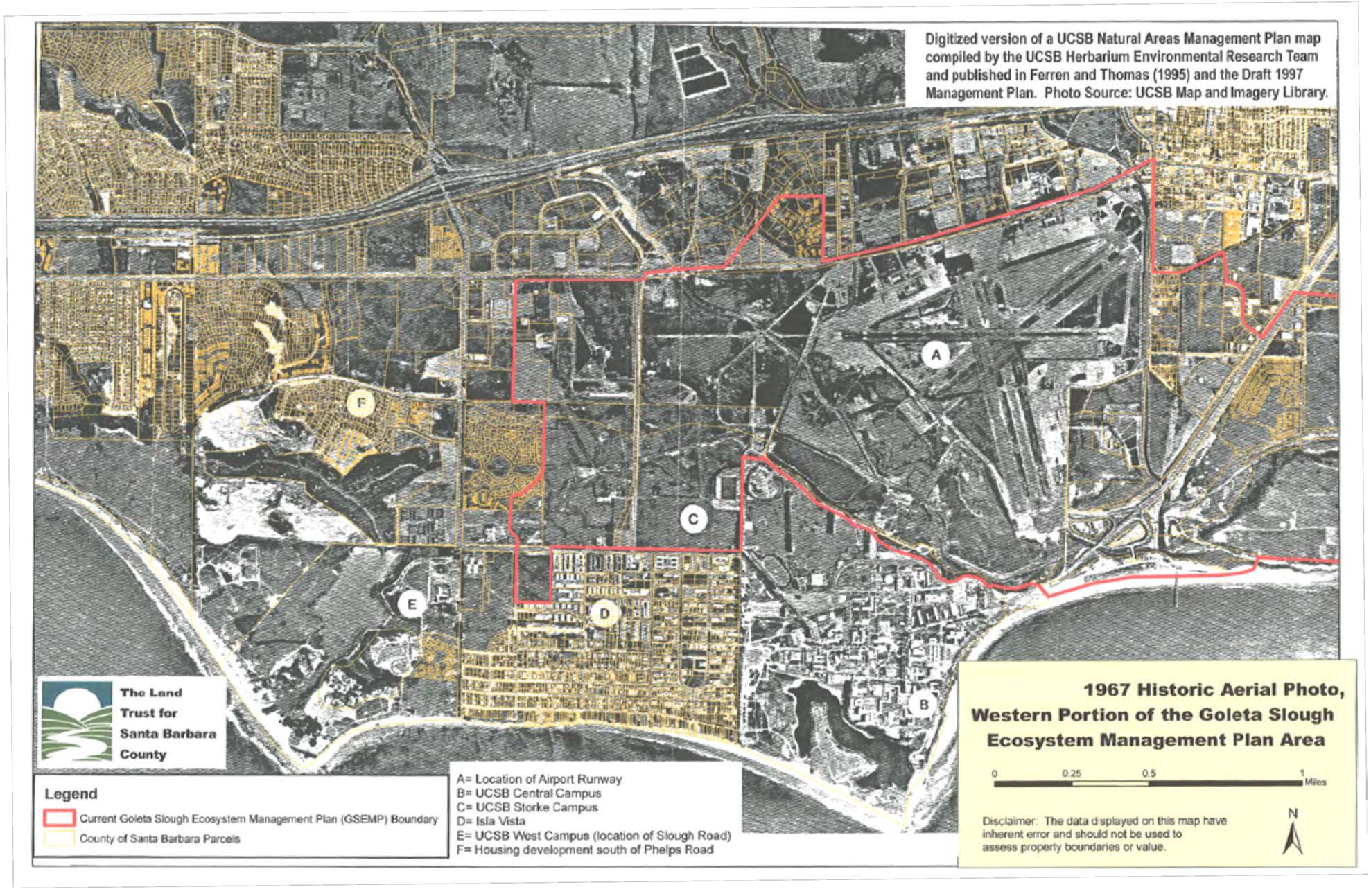

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Figure 2-8g Historic Aerial Photograph – 1975

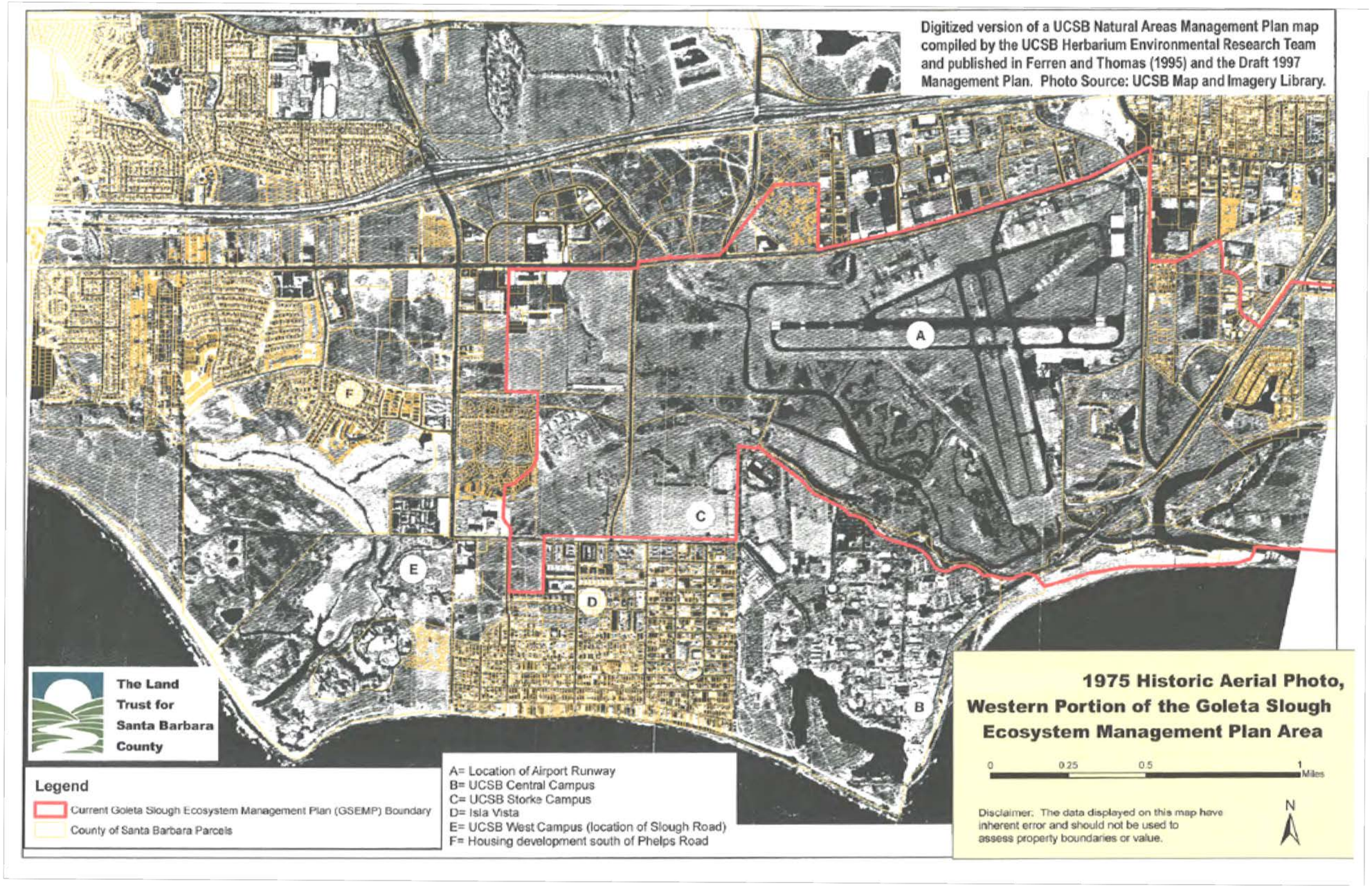

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Figure 2-8h Historic Aerial Photograph – 1991

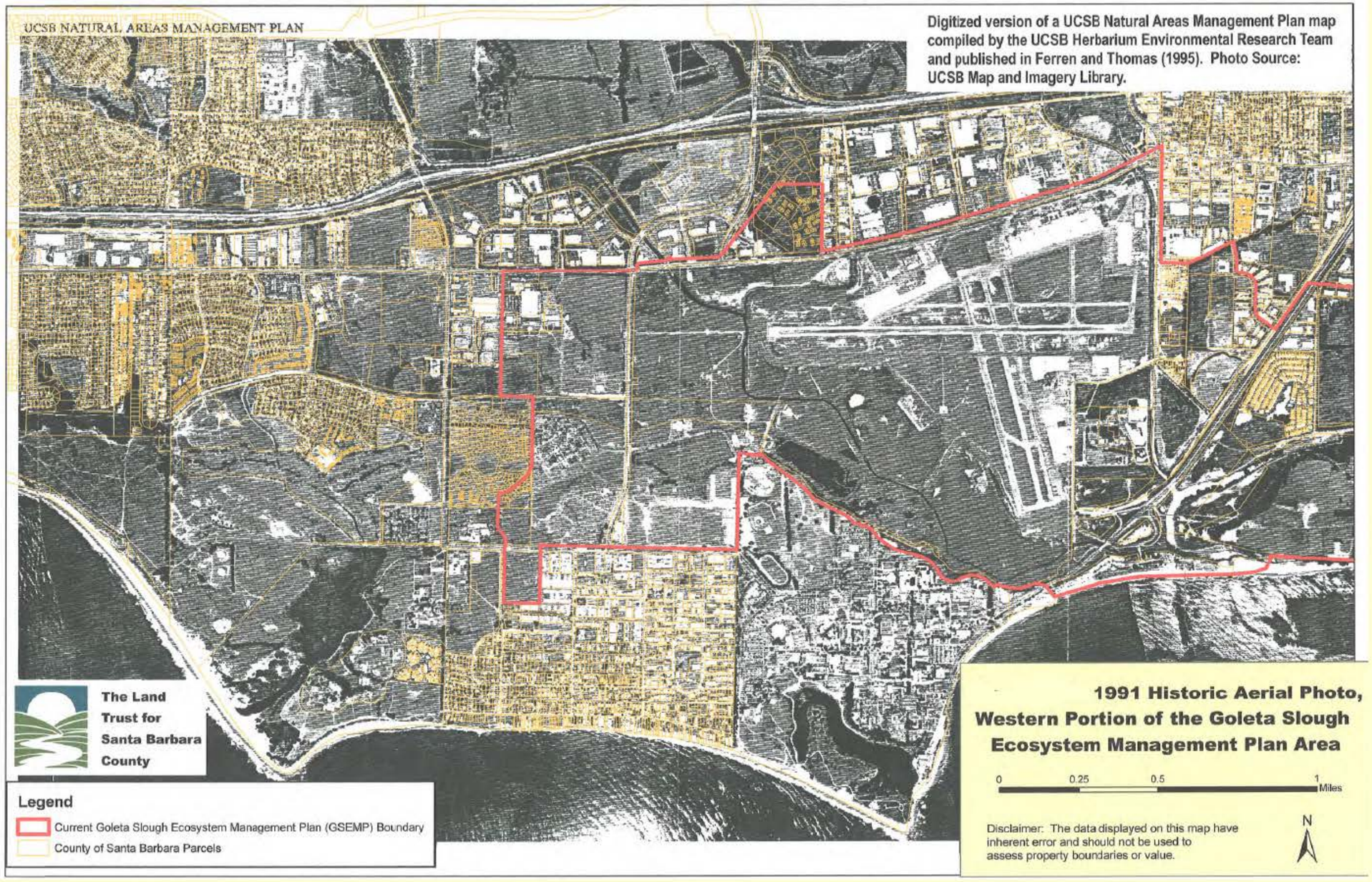

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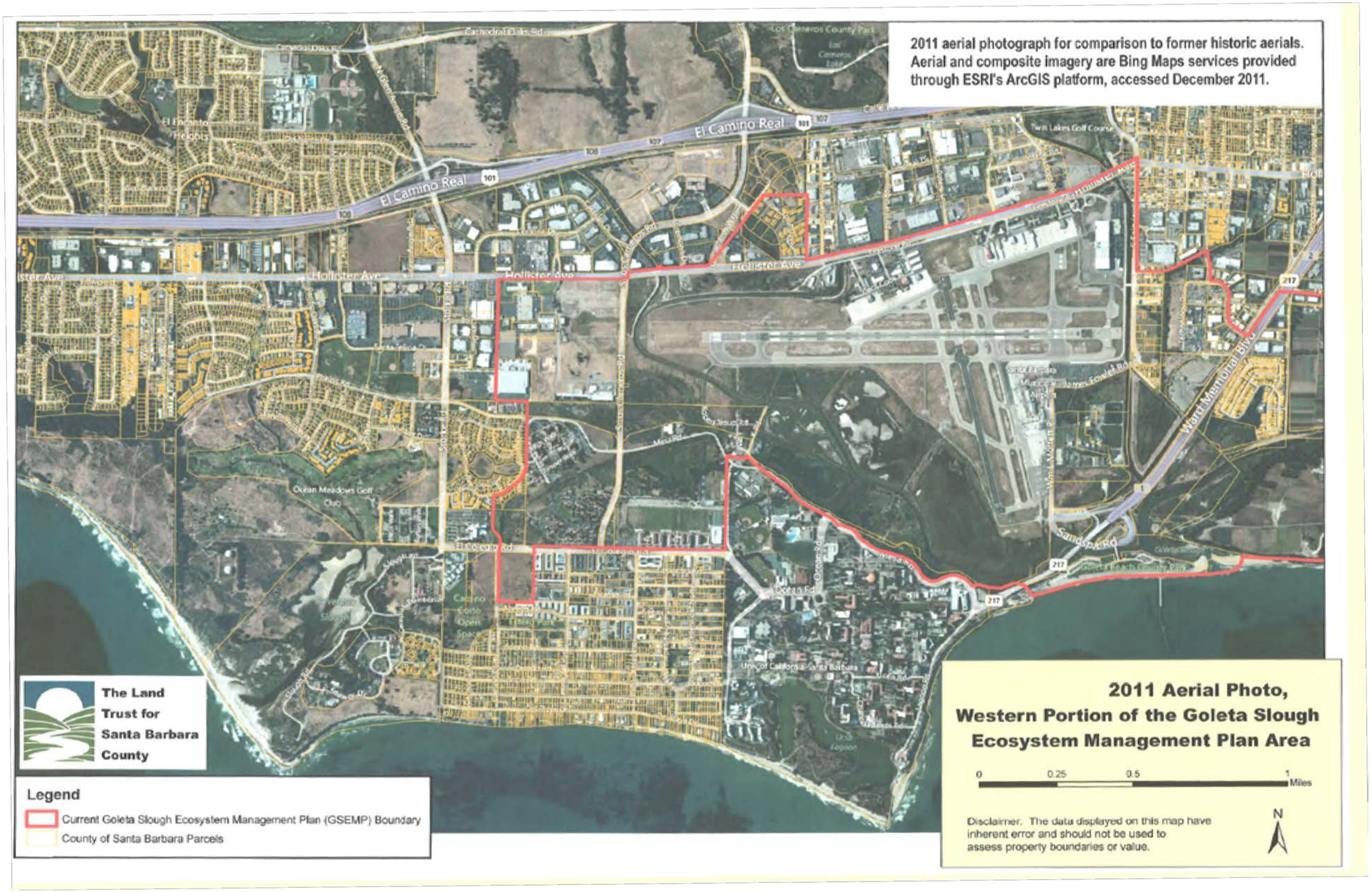
Figure 2-8i Historic Aerial Photograph – 2011



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Approximately 430 acres of the Slough are designated as the Goleta Slough Ecological Reserve. Of this acreage, approximately 400 acres are owned by the City of Santa Barbara and the remaining acreage is owned by CDFW. The entire Ecological Reserve is managed by CDFW under a Memorandum of Understanding between the agency and the City first approved in 1986. The City of Santa Barbara's portion of the Ecological Reserve is also zoned "Goleta Slough Reserve" outlined in Chapter 29.25 of the Santa Barbara Municipal Code. The City-owned portion lies in the Coastal Commission's original permit jurisdiction (see Figure 2-7W and 2-7E, CCC Jurisdiction).

2.6 Resource Stewardship

As discussed earlier in this section, there are many jurisdictions and agencies that manage and regulate assets and resources in the Goleta Slough Ecosystem area. In terms of "stewardship," i.e., responsible use and protection of the environment, many groups contribute to protecting the Slough including the More Mesa Preservation Coalition, Santa Barbara Channelkeeper, Urban Creeks Council, Santa Barbara Audubon Society, and groups concerned with preserving Goleta Beach. The two primary groups that serve as stewards of Ecosystem resources are GSMC and the California Department of Fish and Game as discussed below.

2.6.1 Goleta Slough Management Committee

The Goleta Slough Management Committee (GSMC) was established in 1991 in recognition of the importance of the Slough and the challenge of managing it comprehensively. No single entity has management authority over the entire Slough area, but a number of agencies play a major role in the area including two cities, a county, several special districts, a public university, and several state and federal regulatory agencies. GSMC was formed to work cooperatively with regulatory agencies, property owners and public interest groups to provide for a healthy Goleta Slough Ecosystem irrespective of jurisdictional or other boundaries.

GSMC continues to identify and resolve issues related to management of the Goleta Slough Ecosystem Management Area and serves in an advisory capacity to lead agencies (e.g., City of Goleta, City of Santa Barbara, Santa Barbara County, California and UC Regents). GSMC serves as a forum to review projects that involve property owners, sensitive habitats, interested parties and multiple jurisdictions. GSMC has supported projects that they believe benefit the Ecosystem as a whole. GSMC has written letters of support for restoration and enhancement projects that are seeking funding or discretionary approval and has provided comments on development projects proposed in the Slough area.

2.6.2 California Department of Fish and Wildlife (CDFW)

In 1988, CDFW prepared a draft management plan for the Goleta Slough Ecosystem. This plan initially named the subareas or basins within the Slough (see Figure 2-2W, Features and Subareas of the GSEMP Area). The plan was never finalized but the lettering system for the sub-basins is still used today.

Much of the Slough and area near the Atascadero Creek outfall is designated the Goleta Slough State Marine Conservation Area (MCA) and is managed by CDFW. This 160-acre area is considered a "no take" zone meaning that no marine life may be taken or caught. According to CDFW's Marine Life Protection Act website (https://www.wildlife.ca.gov/Conservation/Marine/MPAs), the Slough's designation as an MCA occurred on September 20, 2007.

2.7 Restoration Efforts since 1997

GSMC provides a broad perspective on restoration practice, opportunities and accomplishments, irrespective of jurisdictions or ownership of the land to be restored. Figures 2-9W and 2-9E, Restoration Project Locations 1997-2011, show the many restoration projects that have occurred in the last fifteen years in the Ecosystem. These 36 projects represent approximately 175 acres of restored habitats. A detailed description of these projects is included in Appendix B, Restoration and Enhancement Projects.

Figure 2-10, Restoration Project Areas by Type 1997-2011, highlights the same restoration projects shown in Figures 2-9W and 2-9E by type of restoration. Much of the work in the Airport's portion of the Slough has been removal of weeds, grading and native plantings. Elsewhere in the Ecosystem, a considerable number of projects have been completed to enhance existing habitats. In other places, single species weed eradication has occurred with a focus on removal of Pampas Grass, especially along and near Atascadero Creek.

2.8 Tidal Restoration Demonstration Project

As discussed above, Goleta Slough was historically a large embayment of approximately 18 square miles that has over time been reduced to about 430 acres. Some of the Slough is still tidally influenced including Tecolotito and Carneros Creeks and Areas A and B (see Figure 2-3 for locations). The remainder of the Slough is brackish or freshwater because most basins have berms that cut off tidal flow. The freshwater and brackish basins tend to fill with rainwater during the winter months and, depending on the amount of annual rainfall, are typically dry by late spring or summer. Ducks and waterfowl are commonly seen in these basins while smaller birds such as Belding's savannah sparrows tend to frequent the tidal basins.

Since its inception, GSMC members have expressed an interest in restoring tidal circulation to portions of the Slough that have been cut off from tidal influence for decades by removal or breaching of berms. One major impediment to restoring tidal circulation is the proximity of the Santa Barbara Airport and concerns about bird strikes. The Federal Aviation Administration (FAA) has expressed concern that restoring tidal circulation to portions of the Goleta Slough could modify bird activity in and near the airfield and possibly increase aviation bird strike hazards.

Biologists and ornithologists familiar with the area have long maintained that changing from freshwater and brackish marsh to estuarine marsh would, in fact, reduce the number of birds that represent hazards to aircraft. To test this assertion, in 2003 a Tidal Restoration Study was prepared by John Gray of URS that was ultimately approved by all permitting agencies in 2006. Two basins were chosen, Basins E and F, with one to be inundated with tidewater and the other served as a non-tidal control. Extensive year-long surveys of bird activity in and near the Airport were conducted with objectives to characterize seasonal bird activity in tidal and non-tidal basins, to document bird overflights over the runways, and to identify bird movement patterns and attractants in the vicinity of the Airport. One condition of approval was that, if the type and number of birds that represent bird strike hazards increases, the experiment would be halted immediately.

The experiment was conducted from 2006 through 2009 and, at its conclusion, was considered a success. The year 3 monitoring report concluded[2]:

[2] *Tidal Restoration Demonstration Project Year 3 Annual Monitoring Report*, URS, March 2009.

> "Data for the tidal basin suggest that the introduction of tidal flow has suppressed bird-strike hazards associated with that basin. Bird numbers for this area over the course of the year continue to be low compared with the control basin, even though the control basin was dry for most of Year 3…. It appears likely that bird strike hazards associated with the tidal area will remain low as the habitat continues to mature."

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Figure 2-9E Restoration Project Locations 1997-2011

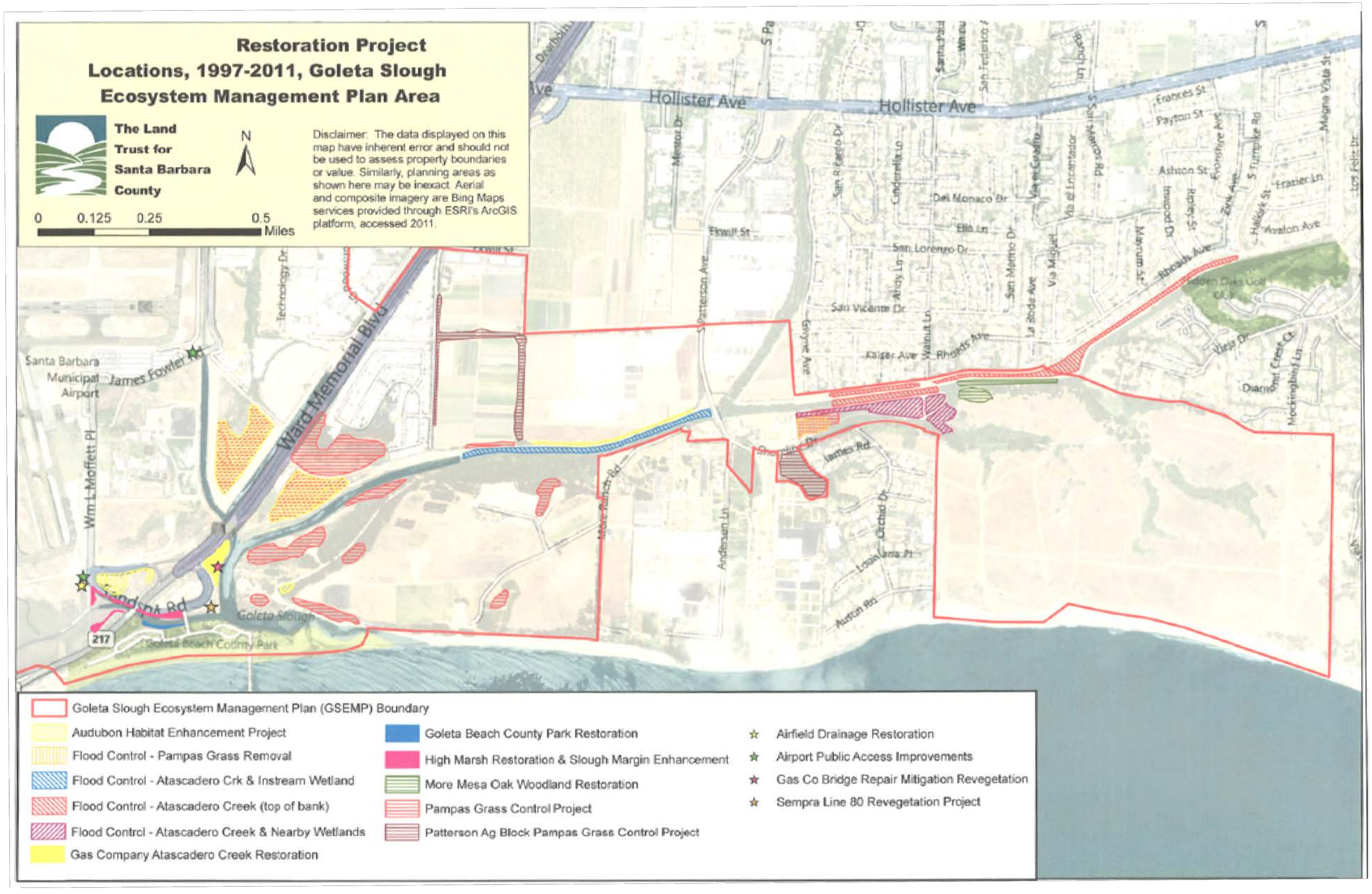

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Figure 2-9W Restoration Project Locations 1997-2011

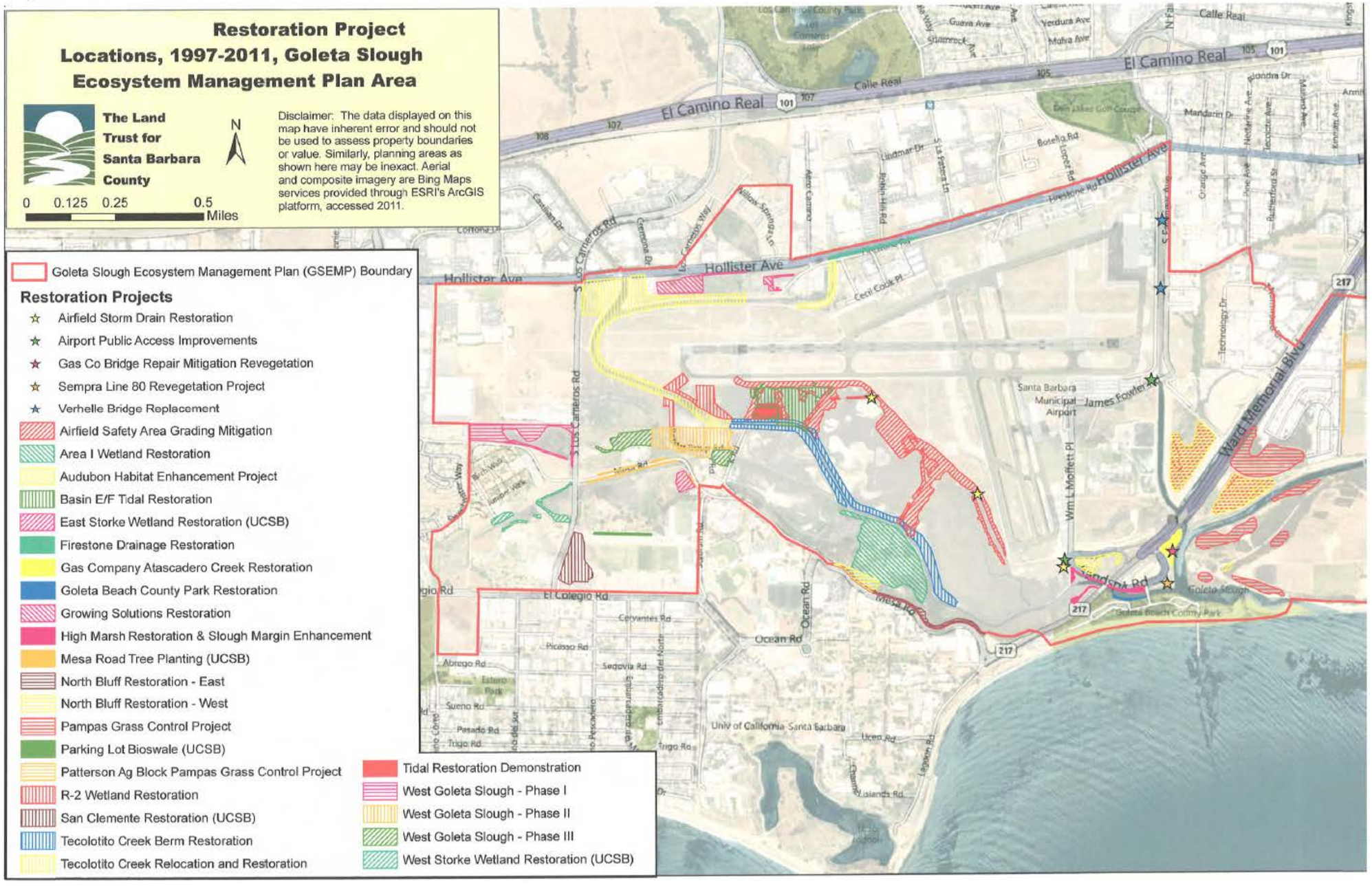

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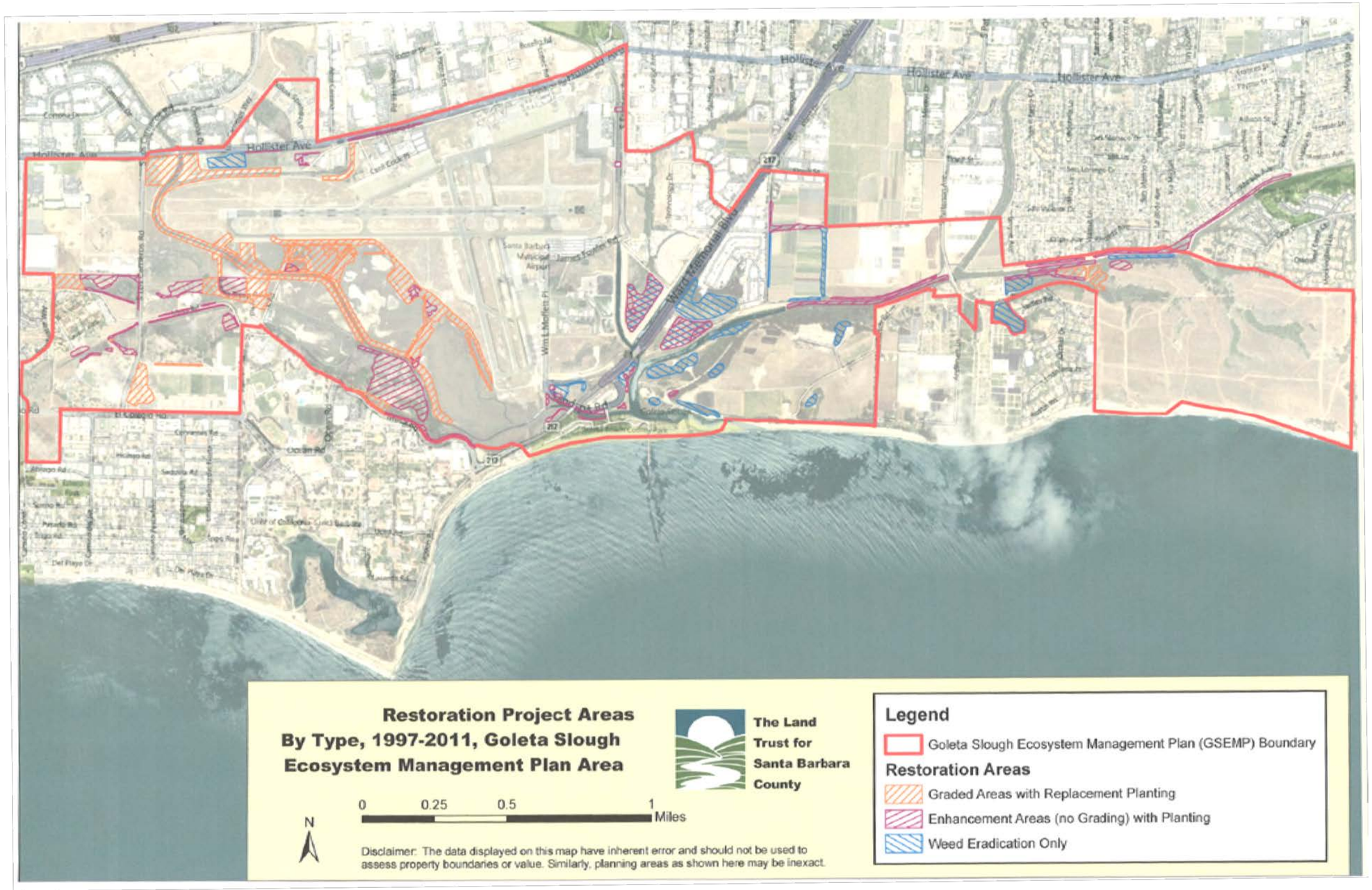
Figure 2-10 Restoration Projects by Type



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2.9 Physical Environment

2.9.1 Geomorphology, Geology and Soils

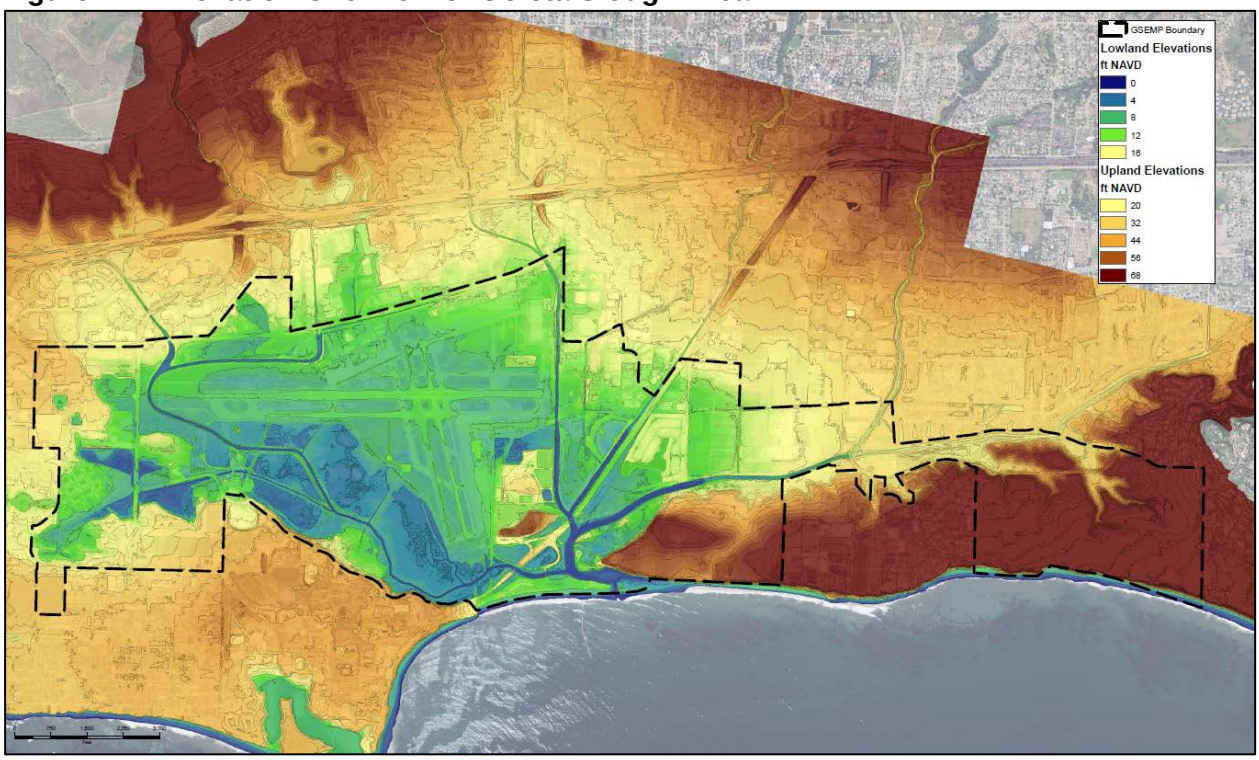
The Goleta Valley lies within a coastal valley created by vertical displacement along a syncline to the north along the Santa Ynez Fault and to the south along the east-west trending More Ranch Fault. The mesas of Isla Vista, UCSB, More Mesa and what remains of Mescalitan Island are related anticlines uplifted along this fault. Structurally, Goleta Slough is a large, shallow basin flooded by the sea. The Slough is not located at a river mouth or coastal canyon, as most other coastal estuaries along the South Coast are located.

The planning area was flooded by high sea levels in the early to mid-Pleistocene, but later drained during low sea levels associated with the glaciation of the middle Pleistocene. During the latter period, drainages were excavated as much as 230 feet below current levels and the mouth of the Slough extended southward beyond its current location at Goleta Beach. During the late Pleistocene and continuing into relatively recent times, gradually rising sea levels drowned the valley, producing a navigable coastal embayment of approximately 18 square miles (Lohmar et al. 1980).

Current elevations within the planning area vary from mean sea level (2.66 feet NAVD) to 140 feet above mean sea level (143 foot NAVD), with the highest points being near the northeastern boundary of the planning area along the eastern edge of More Mesa. See Figure 3-1a, Elevation Overview of GSEMP, for general elevations within the planning area. Within the Slough basin itself, elevation gradients are much more gradual. Elevations here range from sea level to 17 feet NAVD, with the highest point immediately east of Los Carneros Road and north of the eastern CDFG Parcel on Airport property. Not coincidentally, this area includes a Native American archaeological site, as it is known to have been a historical high point within the marsh.

Other points within the Slough that are higher than 17 feet NAVD are anthropogenic in nature, e.g., abandoned military bunkers, levees alongside drainages and creeks, and roads. Figure 2-11and 3-1a-f, Elevation Overview of GSEMP Area, show the elevations within the Slough basin. These maps show the best and most current elevation data available. The figures are a compilation of survey data of Airport property as well as topographic contours digitized from as-built drawings of recent restoration projects that involved grading. In February 2011, Light Detection and Ranging (LIDAR) topographic data was collected by the state. This data was utilized in the sea level rise analysis to refine elevation figures and provide more accurate data in this updated Plan.

Figure 2-11 Elevation Overview of Goleta Slough Area



The low-lying portions of the Ecosystem, like most of the Goleta Valley, are covered with recent, unconsolidated alluvial deposits of silt and sand. Older alluvial deposits cap More Mesa, UCSB and what remains of Mescalitan Island. Along the slopes and ravines of the mesas and Mescalitan Island, older shales, sandstones, and siltstones, primarily the Monterey formation and, more locally, the Santa Barbara formation, are exposed (Dibblee 1987; Ferren and Thomas 1995).

Figures 2-12E and 2-12W, USDA Soils Series, provide complete soil series descriptions of the planning area. The vast majority of soils within the planning area are fine sandy loams, which is to be expected for an alluvial basin at the base of the Santa Ynez range and at the confluence of many creeks and watersheds. A few clay lenses are also found along the tops of the coastal mesas. The majority of the soils near known Native American archaeological sites are characterized as “Xerorthents” (cut and fill areas), perhaps due to the fact that these high points around the Slough margin have been excavated for fill soil, or perhaps due to the large amount of midden material in these areas, or both. The central portion of the Slough itself (on Airport property) is designated as “Aquents – fill areas” or “Aquents – flooded.”

The present character of the Slough also reflects historic and anthropogenic impacts on sediment supply. Actions such as historic overgrazing, altered watershed hydrology due to urbanization and development, channelization of the creek banks, constrained mouth dynamics, and the removal of sediment from the creek channels have all contributed to the disruption of the natural sediment dynamics that shape the Slough landscape and altered patterns of erosion and deposition within the Slough’s waterways and wetlands.

Figure 2-12E Soils within the Goleta Slough Ecosystem Management Plan Area - East

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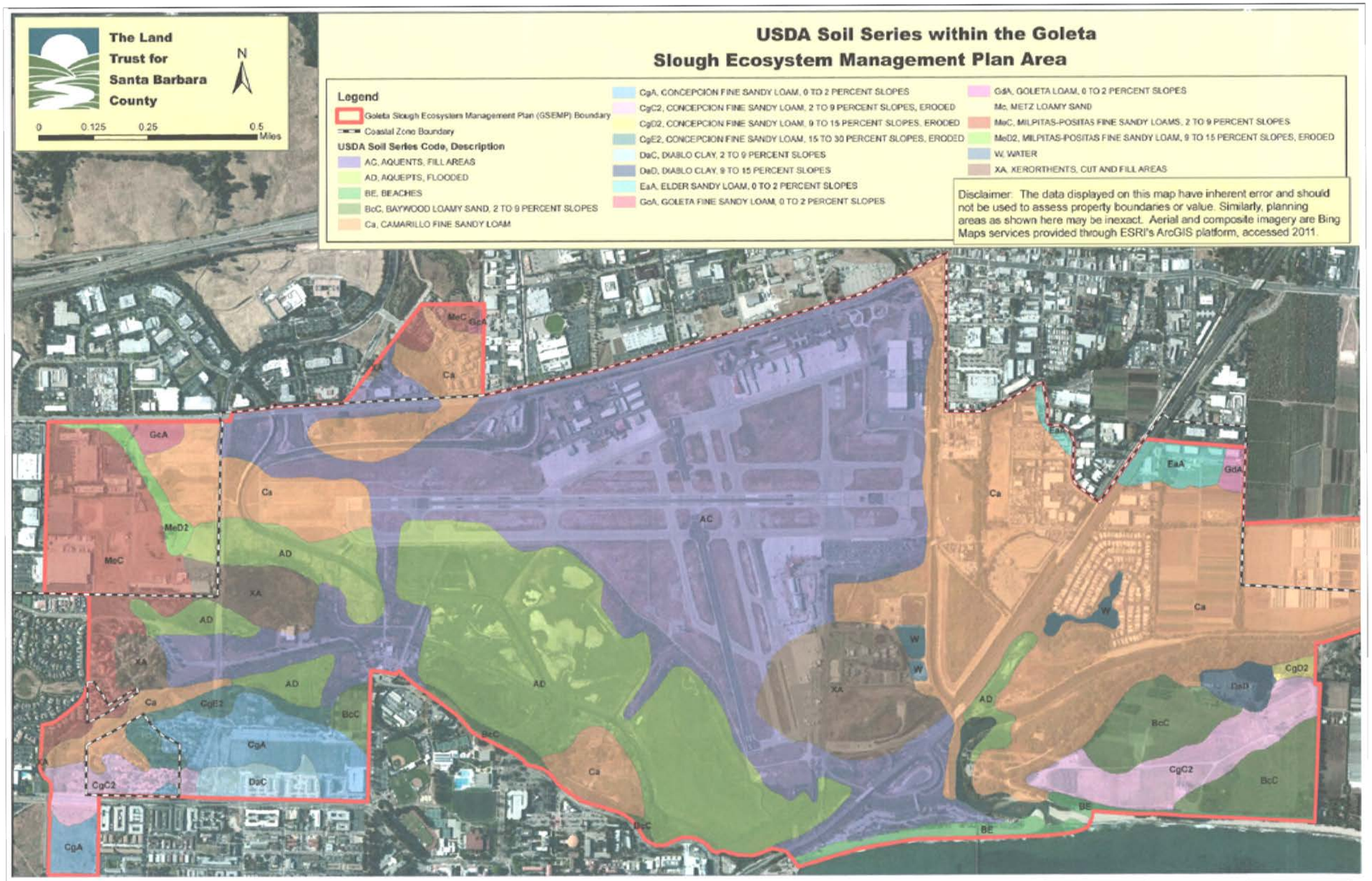
Figure 2-12W Soils within the Golteta Slough Ecosystem Management Plan Area – West



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2.9.2 Climate

The Goleta Slough area has a Mediterranean climate, characterized by a warm, dry "summer" extending from May through October and a mild, moist "winter" lasting from November through April. The climate is similar to the rest of coastal southern California, being significantly warmer and drier than what occurs a relatively short distance to the north beyond Point Conception. As a result, the biological communities of the Ecosystem closely resemble those of coastal southern California and include a number of species that reach their northern distributional limits at Goleta Slough (Ferren and Thomas 1995).

The Pacific Ocean helps to moderate local temperature ranges. Summer maximum temperatures average in the 70s (degrees Fahrenheit) while minimums average in the 50s to low 60s. Maximum air temperatures during the winter months average in the 60s with minimums in the 40s. Temperatures slightly below freezing are not uncommon during the coldest mornings of the year.

The planning area is partially shielded from the prevailing northwesterly winds by the Santa Ynez Mountains to the north. The mountains also help in deflecting the wind, resulting in daytime sea breezes from the southeast to the southwest along the southern Santa Barbara coast. Light northeasterly land breezes usually occur at night within the planning area; these breezes may extend many miles offshore during the colder months of the year until daytime heating reverses the flow back onshore.

Over 90 percent of the total annual precipitation in the project area occurs from November through April. Annual precipitation is approximately 18 inches at the Airport and increases to more than 30 inches in the Santa Ynez Mountains to the north of the planning area (see Figure 2-13). Although the majority of the precipitation in the planning area is produced by winter storm systems from the north Pacific, summer tropical moisture can also produce clouds and occasional rainfall.

Along the Southern California coastline, an inversion layer often forms at altitudes of 500 to 2,000 feet, trapping cool, moist air at lower elevations. Fog and low clouds are formed by condensation below the inversion layer, especially at night and in the morning when air temperature is lower. Fog is most frequent during summer, when the ocean is relatively cool and the marine layer is drawn inland by warm air rising above land.

2.9.3 Watershed

The watershed of the Goleta Slough is approximately 48.2 square miles and is shown in Figure 2-14. Seven creeks—Tecolotito (Glen Annie), Carneros, San Pedro, Las Vegas, San Jose, Atascadero and Maria Ygnacio—drain southward off the Santa Ynez Mountains, discharging into the Slough. Two sub-watersheds of Atascadero Creek, Hospital Creek and Cieneguitas Creek, are also shown in Figure 2-14, as is San Antonio Creek, a sub-watershed of Maria Ygnacio Creek. The Devereux Slough, UCSB Lagoon, and Laguna Blanca watersheds are also shown on that figure as important adjacent watersheds although they do not drain into Goleta Slough. It should be noted that Laguna Blanca is a natural but managed lake, and in wet years excess water is released into the Cieneguitas Creek watershed. Additionally, Goleta Slough also receives runoff from most of More Mesa and the north-facing bluffs of UCSB.

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Figure 2-13 Goleta annual rainfall

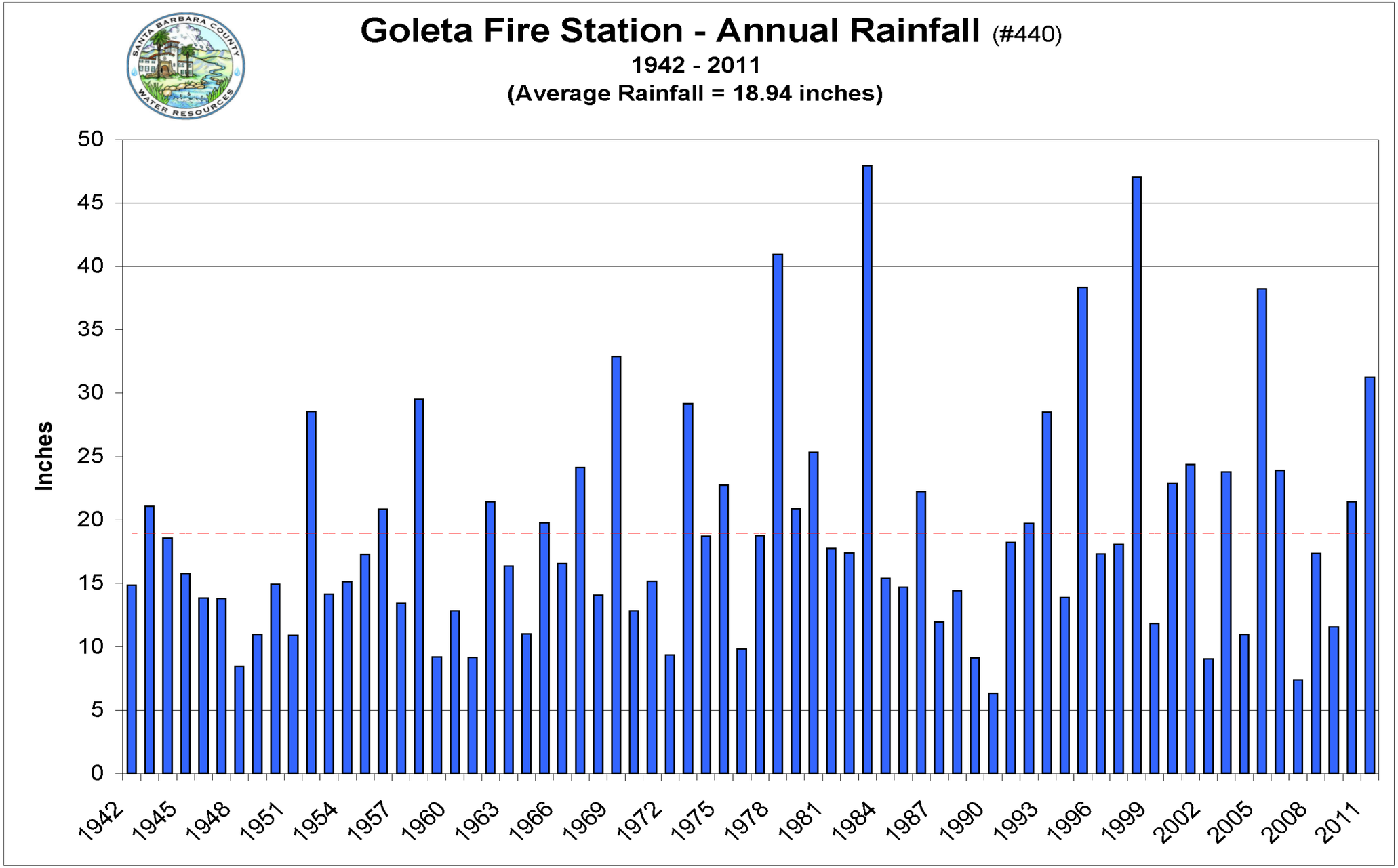

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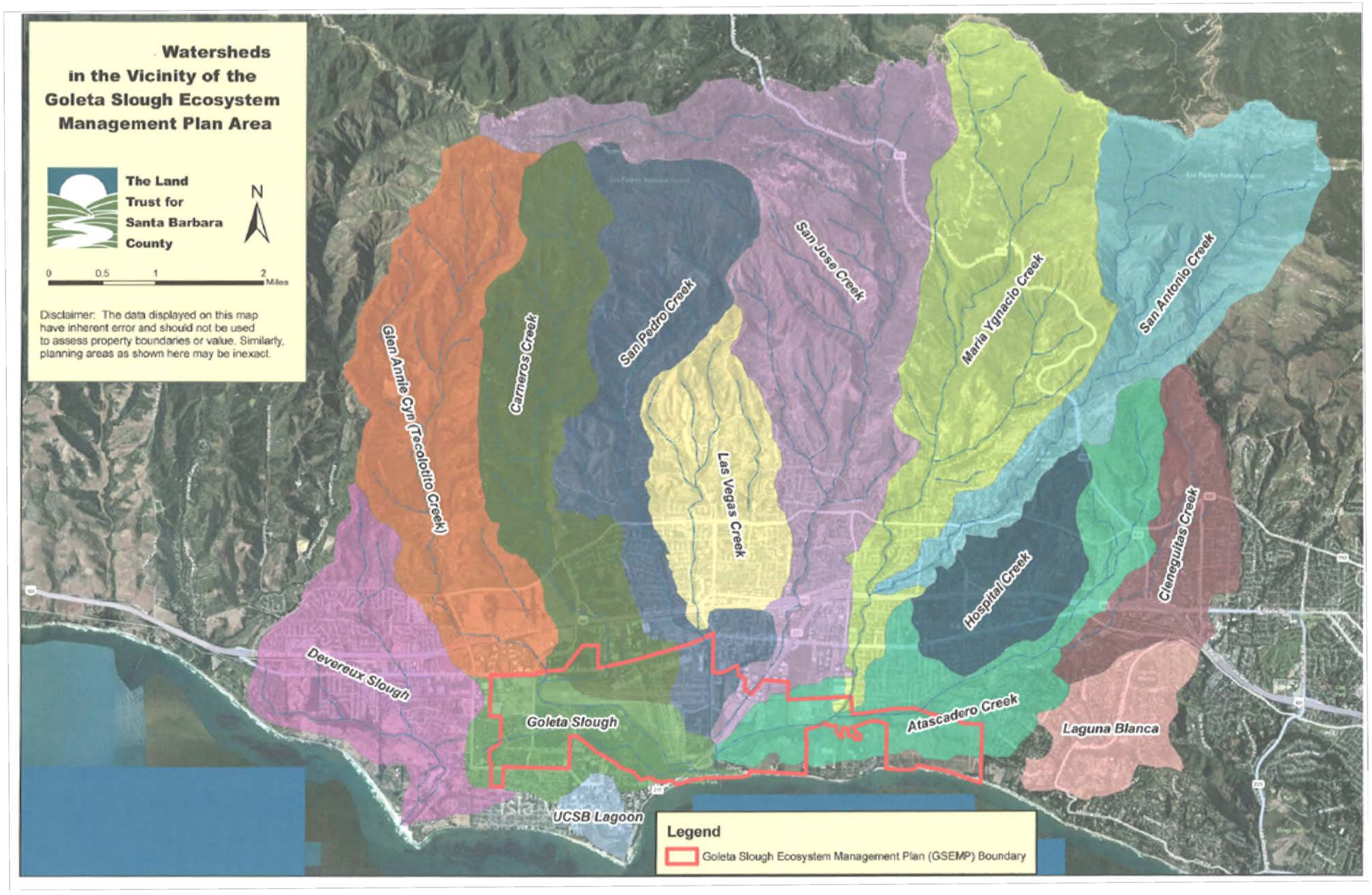
Figure 2-14 Watersheds



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2.9.4 Flood History

Historical accounts state that prior to 1861, the area of the Goleta Slough was comprised of a permanently flooded, shallow estuarine embayment. Some accounts and maps suggest that the embayment was continuous with what is now Devereux Slough (Stone 1982). This navigable bay was substantially filled by sedimentation during catastrophic flooding during the winter of 1861- 62 following extensive hillside grazing and fires in the watershed. About 14 feet of sediment was deposited into the Slough creating a shallow lagoon with extensive bordering intertidal wetlands. Deltaic deposits at the mouths of the creeks produced a much-dissected system of tidal drainages and bordering salt and brackish marshes (Speth et al. 1970; Lohmar et al. 1980; Ferren et al. 1987; Ferren and Thomas 1995) (Figure 2-15). In 1938, just prior to the construction of the Marine Corps Air Station (that became Santa Barbara Airport after WWII), a flood event moved substantial amounts of sediment through the Slough and into the ocean and could be seen as a large ebb shoal off of Goleta Beach. Since the construction of the airport, there has been a significant reduction in tidal prism decreasing the ability of the Slough system to move sediment to the ocean and the ebb shoal has never been as large (Revell and Griggs 2006).

There have been two major flood events at Goleta Slough since the construction of the airport in the late 1930s. The 1969 flood resulted in the highest water levels observed within the Slough in modern times (Figure 2-16). Based on a review of historic photos from the 1969 event, we have estimated that water levels within the Slough exceeded 12' NAVD, covering most of the Airport runway, access roads and parking lots. A second major flood event occurred in 1995, with estimated water levels in the Slough reaching 10' NAVD (Figure 2-17). This flood event caused ponding on low-lying sections of the runways and deposited a considerable amount of sediment on the runways and taxiways. These elevated water levels disrupted operations at the Airport for several days and caused significant damage to the airport facilities and neighboring properties.

Observational data is relatively sparse for these two flood events. No records have been found of the condition of the Slough mouth before either of these events (e.g., berm elevation), nor do we have a complete record of the precipitation or stream flow for either event. The peak stream flow on Atascadero Creek reached 4,000 cubic feet per second (cfs) during the 1969 event and exceeded 10,000 cfs during the 1995 event. Substantial flood channel widening and structural improvements made in the mid-70s after the 1969 event reduced the over flood levels in the Slough. However, the higher water levels within the Slough during the 1969 event, despite the more modest peak stream flow, were also coupled with substantial ocean wave energy suggesting that precipitation and stream flow is not the only driver of flooding within the Slough.

Figure 2-15 1928 Goleta Slough. Spence Collection, UCLA

Figure 2-16 1969 Flooding around Santa Barbara Air Terminal

Figure 2-17 1995 Flooding of airfield

2.9.5 Role of Fluvial Processes in Goleta Slough

Stream flows play an important role in driving the physical and ecological processes that occur in Goleta Slough. Stream flows are a primary component of the Slough water levels and strongly influence the frequency of the breaching of the Slough mouth. Freshwater inflows from the creeks also influence water quality, both by reducing salinity, as well as transporting sediments and potentially contaminants from the watershed. Changes in the salinity can have important implications for habitat and ecosystem function, and contaminants introduced to the Slough from upland areas can compromise habitats and interfere with recreational uses of the Slough and beach. Finally, sediments transported from the upland watershed are a major contributor to the health of local wetlands and are one of the key resources for adapting to rising sea levels.

Stream flow is the primary source of fresh water within the estuary. The distribution of salinity within the estuary is determined by the balance of freshwater streamflows and saline waters entering the lagoon from the ocean. Some estuarine species (e.g. tidewater gobies) are adapted to thrive in the brackish salinities that occur when saline seawater that enters the Slough during high tides and wave overtopping events is mixed with freshwater inflows from the watershed. Consequently watershed discharges are a critical factor in maintaining the habitats and diversity of species present within the estuary.

As water flows into the Slough from the watersheds it carries sand, silt, cobbles and other sediment particles, some of which may deposit in the estuary while a fraction washes out into the ocean. Historically, sedimentation has profoundly affected the Ecosystem through time and continues to affect patterns of flooding and the development of wetland versus upland habitats. This sediment supply can become an important resource for the management of wetland habitat areas under future sea level rise conditions. If allowed to deposit naturally on the marsh surface, sediment can gradually increase the ground elevation, potentially allowing the marsh to keep pace with sea level rise over time.

Sediment and debris, when funneled into relatively narrow areas as a result of creek channelization and development, diminish the capacity of the creek channels to convey

floodwaters through developed areas. The urban encroachment into the Slough and floodplain areas necessitates periodic channel maintenance by Santa Barbara County Flood Control.

Between 1995 and 2011, 1,050,000 cubic yards of sediment were removed from the estuary as part of flood control maintenance (Table 2-3). Some of that has been placed at Goleta Beach, but much of it has been removed from the system. If that volume of sediment were evenly distributed over the existing marshes in Goleta Slough it would increase the ground elevation by ~1.5 ft. In the future as sea levels rise, the fluvial sediment supply should be studied to see if it could prove to be a valuable adaptation resource that can help the wetland habitats in Goleta Slough persist by enhancing natural accretion processes. Without sediment, tidal marshes and wetlands are at risk of drowning or converting to subtidal habitats over time as sea levels rise.

2.9.6 Sediment Supply

A majority of the Goleta Slough watershed is on steeply sloping chaparral covered, undeveloped National Forest or agricultural land on the south-facing slope of the Santa Ynez Mountains. Large volumes of sediment and debris are contained in runoff from the mountains, much of which falls out of suspension as topography flattens and stream flow velocities drop as the creeks enter Goleta Slough.

Table 2-3 below shows the average annual volume of sediment removed from five key creeks that drain into Goleta Slough from 1994 through 2011. The District has been maintaining sediment removal basins in this system for over 40 years to increase the creeks' capacity to convey flood flows. The Santa Barbara County Flood Control District has used some of the removed material for beach nourishment at Goleta Beach. Without ongoing maintenance, Goleta Slough could accumulate sediment that would likely decrease channel capacity and increase the potential for flooding.

While the removal of sediment from the Slough channels reduces the risk of flooding of nearby infrastructure, it also disrupts the natural accretion processes that help maintain the ecological function of the estuary. In an unmanaged estuary, sediments that are deposited in the channels during normal stream flows can be transported onto the marsh plain or flushed out through the mouth during larger flow events. Sediments that deposit on the marsh plain provide nutrients and substrate that allows wetland vegetation to thrive. The process of sediment depositing on the marsh plain may help prevent estuarine wetlands from drowning under rising sea levels, and therefore offers one of the best natural mechanisms for maintaining healthy marshes and improving the resilience of habitats to climate change.

Table 2-3
Summary of Historical Sediment Volumes Removed (cubic yards)
Creeks that enter into Goleta Slough
1994/95 through 2011

Year	Atasca-dero	San Pedro	San Jose	Los Carneros	Tecolotito	Totals
94/95 (Phase I)	130,000	50,000	30,000	18,000	40,000	**268,000**
95/96 (Phase II)	63,853	12,134	18,054			**94,041**
98/99	91,000	34,500	33,000	10,000	30,000	**199,000**
00/01	14,800	6,100	4,100	6,000		**31,000**
01/02	33,450	9,565	17,850	1,400	3,000	**65,355**
2003	8,100	6,600	7,200			**21,900**
Jan/Feb 2005	20,000	50,000	35,000			**105,000**
2005	46,520	10,790	13,190	30,000	60,000	**160,500**
2006		6,500	3,000	2,500	7,000	**19,000**
Gap Fire (July 2008) affected Los Carneros, Tecolotito, San Pedro, and San Jose Creek Watersheds (among others outside of the Goleta Slough Watershed).						
2008		6,500	3,000	2,500	7,000	**19,000**
Jesusita Fire (May 2009) affected Atascadero Creek Watershed within the Goleta Slough (among others outside of the Goleta Slough Watershed).						
2009	13,000					**13,000**
2/2010		3,900		3,300		**7,200**
12/2010	10,300	11,650	6,900			**28,850**
3/2011		8,100	7,600	5,400	8,700	**29,800**
Totals	***431,613***	***214,839***	***175,894***	***81,600***	***148,700***	***1,052,646***

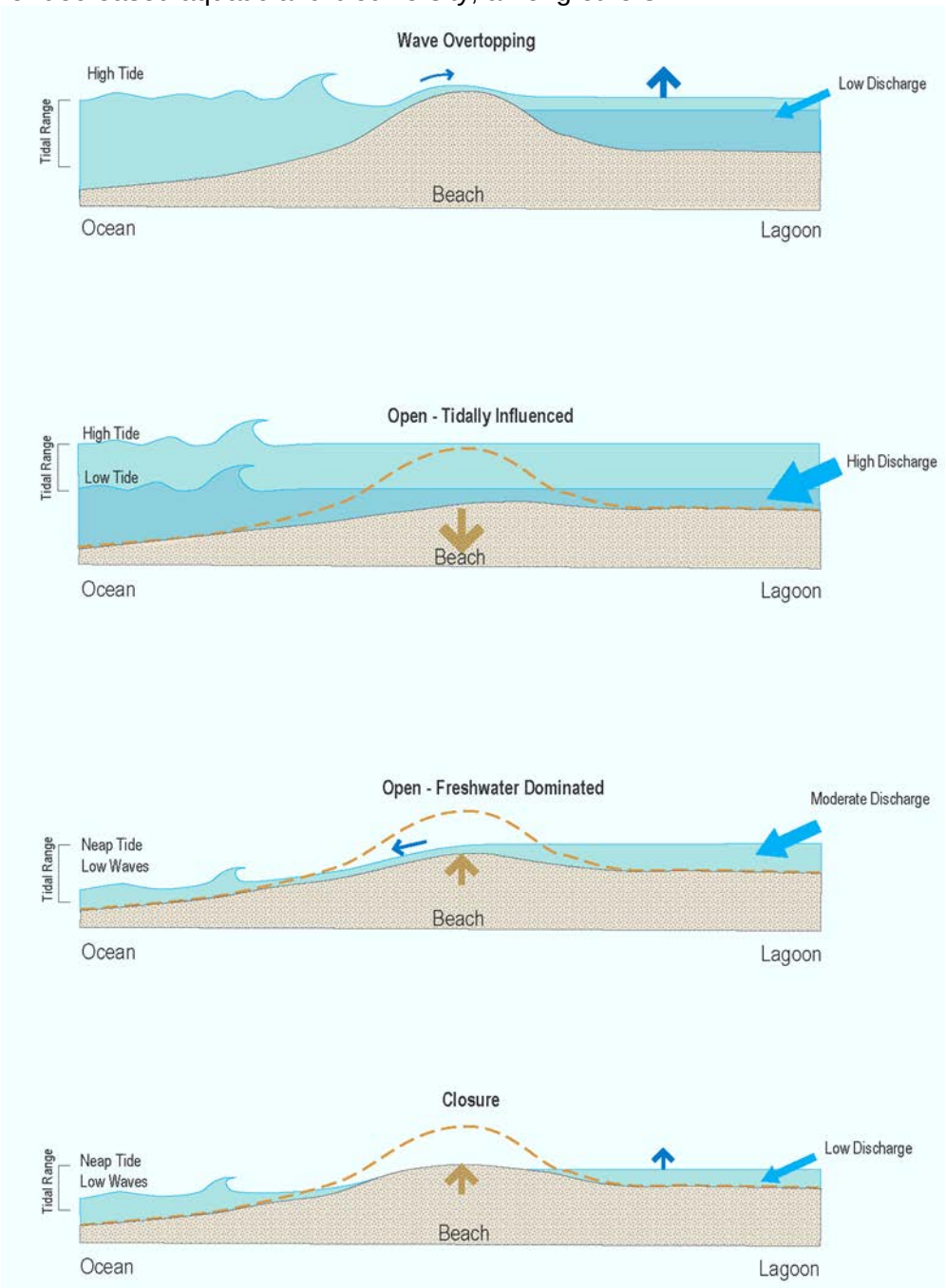
Source: Santa Barbara County Flood Control

2.9.7 Natural Functioning of Goleta Slough

Point Conception in the northwest and the Channel Islands to the south create a narrow swell window that shelters much of the south-facing coast of Santa Barbara County from extreme wave events during the winter months. During the summer months the wave energy is significantly reduced allowing the beach to build up and naturally close the Slough inlet.

Under existing conditions, water levels in Goleta Slough are controlled by the presence and elevation of the beach berm at the inlet mouth at Goleta Beach (Figure 2-18). Seasonally, the Slough cycles between closed and open inlet conditions. Depending on the elevation of the beach berm crest, wave overtopping and freshwater flows fill the Slough like a bathtub (Figure 2-18a). At some point, as the water level elevations of the Slough reach the berm crest elevation, the inlet breaches. This breaching is typically associated with a rainfall/runoff event but in some cases a significant overtopping event can also initiate the breach. Regardless of the actual cause, the breach scours a channel through the beach reintroducing tidal exchange (salt water) to the Slough (Figure 2-18b). Eventually, as the streamflow diminishes and sand begins to accumulate in the inlet mouth, the beach forms a sill that limits the amount of tidal influence. During this phase (Figure 2-18c), the system is predominantly freshwater flow controlled. At Goleta Slough this often is the phase when the inlet has migrated east down the beach. Eventually, the beach builds up and closes off the inlet mouth causing a bathtub-like filling of the Slough, and a slow increase in the Slough water elevations (Figure 2-18d). Problems that can arise when the Slough mouth remains

closed indefinitely include localized flooding, increased mosquito breeding, fish kills, and potential for decreased aquatic and biodiversity, among others.



Figures 2-18 a, b, c & d – Bar Built Estuary Function

2.9.8 Tidal Influences

Tides along the California coast are of the mixed, semidiurnal type, meaning that there are two daily high tides of unequal height separated by low tides that are also of unequal height or amplitude. The Goleta area experiences an average daily tide range of 5.2ft. Extreme high water, the highest tide experienced during an average year, is approximately +6.9 ft NAVD, although

storm surges and other meteorological phenomena can cause higher coastal water levels during rare events. Table 2-4 shows the elevation of the key tidal datums at the Santa Barbara tide gauge.

Table 2-4
Goleta tides

Datum	ft NAVD88
Extreme High Water	6.90
Mean Higher High Water	5.27
Mean High Water	4.52
Mean Sea Level	2.66
Mean Low Water	0.85
Mean Lower Low Water	-0.13

Source: NOAA Tides and Currents, Santa Barbara Tide Gauge, STA # 9411340

Tidal patterns in Goleta Slough have not been systematically measured. Observations made during the tide gate experiment in 1994-1995 suggest that, similar to the Carpinteria Salt Marsh (Hubbard 1995), tides extending up the Goleta Slough are of diminished amplitude and exhibit a time lag relative to predicted tides along the open coast. For example, at the tide gate at Adams Road (near the Goleta West Sanitary District plant), spring tide ranges of 2-3 feet were observed, rather than the 6-8 feet predicted by local tide tables, and appeared to lag several hours behind tides at the mouth of the Slough (Dugan and Saley, personal communication). Similar observations have been made for Los Carneros Creek that also show diminished amplitude (Stratton, pers. comm.).

Tidal circulation within the Slough is driven by tidal flows passing through lagoon mouth. Wave and watershed processes cause the lagoon mouth to periodically open and close, consequently Goleta Slough experiences intermittent periods of tidal action separated by periods where the lagoon is closed to the tides. Factors affecting the breaching and closure of the lagoon mouth are discussed further in Part 3 of this document.

A gauge located on the access bridge to Goleta Beach shows that, during periods when the lagoon mouth is open, at high tide water levels within the Slough tend to match those on the open ocean, however the Slough often does not fully drain during low tides. The lowest low tides measured at the access bridge between 2011 and 2014 were approximately 1 foot higher than the lowest low tide levels on the open ocean.

Tidal circulation extends from the mouth of the Slough at Goleta Beach up each of the tributary streams of the Slough, with the exception of Las Vegas and Maria Ygnacio Creeks. These two creeks enter San Pedro and Atascadero Creeks, respectively, above the tidal limit. Tidal influence extends up Tecolotito and Carneros Creek channels to Hollister Avenue. Extensive areas of historic salt marsh below the high tide line are currently isolated from tidal exchange by berms and levees. Tidal inundation is generally limited to the stream channels and to the south-central portion of the Slough.

2.10 Natural Resources

The 1997 GSEMP included an extensive discussion of ecosystem resources in the GSEMP area. Historic conditions were described, based in part on 1995 information from the UCSB Natural Areas plan and Airport Master Plan EIR/EIS that was completed in the early 1990s. Other sources included the 1993 Goleta Community Plan and various EIRs, studies and plans that had been

done in the area. Existing 1997 conditions were also described as well as anticipated future habitats.

Due to budget limitations, most of the natural resource information in the 1997 GSEMP has not been updated in this report. However, considerable information about natural resources in the eastern part of the Goleta Slough Ecosystem is available in the *Draft Goleta Valley Community Plan* at:

http://longrange.sbcountyplanning.org/planareas/goleta/documents/Planning%20Commission%20Hearing%206.17.2015/Draft%20Final%20EGVCP%20PC%206-17-2015.pdf

The community plan's Draft Final Environmental Impact Report can be found at:
http://longrange.sbcountyplanning.org/planareas/goleta/documents/EIR/FEIR/Volume_I_FEIR_052215.pdf

UCSB's *Long Range Development Plan,* certified by the Coastal Commission in November 2014, also has information about the western part of the Ecosystem at:
http://lrdp.id.ucsb.edu/sites/default/files/sites/client057/www/streaming/USCB%202010%20LRDP.pdf.

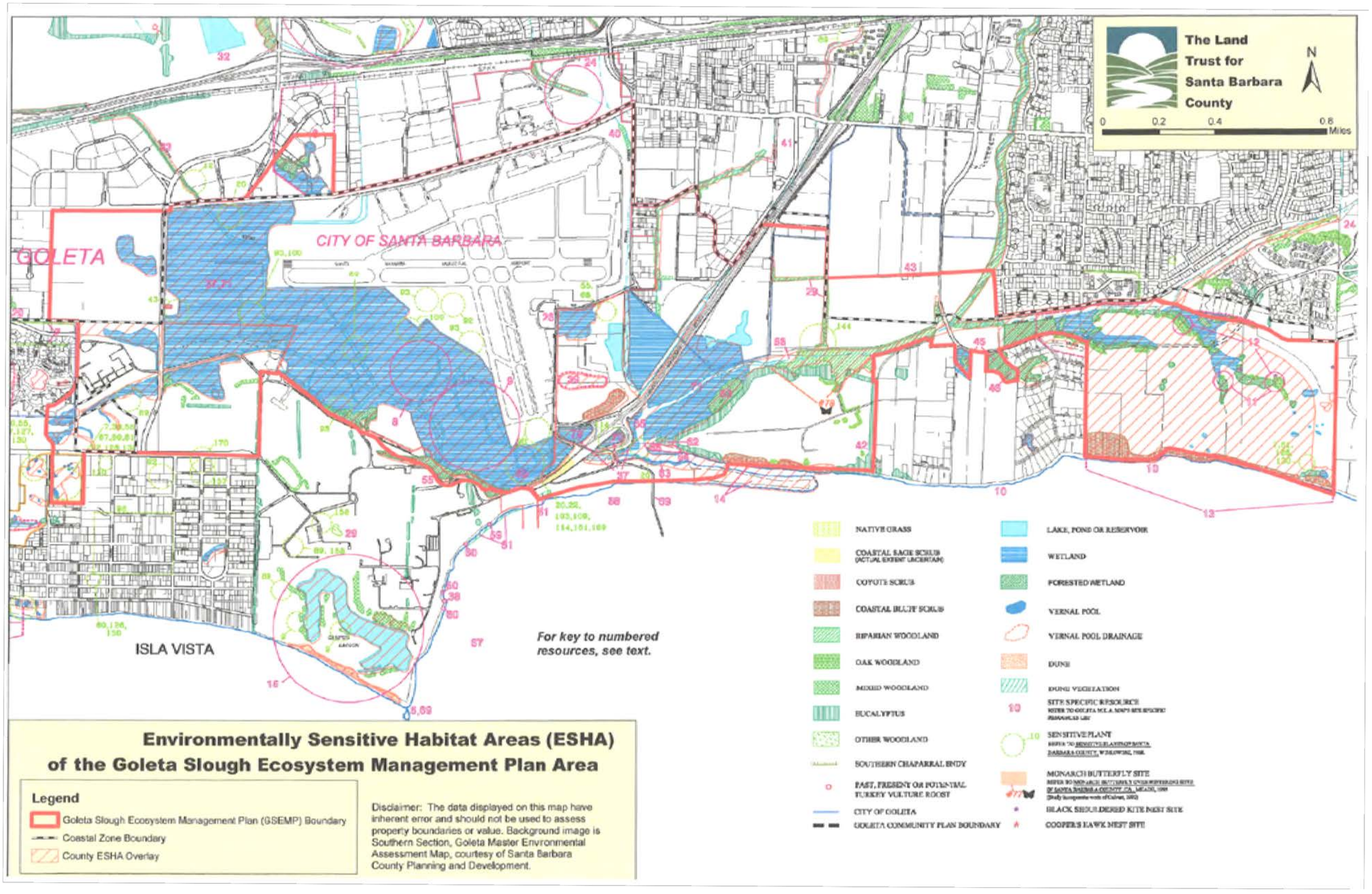
The LRDP EIR is available at:
http://lrdp.id.ucsb.edu/sites/default/files/sites/client057/www/streaming/LrdpFnlEIR.pdf

The updated natural resources information in this report is limited to Environmentally Sensitive Habitat Areas as shown in Figure 2-19. These habitats update Figures 19A and 19B from the Draft GSEMP (P. I-55 and I-57), including using more up-to-date nomenclature for various habitats.

Site-specific resources are numbered in pink on that figure and refer to information included in the Goleta Master Environmental Assessment that was originally prepared by Santa Barbara County Planning and Development. The light green numbers refer to specific plants as listed in the *Sensitive Plants of Santa Barbara County* prepared in 1988 by Tara Wiskowski for the Santa Barbara County Division of Environmental Review. Some information was also taken from the February 2011 *Draft Goleta Valley Community Plan* initiation draft document.

Note that while the Figure 2-25 legend refers to "Black-shouldered kite nest site," the correct name for this bird is now "White-tailed kite". More Mesa and the North Bluff area of UCSB are the only known White-tailed kite nesting sites in the study area.

Environmentally Sensitive Habitat Areas – Figure 2-19



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Tidewater Goby

One notable species that was not known to exist in the Ecosystem when the 1997 plan was written is the Tidewater goby (*Eucyclogobius newberry*). Tidewater goby is a Federally-listed endangered species. Tidewater goby was thought to have been extirpated from the Goleta Slough, however in August 2006 Tidewater gobies were found in the two sediment basins near Hollister Avenue in during the Creek Relocation Project. Following the observation of Tidewater goby within the project area, work on the creek project was halted and the Airport contacted the US Fish and Wildlife Service pursuant to the Endangered Species Act.

The US Fish and Wildlife Service conducted a site visit with Airport staff and agreed that, given the work already completed, the tidewater goby could not leave the site on its own and must be relocated. In September 2006, the US Fish and Wildlife Service issued a Biological Opinion on the Airfield Safety Projects with respect to the tidewater goby allowing "incidental take" during the fish relocation project. A total of 1,502 tidewater gobies were relocated in this effort. Additionally, the creek bottom soil was stored separately and was laid out in the new creek alignment to maintain similar feeding/breeding conditions in the new creek alignment.

An unintended benefit of the Airfield Safety Projects is that the new creek alignment increased the extent of suitable Tidewater goby habitat. The Airport conducted tidewater goby surveys in 2007 and in 2008. These surveys found a stable population of breeding Tidewater gobies.

The following excerpt from Appendix C, page C-79 of the Santa Barbara Airport Master Plan DEIR (August 2015) provides additional information on the observations of Tidewater goby within the Slough:

> Tidewater goby (*Eucyclogobius newberryi*) […] is found in brackish or freshwater in bays, sounds, and lagoons and creeks along the coast from Del Norte County south to San Diego County. Half-grown and adult tidewater gobies move upstream in summer and fall, usually up to 1 kilometer (0.62 miles) from the estuary, but in some areas from 5 to 8 kilometers (3.1 to 5.0 miles). Reproduction occurs at all times of year, but peak spawning occurs during spring and late summer (USFWS 2005). Although this species inhabits creeks along the entire coast of Santa Barbara County and was present in Goleta Slough in the 1960s, collecting efforts in the 1990s failed to find tidewater gobies there, and the species was considered extirpated in the area in 2005 (USFWS 2005). However, surveys conducted in 2006 in relation to the Creek Relocation Project recorded tidewater gobies in both Tecolotito and Carneros Creeks (URS 2008c, County 2010).
>
> Since tidewater gobies were rediscovered in Goleta Slough in 2006, most surveys have involved sampling of limited areas of the slough and have resulted in small numbers of tidewater gobies detected. However, prior to construction activities for the Creek Relocation Project, capture and relocation efforts in August and September 2006 covered all areas within Tecolotito and Carneros Creeks to be impacted by construction. These efforts resulted in the capture and relocation of 1,502 tidewater gobies, with most fish captured in upstream portions of Tecolotito Creek (URS 2007, 2008c). Post-construction surveys found the species in both of these creeks in 2007 and 2008 (URS 2007, 2008c). However, no tidewater gobies were found in sampled areas of Tecolotito and Carneros Creeks in August 2008. These surveys occurred two weeks after anoxic conditions resulting from an algal bloom caused the death of large numbers of topsmelt (Antherinops affinis) within Goleta Slough; these conditions may have the potential to reduce the habitat area for tidewater gobies (URS 2008c, USFWS 2005). However, tidewater gobies were detected in this area

> in subsequent years. Surveys within limited areas of Basin E/F and adjacent portions of Tecolotito Creek resulted in observations of one tidewater goby in September/October 2010, five in May 2011, and none in August 2011 (URS 2012).

This species was also found in Atascadero Creek subsequent to its discovery in Tecolotito and Carneros Creeks in 2006 (County 2010). The County's Final Subsequent Environmental Impact Report (FSEIR) on Flood Control's maintenance activities in the Slough noted the species had not been detected in San Pedro and San Jose Creeks. However, the FSEIR assumed tidewater gobies were present in all five creeks, and conditions for on-going Flood Control activities in all of these creeks required exclusion of tidewater gobies for work conducted in these areas (County 2010). Although USFWS did not include any portion of the Santa Barbara Airport in its final designation of tidewater goby critical habitat in 2008 (73 FR 5920-6006), all five creeks converging in Goleta Slough were included within a proposed revision of critical habitat for the species in 2011 (FR 76 64996-65060). No focused surveys for this species were conducted in early 2012.

In 2014 and 2015, the Airport Department and its consultants have worked with state and federal agencies to address the potential for "takings" of Tidewater goby, Southern steelhead (see next section), and other protected species which could result from management actions at the Slough mouth intended to reduce flooding of the Airport and surrounding areas.

Steelhead

The *Draft Goleta Slough Mouth Management Biological Assessment*, Rincon et. al., 2015 describes the southern steelhead population in the Goleta Slough Area, as follows:

> "The steelhead population that potentially occurs in Goleta Slough is part of the southern California steelhead Distinct Population Segment (DPS) which extends from the Santa Maria River in San Luis Obispo County to the U.S-Mexico border (NMFS 2006). This DPS is listed as endangered under the federal Endangered Species Act, and designated critical habitat includes Goleta Slough (NMFS 2006).

Both anadromous and resident O. mykiss occur within tributaries to Goleta Slough (Stoecker 2002, National Marine Fisheries Service 2013, as cited in U.S. Army Corps of Engineers 2014), although detailed information on the relative proportion of each type is not available. Little data on steelhead spawning timing exists for Goleta Slough, although both spawning timing and distribution within the basin is related to timing, frequency, and duration of sandbar opening and winter flow conditions. Adult steelhead occurrence in Goleta Slough is necessarily limited to periods when the estuary is open, at which point adults are expected to use it as a migration corridor to the upper watershed as soon as water depth in the river allows. Timing of smolt outmigration also depends on when adequate flow conditions are present to connect the estuary to the ocean.

Juvenile steelhead may rear for extended periods within upstream freshwater habitats of the Goleta Slough depending upon seasonal variations in rainfall that control the extent of wetted channel and connectivity from the Slough to upstream locations. Juvenile O. mykiss have been reported in upstream habitats of Atascadero, San Jose, San Pedro, and Tecolotito creeks as well as in some of their tributaries including West Fork San Jose Creek, and Maria Ygnacio and San Antonio creeks which flow into Atascadero Creek (Stoecker 2002). Adult steelhead have been reported in the lower sections (south of Highway 101) of San Pedro, Atascadero, and Maria Ygnacio creeks (Stoecker 2002). In 2013, two adult steelhead and numerous juveniles were

observed by NMFS staff in Atascadero Creek below the drop structure (i.e., grade control) at the Patterson Avenue Bridge (National Marine Fisheries Service 2013, as cited in U.S. Army Corps of Engineers 2014).

Although closed-mouth conditions may force periods of lagoon rearing, little is known regarding habitat use within the Goleta Slough. Numerous tidewater goby protocol surveys conducted throughout the Slough between 2006 and 2008 reported no capture of steelhead (URS Corporation 2008a,b,c,d, URS Corporation 2009c), although the survey methods are unlikely to be effective for capture of steelhead. Under open-mouth conditions in the Goleta Slough, steelhead are assumed to use the lagoon habitat primarily as a migratory corridor, although there is potential for rearing within the freshwater/brackish ecotone."

Belding Savannah Sparrow

The *Draft Goleta Slough Mouth Management Biological Assessment*, Rincon et. al., 2015 describes the Belding Savannah Sparrow population in the Goleta Slough Area, as follows:

> [Goleta Slough's pickleweed marsh habitat supports] "a nesting population of Belding Savannah Sparrow, (*Passerculus sandwichensis beldingi*), a state endangered species. Other than one or two territories present irregularly at Devereux Slough, approximately 1.25 miles west of Goleta Slough, the population at Goleta Slough is the furthest northwestern occurrence for the subspecies. Periodic surveys (approximately every five years) have yielded counts of between 52 and 68 territories since 2001, although more extensive surveys in 1992 and 1994 recorded 117 and 140 pairs, respectively (Zembal and Hoffman 2010, Compton 2015, Holmgren and Burnell 1992, Holmgren and Kisner 1994).

See the full report for a more detailed analysis of this species' presence in the Slough.

PART 3 – Looking Ahead (2015 and Beyond)

Goleta Slough is a coastal estuary in Santa Barbara County that contains more than 300 acres of tidal wetland habitats. These wetlands provide key habitat for several threatened and endangered species including tidewater goby and southern California steelhead.

Goleta Slough has experienced several major flood events over the past century that have forced the closure of Santa Barbara Airport and surrounding areas. As the climate changes and sea levels rise, the risk of flooding and other adverse impacts to both infrastructure and habitats will increase due to the more frequent occurrence of elevated water levels within Goleta Slough.

Part 3 of the Goleta Slough Area Sea Level Rise and Management Plan provides a summary of projected effects of climate change at Goleta Slough and the impacts it may have on the natural ecosystem and the built environment. This section includes an inventory of the infrastructure and habitats that may experience impacts due to rising Slough water levels. For each vulnerable infrastructure element or habitat, this section presents a set of adaptation strategies which could be adopted in order to reduce the risk to that infrastructure or habitat. The final segment of this section describes analysis conducted to compare the expected outcomes of different lagoon inlet management strategies under existing conditions and with increasing amounts of sea level rise.

The purpose of this section is to provide information to decision-makers, planners, managers, and stakeholders to assist them as they identify and prioritize adaptation strategies, including infrastructure improvements, policy changes and management approaches to address existing challenges facing Goleta Slough as well as future sea level rise related impacts. The goals of these adaptation strategies are twofold:

1. To maintain and enhance existing ecosystem functions provided by Goleta Slough in the face of rising sea levels, and to enhance and expand priority habitats where possible; and,
2. To minimize the risk of damage to infrastructure within the Goleta Slough Ecosystem (see Figures 2-1 and 2-4) due to flooding under anticipated future sea level rise conditions.

3.1 Climate Change Projections

During the preparation of this document, Environmental Science Associates (ESA) conducted a review of the current science related to future sea level and climate conditions. The following section presents a summary of the projected effects of climate change for the Goleta Slough area. Detailed climate change projections are provided in Appendix D. A major goal of this document is to identify adaptation measures that address the expected impacts of sea level rise on habitats and infrastructure in and around Goleta Slough. It is also important to recognize that rising sea levels are just one of the many anticipated consequences of changes in the global climate that are projected to occur over the coming century and beyond. Other impacts of climate change that are expected to affect Goleta Slough habitats and functioning include increases in temperature and changes in precipitation.

3.1.1 Proposed Goleta Slough Climate Change Scenarios

The scientific community commonly presents sea level rise projections in terms of the range of predicted future sea levels at a given target year in the future (often 2050, 2100). For example, the National Research Council's (NRC) 2012 report presents a range of scenarios showing 17.4 to 65.5 in of sea level rise by the year 2100. These "year 2100" projections are sometimes mis-interpreted as the "maximum" amount of projected future sea level rise. This interpretation is

incorrect. While there continues to be uncertainty with respect to the rate of future sea level rise, the scientific consensus based on current projections for greenhouse gas emissions is that sea levels will continue to increase for the next 1000-2000 years (IPCC, 2013, California Coastal Commission Final SLR Policy Guidance, 2015; http://www.coastal.ca.gov/climate/slrguidance.html).

It is recommended that planners and managers evaluate Slough assets, including habitats, development areas and infrastructure, in terms of the amount of sea level rise that can be accommodated before that asset becomes at risk of impacts from sea level rise. Adaptation strategies should include the ability to accommodate an increasing amount of sea level rise over time, and should anticipate the required lead in time necessary to implement these strategies.

For current planning efforts we recommend the identification of adaptation strategies to accommodate at least 5 feet of sea level rise. Moderate sea level rise scenarios indicate that this is approximately the amount of sea level rise expected to occur by the year 2100. Given an expected project lifespan of 50-100 years, it is reasonable to assume that infrastructure constructed today may still be in use in a world that has experienced more than 5 feet of sea level rise.

In addition to the anticipated increase in mean sea level over time, changes in future wave conditions can affect coastal water levels. Currently, there is no scientific consensus on the expected changes to wave climate (direction, height, period) caused by climate change. The NRC report, reviewing previous global climate modeling and downscaled analysis for California (Cayan et al 2008), discusses a potential northward shift in the storm track affecting waves over the next century (NRC 2012), however current USGS wave modeling efforts utilizing the updated modeling for the next IPCC report (CMIP5) show a shift in wave direction about 15 degrees south (Barnard et al in prep). A shift in 15 degrees to the south can cause significant increases in waves in the Santa Barbara Channel (Adams et al 2007), and has been shown to be a controlling factor of the Goleta Beach widths, which directly affect the functioning of Goleta Slough (Revell and Griggs 2006).

To date there has been no formal evaluation of the expected changes in the hydrology of the Goleta Slough watershed due to climate change. The NRC report indicates a potential decrease in precipitation for the Goleta watershed, showing a decrease of 7.4% for emissions scenario B1 and a decrease of 24.4% for emissions scenario A2 by the year 2100. The report also indicates a potential decrease in runoff (-1.8% for B1, -31.0% for A2) due to precipitation. In general, the predicted trends for these parameters suggest that watershed runoff into Goleta Slough will decrease over the coming century.

There are many climate change models and scenarios producing different projections of rainfall patterns and the frequency and extent of fires. Some project increasing drought, more intense storms, and increased incidence of fires, which in future studies should be integrated with projections of sea level rise to evaluate effects on sediment transport and deposition and water levels in the Slough. Although mean changes in precipitation or runoff may not be great, most models indicate increases in climate variability (e.g., prolonged droughts, intense storms), which will have significant effects on ecosystems. Because 80% of the erosion occurring in chaparral ecosystems occurs after fires, it will be important to include the impacts of wildfires in future models predicting the effects of climate change on the Slough (sediment loading, marsh and channel accretion, runoff, and water levels).

3.1.2 Sea Level Rise Vulnerability Analysis

ESA has analyzed the vulnerability of natural and manmade assets in the Goleta Slough area to sea level rise related impacts. The goal of the habitat and infrastructure vulnerability analyses is to provide a practical planning-level assessment of the expected extent of future impacts of sea level rise within the Goleta Slough Ecosystem and to suggest and provide a preliminary evaluation of potential adaptation strategies for reducing the vulnerability of both habitats and infrastructure. This analysis is intended to inform regional and local planning efforts and to provide information pertinent to the development of long-term policy and management strategies for the region based on the available data and the current scientific understanding of the physical processes which affect the Slough system.

The following subsections describe the methodology and conceptual framework used to conduct the habitat and infrastructure vulnerability analyses. The results of these analyses are presented in summary sheets in Appendices E and F. Each summary sheet is comprised of a map and a table. The map shows the location of the key habitats or infrastructure within the study area as well as a table describing the exposure and sensitivity to sea level rise flood impacts.

For habitat, potential adaptation strategies are discussed below in section 3.2.1. For infrastructure, a brief discussion of adaptation strategies that might be used to reduce or mitigate for the anticipated flood impacts is presented below in section 3.2.2, with additional strategies presented in the tables in Appendix F.

Vulnerability Methodology

The vulnerability of habitats and infrastructure to impacts from sea level rise is based on the evaluation of three key qualities that are explained further below:

1. The expected **exposure** of that habitat or infrastructure to increased inundation and flooding due to sea level rise;
2. The **sensitivity** of that habitat or infrastructure to increased inundation in order to determine the likely damage due to future flooding; and,
3. The **adaptive capacity** of each habitat or infrastructure, determined by identifying strategies that may be implemented to reduce the risk of damage.

1. Assess Exposure

The exposure of habitat or infrastructure to sea level rise is a function of location and elevation as well as the condition of any existing flood protection. Exposure is first determined by identifying the key habitats and infrastructure that are present within the Slough. ESA has prepared an inventory of these assets within Goleta Slough through an outreach process aimed towards the general public, local government, utilities, and other regulatory agencies.

Public and focus group meetings were held on February 11th and 12th, 2014 in which approximately 40-50 people were involved in discussions of the Slough and surrounding area's vulnerability to sea level rise.

The habitats and infrastructure at Goleta Slough were organized into several general categories. The expected change in inundation frequency was evaluated for each habitat and infrastructure category by comparing the ground surface elevation at the location of that infrastructure of habitat (or the elevation of any existing flood protection berms/levees/tide gate) to the expected future extreme water levels due to sea level rise. Future Slough water levels due to coastal flooding have been estimated based on projected rates of sea level rise and an analysis of the physical processes which shape the Slough.

2. Habitat and Infrastructure Inventory

Existing Habitats

In 2008, URS developed a map of existing vegetation within Goleta Slough as part of the Western Goleta Slough Restoration Project. This mapping effort compiled data from several prior studies and incorporated data from new surveys conducted specifically for that project. This map is shown in Figure 3-1 and comprises the habitat inventory used in this analysis.

Infrastructure Inventory

An inventory of existing infrastructure located in the vicinity of Goleta Slough has been developed based on consultation with local government, utility agencies, planers and other stakeholders. This data inventory was used to identify infrastructure and relevant elevations which may be vulnerable to impacts related to projected sea level rise over the next 100 years. Information was solicited from a variety of local, county and state sources. Table 3-1 lists the key data sources used for this study.

Table 3-1
Key data sources for infrastructure inventory

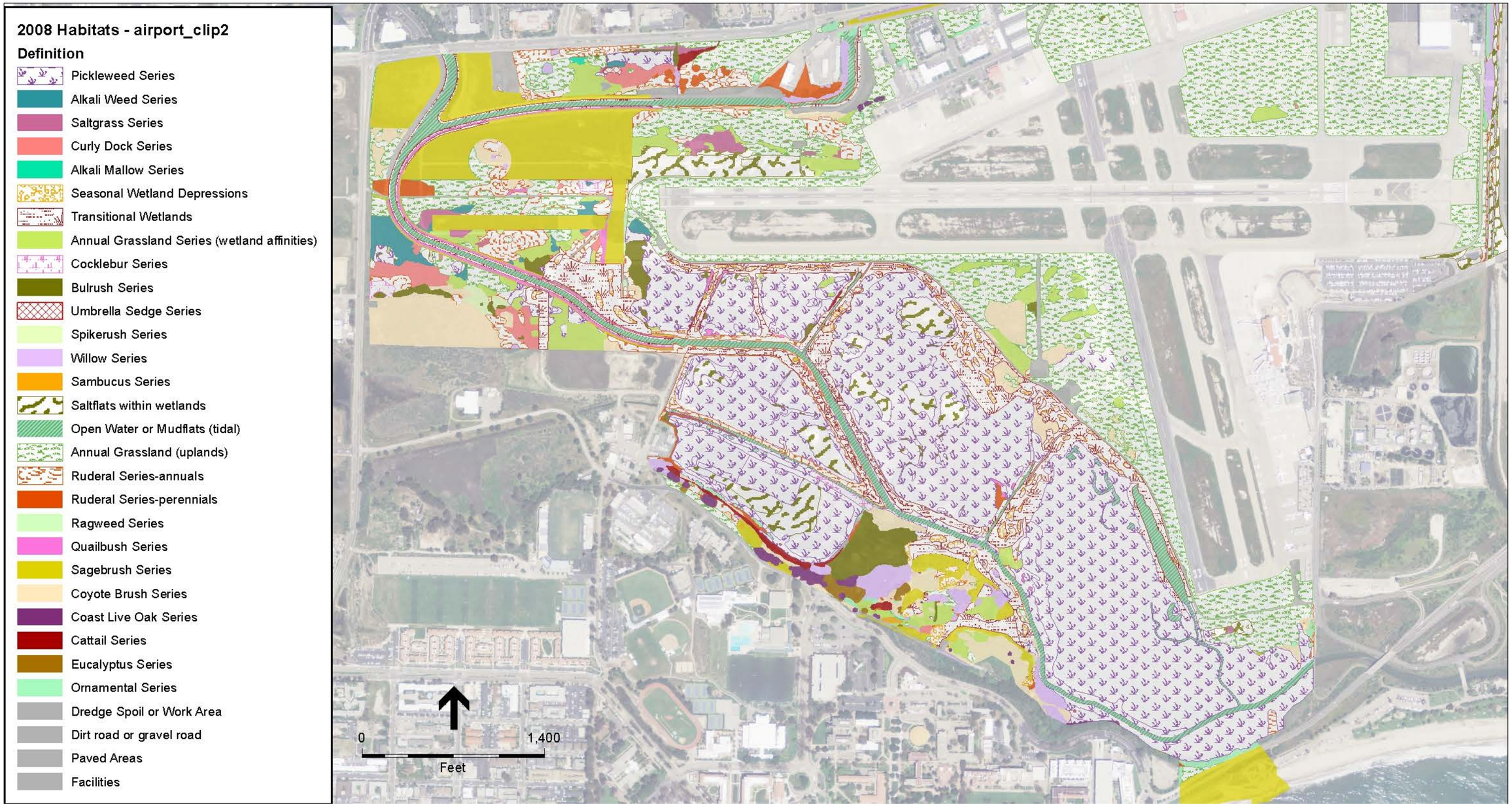
Infrastructure Category:	**Source:**
Airport Runways and Taxiways	2010 State Coastal LiDAR Penfield and Smith Ground Survey
Roads	Santa Barbara County
Buildings	Santa Barbara County
Storm Sewer and Sanitary Sewer Pipelines	Goleta Sanitary District Goleta West Sanitary District Santa Barbara Airport
Water Treatment Facilities	Goleta Sanitary District Goleta West Sanitary District
Remediation Sites	California State Water Board
Hazardous Materials	Santa Barbara County Fire Department
Natural Gas Pipelines and Storage Wells	Southern California Gas Company (Sempra Energy)
Recycled Water Pipelines	Goleta Water District

Multiple attempts were made to acquire information regarding several additional infrastructure categories; however data for the following infrastructure categories were not made available for use in this study:

- Electrical Distribution Infrastructure
- Utility Service Natural Gas Pipes and Facilities
- Telephone, Cable, and Internet Service Infrastructure

Anecdotal reports suggest that these infrastructure categories are present within the Goleta Slough plan area, however they are not included in the vulnerability assessment due to the lack of available data.

Figure 3-1 Existing vegetation map (URS 2008)



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3.1.3 Estimated Future Slough Water Levels due to Sea Level Rise

The expected increase in future water levels due to sea level rise in Goleta Slough is based on a review of the natural physical processes which shape the Slough system. As described in the *Goleta Slough Existing Conditions and Monitoring Report* (June 30, 2012), coastal estuaries such as Goleta Slough are shaped by both fluvial[1] and coastal processes. Future climate change will have three primary impacts on water levels within the Slough:

1. Increased ocean tide elevations will lead to elevated water levels within the Slough during periods when the Slough inlet is open.

2. Increased sea levels will increase the elevation of wave run-up, which will increase the potential size and elevation of the beach berm. Increased elevation of the beach berm may cause higher water levels within the Slough due to ponding when the inlet is closed. Ponded water levels may significantly exceed tidal water levels depending on overtopping of the berm and stream flows into the Slough. The height of the beach berm and therefore the height of ponding will depend on the management of the beach and Slough inlet.

3. Even with 5 feet of sea level rise, fluvial flood events will continue to cause the most extreme water levels in areas of the Slough nearest to the upstream creek confluences. Fluvial flood levels near the Slough may increase as a result of future climate change, however the analysis of fluvial flooding was beyond the scope of this study.

There is only limited water level data available for Goleta Slough. UC Santa Barbara's Cheadle Center for Biodiversity and Ecological Restoration (CCBER) installed a water level gage in the Slough starting in October 2006. This gage has collected intermittent data from 2006 to the present. The City of Santa Barbara installed a second gage in the Slough in May 2013. These two gages provide about 5 years of historic water level data for the period when the slough inlet was managed for open conditions, and 1 year of water level data for when the Slough inlet was left unmanaged. USGS maintains an additional water level gage along the lowest reach of Atascadero Creek, however this gage is located upstream of an artificial weir, and consequently water levels observed at this gage are not representative of water levels within the rest of the Slough.

The historic water level dataset has several gaps and is of insufficient duration to be used for the evaluation of extreme water level events. Historic records show that the two largest flood events of the past 75 years were the floods of 1969 and 1995 with flood elevations greater than 12 and 10 feet NAVD respectively. The FEMA flood map for the Slough shows the 100-year base flood elevation at 14 feet NAVD for the majority of the flatlands adjacent to the creeks in the Slough.

At the time of this study there is considerable uncertainty with respect to the future management of the Slough inlet. The condition of the Slough inlet is one of the primary drivers of elevated water levels within the Slough during winter storm events. Consequently, Slough inlet management is an important adaptation strategy for the management of water levels within Goleta Slough. The City of Santa Barbara has commissioned a study of management options for the Slough inlet with results expected in 2015.

3.1.4 Critical Water Surface Elevations

The short duration of the available historic water level data limits a probabilistic analysis of flood Slough water surface elevations (e.g., to estimate 100-year flood elevations, etc.). Instead, for this

[1] Fluvial – processes related to rivers and streams.

study we have identified a set of critical Slough water surface elevations that are linked to the physical processes that affect water levels within the Slough. We have used these critical water surface elevations to evaluate the expected extent of flood impacts under future conditions. These critical elevations represent our best estimate for the expected elevation of frequently occurring high water levels within Goleta Slough caused by coastal processes. The relevant critical water surface elevation that is expected to occur under future scenarios will depend on the planned lagoon management or adaptation strategies implemented for that scenario, as discussed below.

The critical elevations are not a result of hydraulic or hydrodynamic analysis of the Slough and upland watersheds and are not to be interpreted as "Base Flood Elevations". The results presented in this document do not represent a flood study for purposes of determining flood risk, flood insurance rates, or otherwise. This analysis represents our best estimate of the likely future extent of flood hazards based on available data and is intended to inform future planning and management efforts. The analysis and results presented herein are not intended to evaluate the present or future flood hazard or flood risk for any particular property or location.

Coastal influenced high water elevations within the Slough are controlled by the state of the lagoon inlet. When the inlet is open high water levels within the lagoon closely match the elevation of the high tide. Consequently, our first critical elevation is elevation 5ft NAVD, which represents the mean high tide elevation. This is the elevation water levels within the Slough will reach on a daily basis. As sea levels rise the high tide elevation will increase. Our planning horizon is considering up to +5ft of sea level rise, thus we have identified elevation 10 as the expected future daily high water level within the Slough.

Historic events have shown that the highest water levels within the Slough are most often the result of ponding within the Slough when the inlet is closed and a rain event increases stream flow, rather than high tide levels or wave-overtopping events. During a ponding event water levels within the Slough can rise to match the height of the beach berm before the Slough inlet naturally breaches. The elevation of the beach berm crest increases over time following the closure of the inlet and will approach a characteristic equilibrium elevation that is partially determined by wave run up[2], which varies seasonally. The highest elevation is typically found in the fall and early winter before the first rains of the season. Field surveys and site observations at Goleta Beach suggest that the typical fall beach berm crest elevations is approximately 10 feet (NAVD88). This elevation provides a good indication of the typical expected elevation for flood-related impacts if the lagoon inlet is left unmanaged over the course of a year. Therefore, we have identified elevation 10ft NAVD as the second critical water surface elevation for present day conditions. Because the elevation of the beach berm is controlled by the extent of wave run-up, we expect that the beach berm elevation will rise over time at about the same rate as sea level rise, therefore we identified elevation 15ft NAVD as representative of expected future annual flood elevations if the lagoon mouth is allowed to close.

Finally, elevation 15ft NAVD represents the 100-year flood elevation at the upper end of the Slough, near the creek mouths (based on the current FEMA flood map). Therefore, elevation 15 is approximately representative of the 1 in 100 year (or 1% annual chance exceedance) flood elevation due to fluvial flooding. The FEMA mapped 1 in 100 year flood elevation varies by location and is generally higher in areas that are farther upstream from the lagoon mouth.

[2] Wave run up: the distance that a wave pushes water up a sloped beach face.

Table 3-2 lists the critical elevations used to evaluate the expected extent of the impacts related to sea level rise within Goleta Slough. We have listed estimated recurrence intervals for these water levels to inform the interpretation of the vulnerability analysis results. Several of these recurrence intervals have been estimated based on extremely limited datasets and include a high degree of uncertainty.

Table 3-2
Critical elevations used to evaluate sea level rise impacts

Elevation	Physical Interpretation	Estimated Recurrence Interval 2015	Estimated Recurrence Interval with 5ft of SLR
5' NAVD	Approx. Mean High Water Level (2014)	**Daily**	**Almost Always**
10' NAVD	Approx. Elevation of beach berm crest (2014); or Approx. Mean Sea Level +5ft SLR	**1-5 Years*** (without inlet management) **5-100 Years*** (with inlet management)	**Daily**
15' NAVD	Approx. Elevation of beach berm crest + 5ft SLR	**~100 years***	**1-5 Years*** (without inlet management) **5-50 Years*** (with inlet management)

* High Level of Uncertainty

If an extreme fluvial[3] flood event occurred concurrently with a king tide, storm surge, or a large wave event, then water levels could significantly exceed the critical water levels listed in Table 3-2. Existing FEMA flood maps show the expected extent of flooding caused by a current 100 year fluvial event (1 in 100-year). FEMA's floodplain mapping did not consider the potential for elevated water levels caused by a closed Slough inlet or by future sea level rise.

This study has not evaluated the expected extent of flooding due to extreme fluvial flood events. The flood hazard due to an extreme fluvial event may exceed the flood hazard due to coastal flooding even with 5 feet of sea level rise. The fluvial flood elevation increases upstream along the creek channels. Sea level rise is expected to increase future fluvial flood elevations and extents due to the backing up of water in the lower parts of the Slough during high tides.

3.1.5 Evaluating Sensitivity to Sea Level Rise

Different habitats and infrastructure may have different levels of sensitivity to elevated water levels within the Slough. Some wetland habitats may be able to keep pace with sea level rise through natural accretion processes while others may convert to different habitat types with different rages of species and vegetation compositions that are more tolerant of increased inundation frequency.

Some infrastructure, such as the airport tarmac, are highly sensitive to inundation and may become inaccessible or unusable if ponded water is present while other infrastructure, such as sewer pipelines, can tolerate complete inundation as long as key pump facilities and electrical infrastructure are not damaged.

[3] Fluvial: related to rivers and creeks. A fluvial flood event occurs when the amount of flowing water exceeds a river or creek channel's capacity.

The sensitivity of the various habitat categories to sea level rise were evaluated using the Sea Level Affecting Marshes Model (SLAMM) modeling tool[4]. The results of this analysis are discussed in Section 3.1.6. The SLAMM results have been compared with a simplified Inundation Frequency (IF) habitat model to provide a validation dataset for the SLAMM model that is discussed in Section 3.1.7. An additional focus group was conducted with representatives from several resource agencies, ecologists and other scientists to discuss issues concerning the habits and ecological systems in the Slough. This focus group provided valuable local knowledge that aided with the interpretation of the SLAMM and IF model results.

A series of focus groups with the operators and managers of the key infrastructure in the Goleta Slough study area was engaged to understand the sensitivity of local infrastructure to flood related damage. The goal of these focus groups was to understand the conditions and mechanisms and crucial components by which existing infrastructure may become damaged, inaccessible, or inoperable as a result of high water levels in the Slough. In some cases, such as for hazardous materials and remediation sites, the sensitivity to sea level rise impacts is not well understood. Infrastructure sensitivity is discussed in Section 3.1.8.

3.1.6 Assessing Habitat Exposure and Sensitivity Using Habitat Evolution Modeling (SLAMM)

Habitat exposure and sensitivity to SLR related impacts were assessed using SLAMM. SLAMM can simulate the evolution of tidal wetland habitats over time by comparing the ground surface elevation, water table and habitat location with rising tide elevations and rates of erosion and accretion. SLAMM uses data from existing habitat surveys in order to develop correlations between habitat types and elevations relative to tidal water levels. SLAMM also tracks the rate of marsh accretion and erosion based on estimates for the local sediment supply and wave energy. The model tracks how marsh elevations evolve over time, and then predicts the extents of future marsh habitats based on the elevation correlations and projected rates of sea level rise. It was initially developed in the mid-1980s with EPA funding to evaluate changes to east coast habitats and wetlands and has evolved over time with support from many other funding sources, including The Nature Conservancy (TNC). The software is open source and freely available. This project used SLAMM version 6.2 beta. It should be noted that SLAMM only projects changes in a tidally influenced system. If the Slough inlet is allowed to remain closed, then the SLAMM results should not be used to support decision-making.

SLAMM simulates the dominant processes involved in wetland conversions during long-term sea level rise: inundation, erosion, overwash, saturation, and accretion. A complex decision tree incorporates both geometric and qualitative relationships to model habitat conversions in coastal habitats through spatial relationships (e.g. adjacency and elevation). It is important to note that while the dominant processes are represented, this is not a hydrodynamic or sediment transport model[5]. The following model processes are applied at each time step:

- *Inundation*: As sea level rises, the ground surface elevation decreases relative to mean sea level. This causes habitats to convert to habitats found lower in the tide frame. Inundation is calculated based on the minimum elevation and slope of the local topographic grid cell.

[4] SLAMM is an Open Source model that is maintained and distributed by Warren Pinnacle Consulting, Inc.

[5] SLAMM simulates processes related to the evolution of different habitats over time. A hydrodynamic model simulates the flow of water due to natural and mechanical forces. A sediment transport model simulates the movement of sediment, often caused by wind or flowing water.

- *Erosion*: Horizontal erosion representing wave action along shorelines is triggered given a minimum fetch threshold and proximity of the marsh to estuarine water or open ocean.
- *Saturation*: Migration of coastal swamps and fresh marshes onto adjacent uplands as driven by a rising water table.
- *Accretion*: Vertical rise of marsh due to buildup of organic and inorganic matter on the marsh surface.
- *Overwash*: Overwash occurs at a specified interval (i.e. every 20 years) causing barrier islands to migrate inland over time. The overwash module has been disabled for this project since barrier islands and the associated overwash by major U.S. East Coast storms (i.e. hurricanes) are not applicable to the Goleta Slough study area.

The primary inputs to SLAMM include a high-resolution digital elevation model, a map of current wetland habitats, future sea level rise projections, marsh accretion rates, tide ranges, and erosion rates. The resulting SLAMM projections of future extents of individual habitats with sea level rise are shown in the habitat summary sheets (Appendix E). Figures 3-2 through 3-4 show the projected habitat extents under current and future conditions assuming open inlet management. The results of the SLAMM analysis are tabulated in Table 3-3 Predicted Habitat Areas and Table 3-4 Predicted Change in Habitat Areas.

Figure 3-2 Habitat bands by inundation frequency under existing conditions using SLAMM model

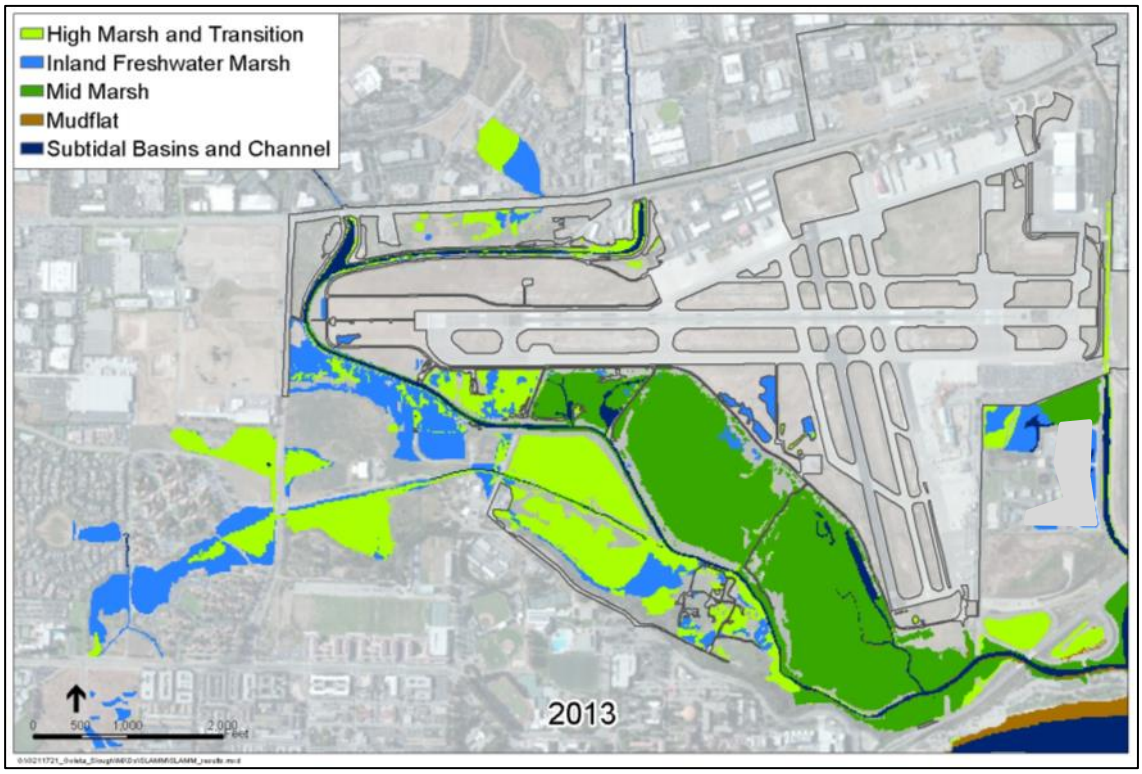

Figure 3-3 Habitat bands by inundation frequency in 2100 with 1mm/year accretion rate using SLAMM model

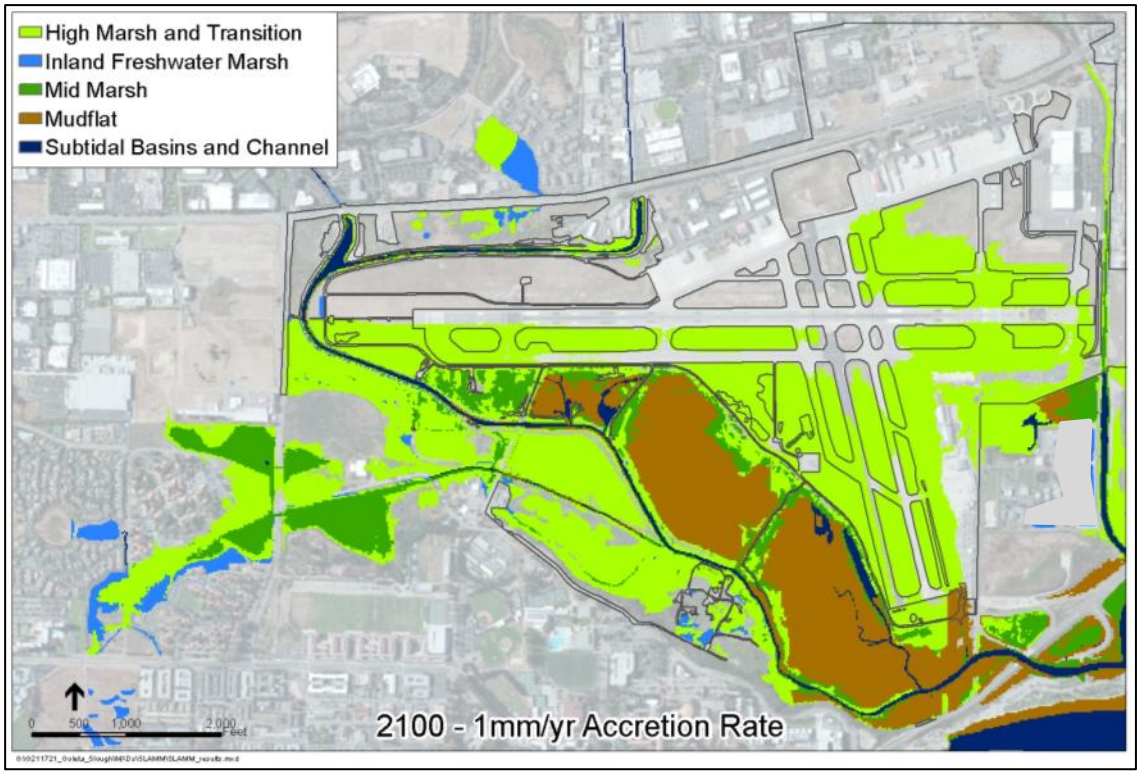

Figure 3-4 Habitat bands by inundation frequency in 2100 with 5mm/year accretion rate using SLAMM model

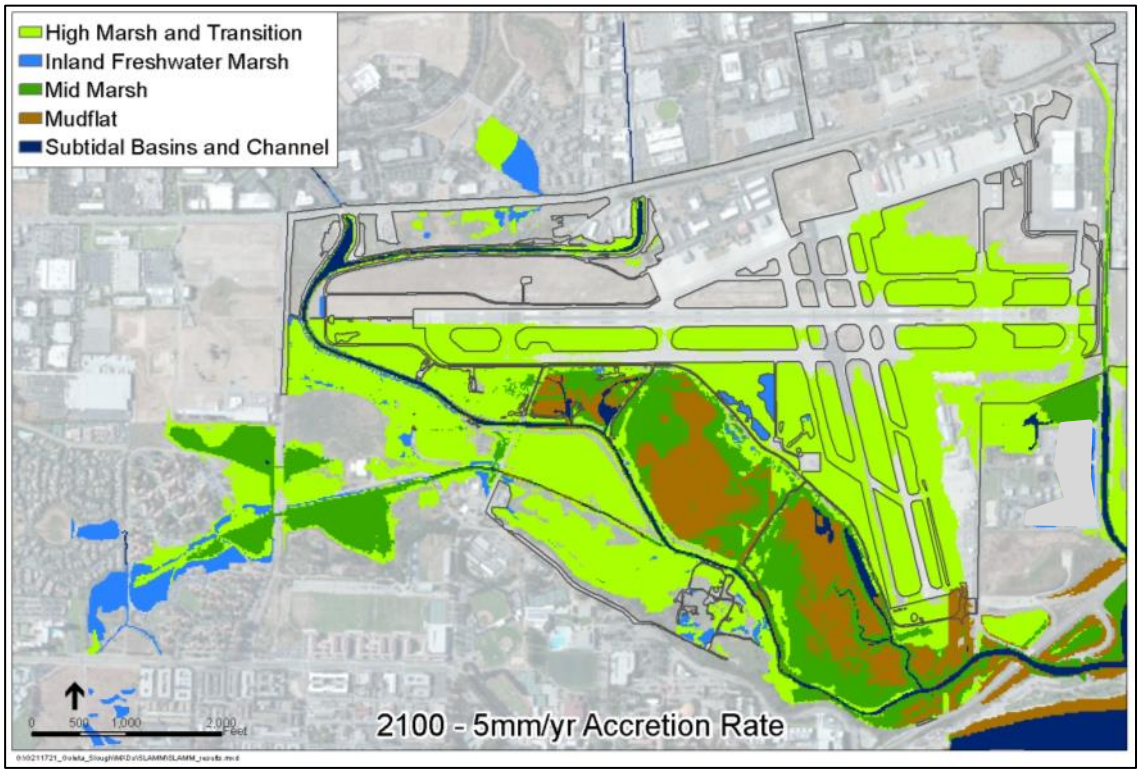

Table 3-3 Predicted Habitat Areas (from SLAMM analysis)

	Acres								
	Year 2013	Year 2050				Year 2100			
	With Tide Gate	With Tide Gate		Without Tide Gate		With Tide Gate		Without Tide Gate	
Habitat Type	(no accretion)	1 mm/yr accretion	5 mm/yr accretion	1 mm/yr accretion	5 mm/yr accretion	1 mm/yr accretion	5 mm/yr accretion	1 mm/yr accretion	5 mm/yr accretion
Uplands	597	595	595	594	594	553	553	548	549
Freshwater Non-Tidal Marsh	26	24	26	21	22	19	20	13	16
Open Water	38	40	40	40	40	43	42	46	44
Mudflat	8	7	7	10	9	26	18	27	20
Saltmarsh	24	24	24	25	25	11	17	12	18
High Marsh/Transitional	11	14	13	15	14	53	54	58	58
Total	728	729	729	729	728	728	729	726	729

Table 3-4 Predicted Change in Habitat Area, Relative to 2013 (from SLAMM analysis)

	Acres	Change in Acreage							
	Year 2013	Year 2050				Year 2100			
	With Tide Gate	With Tide Gate		Without Tide Gate		With Tide Gate		Without Tide Gate	
Habitat Type	(no accretion)	1 mm/yr accretion	5 mm/yr accretion	1 mm/yr accretion	5 mm/yr accretion	1 mm/yr accretion	5 mm/yr accretion	1 mm/yr accretion	5 mm/yr accretion
Uplands	597	(2)	-	(1)	-	(41)	-	(5)	1
Freshwater Non-Tidal Marsh	26	(2)	2	(5)	1	(3)	1	(7)	3
Open Water	38	2	-	-	-	3	(1)	4	(2)
Mudflat	8	(1)	-	3	(1)	17	(8)	9	(7)
Saltmarsh	24	-	-	1	-	(14)	6	(5)	6
High Marsh/Transitional	11	3	(1)	2	(1)	39	1	4	-

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3.1.7 Inundation Frequency Model

In order to validate the SLAMM results, a simplified Inundation Frequency habitat model has been applied to the Goleta Slough system. Like SLAMM, the Inundation Frequency model predicts future habitats based on the elevation of the landscape relative to the tides. However the Inundation Frequency uses a simplified method for determining habitat type based on the range of inundation frequencies characteristic of different habitat types.

Clusters of wetland species have been observed to occupy regions of tidal marsh based on the frequency of inundation. Relationships between habitat occurrence and the amount of time submerged (inundation frequency) were developed based on observations of habitat occurrence at several coastal lagoons along the Santa Barbara County coast (Hubbard, pers. comm., 2013). Table 3-5 lists the several key wetland habitat categories and their associated inundation frequencies.

Table 3-5. Wetland Habitat Inundation Frequency

Habitat Category	Inundation Frequency
Subtidal	100%
Mudflat	45%-100%
Low Marsh	20%-45%
Mid Marsh	5%-20%
High Marsh	0%-5%
Uplands	0%

In a tidal estuary like Goleta Slough, the frequency of inundation at a given location is determined by the elevation relative to the local tides. A frequency analysis of water levels in Goleta Slough was undertaken using water level data provide by CCBER and the City of Santa Barbara in order to identify the inundation frequency at different elevations. The results of this analysis were used to identify the elevations associated with six representative habitat categories. These relationships between elevation and habitat were then applied to the 2010 Coastal LiDAR topography (Figure 3-5) in order to map the expected habitats across the site.

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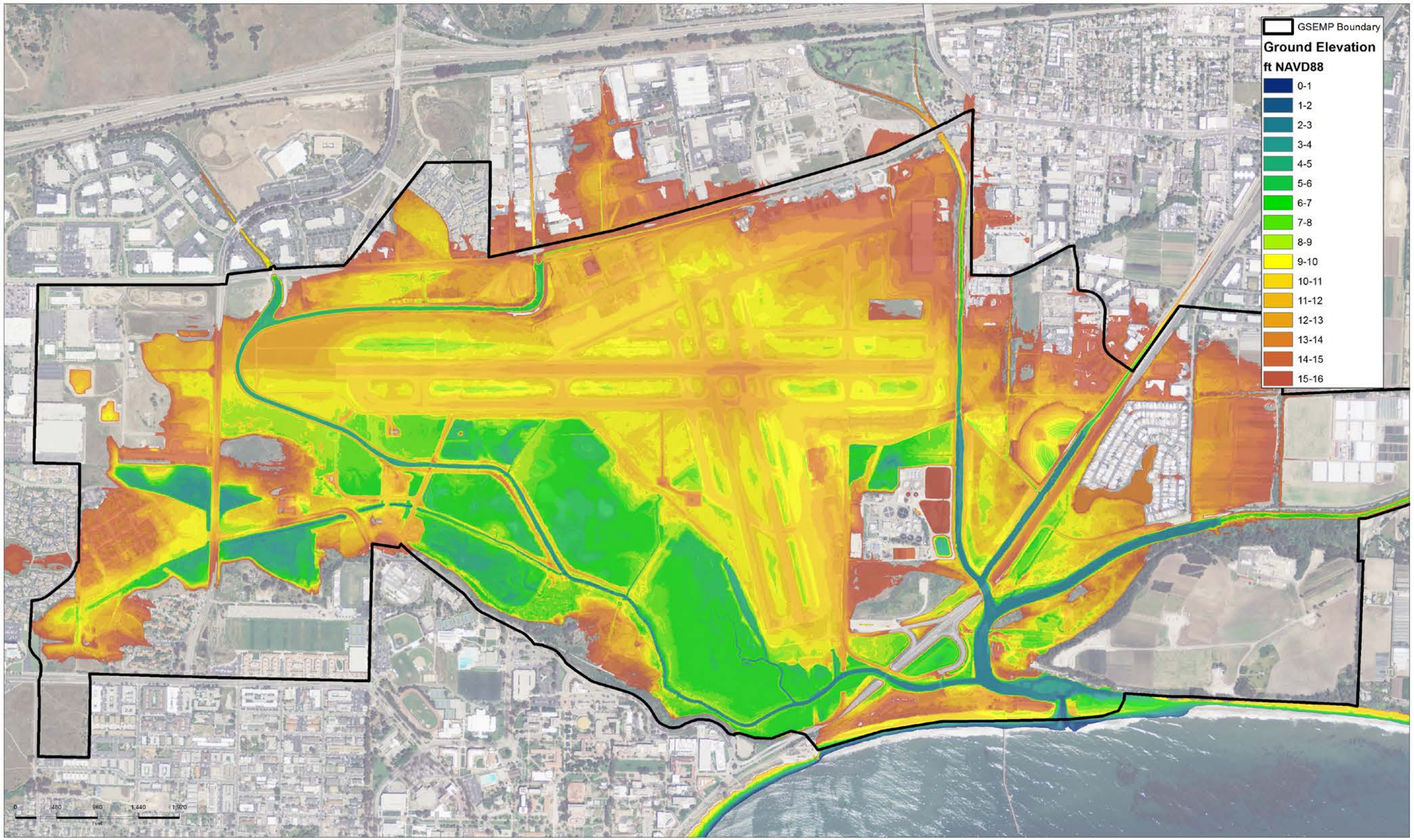
Figure 3-5 2010 Coastal LiDAR topography



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The method outlined above was used to map future habitats extents by shifting the elevations for each habitat type upward based on the expected amount of future sea level rise and accretion. This method can also project habitat changes for a non-tidally influenced Slough during which the inlet of the Slough is allowed to close based on observed water levels within the lagoon during closed conditions. Note that there is a high degree of uncertainty with respect to the future habitats under closed conditions due to the relatively infrequent occurrence of closed conditions at Goleta Slough in recent history for closed conditions and the lack of other large, frequently closed lagoons that might serve as reference sites. Figures 3-6 and 3-7 show the projected habitat extents under current conditions assuming open and closed inlet management. Figure 3-8 shows the projected habitat extents for the year 2100 with future sea level rise and open inlet conditions. The patterns of habitat transgression shown in these figures match the general patterns predicted using the SLAMM model for areas connected to tidal processes.

Figure 3-6. Habitat bands by inundation frequency under existing conditions and with open inlet management.

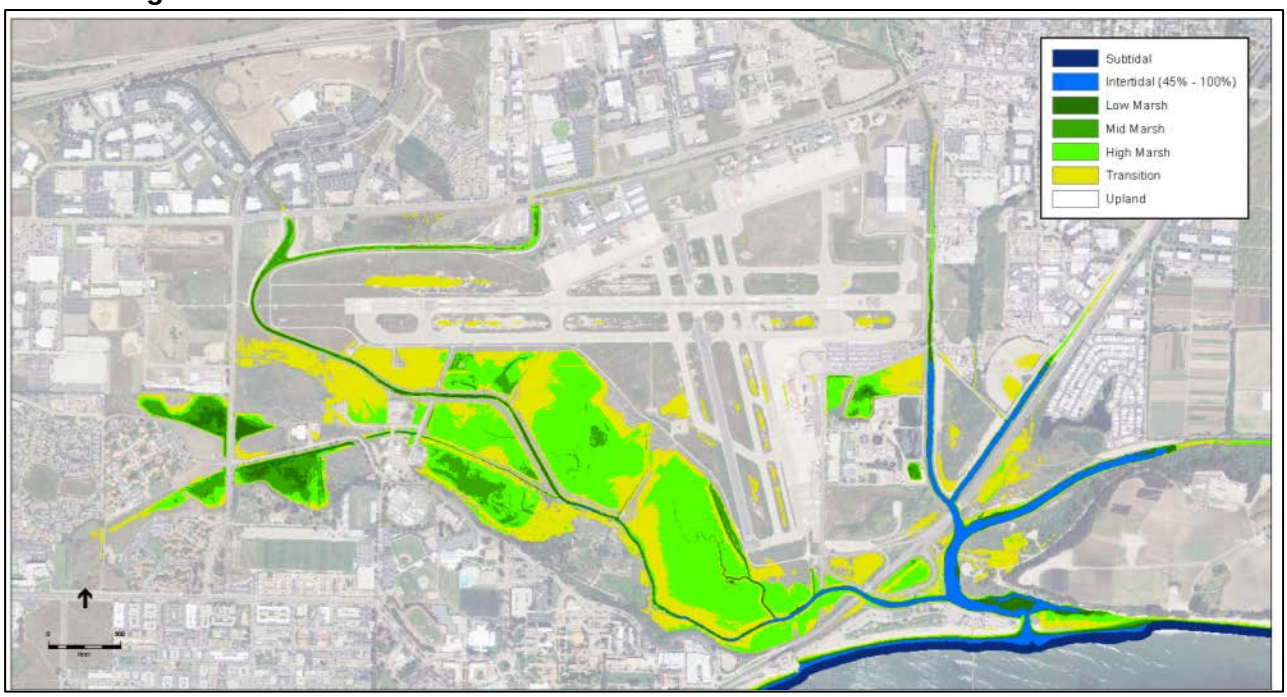


Figure 3-7. Habitat bands by inundation frequency under existing conditions and with closed inlet management.

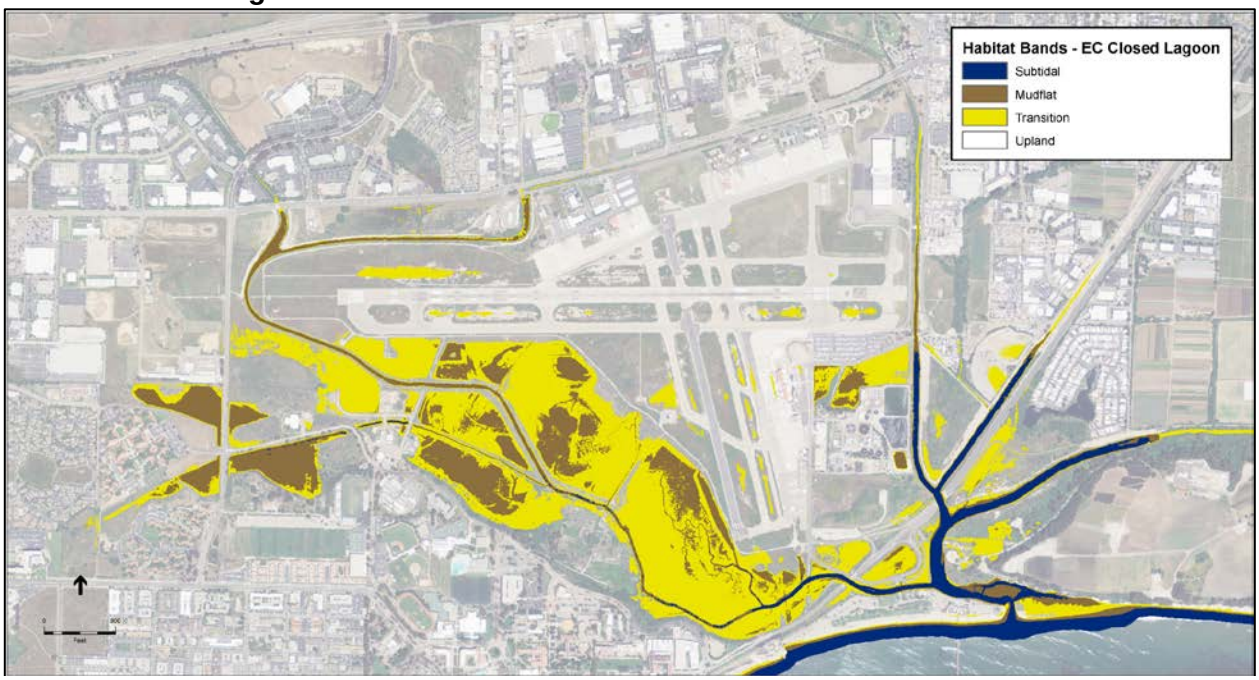
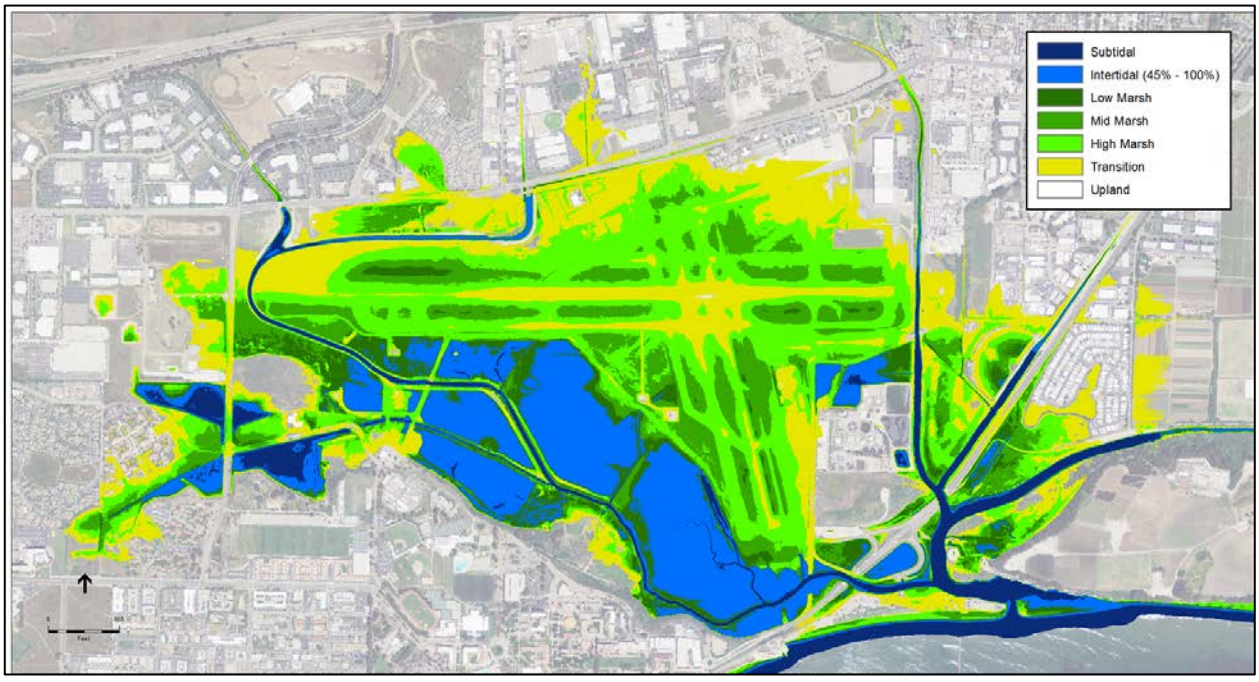


Figure 3-8. Habitat bands by inundation frequency under SLR scenario at 2100 with open inlet management



3.1.8 Assessing Infrastructure Exposure and Sensitivity

This study provides an estimate of the expected present and future extent of infrastructure vulnerability within the study area and attempts to identify infrastructure that is likely to be most vulnerable to future flood impacts based on the best available data. Due to the inherent uncertainty in the methods of this study, the results of this study are intended for informational purposes only and should not interpreted as a formal flood study or as an assessment of vulnerability for any specific property, structure or infrastructure. The vulnerability of specific structures or infrastructure should be assessed by a qualified professional.

Maps depicting the location of key infrastructure within the vicinity of Goleta Slough were developed based on input from local municipal agencies and utility companies (see Appendix F). The infrastructure elements for which elevation data is available have been color coded to reflect the relative vulnerability of each piece of infrastructure to increases in sea level. In general, the vulnerability of infrastructure in low-lying areas is expected to increase with time as sea levels rise over the next century. The vulnerability classification is based solely on the elevation of that infrastructure relative to the critical elevations identified in Table 3-2 plus any specific vulnerability identified during the stakeholder outreach process. The future vulnerability of infrastructure within Goleta Slough will also depend on the future management of the lagoon inlet and any new flood protection measures that may be implemented in the future.

These maps also contain an overlay identifying the area where the ground surface elevation is below each of the three critical elevations of 5, 10, and 15 feet NAVD as described in Table 3-2. This overlay is intended to indicate the approximate extent of inundation if water levels within the Slough are to pond at each of the three critical elevations.

While topographic elevation is generally a good indicator of an area's vulnerability to flooding, it is important to acknowledge the limitations of this method for vulnerability estimates. The elevation overlay does not reflect the flood protection provided by non-certified berms and other topographic features that, while not certified as flood control levees, may provide some level of flood protection for some low-lying areas. In addition, the elevation overlay does not represent variations in water level due to local hydraulic conditions such as creek inflows, weirs, and wave run-up/overtopping. Consequently, the actual extent of inundation during a real storm event may vary from that shown in the elevation overlay due to localized conditions.

For this analysis we have estimated the ground floor elevation of structures based on nearby ground surface elevations as shown in available LiDAR datasets. This method may over-estimate the vulnerability of structures with ground floor elevations that are raised above the adjacent ground surface.

3.1.9 Vulnerability Results

The methodology and conceptual framework described above was used to conduct the habitat and infrastructure vulnerability analyses and the results of these analyses are presented in Appendices E and F. These appendices contain a set of summary sheets which summarize the results of this analysis. An example summary sheet is shown in Figure 3-9. Each summary sheet addresses a different category of habitat or infrastructure and contains a map showing the location of the habitat or key infrastructure within the study area as well as a table describing the exposure, sensitivity and vulnerability of each category to sea level rise related impacts.

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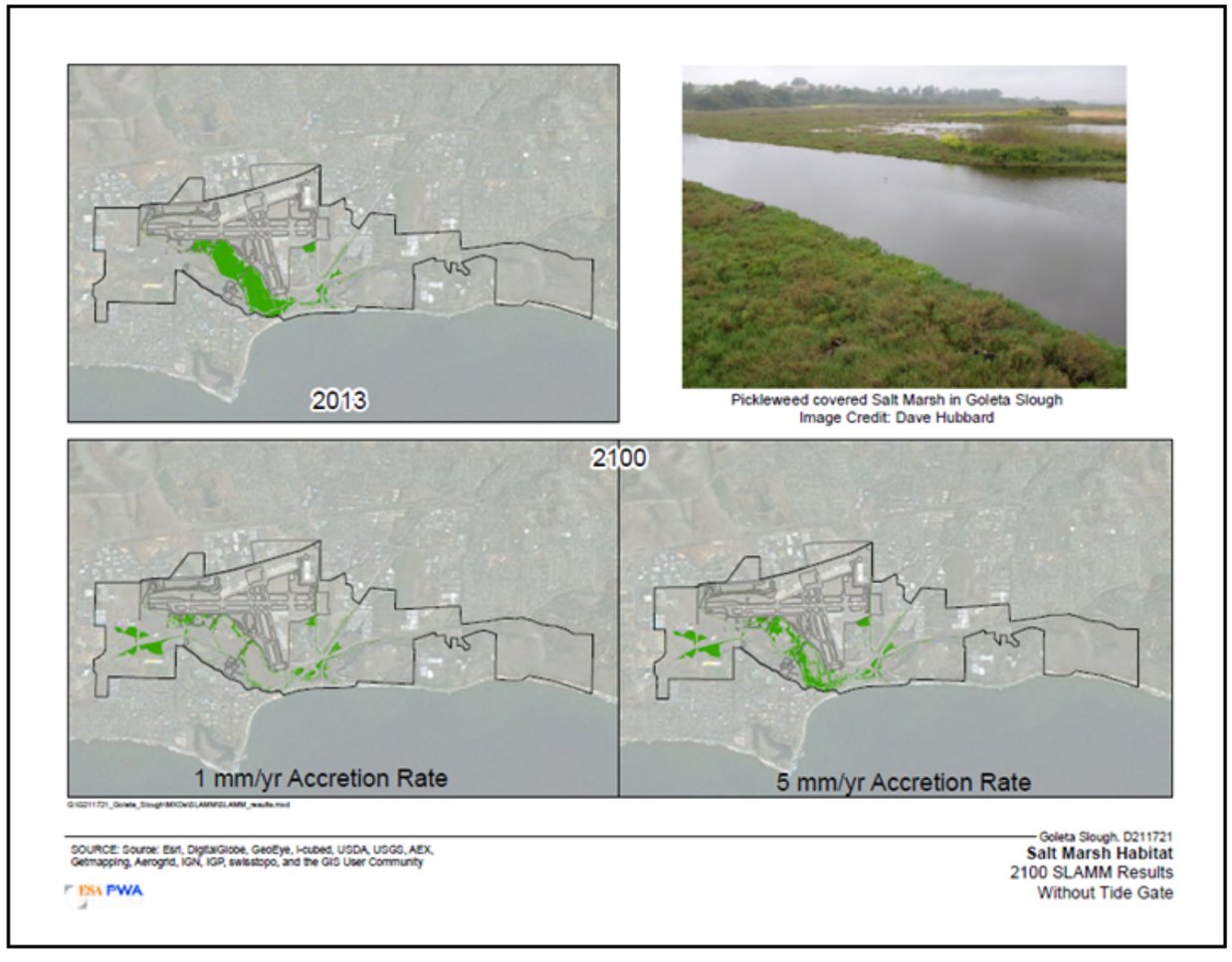
Figure 3-9 - Example of Vulnerable Habitat Summary Sheet included in Appendix E



Pickleweed covered Salt Marsh in Goleta Slough
Image Credit: Dave Hubbard

Function	Salt Marsh
Location	Tidal salt marsh is a wetland habitat that is periodically inundated by saline water on rising tides. Tidal salt marsh habitats are characterizes by a collection of plant species, such as pickleweed *(Salicornia virginica)*, which are adapted to thrive in a frequently inundated, high salinity environment. Salt marsh species generally occur in areas that are tidally inundated 5% to 45% of the time. Under historic lagoon mouth management conditions at Goleta Slough, this habitat generally occurred at elevations ranging from 3.5 ft to 5.5 ft NAVD[1].
Types of Hazard	Conversion of existing habitat due to more frequent tidal and fluvial inundation. With modeled increases in sea level and water levels within Goleta Slough, salt marsh habitat would migrate upslope, replacing existing high marsh and transitional habitats, while being replaced by mudflats.
Proximity to Hazard	Habitat Evolution Modeling for the Goleta Slough ecosystem predicts the extensive conversion of salt marsh habitat into mudflat and the limited upslope migration of tidal high marsh habitat: • Large areas of Salt Marsh are found within the basins south of airport runways. • Limited pockets of salt marsh occur in areas adjacent to the Atascadero and San Jose Creek channels.
Anticipated Changes	• Increased sea level and inundation times across within Goleta Slough would lead to the conversion of existing salt marsh to mudflat and vegetated intertidal habitats. The conversion of salt marsh to mudflat due to rising sea levels, may be slowed or in some cases prevented by accretive processes related to sediment accumulation. • Loss of bio-geochemical cycling functions associated with vegetated marsh (carbon sequestration, nutrient uptake) may compromise lagoon water quality. • Salt marsh habitats may migrate upslope, replacing existing High Marsh habitats; however the local topography within Goleta Slough is such that there are few areas where this upslope migration is viable, the most notable being the pond areas near Los Carneros and Mesa Rd.
Severity of Changes	• Conversion of habitat types may lead to the loss of intertidal pickleweed habitats and loss of animals dependent on those plant species. • The loss of salt mars habitat would disrupt bio-geochemical cycling associated with vegetated marsh, including carbon sequestration and nutrient uptake.
Risk of Changes	Risks associated with the conversion of salt marsh habitats and associated losses are linked directly to rising water levels within the slough and increased inundation frequencies. Habitat evolution modeling predicts a significant loss of salt marsh habitat under future sea level rise conditions. The extent of habitat loss varies based on the availability of sediment within the water column. An increased sediment supply may reduce the risk of salt marsh habitat loss.

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Generally, Goleta Slough can expect to experience significantly more frequent occurrence of high water levels due to sea level rise. Increased water levels may lead to significant shifts in the distribution of wetland habitats within the Slough. Most notably, pickleweed marsh is expected to convert to mudflat due to increased inundation, and a net loss in mid and high-marsh habitats will occur unless upland areas are made available for habitat transgression.

Habitat Changes
For the given sea level rise scenarios, and assuming that the lagoon continues to be managed for open inlet conditions and no special actions to address sea-level rise, the following habitat changes are expected:

1. Low marsh would convert to mudflats in the basins south of the Airport runways;
2. Upland habitats adjacent to the Slough are expected to convert to high marsh; however the current land use for many of the uplands adjacent to the Slough are not compatible with a conversion to wetland habitat (e.g., Airport operations areas); and,
3. Freshwater wetlands located near the downstream reaches of the Slough are expected to convert to saltmarsh due to elevated tide levels.

Infrastructure Vulnerability
Several key infrastructure assets within the Slough are already vulnerable to flooding under existing conditions, most notably the airfield runways and stormwater systems, the Placencia Street neighborhood east of the Terminal, and low-lying sections of Mesa and Fowler Roads (see Appendix F). These areas will experience more frequent flooding with sea level rise.

Additional infrastructure assets will become exposed to frequent flood impacts due to rising sea levels. These include the Goleta West Sanitary District pump station (near the UCSB Police Station), and numerous commercial and residential structures in areas adjacent to the Slough. Existing storm water and sewer infrastructure in these areas may also become compromised due to the increased frequency of flooding.

3.2 Sea Level Rise Adaptation Measures

3.2.1 Habitat Adaptation Measures
Goleta Slough has been managed for high tidal function and water quality for more than twenty years, primarily through periodic mechanical opening of the Slough inlet when it naturally closes. Maintaining tidal functions and restoring more tidal habitat have been stated goals of the GSEMP since 1997. Goleta Slough currently has a much smaller tidal prism[6] than it did historically as a result of the following historic events:

- Large volumes of sediment moved into the system after land use practices changed in the watershed in the post-European contact period and subsequent fires, flooding and erosion;
- Filling of a portion of the estuary occurred during the construction of the Marine Corps Air Station (now the Airport) during World War II; and,
- Some potential tidewater area is cut off by a tide gate that was installed near the Goleta West Sanitary District plant about 50 years ago.

The reduction of Goleta Slough's tidal prism has reduced the ability of the tidal channel to stay open without active management. While the lagoon historically functioned as a primarily open tidal system, these reductions in tidal prism have increased the tendency for the inlet to close and the

[6] Tidal prism – the volume of water that flows into or out of a tidal basin during an average tidal cycle.

lagoon to become impounded and cut off from the tides. The inlet has been mechanically opened an average of twice a year over the last twenty years to reduce flooding potential, maintain tidal circulation and manage water quality.

For the Goleta Slough system the most notable management adaptation issue is the decision whether or not to continue to breach the Slough inlet following natural closure events. A Draft Biological Opinion issued by National Marine Fisheries Service (NMFS) in early 2013 changed the management of the Goleta Slough inlet from a regime where the lagoon inlet was breached within two weeks of closure to the current practice where the lagoon mouth is breached only when there is an imminent threat of flooding. The management regime for the Slough inlet is still being studied; therefore this report considers two general scenarios for Goleta Slough in the future:

1. The Inlet is managed open conditions and for high tidal circulation trough managed breaches, and,
2. The Inlet is allowed to close naturally and remains closed until non-tidal for some of the year and is breached during or immediately prior to large precipitation events where there is the potential for flooding.

In 2014 ESA conducted a detailed study to evaluate the likelihood of open or closed inlet conditions in the absence of active inlet management under a range of potential future scenarios. The results of this study are discussed in detail in Section 3.3.

In the case that Goleta Slough inlet is managed to remain open and tidally connected most of the year, the model results indicate that estuarine habitats are expected to migrate upslope as increasing sea level increases the frequency of inundation at lower elevations. Although there is little data for suspended sediment in the Goleta Slough system, the modeled sea level rise scenarios include two alternatives representing low and high sediment accumulation rates (estimated based on typical sedimentation rates in San Francisco Bay). These two scenarios are intended to highlight the important role that sediment supply plays in determining potential ecological responses to rising sea levels. The modeling for this study and observations in other systems (San Francisco Bay) show that even moderately high suspended sediment loads seem unlikely to prevent major changes in marsh ecosystems with high sea level rise rates, however higher sediment concentrations will reduce the rate at which tidal marsh habitat is lost and may allow for greater opportunities for the marsh to successfully transgress to adjacent uplands (Stralberg et al. 2011).

If the inlet remains closed for extended periods of time, then salt marsh systems subject to prolonged impoundments will not necessarily track the rising sea level in a linear way because the habitats will not be consistently connected to tidal processes. Under closed inlet conditions species that are dependent on regular tidal action or on consistent salinities and high water quality may be lost from the system. Habitats in impounded systems may be exposed to prolonged periods of very low or very high salinities, low oxygen levels, high temperatures, and periods with hypersaline soils during dry years. Under such conditions it will become increasingly difficult to maintain healthy tidal marshes, however the extent of subtidal and mudflat habitats would be expected to increase. The habitat adaptation measures described below first look at improving hydraulic connectivity and then altering the topography by sediment placement. These measures are shown in Figure 3-10 and 3-10 and are evaluated in Table 3-6. All the measures described below are limited at some point by constraints of infrastructure flooding and the consequent maximum water surface elevation. Measures to increase the maximum water surface elevation before flooding occurs are described in section 3.2.2.

Improve hydraulic connectivity (Figure 3-10 and Table 3-6)
In addition to managing the inlet, there are opportunities to encourage greater tidal flows into and out of the Slough by breaching dikes and restoring tidal action. There are several areas within the Goleta Slough system where the existing ground elevations are suitable for the establishment of marsh vegetation but that are currently colonized by upland plants due to poor hydraulic connectivity. These areas offer significant opportunities for the creation of new tidal wetland habitats. In the case of the leveed basins south of the airfield runway, habitat creation and restoration could be achieved by breaching the existing berms adjacent to the Los Carneros Creek channel at key locations. Section 3.3 provides greater detail regarding the expected impact that increasing the volume of the slough will have on the natural patterns of breaching and closure of the lagoon inlet. The general finding of the inlet study is that small restoration efforts are unlikely to cause a shift in lagoon dynamics, as the relatively small increase in tidal prism due to a small restoration would not be enough to create a self-scouring inlet. In contrast, a large scale restoration effort (one in which all of the areas indicated on Figure 3-10 were opened to tidal action) would be expected to shift the lagoon towards more frequently open conditions. This is because the much larger increase in tidal prism under such a scenario would increase tidal scour at the inlet to the point that the tidal flows would self-scour out the inlet channel under most tide and wave conditions.

Remove or relocate the tide gate near Goleta West Sanitary District
The tide gate located near the Goleta West Sanitary District pump station currently restricts tidal flows to the low-lying areas near Los Carneros Road and Mesa Road. The tide gate, installed in the mid-1950s by Thomas Storke, was built to provide flood protection to grazing land, homes and businesses to the west of Goleta Slough, however it also has caused noticeable changes in the wetland habitats in the area.

ESA has applied the SLAMM model to evaluate the evolution of wetlands habitats under future conditions with and without the tide gate. The results of this modeling indicate the potential for the areas behind the tide gate to convert to tidal marsh habitats, and that the future extent of these habitats is highly sensitive to the rate of sediment accretion within these new tidal wetland areas. Additional flood protection may be needed to prevent flood damage to low-lying structures in nearby areas, particularly if the tide gate is to be opened or removed.

Enhance Sediment Supply to Tidal Wetlands
Tidal wetlands grow over time following changing sea levels. Marsh vegetation traps sediment from the water column, and the accumulation of vegetation biomass also contributes to the accretion of the marsh plain, allowing marshes to increase their elevation to match rising sea levels. Marsh accretion can be enhanced by increasing the amount of available sediment reaching the marsh plain. Figure 3-11 shows the five sediment basins currently maintained by Santa Barbara County Flood Control. The material from these basins is currently removed from the Slough and used as offsite fill materials, for beach nourishment and/or is sent to landfills. Sediment removed from these basins as part of ongoing flood control activities could instead be used to improve habitat resilience through marsh sediment augmentation efforts that could increase marsh plain accretion rates. Increased marsh plain accretion would enhance the overall resiliency of the marsh to sea level rise. Marsh plain accretion could be increased by:

- Improving the connection between the creeks and neighboring marsh plains, which would allow natural deposition of sediment on the marshes
- Delivering thin layers of sediment to the marsh through mechanical methods, potentially through the use of low-impact grading techniques or hydraulic delivery methods

Upland areas adjacent to marshes can provide valuable habitat, increase connectivity between habitat areas and create areas that are suitable for future upland transgression of marshes as sea levels rise. In addition to using sediment to enhance marshplain accretion, there are opportunities to use the material from the sediment basins within the Slough to increase the extent of upland transitional areas, especially along the southern and western perimeter of the airport. There may be opportunities to acquire open space areas adjacent to the Slough for conservation purposes, and material from the sediment basins is a valuable resource that could be used for grading and shaping such areas to promote the establishment of target habitats as part of restoration and habitat enhancement efforts.

Figure 3.10 – Hydraulic Connectivity Measures

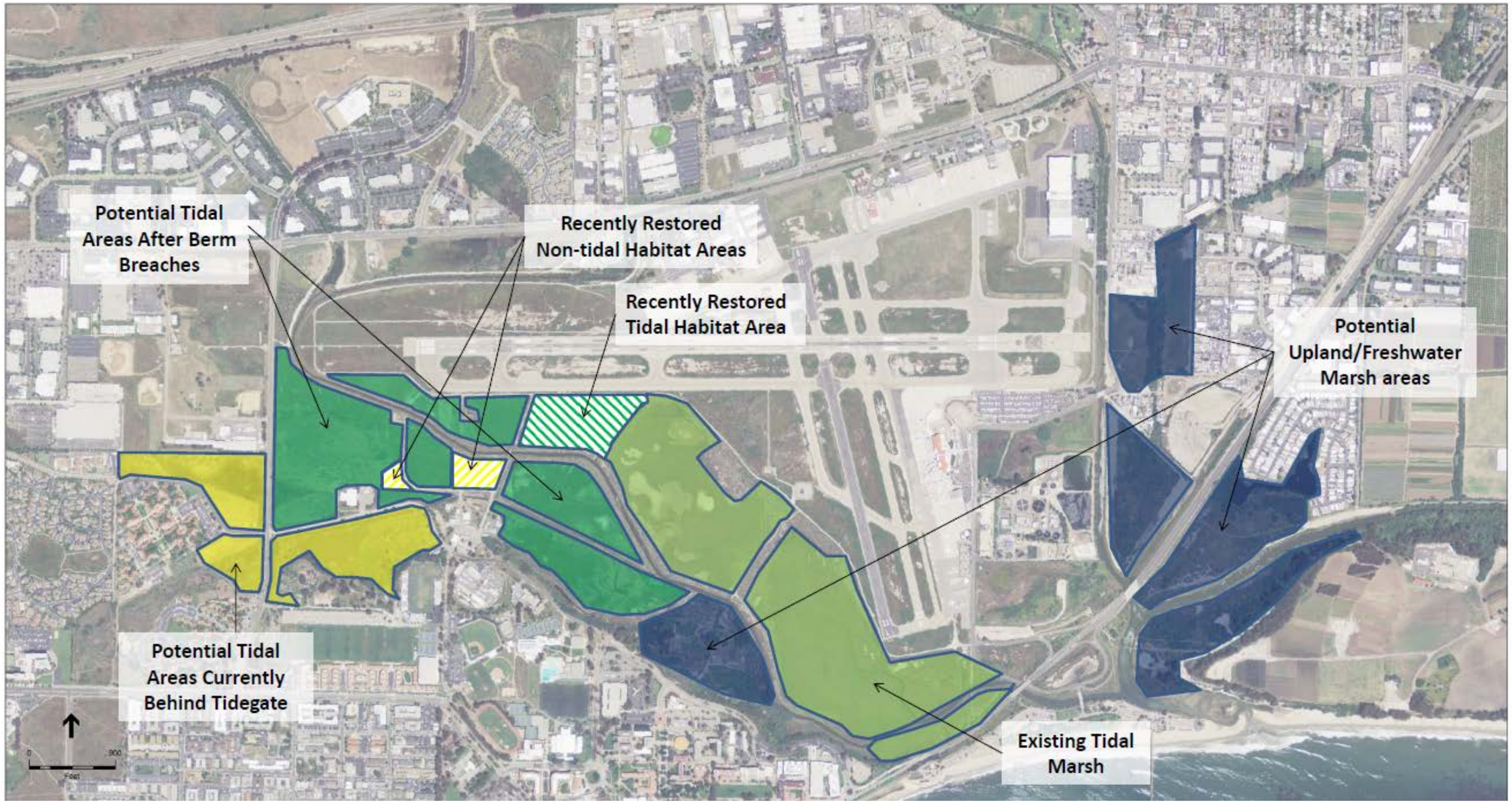

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Figure 3.11 – Topographic Adjustment Measures

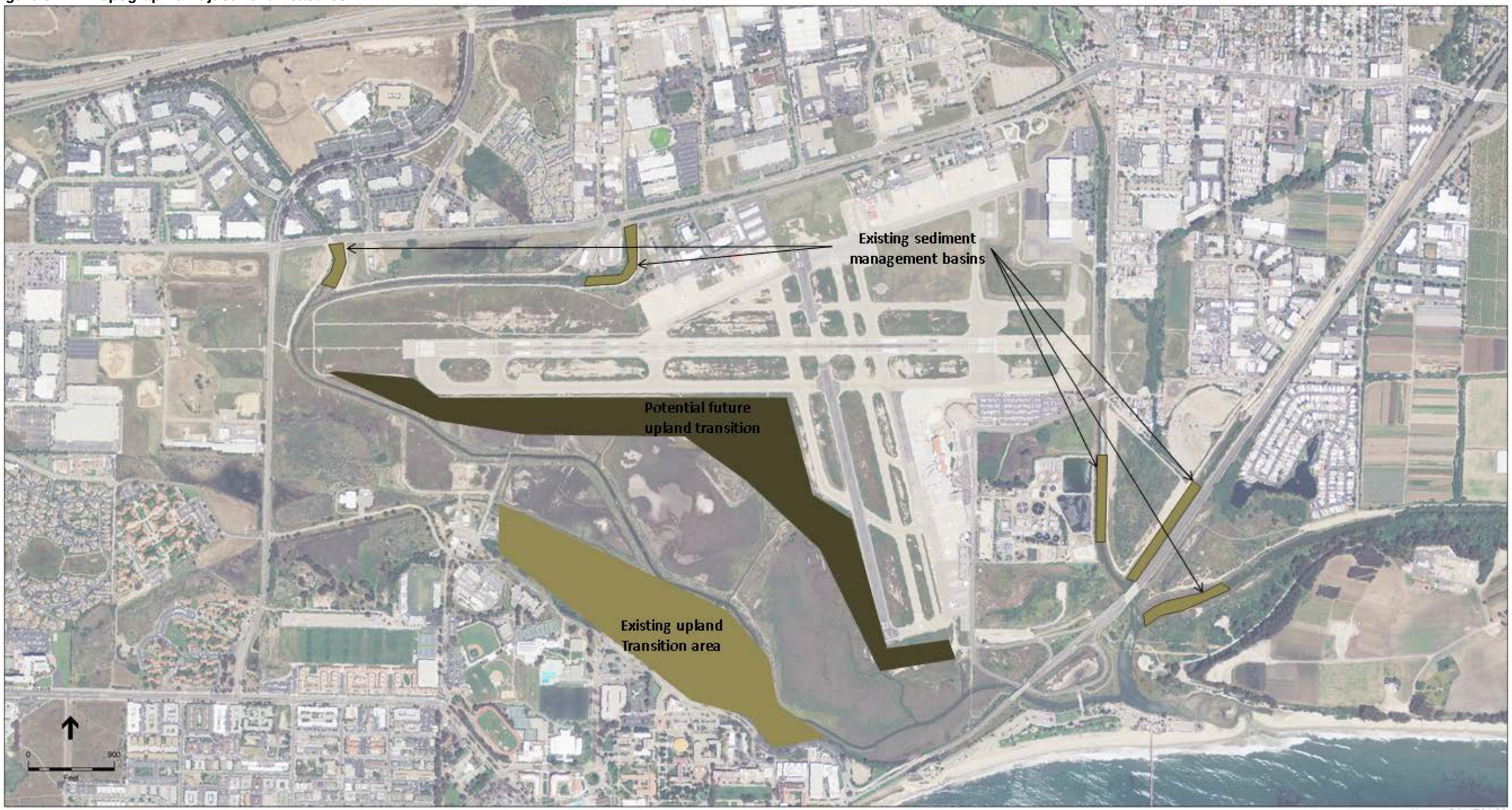

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Table 3.6 Comparison of Adaptation Measures for Tidal Wetlands and Prerequisites for Implementation of Individual Measures

Adaptation Strategy	Individual Adaptation Measure	Benefits	Drawbacks	Sea Level Rise Accommodation	Relative Cost	Estimated Lead Time and Prerequisite
No Action	No managed inlet breaches, emergency inlet breaches only as need to protect the airfield and other low-lying areas from flooding.	• More mudflat in dry period. • Potential benefits to tidewater goby and steelhead.	• Potential loss of tide dependent species, functions and ecosystem services. • Specifically loss of Belding Savanah Sparrow (BSS) nesting habitat. • Vector control and bird strike issues may lead to intervention.	Limited by infrastructure constraints. Little opportunity for habitats to transgress upslope.	$	*Status quo*
Inlet Management (Managed Breaches of Beach Berm)	Manage inlet breaches to maintain open tidal conditions; fully tidal.	• High tidal function. • Increased tidal range and prism. • Increased circulation – water quality benefits. • Supports widest range of tide dependent species, functions and ecosystem services. • Maintain and enhance BSS habitat. • Minimizes vector control and bird strike issues.	• Requires management and resources to breach. • Needs to account for needs of special status species.	Limited by infrastructure constraints. Potential to transgress upslope because of tides.	$$	Done before, Short lead time– but needs regulatory discussion.
Control Hydrology Option #1	Breach channel levees and remove berms along tidal basins south of airport.	• High tidal function. • Increased tidal prism. • Increased biocomplexity and diversity. • Connection to uplands. • Increased habitat patch size and connectivity between patches. • Supports widest range of tide dependent species, functions and ecosystem services. • Maintains and enhances BSS habitat. • Minimizes vector control and bird strike issues.	• Potential loss of seasonal ponds used by waterfowl and wading birds.	Limited by infrastructure constraints. Potential to transgress upslope because of space and connectivity.	$$	Planning, permits, resources Precursor – needs inlet management.
Control Hydrology Option #2	Modify tide gate to allow tidal flows in western basins.	• Increase tidal function. • Increased tidal prism. • Increased biocomplexity and diversity. • Connection to uplands. • Increased parcel size and connectivity between parcels. • Supports widest range of tide dependent species, functions and ecosystem services. • Maintain and enhance BSS habitat. • Reduces vector control and bird strike issues.	• Lose freshwater habitat. • Potential loss of seasonal ponds used by waterfowl and wading birds. • Limited by culverts and gates. • Low-lying, poorly drained areas may become shallow ponds – potential to attract ducks. • May increase flood risk to existing development.	Limited by infrastructure constraints. Increased space balanced by hydraulic controls in place.	$$	Needs preparation of infrastructure before modification. Precursor – needs inlet management.
Sediment Management	Beneficial reuse of sediment from flood control sediment basins. Encourage natural sedimentation by reconnecting creeks to marshplain.	• Natural process. • Reconnects water, nutrients, fish and sediment to the marshplain. • Balance accretion of marsh with sea level rise. • Creation of natural marsh levees adjacent to channels to increase heterogeneity.	• Less control of accretion location. • Potential sedimentation in the Slough reducing conveyance, also requires measures to increase tidal prism. • Large event may convert marsh to high marsh ahead of sea level rise.	Limited by infrastructure constraints. Increases resiliency of marshes to sea level rise.	$$	Need permits, sediment quality, needs removal of berms first Precursor - needs inlet management and berm removal.
Grade Topography	Selectively grade and place material to create upland areas to improve potential for upland marsh transgression with sea level rise.	• Immediate benefit of restoration of upland habitat. • Transgression of marsh habitat with sea level rise. • Upland habitat can be planned to maximize contribution to ecosystem.	• Infrastructure constraints. • Best marsh habitat in Slough not necessarily adjacent to upland opportunities. • Conversion of existing upland habitat.	Limited by infrastructure constraints. Increase adaptive capacity of marshes.	$$$	Precursor – needs inlet management.
Easement on Adjacent Uplands	Opportunistic use of new open space.	• Potential future benefits of restoration of upland habitat or wetland transgression. • Connectivity of adjacent parcels.	• Not many opportunities and not located in best places. • Cannot control timing.	Limited by infrastructure constraints. Increase adaptive capacity of marshes.	$-$$$	Precursor – needs inlet management.

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3.2.2 Infrastructure Adaptation Measures

There is a broad range of infrastructure present in the study area, some of which has been identified as vulnerable to rising sea levels. Measures that promote the protection of vulnerable infrastructure have been identified and are presented in Appendix F. These measures are classified according to the estimated ability of each to reduce the vulnerability of exposed infrastructure in terms of the amount of sea level rise accommodation that each may offer. These estimates are based on a conceptual understanding of the physical response of the Slough system to the various strategies, as well as feedback received from local planners, city and regional government agencies, utility representatives and past project experience.

For each measure, anticipated challenges related to the implementation of that strategy are also listed. The listed challenges were identified through discussions with local agencies and stakeholders. These lists are not necessarily all-inclusive and unanticipated challenges may arise during project implementation.

Each measure is categorized based on the anticipated level of expense and time to implement each strategy. These categorizations are based on discussions with the agencies responsible for the upkeep and maintenance of the various infrastructure assets. These categorizations are intended to inform the relative comparison of different strategies for planning purposes. These categorizations not intended to represent engineering cost estimates or assessments of project feasibility.

The Santa Barbara Airport stands out as the largest and most vulnerable facility within the Ecosystem. The Airport faces two primary vulnerabilities:

1. Flooding of the low-lying sections of runways and taxiways (see photos in Section 2, Background); and
2. Failure of the storm-water management system during high Slough water levels.

In addition, there are other low-lying areas where specific measures that could be implemented in the short-term to raise the maximum water surface elevation. These include not just specific assets but also roads that provide access to those assets such as the Airport Terminal, GSD plant, and Goleta Beach. Adaptation measures to address these vulnerabilities that appear likely to provide the most immediate benefits include:

Raise Airport Runways/Taxiways

The 2010 Coastal LiDAR shows that portions of the taxiways are located at elevations as low as 9.5’ NAVD88 making them prone to flooding under existing closed Slough inlet conditions. The runway low point is at 10.5 feet NAVD. Significant flooding of the runways and taxiways occurred during the 1969 and 1995 storm events. As sea levels rise the tarmac will flood more frequently, creating the potential for more frequent disruption of Airport operations.

One strategy for reducing the risk of flooding at the Airport is to increase the elevation of the tarmac by applying thicker pavement during the regular resurfacing of the runways, taxiways and safety areas. Applying thicker pavement at regular intervals over the lifetime of the Airport may significantly reduce the potential for flooding on the tarmac. This adaptation strategy has considerable potential effectiveness for the near term, as it can be readily incorporated into regular Airport capital improvement plans. This will also require the elevation of infield and overrun areas, some of which provide some habitat. The effectiveness of this strategy over the long-term may be reduced due to increased ground settlement as the thickness and therefore the weight of paving increases.

Improve the Airport Stormwater Management System
The network of storm drains, pipes and outfalls which currently convey storm water for the Airport tarmac and infields into Goleta Slough is a gravity driven system that drains into the Slough at elevation 5'. As water levels rise above 5' either from closed Slough or sea level rise, the stormwater system becomes increasingly ineffective. As the water level within the Slough increases, this could lead to ponding on the infield areas and eventually the runways and taxiways. Elevated Slough water levels may occur due to fluvial flows during storms, inlet closure, high tides and/or extreme wave events, and will occur more frequently under future sea level rise conditions.

Airport planners should anticipate implementing improvements to the storm water system within the near term in order to avoid disruption of Airport operations. The necessary level of improvement will depend on the future management of the Slough inlet, and may include improvements to the tide gates; the installation of swales, basins or cisterns to provide increased retention capacity; and/or the installation of pumps to provide increased drainage capacity.

Improve Flood Protection/Implement Land Use Changes at the Placencia Neighborhood
The neighborhood near Placencia Street on the east side of the Airport contains the most vulnerable commercial and residential buildings within the Goleta Slough plan area. The access road to this neighborhood floods under existing conditions when Slough water levels approach 9 feet. This area will flood more frequently over time, potentially resulting in property damage and water quality impacts due to the increased likelihood of sewer overflows.

Eventually more frequent flooding will make this area less habitable and more difficult to manage unless there are improvements to the existing flood control berms and levees. In addition, some retrofitting of the sewer lines may be required to seal the manhole covers and minimize the intrusion of Slough water into the sanitary sewer system. City Public Works planners should determine whether improved flood protection is feasible for this neighborhood. Alternately, if enhanced flood protection is not feasible, the City of Goleta may want to pursue opportunities to change the existing land use zoning in this neighborhood to open space/habitat in order to minimize future flood impacts.

3.2.3 Sea Level Rise Adaptation Strategies
The measures described in the preceding two sections describe near-, mid- and long-term habitat and infrastructure adaptation measures that need to be developed into a comprehensive strategy that includes specific thresholds for triggering actions. These thresholds may be the amount of sea level rise and the frequency of inundation, or they may be related to opportunistic structural changes such as capital improvement plans. To be effective, this strategy needs to move away from piecemeal habitat restoration and have a coherent vision and implementation plan. In addition, the strategy needs to accommodate the uncertainty inherent in the management of climate change risks.

To move forward in developing a vision of the future habitat, protection of vulnerable infrastructure and a plan for implementation will require a feasibility study of measures in order to develop priorities for implementation. This should be a next step together with the identification of some smaller habitat restoration opportunities that can serve as demonstration projects while funding and land use rights are secured to allow for larger scale habitat enhancements.

3.3 Goleta Slough Inlet Management

Since the mid-1990s, the Santa Barbara County Flood Control District (SBCFCD) had maintained the Slough inlet for open conditions through routine artificial breaching of the beach berm within 2 weeks of inlet closure. This practice was intended to reduce the flood risk to infrastructure adjacent to the Slough, and to avoid stagnation and thus improve water quality. The result of this management action is that it also supported the presence of tide-dependent species and habitats in the Slough. This Section discusses the key role that inlet management plays in shaping that habitats and function of Goleta Slough, and presents the results of a technical study conducted by ESA in 2015 to evaluate patterns of breaching and closure of the lagoon inlet under natural and managed conditions.

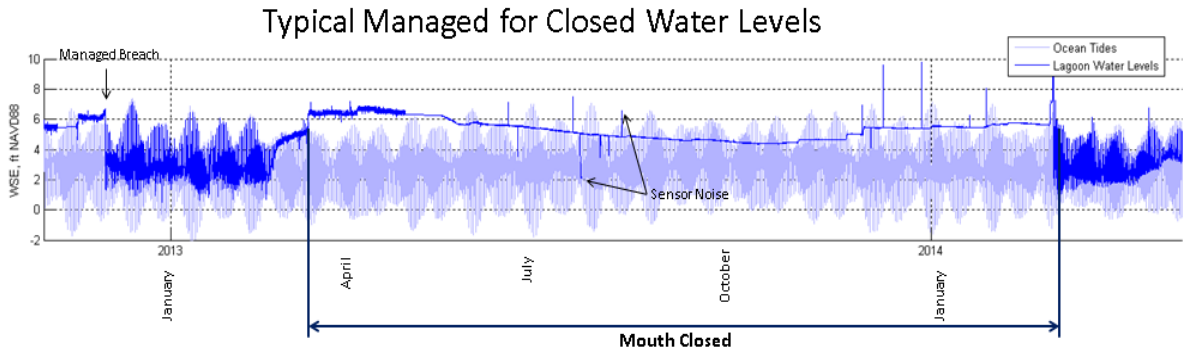
The Flood Control District's (FCD) *Final Subsequent EIR for Maintenance Activities in the Goleta Slough* (2010) that addresses maintenance activities, indicates that from 1994 through 2009 the inlet was opened 28 times or an average of just less than two openings per year. The inlet was opened three times in 1994, 2004 and 2009. Managed breaches were typically conducted using mechanized earth-moving equipment within 2 weeks of the Slough inlet closure.

In 2013, the National Marine Fisheries Services produced a draft Biological Opinion regarding the presence of steelhead within Goleta Slough, which led to the FCD stopping the managed breach program. In 2014, the Airport began studying the issues associated with Slough inlet management, with a final report expected in 2015.

3.3.1 Recent Management Actions and Flooding

When the Slough inlet closed in the spring of 2013 it was not artificially breached, and instead the Slough was allowed to remain under closed conditions for nine months until the imminent threat of flooding lead to an emergency inlet breach on March 1, 2014. The observed water levels in the Slough during this period are shown in Figure 3-12.

Figure 3-12 Ocean and Slough water levels between November 2012 and April 2014.



The fall and winter of 2013 were unusually dry. Between September 1, 2013 and February 1, 2014 the precipitation gage at the Goleta Fire Station recorded only 4 minor rain events, resulting in a combined total of 1.1 inches of cumulative precipitation. This is significantly less than the average rainfall for these months (the mean cumulative precipitation at the Goleta Fire Station for September through January is 9.8 inches). One consequence of this below average rainfall was that the Slough inlet remained closed for nearly 9 consecutive months. During this period wave action caused the beach berm to grow to an elevation exceeding 10 feet NAVD. This 10+ foot beach berm crest elevation at the Slough inlet is consistent with beach berm elevations measured elsewhere along the Santa Barbara County coastline. Anecdotal reports suggest that this was one

of the highest beach berm elevations observed at the Goleta Slough inlet since managed breaching of the Slough inlet began.

On February 27, 2014 the first major rains of the season arrived, with 3 inches of rain falling over 48 hours between February 27 and 28. This rain event led to modest stream discharges (e.g., 600 cfs measured at Atascadero Creek gage). Water levels within the Slough increased steadily, and approached 9 feet NAVD during the night of February 28th. Water levels were still rising when an emergency managed breach was conducted by FCD on the morning of March 1, 2014.

The elevated water levels within the Slough were attributed largely to the high beach berm at the time of the storm, which formed a dam at the Slough inlet and caused water to pond within the Slough. The continued rainfall during the days following the emergency breach suggests that the Slough inlet likely would have breached naturally during the falling tide on Marsh 1st, however by that time the rising water levels within the Slough may have flooded parts of the airfield and low-lying neighborhoods adjacent to the Slough.

Figure 3-13a shows the marsh south of the airfield during a typical high tide. The water level is approximately ~6.9ft NAVD and the water surface can be seen between patches of pickleweed and in the salt panne areas, but the top of the vegetation remains clear above the water surface. Figure 3-13b shows the same area of marsh on February 28, 2014. In this image, the high water level covers the entire marsh, submerging all but the tallest marsh vegetation. This image also illustrates the airfield relative to the flooded marsh. At the time of the photo water levels were approximately 1ft below the elevation of the airport tarmac.

Figures 3-13 a & b Photos comparing typical high tide water levels with peak water levels prior to March 1, 2014 breach.

This event was a dramatic demonstration of how a high naturally equilibrated beach berm can cause elevated water levels within the Slough during moderately sized rain/stream flow events. During a major rain event we would expect higher stream flows and a more rapid rise in Slough water levels. Under such a scenario, while the flows may naturally breach the lagoon inlet, there may also be a shorter window to mobilize earthmoving equipment for an emergency breach before damaging flooding occurs or the elevated Slough water levels cause the sand bar at the inlet to naturally breach.

3.3.2 Habitat Implications

When the inlet is open, Goleta Slough experiences muted tidal conditions, with the tide range varying between 0 to 4 feet depending on the size and elevation of the Slough inlet. In such

conditions, different areas within the Slough experience varying frequencies of inundation depending on their elevation. The varying water surface elevation results in a diverse range of hydrologic conditions that support a variety of tidal wetland habitats.

Figure 3-14 shows the inundation-frequency curve for the Slough for open inlet conditions and identifies the typical elevation range where various wetland habitat types are expected to be found under full tidal conditions. Figure 3-15 shows the expected spatial distribution of these habitat types mapped across Goleta Slough based on the existing ground surface elevation (2010 NOAA Coastal LiDAR). This figure illustrates the potential extent of various habitat types within the Slough if existing hydraulic restrictions (berms, tide gates, etc.) are removed, and reveals opportunities for the restoration of additional tidal habitat by improving hydraulic connectivity. In particular, the areas that are at elevations that would be suitable for the establishment of marsh vegetation include:

- Basins southwest of the Airport runway which are separated from the Los Carneros creek channel by large berms
- Areas currently behind the tide gate near the Goleta West Sanitary District pump station

These areas are not currently high functioning salt marsh because these areas have poor hydraulic connectivity with the rest of the Slough.

Figure 3-14 – Inundation Frequency for Open Slough Inlet

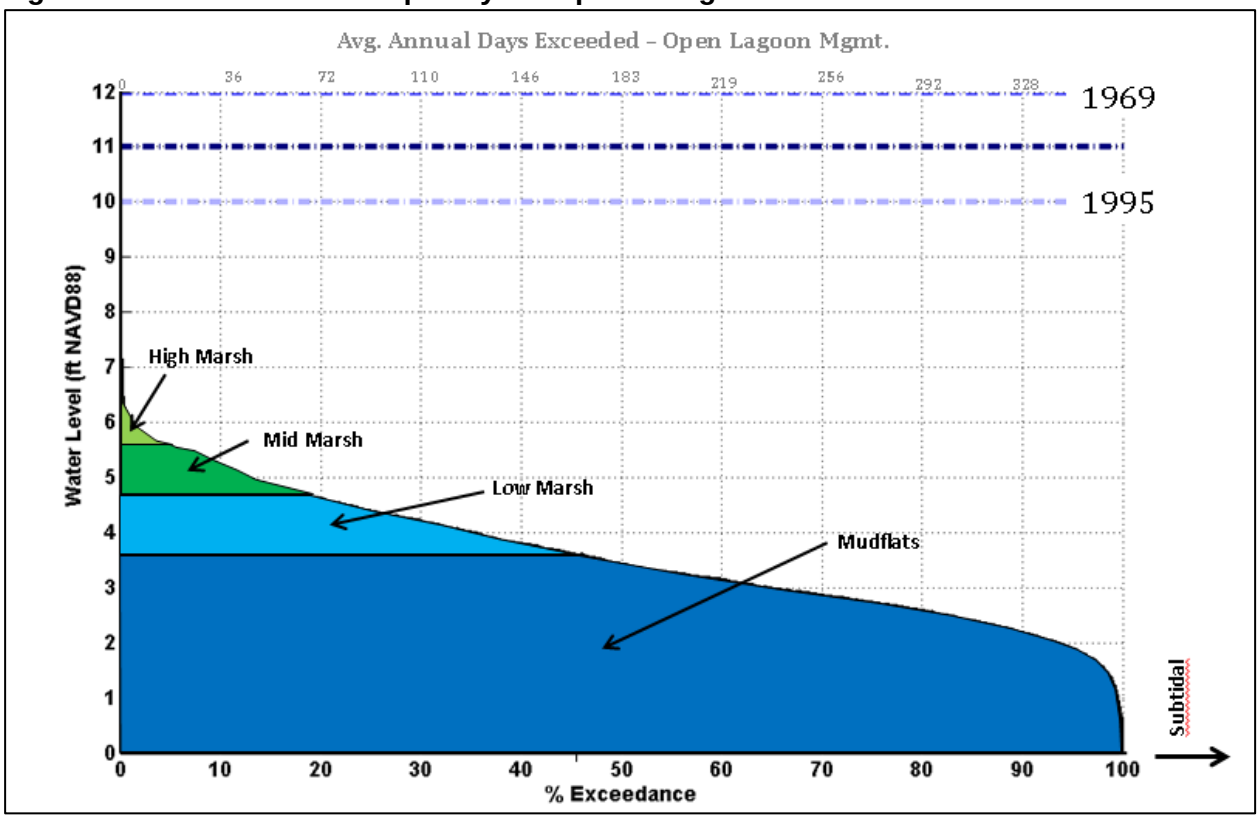


Figure 3-15 – Spatial Habitat Distribution for Open Slough Inlet

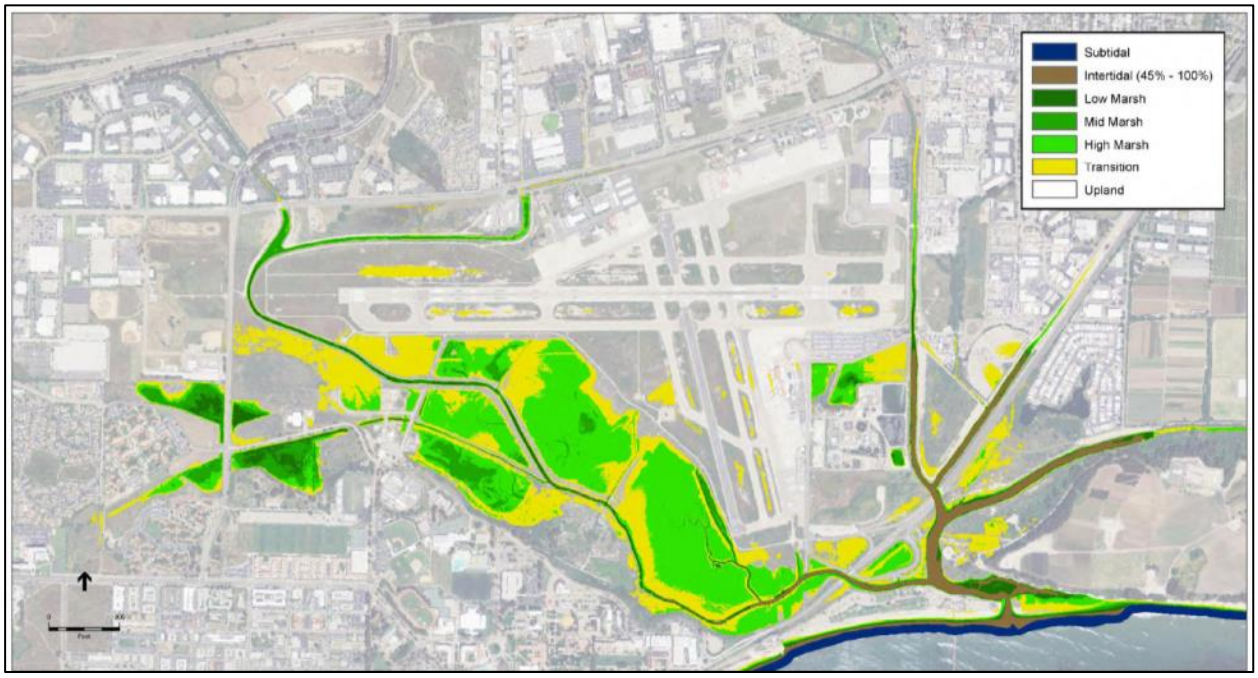


Figure 3-15 shows the inundation frequency curve and habitat elevations for closed inlet conditions. When the inlet is closed, the Slough does not experience tidal variations in water levels. Instead water levels within the Slough are driven primarily by watershed inflows, evaporation, and seepage through the beach berm. During the summer months there is minimal inflow from the watershed, and water levels within the Slough remain relatively low, varying between 4 and 5ft NAVD. During the winter months inflows from the watershed increase which leads to increased water levels within the Slough, ranging from 5 to 6ft, and rising up to more than 8ft immediately after major rain events.

The lack of tidal variation and change in inundation regime within the Slough creates a very narrow elevation range for most wetland plant species. Consequently, with the Slough inlet closed, mudflats and uplands become the most favored habitat types. Figure 3-16 shows the expected extent of habitats within the Slough if it were maintained for closed conditions for an extended period of time. The closed Slough inlet would block tidal action, resulting in significant shift in the habitat distribution within Goleta Slough. Closed inlet conditions favor a binary habitat structure, where most existing wetland areas convert to uplands as they would no longer be inundated during high tides. The remaining areas of marsh would convert to seasonally inundated mudflats, which would be dry during the summer months, but then would be submerged for most of the rainy season. Only a narrow band of tidal wetland vegetation would survive under sustained closed Slough inlet conditions. The extensive mudflats and open water areas at nearby Devereux Slough, located 2 miles west of Goleta Slough, are a good example of the expected habitat conditions that are expected to become prevalent at Goleta Slough if the Slough inlet were to remain closed for a significant portion of the year.

Figure 3-16 – Inundation Frequency for Closed Slough Inlet

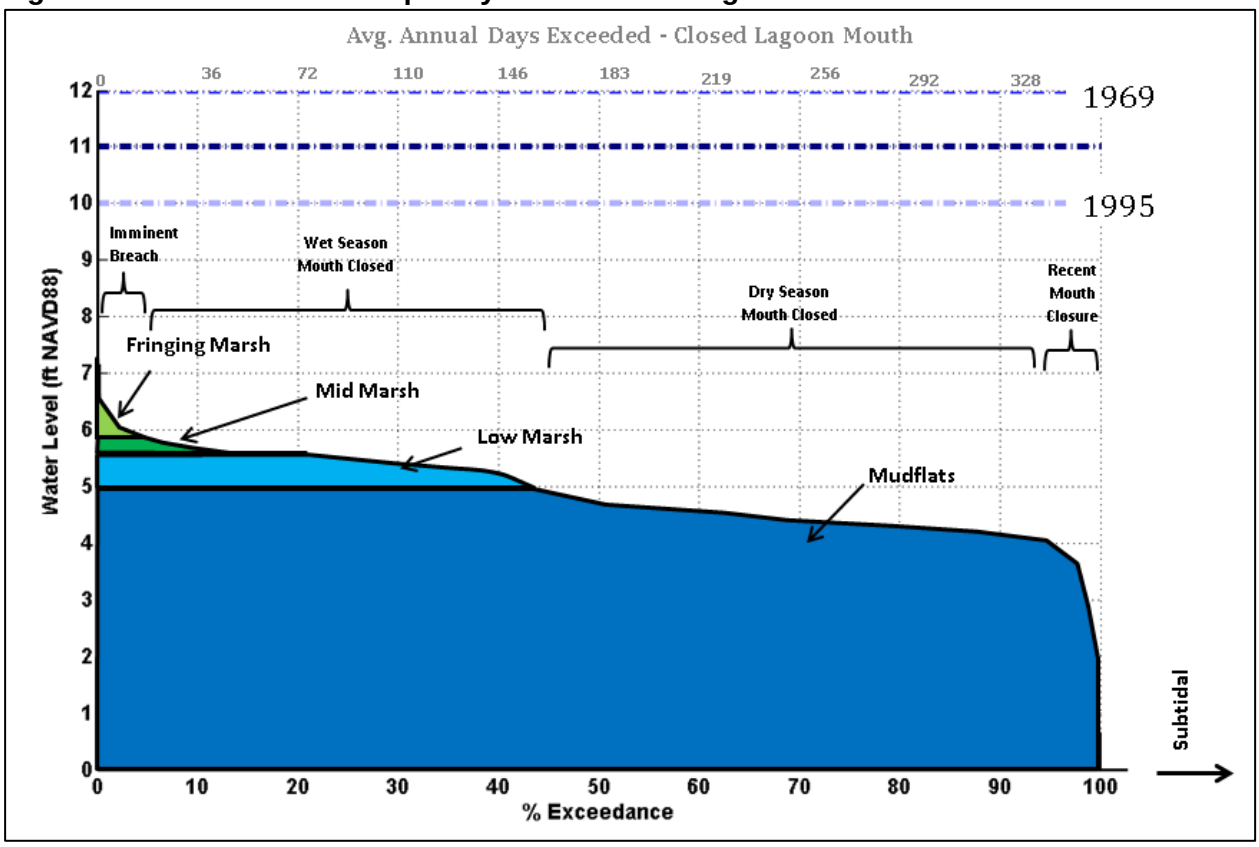
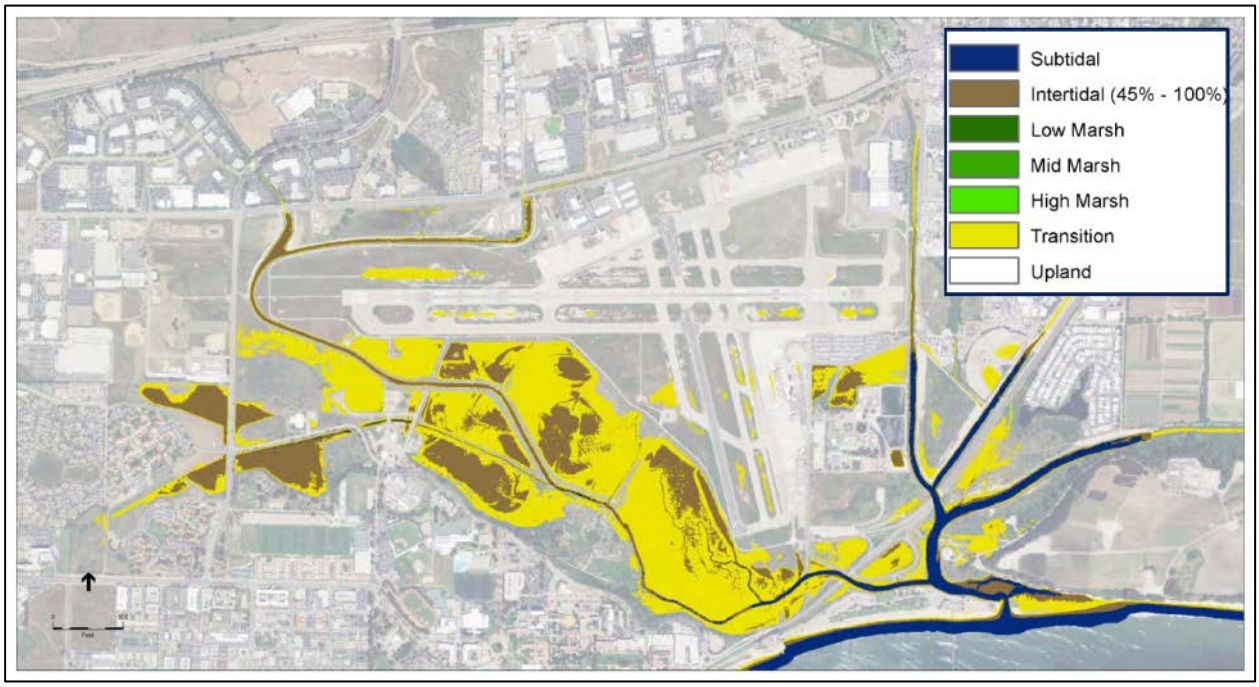


Figure 3-17 – Spatial Habitat Distribution for Closed Slough Inlet



3.3.3 Goleta Slough Inlet Modeling Study

This section presents the results of the Goleta Slough Inlet Modeling Study, which was conducted by ESA in 2015. The goal of this study is to apply a Quantified Conceptual Model of lagoon dynamics to evaluate and compare several potential lagoon management strategies under existing conditions and for future sea level rise scenarios. The evaluation of changes in watershed hydrology due to climate change was outside the scope of this inlet modeling study. Expected changes in watershed runoff may have a significant impact on dynamics of the lagoon inlet, including the frequency of breach and closure events, and future investigation of this process is recommended in the near term.

Appendix G includes additional background and technical detail related to the Quantified Conceptual Model used for this analysis.

3.3.4 Quantified Conceptual Model (QCM)

A Quantified Conceptual Model is a numerical model that attempts to simulate the evolution of complex physical systems through the use of numerical parameterizations of each of the key processes that control how that system behaves. The QCM used for this inlet modeling study was first developed by ESA to evaluate the Russian River lagoon inlet. The model has since been applied to several other lagoons along the California Coast, including Devereux Slough and Mission Creek Lagoons.

The coastal lagoon QCM used for the inlet modeling study represents the key processes which control water levels within the Slough. These include the growth and erosion of the beach berm due to waves, tidal scour of the inlet channel, and scour due to stream flows; inflows to the lagoon due to precipitation and watershed inputs; and outflows from the lagoon due to evaporation, groundwater seepage, and flow through the lagoon channel. By tracking these several processes over time, the QCM can be used to predict water levels within the lagoon and to evaluate the periodic opening and closure of the lagoon inlet.

The QCM uses observed historic data to represent the influence of coastal and watershed processes on the lagoon. Key input parameters include:

- Near shore wave data derived from prior ESA studies at Goleta Beach
- Synthetic stream flow time series based on hydrologic analysis of the Goleta Slough watershed.
- Evaporation and rainfall data from CIMIS Station #94 (Goleta Foothills)
- Seepage estimated based on basic beach geometry, observations of beach sediment size, and nearby seepage studies.
- Beach growth rate parameters estimated from local observations of beach elevation

See the “The Inlet Quantified Conceptual Model” section of Appendix G for a detailed description of the model set-up, further detail documenting each of these input parameters, and a discussion of the limitations and uncertainties of the model results.

The QCM was validated based on observed water levels in Goleta Slough from 2010 to 2014. The aim of the validation process is to use the QCM to reproduce observed historic conditions as closely as possible, in order to establish confidence that the QCM produces a realistic representation of the physical system and to reveal potential shortcomings or limitations of the model. This period includes dry and wet years, as well as varying degrees of active lagoon inlet management. Several managed breaches are believed to have occurred during the validation

period: July 11, 2011, October 25, 2011, February 12, 2012, and March 1, 2014 (Andrew Bermond, pers. coms. 2014). For the validation scenario managed breaches were specified to occur on these dates in order to accurately model these events, since these breaches were not the result of natural physical processes, and therefore would not otherwise have been captured by the model.

Figure 3-18 shows the measured and modeled lagoon stage within Goleta Slough for the validation period.

The model was found to perform well during the simulation of the validation period. The model was found to accurately predict most breach and closure events, and produced predictions of lagoon water levels that generally matched the observed water levels. The model demonstrated minor deviations in the timing of breach events, and appears to slightly over estimate the rate of inlet closures during times when the lagoon experiences muted tidal conditions. There is no measured data tracking rates of outflow, wave over wash, beach seepage and evaporative losses at Goleta Slough, however modeled values were within the range of expectation based on observations of the lagoon system and measured values from similar lagoon systems.

The model appears to underestimate the depth of scour during large rain events, including the 2010 winter rains and the spring 2014 breach event, however it appears to accurately capture scour during moderate rain events. The model does show minor errors in the predicted timing of breach events, and appears to slightly overestimate the speed at which the lagoon inlet closes during times when the lagoon experiences muted tidal conditions. Such errors are to be expected given the difficulty in modeling a complex coastal system.

See Appendix G for a detailed discussion of model limitations and uncertainty.

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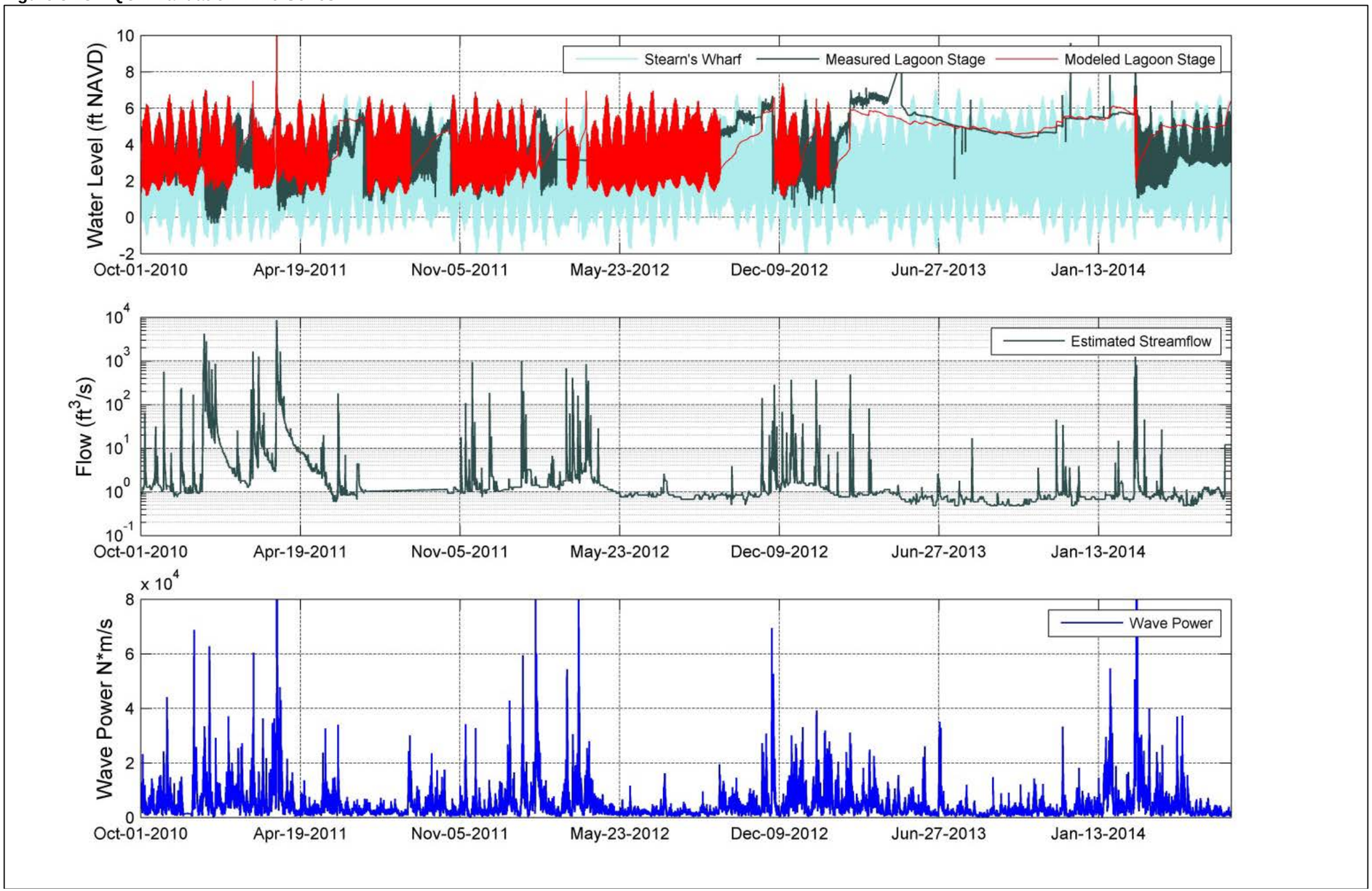
Figure 3-18 – QCM Validation Time-Series



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3.3.5 Modeling of Scenarios

The QCM was used to evaluate a range of potential future scenarios in order to provide additional understanding of the role that key processes play in driving lagoon dynamics, and to inform future lagoon management. These scenarios were developed in order to evaluate the following topics:

- **Changes to the Lagoon Storage Volume** - For these scenarios, the Stage-Storage relationship that is used to represent the volume of the lagoon was increased and decreased by +/-25% in order to represent the hydrodynamic impact of potential future projects that may cause alterations to the Goleta Slough landscape, changing the size of the lagoon. Additional sensitivity tests representing larger changes to the lagoon Stage-Storage relationship were also conducted in order to evaluate the sensitivity of the system to larger scale landscape alterations.

- **Sea Level Rise** - Sea Level Rise scenarios were developed by applying a vertical shift to the tidal boundary condition in order to represent +0', +1', +3' and +5' of sea level rise.

- **Inlet Management Practices** -The Inlet Management scenarios simulate mechanical breaches of the lagoon inlet whenever lagoon water levels within the lagoon exceed a pre-determined threshold elevation.

The QCM was used to model each scenario based on wave and watershed conditions observed during a continuous period spanning from 2010 to 2014. Results tracking the duration of closures and breach frequency were tabulated for separately for Wet (2011) and Dry (2013) years in order to highlight the range of variability which may occur due to year-to-year variations in precipitation.

3.3.6 Results

This section presents the key findings of the Inlet Modeling Study. See Appendix G for a detailed discussion of the study results and findings, as well as discussion of sources of uncertainty and limitations related to the modeling effort.

Testing the Sensitivity to Changes in Lagoon Volume

ESA has evaluated a set of model scenarios that test the sensitivity of the lagoon inlet to adjustments to the storage volume of the Slough. This sensitivity analysis evaluates the expected impact of large changes to the Goleta Slough landscape on the dynamics of the lagoon. These scenarios are representative of landscape-scale changes to the Goleta Slough topography, such as large-scale habitat restoration projects and major flood protection projects. The following are the key findings of this study related to storage volume adjustments:

- **Alterations to the Goleta Slough landscape** which increase the volume of the Slough are predicted to have two main effects on the lagoon inlet:
    1. An increased lagoon volume delays natural inlet breaches that are caused by watershed inflows due to the larger storage capacity below the breaching water level; and
    2. An increased lagoon volume delays the closure of the lagoon inlet due to increased tidal scour associated with the increased intertidal volume, also called "tidal prism".

- **Specific projects** can be designed to emphasize open conditions or closed conditions by adding or removing storage volume within certain elevation ranges. Storage volume added in the intertidal range enhances tidal scour, which encourages open conditions. Storage

volume added between the high tide elevation and the elevation of the beach berm encourages closed conditions by increasing the potential for ponding during rain events.

- **Decreasing the Slough volume by 25%** is predicted to cause a small increase in the percent of time that the lagoon inlet is open since the lagoon will breach more quickly during rain events, but it will also reduce tidal exchange and increase the likelihood of closure during dry conditions.

- **Increasing the Slough volume by 25%** is predicted to cause a small increase in the percent of time that the lagoon inlet is closed, since the larger lagoon will require a greater volume of watershed inflow in order to initiate a natural breach. A 25% increase in lagoon tidal prism was not found to cause a significant increase in tidal scour at the inlet channel.

- **Sensitivity analysis** suggests that increasing the tidal prism of the lagoon by ~600-800 ac-ft (+300-400% of the existing tidal prism) would result in an almost-always open system. Such an increase in lagoon tidal prism may greatly reduce the frequency of mechanical breaches required in order to achieve flood protection and habitat goals. There does not appear to be sufficient open space available near Goleta Slough to achieve this level of tidal prism enhancement through the creation of intertidal habitat without significant land use changes.

- **Smaller increases in lagoon volume**, on the order of ~200-400 acre feet (+100-200% of the existing tidal prism) may increase the frequency of natural open conditions, but would still require intermittent lagoon inlet management to reduce the risk of flooding during closure events. This result suggests the potential for multi-benefit projects through the creation of new tidal wetlands in areas of the Slough that are currently diked off from tidal action.

- **Potential restoration -** Figure 3-10 identifies nearly 100 acres of undeveloped land adjacent to Goleta Slough that could be potentially restored to full or near full tidal action. Constructing intertidal habitat on these parcels, combined with the expansion of the network of distributary channels in the Slough, could increase the tidal prism of the Slough by 200-300 acre-ft. This increase in tidal prism could shift the dynamics of the lagoon inlet toward more frequently open conditions; however, occasional inlet closure events would still be expected should these parcels be converted to intertidal habitat.

Testing the Sensitivity to Sea Level Rise

ESA has evaluated several scenarios that represent existing conditions and expected future conditions at the Slough based on projected rates of sea level rise. These scenarios consider conditions at the lagoon assuming no inlet management; see the “Inlet Management” section for scenarios that consider sea level rise and inlet management. The following are the key findings of this study related to sea level rise:

- Rising sea levels are predicted to increase the elevation of the beach berm, which will in turn increase the storage volume of the lagoon and decrease the likelihood of the lagoon breaching naturally during small and medium sized rain events.

- For small amounts of sea level rise (up to +1 foot) the model results indicate an increased likelihood of extended periods of inlet closure, especially during dry years (assuming no managed breaches occur) relative to existing conditions.

- If the lagoon inlet is not managed, model results predict an increase in the duration of ponded conditions at the lagoon for sea level rise up to +1 foot. The increased occurrence of ponding causes predicted average water levels within the lagoon to rise faster than the rate of sea level rise under unmanaged conditions for up to +1 foot of sea level rise.

- As sea levels continue to rise, eventually the tidal prism of the lagoon will grow large enough that the lagoon channel will become self-scouring. At this point the lagoon will transition to an almost always open system, with water levels controlled primarily by the tide elevation. Model results indicate that the lagoon inlet will almost always be open once sea levels rise +3 feet above existing conditions, with or without inlet management.

Testing Sensitivity to different Inlet Management Scenarios
ESA has evaluated several scenarios representing potential future inlet management strategies where the lagoon inlet is mechanically breached by excavating a shallow channel whenever water levels within the lagoon exceed a pre-determined threshold elevation. Several threshold elevations have been evaluated:

- El. 6.5' NAVD (1.25' above MHHW) – An elevation low enough to avoid ponding on the existing pickleweed marshes.
- El. 7.5' NAVD (2.25' above MHHW) – An elevation which would allow extended ponding on the marsh plain while providing ~1.5 feet of freeboard before existing infrastructure is threatened.
- El. 9.0' NAVD (3.75' above MHHW) – The elevation above which significant extents of existing infrastructure becomes threatened.

It was assumed that these management threshold elevations will shift upwards over time, tracking rising sea levels. The following are the key findings of this study related to these management strategies:

- Existing infrastructure near the Slough is at risk of flooding when water levels in the Slough reach approximately El. 9.0' NAVD. Model results indicate that the managed breaching threshold elevations of 1.25 and 2.25 feet above MHHW (El.6.5' and 7.5' NAVD) greatly reduces the frequency of occurrence of water levels above El. 9.0' NAVD in the Slough for scenarios with +0 and +1 feet of sea level rise.

- Model results for managed breaching at 3.75' above MHHW (El. 9.0' NAVD) and for unmanaged conditions showed the regular occurrence of water levels greater that El. 9.0' in the Slough, indicating a significant risk of inundation of nearby infrastructure under these scenarios.

- Model results indicate that managed breaching at any elevation cannot prevent the occurrence of water levels in the Slough above El. 9.0' NAVD for scenarios with +3 and +5 feet of sea level rise. The predicted frequency of occurrence of elevated water levels within the Slough continues to increase as sea levels rise.

- Sensitive pickleweed marsh habitat in the Slough may become degraded if inundated (water levels >7.0' NAVD) for an extended duration. Model results indicate that managed breaching with threshold elevations at 1.25 and 2.25 feet above MHHW (El.6.5' and 7.5' NAVD) can greatly reduce the frequency of occurrence of water levels above El. 7.0' NAVD relative to unmanaged conditions, both for existing sea levels and for scenarios with +1 feet of sea level rise.

- Based on these results, we conclude that active inlet management is likely to be a viable strategy for achieving flood protection and habitat goals in Goleta Slough during the short- to medium-term for conditions on the order of +1 foot of sea level rise. The model results indicate that inlet management will become less effective at achieving flood protection and habitat goals under conditions with +3 or more feet of sea level rise.

- The model results indicate that the selection of a lower threshold elevation results in an increase in the number of predicted managed breaches, and a corresponding increase in the frequency of open lagoon conditions.

3.3.7 Recommendations

Based on the results of the Inlet Modeling Study, we offer the following recommendations to help guide future planning actions in the Goleta Slough:

- We recommend the development and implementation of a long-term management plan for Goleta Slough which clearly and specifically articulates goals and objectives for habitat management, land use and flood protection.

- The QCM results suggest that flood protection can be achieved under a range of managed breach thresholds (e.g.. 6.5' and 7.5' NAVD). We recommend further refinement of the proposed mechanical breach thresholds to achieve optimum benefits for the local ecology.

- The QCM results do not predict the occurrence of elevated water levels above El. 6.5' NAVD during the summer months for scenarios with +0 and +1 feet of sea level rise (with or without inlet management). This finding indicates that summer time pumps/siphons are unlikely to be needed under typical conditions.

- Long-term plans for the Goleta Slough region should anticipate the decreasing effectiveness of inlet management as a management tool for achieving flood protection and habitat goals as sea level rises reaches +3 feet.

- Long term plans for the Goleta Slough area should incorporate adaptation strategies that anticipate significant increases in lagoon water levels and near-continuous open-lagoon conditions by the end of the century.

- We recommend additional study to evaluate the feasibility of large-scale landscape shaping and to evaluate specific opportunities for multi-benefit projects for habitat enhancement, restoration and lagoon management. We recommend that the evaluation of potential project alternatives include a refined analysis of impacts on local channel hydraulics and lagoon inlet dynamics.

- We recommend that future studies include a statistical analysis of coastal and hydrologic processes in order to better characterize the expected frequency occurrence of extreme conditions including prolonged droughts, El Niño and extreme rain/flood events.

- Finally, while the Inlet Modeling Study has not considered the impacts of climate change on watershed inflows and evaporation rates, these impacts may be significant in shaping future conditions at Goleta Slough. We recommend that future studies evaluate the projected changes in hydrologic conditions and the potential impacts of these changes on water levels and breach and closure patterns at the lagoon.

In addition, we encourage local planning agencies to continue data collection efforts to enhance the understanding of the physical processes which shape Goleta Slough. In particular, we feel that the following monitoring actions would provide highly valuable data for refining the QCM model:

- Continued monitoring of water levels within the Slough

- Regular surveys of the elevation of the beach berm and the dimensions of the lagoon channel. Survey data collected immediately before and after the lagoon inlet breaches is expected to be most useful for continued model refinement.

- Documentation of future managed and natural breaches, including timing of the breach, excavated channel width and depth, and the timing of future lagoon inlet closures.

We hope that these findings and recommendations are informative for the development of future inlet management practices and local planning efforts. Goleta Slough is a unique natural resource that provides great value to local flora and fauna and to the Goleta community. By continuing to improve our understanding of this complex and vibrant system we can work to develop management practices that enhance the ecosystem while allowing for the protection of nearby infrastructure. In this way the Slough may continue to benefit the Goleta community for present and future generations.

PART 4
GOALS, POLICIES AND ACTIONS

4.1 1997 GSEMP Goals, Policies and Actions

The 1997 *Goleta Slough Ecosystem Management Plan* included goals and policies that were derived from local policy documents including the City of Santa Barbara's Airport/Goleta Slough Local Coastal Plan (LCP), Santa Barbara County's LCP, the Goleta Valley Community Plan, and UCSB's 1992 Long Range Development Plan. Most of these documents have been updated since 1997 and/or are being updated. The City of Goleta incorporated in 2002 and the City's General Plan/Coastal Land Use Plan was adopted in 2006. In 2015, the City of Goleta is drafting a Local Coastal Program for submittal to the California Coastal Commission with certification anticipated in 2016. The LCP will include a sea level rise vulnerability assessment and related climate adaptation policies/regulations. The City of Santa Barbara and County of Santa Barbara are also updating their LCPs, including incorporating preliminary sea level rise and climate change information.

The original 1997 policies and policy documents discussed above serve as the foundation of the revised goals, policies and actions included in this section. Relevant policies from local jurisdictions' policy documents have been updated and are listed in Appendix C, Policies from Relevant Jurisdictions.

Based on these 1997 policy documents and the goals of the Committee, the four primary goals identified in the 1997 GSEMP were:

1997 GSEMP Goals

ADMINISTRATIVE FRAMEWORK - Provide an administrative framework for the adoption of GSEMP, through cooperative interaction between landowners, public interest groups, responsible agencies & jurisdictions. Compatibility with surrounding land uses must also be considered in the review of plans & projects.

PROTECTION AND MAINTENANCE OF EXISTING RESOURCES, FUNCTIONS AND VALUES – Protect and maintain the natural diversity of species, habitat types & Ecosystem functions through protection of physical processes that naturally maintain these resources.

EDUCATION, RESEARCH AND PUBLIC ACCESS – Promote the Ecosystem's research and public educational and recreational opportunities consistent with protection of the Slough's functions and values and Airport safety, operations and facilities requirements.

RESTORATION AND ENHANCEMENT OF HISTORIC RESOURCES, FUNCTIONS AND VALUES – To the maximum extent, enhance and restore the Slough's natural diversity of resources, habitats, physical processes and functions that have been lost or degraded, through enhancement and restoration of natural self-sustaining processes.

4.2 Status of 1997 Goals, Policies and Actions

Many of the goals, policies and actions in the 1997 GSEMP have been implemented or are ongoing. The status of the original 1997 policies and actions as of 2014 is provided in Table 2-1, Status of GSEMP Policies and Actions, 1997 v. 2014.

Table 4-1
Status of GSEMP Policies and Actions
1997 v. 2014

Policy/ Action #	***Summary of Policy or Action***	***Status – Change from 1997 to 2014***
ADMINISTRATIVE FRAMEWORK **Goal - Provide an administrative framework for the adoption of GSEMP, through cooperative interaction between landowners, public interest groups, responsible agencies & jurisdictions. Compatibility with surrounding land uses must also be considered in the review of plans & projects.**		
Policy A-1	**Implementation and updating of the GSEMP should be coordinated with GSMC. This should be accomplished through cooperation and collaboration…consistent with the Committee's advisory role.**	
Action A-1.1	Pursue formalization of GSMC to secure grants, mitigation funds & other monies to implement restoration & enhancement projects.	Ongoing - GSMC not formalized but have secured grants for restoration projects.
Action A-1.2	Pursue funding for the Committee to ensure that it can continue to meet …as needed to advise on proposed projects, plans, funding of improvements and mitigation measures & other related tasks that may affect the Ecosystem.	Ongoing - Since 1991, SB Airport has funded staff support for GSMC. Additional funding has been provided for the staff to manage the update of the GSEMP.
Action A-1.3	Pursue funding for a manager to oversee the implementation of the Plan & coordination with agencies, property owners & interested parties in the implementation of the Plan.	
Action A-1.4	In cooperation with public agencies & property owners, where feasible, pursue funding to map ESHA, including wetlands & other sensitive habitat within the Ecosystem.	Ongoing - This has been done by City of SB, City of Goleta, SB Co. & UCSB.
Action A-1.5	Update this Plan at five-year intervals or as needed.	Complete – Plan is being updated in 2014-15.
Policy A-2	**To the maximum extent feasible & where necessary to accomplish the goals of the Plan, the plans & policies of other jurisdictions should support this Plan.**	
Action A-2.1	Work with responsible agencies to amend their existing plans & policies where necessary to enhance conformity with this Plan.	Ongoing – GSMC comments on plans & policies to ensure they are consistent with GSEMP policies.
Action A-	Provide commentary on projects & their consistency with the	Ongoing – GSMC comments on projects relative to

2.2	goals of this Plan.	consistency with GSEMP.
Policy A-3	**Coordinate with jurisdictions & agencies on plans, policies, & mitigation measures, including those already adopted & proposed, that could potentially affect the Ecosystem.**	
Action A-3.1	Work with the Airport to resolve conflicts between policies & actions included in this Plan, particularly those relating to flooding & wildlife hazards, & the Airport's safety, operations & facilities requirements.	Complete/Ongoing – Tidal Circulation Study has allowed for increased tidal action; Airport Master Plan is expected to be completed in 2015.
Action A-3.2	Coordinate with agencies & other groups in the gathering & dissemination of technical data relating to the Slough ecosystem.	Ongoing – GSMC is involved in sharing technical data with others.
Action A-3.3	Work with agencies in reviewing, adopting or amending their plans that directly or indirectly affect the Slough to ensure they are compatible with this Plan. Encourage agencies to provide incentives for preservation of ESH resources…	Ongoing. GSMC comments on plans that may affect the Ecosystem. ESH resources are highly protected in all jurisdictions' plans that include the Goleta Slough area.
Action A-3.4	Coordinate with the Goleta Valley Vector Control District in the management of mosquitos & other species under their jurisdiction that occur in the Slough. Pursue alternatives to District vehicle access in the Slough to minimize disruption of wetland habitats. Work with the District to identify changes in their workload due to physical changes in the Slough as well as the potential need for additional funding in order for the District to carry out its mandate.	The Mosquito and Vector Management District of Santa Barbara County continues to work in the Slough to eradicate pests (need to confirm).
Action A-3.5	Work with Goleta West & Goleta Sanitary Districts, So Cal Gas & other utilities to pursue grants other funding to relocate sanitary sewer trunk, gas & other lines out of the Slough & other sensitive habitats.	Ongoing – GSMC supported GSD's & GWSD's projects to move pipelines out of sensitive habitats.
Action A-3.6	Work with County, Caltrans & other agencies to ensure that, to maximum extent feasible, roadway maintenance, widening or new construction is designed to accommodate restoration & preservation of Ecosystem.	Ongoing – GSMC reviews road widening plans including El Colegio and Mesa Road.
Action A-3.7	Work with County, RWQCB & other entities to minimize non-point sources of pollution in the Ecosystem watershed.	New stormwater standards have been added to Table 2-1 and are considered in reviewing plans and projects.
PROTECTION AND MAINTENANCE OF EXISTING RESOURCES, FUNCTIONS AND VALUES. **Goal – Protect and maintain the natural diversity of species, habitat types & Ecosystem functions through protection of physical processes that naturally maintain these resources.**		
Policy P-1	**Wherever possible, projects should avoid wetland resources.**	

Action P-1.1	Work with the County and other agencies in the review of projects to avoid direct or indirect impacts on wetland resources. Provide appropriate buffers along riparian corridors, adjacent to wetlands and other sensitive habitats	Ongoing during project review; GSMC comments on many projects.
Policy P-2	**The opening and closure of the mouth of the Slough at Goleta Beach should be managed to maintain optimal tidal circulation.**	
Action P-2.1	Following confirmation that closure of the mouth of the Slough has occurred, actions to open the mouth should be taken as soon as possible. The Committee should work with Flood Control, County Parks and the Coastal Commission to implement this policy.	Ongoing/complete – In late 2014, the issue of managing the mouth of the Slough is being studied as it relates to effects on Tidewater gobies and Steelhead trout and remains unresolved.
Policy P-3	**Protect & maintain wetland & other habitat types & populations of sensitive species that are part of or contribute to the Ecosystem.**	
Action P-3.1	To the maximum extent feasible, protect areas of riparian and oak woodland, including along Atascadero Creek and the north bluff of UCSB.	Ongoing – GSMC strives to protect these areas during project review.
Action P-3.2	Maintain areas of fresh and brackish marsh associated with the transition from estuarine to palustrine wetlands within the Ecosystem.	Ongoing - CDFG basin on east and west side near Los Carneros have maintained fresh & brackish marsh. Also Area K maintained as brackish. Need to determine if other areas also have this type of wetland.
Action P-3.3	To the maximum extent feasible, eradicate existing noxious, non-native weeds recognized by the CNPS, California Exotic Plant Pest Council & other organizations.	Ongoing - GSMC has supported several eradication projects throughout the Ecosystem.
Action P-3.4	Work with the County and other jurisdictions to ensure that noxious, non-native weeds recognized by CNPS, etc., are not included in landscaping plans within the Ecosystem. To the max extent feasible, landscape with native plants and avoid planting & maintaining exotic plant species.	Ongoing/complete - GSMC reviews projects; jurisdictions have approved plant lists with natives
Action P-3.5	Work with agencies to ensure that the planting or replanting of Eucalyptus trees is discouraged.	
Action P-3.6	Work with UCSB, the Airport, Goleta Beach Co. Park and other landowners where appropriate to lessen the impact on the Ecosystem's bird populations by non-native carnivores, including feral and domestic cats, domestic dogs & red fox.	Ongoing. Need to update what agencies' actions are in this regard.
Action P-	Identify and encourage protection of existing wildlife	There has been a local effort to coordinate on wildlife

3.7	corridors and habitat linkages.	corridors. Need to update.
Policy P-4	**Sedimentation from the watershed into tidal marshlands & flats of the Slough should be controlled to the max extent feasible. Sediment control measures should strive to reduce erosion & be compatible with flood protection for the Airport & other potentially affected landowners.**	
Action P-4.1	Reduce & manage sedimentation in the Slough through the construction & maintenance, in an environmentally acceptable manner, of sediment basins, berms along creek channels, dredging of creek channels & other measures.	Ongoing – This updated management plan is taking a new look at the use and value of sediment vis a vis sea level rise and other factors. See updated policies and actions .
Action P-4.2	Work with the County, US Forest Service & NRCS to prepare the necessary studies in order to adopt policies & other measures to reduce erosion upstream & resulting sedimentation downstream.	No progress - No studies have been done to date; after the Gap Fire aerial mulching occurred along the Goleta Valley foothills to reduce erosion. Need to update info.
Action P-4.3	Provide input to the County's review of projects & long range planning efforts as they relate to the larger watershed of the Slough.	Ongoing – GSMC reviews County areawide plans, e.g., *Draft Eastern Goleta Valley Community Plan* which is still under review in 2015.
Action P-4.4	Work with the County to ensure that agriculture and recreational uses are protected along Atascadero & Maria Ygnacio Creeks to serve as a buffer between creeks & adjacent commercial, industrial & residential areas.	Ongoing/complete - The *Draft Eastern Goleta Valley Community Plan* provides for protection of ag & recreational uses along Atascadero & Maria Ygnacio Creeks
Action P-4.5	Work with watershed landowners & users to reduce direct and indirect impacts on the Slough due to sedimentation, use of chemicals, etc.	No progress – RWQCB has an ag waiver program. Need to update info.
Policy P-5	**Flood-deposited sediment that has accumulated in the former tidal wetlands should be periodically removed as a part of a long-term program.**	
Action P-5.1	Promote the periodic removal of sediment in the Slough, feeder creeks & other sensitive habitat areas, particularly after major storm events.	Ongoing – While no significant progress has been, Teco-lotito and Carneros Creeks have sediment basins that are dredged as needed, particularly after major storm events. Restoration projects have removed sediment as well.
Action P-5.2	Work with Flood Control & other agencies to ensure that the sediment basins that benefit the Slough are maintained.	Ongoing – Flood Control has sediment basins that are regularly dredged.
Policy P-6	**To the maximum extent feasible, place dredge materials suitable for beach nourishment in the littoral system.**	
Action P-6.1	Work with Flood Control, Coastal Commission & other agencies to place dredge material suitable for beach nourishment in the local beach littoral system.	Ongoing – Flood Control has sediment basins that are regularly dredged and much of that material is deposited on Goleta Beach to make its way into the littoral current.
Policy P-7	**Support continued monitoring of water quality in the Slough & take corrective actions when necessary to**	

	maintain and, if possible, improve water quality in the Ecosystem.	
Action P-7.1	Work with Co. Environmental Health, RWQCB & other agencies to identify, minimize non-point sources of pollution.	Need to update info.
Action P-7-2	Review & comment on the results of water quality monitoring programs conducted by Flood Control, the Airport, Goleta Sanitary District & other agencies.	Ongoing; GSMC reviews the Airport's SWPPP, NPDES, etc.
RESTORATION AND ENHANCEMENT OF HISTORIC RESOURCES, FUNCTIONS AND VALUES **Goal – To the maximum extent, enhance and restore the Slough's natural diversity of resources, habitats, physical processes and functions that have been lost or degraded, through enhancement and restoration of natural self-sustaining processes.**		
Policy R-1	**Priorities for restoration and enhancement should be based on restoring historic functions and providing the greatest benefit to the Ecosystem.**	
Action R-1.1	To the max extent feasible, priorities for restoration and enhancement should be (not in priority order) as follows and as illustrated in Figures 26A and B: a. Restoring tidal circulation to historic tidal wetlands; b. Increasing habitat diversity by restoring and enhancing tidal mud flats and high marsh habitats; c. Protecting historic uplands where appropriate to maintain natural and cultural heritage values; d. Providing for fish and wildlife habitat along riparian corridors; and e. Protecting and restoring water quality consistent with beneficial uses identified in the RWQCB's "Basin Plan."	Ongoing/complete – a. Tidal circulation experiment conducted by Airport is complete and consequently tidal circulation is slowly being returned to basins in the Slough. b. Tidal mud flats & high marsh habitats have been restored, e.g., in CDFG wetlands. c. Area I was restored to meet this action. d. Fish passage projects?? Also, Tecolotito realignment provided habitat?? e. Need to update info.
Action R-1.2	[Estuarine and palustrine] habitats that were historically prevalent in the Ecosystem and are desirable for restoration and enhancement are (as shown on the Future Conditions maps, Figures 26A & B [see action for specific habitats]	Ongoing/complete – Restoration to date has included Coastal Sage Scrub, high marsh, etc., as shown in Figures 26A & B.
Action R-1.3	Support the acquisition of easements, land in fee or other measures to facilitate enhancement and restoration projects including, but not limited to, the parcels shown in Table 7 ("Priority Properties for Acquisition for Restoration and Enhancement").	Ongoing – GSMC has tried to acquire land for restoration but has not been successful. However, a considerable number of restoration projects have occurred that GSMC supported.
Policy R-2	**Where compatible with existing land uses, restore historic estuarine habitats, functions and conditions. Where existing sensitive resources may be adversely affected by tidal restoration, action should not be taken unless adequate provision for these resources already exists or is made elsewhere in the Ecosystem.**	
Action R-	Return Subarea K, located near the GWSD office and UCSB	No progress - Subarea K has not been modified.

2.1	(See Figure 19) to estuary, providing that comparable existing functions and values can be established or are adequately provided elsewhere.	
Action R-2.2	Consider temporary measures, e.g., opening tide gates or breaching berms to inundate new areas, and monitor the effects in order to determine the best actions to benefit the Slough as a whole.	Ongoing – The tide gates have not been opened but restoration work to the west of the gates has been planned to accommodate the possibility that the gates will be removed or relocated to the west in the future. Tide circulation experiment may result in more berms being breached to restore tidal flow.
Action R-2.3	Work with Flood Control, UCSB, SB Airport, Coastal Commission and other agencies and landowners to restore tidal circulation to its historic extent, particularly in the southwest part of the Slough.	Ongoing/complete - The tidal circulation study has resulted in some areas of the Slough reverting to tidal; more areas could be converted.
Policy R-3	**Expand and/or restore habitats and sensitive species that have declined within the Ecosystem and/or region. Restoration of habitat or reintroduction of species should be considered in the context of this Plan and other region-wide, state and federal plans.**	
Action R-3.1	Restore tidal circulation to diked or otherwise isolated areas of former tidal marsh as shown in Figures 26A & B to benefit Belding's Savannah Sparrow and other estuarine species.	Ongoing/complete – With the success of the tidal circulation study, some basins have been restored to tidal but more basins could be restored to tidal. Change in mouth management may threaten past restoration efforts.
Action R-3.2	Increase the acreage of upper marsh habitats existing near the upper limit of tidal action … through such measures as: a. The restoration of tidal circulation to areas previously isolated by berms, dikes or other barriers; and b. The recreation of historic upper marsh habitats along a gradual transition from wetland to upland through the removal of old berms and dikes that were placed at the margins of the estuary.	Ongoing/complete – a. Some basins have had tidal circulation restored and more basins could be converted in the future. b. Seven acres of upper marsh/pickleweed habitat has been provided in the East CDFG basin. c. Change in mouth management may threaten past restoration efforts.
Action R-3.3	Where feasible, reintroduce species that have become extirpated in the Slough into appropriate habitats using source material from the closest geographical location. Locally and regionally rare estuarine plant species should be propagated from seed or cuttings obtained from existing Goleta Slough populations & new populations should be established in appropriate habitats within the Slough.	Ongoing/complete – Several extirpated species have been reintroduced including *Lasthenia glabrata coulteri* (Gold Fields) and *Centromadia parryi australis* (Tar Plant).
Action R-	Support the restoration of properties that are contiguous to	Ongoing – The Modoc Open Space has had a

3.4	the GSEMP area or could potentially provide important habitat within the watershed. Identify appropriate sites for restoration outside the GSEMP area including, but not limited to, the Modoc Open Space, lake Los Carneros County Park and riparian sites along creeks in the watershed.	conservation easement protecting it since 1999 though no restoration has occurred; Lake Los Carneros has had some restoration work. Need to update info.
Policy R-4	**Improve ecological linkages and avoid habitat fragmentation both within the Ecosystem and between the Slough and adjacent ecosystems.**	
Action R-4.1	Identify where habitats are fragmented and potential linkages to reduce fragmentation within the Ecosystem.	There has been a local effort to coordinate on wildlife corridors, including providing for fish passage upstream. *Need to update.*
Action R-4.2	Promote creek restoration projects, especially those that provide wildlife corridors and habitat linkages.	Ongoing – GSMC has supported numerous creek restoration projects as outlined in Appendix B.
Action R-4.3	Remove berms that separate or isolate habitats in the Slough as shown in Figures 26A and B.	Ongoing/complete – Some berms have been removed but more remain that isolate habitats.
Action R-4.4	Encourage the removal and/or retrofitting of existing culverts or other structures that may impede fish migration or movement.	Ongoing – GSMC has supported fish passage projects in area creeks. Need to update info re culverts.
Policy R-5	**The preferred mitigation for permitted habitat disturbances is that which is the most ecologically beneficial and cost effective for the Ecosystem as a whole. Compensation or mitigation should be implemented within the Ecosystem and should result in no net loss or, if possible, a net gain in habitat area and ecosystem functions.**	
Action R-5.1	For permitted disturbance of privately owned wetlands or other habitats, the priority for mitigation is as follows: a. On the project site; b. Off site on privately owned land; or c. Off site on publicly owned land. [See action for more re mitigation priorities and guidance]	Ongoing – All required mitigation (public or private projects) has occurred within the GSEMP area.
Action R-5.2	For permitted disturbance of publicly owned wetlands or other habitats, the priority for mitigation is as follows (all within GSEMP area): wetlands or other habitats, the priority for mitigation is as follows: a. On the project site; b. Acquisition of private land for restoration; or c. Other public land for restoration.	
Action R-	Develop mechanisms whereby mitigation can occur on	Need to update info.

5.3	property not owned or controlled by the project proponent if it results in a greater benefit to the Ecosystem. These mechanisms can include focusing on lower priorities in Actions R-5.1 and R-5.2, mitigation banking, in lieu fees, etc.	
Policy R-6	**If the potential exists to acquire property for wetlands restoration and/or mitigation purposes, criteria for selection should include the following (not in priority order):** [See policy for criteria for selection]	
Action R-6.1	Pursue funding for restoration and/or mitigation by purchasing land in fee, acquiring conservation or other easements, dedication of development rights or other legal means as shown in Figures 26A and 26B.	Ongoing – GSMC has a long record of supporting restoration projects, conservation easements or other means to restore property in perpetuity.
EDUCATION, RESEARCH AND PUBLIC ACCESS **Goal – Promote the Ecosystem's research and public educational and recreational opportunities consistent with protection of the Slough's functions and values and Airport safety, operations and facilities requirements.**		
Policy E-1	**Provide for the enjoyment and education of the public about the Slough Ecosystem.**	
Action E-1.1	Provide public access to the Slough including interpretive access and public turnouts with parking, if possible, in locations that offer views of the Slough (e.g., North Bluff area at UCSB) as shown in Figure 26A.	Ongoing – Several overlooks have been built & tours occur occasionally.
Action E-1.2	Provide Ecosystem interpretive center(s), representing appropriate agencies and interest groups, to educate the public. Interpretative signs should be provided on the periphery of the Slough and wherever else is appropriate.	Ongoing – Signs have been added at two overlooks. Need to update info re newer interpretive signs.
Action E-1.3	Where necessary to protect sensitive resources, limit access into the Slough to those persons and organizations conducting compatible research, educational projects and other appropriate activities.	Ongoing – Because of the Airport, access is somewhat limited though still occurs for research and education. CDFG has said that access to the Ecological Reserve should be restricted.
Action E-1.4	Develop a web page on the World Wide Web.	Ongoing – The website is being updated in 2015.
Policy E-2	**Promote field research in the Ecosystem with an emphasis on estuarine functions and related watershed and coastal processes.**	
Action E-2.2	Sponsor applications for grants and other monies sought by independent researchers, including UCSB undergraduate and graduate students.	Ongoing – GSMC has supported several grant requests in the past.
Action E-2.3	Monitor the effects of the Plan on the overall health of the ecosystem including hydrology, sensitive species, habitats and biodiversity.	Ongoing – The GSEMP is being updated at this time.

4.3 Development of the Updated Goals, Policies and Actions

An important aspect of updating the 1997 GSEMP and 2012 *Existing Conditions and Monitoring Report* is to update the goals, policies and actions to reflect the current understanding of the relevant information and issues affecting the Ecosystem. The 2015 goals, policies and actions are derived from several sources:

- **1997 GSEMP** - Table 4-1 lists the 1997 policies and actions and their status as of 2014. Many actions were one-time actions that have been implemented, therefore they have been deleted. Where a policy or action is ongoing, it has been updated and retained.

- **Sea Level Rise Vulnerability Assessment** – GSMC decided that incorporating SLR considerations into the policies and actions, instead of creating a new stand alone set of SLR policies, allows for a more comprehensive approach to the issues relating to the SLR and the Goleta Slough Ecosystem and its management. The results of this important study resulted in many revisions to policies and actions as local impacts of climate change were not issues discussed by GSMC in the mid-1990s. Section 3 (Looking Ahead) summarizes the findings of this study, and more complete information is provided in Appendices D and F.

- **Inlet modeling** – Appendix G includes the Goleta Slough Inlet Modeling Study that was completed in early 2015 and incorporated into this Plan. The key findings from this study were integrated throughout the goals, policies and actions.

- **Goleta Slough Mouth Management Study** – This study is being prepared by the Airport and will be released in fall 2015. Preliminary information from the study has been considered in the review and updating of policies and actions.

- **GSMC discussion** – GSMC held monthly meetings between March and August 2015 during which there were animated discussions of the origin, intent and purpose of the goals, policies and actions. Many edits were made at the meetings, resulting in clearer, broader and more comprehensive goals, policies and actions contained in this Plan.

Consequently, while the 1997 Plan included policies derived from those of local jurisdictions, the updated goals, policies and actions go farther than those in that plan, particularly relating to climate change, sea level rise, and Slough and mouth management issues. Moreover, as local agencies begin conducting SLR studies and LCP updates, it is hoped they will find some of the methodologies used in the studies, policies and actions included here useful in their planning.

4.4 Updated Goals, Policies and Actions – 2015

The 2015 updated goals are similar to the 1997 goals (see Section 4.1 above), but have been updated to include new information and the findings of the SLR Vulnerability Assessment summarized in Section 3. Depending on the outcome of the inlet (or mouth) modeling and management option studies that are underway in early 2015, these goals, policies and actions may need to be revisited as they rely heavily on having tidal circulation in the estuary.

> **ADMINISTRATIVE FRAMEWORK (Goal A)** - Provide an administrative framework for the adoption, implementation and periodic updates of the 2015 *Goleta Slough Area Sea Level Rise and Management Plan* through cooperative interaction between landowners, public

interest groups, responsible agencies and jurisdictions. Consider the evolution of habitats, adaptive management and other changes that are likely to occur over time, including those related to climate change. Compatibility with surrounding land uses must also be considered in the review of plans and projects.

PROTECTION AND MAINTENANCE OF EXISTING RESOURCES, FUNCTIONS AND VALUES (Goal P) – Protect and maintain the natural diversity and resilience of species, habitat types and Ecosystem functions through protection of physical processes that naturally maintain these resources. More deliberate adaptation actions may be necessary as sea level rise accelerates and other climate change impacts become more apparent. These adaptation strategies, when implemented, should to the maximum extent feasible avoid further alteration of habitats or physical processes.

RESTORATION AND ENHANCEMENT OF RESOURCES, FUNCTIONS AND VALUES (Goal R) – To the maximum extent possible, enhance and restore the Slough's natural diversity of resources, habitats, physical processes and functions that have been lost or degraded and that are needed to maintain the resilience of the Slough in the light of climate change.

EDUCATION AND RESEARCH (Goal E) – Increase the understanding and awareness of the Goleta Slough Ecosystem and its historic and future functions and values, through providing inventories of resources and supporting research and monitoring, to inform decision makers and the public.

A significant change in the policies and actions as a result of the SLR information is that sediment that accretes in the Slough is now seen as a potential tool to combat sea level rise, rather than something that is a detriment to the functioning of the riparian, upland and wetland habitats in the Goleta Slough area.

The Goals, Policies and Actions of the 2015 *Goleta Slough Area Sea Level Rise and Management Plan* are:

ADMINISTRATIVE FRAMEWORK

Goal A - Provide an administrative framework for the adoption, implementation and periodic updates of the GSEMP through cooperative interaction between landowners, public interest groups, non-profits, responsible agencies and jurisdictions. Consider the evolution of habitats, coastal hazards, adaptive management and other changes that are likely to occur over time, including those related to climate change. Compatibility with surrounding land uses must also be considered in the review of plans and projects.

Policy A-1 - Implementation and updating of the *Goleta Slough Area SLR and Management Plan* should be coordinated with GSMC. This should be accomplished through cooperation and collaboration consistent with the Committee's advisory role.

Action A-1.1 - Pursue formalization of GSMC (e.g., acquire non-profit status, form a joint powers agreement with interested groups and agencies, etc.) to secure grants, mitigation funds and other monies to implement restoration and enhancement projects.

Action A-1.2 - Pursue funding for the Committee to ensure that it can continue to meet as needed to advise on proposed projects, plans, funding of improvements and mitigation measures and other related tasks that may affect the Ecosystem.

Action A-1.3 - Pursue permanent funding for a manager to coordinate with agencies, property owners and interested parties in the implementation of the Plan.

Action A-1.4 - In cooperation with public agencies and property owners, where feasible, pursue funding to map ESHA, including wetlands and other sensitive habitats within the Ecosystem.

Action A-1.5 - Update this Plan at five-year intervals or as needed, including natural resources and other technical information that have not been updated since 1997.

Policy A-2 - Coordinate with jurisdictions and agencies on plans, policies, and mitigation measures, including those already proposed and adopted, to ensure that they benefit the resources of the Goleta Slough Ecosystem to the extent feasible.

Action A-2.1 - Work with responsible agencies to amend their existing plans and policies where necessary to encourage conformity with this Plan**.**

Action A-2.2 - Provide commentary on projects and their consistency with the goals of this Plan.

Action A-2.3 - Work with the Airport to resolve conflicts between policies and actions included in this Plan, particularly those relating to flooding and wildlife hazards, and the Airport's safety, operations and facilities requirements.

Action A-2.4 - Coordinate with agencies and other groups in the gathering and dissemination of technical data relating to the Slough Ecosystem**.**

Action A-2.5 - Work with agencies in reviewing, adopting and amending their plans that directly or indirectly affect the Slough to ensure they are compatible with the goals of this Plan. Encourage agencies to provide incentives for preservation of ESHA resources.

Action A-2.6 - Coordinate with the Goleta Valley Vector Control District in the management of mosquitos and other species under their jurisdiction that occur in the Slough area. Pursue alternatives to District vehicle access in the Slough to minimize disruption of wetland habitats.

Action A-2.7 - Coordinate with Goleta West and Goleta Sanitary Districts, Goleta Water District, So. Cal Gas and other utilities to pursue grants or other funding to relocate sanitary sewer trunk, gas and other lines out of the Slough and other sensitive habitats**.**

Action A-2.8 - Coordinate with County, Caltrans and other agencies to ensure that, to maximum extent feasible, roadway maintenance, widening or new construction is designed to accommodate restoration and preservation of the Ecosystem**.**

Action A-2.9 - Coordinate with the U.S. Forest Service, County, RWQCB and other public and private entities to minimize non-point sources of pollution, flooding and erosion in the Ecosystem watershed.

Action A-2.10 – Work with local agencies, utilities, special interest groups and property owners to minimize impacts associated with management of the Goleta Slough mouth, enhance habitat for endangered and other sensitive species, improve water quality, etc. Coordinate with local agencies and others on mitigation and restoration projects that cross jurisdictional lines.

PROTECTION AND MAINTENANCE OF EXISTING RESOURCES, FUNCTIONS AND VALUES

Goal P – Protect and maintain the natural diversity and resilience of species, habitat types and Ecosystem functions through protection of physical processes that naturally maintain these resources. More deliberate adaptation actions will be necessary as sea level rise accelerates and other climate change impacts become more apparent. These adaptation strategies, when implemented, should to the maximum extent feasible avoid further alteration of habitats or physical processes.

Policy P-1 - Wherever possible, projects should avoid wetland and upland resources.

Action P-1.1 - Coordinate with the Cities of Goleta and Santa Barbara, UCSB and the County in the review of projects to avoid direct or indirect impacts on wetland resources. Provide appropriate buffers along riparian corridors, adjacent to wetlands and other sensitive habitats.

Policy P-2 - The Goleta Slough inlet should be managed to maximize tidal circulation, water quality, and diversity and resilience of species and habitats.

Action P-2.1 – When the Goleta Slough inlet has closed and to-be-defined thresholds have been exceeded, the Slough inlet should be opened to maintain tidal circulation, water quality, and diversity and resilience of species and habitats in the Ecosystem.

Action P-2.2 - The QCM results suggest that flood protection can be achieved under a range of managed breach thresholds (e.g., 6.5’ and 7.5’ NAVD). We recommend further refinement of the proposed mechanical breach thresholds to achieve optimum benefits for the local ecology, infrastructure protection, and aviation safety.

Policy P-3 - Protect and maintain the diversity and functions of wetland and other habitat types and populations of sensitive species that are part of or contribute to the Ecosystem.

Action P-3.1 - To the maximum extent feasible, protect areas of riparian and oak woodland, including along Atascadero Creek and the north bluff of UCSB.

Action P-3.2 - Maintain the functions and connectivity of fresh and brackish marsh associated with the transition from estuarine to palustrine wetlands within the Ecosystem and consider changing environmental conditions such as sea level rise.

Action P-3.3 - To the maximum extent feasible, eradicate existing noxious, non-native weeds recognized by the CNPS, California Exotic Plant Pest Council and other organizations.

Action P-3.4 - Work with the County and other jurisdictions to ensure that noxious, non-native weeds recognized by CNPS, etc., are not included in landscaping plans within the

Ecosystem. To the max extent feasible, landscape with native plants and avoid planting and maintaining exotic plant species. Encourage adoption of weed prevention and equipment cleaning protocols.

Action P-3.5 - The planting or replanting of Eucalyptus trees should be discouraged; substitute with the planting of appropriate native vegetation to support butterflies and other native species.

Action P-3.6 - Work with UCSB, the Airport, City of Goleta, SB County Goleta Beach Park and other landowners where appropriate to lessen the impact on the Ecosystem's bird populations by non-native carnivores, including feral and domestic cats, domestic dogs and red fox.

Action P-3.7 - Identify and encourage protection of existing wildlife corridors and habitat linkages.

Action P-3.8 – Encourage modification to the Slough's perimeter fencing (e.g., on the north side of Tecolotito Creek closer to the airfield), consistent with FAA and other safety standards, to improve movement for coyotes, fox and other mammals within the Ecosystem.

Policy P-4 – Sedimentation from the watershed into tidal marshlands and flats of the Slough should be encouraged to the maximum extent feasible in order to maintain natural Slough functioning and to address anticipated sea level rise. Sediment management measures should strive to reduce erosion, maintain channel conveyance, increase habitat diversity and help address future sea level rise. Sediment management should be compatible with flood protection for the Airport and other potentially affected landowners.

Action P-4.1 – Maintain channel conveyance using a variety of approaches including sediment basins, selective breaching of berms along creek channels, and dredging of existing channels. Give consideration to reusing trapped or dredged sediment beneficially in the Slough and on the beach to enhance existing habitats and increase resilience to sea levels rising by allowing, or emulating, accretion and natural sediment transport processes.

Action P-4.2 – Manage topographic diversity and address sea level rise by opportunistic reuse of sediment.

Action P-4.3 - Coordinate with the City of Goleta, County, US Forest Service, RWQCB and NRCS to prepare the necessary studies in order to adopt policies and other measures to reduce erosion upstream.

Action P-4.4 - Provide input to the County's and Cities of Santa Barbara and Goleta's review of projects and long range planning efforts as they relate to the larger watershed of the Slough.

Action P-4.5 - Work with the County to ensure that agriculture, recreational uses and sensitive habitats are protected along Atascadero and Maria Ygnacio Creeks to serve as a buffer between creeks and adjacent commercial, industrial and residential areas.

Action P-4.6 - Work with watershed landowners and users to reduce direct and indirect impacts on the Slough due to sedimentation, use of chemicals, etc**.**

Policy P-5 – Allow accretion to occur within wetlands, as appropriate, to counteract sea level rise.

Action P-5.1 - Promote natural sedimentation processes of fine sediment in the Slough, feeder creeks and other sensitive habitat areas, where appropriate.

Action P-5.2 - Work with Flood Control and other agencies to maintain sediment basins in a manner that benefits the Slough, including limiting impacts to special-status species such as Tidewater gobies.

Action P-5.3 - Investigate other local sources of suitable material that may be available outside the Slough, e,g., the use of material from the Devereux Slough system, to counteract the effects of SLR.

Policy P-6 - Beyond that required for natural Slough functioning, place appropriate amounts of sand and cobbles that are suitable for beach nourishment in the littoral system near Goleta Slough.

Action P-6.1 - Coordinate with Flood Control, BEACON, Coastal Commission and other agencies to place coarse material suitable for beach nourishment in the local beach littoral system.

Policy P-7 - Support continued monitoring of water quality in the Slough and take appropriate actions in line with Goal P when necessary to maintain and, if possible, improve water quality in the Ecosystem.

Action P-7.1 - Work with Co. Environmental Health Services, RWQCB and other agencies to identify and minimize point and non-point sources of pollution.

Action P-7.2 - Review and comment on the results of water quality monitoring programs conducted by Santa Barbara Channelkeeper, Flood Control, the Airport, Goleta Sanitary District and other agencies to ensure that water quality continues to improve throughout the Ecosystem.

RESTORATION AND ENHANCEMENT OF RESOURCES, FUNCTIONS AND VALUES

Goal R – To the maximum extent possible, enhance and restore the Slough's natural diversity of resources, habitats, physical processes and functions that have been lost or degraded and that are needed to maintain the resilience of the Slough in the light of climate change.

Policy R-1 - Priorities for restoration and enhancement should consider functions and diversity in order to provide the greatest benefit to the Ecosystem for future conditions including climate change. However, long-term plans for the Goleta Slough region should anticipate the decreasing effectiveness of inlet management as a management tool for achieving flood protection and habitat goals as sea levels rise. Long-term plans for the Goleta Slough Ecosystem should also incorporate adaptation strategies that anticipate significant increases in lagoon water levels and near-continuous open-lagoon conditions by the end of the century (Inlet Study).

Action R-1.1 - To the maximum extent feasible, priorities for restoration and enhancement should consider historic conditions and future sea level rise and focus on the following**:**

a. Restoring tidal circulation to basins that were previously tidal and established tidal wetlands;
b. Accommodating future habitat diversity by restoring and enhancing vegetated wetlands and transitional upland habitats;
c. Enhancing connectivity of existing and new uplands to the wetlands to maintain natural wetland functions and cultural heritage values;
d. Enhancing existing and providing new fish and wildlife habitat corridors; and
e. Protecting and restoring water quality consistent with beneficial uses identified in the RWQCB's "Basin Plan."

Action R-1.2 – Identify restoration opportunities to create rare habitat types and those that support endangered species that have been lost from the system (e.g., upper marsh transitional habitats) and are compatible with changing climate conditions. (See the 1997 GSEMP for a full list of habitats).

Action R-1.3 - Support the acquisition of easements, land in fee or other measures within the Slough and its watershed to facilitate climate adaptation, enhancement and restoration projects.

Policy R-2 - Where compatible with existing land uses and future conditions, restore estuarine habitats, functions and conditions. Where existing sensitive resources may be adversely affected by tidal restoration, action should not be taken unless appropriate provision for these resources already exists or is made elsewhere in the Ecosystem.

Action R-2.1 - Return Subarea K, located near the GWSD office and UCSB (See Figure 2-2W) to estuary, providing that comparable existing functions and values can be established or are adequately provided elsewhere.

Action R-2.2 – Evaluate optimal tidal circulation and consider pilot projects, e.g., Basins G and L/M, to inundate new areas and monitor the effects in order to determine the best actions to benefit the Slough as a whole. Evaluate the feasibility of large-scale landscape shaping.

Action R-2.3 - Evaluate specific opportunities for multi-benefit projects for habitat enhancement, restoration and lagoon management. Evaluate potential project alternatives to include a refined analysis of impacts on local channel hydraulics and lagoon inlet dynamics.

Policy R-3 - Expand and/or restore important habitats and species that have declined or have been extirpated within the Ecosystem and/or region as appropriate. Restoration of habitat, assisted migration and reintroduction of species should be considered in the context of this Plan and other region-wide, state and federal plans as well as future conditions such as sea level rise.

Action R-3.1 - Restore tidal circulation to diked or otherwise isolated areas of former tidal marsh to benefit estuarine species including Belding's Savannah Sparrow.

Action R-3.2 - Increase the acreage of upper, brackish and freshwater marsh habitats existing near the upper limit of tidal action to create a diverse marsh ecotone through such measures as:

a. The restoration of tidal circulation to areas previously isolated by berms, dikes or other barriers;
b. The recreation of previous upper marsh habitats along a gradual transition from wetland to upland through the removal of old berms and dikes that were placed at the margins of the estuary; and
c. The acquisition of, or easements for, upland areas adjacent to wetlands in anticipation of upslope habitat advancement/transgressions due to future sea level rise.

Action R-3.3 - Where feasible and appropriate in the long term, reintroduce species that have become extirpated in the Slough into appropriate habitats using source material from the closest geographical location. Locally and regionally rare estuarine plant species should be propagated from seed or cuttings obtained from existing Goleta Slough populations and new populations should be established in appropriate habitats within the Slough.

Action R-3.4 - Support the restoration of properties that are contiguous to the GSEMP area or could potentially provide important habitat within the watershed. Identify appropriate sites for restoration outside the GSEMP area.

Action R-3.5 – Encourage the use of Goleta Slough area genotypes in restoration, enhancement and mitigation projects in the Ecosystem.

Policy R-4 - Improve ecological linkages and avoid habitat fragmentation both within the Ecosystem and between the Slough and adjacent ecosystems.

Action R-4.1 - Identify where habitats are fragmented and potential linkages to reduce fragmentation within the Ecosystem. Develop a plan for improving habitat connectivity within the watershed and within the Ecosystem.

Action R-4.2 - Promote creek restoration projects and upland acquisition within the watershed of slough system, especially those that provide fish and wildlife corridors and habitat linkages.

Action R-4.3 - Remove berms and lower culverts (e.g., under Hollister Avenue, Los Carneros Road and along Atascadero Creek that reduce hydraulic connectivity and separate or isolate habitats in the Slough.

Action R-4.4 - Encourage the removal and/or retrofitting of existing culverts or other structures that may impede fish and wildlife migration or movement.

Policy R-5 - The preferred project mitigation and adaptation for permitted habitat disturbances is that which is the most ecologically beneficial and cost effective for the Ecosystem as a whole. Compensation or mitigation should be implemented within the Ecosystem and should result in no net loss or, if possible, a net gain in habitat area and ecosystem functions**.**

Action R-5.1 - For permitted disturbance of privately owned wetlands or other habitats, the priority for project mitigation is as follows:

a. First, on the project site;
b. Second, off site on privately owned land; or
c. Third, off site on publicly owned land.

Action R-5.2 - For permitted disturbance of publicly owned wetlands or other habitats, the priority for project mitigation is as follows (all within the Goleta Slough Ecosystem area):

a. First, on the project site;
b. Second, acquisition of private land or easements for restoration; or
c. Third, other public land for restoration.

Action R-5.3 – Encourage the development and adoption of policies and procedures by regulatory agencies whereby project mitigation and adaptation can occur on property not owned or controlled by the project proponent if it results in a greater benefit to the Ecosystem.

Policy R-6 - If the potential exists to acquire property rights for wetland restoration, climate adaptation and/or project mitigation purposes, criteria for selection should include the following (not in priority order):

a. Potential ecological value of existing or restored habitat in relation to whole ecosystem;
b. Maximum benefit to Ecosystem considering cost of acquisition and/or restoration;
c. Proximity to high quality habitat which creates the potential to have larger, more complex functions among the habitats in the area;
d. Like habitat to that which was lost, consistent with Policies R-1 and R-2;
e. Degree of degradation, i.e., less degraded land may be preferable;
f. Risk of development or permanent loss of habitat;
g. Minimal pre-restoration investment;
h. Projected life of habitat with climate change and sea level rise;
i. Other management considerations, e.g., potential for trespassing, ongoing maintenance needs, flood damage potential, etc.; and
j. The ability to provide room for habitats to transgress upslope.

Action R-6.1 - Support funding for restoration, adaptation and/or project mitigation by purchasing land in fee, acquiring conservation or other easements, dedication of development rights or other legal means.

EDUCATION AND RESEARCH

Goal E – Increase the understanding and awareness of the Goleta Slough Ecosystem to inform decision makers and the public.

Policy E-1 - Monitor Ecosystem functions and values to inform research.

Action E-1.1 - Participate in watershed monitoring programs of sea level rise and Ecosystem change.

Action E-1.2 – Develop comprehensive, well-designed, and rigorous physical, chemical, hydrological and biological monitoring programs to collect information to use to guide restoration, adaptation and management actions. Include procedures to facilitate monitoring in areas with security restrictions such as within the Airport. Specifically monitoring within the Ecosystem to, for example**:**

a. Refine understanding of the hydrodynamics and sediment movement in the Slough;
b. Study how upland habitats and agriculture and open space within the watershed contribute to and affect the functioning of the Slough
c. Monitor the effectiveness of restoration, adaptation and project mitigation projects; and
d. Provide inventories of all natural resources in the Ecosystem including terrestrial and aquatic flora and fauna and how they relate to different habitats.

Policy E-2 - Undertake research on the Ecosystem estuarine functions and related watershed and coastal processes to identify the long-term effects of climate change on the Slough. Future studies should include a statistical analysis of coastal and hydrologic processes in order to better characterize the expected frequency occurrence of extreme conditions including prolonged droughts, El Nino and extreme rain/flood events.

Action E-2.1 - Participate in regional (i.e., California coast) assessments of sea level rise vulnerability, risk and adaptive planning efforts to ensure compatible treatment for sea level rise across jurisdictional boundaries.

Action E-2.2 - Incorporate the best available science, consistent with regional (i.e., California coast) policy efforts, as new, peer-reviewed studies on sea level rise become available and as agencies such as the NRC, OPC, State Lands Commission and the Coastal Commission issue updates to their guidance reports.

Action E-2.3 - Advocate for research and monitoring programs to understand the overall health of the Ecosystem including hydrology, sediment, sensitive species, habitats and biodiversity, the long-term evolution of the Ecosystem and identify triggers and thresholds to guide management decisions. Analyze and research specific issues, e.g., how projected changes in water levels and vegetation will affect wildlife communities and migration corridors as well as specific species, e.g., Belding's savannah sparrow, Tidewater Goby and Steelhead Trout.

Action E-2.4 - Sponsor applications for grants and other monies sought by independent researchers, including UCSB undergraduate and graduate students.

Action E-2.5 - Monitor the effects of the Plan on the overall health of the Ecosystem including hydrology, sensitive species, habitats and biodiversity including:

a. Ongoing comprehensive biological monitoring programs; and
b. Project-specific analysis and follow-up monitoring.

Policy E-3 - Support public education and recreational opportunities consistent with protection of the Slough's existing and future functions and values, to support the goals of this Plan.

Action E-3.1 - Improve public access to the Slough by providing more interpretive signs and public turnouts with parking in locations that offer views of the Slough, (e.g., North Bluff area at UCSB), etc.

Action E-3.2 - Continue to maintain and update the GSMC web page on the World Wide Web.

4.5 Priorities and Implementation of the *Goleta Slough Area SLR and Management Plan*

Implementation of the *Goleta Slough Area SLR and Management Plan* will require continued collaboration among agencies, public interest groups and property owners that have been involved in the development of the plan. Funding for projects, research and studies will likely come from grants, future development projects that require mitigation and monitoring, implementation of other plans and volunteer efforts.

4.5.1 Summary of all Actions

The goals, policies and actions in this Plan are very comprehensive and address a myriad of issues as detailed in Section 4.4 above. GSMC decided to summarize and group all actions by broad category to facilitate their implementation. The Committee also spent considerable time and effort in establishing priorities for the actions, i.e., which should be done as soon as possible, which can wait and which are ongoing? GSMC also ranked the summarized actions by priority to facilitate the Plan's implementation.

Section 4.5.3 below includes a summary of actions recommended in the Plan by subject area with similar actions grouped together and referenced so that the reader can get an overview as well as read the actions in their entirety.

4.5.2 Priorities of all Actions

The priority of each of the summarized actions is listed below in the left column. In assigning the priorities, GSMC did not consider funding, permits required, or any other practical matters. The A, B, C and D priorities are defined as follows:

A. **Most important -** These are very important actions that GSMC will be pursuing immediately.

B. **Important -** These are important actions that can wait a little while to be initiated and implemented.

C. **Other actions -** These actions need to be done eventually but not immediately.

D. **Ongoing actions -** These are or should be ongoing actions, including coordinating with local and regional agencies on updates of plans and review of projects, supporting monitoring and research within the Ecosystem, encouraging connectivity between fragmented habitats, etc.

Finally, GSMC found that there were many 'A' and 'B' priorities and deciding which to implement first would be a formidable task. Therefore, GSMC decided that further refinement of the 'A' and 'B' priorities was needed. Within the priorities, there are A1, A2, A3 and A4 "sub-priorities" defined as:

A1 – Administration and Management - Focus on formalizing GSMC, providing a sustainable funding source, etc., so that this Plan can be fully implemented.

A2 – Goleta Slough Inlet Management - Given the results of the *Goleta Slough Mouth Inlet Study* (Appendix G), it appears that, as conditions change and the effects of climate change increase, the inlet (or mouth) will naturally be open more than current conditions reflect. Moreover, as GSMC advocates for the Goleta Slough inlet being managed to be open in the interim (when to-be-defined thresholds are exceeded), the following priorities assume that the inlet is open much of the year.

A3 – Monitoring and Research – In developing this and other plans, it has become evident that there are many opportunities for monitoring and research to inform future plans and studies.

A4 – Protection, enhancement and restoration – These 'A' priorities were ranked fourth as the first three priorities are essential before large-scale, comprehensive protection, enhancement and restoration projects can be planned, funded and implemented.

The 'B' priorities are also ranked B1, B2, B3 and B4 based on the same priorities as listed immediately above, i.e., B1 is Administration and Management, B2 is Goleta Slough Inlet Management, etc.

The 'C' priorities are not ranked further as they are less likely to be implemented in the near term. The 'D' priorities are ongoing and will continue to be implemented on an ongoing basis.

4.5.3 Summary of Actions and Assignment of Priorities

Administration and Management

A1 **Formalize GSMC -** Pursue formalization of GSMC and funding for a manager to continue its efforts (Actions A-1.1 to 1.3). [Note – GSMC agreed that the biggest question is what's the best model for management of the Slough, e.g., paid manager, create or merge with a non-profit, establish a Joint Powers Agreement, etc.]

D **Update Plan -** Update this Plan at five-year intervals or as needed (Action A-1.5).

D **Encourage conformity with Plan -** Coordinate with agencies to amend their plans and policies to encourage conformity with this plan and continue to review projects and plans and comment on their consistency with this plan. Coordinate on data collection, reducing impacts and new mitigation and restoration projects (Actions A-2.1 through 2.10).

C **Improve public access** to the Slough, including interpretive signs, more access and turnouts with parking, in locations that offer views of the Slough (Action E-3.1).

A1 **GSMC webpage -** Develop and maintain a web page for GSMC (Action E-3.2).

Goleta Slough inlet Management and Tidal Circulation

A2 **Slough inlet closure –** When yet to-be-defined thresholds have been exceeded and the Goleta Slough inlet (or mouth) has closed, the Slough inlet should be opened to maintain tidal circulation, water quality, and diversity and resilience of species and habitats (Action P-2.1).

A2 **Breach thresholds -** The QCM results suggest that flood protection can be achieved under a range of managed breach thresholds (e.g., 6.5' and 7.5' NAVD). We recommend further refinement of the proposed mechanical breach thresholds to achieve optimum benefits for the local ecology, infrastructure protection, and aviation safety (Inlet Study; new Action P-2.2).

B2 **Evaluate optimal tidal circulation -** Consider pilot projects (e.g., Basins G and L/M) to inundate new areas and monitor the effects in order to determine the best actions to benefit the Slough as a whole. Evaluate the feasibility of large-scale landscape shaping. (Action R-2.2).

A2 **Evaluate specific opportunities for multi-benefit** habitat enhancement, restoration and lagoon management projects. Evaluate potential project alternatives to include a refined analysis of climate change impacts on local channel hydraulics and lagoon inlet dynamics (Inlet Study; Action R-2.3).

Monitoring and Research

B3 **Inlet management over the long-term -** Long-term plans for the Goleta Slough region should anticipate the decreasing effectiveness of inlet management as a management tool for achieving flood protection and habitat goals as sea level rises reaches three (3) feet (Inlet Study).

C **Adaptation strategies** - Long-term plans for the Goleta Slough region should incorporate adaptation strategies that anticipate significant increases in lagoon water levels and near-continuous open-lagoon conditions by the end of the century (Inlet Study).

B1 **Statistical analysis -** We recommend that future studies include a statistical analysis of coastal and hydrologic processes in order to better characterize the expected frequency occurrence of extreme conditions including prolonged droughts, El Nino and extreme rain/flood events (Inlet Study; added to Policy E-2).

A3 **Watershed monitoring -** Participate in watershed monitoring programs of Ecosystem change (Action E-1.1).

D **Sponsor research -** Support grants and other monies sought by independent researchers (Action E-2.4).

A **Water quality monitoring -** Review and comment on water quality monitoring programs to ensure water quality continues to improve throughout the Ecosystem (Action P-7.2).

A **Specific monitoring -** Undertake specific monitoring within the Ecosystem to refine understanding of the hydrodynamics and sediment movement and to gauge the effectiveness of restoration, adaption and project mitigation (Action E-1.2).

D **Regional assessments -** Participate in regional (i.e., California coast) assessments of SLR vulnerability, risk and adaptive planning efforts to ensure compatibility across jurisdictional lines. Incorporate the best available science as new studies on SLR become available and as agencies issue guidance updates (Actions E-2.1 and E-2.2).

A3 **Overall health of Ecosystem -** Advocate for research and monitoring programs to understand the overall health of the Ecosystem including hydrology, sediment, sensitive species, habitats and biodiversity and identify triggers and thresholds to guide management decisions (Action E-2.3). Need: (1) ongoing, comprehensive biological monitoring program; (2) project-specific analysis and follow-up monitoring (Action E-2.5).

Protection, Enhancement and Restoration of Habitats

A3 **ESHA mapping -** Cooperate with others to fund mapping of Environmentally Sensitive Habitat Areas within the Ecosystem (Action A-1.4).

D **Avoid impacts -** Work with local jurisdictions to protect and avoid direct or indirect impacts on wetlands and other sensitive habitats (Actions P-1.1 and P-3.1).

D **Functions and connectivity of habitats -** Maintain the functions and connectivity of fresh and brackish marsh and consider changing environmental conditions such as SLR (Action P-3.2).

D **Eradicate weeds -** Work with other agencies to eradicate existing noxious, non-native weeds and avoid planting new exotic and invasive species (Actions P-3.3 to 3.5).

A3/4 **Wildlife corridors -** Identify and encourage protection of existing wildlife corridors, including at the Airport where feasible, including removal of obstacles to wildlife migration (Actions P-3.7 and 3.8).

D **Consider historic conditions -** Priorities for restoration and enhancement should recognize historic functions and diversity in order to create a resilient Ecosystem for future conditions including climate change. Encourage the use of Goleta Slough area genotypes in projects (Policy R-1, Actions R-1.1, R-1.2, R-3.4 and R-3.5).

D **Support acquisition to facilitate climate adaptation and restoration -** Support measures to facilitate climate adaptation, enhancement and restoration projects within the Slough Ecosystem and its watershed (Action R-1.3).

A3/4 **Reduce habitat fragmentation -** Identify where habitats are fragmented (including due to berms or culverts) and potential linkages to reduce fragmentation within the Ecosystem. Promote creek restoration projects, especially those that provide fish and wildlife corridors and habitat linkages, as well as upland acquisition (Actions R-4.1 through 4.4).

A4 **Priority for mitigation -** For permitted disturbance of wetlands or other habitats, encourage mitigation first on the project site, then on privately owned land, then offsite,

with the overall goal of providing the greatest benefit to the Ecosystem (Actions R-5.1, 5.2, and 5.3).

D **Land protection -** Support funding for restoration, climate adaptation and/or project mitigation by acquiring land in fee, through easements, etc., using criteria for selection (see criteria in Policy R-6 – Action R-6.1).

Sedimentation and Beach Nourishment

D **Maintain channel conveyance** in the Slough using a variety of approaches that achieve flood control goals, promote natural sedimentation processes of fine sediment and minimize impacts to natural habitats and organisms. Give consideration to reusing trapped or dredged sediment beneficially to enhance existing habitats and promote natural sediment processes to increase resilience to sea levels rising and/or for beach nourishment (Actions P-4.1, 5.1, 5.2 and 6.1).

D **Creek buffers -** Work with local agencies to ensure adequate riparian habitat is available to serve as buffers along Goleta Slough Ecosystem creeks and other sensitive habitats (Action P-4.5).

Support of Specific Species

D **Increase rare habitat types that are or were native to the Ecosystem -** Identify restoration opportunities to create rare habitat types such as upper marsh (transitional) habitats that have been lost from the Ecosystem and are compatible with changing climate conditions. (Action R-1.2 and R-3.1).

A4 **Create habitat types for sensitive species -** Identify restoration opportunities to create habitat that support endangered species that are or were native to Ecosystem and are compatible with changing climate conditions (Action R-3.1) (See 1997 GSEMP for list of habitats - Action R-1.2).

C **Reintroduce extirpated and listed species -** Where feasible and appropriate, reintroduce species that have been extirpated in the Ecosystem using source material from the closest geographical location. Where catastrophes, lack of corridors, or low dispersal rates have led to reduced complexity in the Ecosystem, deliberate reintroduction programs may be appropriate (Action R-3.3).

Watershed/Areawide Issues

A3 **Reduce upstream erosion -** Coordinate with local, state and federal agencies to prepare short, medium and long-term studies and plans to reduce erosion in the watershed and upstream of the Slough (Actions P-4.3 and 4.4).

A3 **Study fluvial–Slough interactions** – Promote studies of the whole watershed to understand the overall health of the Ecosystem including hydrology, sensitive species, habitats and biodiversity (Action E-2.3).

D **Reduce watershed impacts on Slough -** Coordinate with watershed landowners and users to reduce impacts on the Slough due to sedimentation, chemical use, etc. (Action P-4.6).

- **D Minimize point and non-point pollution to improve water quality -** Coordinate with local and state agencies to identify and minimize point and non-point sources of pollution (Actions P-7.1 and 7.2).

- **D Support restoration of properties contiguous to the Goleta Slough Ecosystem** or where could potentially provide important habitat within the watersheds. Identify appropriate restoration sites outside the Ecosystem (Action R-3.4).

4.6 Monitoring Protocols

This section discusses how we measure the effectiveness of management actions on:

1. Status and trends of the Ecosystem;
2. Special status species and rare habitats;
3. Water quality
4. Human health
5. Ecosystem services, e.g., flood control, water quality, wildlife support, recreation etc.
6. Mitigation, restoration and adaptation as it relates to natural resources and processes

Furthermore, the section offers possible standards for and questions about Ecosystem monitoring of natural changes independent of projects. This is needed to maintain awareness of natural resource events and shifts in community composition, recognizing climate change and sea level rise.

Past monitoring programs have focused on assessing the success of mitigation and restoration efforts, concentrating on selected past examples and performance standards for restoration projects. While these are important, given growing concerns about climate change, the shift in focus of monitoring efforts should be to:

1. Establish current conditions as a baseline (e.g., we need to know the kinds, amounts, and distributions of different natural resources to document change and manage them);
2. Compare observed and projected changes (e.g., due to sea level rise, restoration projects, development, etc.) against the baseline that can form the basis for triggering adaptation actions; and
3. Detect short-term or catastrophic events (such as fish kills), especially given the constantly changing conditions in the Slough.

4.6.1 Review of Existing Monitoring Protocols

There have been over 40 restoration and enhancement projects approved and implemented within the Ecosystem area since 1997 totaling over 175 acres. Appendix B lists these projects that include grant-funded restoration and enhancement projects, volunteer projects and major public works projects (e.g., Runway Safety Area, UCSB housing projects, etc.) that required restoration or enhancement. Many of the regulatory agencies discussed in the Background section of this plan were involved in these projects and applied conditions of approval, including monitoring to ensure success.

Within the Goleta Slough Ecosystem area, the scope of maintenance and monitoring requirements for projects has varied greatly depending on the goals of the particular restoration project and, where construction was proposed, the scale of the project and its mitigation requirements. To

illustrate the variation in maintenance and monitoring requirements, Table 4-2, Summary of Maintenance and Monitoring Requirements for Select Projects, provides a comparison of 15 projects that have occurred in the GSEMP area. These projects varied in size from large (relocating two creeks in the Slough to accommodate a shift in the main runway) to small (repair of a gas line located in a wetland). Information about these projects is provided in Appendix B. The mitigation and monitoring requirements for these projects sometimes include comparisons to reference sites but it is often not clear how reference sites are identified and monitored, particularly given the degraded condition of most southern California estuaries.

Table 4-2
Summary of Maintenance and Monitoring Requirements
Select Projects and Programs in Goleta Slough Ecosystem Area

Applicant & year(s)	Project Description and Acreage	Monitoring		
		Time Period	Monitoring Requirements	Performance Standards
PROJECTS				
Goleta Beach County Park 2.0 (2015)	As built approval of revetments and other improve-ments to beach park (29 acres)	20 years - length of approval (5/14/ 2015)	• Baseline and periodic beach profiles established • Monthly revetment inspections • Annual and mid-term (10 years) monitoring assessments	• Exposure of revetment over time would trigger backfilling with sand & planting with native dune plants • Change to beach/shoreline profiles • Change in public access
Goleta Beach County Park Bridge Replacement (2015)	Replacement of existing bridge leading to Goleta Beach Co Park (1.1 ac impacted)	5 years	• General site and biological monitoring data collection all 5 years • Annual report 1st four years and Mitigation Completion Report in year 5	• Restoration of 0.331 ac coastal sage scrub and 0.254 ac of coastal salt marsh • Enhancement of 0.687 ac of coastal bluff scrub and 0.346 ac coastal salt marsh • 2.273 ac of tidal flow restoration and estuarine enhancement
City of Goleta Ekwill-Fowler Road Project (2015)	Two new roads to connect Old Town, Airport & UCSB (0.77 in SB; ±25 ac overall)	5 years	• Biological Mitigation & Monitoring • Plan submitted prior to construction • Annual monitoring reports	• Meet requirements of Biological Mitigation & Monitoring plan • Meet requirements of Tree Protection Plan •
UCSB's Kavli Institute of Theoretical Physics (2014)	35 units for visiting professors (0.05 ac) Tarplant seedbank restoration plan	4 years	• Hand weeding • Individual plantings/seeding of annual species	• Photographs and % cover characterization of the whole site • Percent cover of natives must be 80% after 3 years and 90% after 4 years

Applicant & year(s)	Project Description and Acreage	Monitoring		
		Time Period	**Monitoring Requirements**	**Performance Standards**
Goleta West Sanitary District Mesa Road Trunk Sewer Relocation (2011 - 2015)	Construction of a new 42" trunk line along Mesa Rd & abandonment of existing 33" sewer line in Storke Wetlands (0.15 ac direct impact)	3 years	• Plantings monitored semi-annually 1st year & annually in 2nd & 3rd years • Establishment monitoring during years 1 and 2 • Effectiveness monitoring once vegetation established (years 2 and 3) • Noxious weeds monitored for 3 years & removed if found.	• Site stabilization • Native plant establishment • Invasive weed management • Open space aesthetics
Airfield Storm Drain Restoration Project (2007-2014)	Wetland maintenance and monitoring during the Airfield Drainage System Rehabilitation Project (3.2 ac)	7 years starting in 2007	Monitored and maintained for 7 years in accordance with the California Coastal Commission Coastal Development Permit	• Headwall (Bank) Restoration o Container plants on banks maintained o Noxious weeks shall be removed on as-needed basis & shall not exceed % of adjacent undisturbed areas o If after 3 yrs the native plant cover is not 75% of pre-project conditions, banks shall be re-planted • Seasonal Wetland Areas o Newly established seedlings shall be maintained o Noxious weeks shall be removed from disturbed areas on as-needed basis and shall not exceed that of the adjacent undisturbed areas o If after 3 years the native plant cover has not reached 7% of the pre-project conditions, the areas shall be re-seeded • Upland Restoration Areas o Noxious weed cover maintained at less than 20% cover for 3 years following construction o Cover by native and naturalized plants shall reach 75% by 3 years
Firestone Channel Restoration Project (2004-2008)	Firestone Channel Improvements Project and restoration (0.95 acres)	5 years; 2004-2008	• Monitored for 5 years • Annual monitoring reports	• Planted areas must have 80% survival after the 1st year and 100% survival thereafter • Native cover must be 75% after 3 years and 90% cover after 5 years

Applicant & year(s)	Project Description and Acreage	Monitoring		
		Time Period	Monitoring Requirements	Performance Standards
Las Vegas Creek Project (2004-2008)	Las Vegas Creek Improvements and restoration (0.41 ac)	5 years; 2004-2008	• Restoration must be monitored 2x/ year for a min of 5 years	• Planted areas must have 80% survival after the 1st year and 100% survival thereafter • 75% native cover after 3 yrs and 90% after 5 years
Verhelle Bridge Replacement Project (2006)	Replacement of bridge located off Fairview Avenue and restoration	7 years	• Monitored and maintained for 7 years • Annual monitoring report	• Plantings must have a minimum of 80% survival after the 1st year and 100% thereafter • 75% native cover after 3 yrs and 90% after 5 years • Project site must be without supplemental irrigation for a minimum of 2 years • No single species > 50% of the vegetative cover • No woody invasive spp shall be present and herbaceous invasive spp shall not exceed 5%
UC Santa Barbara West Storke Wetland Restoration (2006)	Restoration of 1.5 acres of 26-acre Storke Wetland	5 years	• 6 vegetation transects – 1-meter quadrants every 3 meters with all species identified & cover estimated. • Bird monitoring monthly over 1 year. • Successful site restoration if 90% cover with native species at end of monitoring period • During monitoring period all artificial inputs (e.g., irrigation) shall be removed. If inputs required beyond 1st 2 years, monitoring period shall be extended one year for every additional year inputs required.	• Revegetation of native plant species ≥ 90% at end of 5 years • Submit written monitoring report for 5 years & final detailed report at end of 5 years. • Bird monitoring requirements also included in monitoring plan.
Western Goleta Slough Restoration Project on	Restoration of parcel owned by CDFG (part of Goleta Slough Ecological	5 years	• 3 years maintenance & 2 monitoring. • Fall of each of 5 years, germination rate of seeds & survival rate of container plants determined by a sampling protocol to establish the	• Qualitative inspection 4x/year & quantitative 2x/year (spring & fall) during maint. period. • Spring & fall monitoring for next 2 years including # of container plants that have died. • 70% native cover by end of year 3 & retain 70%

Applicant & year(s)	Project Description and Acreage	Monitoring		
		Time Period	Monitoring Requirements	Performance Standards
CDFG land (2006)	Reserve). Project sponsored by Land Trust of Santa Barbara County		requirement for replacement planting. • Fixed line transects to sample for: o Species occurring within transect, species wetland indicator status & whether native or introduced o % absolute plant cover & cover of native v. non-native species o Depth of water.	coverage by end of 5-year maintenance & monitoring period. • Non-native invasive weeds (excluding grasses) <10% of total cover. • After 5 years, woody or herbaceous invasive species (excluding grasses) shall not exceed 5% cover. • Vegetation must survive w/o irrigation for minimum of 2 years. • No single species shall constitute > than 50% of vegetative cover. • Replacement plants shall be monitored for a minimum of 3 years.
Sempra Line 80 Repair Work (So Cal Gas Co. - 2006)	Inspect and maintain 3,400 linear feet of above-ground and subterranean natural gas pipeline including temporary disturbance of 0.2 acres of salt marsh & adjacent upland habitat.	3 years	• Belding's Savannah Sparrow – At least 2 early morning surveys 1 week prior to pipeline work. If 1 or more BSS observed displaying breeding or nesting behavior w/in 300' of project's footprint, work ceases. Work may resume when no breeding/nesting birds in area. • Maintenance monitoring of plants monthly for 1st 6 months, then quarterly through 2nd year. • Performance monitoring conducted at least once per 3 years.	• For pickleweed-dominated areas a min. of 80% total vegetative cover. Of that, at least 80% of cover is native species & a max. of 20% non-native species. • For transition/upland areas a min. of 50% total vegetative cover of which 60% is natives & a max. 40% cover and/or 10% frequency of non-native species. • If performance criteria met sooner, project considered a success & no further monitoring.
City of SB Airport Airfield Safety Projects (2003)	Relocation of main runway 800 feet to the west including rerouting and restoring Carneros and Tecolotito Creeks	7 years	• 3 years maintenance & 4 monitoring of plants. • In maintenance period – regularly scheduled maintenance (watering & replanting), formal monitoring inspections 6x/year & annual reports	• Performance criteria differentiated between 4 sites & type of wetland: o Berms & tidal salt marsh - Min. of 85% natives & max. of 10% non-native weedy species at 7 years. o Area I amongst uplands & adjacent to tidal marsh – Min. of 75% natives & max weeds of 10% at 7

Applicant & year(s)	Project Description and Acreage	Monitoring		
		Time Period	**Monitoring Requirements**	**Performance Standards**
			for agencies. • In monitoring period – As needed maintenance work & formal monitoring 4x/year. • After 7-year program, as needed weeding & formal monitoring inspections 4x/year. • Non-native invasive weeds must remain <15% of total vegetative cover during 7-year maintenance & monitoring period & for perpetuity. • Annual monitoring reports	years o Area R-2 amongst upland & wetland grassland mosaic – Same as Area I. o New banks of Tecolotito & Carneros Creeks – Min. of 10% natives & max. of 10% weedy species at end of 7 years. • Seeding & plant survival of 70% at end of 1st year & 80% at end of 2nd year. If not met, replanting & reseeding will occur as needed.
City of Santa Barbara Airport Safety Area Grading Mitigation Project (1997)	Grading of areas adjacent to runways and taxiways, some of which was in Goleta Slough Ecological Reserve and GSR Zone.	7 years	• 2 years maintenance & 5 years monitoring • Transects throughout site: o Plant species – Wetland indicator, native or introduced? o % absolute plant cover o Depth of water or wet soil o Soil salinity at surface & 12-15” o Soil pH at surface & 12-15”	• Plant survival of ≥ 80% per species • % vegetation cover of a minimum of 40% after 3 years, 45% after 4, 50% after 5, 60% after 6 & 70% after 7 years • Plant species diversity – survival of at least 8 of planted species with no one species > 40% of cover
PROGRAMS/MANAGEMENT				
Goleta Slough Mouth Management (2015)	Management program for Goleta Slough mouth	TBD	TBD	TBD

Applicant & year(s)	Project Description and Acreage	Monitoring		
		Time Period	Monitoring Requirements	Performance Standards
County Flood Control 5-year Maintenance Program (2010)	5-year program for maintenance of creeks, sediment basins, etc.	5 years	• Spill Prevention Plan • Water Quality Sampling & Analysis Plan • Restoration/Revegetation Plans • Oak Tree replacement • Raptors & breeding bird monitoring • Marine turbidity plume monitoring • Archaeological site monitoring	See document.
Goleta Slough Tidal Restoration and Birdstrike Experiment (2003)	Short-term field experiment to increase tidal circulation for wetland enhancement purposes. Creation of small tidal basin & control basin.	3 years	• Monitored bird variety & use, vegetation establishment, benthic macro-invertebrates (BMI), tidewater goby, & tidal features (hydrology & water quality) responses to new hydrologic regime. • Initially 2 year experiment but added 3rd year due to inconclusive results relating to bird strike hazard	• Changes in overflights by birds, particularly those called “high-hazard individuals” such as geese, pelicans, etc. considered hazardous to aviation • Increase in average % native plant cover & decrease in non-native cover. • Successful colonization by BMI similar to Tecolotito Creek. • Tidal features (e.g., water quality) within expected range for tidal basins.

4.6.2 Considerations for future monitoring

The review of existing monitoring protocols raises questions that need to be considered in future monitoring programs:

- For any project, consider:
    - What is the question being asked? What specifically is it you want to know? How will monitoring help answer the question?
    - What resources do you have to bring to the task?
    - How will results be stored and tracked so they can be used again in the future?
- Specific consideration should be given to:
    - Be clear in the specification of native species.
    - Choose appropriate metrics to answer specific questions
    - Reference sites are needed to guide and measure the desired future condition.
    - Establish permanent plots to detect long-term vegetation changes at the community level.
    - Monitoring protocols should be specific to each vegetation (e.g., herbaceous v. shrub v. woodland) and habitat type.
    - Monitoring should be tailored to management actions (e.g. containerized plantings should have their own standards as compared to seeded areas) and to habitat type.

4.6.3 Ecosystem-wide protocols for future monitoring

There is a pressing need for a comprehensive, well-designed, and rigorous biological monitoring program to collect information used to guide restoration, adaptation and management actions. This would help address:

- Long term change in environmental variables related to climate change;
- Naturally-occurring events in the estuary which may be overlooked due to restricted physical and visual access to many parts of the Slough;
- Ensure that monitoring occurs in all parts of the Slough including areas that have security restrictions related to the Airport.

Such a program would focus not just on the most vulnerable areas that are changing today, but would look at adjacent areas for possible future restoration and areas to relocate habitats. Such a program would provide consistent long-term information that tells the “story” of the Slough evolution, e.g., sediment accretion in 5-year intervals.

A comprehensive program needs to define the following protocols and set performance standards to trigger adaptive actions:

Physical Performance Standards – Depending on the scope of the project’s impacts or ecosystem monitoring goals, possible physical performance standards could include:

Water Quality. Water quality variables [to be specified] shall be similar to reference wetlands.

Habitat or species survival areas. The area of different habitats or species shall not vary by more than X percent from the areas or species indicated in the final restoration plan.

Tidal Range. Depending on the target species, habitat or ecosystem monitoring goals, the designed tidal range shall be maintained to the maximum benefit of as many species and habitats as possible and consistent with approvals, particularly as it relates to the Goleta Slough mouth.

Biological Performance Standards – Depending on the scope of the project's impacts or ecosystem monitoring goals, possible biological performance standards could include:

Specific success criteria by habitat type – Rather than looking at the entire mitigation or restoration area, different habitat types should have different requirements, e.g., wetlands, uplands, shrub layers, herb layers, etc.

Native cover – Define what constitutes native cover and whether it is relative or absolute cover. Provide specific standards for each layer or vegetative type, e.g., herbaceous cover standards would likely be different from shrub cover standards. Providing reference sites to show the desired future condition is advantageous.

Biological Communities. Within X years of construction, the total densities and number of species and/or of fish, macro-invertebrates and birds shall be similar to the densities and number of species in similar habitats in the reference wetlands.

Vegetation. The proportion of total vegetation cover and open space in the Slough shall be similar to those proportions found in the reference sites that are determined as part of the mitigation program. The percent cover of algae shall be similar to the percent cover found in the reference wetlands.

Recolonization by invasive species – The proportion of invasive species as defined in the restoration plan shall not exceed X percent. Respond to and eradicate invasive species as outlined in the plan.

Reproductive Success. Certain plant species, as specified in the restoration plan, shall have demonstrated reproduction (i.e., seed set) at least once in X years.

Food Chain Support. The food chain support (to be defined based on the monitoring goals) provided to birds shall be similar to that provided by the reference sites, as determined by feeding activity of the birds.

Exotics. Remove exotic species immediately upon detection.

Maintenance activities and equipment used. Institute cleaning protocols for equipment to prevent introducing weeds into project areas, and to prevent spreading weeds from one area to the next.

Other Standards – Depending on the scope of the project's impacts or ecosystem monitoring goals, other possible standards could include:

Cultural Resources. Where environmental review process has shown that cultural resources may be present on a project site, provide appropriate studies and monitoring to ensure protection.

4.6.3 Existing and Additional Ecosystem Monitoring Efforts

In the coming years, the triggers or thresholds when adaptation strategies are implemented need to be determined. The baseline for these triggers needs to be established to some degree and should begin with the existing monitoring programs that are listed in Table 4-2 below, subject to site-specific studies and input from experts. Table 4-3 lists additional Ecosystem monitoring efforts that would be needed to begin to create a comprehensive monitoring program.

Table 4-3
Existing Ecosystem Monitoring Efforts

Program	Frequency
Vertebrates	
Belding's Savannah sparrow surveys	Typically monitoring tied to mitigation for projects that may impact habitat
White-tailed Kite surveys	Nesting season, roost site documentation
Fish surveys – Tidewater goby, Steelhead trout	Occasional
Shorebirds on beach	Uncertain
Invertebrates on beach	Unknown
Mosquitos	Unknown
Hydrology	Ongoing (if possible)
Water Quality	See these websites: • SB County Water Resources Div. (http://cosb.countyofsb.org/pwd/pwwater.aspx?id=2956) • SB City Project Clean Water (http://www.santabarbaraca.gov/gov/depts/parksrec/creeks/default.asp) • SB Channelkeeper (http://www.sbck.org) websites

Table 4-3
Additional Ecosystem Monitoring Efforts

Program	Frequency	Data Gathering
Natural Resources	TBD	Inventories of all natural resources in the Ecosystem including terrestrial and aquatic flora and fauna
Physical Processes	TBD	Sediment accretion rates measured using SET tables. Coring could be undertaken to understand historic rates
General bird survey	Monthly at least	Astute observer familiar with the Ecosystem and armed with a checklist of things to be attentive to. The checklist would conform somewhat to the skills of the observer.
Aquatic Species	TBD	These are often the species most affected by Slough changes.

Program	Frequency	Data Gathering
Mammal trapping	Quarterly for 1 year; repeated at some TBD frequency	Permitted trapper who will provide desperately needed baseline information on mammal species present and the condition of the processes that sustain those habitats.
Vegetation Surveys	Quarterly for one year; repeated at some TBD frequency	Establish a system of permanently marked or well-identified baselines for vegetation in different habitat types at "representative areas." Some of these areas may be found to be suitable to serve as "reference sites" but they will be changing, too.
Water Quality	During dry and wet periods; Weekly or biweekly; and/or continuous	Data loggers should be used when appropriate; Sampling should include water temperature, salinity, Dissolved O_2, Nitrate (NO_3), Total Dissolved Nitrogen, Total Suspended solids (TSS), Total Petroleum Hydrocarbons (TPH), Phosphates, Ammonium (NH_4), Sediment Cores, metals, conductivity, pH, etc. Dissolved oxygen should be monitored using continuous data loggers placed at various locations and at various depths to accurately detect minimum DO.
Flooding events	During events	Could use tide gauges to provide comparative results (e.g., Atascadero bike bridge v. at the tide gate in the Slough) and pressure transducers to measure water levels, high water marks, extent of depths, velocities, etc. Sediment flow patterns would also be helpful.

4.7 Future Updates to the Plan

The *Goleta Slough Area Sea Level Rise and Management Plan* is an update to the 1997 GSEMP and 2012 *Existing Conditions and Monitoring Report* prepared by GSMC. It also includes a thorough assessment of the Ecosystem's vulnerability to climate change and sea level rise and potential impacts and adaptations to address these phenomena. This is the first of several studies and plans being done in the area to assess the effects of climate change on habitats, infrastructure and existing land use development.

As mentioned several times in this Plan, this is an informational document and that will hopefully serve as a basis for updates to local and regional agencies' plans, including those that address SLR vulnerability and potential adaptations, and during the review of proposed projects. Our intent is that, as new information and methodologies become available and plans and studies are completed, where appropriate they will be incorporated or referenced in an update to this Plan, including updating the goals, policies and actions of this Plan. Regardless, as noted in Action A-1.5, our intent is that this Plan will be updated every five years or as needed.

We look forward to working with public interest groups, property owners, local jurisdictions and state and federal agencies to continue to improve this unique Ecosystem for all.