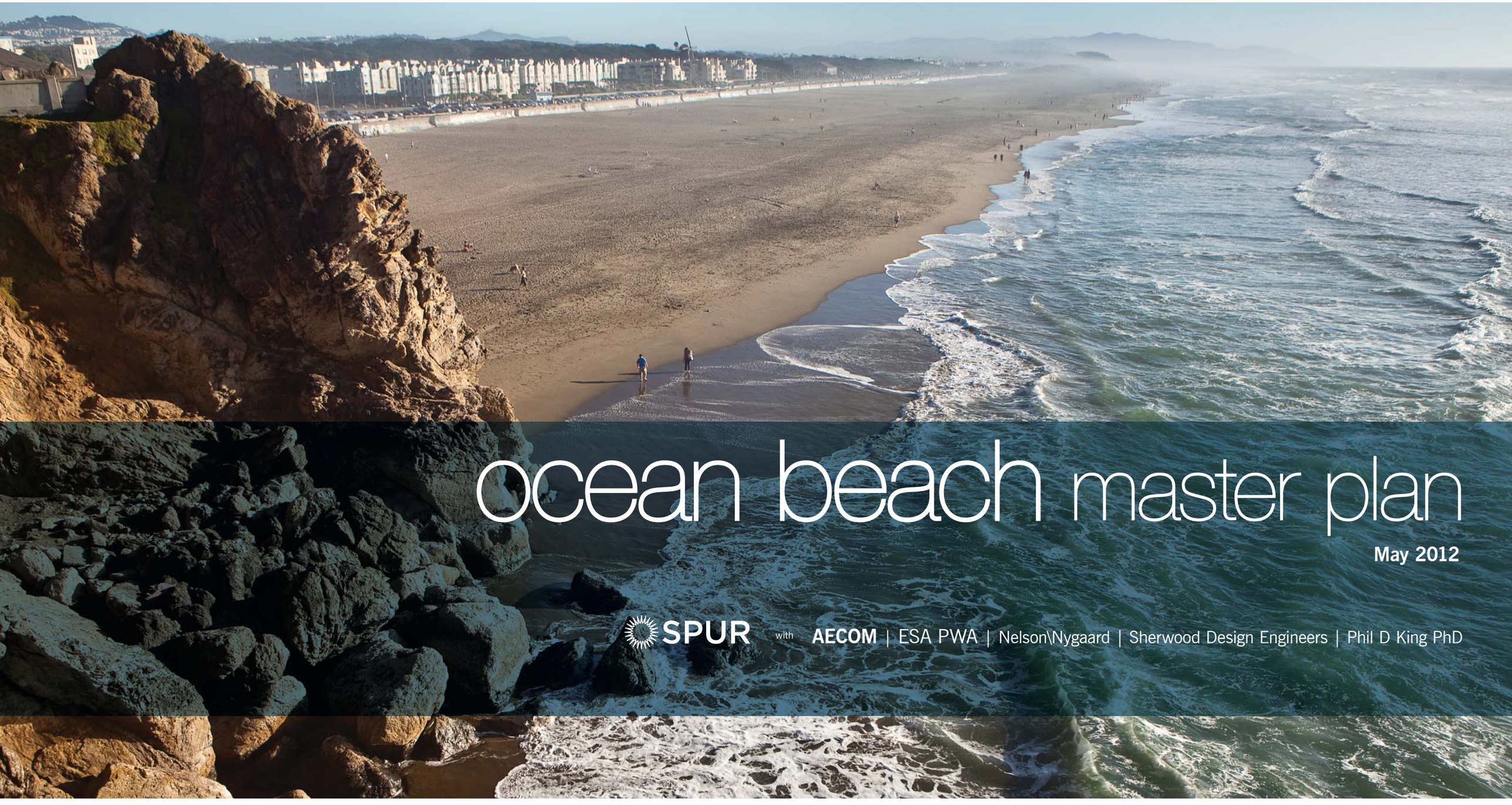

ocean beach master plan

May 2012

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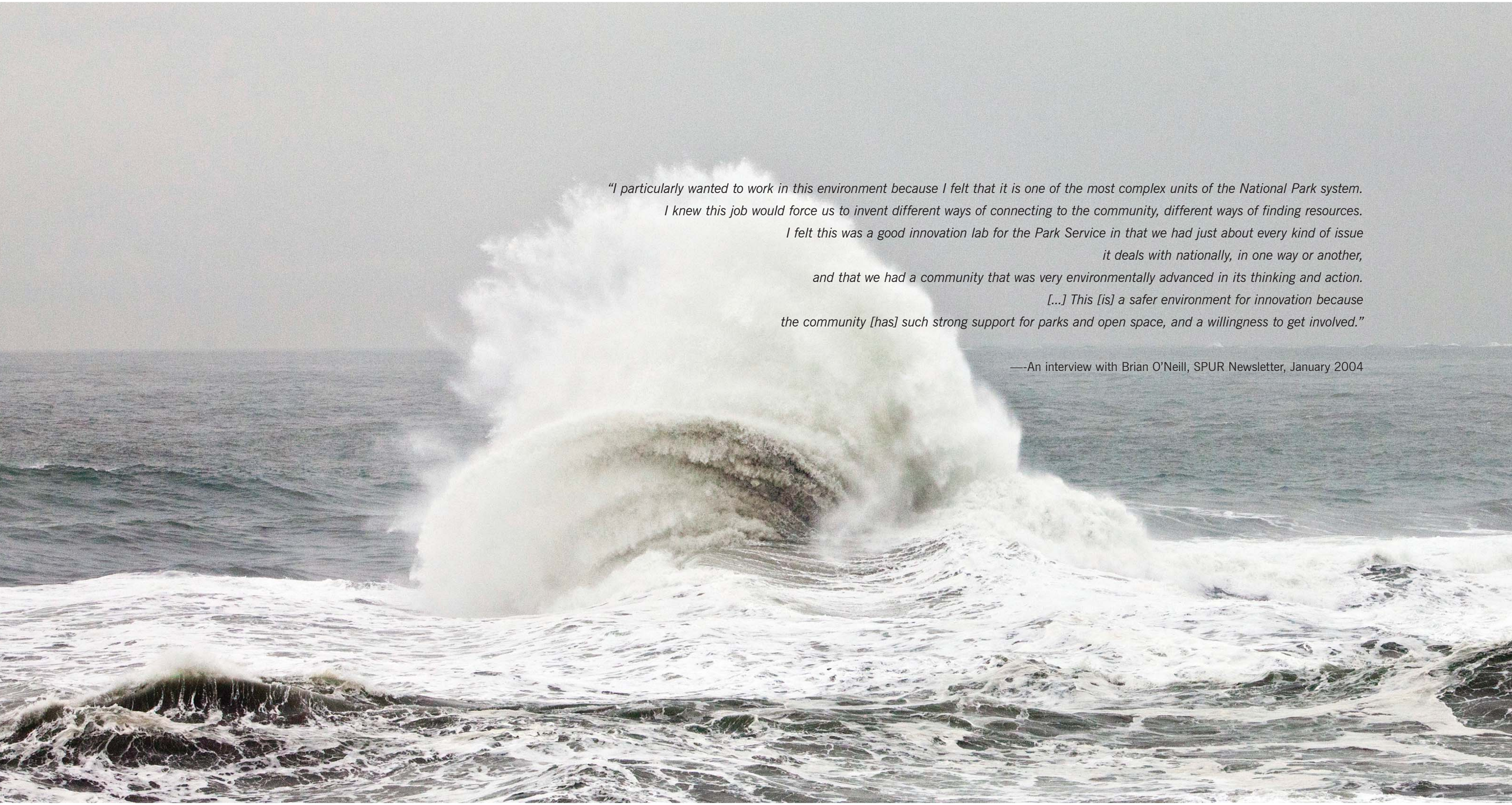
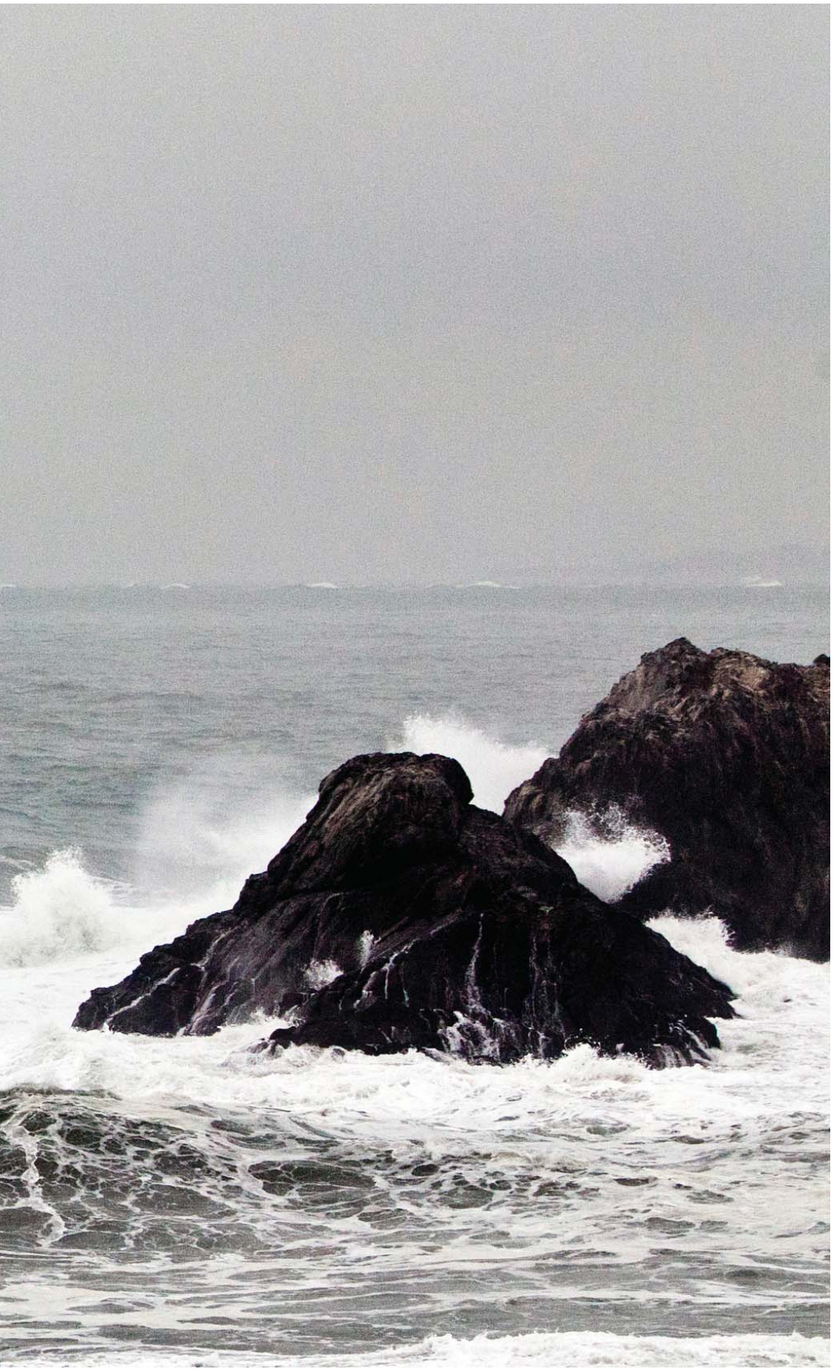


"I particularly wanted to work in this environment because I felt that it is one of the most complex units of the National Park system.
I knew this job would force us to invent different ways of connecting to the community, different ways of finding resources.
I felt this was a good innovation lab for the Park Service in that we had just about every kind of issue
it deals with nationally, in one way or another,
and that we had a community that was very environmentally advanced in its thinking and action.
[...] This [is] a safer environment for innovation because
the community [has] such strong support for parks and open space, and a willingness to get involved."

—-An interview with Brian O'Neill, SPUR Newsletter, January 2004



This document is respectfully dedicated
*to the memory of **Brian O'Neill** (1941-2009),*
beloved superintendent of the
Golden Gate National Recreation Area.

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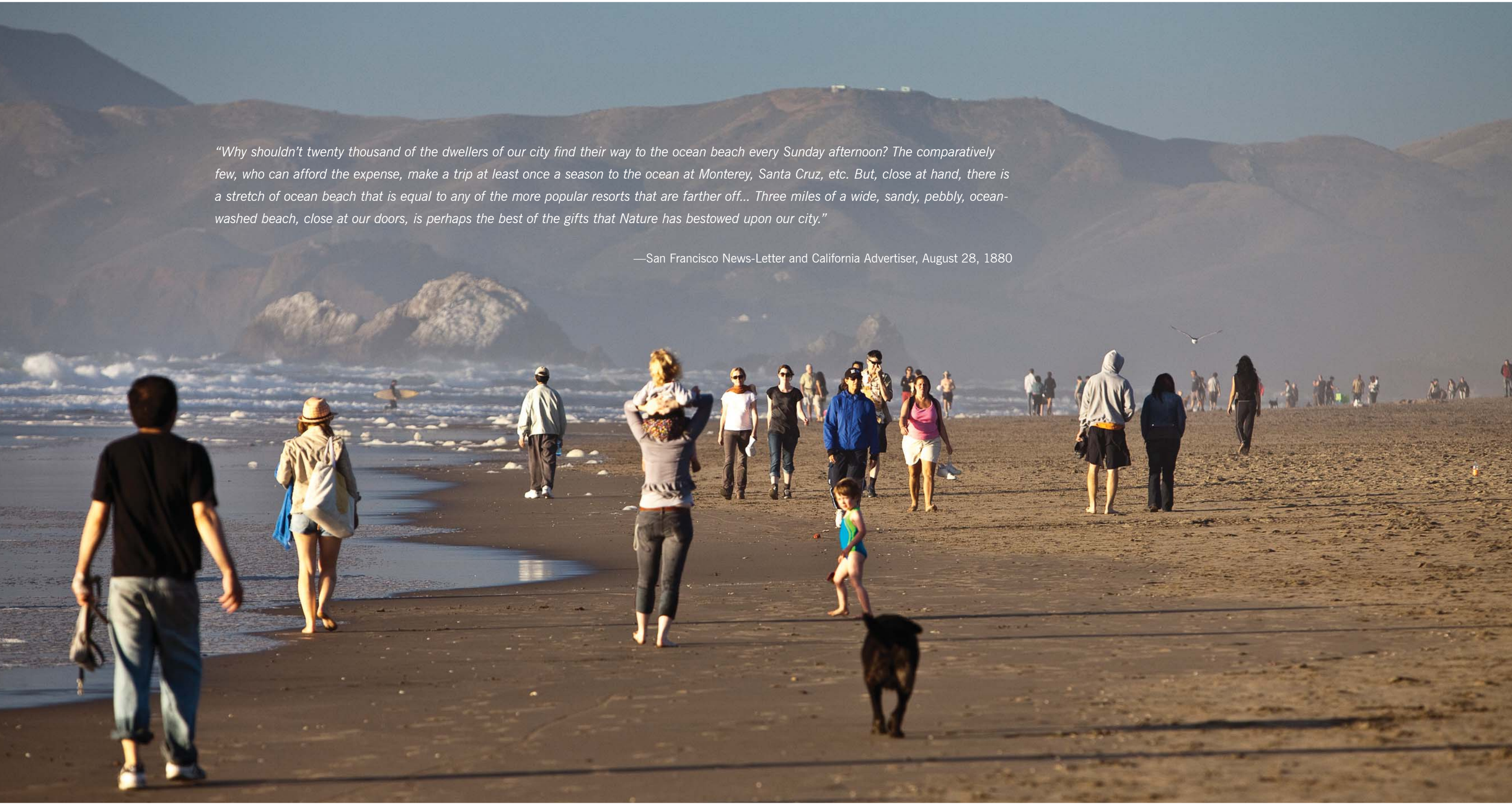

"Why shouldn't twenty thousand of the dwellers of our city find their way to the ocean beach every Sunday afternoon? The comparatively few, who can afford the expense, make a trip at least once a season to the ocean at Monterey, Santa Cruz, etc. But, close at hand, there is a stretch of ocean beach that is equal to any of the more popular resorts that are farther off... Three miles of a wide, sandy, pebbly, ocean-washed beach, close at our doors, is perhaps the best of the gifts that Nature has bestowed upon our city."

—San Francisco News-Letter and California Advertiser, August 28, 1880

executive summary

Executive Summary Table of Contents

- Overall Project Goal and Aspirations
- Seven Focus Areas
- Test Scenarios
- Evaluation Criteria
- Master Plan Recommendations: Six Key Moves
  - Assumptions
  - South Reach: South of Sloat Boulevard
    - Key Moves 1 & 2
  - Middle Reach: Lincoln Avenue to Sloat Boulevard
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  - North Reach: Lincoln Avenue to 48th Avenue
    - Key Moves 5 & 6
- Implementation Actions

executive summary

This plan presents recommendations for the management and protection of San Francisco's Ocean Beach, 3.5 miles of beach and rugged coast from the Cliff House to Fort Funston. Ocean Beach is a national park, a popular urban open space, the site of a major infrastructure complex and a beloved San Francisco landscape. It faces a wide range of complex challenges — including severe erosion, jurisdictional issues, a diverse array of beach users and points of view, and the looming challenge of climate-induced sea level rise.

This document describes the challenges and presents a series of recommendations that chart an ambitious and proactive course for a more sustainable future. The Ocean Beach Master Plan (OBMP) is the result of a robust, 18-month-long public process in which a wide range of stakeholders and the public participated over an 18-month period. Several earlier efforts brought attention to the ongoing issues at Ocean Beach. This plan translates that energy into a series of implementable actions by the responsible agencies over a nearly 40-year period.

Seven Focus Areas [section III, page III-1]

The complex issues facing Ocean Beach are addressed through seven Focus Areas, each of which is described in some detail. In summary, they are as follows:

1 Ecology

Ocean Beach is a national park and supports important natural resources, including two threatened birds and other migratory waterfowl. Its non-native dunes hold the potential for ecological restoration, which could provide improved habitat for native species and a corridor linking other park resources.

2 Utility Infrastructure

A major complex of wastewater infrastructure, which protects coastal water quality, is located at Ocean Beach. The Oceanside Treatment Plant is fed by large stormwater and wastewater transport structures under the Great Highway, which are subject to erosion hazards.

3 Coastal Dynamics

Ocean Beach is the visible portion of a much larger coastal sediment system. Erosion problems will worsen with climate-related sea level rise, and will need to be managed through a variety of approaches, including retreat, nourishment and coastal armoring. Ongoing dredging of the Golden Gate marine shipping channel provides a ready source of sand for nourishment of Ocean Beach.

4 Image and Character

Ocean Beach has a wild, rugged character and a unique culture and history. Once home to destinations like Sutro Baths, Playland and Fleishhacker Pool, today the beach draws users who find the elemental beauty of its wind, waves and fog a scenic respite from the city. Improvements should retain and draw upon these qualities.

5 Program and Uses

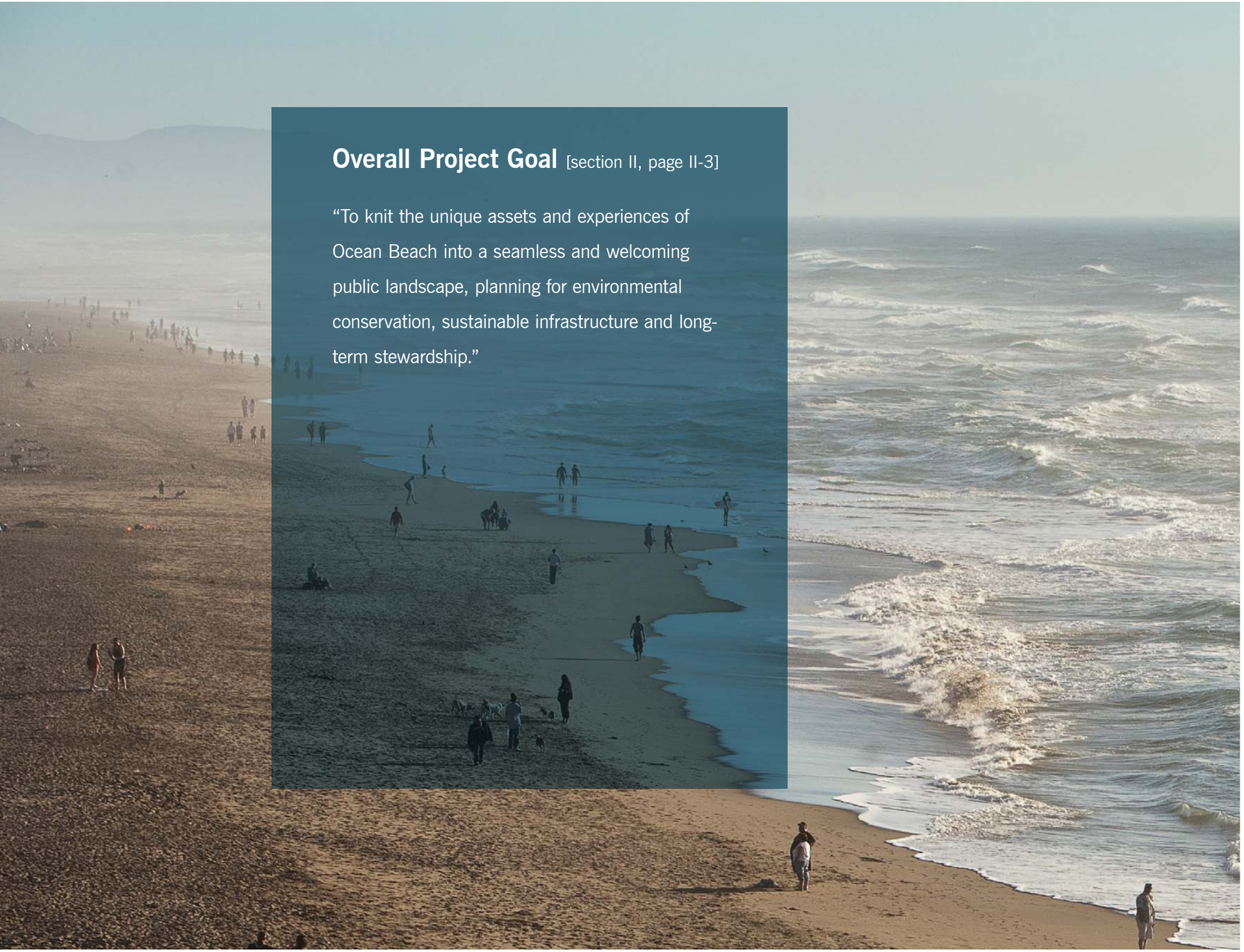
Ocean Beach is used in a variety of ways, from bird-watching to surfing to dog walking, that can come into conflict. It should be managed to benefit everyone.

6 Access and Connectivity

Ocean Beach links a wealth of open spaces and is transit-rich, but key gaps and some problematic street configurations could be improved to welcome all users, especially cyclists and pedestrians.

7 Management and Stewardship

Though visitors experience a single place, a host of different federal, state and local agencies are responsible for different aspects of Ocean Beach, and they lack a shared guiding policy. The recommendations in this plan, and the dialogue they reflect, are important first steps in working across jurisdictional boundaries for the benefit of all.



Overall Project Goal [section II, page II-3]

"To knit the unique assets and experiences of Ocean Beach into a seamless and welcoming public landscape, planning for environmental conservation, sustainable infrastructure and long-term stewardship."

Project Aspirations [section II, page II-4]

Focus Area 1: Ecology
Restore and establish conditions that support thriving biological communities.

Focus Area 2: Utility Infrastructure
Evaluate infrastructure plans and needs in light of uncertain coastal conditions, and pursue a smart, sustainable approach.

Focus Area 3: Coastal Dynamics
Identify a proactive approach to coastal management, in the service of desires outcomes.

Focus Area 4: Image and Character
Preserve and celebrate the beach's raw and open beauty while welcoming a broader public.

Focus Area 5: Program and Uses
Accommodate diverse activities and users, managed for positive coexistence.

Focus Area 6: Access and Connectivity
Provide seamless and fluid connections to adjacent open spaces, the city and the region.

Focus Area 7: Management and Stewardship
Provide an approach to long-term stewardship across agencies, properties and jurisdictions.

executive summary

Test Scenarios [appendix, page A-29]

The Ocean Beach Master Plan team developed four Test Scenarios to model the outcomes of very different approaches to managing Ocean Beach through 2100. These scenarios and tested a wide variety of ideas from stakeholders and the public, and organized technical analysis, modeling singular goals to their extremes. They are not proposals or alternatives. The four scenarios are:

> Maximum Habitat
> Maximum Recreation
> Maximum Green Infrastructure
> Maximum Infrastructure

Evaluation Criteria [section VII, page VII-2]

Criteria were developed in consultation with the OBMP Planning Advisory Committee to evaluate outcomes of Test Scenarios and Plan Recommendations. The criteria present key objectives within each focus area and rate each on a five-point scale.

Figure 0-1 (opposite page):
Master Plan Aerial View

Artist's sketch of Ocean View Master Plan's vision from the southwest.

executive summary

Plan Recommendations: Six Key Moves [section V, page V-5]

These six Key Moves outline the Ocean Beach Master Plan's major recommendations. Each one includes many individual recommendations, for more than 40 in all. They are organized by three geographical reaches and are designed to be implemented incrementally over a period of decades.

Assumptions that inform plan recommendations include:

> Analysis and modeling to 2100 horizon
> Recommendations to 2050
> Ongoing monitoring and adaptive management
> Reevaluation in 2030

South Reach: South of Sloat Boulevard

Key Move 1:

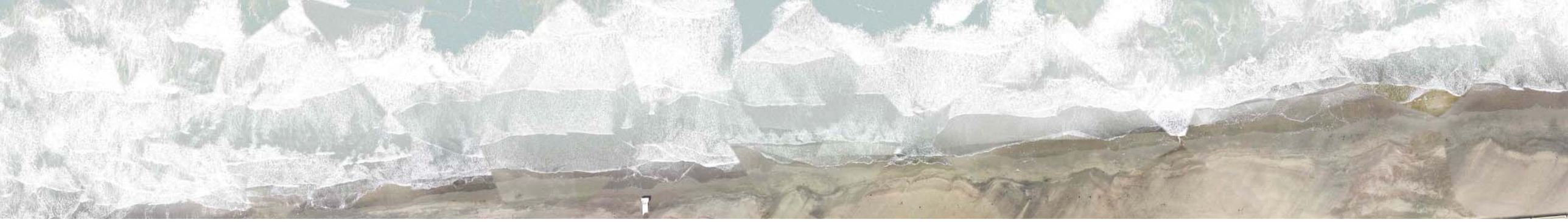
Reroute the Great Highway behind the zoo via Sloat and Skyline Boulevards

> Close the Great Highway south of Sloat and replace it with a coastal trail
> Reconfigure Sloat and key intersections to create a safer, more efficient street
> Consolidate street parking, the L Taraval terminus and bicycle access along the south side of Sloat
> Reconfigure the zoo's parking lot for access via Skyline and Zoo Road

Key Move 2:

Introduce a multipurpose coastal protection/restoration/access system

> Incrementally dismantle the Great Highway and parking lots, allowing erosion to proceed inland
> Protect the existing Lake Merced Wastewater Tunnel in place with three layers: a low-profile hard structure, a cobble berm or dynamic revetment, and placed sand
> Allow storm surges to wash over the tunnel and dissipate toward higher ground
> Restore and revegetate the surface to allow recreational and ecological functions



Middle Reach: Lincoln Way to Sloat Boulevard

Key Move 3:

Reduce the width of the Great Highway to provide amenities and facilitate managed retreat

- > Narrow the Great Highway from four lanes to two south of Lincoln
- > Use the current southbound lanes for parking pockets, restrooms, signage, etc.
- > Introduce a multiuse promenade west of the road
- > Between amenities, allow dunes to migrate inland over the road and transport box

Key Move 4:

Restore the dunes along the middle reach

- > Nourish the beach with sand dredged by the Army Corps of Engineers along the southern end of the Middle Reach
- > In phases, restore native dunes in key locations, especially at Lincoln and Vicente
- > Install sand ladders and modular boardwalks to provide access, limit impacts

North Reach: Lincoln Way to 48th Avenue

Key Move 5:

Create a better connection between Golden Gate Park and Ocean Beach

- > Tighten and reconfigure the parking lot at the O'Shaughnessy Seawall parking lot to improve pedestrian conditions, bike access and traffic circulation
- > Introduce permeable paving, amenities and appropriate vegetation to create a more welcoming, attractive space
- > Retain events capacity and historic character

Key Move 6:

Introduce bicycle and pedestrian improvements north of Balboa Street

- > Narrow the Great Highway and Point Lobos Avenue from four lanes to two
- > Introduce a physically separated bikeway with connections to Lands End and beyond

Implementation Actions [section VI, page VI-1]

As a nonregulatory plan, the Ocean Beach Master Plan does not have the force of policy or law. Rather, it lays out a vision based on the extensive participation of all stakeholders and responsible agencies and serves as a guidance document for future actions. Implementation of these recommendations depends on each agency initiating projects, conducting technical studies and undertaking environmental review according to its own planning processes.

Implementation of some of the recommendations will require public agencies to conduct environmental review under the California Environmental Quality Act (CEQA) or the National Environmental Policy Act. They may also require a Coastal Development Permit under the California Coastal Act.

SPUR has received additional funding from the State Coastal Conservancy, the San Francisco Public Utilities Commission and the National Park Service to pursue implementation of plan recommendations through the following projects:

- > Ongoing implementation leadership and coordination
- > Circulation and access study
- > Joint coastal management framework
- > Joint open space management plan

Figure 0-2:
Ocean Beach Master Plan Illustrative

The Ocean Beach Master Plan responds to desired outcomes within the beach's three reaches (i.e.—improved access, restored ecological health, a sense of history) by providing a series of recommendations that support them through a diverse array of strategies.

Ocean Beach Master Plan Key Moves:

1. KEY MOVE 1: Reroute the Great Highway behind the zoo via Sloat and Skyline Boulevards
2. KEY MOVE 2: Introduce a multipurpose coastal protection/ restoration/access system
3. KEY MOVE 3: Reduce the width of the Great Highway to provide amenities and facilitate managed retreat
4. KEY MOVE 4: Restore the dunes along the middle reach
5. KEY MOVE 5: Create a better connection between Golden Gate Park and Ocean Beach
6. KEY MOVE 6: Introduce bicycle and pedestrian improvements north of Balboa Street

"Ocean Beach is a natural treasure, which unfortunately over the years has slid into neglect. We can't expect to turn things around unless we put an end to temporary solutions and create a long-term strategy that takes the environment and future recreational uses into consideration."

—Mayor Gavin Newsom, announcing the appointment of the Ocean Beach Vision Council, 2008

introduction

section

Section I: Introduction Table of Contents

About Ocean Beach
- Ocean Beach: A Brief History
- Erosion Emergency: Response and Criticism
- Adaptation: Planning for a Changing Climate
- Multiple Jurisdictions
- Partner Agencies

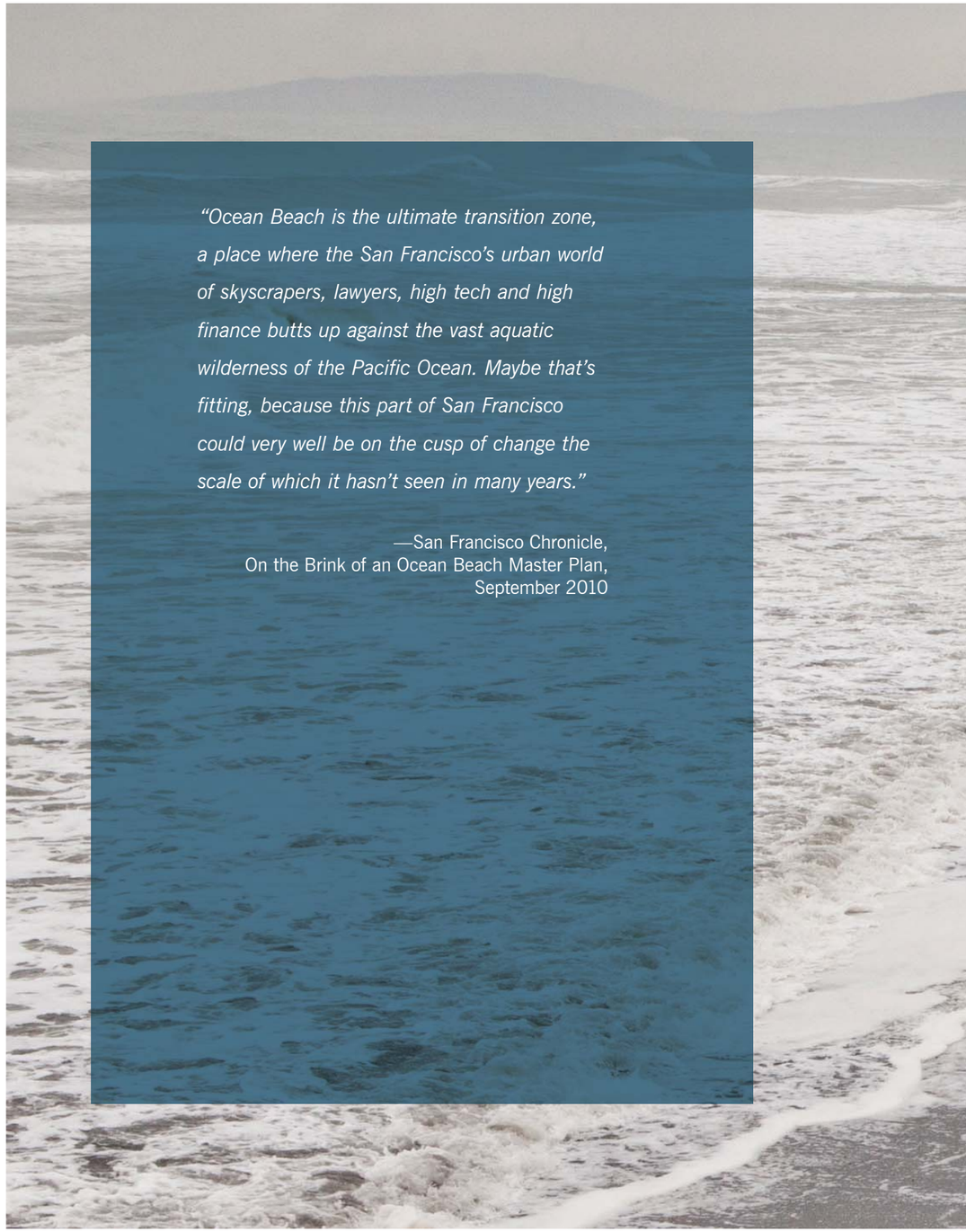
About This Project
- What Is the Ocean Beach Master Plan?
- Project Funders
- Scope and Study Area
- About this Document

introduction

About Ocean Beach

Ocean Beach, a 3.5-mile stretch of sand along San Francisco's rugged Pacific coast, is one of the gems of the city's landscape. It draws a diverse population of more than 300,000 visitors each year to stroll, bike, surf, walk dogs and enjoy the stunning natural setting. It is an important piece of the Golden Gate National Recreation Area, a wild landscape, an urban sea strand and a grand public open space. Ocean Beach is also home to major elements of San Francisco's wastewater and stormwater infrastructure, which protects coastal water quality.

Ocean Beach is a challenging setting, exposed to the relentless pounding of ocean waves. Over more than a century, it has been pushed more than 200 feet seaward of its natural equilibrium. Neighborhoods, roads, parks and infrastructure have been built close to the coastline, and seawalls and other structures have been installed to protect them. Erosion has taken a toll, and is likely to worsen with climate-related sea level rise. We face difficult choices about how to manage these hazards while maintaining valued resources. Deepening these challenges is the complex array of federal, state and city agencies that oversee Ocean Beach, each with different responsibilities and priorities. This plan examines Ocean Beach as a whole, and proposes a series of actions to preserve and enhance it into the future.



The history of Ocean Beach illustrates how this managed landscape has been shaped over time by a series of human interventions that reflect evolving perceptions of the beach and its relationship to the city.

A Brief History

Ocean Beach, San Francisco's portal to the vast Pacific, offers a sense of rugged wildness at the city's edge — a quality well suited to its identity as a national park. But it is very much a managed landscape, shaped over time by a series of human interventions that reflect evolving perceptions of the beach and its relationship to the city.

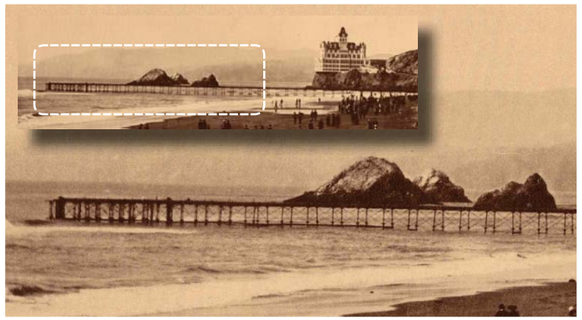
A century ago, Ocean Beach was a very different kind of place, more Coney Island than Yosemite. Before the Richmond and Sunset Districts took shape in the "Outside Lands," Adolph Sutro's 1888 steam railway drew day-trippers through miles of sand dunes to his gardens and to Sutro Baths — at the time the world's largest natatorium. As cable cars and later trolleys took over, "Carville," a settlement built of decommissioned horsecars, offered a destination for bohemians and bicycle clubs. Amusement concessions near Fulton Street were gradually consolidated into Chutes-at-the-Beach (later Playland-at-the-Beach), which offered rides and games into the 1970s and gave the world the It's-It ice-cream sandwich. This evolving cluster of beach amusements was a boisterous outpost of the city, and offered a transit-based escape for ordinary San Franciscans for whom tonier destinations were out of reach.

The Fleishhacker Pool, a massive saltwater recreation center near the current site of the San Francisco Zoo, was built in 1924, and served generations of San Francisco swimmers until its closure in 1971. The pool, since filled, is the current site of the zoo parking lot. Its decrepit poolhouse today offers a tempting opportunity for adaptive reuse.

Cliff House - (1858; 1863; 1896; 1937; 2003 to date)

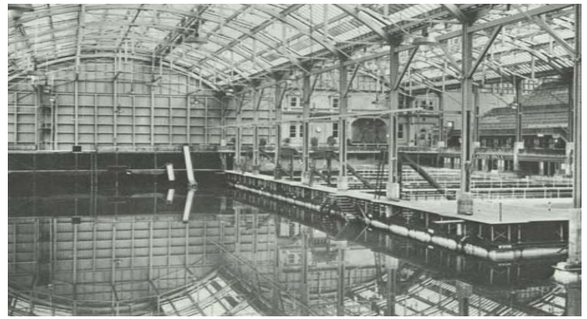
1863

Lurline Pier - (1894 to 1967)



1894

Sutro Baths - (1896 to 1966)



1896

O'Shaughnessy Seawall at Kelly's Cove - (1920s to date)

1920

As the automobile came to prominence, the soft sand and other fill was pushed seaward to create a “Great Highway” for Sunday drivers, which was improved, straightened and widened over several decades. Dune stabilization efforts, such as fences at the high-tide line, had begun at Ocean Beach in the 1860s. Efforts to widen the Great Highway by dumping fill began as early as 1890 with a series of improvements following over several decades.

In 1929, the Great Highway, Esplanade and O’Shaughnessy Seawall (with its unique and still extant equestrian ramp) were ceremoniously opened. This completed the Great Highway’s transition to an automobile expressway, touted as the widest paved roadway in the United States.

The O’Shaughnessy Seawall also inaugurated serious efforts to resist coastal erosion. It was followed by the Taraval Seawall in 1941 and the Noriega, or “new,” Seawall in the 1980s. With the addition of boulder revetments south of Sloat Boulevard in the last 15 years, more than 10,000 feet of coastal armoring now lines Ocean Beach, with important implications for future coastal management. Since the 1970s, significant amounts of sand have also been placed to counteract erosion.

As amusements and recreational facilities declined, Ocean Beach took on a new identity as a national park, with the beach and dunes becoming federal property in 1975, and a new emphasis on natural resources and the beach’s wild character.

In 1974, the San Francisco Public Utilities Commission issued its Sewer System Master Plan, which called for upgrading sewer infrastructure citywide to reduce pollution caused by combined sewer-stormwater overflows and bring the city into compliance with the 1972 Clean Water Act. From the late 1970s until 1993, the Clean Water Program constructed a major complex of sewer infrastructure at Ocean Beach, including the Oceanside Treatment Plant, adjacent pump station and the associated underground transport and storage structures under the Great Highway. The Clean Water Program reduced coastal water pollution events by a factor of ten. Its construction included the narrowing and redesign of the Great Highway, the installation of existing dune-like sand embankments and considerable restoration of vegetation and amenities. Since 1993, erosion has degraded surface conditions and resulted in emergency armoring, precipitating ongoing debates about future coastal management and infrastructure protection.

Playland (originally Chutes) at the Beach - 1913 to 1972

1922

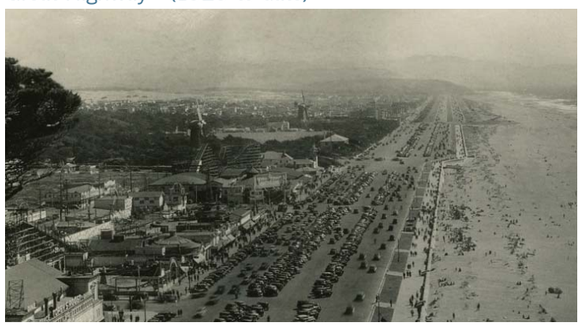
Fleishhacker Pool - (1925 to 1971)

1925

Beach Chalet - (1925 to date)

1925

Great Highway - (1929 to date)



1929

Bluff and beach erosion during severe weather conditions is a constant occurrence on the southern end of Ocean Beach. This poses a very real threat to a critical sewage-treatment complex that is essential to protect coastal water quality in San Francisco. The environmental consequences of a rupture and sewage spill would be severe.

Erosion Emergency: Response and Criticism

In the El Niño winter of 2009–2010, powerful storms battered the bluffs of Ocean Beach south of Sloat Boulevard, resulting in dramatic erosion. In some locations, bluff tops receded 40 feet, undermining the asphalt of parking lots and the shoulder of the Great Highway, which was closed southbound for much of the year. The episode was the most serious in a series going back several decades.

The city's response — the construction of 425 feet of rock revetments (boulder embankments) — drew criticism from environmentalists, who are concerned that such armoring often carries a heavy cost in beach and habitat loss and question the characterization of predictable erosion events as emergencies. Indeed, a similar episode in 1997 resulted in the construction of rock revetments that are still in place. Without a policy guiding erosion response, the city repeatedly found itself in a reactive posture, shoring up the bluffs under an emergency declaration with the reluctant sanction of the California Coastal Commission and the National Park Service. This situation reflects above all the lack of a policy framework to guide action in a crisis.

That critique notwithstanding, erosion poses a very real threat to a critical sewage-treatment complex that is essential to protect coastal water quality. The environmental consequences of a rupture and sewage spill would be severe. In the absence of another approach, this infrastructure, some of which lies underneath the Great Highway, must be armored against coastal hazards.

In the summer of 2011, the California Coastal Commission unanimously denied a permit application from the City and County of San Francisco for additional armoring and retroactive permits, leaving near-term hazards unresolved but sending a clear message that a new approach is needed. City agencies have been working to develop a more proactive and sustainable approach, including softer and more reversible interim coastal protection measures, partnership with the Army Corps of Engineers to implement beach nourishment with dredged sand and active participation in this planning process.

Adaptation: Planning for a Changing Climate

This document is above all a climate-change adaptation plan. Climate-change adaptation consists of policy and design responses to the negative effects of climate change that have already been "locked in," regardless of how we address carbon emissions going forward. Adaptation will be required in many arenas, from water supply to biodiversity to extreme heat events, but few are as vivid and pressing as sea level rise.

The overwhelming consensus among climate scientists is that sea levels are rising due to melting polar ice and thermal expansion of the oceans, and that the rate of sea level rise is likely to increase dramatically in the coming decades. The frequency and severity of storms are also likely to increase in California, and changes in precipitation may also occur, though their nature is uncertain.

This document is above all a climate-change adaptation plan. For Ocean Beach this means focusing on sea level rise impacts. Although there is uncertainty about exact timing and extent, studies suggest that the erosion episodes that have taken place recently at Ocean Beach will happen more frequently, causing significant shoreline recesion unless something is done to manage it.

At Ocean Beach, this means that the sort of erosion episodes that took place in 1997 and 2010 will happen more frequently. As the shoreline recedes, critical wastewater infrastructure along Ocean Beach will face increasing pressure and will need to be protected, reconfigured or abandoned. Natural habitat and recreational amenities are threatened as well. Although we have a pretty clear picture of what will happen as sea levels rise, there is a great deal of uncertainty about its timing and extent.

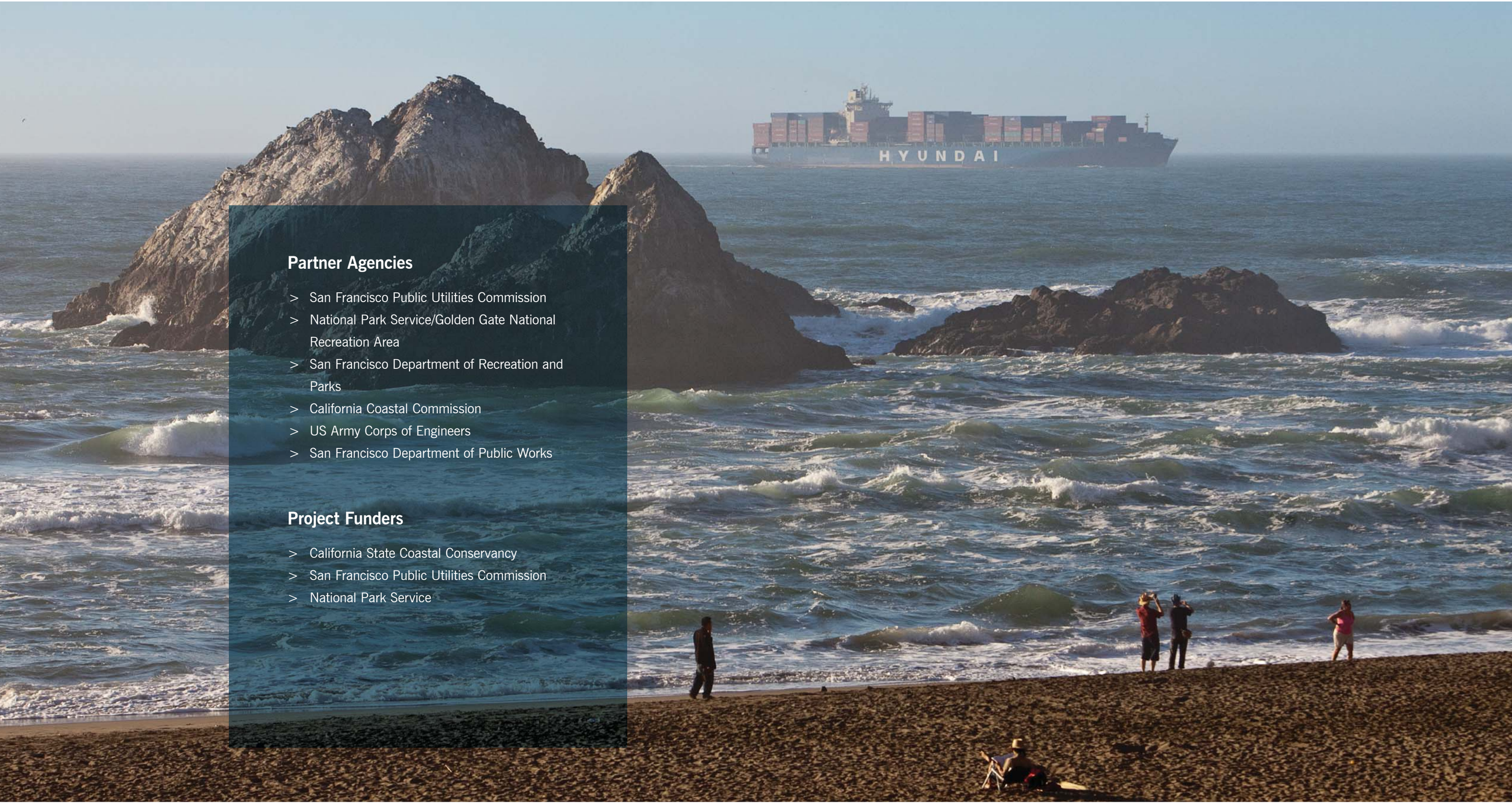
The State of California, in its 2010 "Sea-Level Rise Interim Guidance Document," has directed its agencies to plan for sea level rise of 14 inches by 2050 and 55 inches by 2100. Given the wide variation in the pace and extent of impacts predicted by different climate models, engaging the uncertainties in the climate science is well beyond the scope of this process. The Ocean Beach Master Plan is based on the state's interim guidance but is organized so that actions are sequential and based on physical triggers rather than time-certain. This represents a new kind of challenge for planners, who must consider complex tradeoffs in an uncertain environment and be prepared to adapt to changes as they emerge over time.

Ocean Beach is San Francisco's first real test in responding to the effects of climate change. The proximity of critical public infrastructure to the coast throws the challenges into high relief. Where should we hold the coastline? What is the economic value of a beach? A dune system? A threatened bird species? When and how will private property be exposed to coastal hazards?

There are also significant limitations in the available data about the effects of sea level rise. Existing studies paint a general picture of likely impacts but do not account for local factors like coastal armoring and topography, which will shape coastal processes. The physical modeling conducted in support of this study is the most detailed examination to date of the localized impacts of sea level rise on San Francisco's open coast.

Multiple Jurisdictions

A key challenge at Ocean Beach is the numerous overlapping jurisdictions and boundaries. A host of city, state and federal agencies have different roles and responsibilities, and at times conflicting imperatives. The lack of a single entity responsible for the future of Ocean Beach as a whole accounts in part for the lack of proactive policies to address erosion. SPUR's role is as an outside convener, facilitating communication and coordination among the various jurisdictions while keeping the long view in focus.



Partner Agencies

- San Francisco Public Utilities Commission
- National Park Service/Golden Gate National Recreation Area
- San Francisco Department of Recreation and Parks
- California Coastal Commission
- US Army Corps of Engineers
- San Francisco Department of Public Works

Project Funders

- California State Coastal Conservancy
- San Francisco Public Utilities Commission
- National Park Service

About This Project

What Is the Ocean Beach Master Plan?

The Ocean Beach Master Plan is an interagency effort to develop a sustainable long-term vision for Ocean Beach, addressing public access, environmental protection and infrastructure needs in the context of erosion and climate-related sea level rise.

The master plan process was the result of more than a decade of advocacy by community members and increasing interest by stakeholders, public agencies and decision makers.

In 2009, the Ocean Beach Vision Council, a task force appointed by Mayor Gavin Newsom, submitted an application for planning funds to the California State Coastal Conservancy, with matches from the San Francisco Public Utilities Commission and the National Park Service. These funds made this planning process possible.

This is a nonregulatory guidance document to comprehensively plan for the future of Ocean Beach. It addresses the impact of rising seas, the physical and ecological processes shaping the beach, and improved integration with its natural, recreational, and urban contexts.

Because of the many overlapping jurisdictions at Ocean Beach — an issue that had long been identified as impeding proactive planning — it was clearly necessary for an outside entity to convene a multi-agency, multi-objective planning process. SPUR, the San Francisco Planning + Urban Research Association, was selected for its capacity, its history of effective engagement with challenging public policy questions, its involvement in the creation of the Golden Gate National Recreation Area and its recent body of policy research around climate-change adaptation.

SPUR served as the grantee and project manager, beginning in June of 2010, and assembled advisory committees and a consultant team with the appropriate expertise in the wide range of relevant fields.

Scope and Study Area

The Ocean Beach Master Plan was charged with looking at all major aspects of the beach for the next 50 years and beyond. By taking a decidedly long view, developing a consensus vision and working backward to arrive at near- and medium-term actions, the master plan provides the framework that is missing from short-term decisions today.

The study area encompasses the beach and adjacent lands from the high-water mark to the property line at the eastern edge of the Lower Great Highway and excludes any private property **(Figure 1-1)**. It takes in 3.5 miles of contiguous coastline from the beach's northern extent to the Fort Funston bluffs. Of course, numerous processes and practices that extend beyond these boundaries, from transit access to offshore dredging, must be considered as well. The plan considers Ocean Beach as a whole place: as an urban promenade, a changing coastline, a key segment of the GGNRA, a habitat corridor and a major infrastructure complex. But as much as these aspects are interdependent, the conversation about Ocean Beach invariably returns to the most pressing crisis: the erosion at the south end of the beach and the infrastructure that lies in its path. To plan meaningfully for Ocean Beach as an open space, we must define an approach to coastal management that balances infrastructure needs, natural resource values and the realities of a changing climate.

About This Document

This is a nonregulatory guidance document, which reflects a robust and inclusive public process. It presents a framework for understanding the wide range of issues and challenges at Ocean Beach and a series of recommendations for balancing the many priorities and objectives identified by local agencies and stakeholders.

The recommendations outline an ambitious approach to managing and improving Ocean Beach through 2050 while incorporating analysis and consideration of test scenarios through 2100. Implementation of some of the recommendations in this document will require public agencies to conduct environmental review under the California Environmental Quality Act or the National Environmental Policy Act. They may also require a Coastal Development Permit under the California Coastal Act.

This document is intended to:

- Articulate a compelling and rigorous vision for the future of Ocean Beach that is rooted in the complex realities, perspectives and imperatives of all actors;
- Provide the basis of better and more coordinated management practices;
- Provide guidance for decision making by public agencies and elected officials;
- Provide a roadmap for implementation, technical studies, project initiation, environmental review and capital planning by various agencies;
- Provide a consensus baseline against which future actions may be measured; and
- Provide guidance to public agencies in the development of policies and projects.

Figure I-1:
Scope and Study Area

The study area encompasses the beach and adjacent lands from the high-water mark to the property line at the eastern edge of the Lower Great Highway; and from the beach's northern extent at the foot of the Cliff House to the Fort Funston bluffs. It excludes any private property.

Legend

Approximate Study Area Boundary

Ocean Beach Study Area by the Numbers:

- Total study area's length: 3.5 miles
- Beach width: variable, ~50 feet at its narrowest point; ~350 feet at its widest (north reach)
- Number of existing seawalls: 3 (O'Shaughnessy, Taraval and Noriega)
- Total length of existing seawalls (aggregate of 3 seawalls): ~4,750 feet (approximately 25% of the total lenght of the beach)
- Total length of emergency erosion control reventment installed at Ocean Beach in 2010: 425 feet
- Typical width of Great Highway's right-of-way: 190 feet
- Estimated total visitors per annum: 300,000

"Ocean Beach is as unique and irreplaceable as Muir Woods, the Presidio, the Marin Headlands or any other part of the Golden Gate National Recreation Area. We now have an unprecedented opportunity to work together towards the rejuvenation of Ocean Beach."

—GGNRA Superintendent Brian O'Neill,
during the appointment of the Ocean Beach Vision Council, 2008

project goal and aspirations

section

II

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Overall Project Goal Statement
Project Aspirations

project goal and aspirations

Overall Project Goal Statement

“To knit the unique assets and experiences of Ocean Beach into a seamless and welcoming public landscape, planning for environmental conservation, sustainable infrastructure and long-term stewardship.”

Project Aspirations

The range of issues facing Ocean Beach is addressed through seven Focus Areas, each of which represents a key aspect of this plan. The project team worked with the Planning Advisory Committee and the Steering Committee to develop aspirations within each Focus Area that help define project objectives.

Focus Area 1:
Ecology

Aspiration
Restore and establish conditions that support thriving biological communities.

Focus Area 2:
Utility Infrastructure

Aspiration
Evaluate infrastructure plans and needs in light of uncertain coastal conditions, and pursue a smart, sustainable approach.

Focus Area 3:
Coastal Dynamics

Aspiration
Identify a proactive approach to coastal management, in the service of desired outcomes.

Focus Area 4:
Image and Character

Aspiration
Preserve and celebrate the beach's raw and open beauty while welcoming a broader public.

Focus Area 5:
Program and Uses

Aspiration
Accommodate diverse activities and users, managed for positive coexistence.

Focus Area 6:
Access and Connectivity

Aspiration
Provide seamless and fluid connections to adjacent open spaces, the city and the region.

Focus Area 7:
Management and Stewardship

Aspiration
Provide an approach to long-term stewardship across agencies, properties and jurisdictions.

"San Francisco's Ocean Beach, as a recreational amenity, has a longer and quite different pattern of use than that usually associated with the general image of the urban American 'going to the beach' — an image that involves visions of summertime, picnics, bathing, overexposure to ultraviolet radiation... Some of these elements have of course sometimes been present in use of the Ocean Beach, but a particular historical characteristic of the use of the beach from the Cliff House to Lake Merced has been movement — the beach walk, the beach ride, the beach drive, the excursion to and along the beach."

—Olmsted and Olmsted, Ocean Beach Study, 1979

understanding ocean beach: seven focus areas

section

Section III: Understanding Ocean Beach: Seven Focus Areas Table of Contents

Focus Area 1: Ecology
- Aspiration
- Threatened Bird Species
- Native Dune Restoration Potential

Focus Area 2: Utility Infrastructure
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- History of San Francisco's Western Shoreline
- The Golden Gate Littoral Cell and the Marine Shipping Channel
- Climate Change and Sea Level Rise
- Storm Surge and Coastal Inundation: Today and Tomorrow
- Coastal Management Tools
- Regulatory Actions
- Beach Nourishment
- Why not relocate the Lake Merced Tunnel Today?
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Focus Area 4: Image and Character
- Aspiration

Focus Area 5: Program and Activities
- Aspiration

Focus Area 6: Access and Connectivity
- Aspiration
- Traffic Capacity and Roadway Configurations
- Transit
- Bicycle

Focus Area 7: Management and Stewardship
- Aspiration
- Opportunities for Integrated Management

understanding ocean beach:
seven focus areas

Ocean Beach is a complex, multifaceted environment with a host of overlapping issues and challenges. Specialists in a wide range of fields studied the most relevant and salient information, and synthesized it in the seven focus areas presented herein.

Ocean Beach is a complex, multifaceted environment with a host of overlapping issues and challenges. This plan provides an interdisciplinary, multi-objective approach that synthesizes a wide variety of fields and presents solutions that address many problems simultaneously. To that end, it necessarily favors breadth over depth.

Specialists in a wide range of fields were employed to ensure that the best available technical information informed the problem definition and recommended solutions. However, the project scope allowed only a basic level of technical analysis and engineering. Implementing the recommendations presented here will necessarily involve significant additional technical studies, environmental analysis, feasibility studies and cost estimation.

Focus Area 1: **Ecology**

Aspiration

Restore and establish conditions that support thriving biological communities.

Although Ocean Beach is very much a managed landscape — the alignment of the coast, the shape of the beach and bluffs, and the form and composition of the dunes are man-made — important biological communities make their homes here. The beach and dune system provides a corridor of scarce habitat for numerous species, link habitat in adjacent parklands and feeding and roosting opportunities for large numbers of migratory shorebirds during the spring and fall migrations. Protecting wildlife species and their habitat are key policy goals of the National Park Service yet they face significant constraints in an environment constrained by heavy use and eroding shorelines.

Important biological communities make their home at Ocean Beach. Coastal management should be designed to protect sensitive species — especially during nesting season — and to maximize habitat, by facilitating at least a parcial native dune restoration. Native dune restoration could provide both ecological and interpretive benefits.

Threatened Bird Species

There are two threatened bird species at Ocean Beach. The Western Snowy Plover, a federally listed threatened species, inhabits dry back beach, especially in the central part of Ocean Beach, from July to May, using the upper beach between dunes or seawall and the high-tide line for roosting and the wet sand near the tide line for foraging. As a result of its reliance on back beaches, the species declines as beaches narrow, suggesting that beach nourishment would help maintain plover habitat, provided it was conducted sensitively.

The Bank Swallow, a state-listed threatened species, burrows in exposed bluff faces near sources of freshwater (Lake Merced in this case), where it feeds on insects. A colony of Bank Swallows has been observed at the south end of Ocean Beach in recent years, a vulnerable position given ongoing erosion and the installation of coastal armoring. Coastal management in this area should be designed to maximize the erodible bluff face to the extent possible.

Management practices by public agencies working at Ocean Beach have been designed to limit impacts on threatened species, but rules intended to protect these species from beach users have been poorly enforced. Impacts by humans, dogs and ravens present ongoing pressures. Concerns about the plover are a factor in the GGNRA's recent proposal, which remains under debate, to further limit dog access to parts of Ocean Beach.


Beach wrack crustaceans


Seals


Starfish and shellfish


Willets


Pelicans


Marbled godwit


Beach lupine


Beach burr


Snowy Plover
Federally-listed threatened species


Bank Swallow
State-listed threatened species

Representative and native species of Ocean Beach's coastal ecosystem.

Native Dune Restoration Potential

The "dunes" that predominate from Fulton to Noriega Streets (and recur elsewhere) might be more properly considered a sand embankment. It was primarily constructed as part of the Clean Water Program in the 1980s and helps to protect both wastewater infrastructure and adjacent neighborhoods from coastal hazards. Its morphology (form) and plant communities are both non-native, with European beachgrass (*Ammophila arenaria*) and ice plant (*Carpobrotus spp.*) predominating. The deep root system and dense mats of vegetation formed by Ammophila tend to crowd out the more diverse native vegetation and produce a steep, tall form that launches windborne sand inland over the road.

The dynamics of a complete native dune system would require extensive space that is unavailable without acquiring private property. However, a restoration of native morphology and revegetation with native plant materials could provide both ecological and interpretive benefits. Although removing *Ammophila* is a significant investment, similar projects have been undertaken successfully in California, including at Little River State Beach and Freshwater Lagoon Spit in Humboldt County. Such an effort could enhance biodiversity at Ocean Beach while providing a corridor among adjacent habitats and a recreational and interpretive resource for visitors.

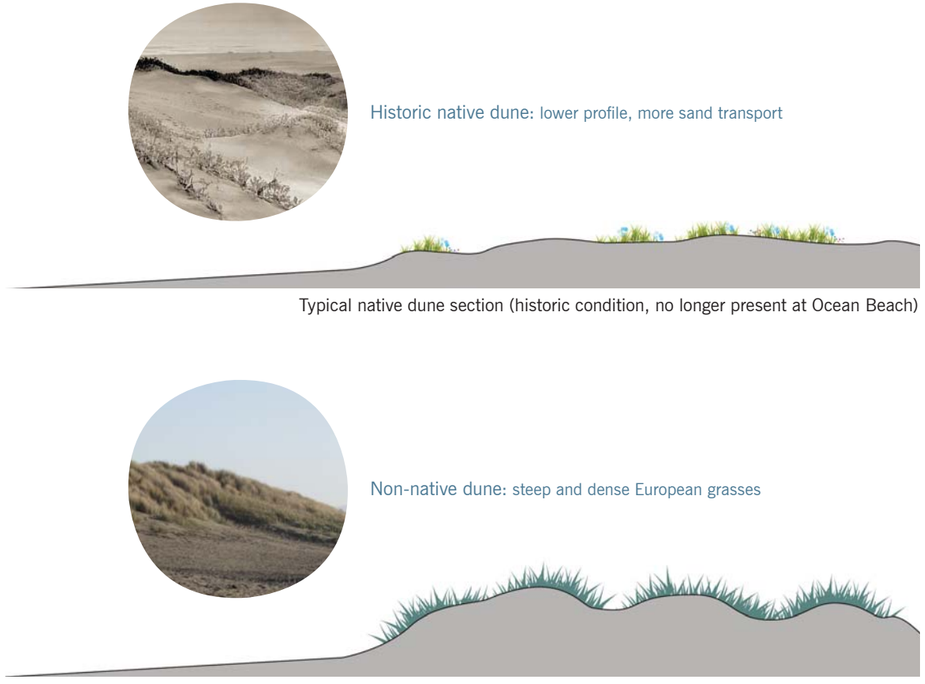


Figure III-1: Sand Dunes Characteristics, Typical Diagrammatic Sections

The typical native Ocean Beach sand dune profile (non-existent today) is the result of the low-profile, creeping behavior of the native plant species of the region. In contrast, the current sand "dunes" at Ocean Beach might be more properly considered a sand embankment, mainly covered with European beachgrass, which yields higher profiles with steeper slopes.

Native dune vegetation

1906

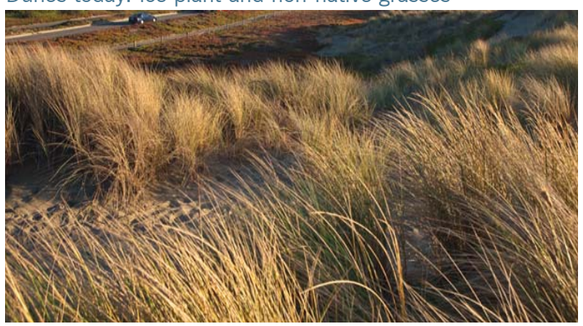
Sunset District encroaching on the native sand dune

1928

Dune restoration undertaken for the Clean Water Program

1980s

Dunes today: ice plant and non-native grasses



Today

Figure III-2:
Existing Ecological Zones Diagram

The beach and dune system provides a corridor of scarce habitat for numerous species, link habitat in adjacent parklands and feeding and roosting opportunities for large numbers of migratory shorebirds during the spring and fall migrations.

Potential threats to protected species such as the Snowy Plovers include:

- > Habitat loss and degradation
- > Human disturbance
- > Urban development
- > Exotic beach grass
- > Expanding predator populations

Figure III-3:
San Francisco's potential Wildlife Corridors

As part of a larger interconnected system, Ocean Beach is a key component of the shorebird migration path running north-south along San Francisco's shoreline.

Legend

- Natural Resource Area
- Historic Sand Dunes

Focus Area 2: **Utility Infrastructure**

Aspiration

Evaluate infrastructure plans and needs in light of uncertain coastal conditions and pursue a smart, sustainable approach.

Beginning in the 1970s, under pressure from the federal Clean Water Act, the SFPUC significantly upgraded the city's combined sewer-stormwater system, especially on the west side, where the ocean was being subjected to 60 to 70 combined sewer overflows each year. The PUC's Clean Water Program completed the current system in 1993 and has reduced the number of overflows to fewer than eight per year.

Wastewater infrastructure on the city's west side is designed to manage water quality on San Francisco's shores. The system is new, expensive and very efficient. It is also exposed to coastal hazard and thus requires protection now and in the immediate future.

The system accomplishes this impressive feat through a series of interconnected components. In dry weather, wastewater (sewage) from large sections of the city's west side runs though the network of local pipes to the Westside Transport Box — a large rectangular tube under the Great Highway — then south to the pump station at Sloat Boulevard. It is pumped to the Oceanside Water Pollution Control Plant and treated, and then the secondary-treated effluent is released through the Southwest Ocean Outfall, 4.5 miles out to sea.

In wet weather, stormwater runoff surges into the system. When the plant's capacity of 65 million gallons per day is overwhelmed, the transport box and Lake Merced Tunnel — two massive structures designed to store runoff and prevent overflows — fill up and retain the combined flow. Overflow there is decanted and pumped to the deep ocean outfall. Only when that system's capacity is exceeded do combined discharges occur, through two large outfall structures on Ocean Beach.

Parts of the Lake Merced Tunnel — a 14-foot-diameter pipe under the Great Highway south of Sloat Boulevard — are immediately vulnerable to erosion and must be protected or moved to prevent serious sewage spill that would contaminate coastal waters. The Westside Transport runs under the Great Highway from Lincoln Boulevard to Sloat Boulevard, and it may become a significant factor in shaping the beach and dunes as the coastline recedes.

Wastewater infrastructure is designed for the long haul: Parts of the current system are more than 100 years old. This system, taken as a whole, is new, expensive and very effective. Unfortunately, it is also exposed to varying degrees of coastal hazard, as recent events have made clear. On two occasions, the City of San Francisco has responded to severe episodes of erosion with emergency armoring in the form of boulder revetments, which, although nominally temporary, are difficult to remove, controversial and degrade ecological and recreation conditions.

Today we have the opportunity to protect the Lake Merced Tunnel in place by replacing the revetments with low-profile engineered structures and placed sand and at the same restore recreational and ecological functions. Eventually, this may become untenable, and we will face a choice between more intrusive armoring and the strategic relocation of infrastructure elements, beginning with the tunnel. The cost, complexity, competing priorities and tight regulatory agreements governing the system's storage make this a challenging prospect, and one that should be examined well ahead of time.

Newer thinking at the SFPUC and elsewhere emphasizes Low Impact Development (LID) and green infrastructure — both terms for modifying urban watersheds to increase stormwater retention and infiltration into the ground. Permeable surfaces, green roofs, swales and the restoration of natural waterways can add up to a significant reduction in stormwater entering the combined system, and help to prevent combined discharges.

SFPUC's newer emphasis on green infrastructure may open alternative possibilities for managing the city's wastewater in the future. The use of low impact technologies throughout the city can add up to a significant reduction in stormwater entering the combined system, and help to prevent combined discharges.

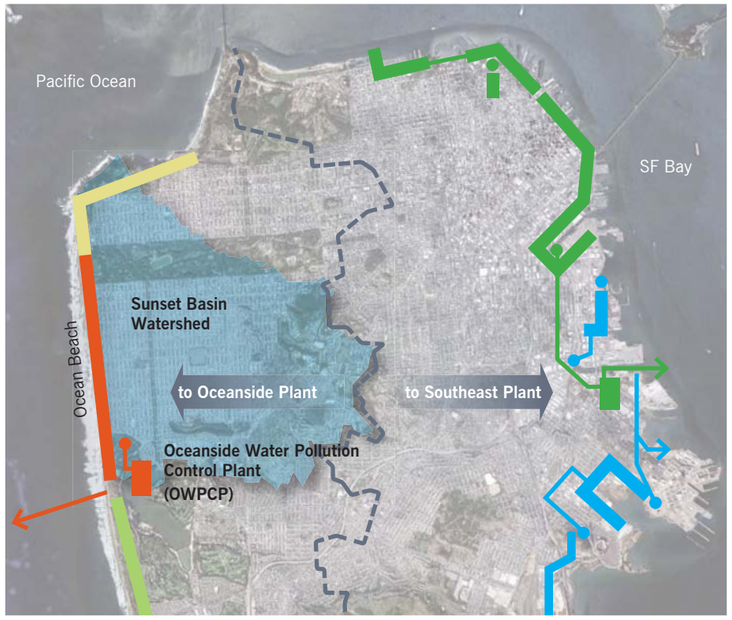


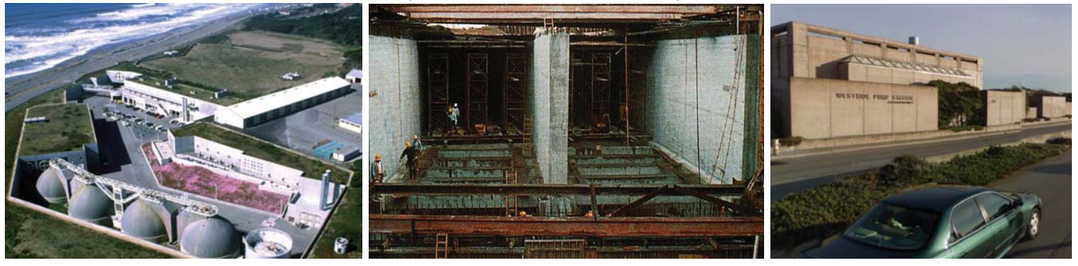
Figure III-4:
San Francisco's Stormwater Management System

San Francisco's combined storm and sewage management system is divided into two main watersheds: bayside and oceanside.

BEFORE: Former water quality issues at Ocean Beach determined development of current utility infrastructure

60 to 70 Combined Sewage Discharges (CSD) per year

WATER QUALITY:
Oceanside Water Pollution Control Plant | Westside Transport Box | Westside Pump Station



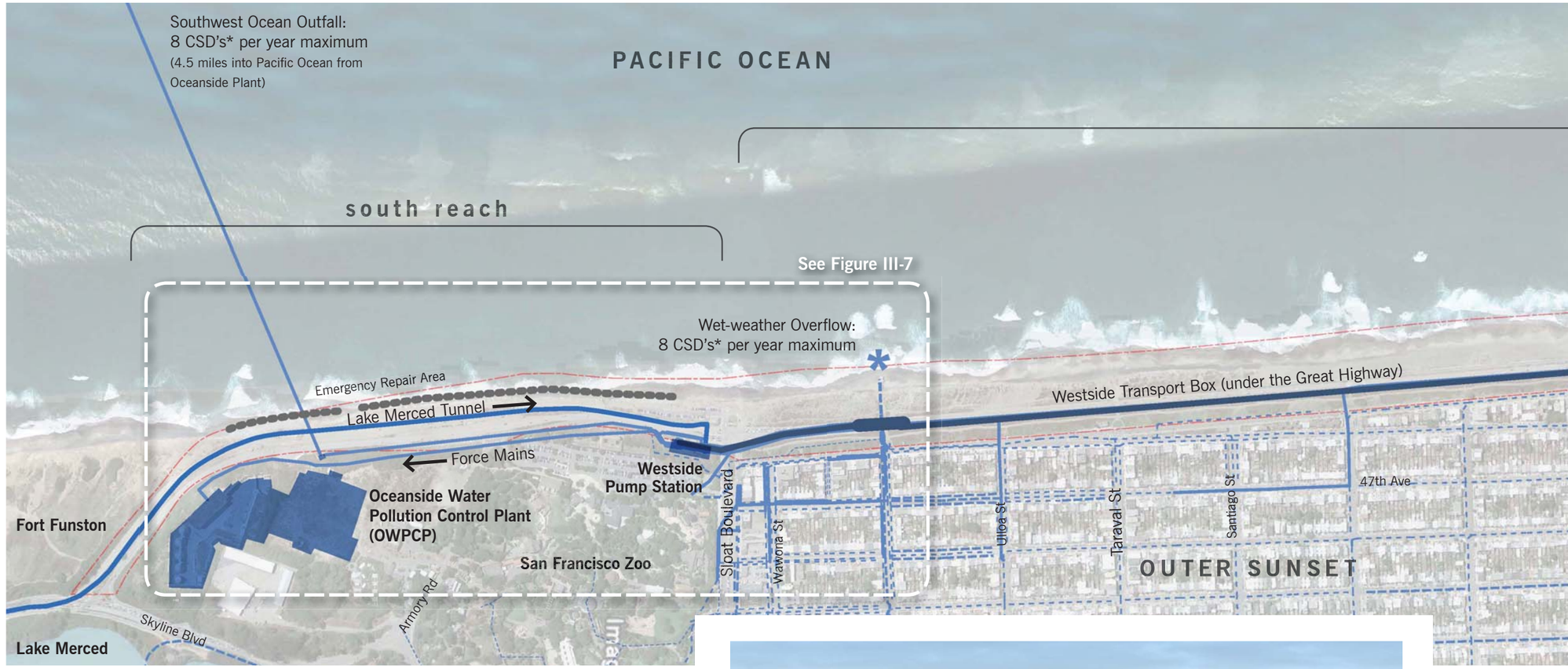
Less than 8 Combined Sewage Discharges (CSD) per year (after Clean Water Program)

GREEN+GREY INFRASTRUCTURE:
Watershed approach, low-impact design strategies

past (1960s) — present (1970s to today) — future

Figure III-5:
Existing Combined Sewage System Diagram

In the early 1970s, the SFPUC significantly upgraded the city's west side combined sewer-stormwater system in order to reduce the number of combined sewer overflows (CSOs) into the Pacific Ocean.



Legend

- Project Boundary

SEWER SYSTEM

- Westside Transport Box
- Sewer Pipe less than 50 years old
- Sewer Pipe more than 50 yrs old
- Sewer Pipe more than 80 yrs old
- Sewer Pipe (unknown age)
- Water/Utility Infrastructure Building
- Wet-Weather Overflow (Combined Sewer)
- Emergency Repair Area
- Overflow Decanting Station

* CSD's = Combined Sewer Discharge

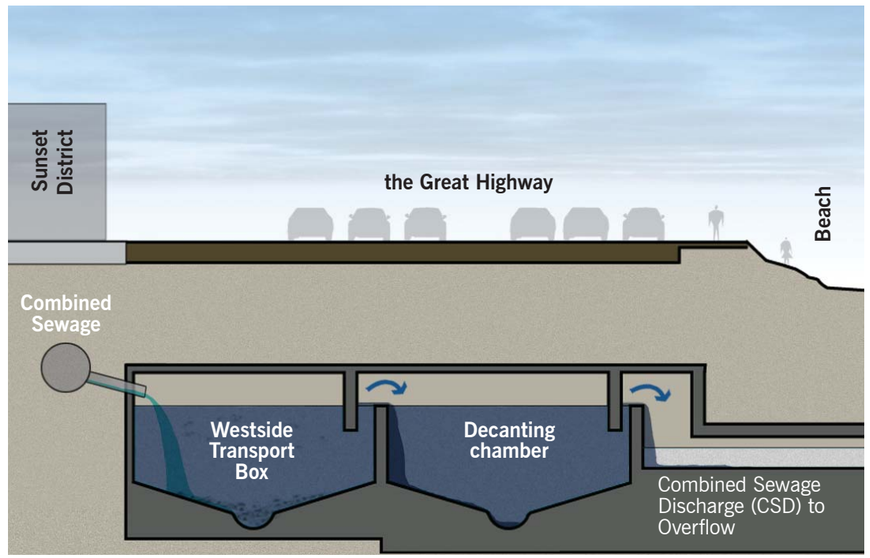
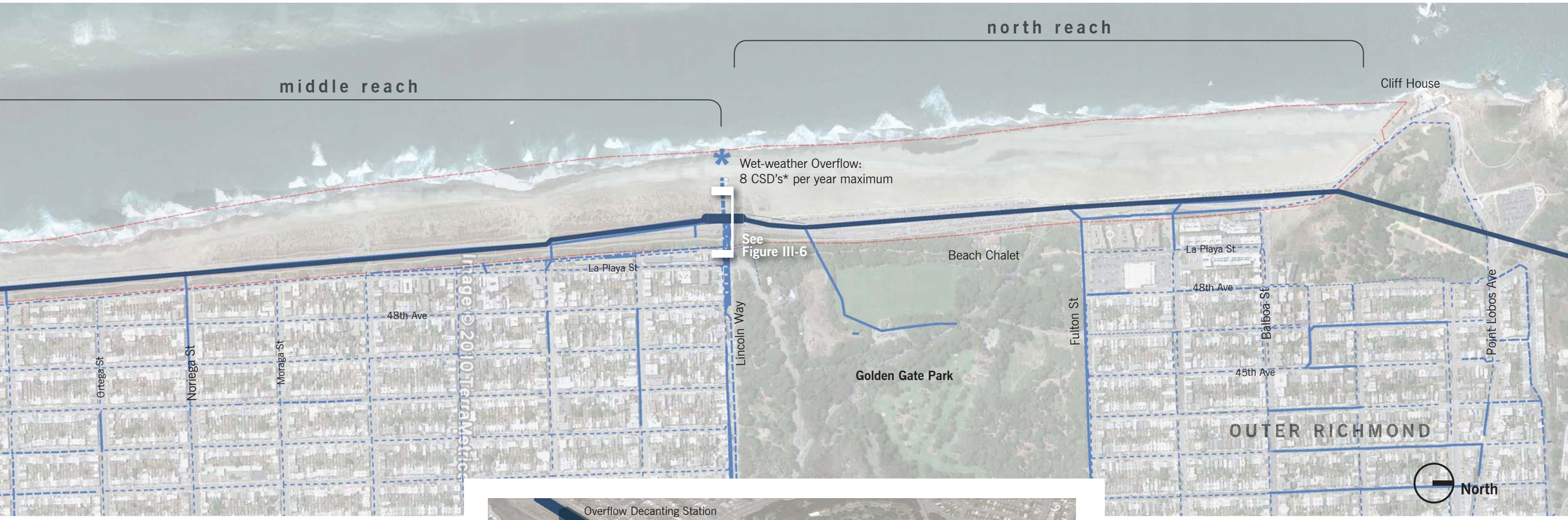
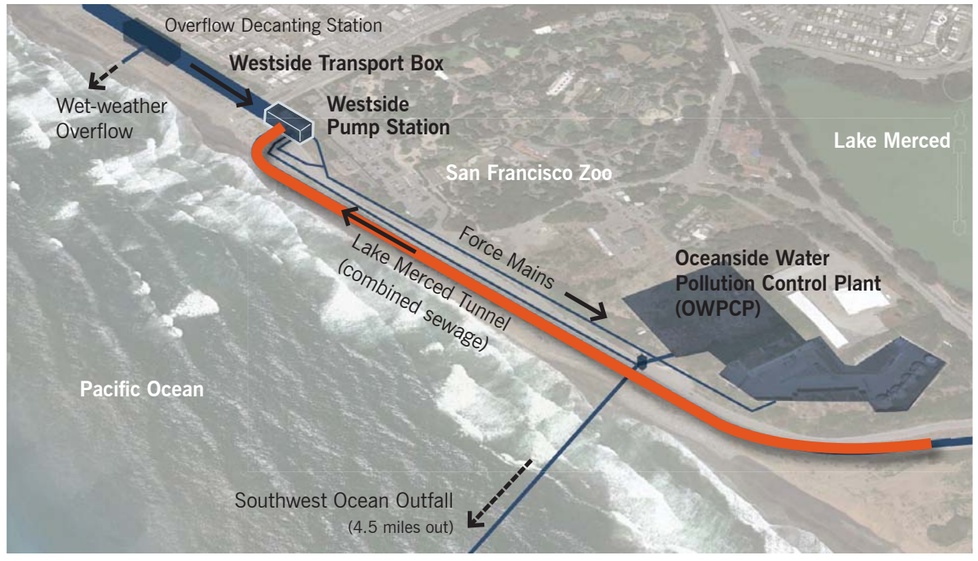


Figure III-6:
Westside Transport Box Sectional Diagram
(at overflow decanting station)

On extreme wet-weather conditions (averaging 7 to 8 times per year), decanting stations within the Westside Transport Box provide primary water treatment (decatation of solids) before combined sewage overflows are discharged onto the beach/ocean.





Legend

- Lake Merced Tunnel (most vulnerable segments)
- Utility Infrastructure Facilities

Figure III-7:
Lake Merced Tunnel Axonometric Diagram

A key component in the city's west side combined storm-sewage system is the 14-ft diameter Lake Merced Tunnel. Some portions of this facility are immediately vulnerable to erosion and must be protected or moved to prevent a serious sewage spill that would contaminate coastal waters.

Focus Area 3: **Coastal Dynamics**

Aspiration

Identify a proactive approach to coastal management in the service of desired outcomes.

Erosion

Ocean Beach is the visible portion of a much larger coastal sand and sediment system. It is an intensely energetic environment, frequently battered by powerful waves and storm surges. South of Noriega Street, and even more so south of Sloat Boulevard, the beach is subject to erosion, in which more sand is removed than deposited by waves and currents, and the shoreline recedes landward.

Ocean Beach is the visible portion of a much larger coastal sand and sediment system. It is an intensely energetic environment, frequently battered by powerful waves and storm surges. The repeated erosion episodes and ad hoc response by city agencies was a major impetus for initiating this plan.

The past 15 years have seen several severe erosion episodes, typically during El Niño seasons, which have resulted in bluffs receding 70 feet over a decade in some stretches south of Sloat. In the 2009–2010 winter alone, the coast eroded 40 feet inland, undermining parking lots and the shoulder of the Great Highway and resulting in closure of the southbound lanes for nearly a year. The City of San Francisco, under a local emergency declaration, armored the area with boulder revetments for the second time since 1997, to the consternation of critics, who have advocated a long-term plan to avoid these sorts of emergency actions.

The repeated erosion episodes and ad hoc response by city agencies was a major impetus for initiating this plan, which is driven by the need for a proactive approach to coastal management.

History of San Francisco's Western Shoreline

The western shoreline of San Francisco is artificially maintained about 200 feet seaward of its natural equilibrium. Sand was pushed west in the late 19th and early 20th centuries to create level ground for the construction of the adjacent neighborhoods and the Great Highway, once billed as the widest highway in the western United States. This new land was then stabilized with pavement and seawalls, but erosion has been a recurring issue from the beginning, in part a symptom of the coastal processes seeking that equilibrium.

Between the late 1970s and the early 1990s, major sewer infrastructure was installed, including the conveyance structures under the Great Highway, a process that included rebuilding the road and constructing the embankments of fill that were revegetated to create constructed "dunes."

South Reach: erosion

1990: Sloat parking lot

early 2000s: Erosion

2010: Emergency revetments

2012: Emergency/temporary repair area

1990s to early 2000s

emergency revetments

North Reach: beach widening

1972: North reach of Ocean Beach at is narrowest

2009: the beach is significantly wider at Ocean Beach's north reach due to passive sand accretion

1922: The O'Shaughnessy seawall is completed

1972: The steps on the seawall are visible

2011: Sand covers the steps of the seawall

2012: Sand reaches the top of the seawall

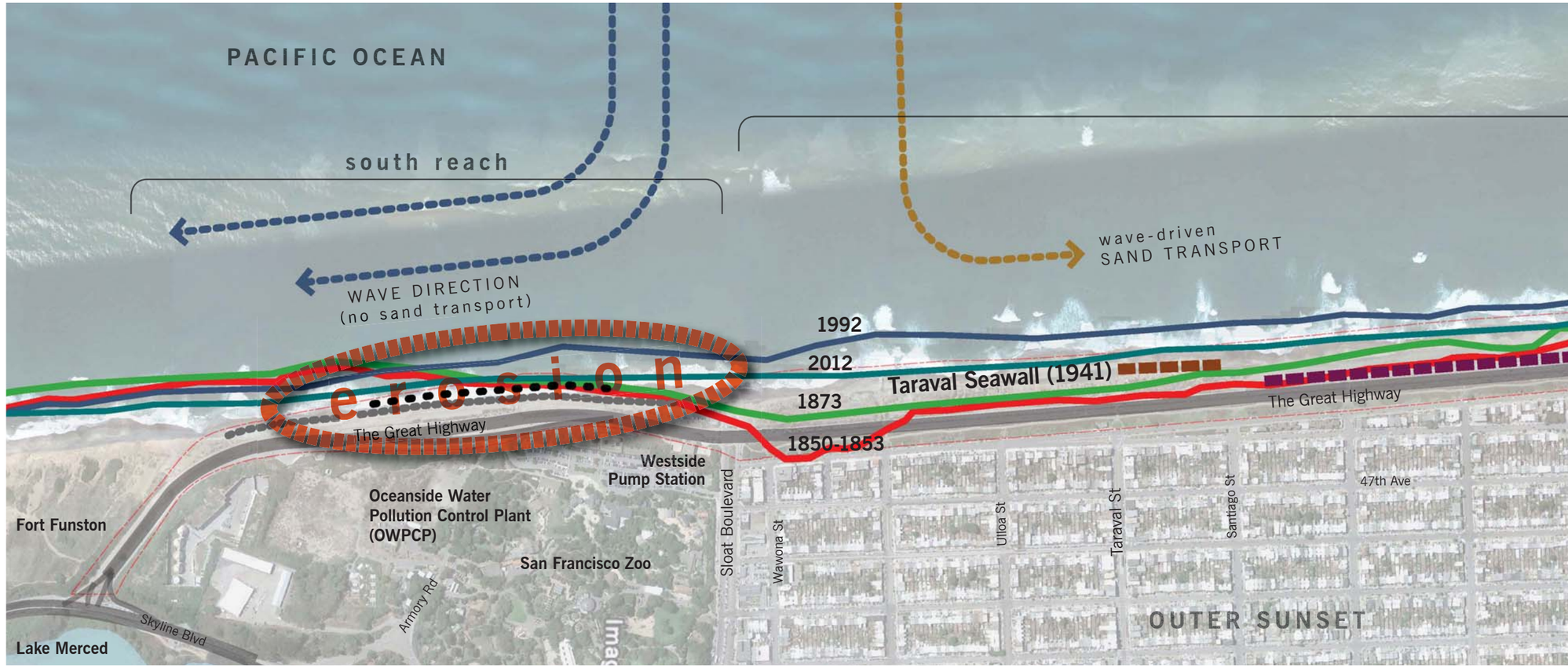
1920s to early 1970s

mid 1970s to today

Channel dredging sand dumped within the littoral cell (pg. III-17)

Figure III-8:
Coastal Dynamics and Historic Shoreline Diagram

The western shoreline of San Francisco is artificially maintained about 200 feet seaward of its natural equilibrium. Sand was pushed west in the late 19th and early 20th centuries to form new land. Erosion on the south reach has been a recurring issue from the beginning, in part a symptom of the coastal processes seeking that lost equilibrium.



Legend

- Project Boundary

HISTORIC SHORELINES
- Current Shoreline
- Shoreline (1992)
- Historic Shoreline (1873)
- Historic Shoreline (1850-1853)

ROADWAYS
- The Great Highway (1929)

SEAWALLS
- O'Shaughnessy Seawall (1915-1922)
- Taraval Seawall (1941)
- Norieaga Seawall (1988-1993)

REVETMENTS
- Exposed Fill
- Emergency Repair Area

middle reach

wave-driven SAND TRANSPORT

north reach

wave-driven SAND TRANSPORT

Cliff House

O'Shaughnessy Seawall (1920s)

Noriega Seawall (1980s)

Beach Chalet

La Playa St

48th Ave

Lincoln Way

Fulton St

45th Ave

Balboa St

Point Lobos Ave

Ortega St

Noriega St

Moraga St

Golden Gate Park

OUTER RICHMOND

North

Scale 0 500 ft 1000 ft

O'Shaughnessy Seawall

Built 1915 to 1922

Taraval Seawall

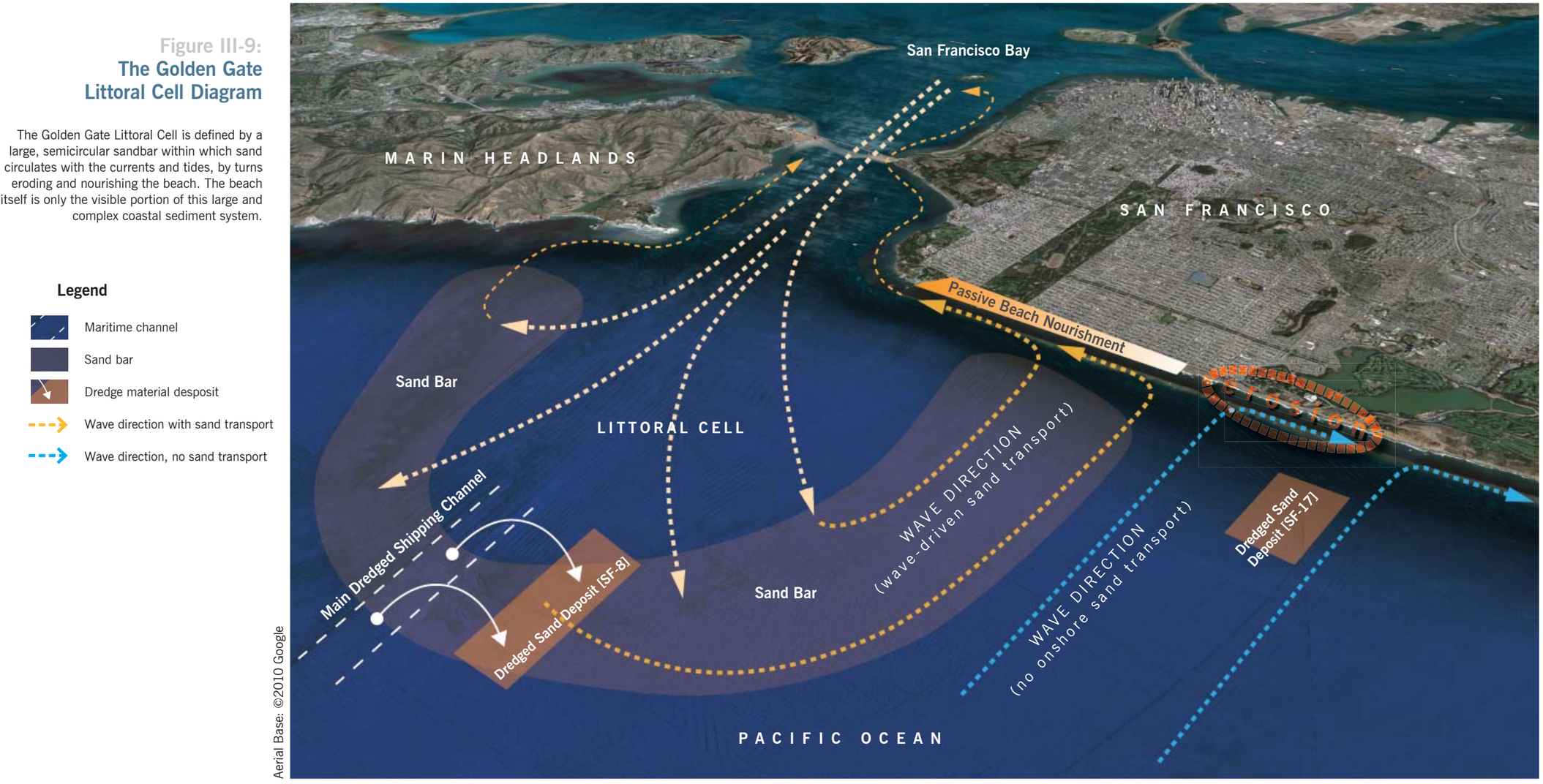
Built 1941

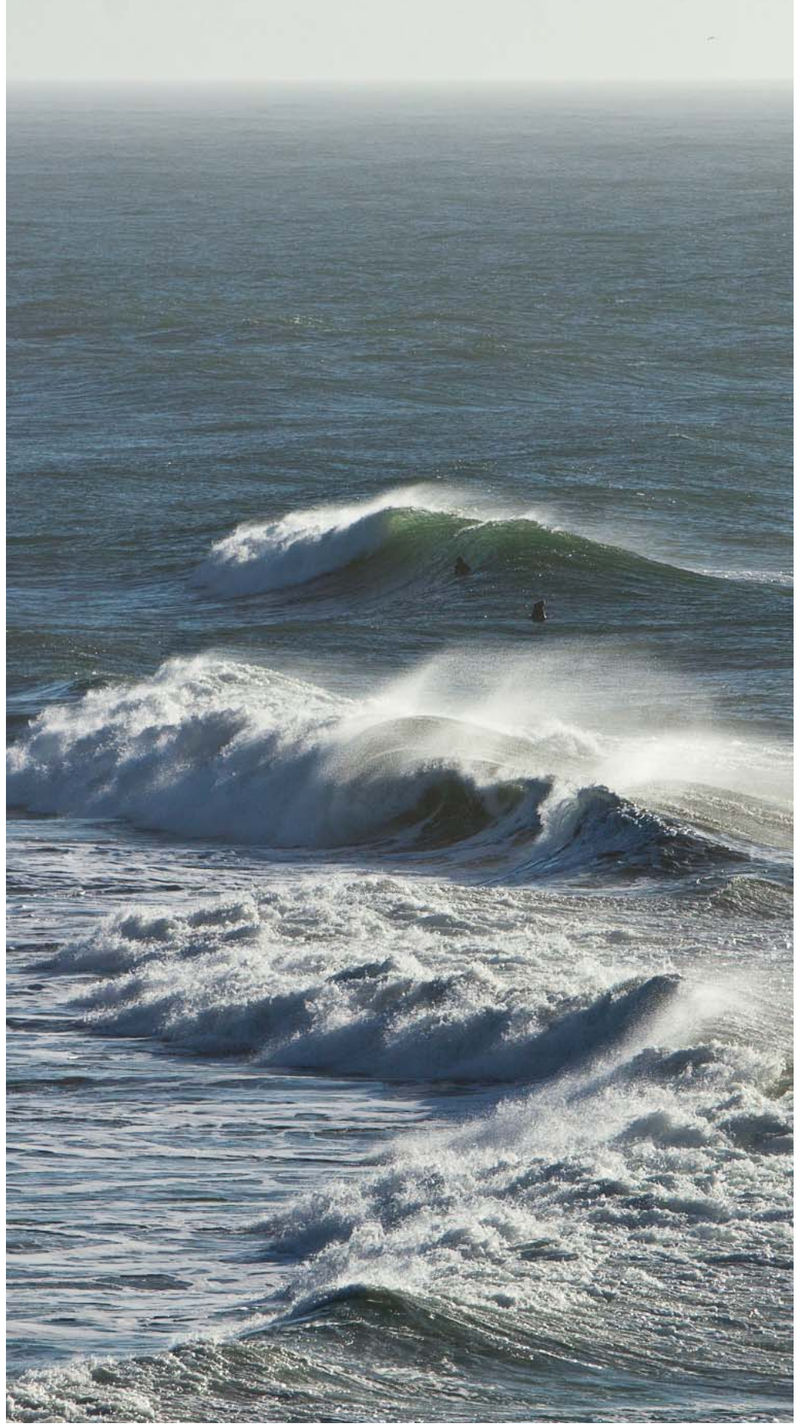
Norieaga Seawall

Built 1988 to 1993

Figure III-9:
The Golden Gate Littoral Cell Diagram

The Golden Gate Littoral Cell is defined by a large, semicircular sandbar within which sand circulates with the currents and tides, by turns eroding and nourishing the beach. The beach itself is only the visible portion of this large and complex coastal sediment system.





The Golden Gate Littoral Cell and the Marine Shipping Channel

The Golden Gate Littoral Cell is defined by a large, semicircular sandbar within which sand circulates with the currents and tides, by turns eroding and nourishing the beach (Figure III-9). Within the cell, sand supply is relatively stable. Average longshore (lateral) currents at Ocean Beach carry sand northward, and it continues to circulate within the bar. South of Noriega, however, currents diverge and southward currents scour sand away and out of the cell, resulting in a net loss of sand and a narrowing beach. This results in an erosion "hot spot" south of Sloat Boulevard.

The U.S. Army Corps of Engineers annually dredges a marine shipping channel in the sandbar to allow access by large ships to the Golden Gate. This dredged sand — about 300,000 cubic yards each year represents a significant opportunity for beach nourishment, in which sand is placed on the beach to counteract the effects of erosion.

The northern end of Ocean Beach has been getting wider since the 1970s because of a combination of sediment management practices (dumping dredged sand within the system rather than in the deep ocean) and natural changes to the sandbars. Meanwhile, the southern end is narrowing as erosive forces scour away sand and bluffs, leaving less and less buffer between waves and critical infrastructure.

More recently, sand has been deposited closer to shore off the southern end of the beach, with results that remain uncertain but have not shown dramatic improvements in beach width.

The Golden Gate Littoral Cell is defined by a large, semicircular sandbar within which sand circulates with the currents and tides, by turns eroding and nourishing the beach. As a result of this dynamic system, the northern end of the beach has been getting wider since the 1970s, while the southern end is narrowing as erosive forces scour away sand and bluffs.

Climate Change and Sea Level Rise

Sea level rise and its impact are fundamental challenges in planning for the future of Ocean Beach, as they directly inform the management of coastal hazards. As sea levels rise, the coastline recedes inland, except where limited by hard structures. This translates into increased erosive pressure and coastal hazards. Although there is a great deal of uncertainty about the timing and extent of climate-related sea level rise, there is considerable consensus on the general nature of its impacts.

The State of California's "Sea-Level Rise Interim Guidance Document" (2010), developed after a considerable interagency examination of the various available climate models, directs state agencies to plan for 14 inches of sea level rise by 2050 and 55 inches by 2100. The OBMP process also uses that figure, in lieu of the capacity to carry out a separate examination of the data and to be in sync with public agencies to the degree possible. It is also assumed that California will likely by subjected to increasingly frequent and severe coastal storm surges, which will be exacerbated by higher sea levels. The data on local changes in precipitation — critical to understanding future loads on combined sewer infrastructure — remain far less conclusive, and this plan assumes that San Francisco will need to be prepared for a range of possible outcomes.

Storm Surge and Coastal Inundation: Today and Tomorrow

Figure III-10 shows the approximate wave runup limits from extreme (1 percent, or 100-year event) coastal flooding events for existing and future conditions. The limits of runup provide a sense of flooding potential landward of the coastal dunes and bluffs. These data may be used to estimate potential flood damages or as a qualitative estimate of damage hazard. These runup limits are an improvement over previous estimates of coastal flooding and erosion to date.

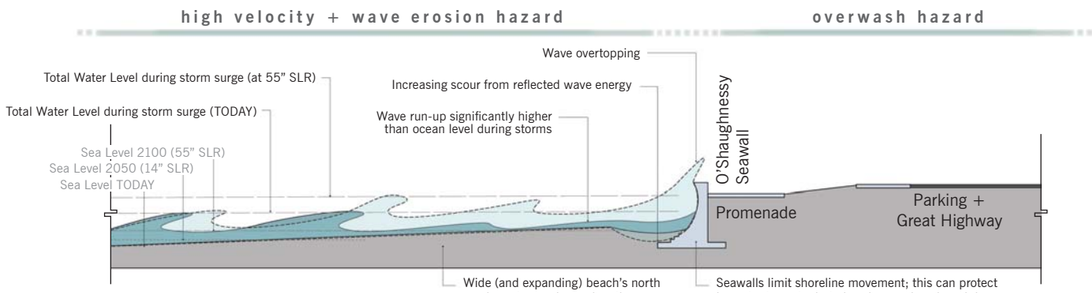


Fig III-10a: **Seawall Section, Typical**
Not to Scale

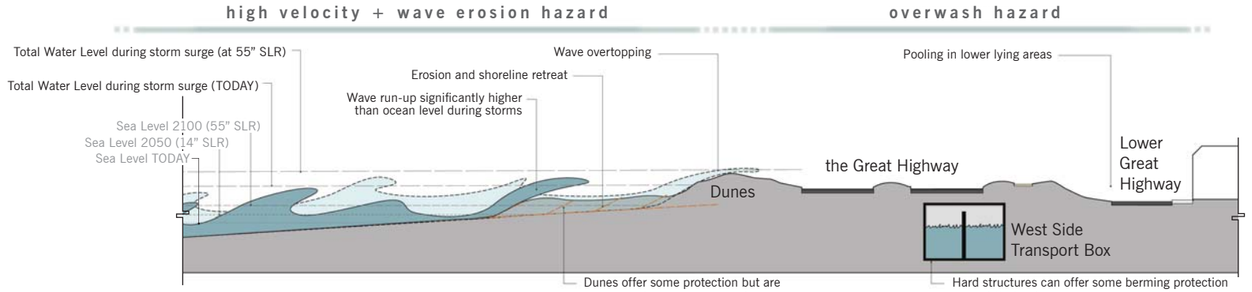


Fig III-10b: **Sand Dunes Section, Typical**
Not to Scale

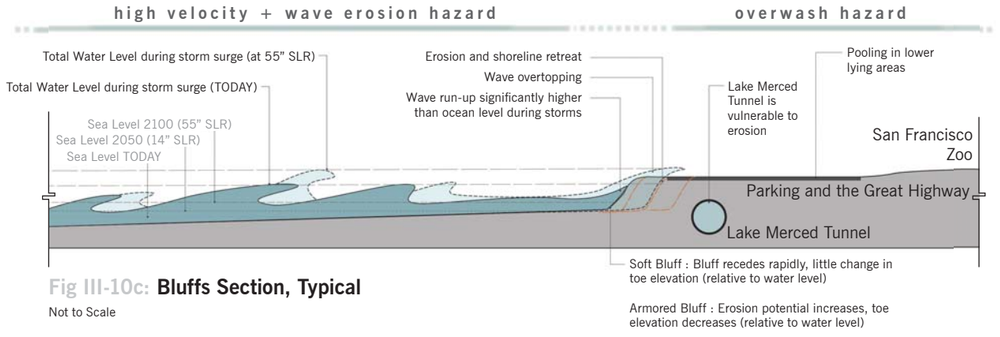


Fig III-10c: **Bluffs Section, Typical**
Not to Scale

Figure III-10:
Coastal Hazards Today and Tomorrow Diagrammatic Sections

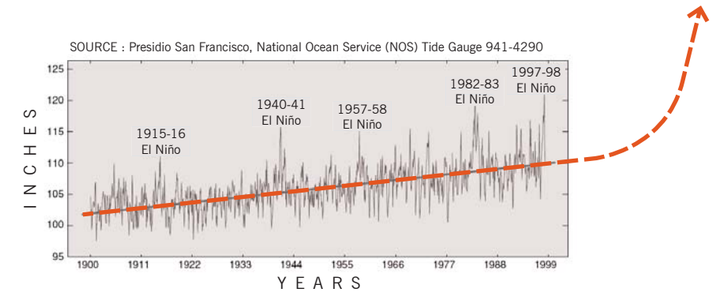
While estimates are the best available mapping of coastal flood hazards, they are still approximate and not intended to assess property values, insurance rates or development potential.

Coastal Management Tools

Sea level rise and accompanying storm surges will significantly worsen erosive pressures at Ocean Beach in the coming years. Options for the management of this erosion include coastal armoring, beach nourishment and managed retreat:

Coastal armoring seeks to resist erosive forces and the receding shore with hard structures such as seawalls or revetments. Depending on its height, a structure might be overtopped by wave runup during storm surges, inundating inland areas. If the coastline recedes until it reaches a hard structure, the beach may be lost, along with the ecological and recreational functions it supports. Reflected wave energy may worsen erosion in adjacent arees. There are nearly 10,000 linear feet of hard structures at Ocean Beach today, in the form of the three existing seawalls and recent revetments. This does not including the Westside Transport Box, which could end up functioning as a sort of seawall if exposed by beach and dune recession. Additional armoring will likely be necessary south of Sloat, but should be placed as part of a proactive and comprehensive strategy to manage coastal dynamics at Ocean Beach. Its placement and design should reflect consideration of ecological and access needs, as well as potential negative secondary erosion effects.

SOURCE : Presidio San Francisco, National Ocean Service (NOS) Tide Gauge 941-4290



Rate of SLR measured at San Francisco is about 8 inches in the last 100 years

Rate of SLR is anticipated to go up exponentially

Table III-1a: **Recent Sea Level Rise (SLR)**

SOURCE : State of California Sea-Level Rise interim guidance document, 2010

YEAR		AVERAGE OF MODELS	RANGE OF MODELS
2030		7 in (18cm)	5-8 in (13-21cm)
2050		**14 in (36cm)**	**10-17 in (13-21cm)**
2070	Low	23 in (59cm)	17-27 in (43-70cm)
	Medium	24 in (62cm)	18-29 in (46-74cm)
	High	27 in (69cm)	20-32 in (51-81cm)
2100	Low	40 in (101cm)	31-50 in (78-128cm)
	Medium	47 in (121cm)	37-60 in (95-152cm)
	High	**55 in (140cm)**	**43-69 in (110-176cm)**

Table III-1b: **Future Sea Level Rise (SLR)**

Table III-1:
Recent and Future Sea Level Rise (SLR)

The OBMP uses the State of California's "Sea-Level Rise Interim Guidance Document" that suggests 14 inches of SLR by 2050 and 55 inches by 2100 in planning for the future of the beach. Sea level rise and accompanying storm surges will significantly worsen erosive pressures at Ocean Beach in the coming years.

Figure III-11:
Coastal Features for Climate Change Planning Diagram

The master plan used the State of California's "Sea-Level Rise Interim Guidance Document" (2010) that directs state agencies to plan for 14 inches of sea level rise by 2050 and 55 inches by 2100. This diagram reflects approximate potential coastal hazards assumed as result of higher sea levels in the Ocean Beach area.

NOTE:
Figure III-11 represents an estimate of potential coastal flood hazards, but they are still approximate and are not intended to assess property values, insurance rates or development potential.

Legend

- Project Boundary

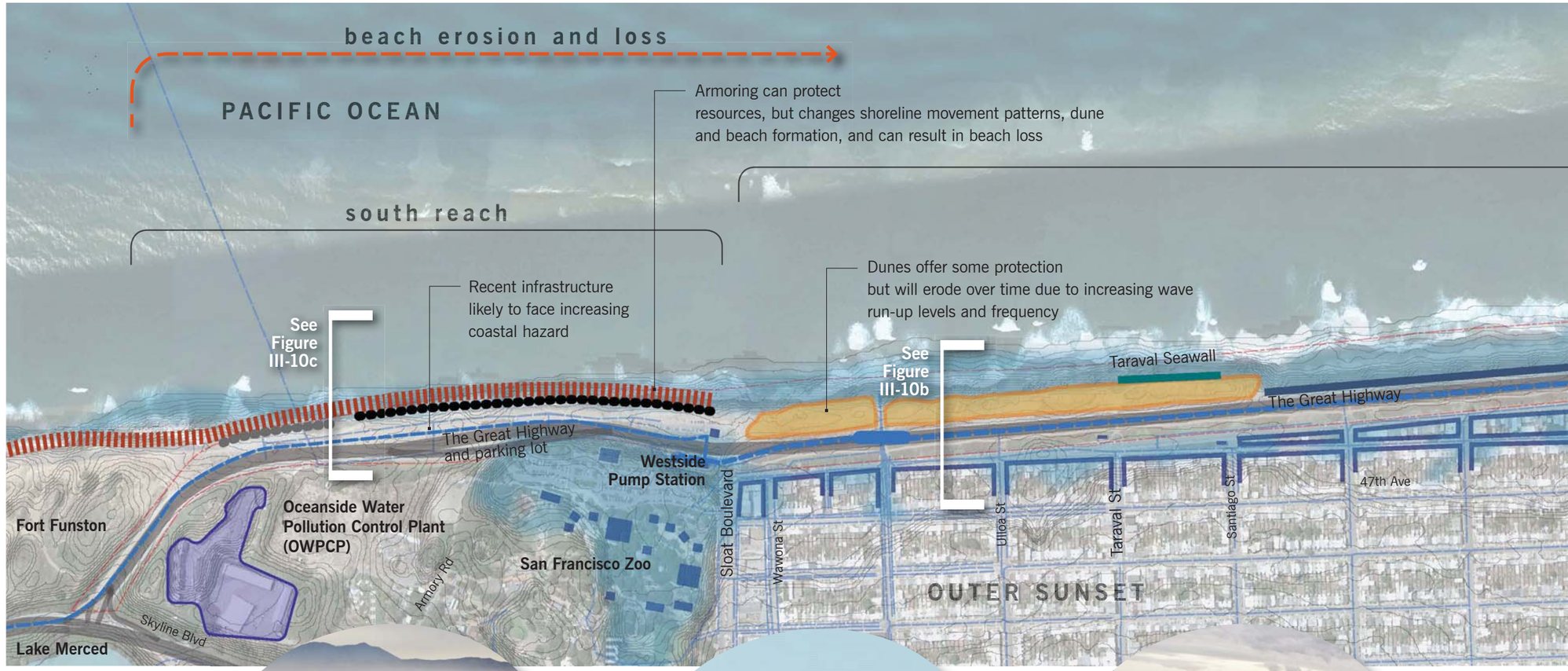
ROADS + PATHS
- The Great Highway (1929)

SEAWALLS
- Noriega Seawall (1968-1993)
- Taraval Seawall (1940)
- O'Shaughnessy Seawall (1915-1922)

REVETMENTS
- Exposed Fill
- Emergency Repair Area (2010)

TOPOGRAPHICAL FEATURES
- Dunes
- Bluffs
- Low-Lying Areas

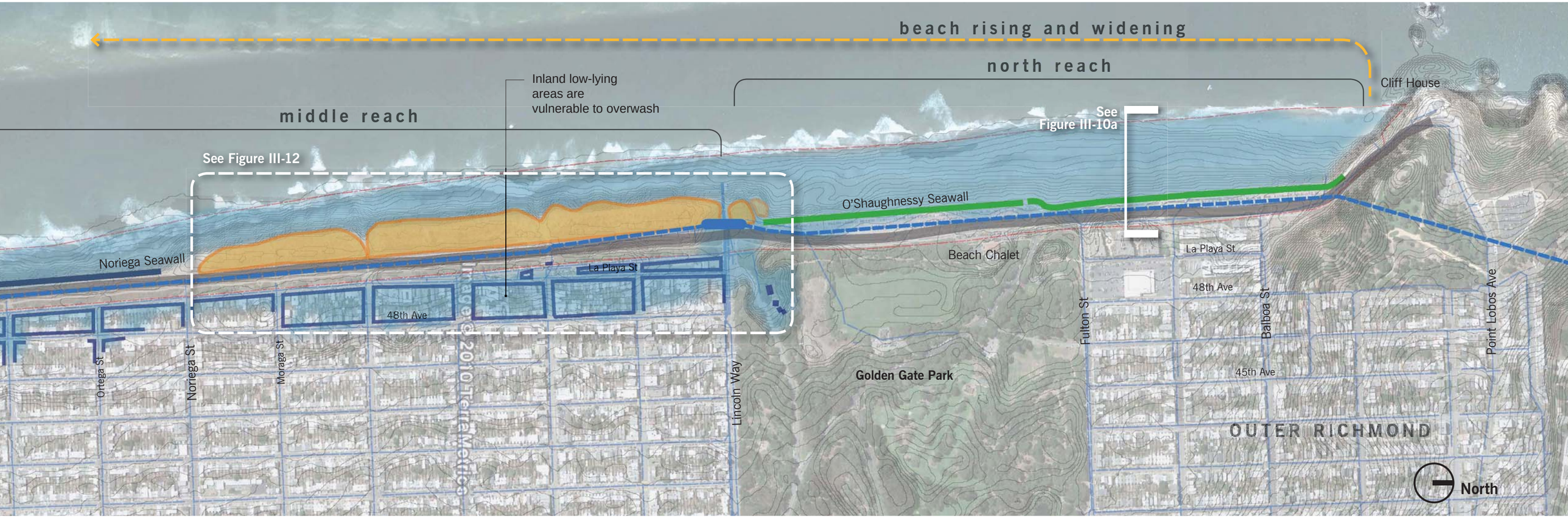
STRUCTURES
- Sewer Pipes
- Major Sewer Infrastructure
- Wastewater Treatment Facility
- Buildings

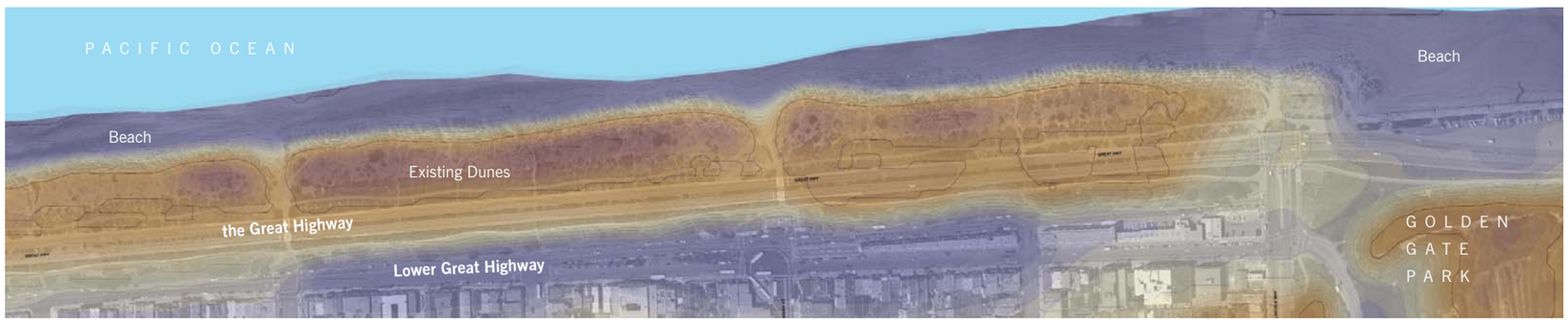


King Tide (2012), Ocean Beach's middle reach at wet-weather overflow facility

Taraval Seawall overtopping (1980s)

King Tide (2012) at Ocean Beach's north reach





Source: Sherwood Design Engineers

Figure III-12: Elevation Diagram, Detail

Low-lying areas in the Lower Great Highway are more susceptible to pooling due to higher frequency storm surges, as the sea level rises.

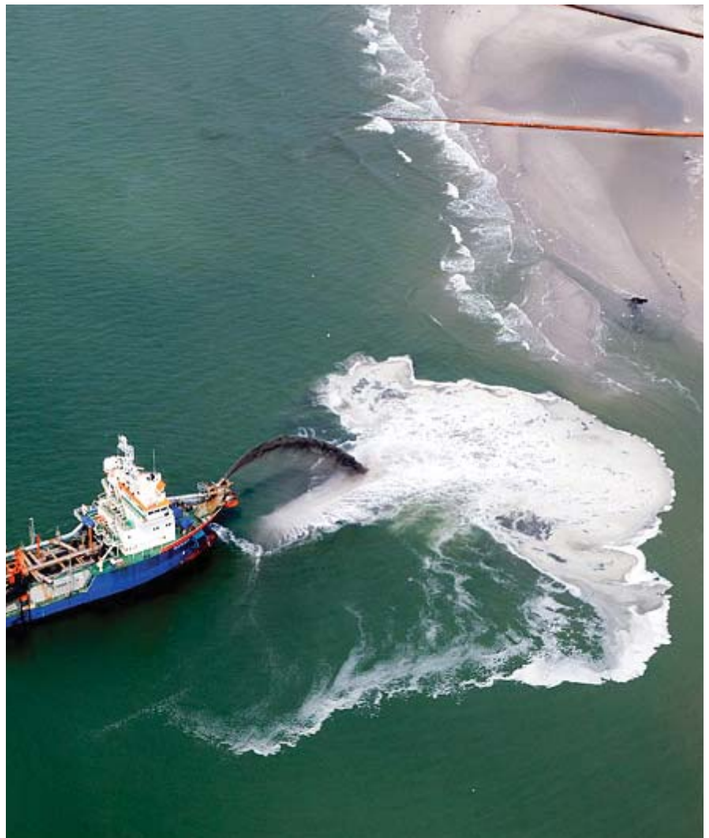
Beach nourishment, the deliberate placement of sand to counteract erosion, is a promising option, since 300,000 cubic yards of dredged sand are available annually for beneficial local use. The cost beyond current practices would be shared between local and federal agencies. An effort is under way to retrofit the Essayons, the Army Corps' dredge, to enable it to pump sand directly onto the beach. This could likely reestablish a wider beach north of Sloat and buy considerable time through sacrificial sand placement to the south.

Managed retreat is the gradual reconfiguration or removal of man-made structures in the path of the retreating coastline, according to pre-established triggers. This approach seeks to avoid expending excessive resources defending structures unnecessarily. Managed retreat has been successfully employed in several locations in California, including the acquisition and demolition of private structures in Pacifica and the phased reconfiguration of parking lots, roads and trails at Surfer's Point in Ventura.

Options for the management of shoreline erosion at Ocean Beach include coastal armoring, beach nourishment and managed retreat.
In 2011, the California Coastal Commission directed the City and County of San Francisco to prepare a long-range coastal management plan for Ocean Beach.

Managed retreat is most readily employed where structures like roads or parking lots are concerned, and space is available. It is significantly more difficult to pursue in a highly constrained setting where expensive publicly funded infrastructure stands in harm's way. The OBMP includes major components of managed retreat in combination with other strategies.

All of these management strategies are recommended at Ocean Beach. A key objective for the plan is to analyze the relative needs, costs and benefits of various approaches, and build consensus around a nuanced, multi-objective approach.

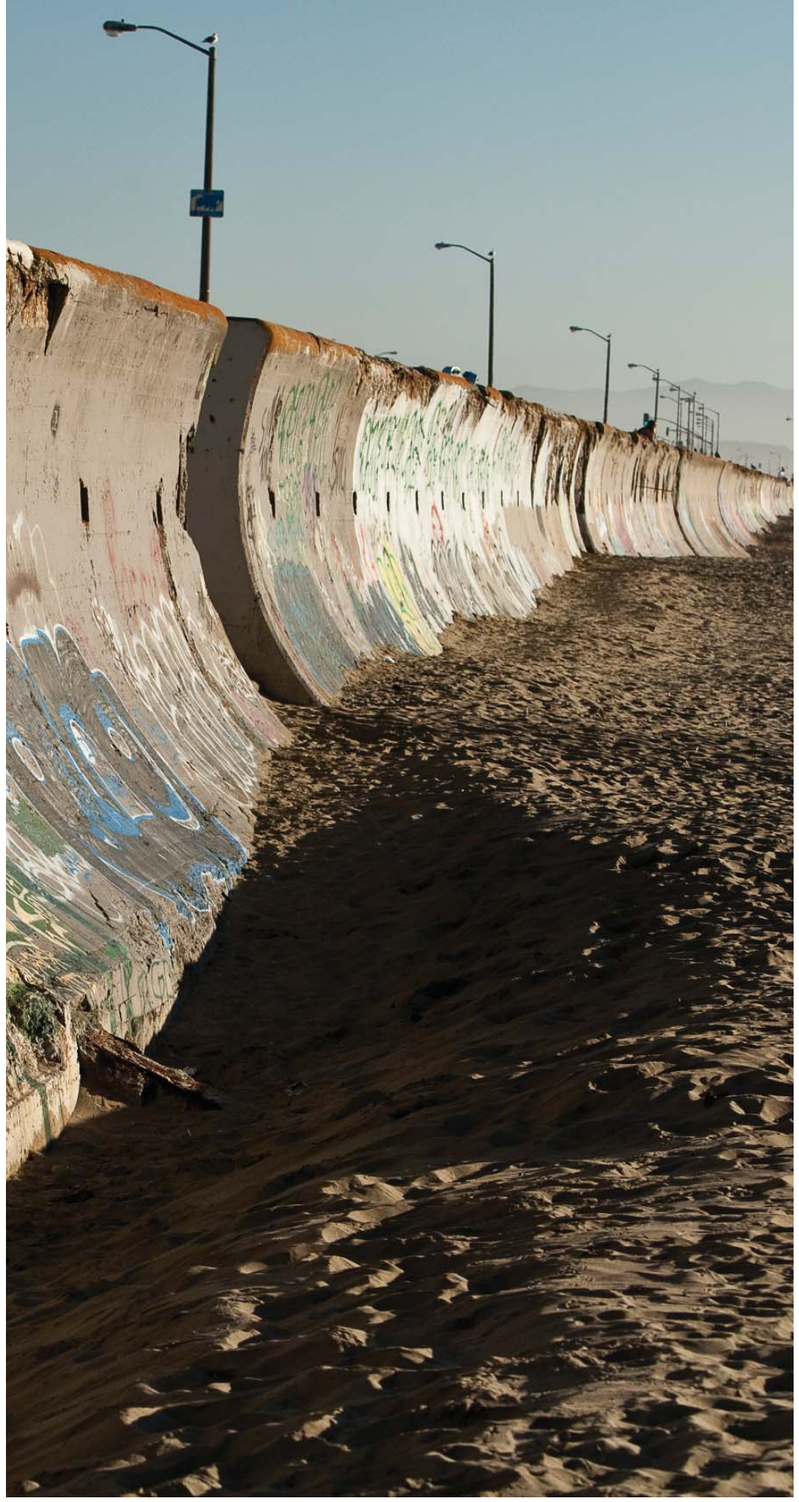


Beach nourishment, the deliberate placement of sand to counteract erosion, is a promising option at Ocean Beach, since 300,000 cubic yards of dredged sand from the Shipping Channel are available annually for beneficial local use.

Regulatory Actions

In July 2011, the City and County of San Francisco submitted an application to the California Coastal Commission for a Coastal Development Permit, which included making permanent the emergency permit for the 2010 revetment, the installation of additional armoring and retroactively permitting the 1997 Emergency Quarrystone Revetment (EQR). The permit was denied by the commission, which demanded a long-range coastal management plan be in place before issuing any additional permits. This sent a clear message that a different approach would be required, but also left the city without a near-term approach to some areas of considerable risk to infrastructure, and the environment.

The commission has since issued an emergency permit for the placement of sandbags (a softer and more patently temporary approach) in the reach of highest risk. We anticipate that this plan will serve as the basis for a long-term approach, and that city agencies will be required to carry these recommendations forward if the commission is to issue Coastal Development Permits in the future.



Beach Nourishment

Beach nourishment —the act of placing sand to widen the beach — has occurred frequently at Ocean Beach, but typically on a relatively modest and incremental scale by moving excess beach sand on land. The opportunity now exists to conduct beach nourishment at a much larger scale by pumping dredged sand directly onto the beach from offshore.

The Army Corps of Engineers is working with the City and County of San Francisco to plan and permit the placement of dredged sand from the marine shipping channel directly on Ocean Beach. Up to 300,000 cubic yards per year is available. While this would be complex to permit and conduct, most parties are enthusiastic that beach nourishment could have a significant impact at Ocean Beach for the near to medium term. The recommendations in this plan assume that the program will go forward and be one component of coastal management. Several processes are necessary for beach nourishment to proceed:

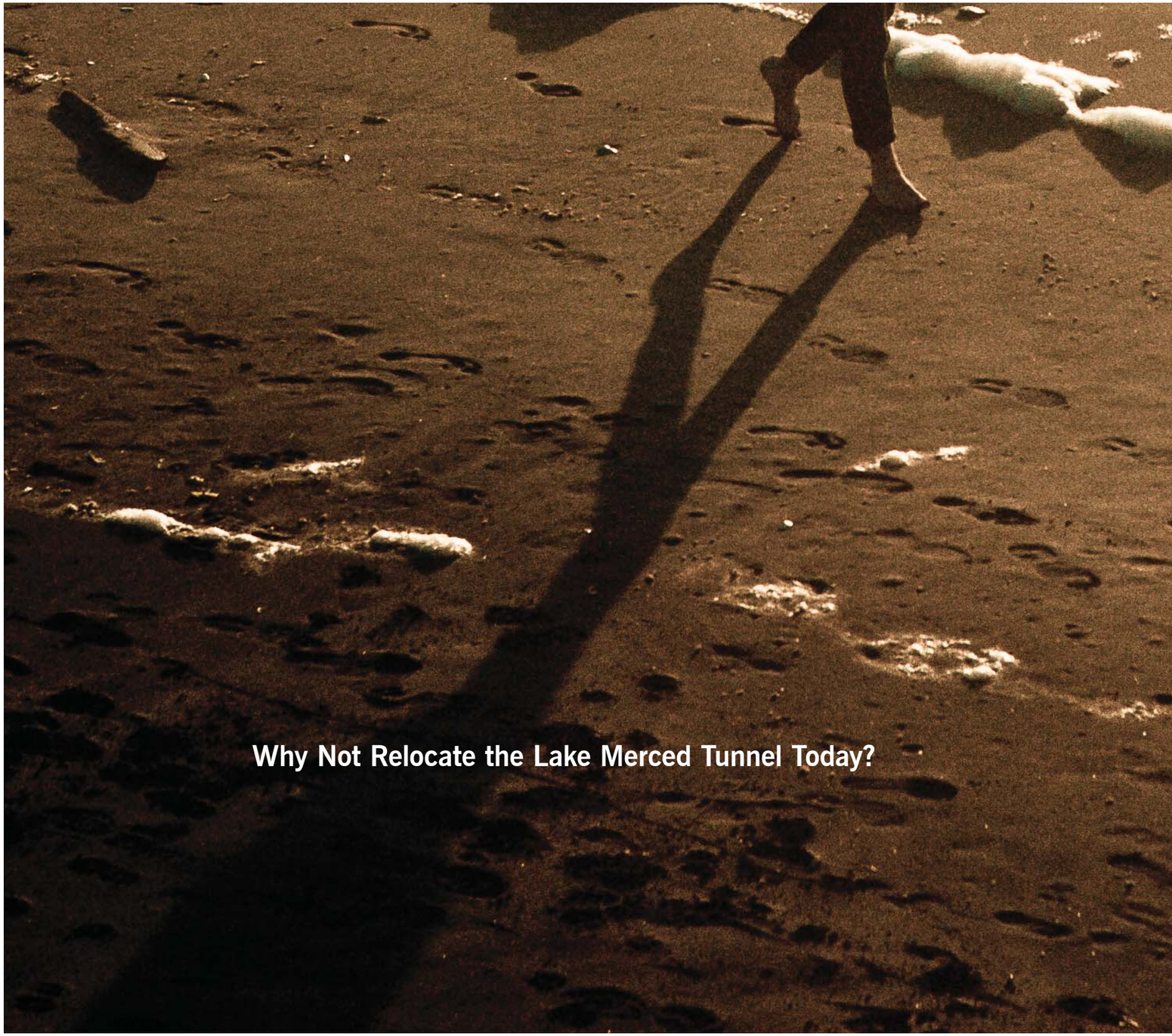
> **Conduct an Environmental Assessment (EA) under the National Environmental Policy Act.** This process is under way, with assessment of direct placement being conducted concurrently with that for near-shore placement at a new dredge deposition site called SF-17.

> **Develop a Beneficial Use ("Section 2037") Plan.** This process allows the Army Corps of Engineers to partner with local agencies to use dredged materials in beneficial local projects. The local partner must provide 35 percent of the project cost over and above the current practice. This plan is in draft form and is proceeding in partnership with city agencies.

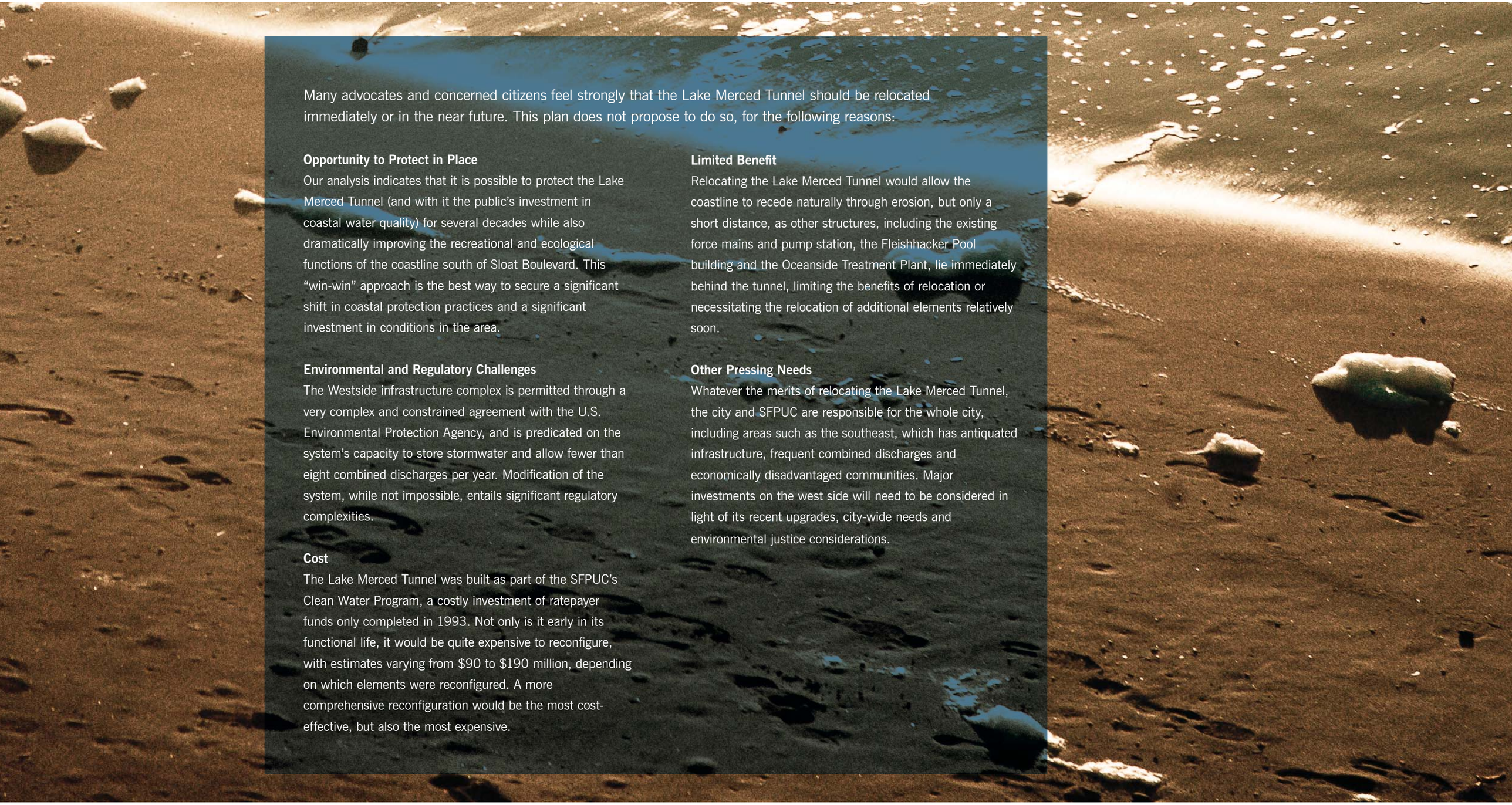
> **Consider dredge availability/retrofit.** The Corps hopper dredge Essayons is one of the only vessels capable of completing the dredging at Ocean Beach, but it must be fitted with pumping equipment to allow direct placement of sand on the beach. Efforts to secure federal funds have not been successful to date, and city agencies are investigating bringing a private contract dredge through the Panama Canal to conduct the work.

Beach nourishment should be conducted using the best available practices to protect and support the ecological functions of the beach and dunes, particularly with respect to the federally listed threatened Western Snowy Plover. This means nourishment activity would best be conducted between May and July of each year, when the bird is absent. Although extensive beach nourishment may have some impact on the beach ecosystem — for example by covering beach wrack that feeds invertebrate detritivores — the existence of a wide beach and improved dunes likely far outweigh such concerns.

The long-term sand supply is another concern. Increased sea levels coupled with the shipping channel side slopes reaching an equilibrium could mean that the availability of sand will decline — which dredge records suggest may already be occurring. This would make it increasingly difficult to rely on beach nourishment to counteract erosion over the long term.



Why Not Relocate the Lake Merced Tunnel Today?



Many advocates and concerned citizens feel strongly that the Lake Merced Tunnel should be relocated immediately or in the near future. This plan does not propose to do so, for the following reasons:

Opportunity to Protect in Place
Our analysis indicates that it is possible to protect the Lake Merced Tunnel (and with it the public's investment in coastal water quality) for several decades while also dramatically improving the recreational and ecological functions of the coastline south of Sloat Boulevard. This "win-win" approach is the best way to secure a significant shift in coastal protection practices and a significant investment in conditions in the area.

Environmental and Regulatory Challenges
The Westside infrastructure complex is permitted through a very complex and constrained agreement with the U.S. Environmental Protection Agency, and is predicated on the system's capacity to store stormwater and allow fewer than eight combined discharges per year. Modification of the system, while not impossible, entails significant regulatory complexities.

Cost
The Lake Merced Tunnel was built as part of the SFPUC's Clean Water Program, a costly investment of ratepayer funds only completed in 1993. Not only is it early in its functional life, it would be quite expensive to reconfigure, with estimates varying from $90 to $190 million, depending on which elements were reconfigured. A more comprehensive reconfiguration would be the most cost-effective, but also the most expensive.

Limited Benefit
Relocating the Lake Merced Tunnel would allow the coastline to recede naturally through erosion, but only a short distance, as other structures, including the existing force mains and pump station, the Fleishhacker Pool building and the Oceanside Treatment Plant, lie immediately behind the tunnel, limiting the benefits of relocation or necessitating the relocation of additional elements relatively soon.

Other Pressing Needs
Whatever the merits of relocating the Lake Merced Tunnel, the city and SFPUC are responsible for the whole city, including areas such as the southeast, which has antiquated infrastructure, frequent combined discharges and economically disadvantaged communities. Major investments on the west side will need to be considered in light of its recent upgrades, city-wide needs and environmental justice considerations.

Long-Term Prospects | 2030 Adaptive Revision

The Ocean Beach environment is highly constrained. It shares with many urban beaches the presence of dense settlement along the coast and many owners and users. But Ocean Beach has additional challenges as well: ongoing erosion, minimal space between the coast and significant features, and the presence of new, high-value, publicly financed infrastructure that is delivering important environmental services. Two major features — the Lake Merced Tunnel and the Westside Transport — run along the coast, limiting the beach's natural evolution by creating a fixed boundary. These structures represent major and successful new investments in water-quality protection, and their near-term relocation is not being contemplated by decision makers.

However, as sea level rise sets in, it is likely to become increasingly difficult to maintain all existing structures in their current locations without an unacceptable degradation of environmental, recreational and aesthetic conditions.

This plan should undergo a major revision by 2030. The revision should include a reevaluation of all assumptions at that time in light of the following factors:

> Better information about the impacts of sea level rise and associated coastal hazards

> Improved policy and technical tools for climate adaptation and coastal management

> Broader awareness by the public and decision makers about climate impacts and possible responses

In particular, two assumptions should be revisited:

> **Strategic relocation/replacement of infrastructure.**
As it becomes increasingly difficult and expensive to protect infrastructure in place without unacceptably compromising environmental and recreational conditions, and as the SFPUC completes pressing capital improvements to improve environmental performance in other parts of the combined sewer system (such as the Southeast Treatment Plant) and with the existing Westside system having provided a greater portion of its design life, it will be essential to consider relocating elements of the system away from coastal hazards. Clearly, the first component that should be considered is the Lake Merced Tunnel, followed by the Westside Transport and Pump Station. A long-term approach that considers other coastal management objectives, sites for all components and ongoing water-quality protection will be required.

> **Acquisition of private property.**
As coastal hazards increasingly threaten private homes at Ocean Beach, and both federal and private insurance become more limited, the gradual acquisition of private land through rolling easements, public right of first refusal or other means may need to be considered. This is **not** considered in this plan, although it was explored in Test Scenario A, "Maximum Retreat" [Refer to Appendix B].

Focus Area 4: **Image and Character**

Aspiration

Preserve and celebrate the beach's raw and open beauty while welcoming a broader public.

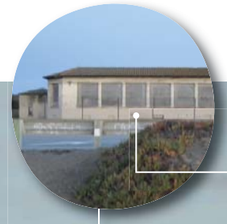
Although Ocean Beach is in the city, its urban setting is dwarfed by the vastness of the natural context. Like many of San Francisco's best open spaces, it offers a portal to the regional landscape. But both its wild and urban aspects are decidedly less genteel than those of other natural places in the city. The environment — built and natural — shows the elemental scour of wind and waves and is known for its dense and persistent fog. The local culture has developed an edge that mirrors the environment: Most days, even a stroll on the sand demands a bit of ruggedness, and the surf's frigid rip currents have regularly threatened and even taken lives.

A century ago, Ocean Beach was a very different kind of place, more Coney Island than wilderness, with gardens, baths, Playland-at-the-Beach and a massive saltwater swimming pool. Today, when those few sweet warm days arrive, Ocean Beach again becomes a retreat for the whole city. A festival atmosphere prevails as a crush of cars, bikes and Muni riders descends, and the shortage of services becomes acute as trash piles up, bikes are heaped up and locked together and dunes become restrooms of last resort.

It would be wrong to ignore the basic needs of the more than 300,000 annual visitors to Ocean Beach. But as many in the community have expressed, "prettying up" is not what the beach needs, either. The master plan team is taking that observation to heart. Good landscape design has the power to strike that balance — to solve problems and serve needs while speaking to the soul of a place.

Ocean Beach is loved for its raw and open beauty. During this planning process, stakeholders and community members expressed their desire for improving some of the beach's facilities but insisted that maintaining the unique character by not "prettying up" of the beach was crucial.

Fleishhacker Pool Photography
©2012 Shawn Clover



Fleishhakker Pool Building

Wildlife Protection Zone

south reach

PACIFIC OCEAN

SURF ZONE

erosion

safety risks

VIEWS

elevated bluff

The Great Highway

enclosed

DUNE BEACH

The Great Highway

Fort Funston

Oceanside Water Pollution Control Plant (OWPCP)

San Francisco Zoo

Lake Merced

Skyline Blvd

Armory Rd

Sloat Boulevard

Wawona St

Ulloa St

Taraval St

Santiago St

47th Ave

OUTER SUNSET

Figure III-13:
Feature Icons and Character Zones Diagram

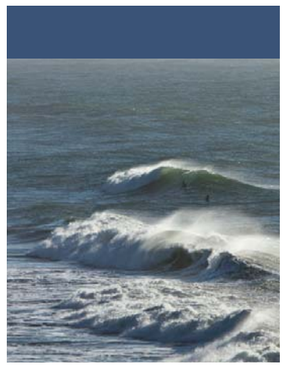
Ocean Beach is a place of multiple, distinct characters... from the ocean to the bluff trails, and from the northern open beach to the southern beach dunes.

Legend

- Project Boundary
- The Great Highway
- Existing Promenade
- Lower Great Highway (Trail)
- Key Views

Linear Landscapes

Surf Zone



Shoreline

Open Beach

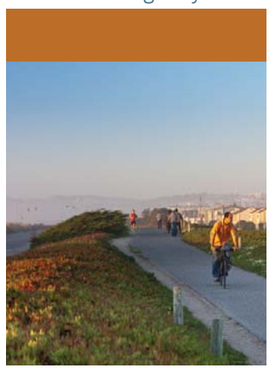
Promenade

Dune Beach

Dune Trail (partial)

the Great Highway

Lower Great Highway Park



middle reach

north reach

Beach Chalet

Seal Rocks

Sutro Baths

Firebowls

SHORELINE

secluded

"PLEASURE DRIVING"

expansive

OPEN BEACH

active

VIEWS

La Playa St

48th Ave

Ortega St

Noriega St

Moraga St

Golden Gate Park

Fulton St

La Playa St

48th Ave

Balboa St

Land's End

45th Ave

Lincoln Way

OUTER RICHMOND

Point Lobos Ave

North

Scale 0 500 ft 1000 ft

Noriega
Seawall and Promenade

Windmills

Firebowls

O'Shaughnessy
Seawall and Promenade

Cliff House

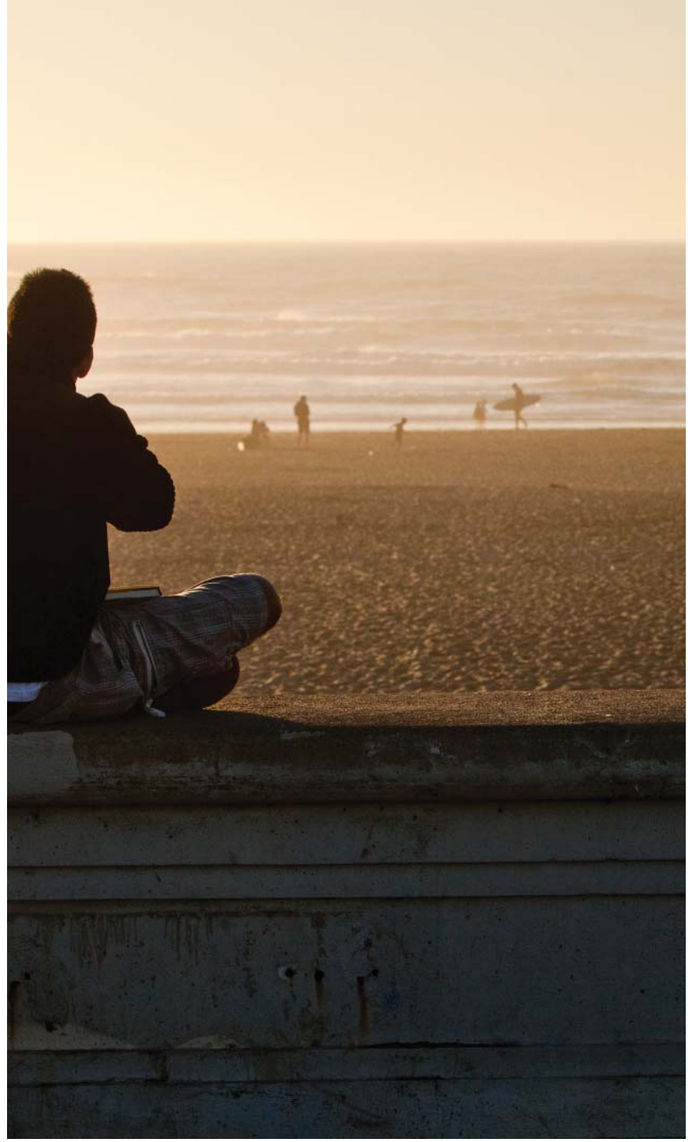
Focus Area 5: **Program and Uses**

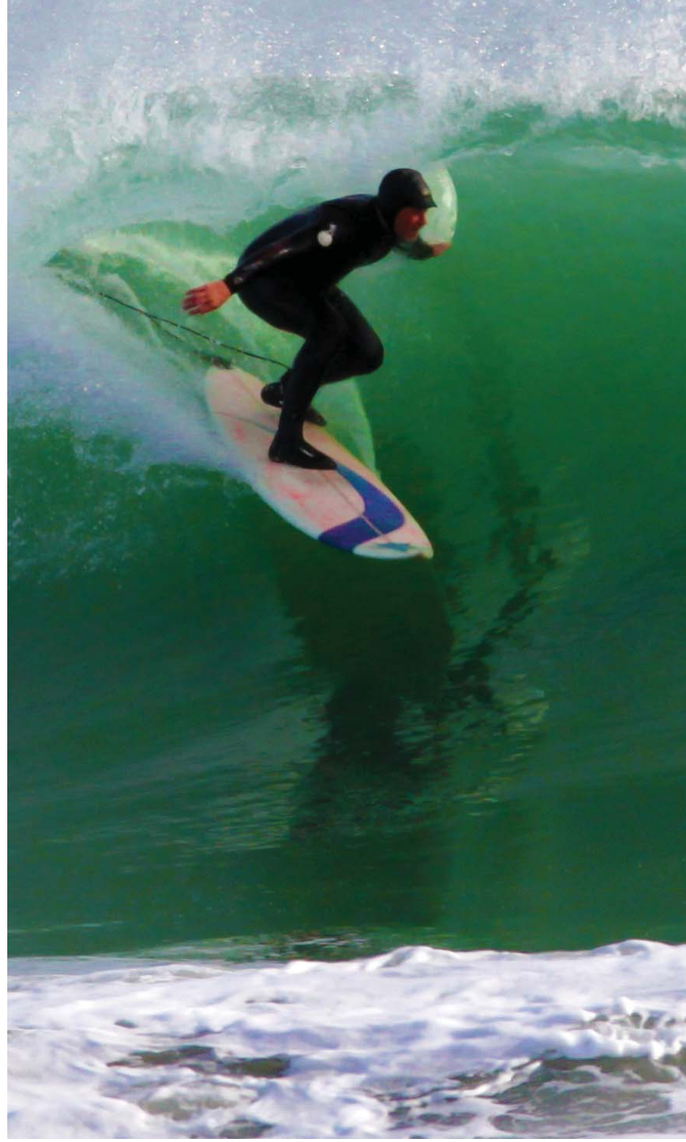
Aspiration

Accommodate diverse activities and users, managed for positive coexistence.

To be successful, improvements at Ocean Beach need to accommodate and balance a wide range of users, from surfers to families, bird-watchers to cyclists. For the most part, activities sort themselves into linear zones that can inform the approach to design and programming: joggers and cyclists on the multiuse path, walkers on the dune trails, promenaders (along with anglers) on the wet sand and surfers in the water. Basic amenities — such as restrooms, waste collection and food — are in limited supply, and jurisdictional challenges complicate their siting, funding and operation.

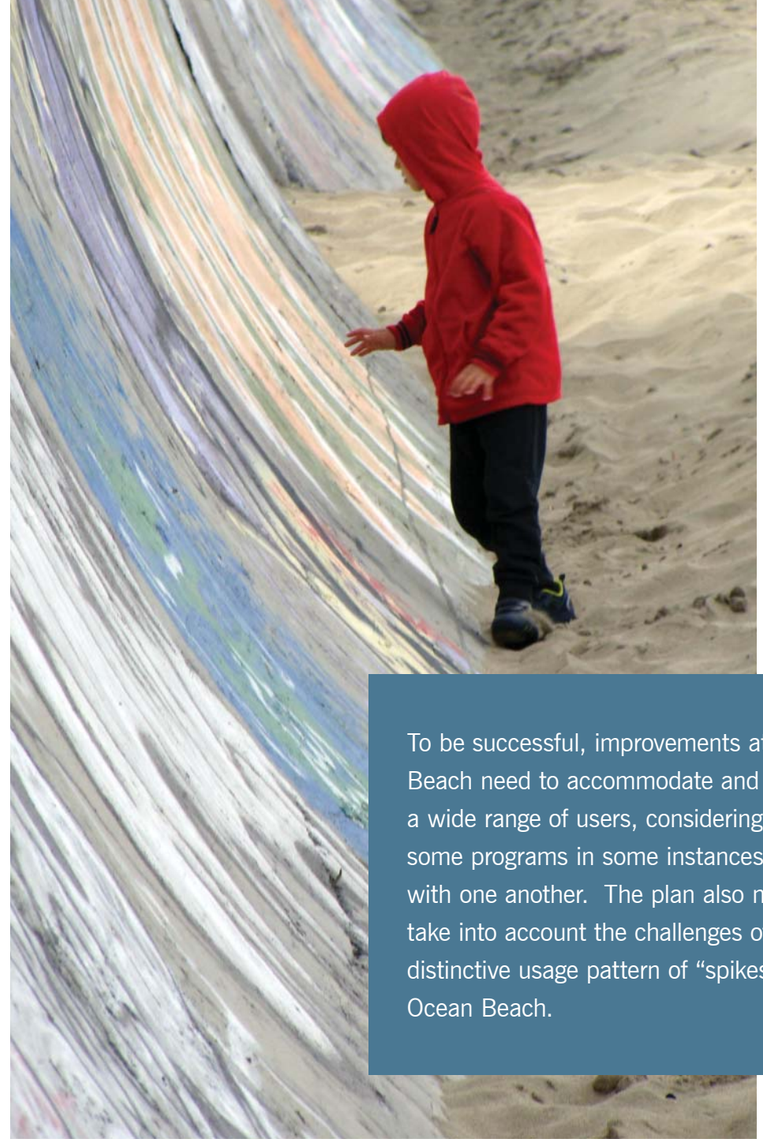
As in most open spaces, there are conflicting ideas about which uses belong where, and which are worthy of accommodation. Pedestrians and cyclists get tangled on the multiuse path, birders raise an eyebrow at dog walkers and nighttime bonfires are a grand tradition to some and a messy nuisance to others.





In January 2011, the National Park Service issued its Draft Dog Management Plan for the Golden Gate National Recreation Area. In its preferred alternative, the northern end of Ocean Beach would remain an off-leash area but much of the beach would be entirely off-limits to dogs. Dogs are already restricted for nine to 10 months of the year (plover season), and the GGNRA would remain the only national park to allow dogs at all. Still, the proposal remains controversial, and the plan is currently undergoing revision, with a new draft expected in 2012.

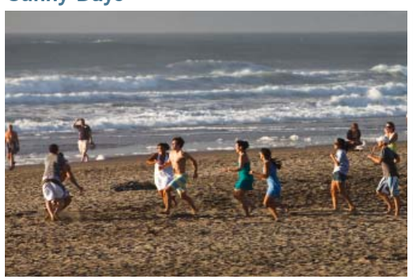
One key challenge is the distinctive pattern of use over time. Most of the time, the beach and promenades are used by relatively few people, many of whom are locals and regular users: walkers and joggers, surfers and cyclists. This "baseline" condition (with its own seasonal and diurnal variations) holds sway until one of those rare hot, sunny weekends, when the beach experiences an enormous spike of visitors from around the city and region.



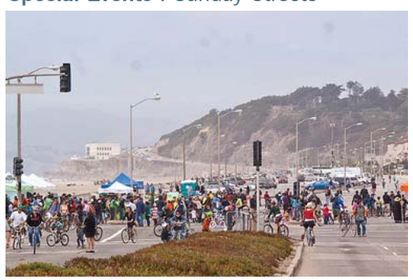
To be successful, improvements at Ocean Beach need to accommodate and balance a wide range of users, considering that some programs in some instances conflict with one another. The plan also needs to take into account the challenges of the distinctive usage pattern of "spikes" at Ocean Beach.

Foggy Days

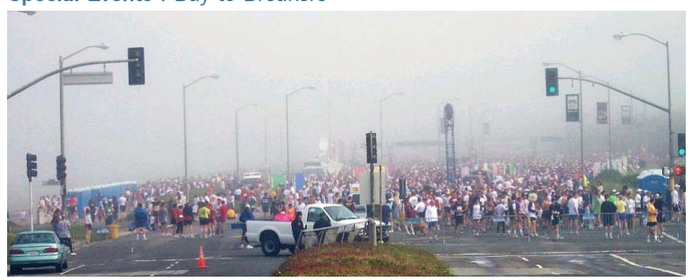
Sunny Days



Special Events : Sunday Streets



Special Events : Bay to Breakers



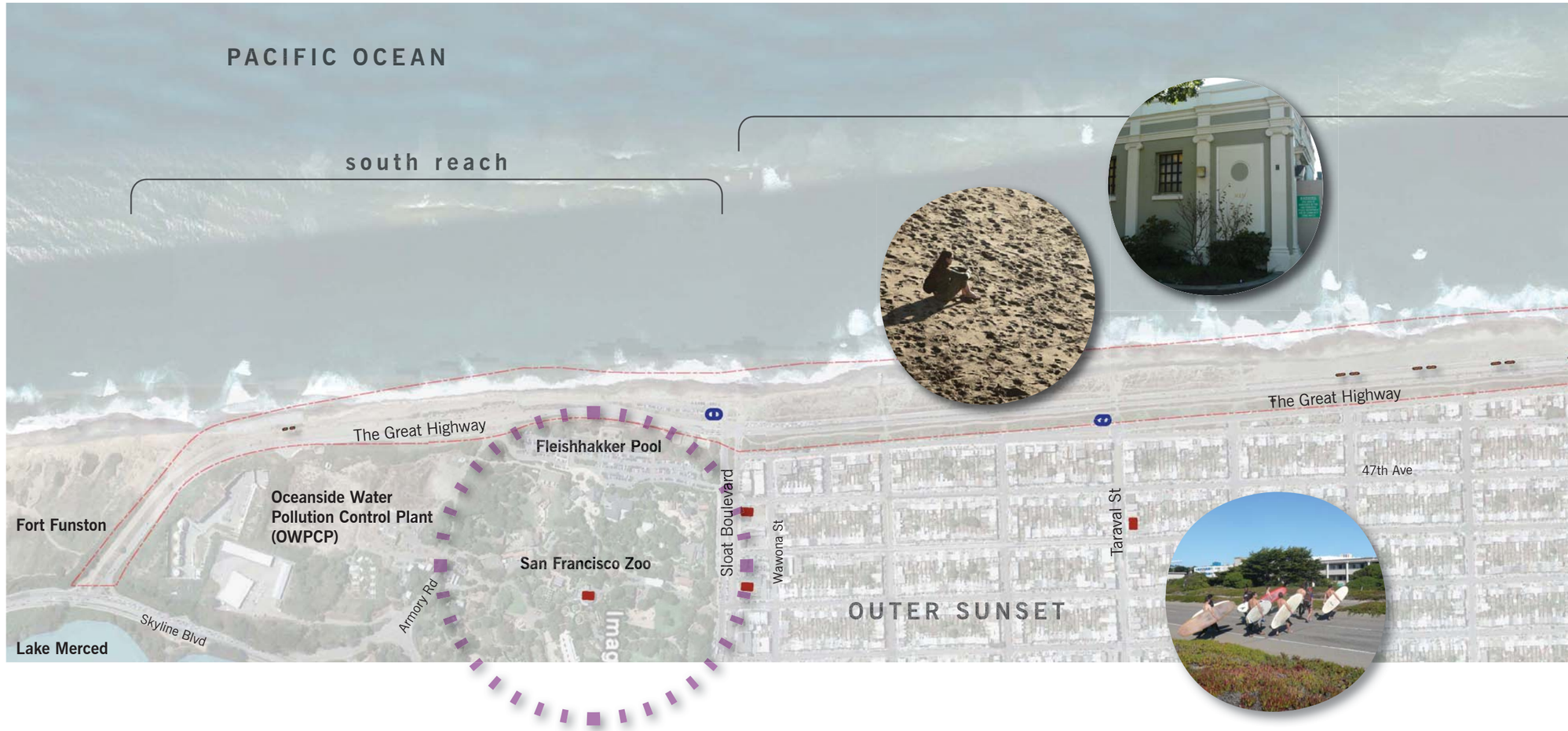
Ocean Beach has a distinctive pattern of use, with visitation "spikes" triggered by favorable weather conditions or special events.

Figure III-14:
Existing Elements and Facilities Diagram

Ocean Beach has a rich and unique history of uses, integrally linked to San Francisco and the Pacific Ocean. OB provides opportunities for outdoor recreation and to enjoy the ocean's vast and dramatic landscape.

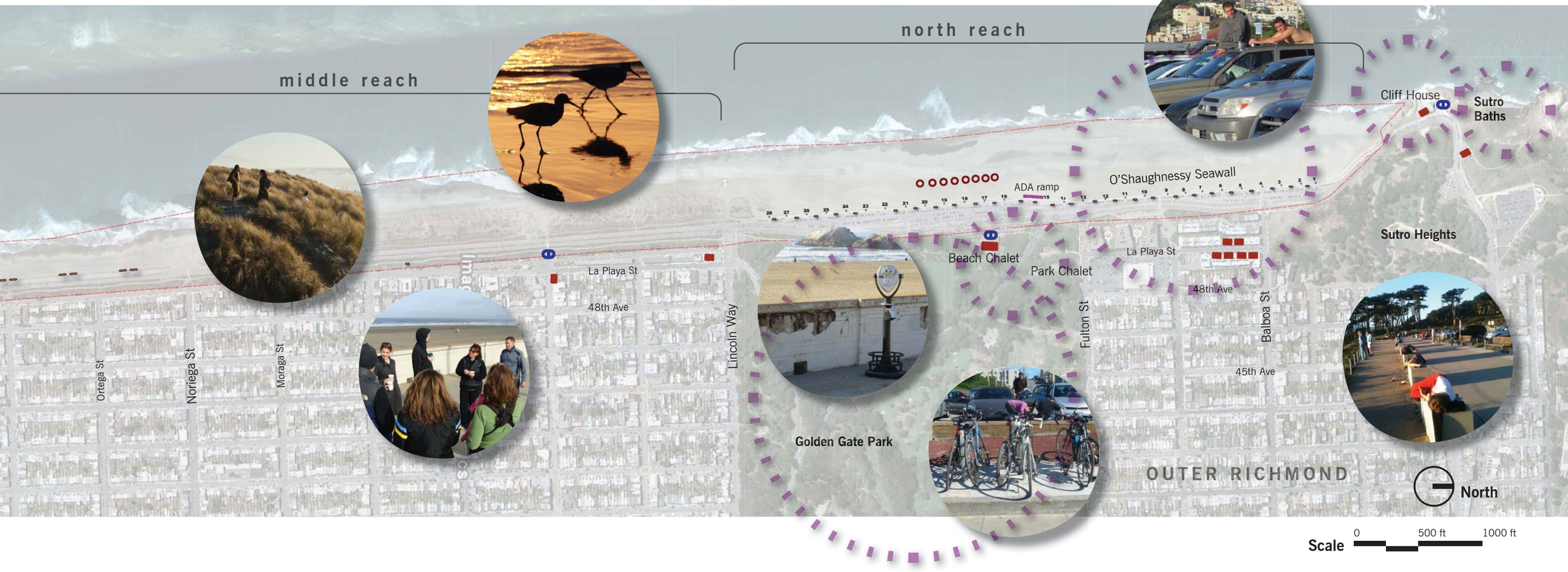
Legend

- Project Boundary
- Existing Restroom
- Existing Cafe / Restaruant
- Existing Bench
- Existing Stairwell
- Approximate Firebowl location
- Visitor Attraction, Element or Node

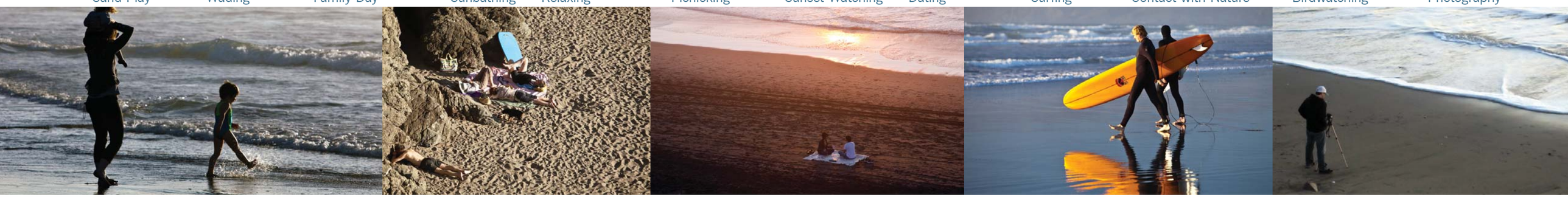


Bike Riding | Heart to Heart Talks | Bonfire | Sky and Star Gazing | Listening to Waves | Walking | Meditating | Dog Walking | Meet Friends

Favorite things to do at Ocean Beach...



Sand Play | Wading | Family Day | Sunbathing | Relaxing | Picnicking | Sunset Watching | Dating | Surfing | Contact with Nature | Birdwatching | Photography



Focus Area 6: **Access and Connectivity**

Aspiration

Provide seamless and fluid connections to adjacent open spaces, the city and the region.

Ocean Beach is not only a destination in itself. It is also a key corridor connecting Lands End and Sutro Heights at the north to Golden Gate Park, the zoo and Fort Funston at the south. While movement along Ocean Beach is fairly easy, the east–west connections to adjoining open spaces, neighborhoods and other amenities are much weaker. In general, Ocean Beach could be integrated much more effectively with its surroundings, particularly for pedestrians, transit riders and cyclists.

Ocean Beach is a key corridor connecting destinations on San Francisco's west side. While movement along Ocean Beach is fairly easy, the east–west connections to adjoining areas are much weaker. Additionally, many of the streets surrounding Ocean Beach are wider than necessary and have more vehicular capacity than actual demand under most conditions.

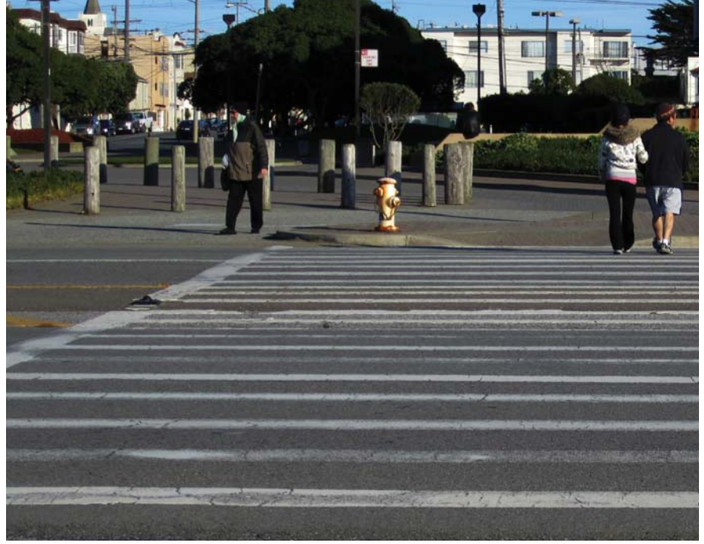
Significant gaps include:

> **Arrival at the beach from Golden Gate Park.** What could and should be a spectacular arrival is an anticlimax for pedestrians and cyclists, who are dropped into a sea of asphalt roadway and parking with little sense of how to proceed.

> **Promenade transition at Lincoln.** The O'Shaughnessy Seawall promenade offers a grand strolling experience from the Cliff House to Lincoln, then suddenly peters out into intermittently visible trails in the dunes. A clear connection is needed.

> **Ocean Beach to Fort Funston.** Trails and promenades dwindle south of Sloat, due in part to erosion and the installation of revetments. Pedestrians are often forced to walk in the roadway and jump a guardrail to access Fort Funston, the next major GGNRA site to the south, via informal trails.

> **Ocean Beach to Lake Merced.** The Great Highway south of Sloat offers no pedestrian or bicycle access, and there is no crosswalk at Skyline allowing access to Lake Merced's popular trails.



Traffic Capacity and Roadway Configurations

Many of the streets surrounding Ocean Beach are wider than necessary and have more vehicular capacity than actual demand under most conditions [Figure III-15]. These include the Great Highway from Lincoln to Sloat, and to a greater degree south of Sloat, and Sloat from the Great Highway to Skyline. Both intersections and roadway configurations are nonstandard in some locations. These include:

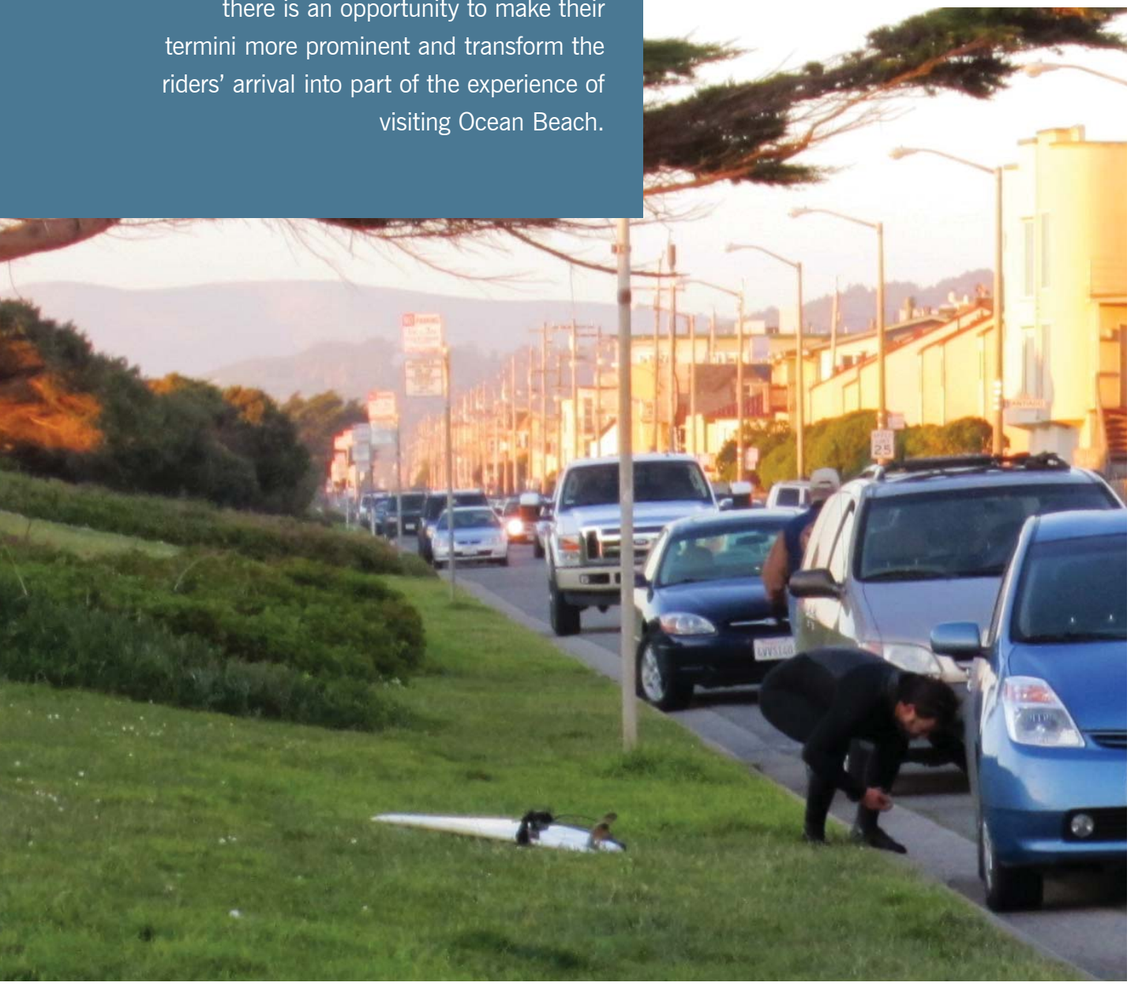
- **Sloat Boulevard corridor,** with six lanes of auto traffic and angle parking in the median, which impedes traffic flow and pedestrian access. This segment is slated for narrowing with painted bicycle lanes, a project that, along with Caltrans's similar effort further east, could provide important data on traffic flow.
- **Sloat–Skyline intersection,** which is quite oversized and features free-right-turn channels that are problematic for pedestrians and cyclists.
- **Great Highway and Skyline,** which lacks a crosswalk to the multiuse trail at Lake Merced, a major recreational amenity.
- **Great Highway at JFK Drive | Beach Chalet | Fulton**, which includes a large concentration of intersections, with long and ambiguous pedestrian crossings.
- **Great Highway at Balboa,** which include a six-lane intersection controlled by a stop sign.

Source: Nelson \ Nygaard

Figure III-15:
Traffic Volumes and Typical Street Configurations

Many of the streets surrounding Ocean Beach are wider than necessary and have more vehicular capacity than actual demand under most conditions.

Several major transit lines terminate at or near Ocean Beach, providing good connectivity to the rest of the city, but there is an opportunity to make their termini more prominent and transform the riders' arrival into part of the experience of visiting Ocean Beach.



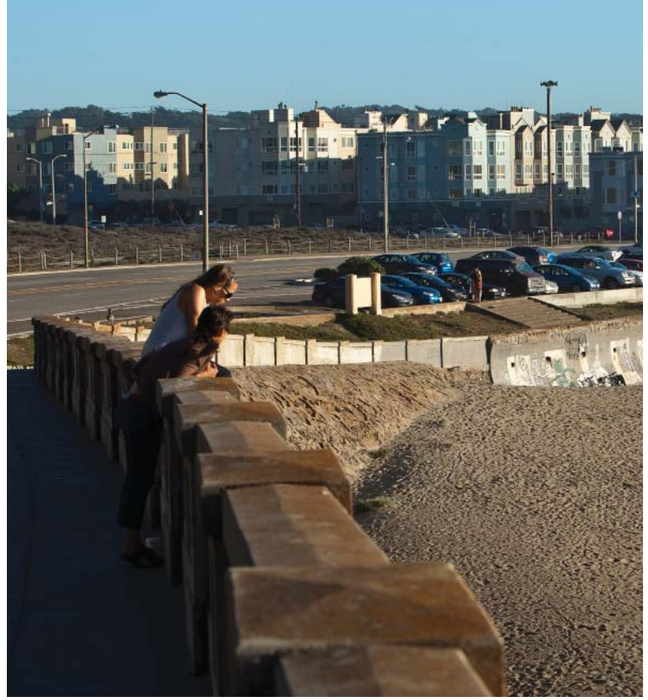
The Great Highway was completed in the 1920s as a grand vehicular promenade. Its reconfiguration in the 1990s narrowed it by nearly half, but it remains a traffic artery first and foremost, with a capacity that exceeds its actual usage. South of Sloat Boulevard, the Great Highway is squeezed between the eroding bluffs and inland structures, with traffic capacity to spare.

In addition, the Great Highway is frequently closed for special events or due to blowing sand or flooding. The Great Highway south of Sloat Boulevard was closed southbound for nearly a year after the severe erosion episode in 2010, with only limited congestion impacts despite minimal management of temporary circulation. The segment from Lincoln to Sloat is unusual in that it lacks any vehicular intersections and is signalized only at pedestrian crossings. This both allows precise signal timing and limits spillover impacts on surrounding residential districts, which nevertheless do occur during periods of heavy use. Unmanaged closures of the Great Highway are a problem, one that area residents and Supervisor Chu's office have been working with the Municipal Transportation Authority to address by installing flip-down signs advising other routes, such as Skyline Boulevard during Great Highway closures. Any steps that would limit traffic throughput on the Great Highway should be accompanied by mitigation measures to limit impacts on adjacent neighborhoods.

The Great Highway

1930s

today



Transit

Several major transit lines terminate at or near Ocean Beach, providing good connectivity to the rest of the city. These include the L Tarava,l, N Judah and 38 Geary. Other lines include the 31, 18, 48 and 23, among others.

Although both the L Taraval and N Judah streetcars terminate near the beach, there is little sense of arrival at a major open space resource and national park. The L Taraval terminus in particular leaves visitors to the zoo and beach at an undifferentiated intersection one block short of Sloat Boulevard. These termini could do more to inform and facilitate coastal and open space access.

Bicycle

Ocean Beach is a popular destination for recreational cyclists, many of whom ride to the ocean via Golden Gate Park, a major bicycle route that is being upgraded extensively. The Great Highway and its multiuse trail are also an important cycling route and constitute a segment of the Pacific Coast route from Canada to Mexico.

Problems faced by cyclists include the following:

> **Inadequate bicycle parking.** Although some bike racks have been added in the O'Shaughnessy lot in recent years, they are frequently over-full, indicating considerable unmet demand, and most of the beach lacks any bike parking at all.

> **Conflicts with other users.** The multiuse trail combines joggers, walkers, skaters and cyclists of different speeds, resulting in frustrating and potentially dangerous conflicts.

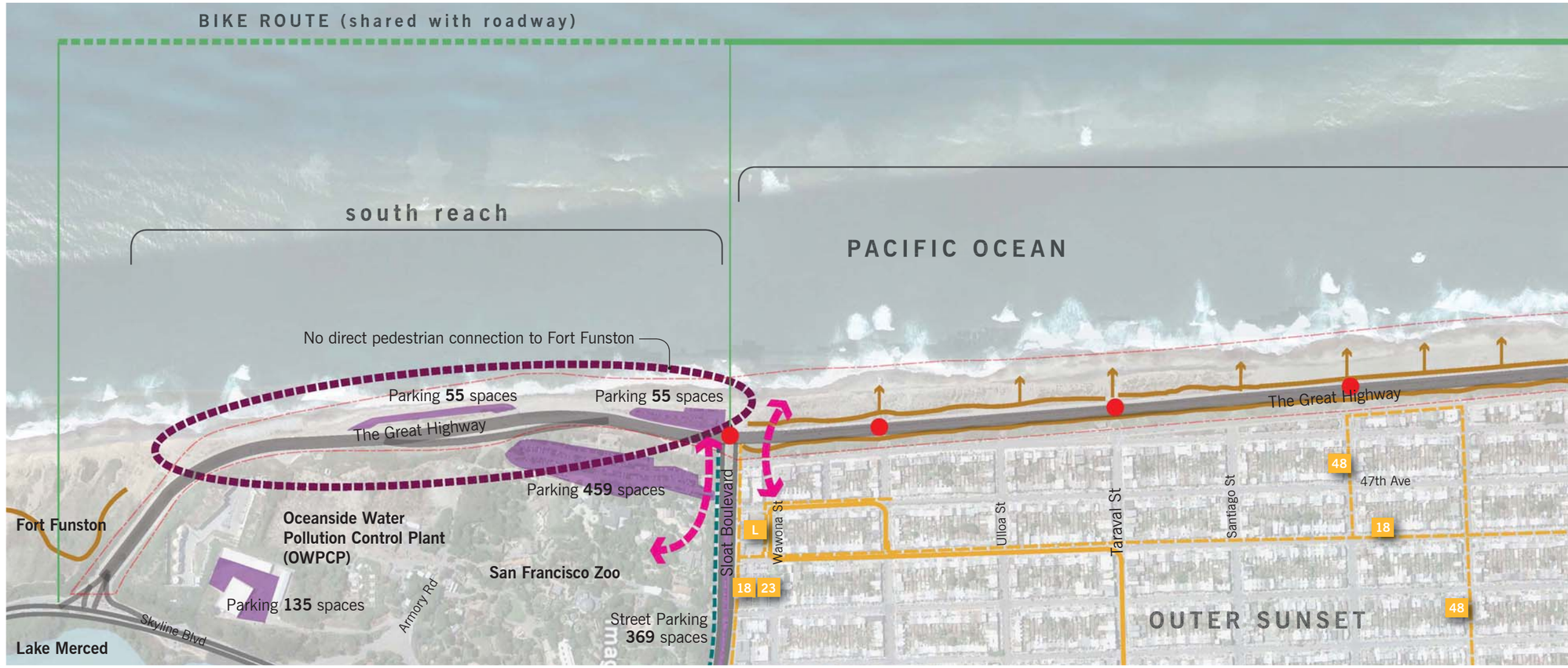
> **Hazardous condition north of Balboa.** As the Great Highway ascends Sutro Heights adjacent to the Cliff House, several factors — a lack of designated lanes, a steep grade, a blind curve and diagonal parking — combine to create a hazardous condition. This segment connects to important cycling routes through Lands End and the Presidio.

The City of San Francisco's Sunday Streets program has closed the Great Highway to cars a few times, showing us a tantalizing multimodal vision, more "great" than "highway." Meanwhile, a campaign by the San Francisco Bicycle Coalition to build a physically separated bikeway from San Francisco Bay to the ocean is highlighting Ocean Beach as a major cycling destination with significant shortfalls in connectivity. As our ideas about multimodal streets and recreational waterfront access evolve, it may be time to reevaluate the vehicular emphasis on the city's only oceanfront street.

Ocean Beach is also a popular destination for recreational cyclists. Although this major bicycle route is being upgraded extensively, there are still improvements necessary, such as better bicycle parking and upgrades to mitigate hazardous riding conditions in key segments.

Figure III-16:
Existing Circulation Diagram

Ocean Beach is served by several major transit lines. Although pedestrian and bicycle is fairly easy within the beach area, there are significant gaps with adjoining open spaces, neighborhoods and other amenities.



Legend

- Project Boundary
- The Great Highway
- Major Arterial Road
- Muni Metro
- Muni Bus
- Promenade
- Pedestrian Connection
- Bike Path | Lane | Route
- Planned Bike Lane
- Traffic Light
- # Muni Line Number
- Pedestrian Connectivity Gap
- Beach Access (Path, Stair, Ramp)
- Key Pedestrian Connections
- Parking

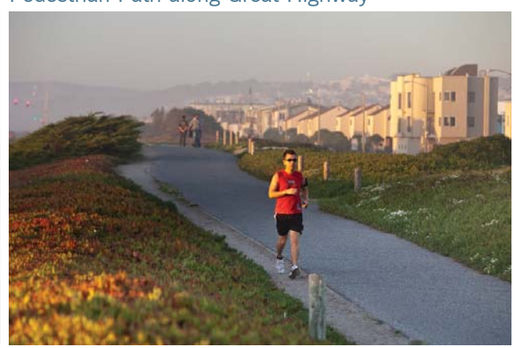
Table III-2:
Existing Parking Spaces

SOURCE : Desktop and site observation counts (approximate), prepared by Nelson\Nygaard

LOCATION	AMOUNT	TOTAL
OWPCP Parking	135	
Great Highway Parking Lot 1	55	
Great Highway Parking Lot 2	55	
Street Parking on Sloat Boulevard	369	
San Francisco Zoo Parking Lot	459	1,679
Golden Gate Park Parking Lot	125	
O'Shaughanessy Promenade Lot	166	
Street Parking at Cliff House	125	
Land's End Parking Lot	134	
Point Lobos Avenue Parking Lot	56	

Bus Stop at La Playa Street

Pedestrian Path along Great Highway



BIKE PATH (designated paved bike path)

BIKE ROUTE (shared with roadway)

north reach

middle reach

Cliff House

Street Parking
125 spaces

Parking
56 spaces

Parking
134 spaces

Pedestrian gap between promenade and trail

Deteriorated trail

Parking **125** spaces

Parking **166** spaces

Beach Chalet

La Playa St

48th Ave

Lincoln Way

Fulton St

Balboa St

Point Lobos Ave

45th Ave

Golden Gate Park

OUTER RICHMOND

Ortega St

Noriega St

Moraga St

71 | 16

N

18

5 | 18 | 31

5

38

38

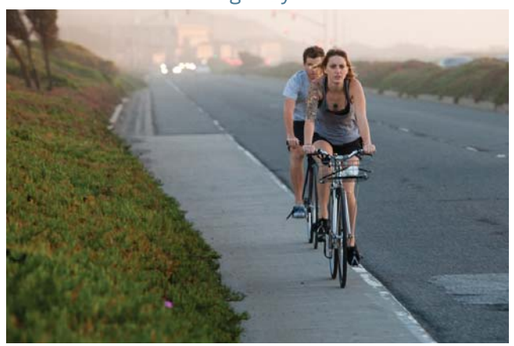
North

Scale 0 500 ft 1000 ft

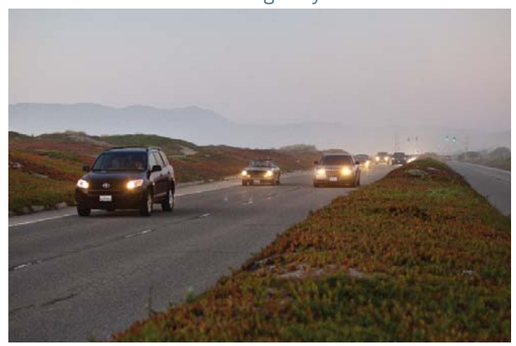
Promenade

Ocean Beach Parking

Bike Route on Great Highway



Vehicular Traffic on Great Highway



Focus Area 7: **Management and Stewardship**

Aspiration

Provide an approach to long-term stewardship across agencies, properties and jurisdictions.

Although visitors experience Ocean Beach as a whole place, its is managed by numerous federal, state and local agencies. The beach, dunes and promenades are mostly federal GGNRA parkland, while the Great Highway, multiuse trail and most parking lots are owned by the San Francisco Recreation and Parks Department. The San Francisco Department of Public Works provides maintenance and emergency repairs on both city and federal property, while the San Francisco Public Utilities Commission owns and manages underground wastewater infrastructure and the Oceanside Water Pollution Control Plant. Dredging and sediment management by the Army Corps of Engineers shape the beach. The California Coastal Commission is the permitting authority at the beach. Further inland within the coastal zone, the San Francisco Planning Department oversees development decisions through the city's Coastal Commission–approved Local Coastal Program (the Western Shoreline Plan).

Not only are these agencies administratively distinct, they often have conflicting priorities as well. For example, National Park Service policies favoring natural resources and processes may conflict with the needs of the PUC's infrastructure, although both serve environmental imperatives. This plan is a major first step in coordinating the activities of these agencies. Several of the recommended implementation steps involve interagency cooperation, including the creation of joint management agreements around both open space and coastal management.

Another challenge at Ocean Beach is the distinctive use pattern: a moderate baseline of regular users punctuated by dramatic spikes during warm weekends. Practices that account for this pattern could help Ocean Beach better accommodate users while protecting the beach and using limited management resources effectively.

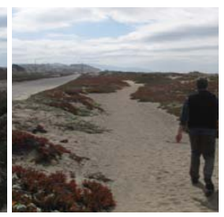
Opportunities for Integrated Management

Several key opportunities exist for more integrated management of Ocean Beach, both at an immediate day-to-day level and in making long-term decisions about stewarding its resources for future generations. The interagency communication established in the service of this planning process can transition into more formalized structures for interagency management in several arenas.

Sand transport by wind

Beach | Sand Maintenance

Dunes and Trails



These interagency management opportunities include:

> **Joint operations management.** Recurring operational issues include waste management, road closures due to windblown sand requiring disposal, major events resulting in traffic and crowd management, and the need for basic visitor amenities. An informal management task force could identify opportunities and challenges in this area, initiate improved practices and form the basis of a formal joint management agreement or a new management entity.

> **Joint coastal management.** Decisions taken to address coastal hazards occur in several different agencies with different responsibilities. In particular, the SFPUC needs to protect public infrastructure, the GGNRA safeguards natural resources and public access and the Army Corps of Engineers manages the dredging of sand, the basis of beach nourishment. With the recommendations in this plan as a starting point, an interagency Coastal Management Framework could lay out an agreed-upon set of actions that incorporates the needs of all responsible agencies.

> **Joint open-space planning.** Investments in the future of Ocean Beach as a public space should be planned and designed in a coordinated fashion, regardless of property lines. Public, private and philanthropic resources should be marshaled in service of a clear vision that serves the needs of the public, protects natural resources and internalizes the best available information about evolving coastal conditions.

Ocean Beach is managed by numerous federal, state and local agencies. Not only are these agencies administratively distinct, they often have conflicting priorities as well. This plan is a major first step in coordinating the activities of these agencies for future potential interagency cooperation in managing the beach and its facilities.

Waste Management

Restrooms | Facilities

Dog Management

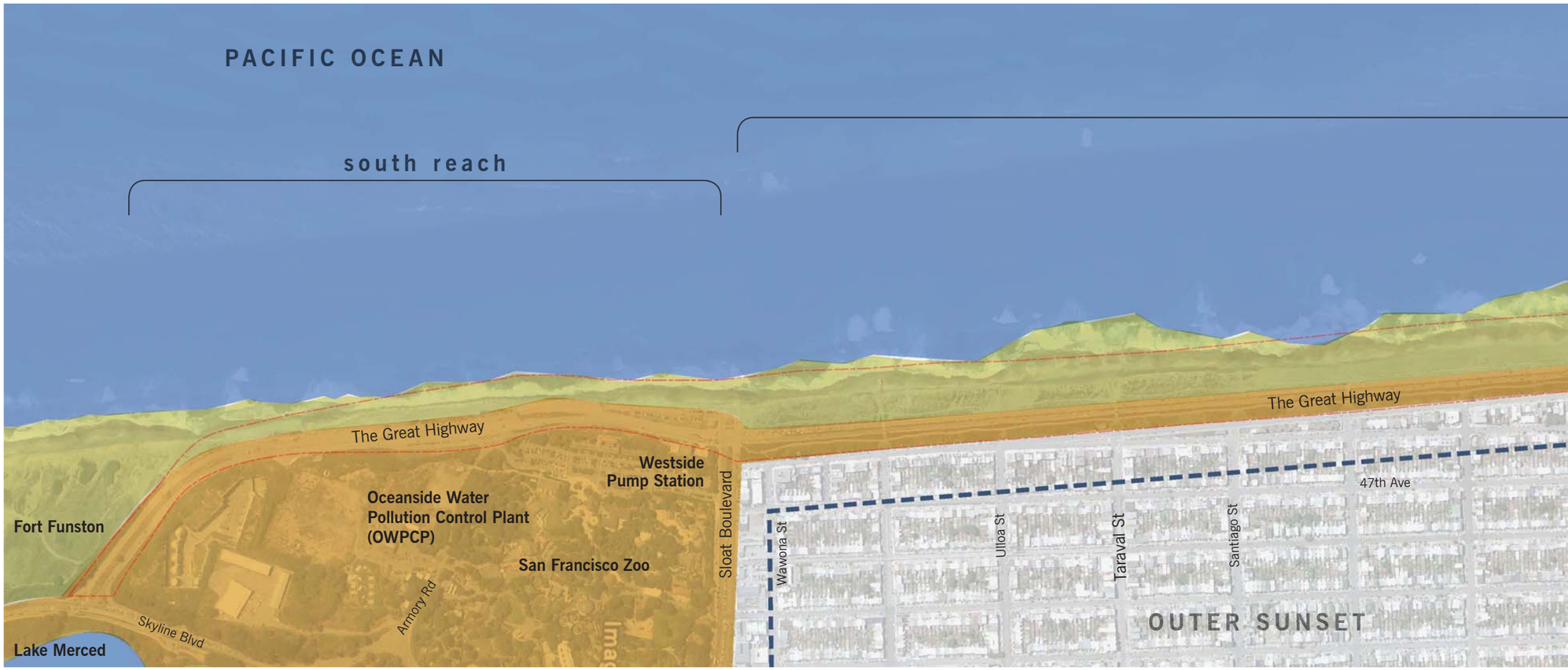
Maintenance and stewardship

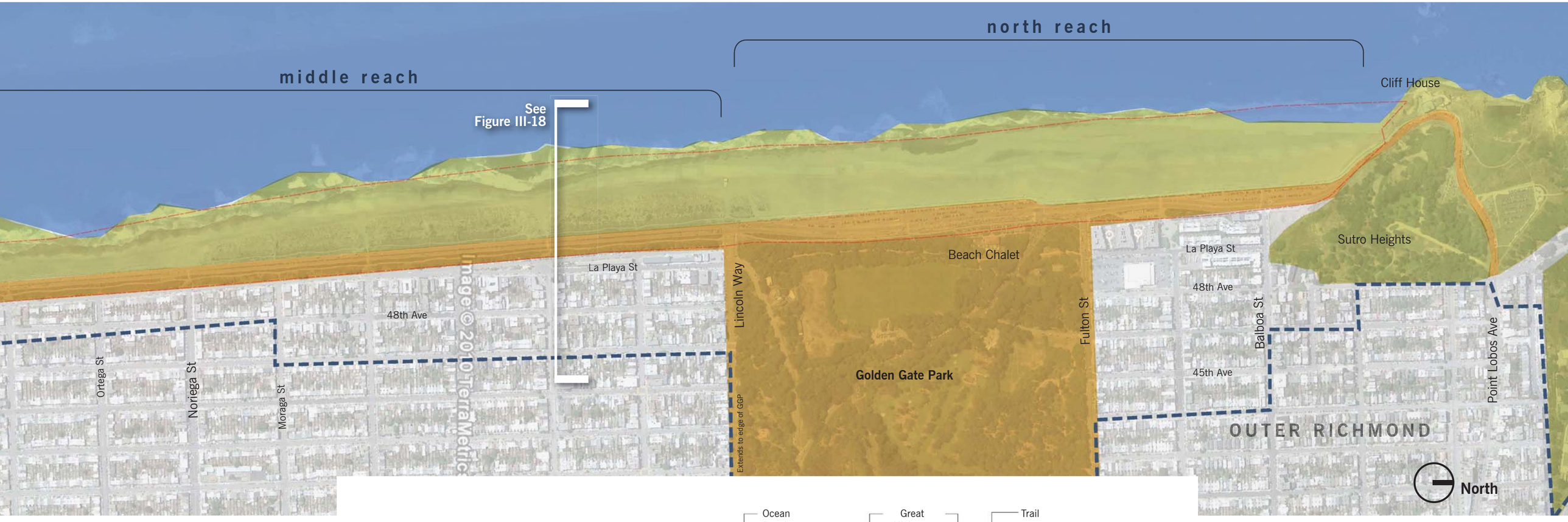
Figure III-17:
Existing Jurisdictions Diagram

Ocean Beach is administered by a number of federal, state and local agencies. This diagram and the key section [Figure III-18] illustrate the jurisdictional map.

Legend

- Project Boundary
- Golden Gate National Recreation Area (GGNRA)
- San Francisco City and County (excludes private property)
- California Coastal Commission Jurisdiction and Army Corps Permitting Authority
- Coastal Zone subject to local coastal program





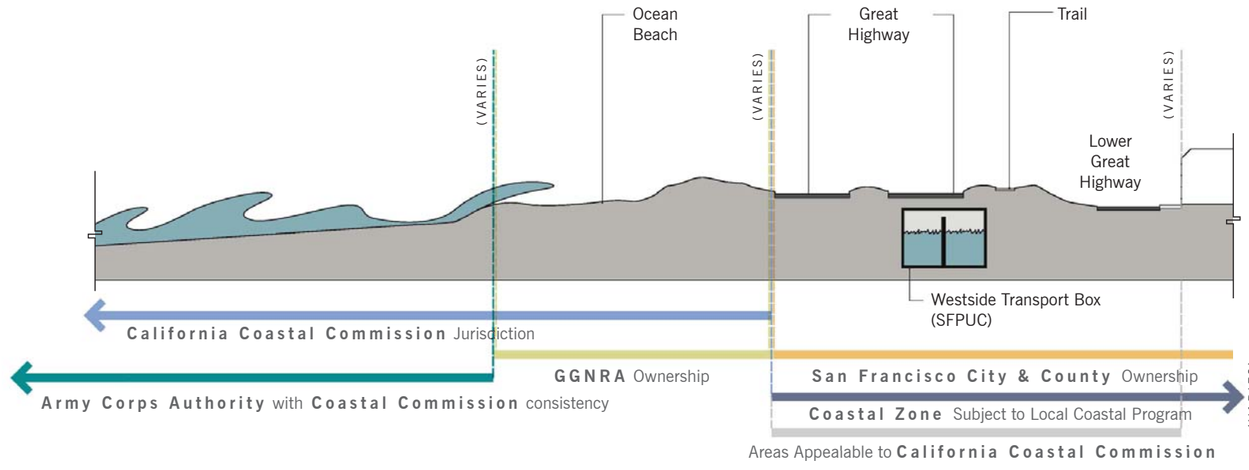
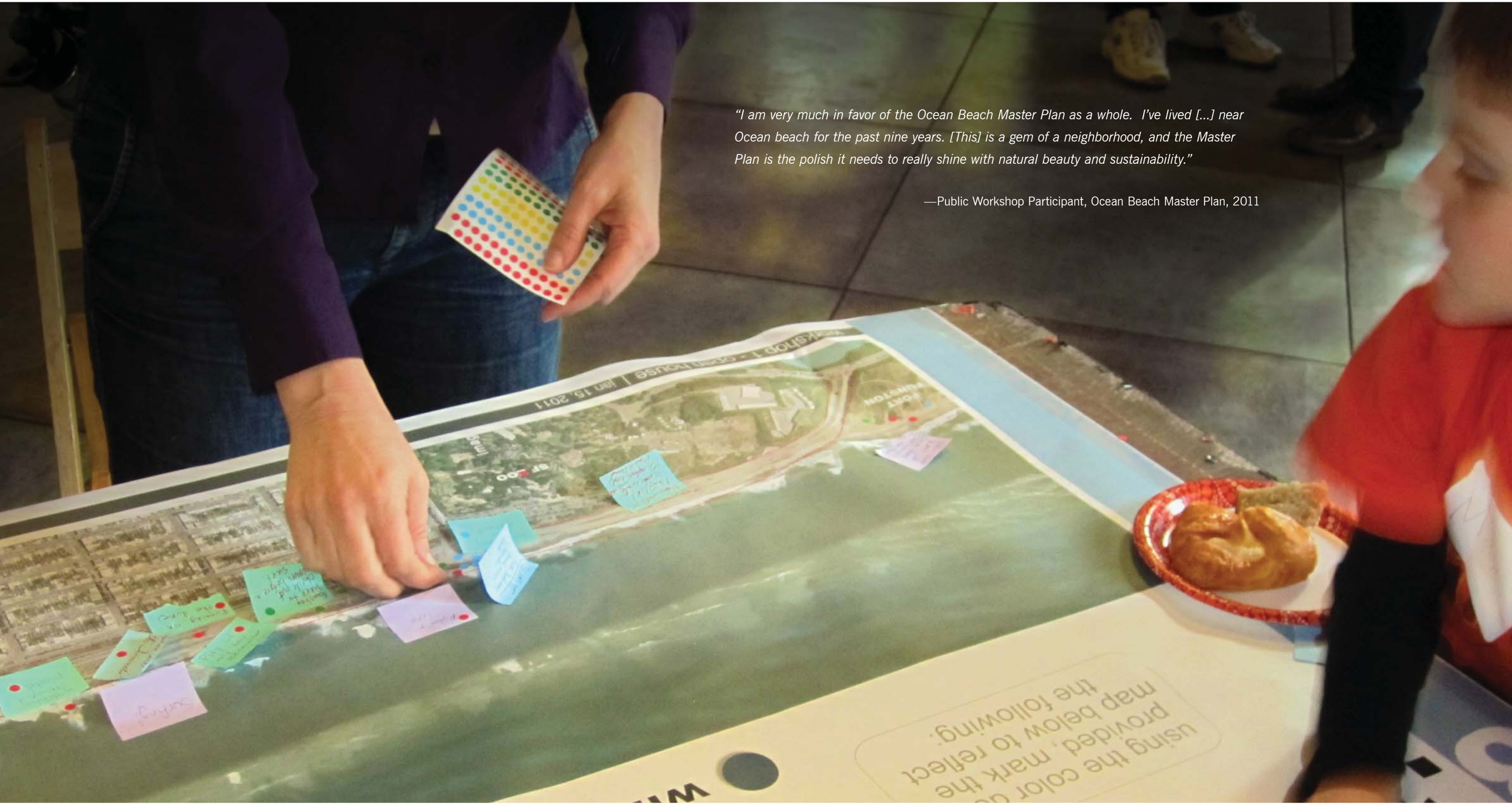


Figure III-18:
Jurisdisctions Diagrammatic Section
Not to Scale

Legend

- Project Boundary
- Golden Gate National Recreation Area (GGNRA)
- San Francisco City and County (excludes private property)
- California Coastal Commission Jurisdiction
- Army Corps Permitting Authority
- Coastal Zone subject to local coastal program



"I am very much in favor of the Ocean Beach Master Plan as a whole. I've lived [...] near Ocean beach for the past nine years. [This] is a gem of a neighborhood, and the Master Plan is the polish it needs to really shine with natural beauty and sustainability."

—Public Workshop Participant, Ocean Beach Master Plan, 2011

public and stakeholder outreach process

section

IV

Section IV: Public and Stakeholder Outreach Process Table of Contents

Outreach Process
- Stakeholder Interviews
- Technical Advisors
- Planning Advisory Committee
- Steering Committee

Public Workshops
Online, Social Media, and Other Channels
Project Phases
Design Framework: Translating Needs into Solutions

public and stakeholder outreach process

Outreach Process

A robust public and stakeholder outreach process was fundamental to the development of this plan. Much of the team's effort was devoted to synthesizing a dizzying array of complex site conditions and tradeoffs into accessible and compelling materials to facilitate informed public participation.

Two earlier community task forces, the Ocean Beach Task Force under Mayor Brown and the Ocean Beach Vision Council under Mayor Newsom, raised awareness and made proposals for the future of Ocean Beach, but neither had a pathway to implementation. The result was increased awareness on the part of decision makers, but frustration at the limited impact on the policies and actions of public agencies.

A robust public and stakeholder outreach process was fundamental to the development of this plan. The Ocean Beach Master Plan's outreach program included stakeholder interviews, three public workshops, and multiple online media resources.

The Ocean Beach Master Plan process was designed to build on the efforts of these task forces by moving quickly and prioritizing results while broadening the base of both community and agency stakeholders.

Stakeholder Interviews

In scoping the project and identifying key issues and voices, the OBMP conducted one-on-one interviews with dozens of public agency and community stakeholders in the summer and fall of 2010.

Technical Advisors

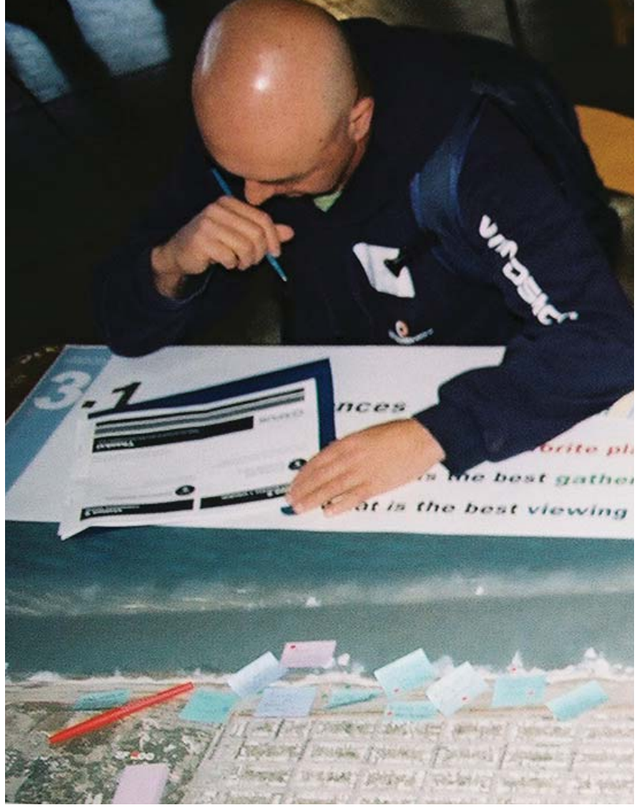
The OBMP enlisted an on-call group of technical advisors to weigh in as needed on the scientific and engineering aspects of the project. These include coastal engineers, climate scientists, traffic specialists and wildlife biologists.

Johanna Partin, Office of Mayor Edwin Lee
Steve Ortega, Golden Gate National Recreation Area
Chris Kern, SF Planning Department
Lesley Ewing, California Coastal Commission
Peter Mull, US Army Corps of Engineers
John Dingler, US Army Corps of Engineers
Patrick Barnard, USGS
Marla Jurosek, SFPUC
Dilip Trivedi, Moffatt & Nichol
Laura Tam, SPUR
Petra Unger, Senior Biologist, AECOM
Anthony Ratto, Senior Estimator, AECOM

Planning Advisory Committee

The Planning Advisory Committee (PAC) consists of more than 30 members representing many points of view. It includes agency staff, issue advocates and community leaders. The PAC met approximately every eight to 10 weeks throughout the process to review work in progress and provide feedback.

Lara Truppelli, CHAIR, SAND/OB, Beach Chalet
Amy Meyer, HONORARY CO-CHAIR, People for a GGNRA
Renee Ananda, California Coastal Commission
Brian Aviles, Golden Gate National Recreation Area
Dan Bernal, Office of Congresswoman Nancy Pelosi
Lisa Beyer, SF Department of Recreation and Parks
John Billovits, SF Planning Department
Cammy Blackstone, Office of Supervisor Carmen Chu
Greg Braswell, San Francisco Department of Public Works
Julie Burns, Planning Assocation of the Richmond
Kevin Conger, CMG Landscape Architecture
Caleb Conn, US Army Corps of Engineers
Alex Doniach, Office of Senator Leland Yee
Marc Duffet, SPEAK
Lesley Ewing, California Coastal Commission
Frank V. Filice, San Francisco Department of Public Works
Radhika Fox, SF Public Utilities Commission
John Frykman, Coalition to Save Ocean Beach
Jonathan Gast, Rep. Jackie Speier
Leslie Ewing, California Coastal Commission
Freddy Hahne, Black Rock Arts Foundation



Kit Hodge, Great Streets Collaborative
Katherine Howard, Golden Gate Park Preservation Alliance
Dean LaTourrette, Save the Waves Coalition
Karen Mauney-Brodek, SF Department of Recreation and Parks
Bill McLaughlin, Surfrider Foundation
Erin Miller, AICP, SF Municipal Transportation Agency
Dick Morten, SF Parks Alliance
Dan Murphy, Golden Gate Audubon Society
Doug Overman, Golden Gate National Parks Conservancy
Ruby Pap, California Coastal Commission
Wayne Reading, San Francisco Zoological Society
Ashley Summers, Assemblywoman Fiona Ma
Andy Thornley, San Francisco Bicycle Coalition
Bob Twomey, California State Assembly
Katie Westfall, Save the Waves Coalition
George Woodin, West of Twin Peaks Central Council

Steering Committee

The Steering Committee is a small, high-level body consisting exclusively of agency directors, elected officials, and the PAC chair. The considerable interagency challenges at Ocean Beach made this high-level body indispensable in considering big-picture challenges at Ocean Beach. The Steering Committee met at key project milestones.

Ed Harrington, General Manager, SFPUC
Frank Dean, General Superintendent, GGNRA
Mohammed Nuru, Director, Department of Public Works
Phil Ginsburg, General Manager, Recreation and Park Department
John Rahaim, Director, Planning Department
Tanya Peterson, Executive Director and President, San Francisco Zoological Society
Ed Reiskin, Director, SF Municipal Transportation Agency
Carmen Chu, San Francisco Supervisor, District 4
Eric Mar, San Francisco Supervisor, District 1
Lara Truppelli, Chair, Ocean Beach Planning Advisory Committee
Gabriel Metcalf, Executive Director, SPUR

Public Workshops

The process included three major public workshops, which provided participants with interactive exercises and numerous channels for obtaining and recording public feedback.

Public Workshop 1:

Public Open House: Understanding Ocean Beach

San Francisco Zoo, January 2011

Attendance: ~150

Ocean Beach is a complex, multifaceted environment, with a host of overlapping issues and challenges. To kick-off the public outreach process, the Ocean Beach Master Plan's first public workshop — named "Understanding Ocean Beach" — focused on presenting the project's site analysis and collecting stakeholders' input regarding ovearching goals and aspirations for the future of Ocean Beach. Using the format of an *open house*, the consultant team set up a number of informational and interactive stations and provided an overview of the site's opportunities and constraints. These opportunities and constraints were organized in the seven focus areas described in Section III of this document.

Public Workshop 2:

Test Scenarios

Golden Gate Park Senior Center, June 2011

Attendance: ~60

A key element of the communications strategy was to test a wide range of options and explore their tradeoffs over a long time period. The OBMP team developed four Test Scenarios to model the outcomes of very different

approaches to managing Ocean Beach through 2100. These scenarios tested a wide variety of ideas from stakeholders and the public, and structured technical analysis work, modeling singular goals to their extremes. The scenarios, which are presented in Appendix B, were organized in four topics as follows: 1) Maximum Habitat, 2) Maximum Recreation, 3) Maximum Green Infrastructure, and 4) Maximum Infrastructure.

The scenarios formed the basis of the second public workshop, where the public was invited to respond with hybrid scenarios of their own invention and to attempt to balance among the many competing priorities. The Test Scenarios thus not only tested different management strategies but were important public education tools, laying out the big-picture tradeoffs at Ocean Beach.

Public Workshop 3:

Draft Recommendations

Golden Gate Park Senior Center, October 2011

Attendance: ~60

Online and Physical Survey Participants: 100

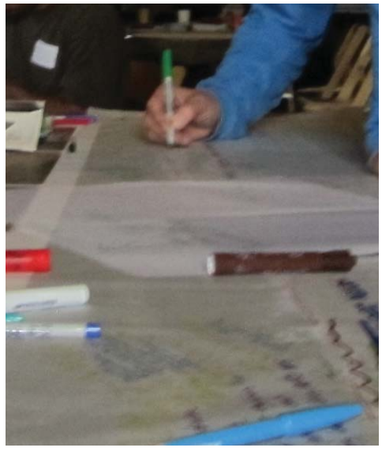
The third public workshop presented a draft of the master plan recommendations for review and comment. During the workshop, participants were given a questionnaire/survey to document their input. This survey was later made available on the project's website, where the consultant team was able to collect additional feedback regarding the draft master plan.

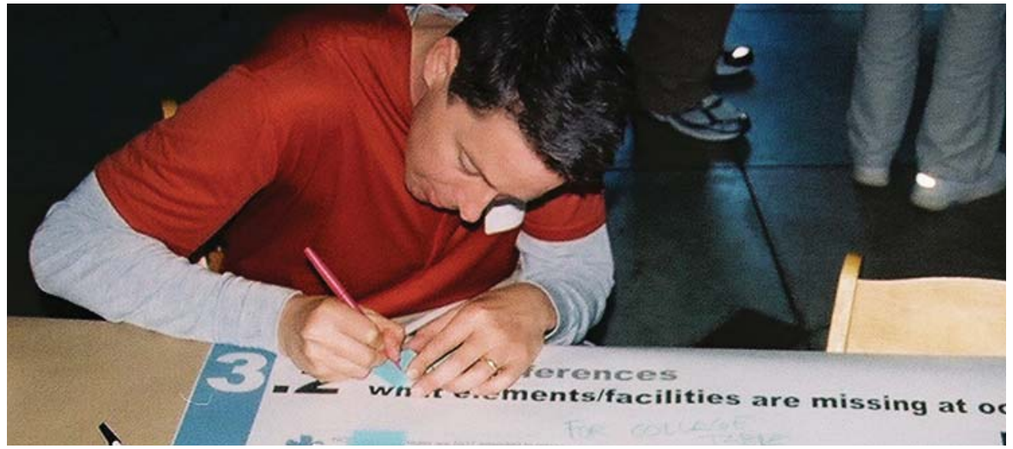
Online, Social Media and Other Channels

Throughout the process, the team sought to use every available channel for public engagement, from posting multilingual fliers to Twitter. The OBMP website includes the entire public record of the project, including all workshop presentations, public feedback, press clippings and other resources. Two digital animations were developed by consultants to explain complex technical processes in a clear, accessible manner. An online feedback tool, which allowed the public to respond to draft recommendations in a systematic and transparent fashion, was heavily used.

Respondents to draft recommendations survey: 100 (15 paper, 85 online)
Twitter followers: 75
Facebook followers: 210

Finally, SPUR used its extensive schedule of public programming to host several panels and an exhibition at the Urban Center Gallery, further extending the project's public engagement.





Project Phases

1. **Startup**
   (June–August 2010)

2. **Problem Definition**
   (September–December 2010)

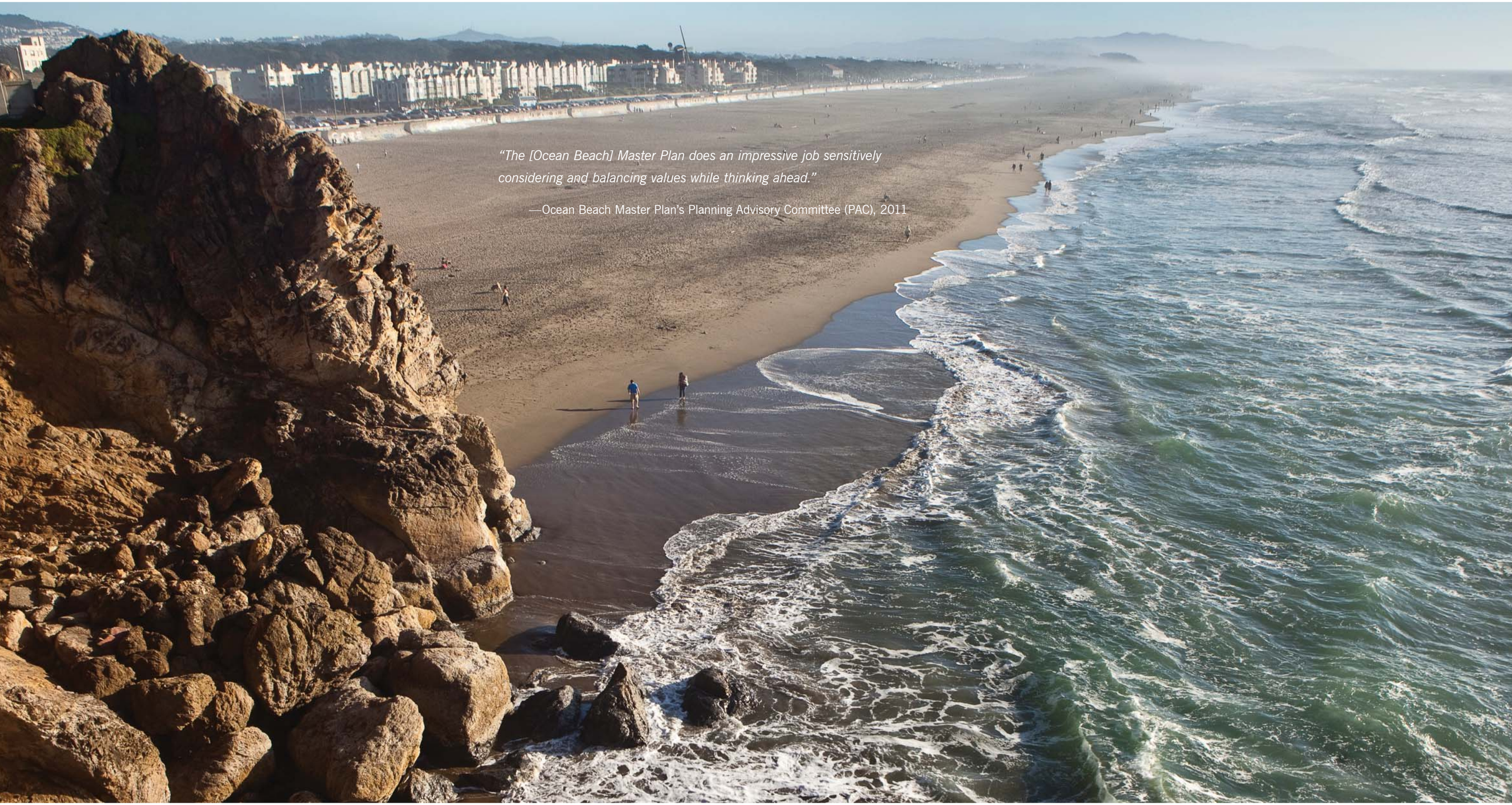
3. **Alternatives/Scenarios Development**
   (January–May 2011)

4. **Draft Recommendations**
   (May–October 2011)

5. **Draft Master Plan Document**
   (October 2011–February 2012)

6. **Final Master Plan Document**
   (May 2012)

Throughout the process, the Steering Committee, the Planning Advisory Committee, and other Technical Advisors provided input and feedback that helped the consultant team develop the final recommendations presented in this summary report.



"The [Ocean Beach] Master Plan does an impressive job sensitively considering and balancing values while thinking ahead."

—Ocean Beach Master Plan's Planning Advisory Committee (PAC), 2011

master plan recommendations: six key moves

section

V

Section V: Master Plan Recommendations: Six Key Moves Table of Contents

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- Create a New Gateway to the Zoo and the Coast
- Open Coastal Access
- Preliminary Phasing
- Benefits
- Constraints
- Outstanding Questions
- Next Steps

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- Armor the Lake Merced Tunnel with a Low-profile Structure
- Layer Flexible, Dynamic Structures over Hard Structures
- Restore the Surface
- Introduce a Stormwater Infiltration Wetland
- Preliminary Phasing
- Benefits
- Constraints
- Outstanding Questions
- Next Steps

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- Benefits
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- Outstanding Questions
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- Constraints
- Next Steps

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- Next Steps

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- Steering Committee Continuity
- Joint Management Working Group
- Joint Management Agreement
- Interagency Implementation Studies
- Non-profit | Philanthropic Partnerships
- Western Shoreline Plan Update
- Ongoing Adaptive Management

master plan recommendations: six key moves

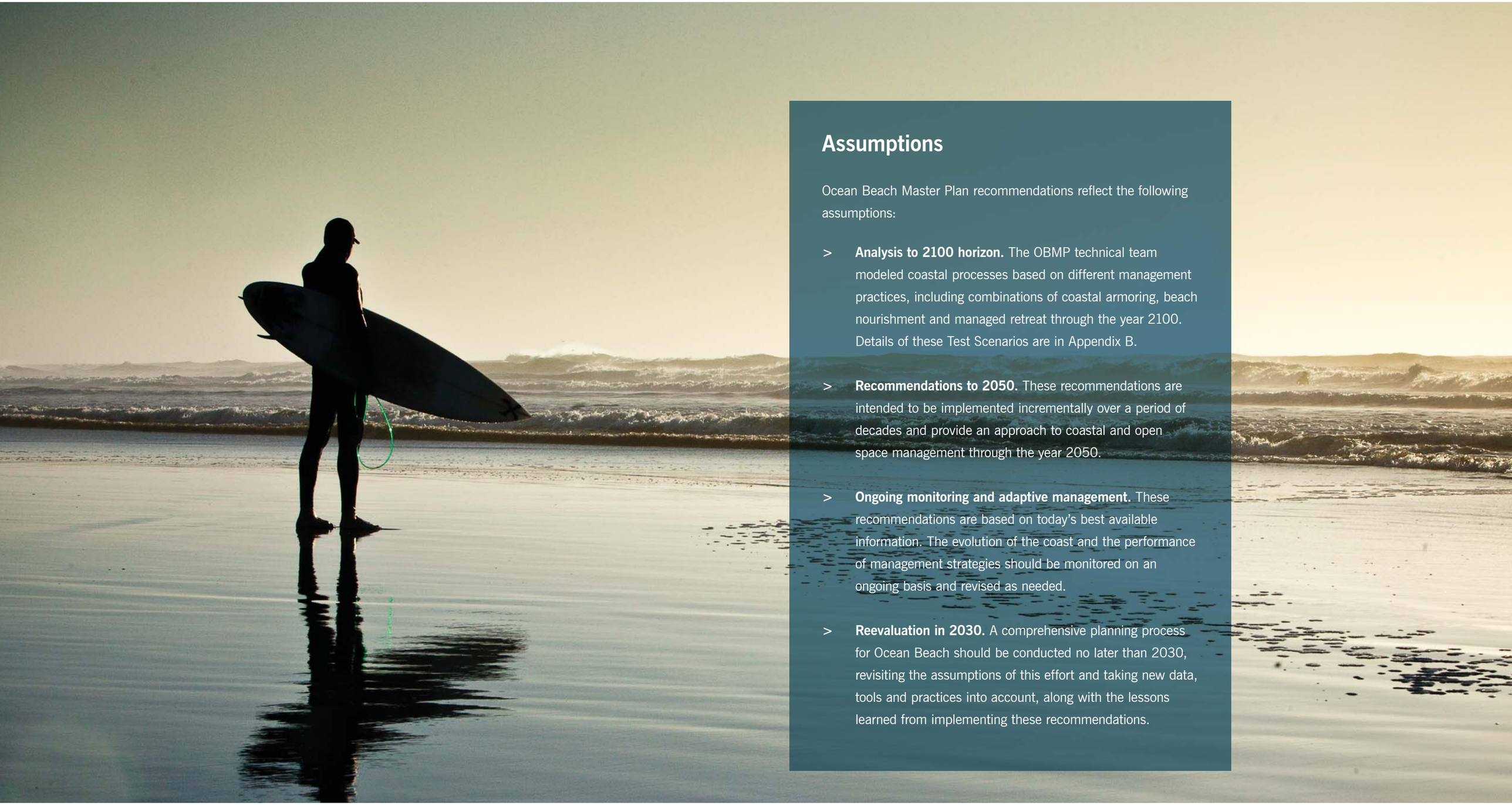
The recommendations presented here address the full gamut of issues explored in Section 3. They define a vision that is comprehensive and ambitious, but also achievable. They also reflect extensive testing and vetting with affected agencies and an unprecedented level of community consensus rooted in honest exploration of the imperatives, priorities and tradeoffs at Ocean Beach.

We present this package of recommendations as a series of improvements, investments and management practices that can achieve best-case outcomes for a wide range of objectives through the year 2050, based on consideration and analysis to the year 2100.

Plan recommendations are grouped into six “Key Moves.” Recommendations will need to be phased in incrementally as physical conditions evolve and as regulatory and fiscal hurdles are cleared.

Finally, these recommendations reflect the state of knowledge, the space of possibilities and the available consensus as of the present planning process. As our understanding of climate change, sea level rise and coastal management develop, so will our civic conversation about coastal decisions. An adaptive approach to implementation, based on the evolution of all these factors, will be essential.

The master plan recommendations presented herein are grouped into six “Key Moves” that address the full gamut of issues explored through this process. They define a vision that is comprehensive, ambitious, and achievable. Nevertheless, an adaptive approach to implementation will be essential.



Assumptions

Ocean Beach Master Plan recommendations reflect the following assumptions:

> **Analysis to 2100 horizon.** The OBMP technical team modeled coastal processes based on different management practices, including combinations of coastal armoring, beach nourishment and managed retreat through the year 2100. Details of these Test Scenarios are in Appendix B.

> **Recommendations to 2050.** These recommendations are intended to be implemented incrementally over a period of decades and provide an approach to coastal and open space management through the year 2050.

> **Ongoing monitoring and adaptive management.** These recommendations are based on today's best available information. The evolution of the coast and the performance of management strategies should be monitored on an ongoing basis and revised as needed.

> **Reevaluation in 2030.** A comprehensive planning process for Ocean Beach should be conducted no later than 2030, revisiting the assumptions of this effort and taking new data, tools and practices into account, along with the lessons learned from implementing these recommendations.

Design Framework: Translating Needs into Solutions

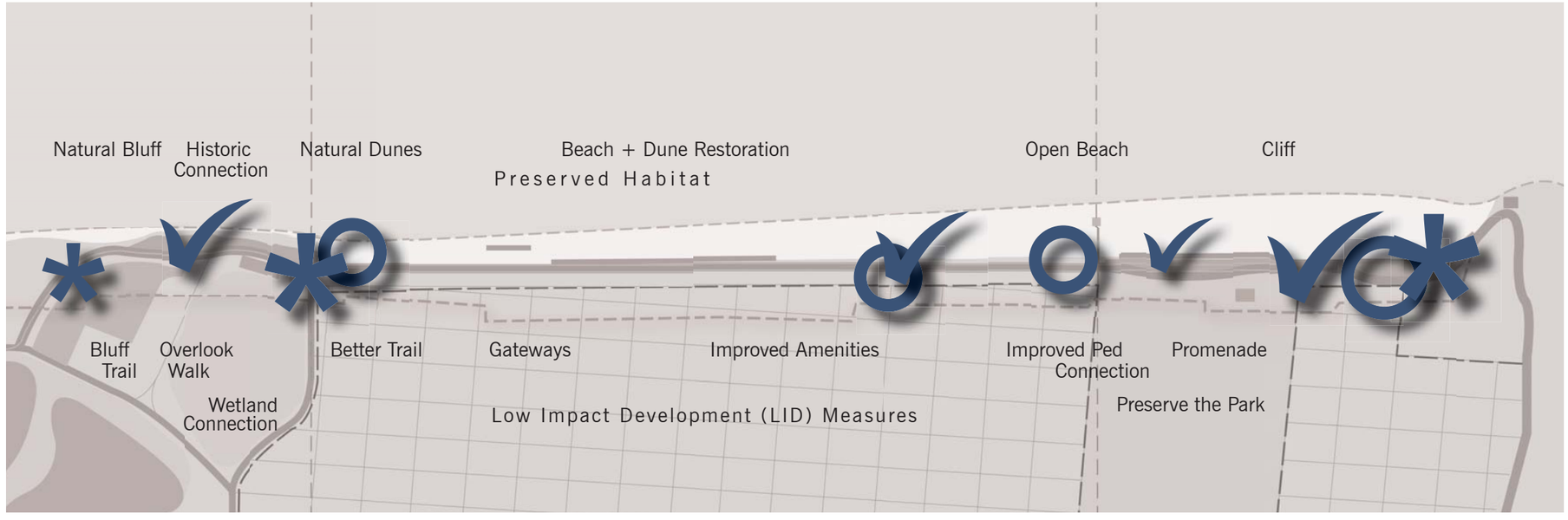
The Ocean Beach Master Plan outreach process [Section IV] resulted in a comprehensive picture of existing conditions at Ocean Beach, and catalogued a wide range of needs and desires. These include the responsibilities and policies of various public agencies, the uses, character, and diverse histories embedded here, and desires and aspirations of user communities. In addition, locations of particular importance were mapped through interactive exercises.

These needs and aspirations can be broadly organized into two major elements as shown in the accompanying diagram [Figure V-1]. The “natural” element (shown in blue) refers to the qualities and experiences that define the coast and beach itself, from wildlife habitat to the rugged landscape to the dynamic evolution of the beach over the seasons. The “social” element (shown in green) speaks to the urban context of Ocean Beach, and how it facilitates encounters with the coast, supports activity, movement, and public life, and expresses the relationship between Ocean Beach, adjacent neighborhoods, and the city as a whole. It also includes the infrastructure that is essential for urban life to flourish in harmony with its natural context.

The project team conceived its challenge as working within a seam (shown in orange) that connects and mediates between these two realms. Although many participants had specific solutions in mind, the intense constraints at Ocean Beach meant that many ideas could not necessarily be applied wholesale. Instead, the team focused on the most consistently desired outcomes (i.e.—improved access, restored ecological health, a sense of history) and developed recommendations — or key moves — that support them through a diverse array of strategies.

Figure V-1:
Overall Design Framework Diagram

The community needs and aspirations for Ocean Beach can be broadly organized into two major elements: the "natural" and the "social". The master plan recommendations are conceived as the seam between these systems, making both stronger.



Legend

- Favorite place at ocean beach
- Best gathering place
- Best viewing spot
- "Natural Element": the ocean, the beach, the 'wild' and expansive beauty, 'nature in the city', wildlife
- "Social Element": the city, 'leisure' driving along the great highway, the promenade, biking, connectivity, amenities for recreation, a sense of history
- Ocean Beach Master Plan Recommendations: six key moves that allow for the best "natural" and "social" systems to thrive

Figure V-2: Illustrative | Key Plan

The Ocean Beach Master Plan responds to desired outcomes within the beach's three reaches (i.e.—improved access, restored ecological health, a sense of history) by providing a series of recommendations that support them through a diverse array of strategies.


north reach
middle reach
Cliff House
Sutro Baths
See Figure V-24
5
See Figure V-21
4
Restored Dunes
O'Shaughnessy Seawall
Promenade + Parking
Beach Chalet
La Playa St
See Figure V-29
6
Noriega Seawall
The Great Highway
La Playa St
48th Ave
Lincoln Way
Golden Gate Park
Fulton St
48th Ave
Balboa St
Point Lobos Ave
45th Ave
Ortega St
Noriega St
Moraga St
OUTER RICHMOND
Geary Boulevard
The Presidio
Ocean Beach Master Plan Key Moves:
1 KEY MOVE 1: Reroute the Great Highway behind the zoo via Sloat and Skyline Boulevards
2 KEY MOVE 2: Introduce a multipurpose coastal protection/ restoration/access system
3 KEY MOVE 3: Reduce the width of the Great Highway to provide amenities and facilitate managed retreat
4 KEY MOVE 4: Restore the dunes along the middle reach
5 KEY MOVE 5: Create a better connection between Golden Gate Park and Ocean Beach
6 KEY MOVE 6: Introduce bicycle and pedestrian improvements north of Balboa Street

south reach

Key Move 1:
Reroute the Great Highway behind the zoo via Sloat and Skyline Boulevards.

The first key move of the master plan proposes to reroute the Great Highway behind the zoo, to reconfigure Sloat Boulevard as a pedestrian-and-bicycle-oriented road, and to create a new coastal trail and gateway to Ocean Beach's south end.

Stop Defending What We Don't Need

To date, the city has been defending the Great Highway south of Sloat Boulevard with boulder revetments. Many officials agree that the road is less of a concern than the Lake Merced Tunnel, a 14-foot-diameter underground sewer and stormwater pipe that runs underneath the highway. The road is lightly traveled and frequently closed (most notably in 2010, when the southbound lanes were closed for nearly a year). Rerouting traffic from the Great Highway to Sloat and Skyline (which have capacity to spare) would allow a more flexible approach to coastal protection and create major restoration and recreation opportunities.

Tame an Unsafe and Overwide Street

Sloat Boulevard is six lanes wide, with diagonal parking in the median. Zoo visitors often park there and jaywalk across the street with small children. Rerouting the Great Highway inland would allow significant improvements to Sloat, including moving parking to the south side along the zoo and adding a physically separated bike path. The L Taraval Muni line could be extended one block to terminate adjacent to the zoo. Counterintuitively, auto access to the region could improve as traffic controls are upgraded and this important link is no longer subject to closure by erosion or flood.

A narrower Sloat Boulevard is already in the works. SFMTA is planning striped bicycle lanes on Sloat, replacing two of the six traffic lanes between the Great Highway and Skyline. Caltrans has recently completed a similar treatment east of Everglade Drive. These should provide preliminary data for a more comprehensive reconfiguration of Sloat Boulevard.

Create a New Gateway to the Zoo and the Coast

Drivers, cyclists and Muni riders would all arrive at the south side of Sloat, where they could visit the zoo and access the coast without crossing any streets. A new coastal access point near the pump station would provide bike parking, restrooms and information, while a restored Fleishhacker Pool house could host a visitor center with food and interpretive elements. Sloat's neighborhood businesses could thrive on a safe, attractive seaside street.

Figure V-3 (opposite page):
South Reach | Key Move 1 Illustrative Plan

The first key move proposes to remove the Great Highway in front of the SF Zoo, opening the opportunity for a coastal trail and alternative manage retreat strategies for the bluff.

Key Move 1:

Reroute the Great Highway behind the zoo via Sloat and Skyline Boulevards.

- **1.1** Reconfigure and signalize Sloat–Great Highway and Sloat–Skyline intersections.
- **1.2** Maintain one-lane driveway from Skyline to treatment plant for trucks.
- **1.3** Reconfigure Sloat with two lanes each way, angle parking along zoo boundary, integrated stormwater management, bikeway and coastal access amenities.
- **1.4** Extend Muni L Taraval south across Sloat, with terminus at zoo entrance.
- **1.5** Introduce coastal trail to Fort Funston and Lake Merced, including a crosswalk at Skyline.
- **1.6** Integrate with California Coastal Trail, linking Lake Merced all the way to Marin County.
- **1.7** Replace beach/zoo parking along Armory Road and at Skyline trailhead.
- **1.8** Reopen Armory Road from Zoo Road to zoo parking lot to provide zoo access.

Open Coastal Access

Removing the Great Highway south of Sloat would offer an amazing recreational resource for cyclists, pedestrians and beach users while allowing for a healthier ecosystem. Today's landscape of asphalt, rubble and boulders can be gradually transformed into a coastal trail linking Fort Funston to the rest of Ocean Beach and beyond, reminiscent of recent improvements at Lands End and Crissy Field. Infrastructure would remain, but the structures used to protect it would be designed with access, aesthetics and natural resources (including the Bank Swallow) in mind.

While emphasizing improved non-auto access, this proposal would actually yield more coastal access parking. In place of the existing parking lot at Sloat and the Great Highway, new lots would be provided at the end of Armory Road, south of the existing zoo parking lot, at a new Skyline trailhead and along the Great Highway north of Sloat. If needed, additional overflow parking could be provided near the Janet Pomeroy Center and on SFPUC property south of the zoo.

Key Move 1 Strategic Actions

The master plan identifies eight strategic actions to achieve Key Move 1 [Refer to Figure V-3]:

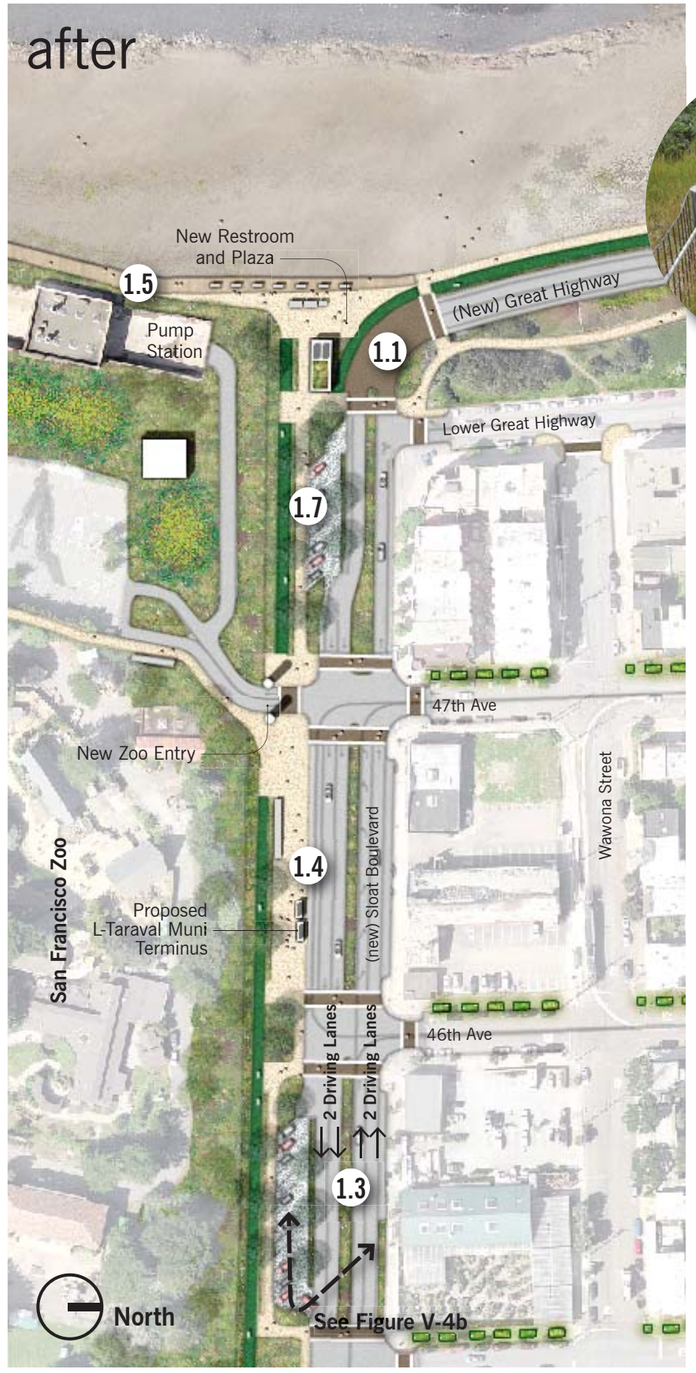
1.1. Reconfigure and signalize Sloat–Great Highway and Sloat–Skyline intersections
1.2. Maintain one-lane driveway from Skyline to treatment plant for trucks
1.3. Reconfigure Sloat with two lanes each way, angle parking along zoo boundary, integrated stormwater management, bikeway and coastal access amenities
1.4. Extend Muni L Taraval south across Sloat, with terminus at zoo entrance
1.5. Introduce coastal trail to Fort Funston and Lake Merced, including a crosswalk at Skyline
1.6. Integrate with California Coastal Trail, linking Lake Merced all the way to Marin County
1.7. Replace beach/zoo parking along Armory Road and at Skyline trailhead
1.8. Reopen Armory Road from Zoo Road to zoo parking lot to provide zoo access

Figure V-4
View of Sloat Boulevard (Before and After)

Key Move 1 proposes reducing the number of driving lanes at Sloat Boulevard from 3 each way, to 2 each way. This reconfiguration allows for the creation of a new pedestrian greenway along the Zoo's edge. This greenway would function as the new bike and pedestrian arrival to Ocean Beach's south end.

Figure V-4a: **Existing Sloat Blvd = Parallel and Diagonal Parking + 3 Driving Lanes + Diagonal Parking + 3 Driving Lanes**

Figure V-4b: **Proposed Sloat Blvd = Bike Lane + Pedestrian Walk + Diagonal Parking Pockets + 2 Driving Lanes + Planted Median + 2 Driving Lanes**



Bluff Protectioon Barrier

Boardwalk

Crushed Stone Path

Figure V-5:
Key Move 1 Detail Plan (Before and After)

The reconfiguration of Sloat Boulevard allows for additional parking pockets to replace the current beach parking at the end of Sloat, and to extend the Muni L Taraval in front of the new Zoo entry.

Legend

1.1 Reconfigure and signalize Sloat–Great Highway and Sloat–Skyline intersections.

1.3 Reconfigure Sloat with two lanes each way, angle parking along zoo boundary, integrated stormwater management, bikeway and coastal access amenities.

1.4 Extend Muni L Taraval south across Sloat, with terminus at zoo entrance.

1.5 Introduce coastal trail to Fort Funston and Lake Merced, including a crosswalk at Skyline.

1.7 Replace beach/zoo parking along Armory Road and at Skyline trailhead.

Scale 0 100 ft 200 ft

Figure V-6:
View of New Sloat Blvd Configuration

As part of Key Move 1, Sloat Boulevard is reconfigured with new parking along the zoo boundary, permeable paving, a Class I bikeway, and other pedestrian-oriented amenities.

Preliminary Phasing

Phase I (1–3 years)

> Develop detailed roadway configuration options
> Conduct traffic modeling
> Implement striped bike lanes
> Work with San Francisco Zoo to develop access plan

Phase II (4–10 years)

> Complete project EIR
> Initiate capital planning
> Reduce the Great Highway to two lanes south of Sloat
> Remove the Sloat parking lot but retain the restroom
> Provide temporary coastal access parking and trail in former southbound lanes
> Begin zoo access reconfiguration

Phase III (10–20 years)

> Reconstruct and signalize Sloat Boulevard
> Complete zoo access reconfiguration and replacement parking
> Close and demolish the Great Highway south of Sloat
> Construct a new coastal access point at Sloat and Great Highway, including restroom
> Construct a coastal trail

Benefits

> Creates a spectacular new coastal trail and continuous pedestrian connection
> Enables significant retreat from coastal erosion and more flexible infrastructure protection
> Results in major improvements to Sloat Boulevard design, with green infrastructure elements

Constraints

> Some traffic impacts, likely minor
> Requires reconfiguring zoo access
> Cost of roadway and intersection improvements

Outstanding questions

> What is the nature of the traffic impacts?
> What is the optimal configuration of Sloat Boulevard and adjacent intersections?

Next Steps

Conduct interagency circulation and access study, to include:

> Development of detailed roadway configuration options
> Detailed traffic analysis, to provide the basis for environmental review

Lead Agency: San Francisco Municipal Transportation Authority (SFMTA)

Partners: San Francisco Planning Department, San Francisco Recreation and Parks Department (SFRPD), San Francisco Department of Public Works (SFDPW)

Status: This study has been funded.

An interagency circulation and access study has been funded to confirm the anticipated minor traffic impacts of Key Move 1.
The main benefits of this proposal include the creation of spectacular new coastal amenities and the significant retreat it enables from coastal erosion.

Key Move 2:
Introduce a multipurpose coastal protection/restoration/access system.

Remove the Road and Take Advantage of the Opportunity

The Lake Merced Tunnel, a 14-foot-diameter pipe, is a significant piece of infrastructure and worth protecting in the coming decades. West of the zoo, the Great Highway is perched atop an erodible berm of construction fill, well above the pipe. Removing the road — and with it the challenge of defending that vertical space from wave action — would allow a much more flexible approach to coastal protection. Instead of holding the line at a steep bluff with a large seawall or revetment, this approach dissipates wave energy across a wide, shallow profile, using a combination of elements.

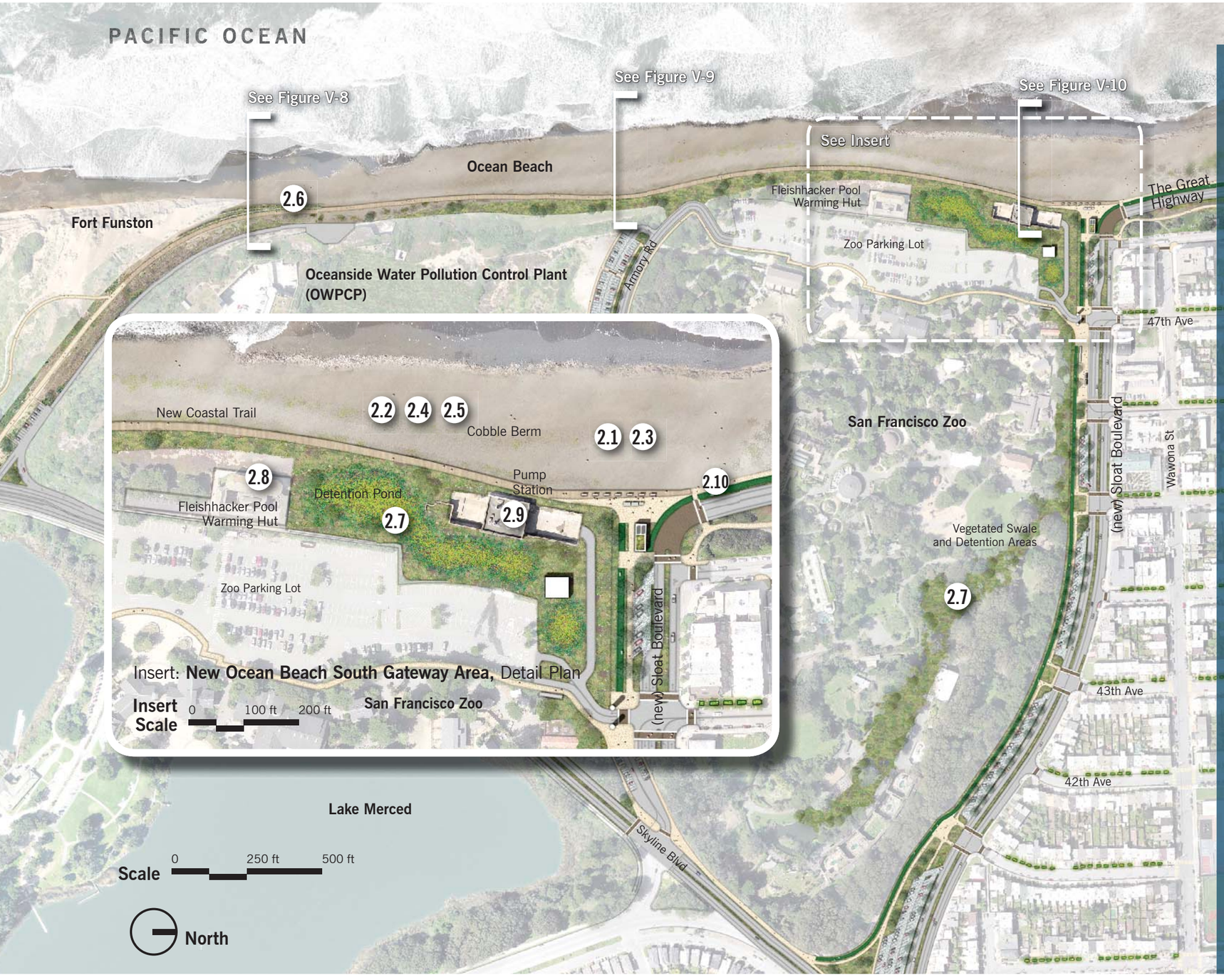
Armor the Lake Merced Tunnel with a Low-profile Structure

The Lake Merced Tunnel sits at a much lower elevation than the roadway. If it can be protected with a low wall, cap or internal reinforcement, it can become a sort of "speed bump" under the beach. This is a significant engineering challenge, as it needs to be protected from wave energy, flotation forces (it is mostly empty most of the time) and seismic forces. The recommended solution is conceptual and will require considerable study to ensure its feasibility. However, a preliminary examination of the approach with coastal and structural engineers and agency technical staff suggests that the principles are sound and merit deeper study.

The second key move takes advantage of the road and parking removal South of Sloat, and provides a form of managed retreat by armoring the Lake Merced Tunnel on site with a low-profile, layered, multi-stage, flexible structure. The resulting dynamic system serves to dissipate wave energy and provides a sandy beach most of the time.

Figure V-7 (opposite page):
South Reach | Key Move 2 Illustrative Plan

The second key move of the master plan proposes to create a dynamic coastal protection system, which consists of placing a cobble berm over Lake Merced Tunnel structure, covered with sand, to serve as wave dissipation zone.



Key Move 2:

Introduce a multipurpose coastal protection/restoration/access system.

- **2.1** Withdraw from bluff edge; incrementally demolish roadway, parking and restroom at Sloat
- **2.2** Reinforce the Lake Merced Tunnel in place with a low-profile structure or internal ballast; remove revetments and fill
- **2.3** Develop and pursue best practices for beach nourishment, including sand placement by Army Corps of Engineers
- **2.4** Place cobble berm over Lake Merced Tunnel structure, covered with sand, to serve as wave dissipation zone; allow severe storm surges to wash over tunnel
- **2.5** Place additional cobble to protect pump station and other wastewater infrastructure
- **2.6** Construct terraced, vegetated seawall with cobble toe along Oceanside Treatment Plant, incorporating tunnel structure, coastal trail, erodable bluff (Bank Swallow habitat) and plant driveway
- **2.7** Create detention swale and constructed wetland through the zoo to passively clean and infiltrate stormwater runoff from Sloat and adjacent parking lot
- **2.8** Renovate Fleishhacker Pool house as a warming hut and interpretive center
- **2.9** Pump station and force mains remain, interpretive elements explain the system to visitors; beautify pump station and reconfigure to maximize adjacent coastal access
- **2.10** Conduct pilot studies of dynamic coastal protection

Layer Flexible, Dynamic Structures over Hard Structures

The hard structure protecting the Lake Merced Tunnel would be covered by a berm of cobble, or stones 2.5 to 10 inches in size. These structures, modeled on natural cobble beaches, can be shaped dynamically by wave action and excel at dissipating wave energy. Additional cobble farther inland would protect existing force mains and high ground near the Fleishhacker Pool building.

A third layer would consist of large quantities of sand, dredged by the U.S. Army Corps of Engineers from the Golden Gate shipping channel and pumped to the beach as part of its beach nourishment program in partnership with the City of San Francisco. Sand would be placed over the cobble, providing a first line of protection and a sandy beach most of the time.

Restore the Surface, Improving Coastal Access and Ecological Function

If infrastructure protection alone were the goal, then a traditional seawall or revetment would do, but other important objectives would be compromised. The recommended approach allows Ocean Beach to protect infrastructure while also improving recreational access, ecological function and character, in keeping with its status as a national park. Regular placement of sand and revegetation would offer an accessible beach environment, with a spectacular trail connecting Sloat Boulevard to Fort Funston. Cobble is passable and attractive even when sand has been washed away, as much of it might be in major storms. And the San Francisco Zoo could find a new expression of its conservation values through an improved relationship to the watershed and the coastal ecosystem.

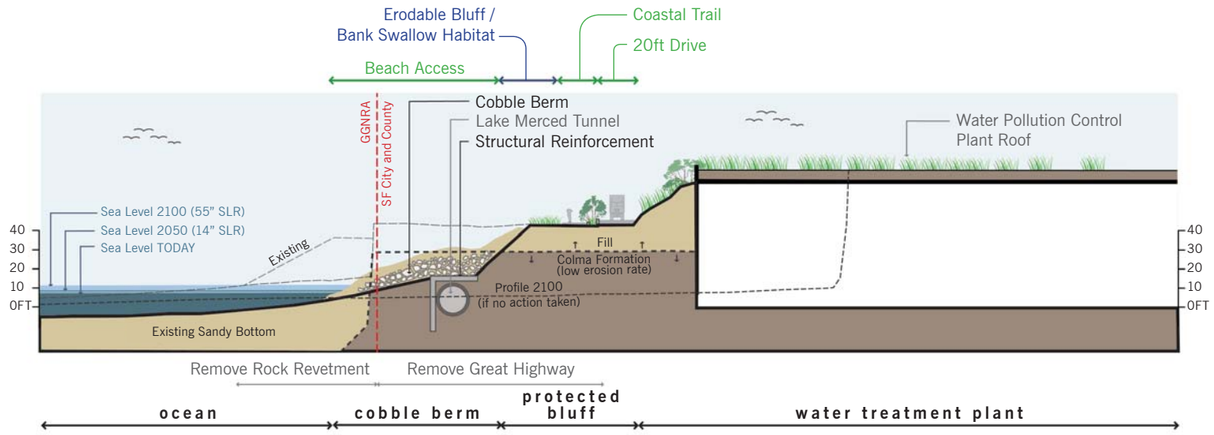


Figure V-8:
Coastal Section at Oceanside Water Pollution Control Plant

Not to Scale

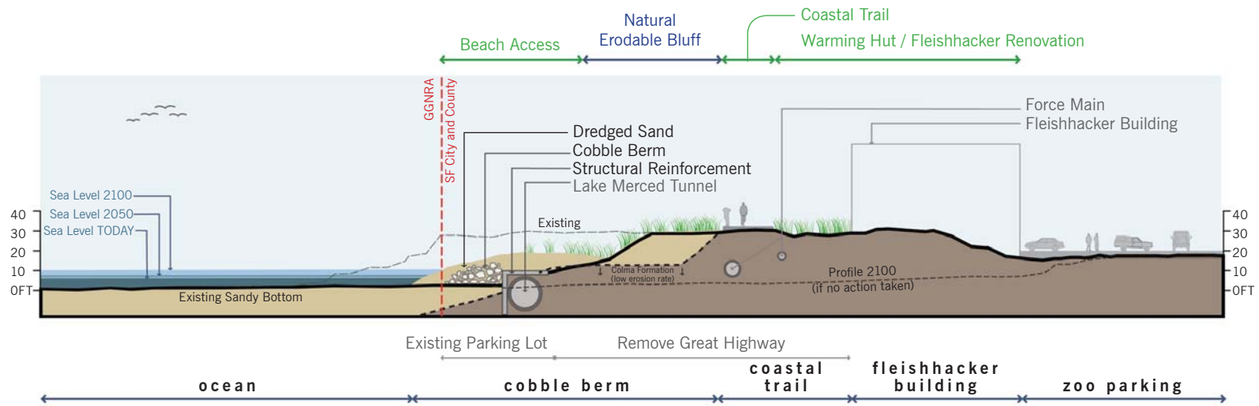


Figure V-9:
Coastal Section at Zoo Parking Lot

Not to Scale

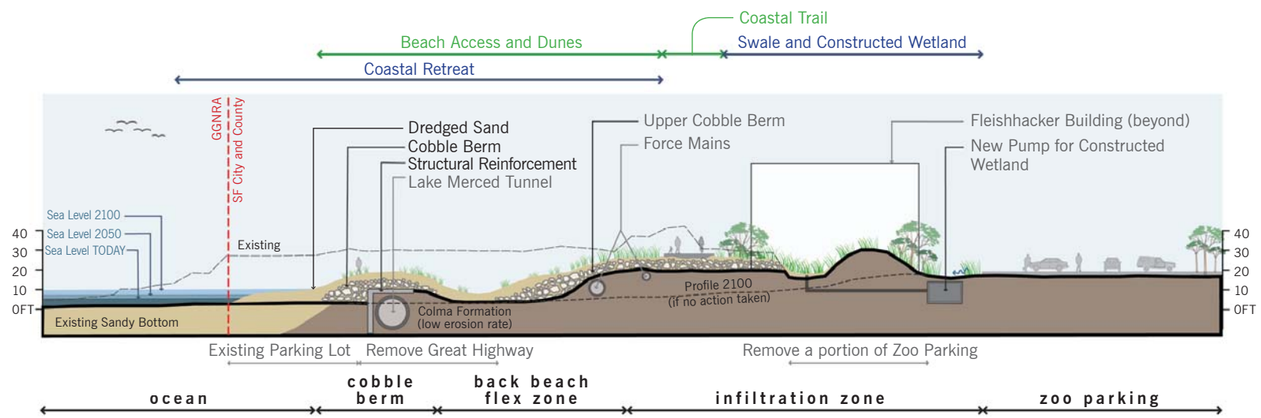
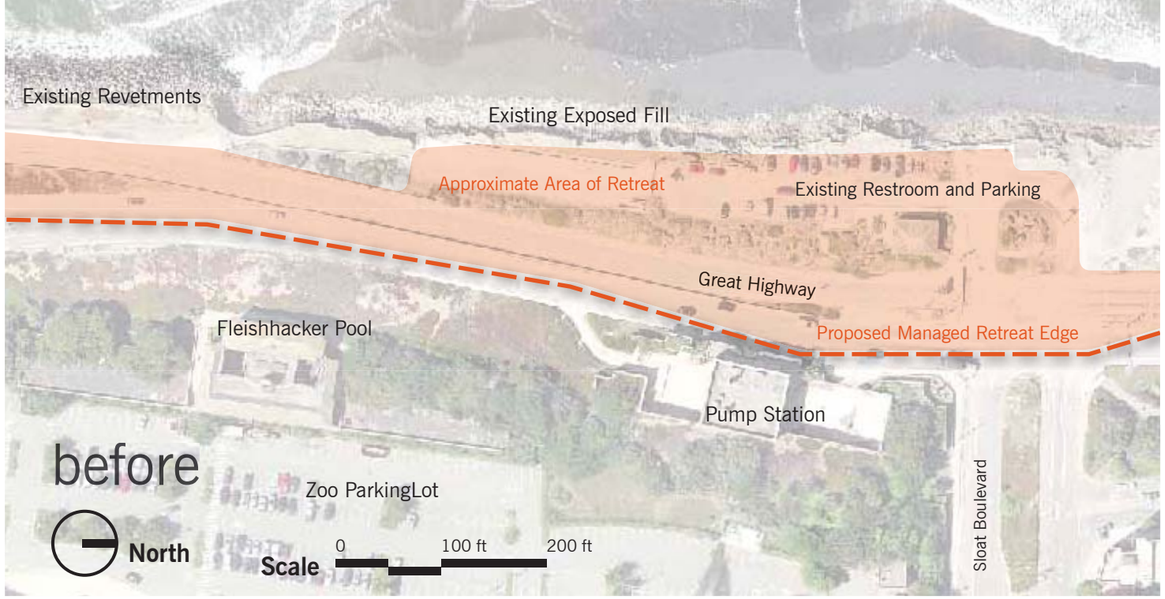


Figure V-10:
Coastal Section at Proposed Wetland and New Fleishhacker Pool Warming Hut

Not to Scale



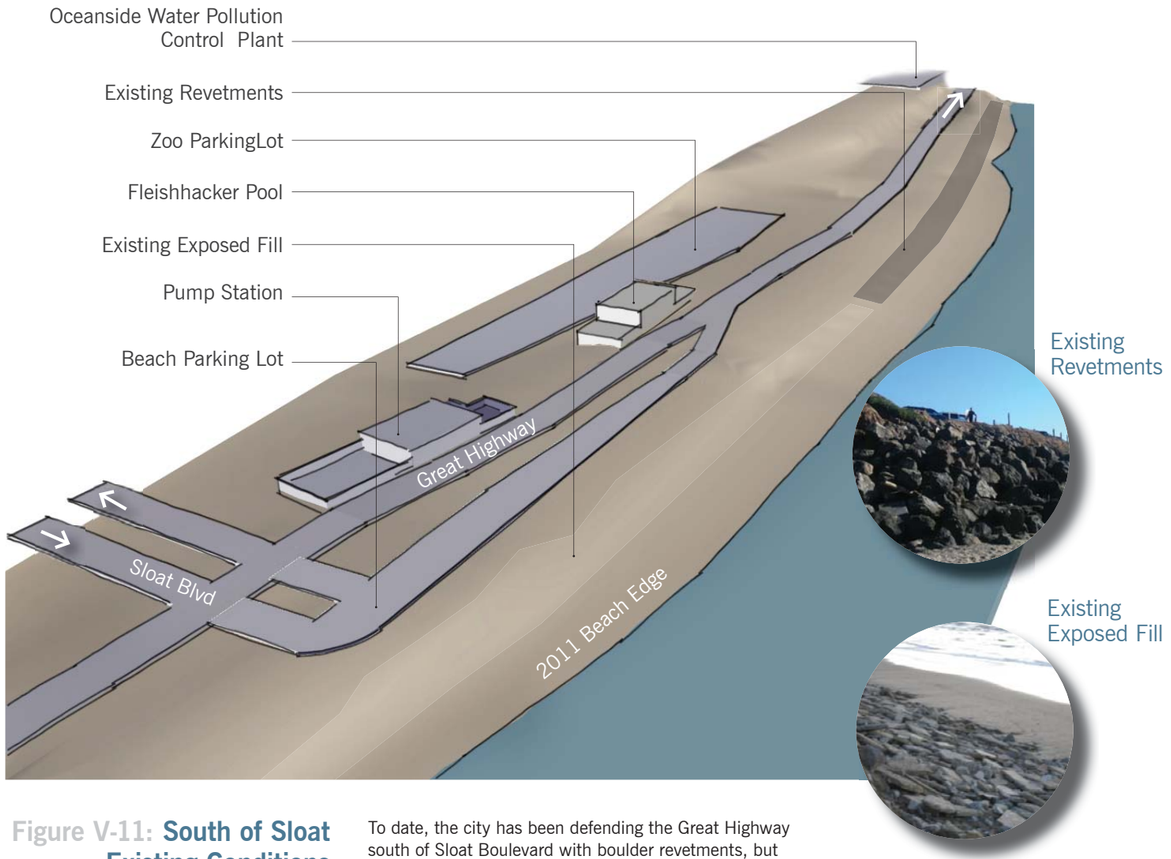


Figure V-11: **South of Sloat Existing Conditions**
Plan and Axonometric

To date, the city has been defending the Great Highway south of Sloat Boulevard with boulder revetments, but many officials agree that the road is less of a concern than the Lake Merced Tunnel.

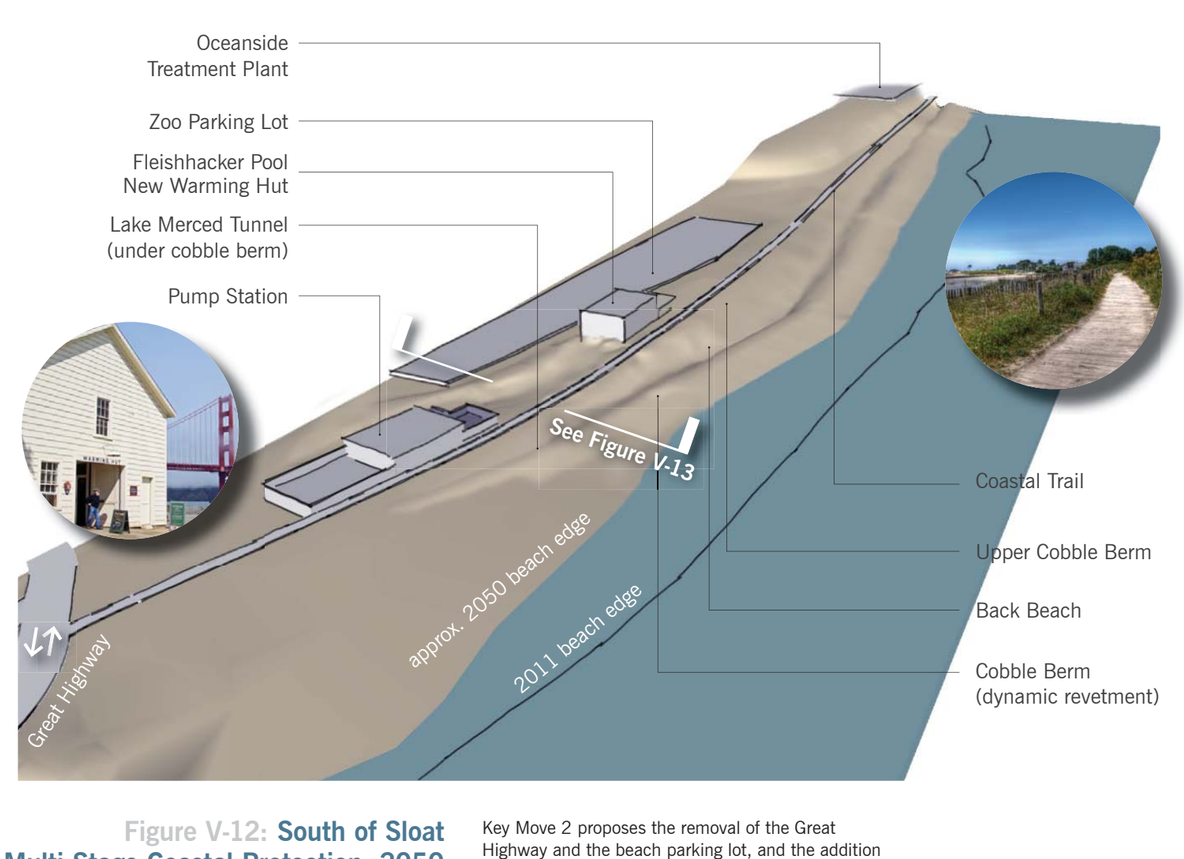


Figure V-12: **South of Sloat Multi-Stage Coastal Protection, 2050**
Plan and Axonometric

Key Move 2 proposes the removal of the Great Highway and the beach parking lot, and the addition of a multi-stage coastal protection system of cobble berms and sand nourishment.

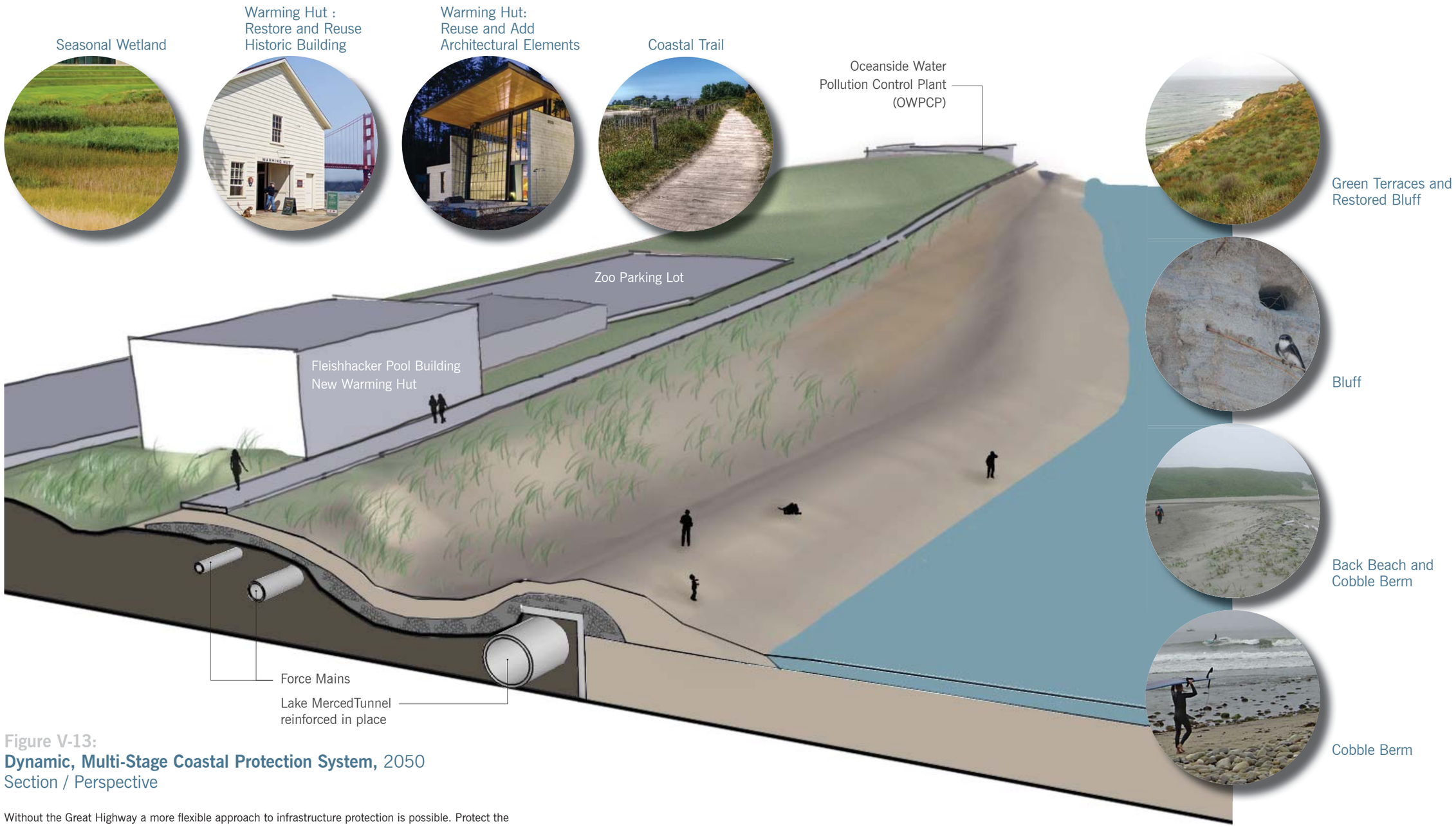


Figure V-13:
Dynamic, Multi-Stage Coastal Protection System, 2050
Section / Perspective

Without the Great Highway a more flexible approach to infrastructure protection is possible. Protect the Lake Merced Tunnel with a low-profile structure, topped with dynamic cobble berms and sand. Storm surges can dissipate by washing over and up a restored beach and dune landscape.

Introduce a Stormwater Infiltration Wetland

The reconfiguration of Sloat Boulevard and its location in the Sunset Basin watershed creates a significant green infrastructure and stormwater management opportunity. A living system combining green street design, swales and restored waterways would move stormwater flows and direct the water to a constructed wetland for retention and infiltration, recharging San Francisco's freshwater aquifer and combating saltwater intrusion. The wetland would be located at the entrance to the zoo parking lot, removing a small number of parking spaces, which could be relocated at a proposed lot at Armory Road.

The wetland and adjacent vegetation would provide habitat and recreational benefits while improving water quality. This system could be incrementally expanded to increase catchment area and riparian features, including portions of the zoo landscape and conceivably even Lake Merced, ultimately removing up to 33.7 million gallons of stormwater per year from the combined system.

This powerful gesture would support San Francisco's citywide commitment to reducing stormwater flows to the bay and ocean and to simultaneously improving public spaces and ecological amenities.

Source: Sherwood Design Engineers

Figure V-14:
Detention Swale and Constructed Wetland System Diagram

Key Move 2 Strategic Actions

In summary, the master plan identifies ten strategic actions to achieve Key Move 2 [Refer to Figure V-7]:

2.1. Withdraw from bluff edge; incrementally demolish roadway, parking and restroom at Sloat

2.2. Reinforce the Lake Merced Tunnel in place with a low-profile structure or internal ballast; remove revetments and fill

2.3. Develop and pursue best practices for beach nourishment, including sand placement by Army Corps of Engineers

2.4. Place cobble berm over Lake Merced Tunnel structure, covered with sand, to serve as wave dissipation zone; allow severe storm surges to wash over tunnel

2.5. Place additional cobble to protect pump station and other wastewater infrastructure

2.6. Construct terraced, vegetated seawall with cobble toe along Oceanside Treatment Plant, incorporating tunnel structure, coastal trail, erodable bluff (Bank Swallow habitat) and plant driveway

2.7. Create detention swale and constructed wetland through the zoo to passively clean and infiltrate stormwater runoff from Sloat and adjacent parking lot

2.8. Renovate Fleishhacker Pool house as a warming hut and interpretive center

2.9. Pump station and force mains remain, interpretive elements explain the system to visitors; beautify pump station and reconfigure to maximize adjacent coastal access

2.10. Conduct pilot studies of dynamic coastal protection

Figure V-15:
Aerial View of Ocean Beach Master Plan Detail

Artist rendering of the improved Ocean Beach's south reach with dynamic coastal protection system, and new coastal trail.

Preliminary Phasing

Phase I (1–3 years)

> Define an interim coastal protection approach, emphasizing reversible, low-impact options
> Initiate beach cleanup, reusing rubble for interim protection where feasible
> Complete environmental clearance, beneficial reuse planning and dredge retrofit to allow beach nourishment by the Army Corps of Engineers
> Develop a feasibility and engineering study of the proposed concept
> Develop a 50-year joint coastal management framework among the SFPUC, the NPS and the Army Corps of Engineers, defining coastal protection phasing, triggers and actions

Phase II (4–10 years)

> Conduct an in situ pilot study of the cobble berm concept
> Initiate beach nourishment through direct sand placement
> Complete EIR/EIS and Coastal Commission approvals of the joint coastal management framework
> Execute a memorandum of understanding among the SFPUC, the NPS and the Army Corps of Engineers
> Begin installation of the coastal protection system behind the bluff face at critical locations
> Begin demolition of the parking lot and excavation of fill
> Pursue private and philanthropic funds for renovation of the Fleishhacker Pool building
> Complete the design and permitting of the stormwater infiltration wetland

Phase III (10–20 years)

> Engage in ongoing beach nourishment
> Remove revetments as new coastal protections allow
> Demolish the restroom and roadway; excavate the roadbed in targeted locations
> Complete the Lake Merced Tunnel protections
> Restore and revegetate back beach surface conditions and integrate with coastal trail
> Implement the Fleishhacker Pool building renovation
> Initiate infrastructure reconfiguration planning and environmental work
> Conduct ongoing research and adaptive management

Phase IV (20+ years)

> Engage in ongoing beach nourishment
> Complete the terraced, vegetated seawall and coastal trail at south end
> Conduct ongoing research and adaptive management
> Revise the master plan

Key Move 2

Benefits

> Incorporates significant coastal retreat
> Protects costly infrastructure in place for decades
> Provides a softer approach to coastal protection that can work with coastal processes
> Restores ecological and recreational function

Constraints

> Significant upfront investment from multiple agencies
> Challenging to maintain sand cover and surface restoration
> Depends on careful integration with Army Corps of Engineers beach nourishment
> Demands a new approach requiring careful study and monitoring

Outstanding Questions

> What is the detailed form and cost of the Lake Merced Tunnel protection?
> What are the dynamics of interaction among hard structure, cobble and placed sand?
> How to phase the protection measures to prevent spills, protect habitat and manage cost?

Next Steps

Joint coastal management framework studies, including:

> Interim coastal protection strategy
> Coastal engineering and feasibility study
> In situ pilot study of dynamic revetment (cobble)
> Joint coastal management framework and agreement

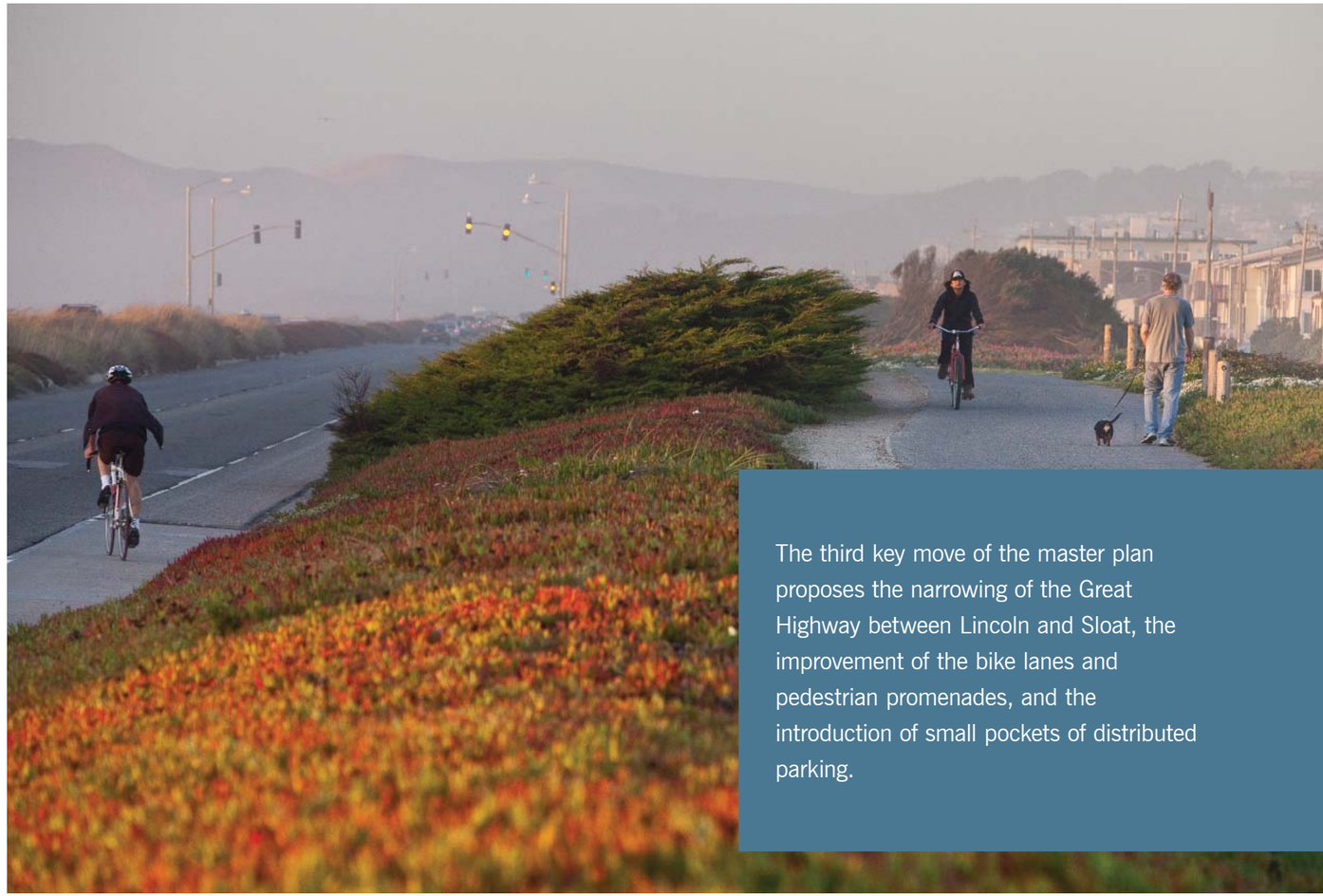
Lead Agency: San Francisco Public Utilities Commission (SFPUC)
Partners: National Park Service (NPS), Army Corpt of Engineers (USACE), San Francisco Department of Public Works (SFDPW), San Francisco Recreation and Parks Department (SFRPD)
Status: These studies have been funded.

middle reach

Key Move 3:
Reduce the width of the Great Highway to provide amenities and facilitate managed retreat.

Today, our major coast road is an auto-oriented expressway. By converting the southbound lanes to other uses — including access amenities like restrooms, bike parking, signage and pockets of auto parking, connected by a new promenade on the ocean side of the road — we apportion this critical public resource to a much wider set of uses and strengthen the connections of local neighborhoods to the coast. The existing northbound lanes would serve as a two-way street.

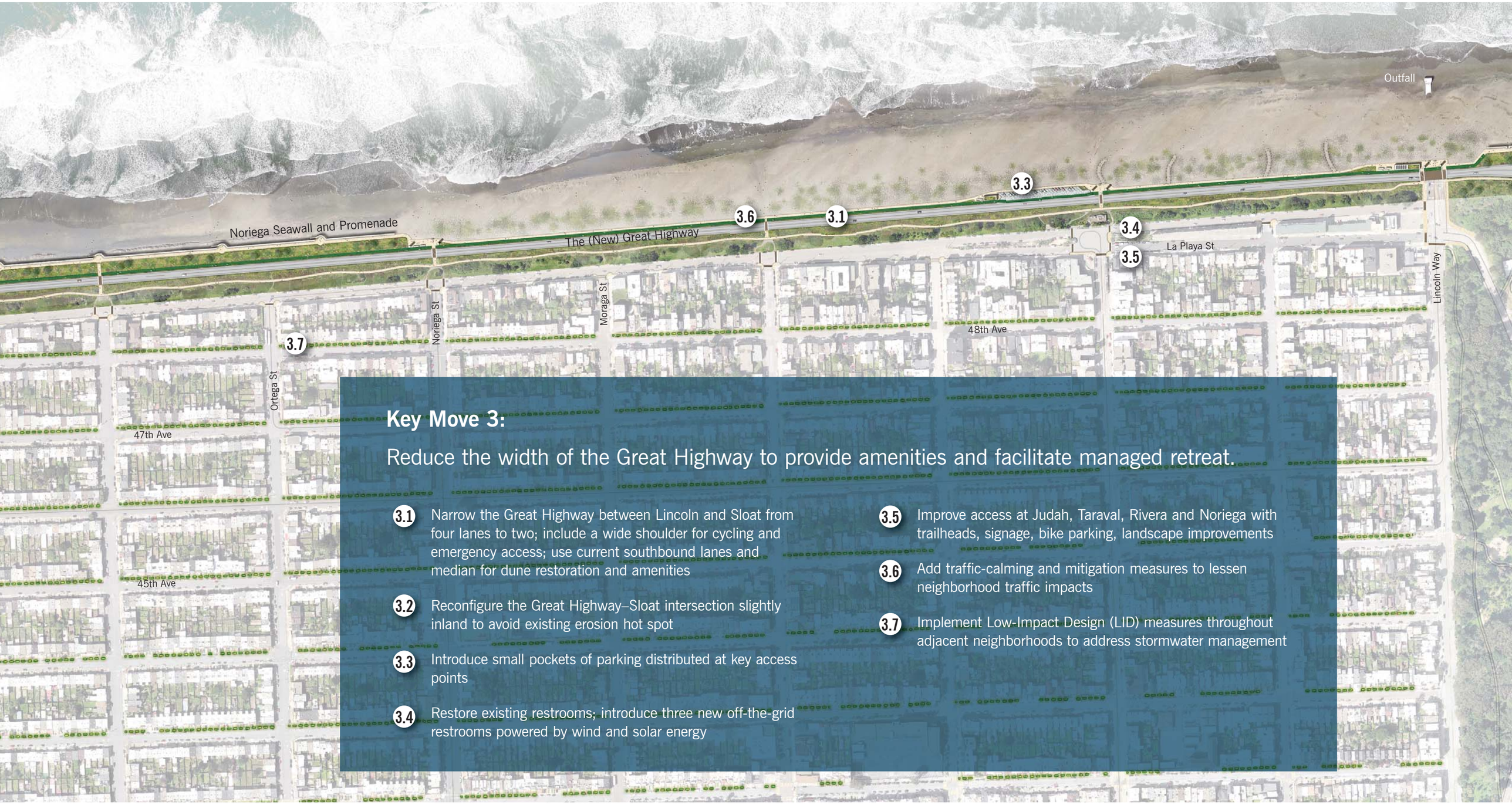
In addition, in areas between major access points, the space gained by narrowing the roadway would be devoted to expansion and restoration of the dunes, which could migrate shoreward, over the top of the Westside Transport Box, which lies under the road. Coupled with the direct placement of sand through the Army Corps of Engineers' proposed beach nourishment program, this approach could extend the period of time in which a significant sandy beach would be feasible south of Noriega.



The third key move of the master plan proposes the narrowing of the Great Highway between Lincoln and Sloat, the improvement of the bike lanes and pedestrian promenades, and the introduction of small pockets of distributed parking.

Figure V-16:
Middle Reach | Key Move 3
Illustrative Plan

The third key move of the master plan proposes the narrowing of the Great Highway between Lincoln and Sloat, the improvement of the bike lanes and pedestrian promenades, and the introduction of small pockets of distributed parking.



Key Move 3:

Reduce the width of the Great Highway to provide amenities and facilitate managed retreat.

- **3.1** Narrow the Great Highway between Lincoln and Sloat from four lanes to two; include a wide shoulder for cycling and emergency access; use current southbound lanes and median for dune restoration and amenities
- **3.2** Reconfigure the Great Highway–Sloat intersection slightly inland to avoid existing erosion hot spot
- **3.3** Introduce small pockets of parking distributed at key access points
- **3.4** Restore existing restrooms; introduce three new off-the-grid restrooms powered by wind and solar energy
- **3.5** Improve access at Judah, Taraval, Rivera and Noriega with trailheads, signage, bike parking, landscape improvements
- **3.6** Add traffic-calming and mitigation measures to lessen neighborhood traffic impacts
- **3.7** Implement Low-Impact Design (LID) measures throughout adjacent neighborhoods to address stormwater management

This change would likely result in some traffic impact, via spillover effects. Much of the traffic along the Great Highway is regional traffic passing through to access northern San Francisco and the Golden Gate Bridge. With the Great Highway closed south of Sloat, and with signage and other measures, a portion of that traffic could be induced to use more appropriate routes such as Sunset Boulevard. Mitigation measures to prevent aggressive cut-throughs in adjacent neighborhoods (already a problem during frequent road closures) would be essential, as would coordination with ongoing planning for circulation throughout the west side. Comprehensive traffic analysis will be essential to determine if the traffic impacts of this intervention would be justified by the considerable improvements in coastal access.

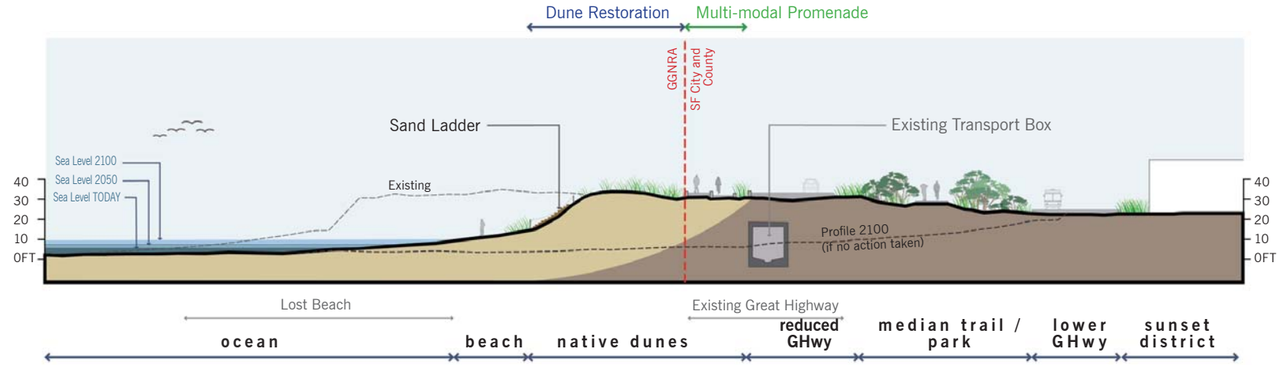


Figure V-18:
Coastal Section
Great Highway at Wawona St

Not to Scale

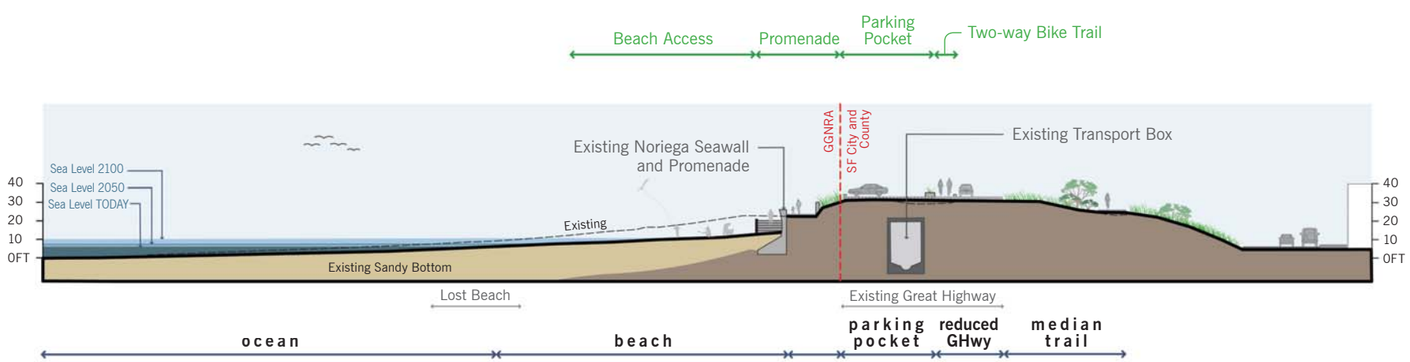


Figure V-19:
Coastal Section
Noriega Seawall at Rivera St

Not to Scale

Key Move 3 Strategic Actions

In summary, the master plan proposes seven strategic actions to achieve Key Move 3 [Refer to Figure V-16]:

3.1. Narrow the Great Highway between Lincoln and Sloat from four lanes to two; include a wide shoulder for cycling and emergency access; use current southbound lanes and median for dune restoration and amenities

3.2. Reconfigure the Great Highway–Sloat intersection slightly inland to avoid existing erosion hot spot

3.3. Introduce small pockets of parking distributed at key access points

3.4. Restore existing restrooms; introduce three new off-the-grid restrooms powered by wind and solar energy

3.5. Improve access at Judah, Taraval, Rivera and Noriega with trailheads, signage, bike parking, landscape improvements

3.6. Add traffic-calming and mitigation measures to lessen neighborhood traffic impacts

3.7. Implement Low-Impact Design (LID) measures throughout adjacent neighborhoods to address stormwater management

Figure V-20:
Distributed Parking and Amenity Node

A number of small parking pockets are proposed under Key Move 3. These areas become nodes for other public amenities, such as vending kiosks, interpretive signage, bike parking, seating, and small overlooks.

Key Move 3

Preliminary Phasing

Phase I (1–3 years):

> Establish weekly Sunday Streets closures
> Implement improved management of road closures and mitigation of neighborhood impacts
> Develop detailed roadway configurations
> Conduct traffic modeling

Phase II (4–10 years):

> Initiate capital planning
> Complete project EIR
> Design detailed public improvements
> Implement trial reconfiguration

Phase III (10+ years)

> Reconfigure roadway; install public amenities and mitigation measures

Benefits

> Gives space for a restored dune system to migrate landward, allowing a wider beach as sea level rise sets in
> Allows space for additional amenities and improved beach access
> Strengthens coastal access from adjacent neighborhoods and discourages regional through traffic
> Favors pedestrians, bicycles, beach access and wildlife over traffic flow

Constraints

> Traffic impacts, which may be significant, in adjacent neighborhoods
> Limited space gained at substantial cost
> Potential to bring more users to sensitive plover habitat areas
> Some redundancy between recreational trails

Outstanding Questions

> What is the nature of traffic impacts and the effectiveness of mitigation measures?
> What is the benefit to beach width over time?

Next Steps

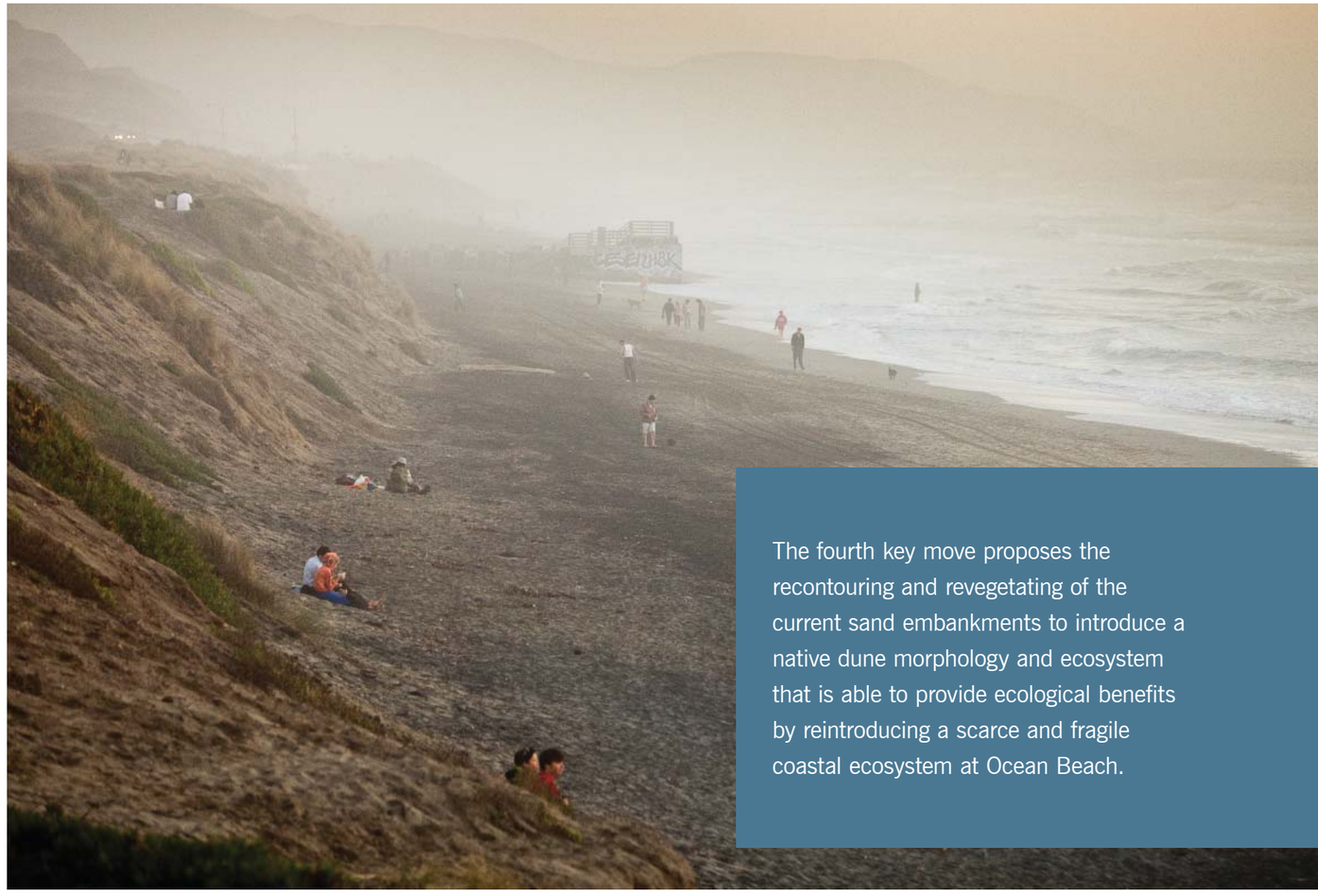
Conduct interagency circulation and access study, to include:

> Development of detailed roadway configuration options
> Detailed traffic analysis to provide the basis for environmental review

Lead Agency: San Francisco Municipal Transportation Authority (SFMTA)
Partners: San Francisco Planning Department, San Francisco Recreation and Parks Department (SFRPD), San Francisco Department of Public Works (SFDPW)
Status: This study has been funded.

Key Move 4:
Restore the dunes along the middle reach.

The existing “dunes” are actually sand embankments, constructed as part of the SFPUC’s Clean Water Program, and vegetated with non-native grasses and ice plant. Recontouring and revegetating these embankments to introduce a native dune morphology and ecosystem would provide ecological benefits by reintroducing a scarce and fragile coastal ecosystem, would increase the visibility of the ocean from the Great Highway and may provide some improvements in sand management by reducing the existing embankment’s tendency to launch windborne sand long distances.



The fourth key move proposes the recontouring and revegetating of the current sand embankments to introduce a native dune morphology and ecosystem that is able to provide ecological benefits by reintroducing a scarce and fragile coastal ecosystem at Ocean Beach.

Figure V-21:
Middle Reach | Key Move 4
Illustrative Plan

The fourth key move of the master plan focuses on the restoration of the beach dunes.

Key Move 4:

Restore the dunes along the middle reach.

- **4.1** Implement beach nourishment by Army Corps of Engineers along southern end of middle reach
- **4.2** Phase in native dune restoration in key locations, especially at Lincoln and Vicente
- **4.3** Add sand ladders and modular boardwalks to provide access while limiting environmental impact

Sand dune restoration is based on the historic native dunes of Ocean Beach: lower profile, more sand transport, crawling plant species.

Yellow Sand Verbena
Abriona latifolia

Pacific Wildrye
Leiums pacificus

Ragweed
Ambrosia chamissonis

Beach Saltbush
Artiplex leucophyllia

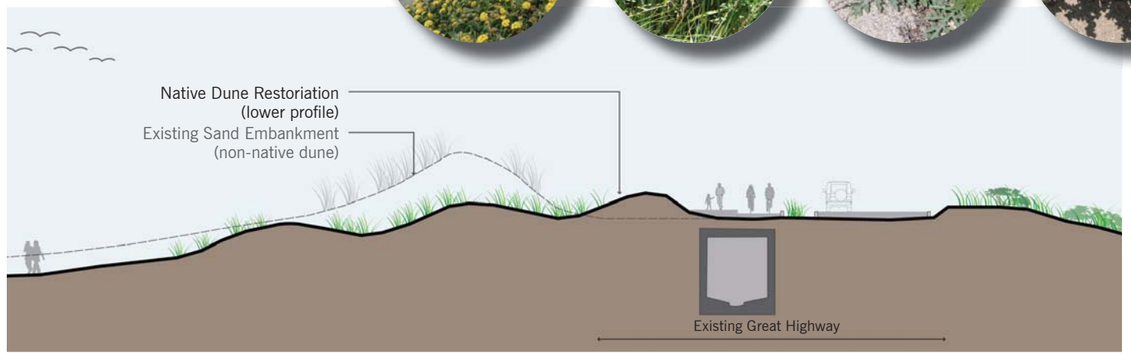


Figure V-22:
Typical Dune Restoration Section

Not to Scale

Key Move 4 Strategic Actions

The master plan includes three strategic actions to achieve Key Move 4 [Refer to Figure V-21]:

4.1. Implement beach nourishment by Army Corps of Engineers along southern end of middle reach

4.2. Phase in native dune restoration in key locations, especially at Lincoln and Vicente

4.3. Add sand ladders and modular boardwalks to provide access while limiting environmental impact

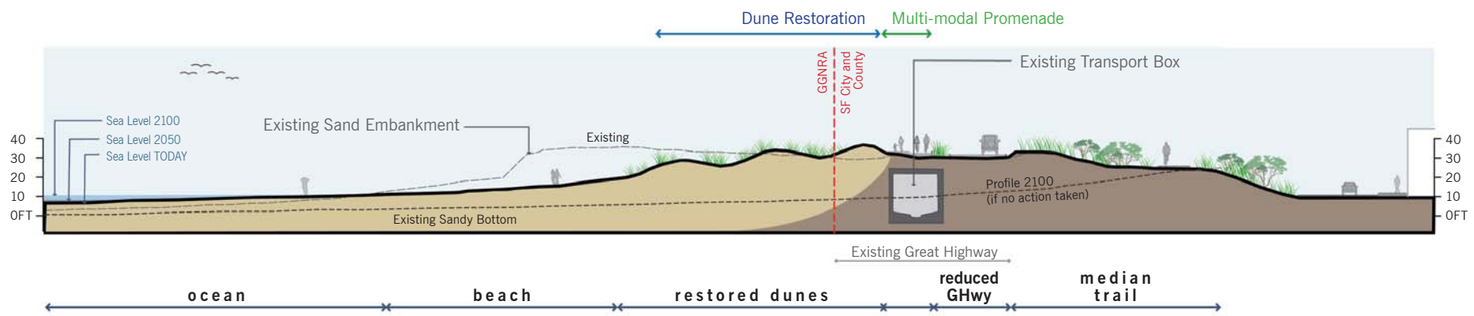


Figure V-23:
Coastal Section
Restored Sand Dune at Moraga St

Not to Scale

Key Move 4

Benefits

> Ecological restoration and improved aesthetics
> Removal of non-native species
> Lower profile allows more visual access to the ocean
> Potential for improved sand management with lower profile

Constraints

> Significant cost
> Challenge of fully removing non-native grasses
> Access to dunes limited, to protect restoration

Outstanding Questions

> What are the coastal protection benefits of native vs. existing dune form?
> How much maintenance will restored vegetation require?
> How great is the improvement of windblown sand management?
> What are the best practices for supporting dune formation and restoration with beach nourishment?

Next Steps

> Fund and initiate restoration pilot projects

Lead Agency: Golden Gate National Recreation Area (GGNRA)
Partners: Golden Gate National Park Conservancy (GGNPC), San Francisco Recreation and Parks Department (SFRPD)
Status: Not yet initiated.

north reach

Key Move 5:
Create a better connection between Golden Gate Park and Ocean Beach.

The coastal frontage of Golden Gate Park — the O'Shaughnessy Seawall promenade and parking lot — does not currently provide the spectacular sense of arrival that it could. Identified by GGNRA plans as a location for active and vibrant activities, it is currently defined by a large expanse of asphalt, with a great deal of unused parking most of the time. Pedestrians and cyclists arriving from the park find a confusing path to the sea and few basic amenities. This recommendation would rework this area to create a multiuse space appropriate to the context and program of this critical connection, while maintaining parking, providing basic amenities and appropriate landscaping, and allowing for continued use for major events.

Benefits

> A sense of arrival in a context-appropriate landscape
> Improved basic amenities at the busiest access point
> Maintains parking and event capacity while improving pedestrian and bicycle safety
> Improved environmental performance with permeable paving, alternative energy

Constraints

> Cost
> Interagency management challenges

The fifth key move of the master plan focuses on creating a stronger the sense of arrival at Ocean Beach and improving pedestrian and bicycle connectivity from Golden Gate Park.

Figure V-24 (opposite page):
North Reach | Key Move 5 Illustrative Plan

Key move number five addresses Ocean Beach's most common arrival zone: at the O'Shaughnessy Seawall / Promenade and Golden Gate Park.

PACIFIC OCEAN

Stormwater Outfall

Ocean Beach

See Figure V-25

See Figure V-27

O'Shaughnessy Seawall and Promenade

5.4 New Gateway Pedestrian Crossing Amenity Pod

5.1 Parking Lot

5.2

the Great Highway

5.5

5.6

5.3 Beach/Park Chalet

5.6

5.8

See Figure V-26

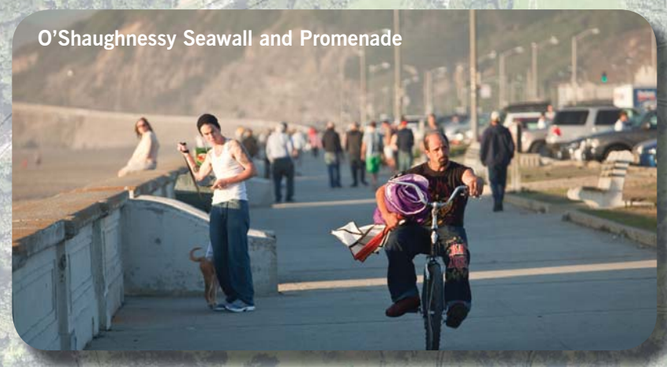
Golden Gate Park

48th Ave

Lincoln Way

Fulton Street

44th Ave



Scale 0 250 ft 500 ft

North

Key Move 5:

Create a better connection between Golden Gate Park and Ocean Beach.

- **5.1** Tighten and renovate parking lot; add permeable paving; preserve flexible use and event capacity
- **5.2** Maintain row of "watching the water" parking spots
- **5.3** Modify parking entrances and improve pedestrian crossings at JFK and Beach Chalet
- **5.4** Use landscape features to mark the oceanfront termination of Lincoln and Fulton
- **5.5** Add a two-way, physically separated bikeway on the east side of the Great Highway north of Fulton, integrated with existing multiuse trail
- **5.6** Add abundant bike parking
- **5.7** Develop a joint city-federal parking management plan; consider some fee parking on peak days
- **5.8** Introduce landscape site elements and seating appropriate to rugged conditions; introduce and restore climate-appropriate/ native landscape planting

Key Move 5 Strategic Actions

Eight strategic actions are recommended for Key Move 5 [Refer to Figure V-24]:

5.1. Tighten and renovate parking lot; add permeable paving; preserve flexible use and event capacity

5.2. Maintain row of “watching the water” parking spots

5.3. Modify parking entrances and improve pedestrian crossings at JFK and Beach Chalet

5.4. Use landscape features to mark the oceanfront termination of Lincoln and Fulton

5.5. Add a two-way, physically separated bikeway on the east side of the Great Highway north of Fulton, integrated with existing multiuse trail

5.6. Add abundant bike parking

5.7. Develop a joint city-federal parking management plan; consider some fee parking on peak days

5.8. Introduce landscape site elements and seating appropriate to rugged conditions; introduce and restore climate-appropriate/ native landscape planting

Figure V-26:
View at Lincoln and Great Highway Intersection

Image shows potential improvements to create the Lincoln avenue gateway; this key move proposes to provide vertical arrival element / overlook at both ends of Golden Gate Park.

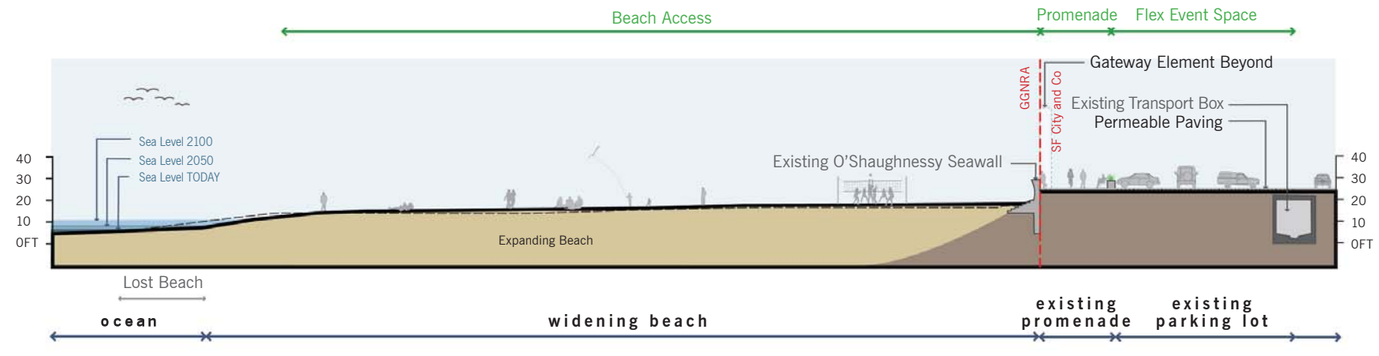


Figure V-25:
Coastal Section at O’Shaughnessy Seawall

Not to Scale

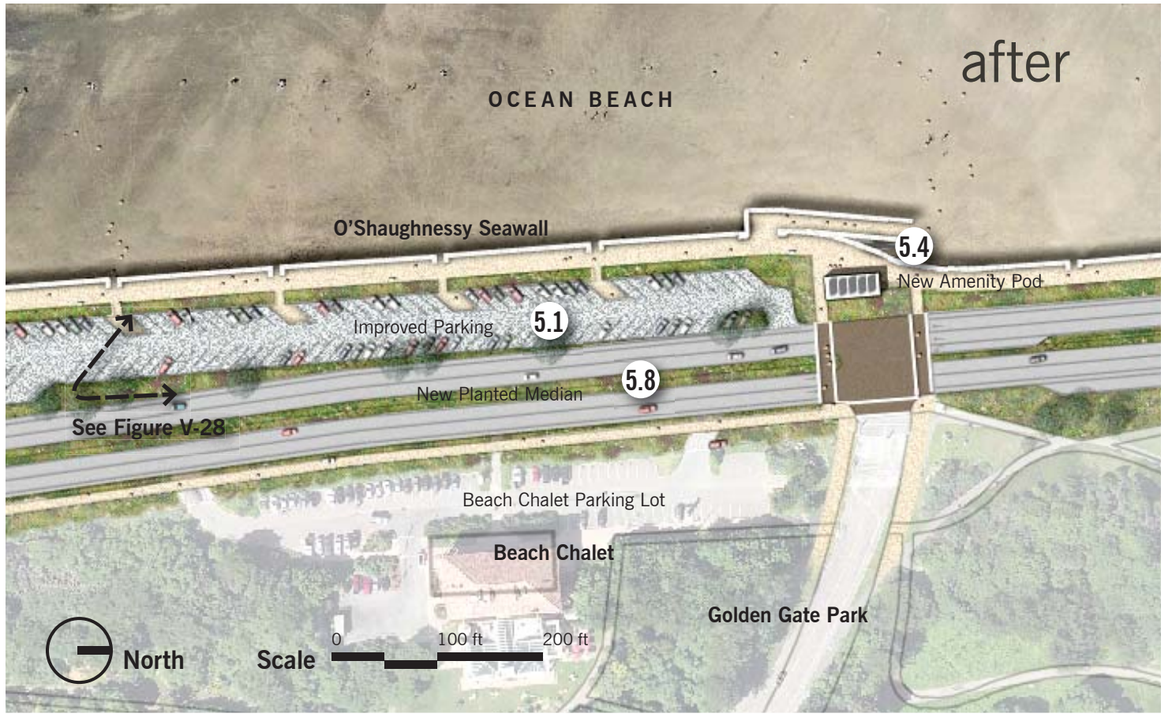


Figure V-27:
North Reach | Key Move 5
Detail Plan (Before and After)

Key move number five addresses Ocean Beach's most common arrival zone: at the O'Shaughnessy Seawall / Promenade and Golden Gate Park.

Figure V-28:
View of Improved Parking

This view illustrates the replacement of asphalt for permeable paving, preserving and improving the event / flex-space capacity at the O'Shaughnessy praking lot area.

Next Steps

Joint open space management plan, to include schematic design of this feature

Lead Agency: Golden Gate National Recreation Area (GGNRA)

Partners: SF Recreation and Parks Department (SFRPD), SF Public Utilities Commission (SFPUC), Golden Gate National Park Conservancy (GGNPC), SF Department of Public Works (SFDPW).

Status: This project has been funded.

Key Move 6:
Introduce bicycle and pedestrian improvements north of Balboa Street.

North of Fulton Street, the Great Highway carries much less traffic than its design would suggest, and it presents a confusing and unwelcoming condition to pedestrians and cyclists. North of Balboa, there is a dangerous combination of bicycle traffic, diagonal parking, and a steep grade. These recommendations would narrow the roadway from four lanes to two, allow for a physically separated two-way bikeway along the bluff adjacent to the Cliff House while leaving the diagonal visitor parking intact. This shortens pedestrian crossings and addresses the non-standard intersection at Balboa. It also presents an opportunity to make a key connection for cyclists and pedestrians to the trails at Land's End, the Presidio, and beyond, in keeping with the role of Ocean Beach as a key connector of the broader open space network.

The master plan's final key move proposes to narrow the Great Highway north of Balboa, allowing for a Class I bike lane to Point Lobos, while preserving the existing diagonal parking near the Cliff House.

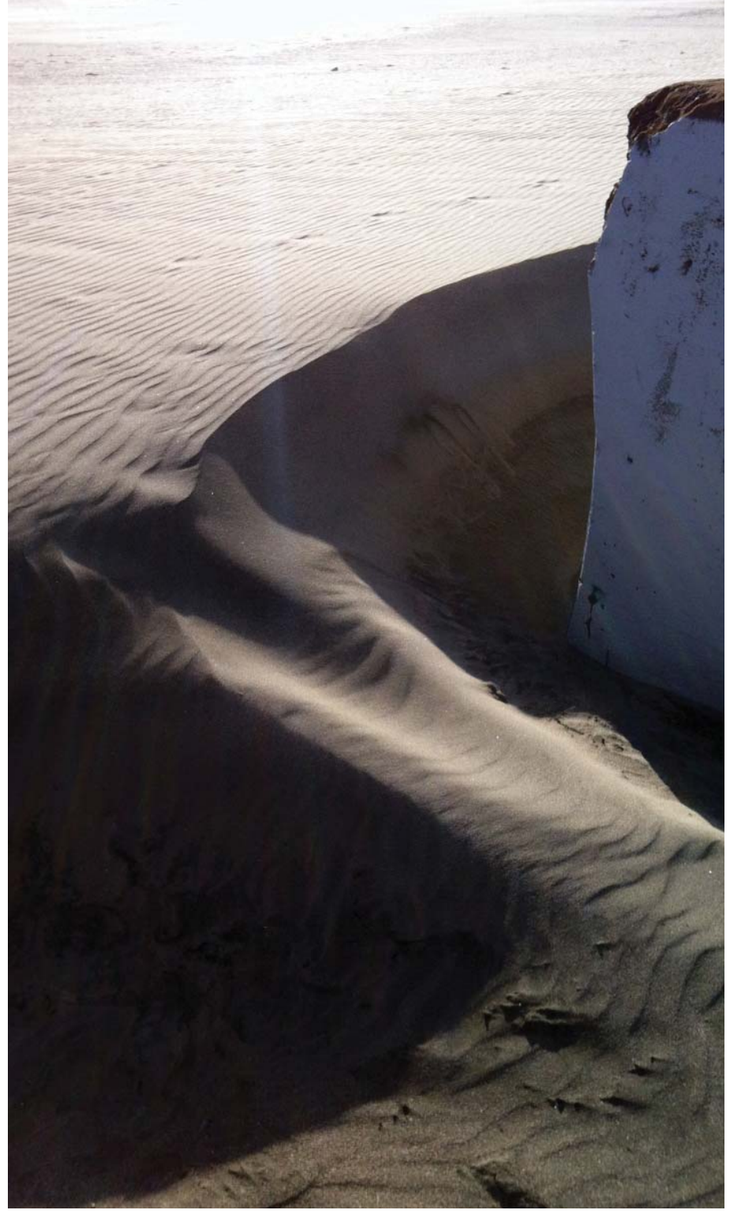


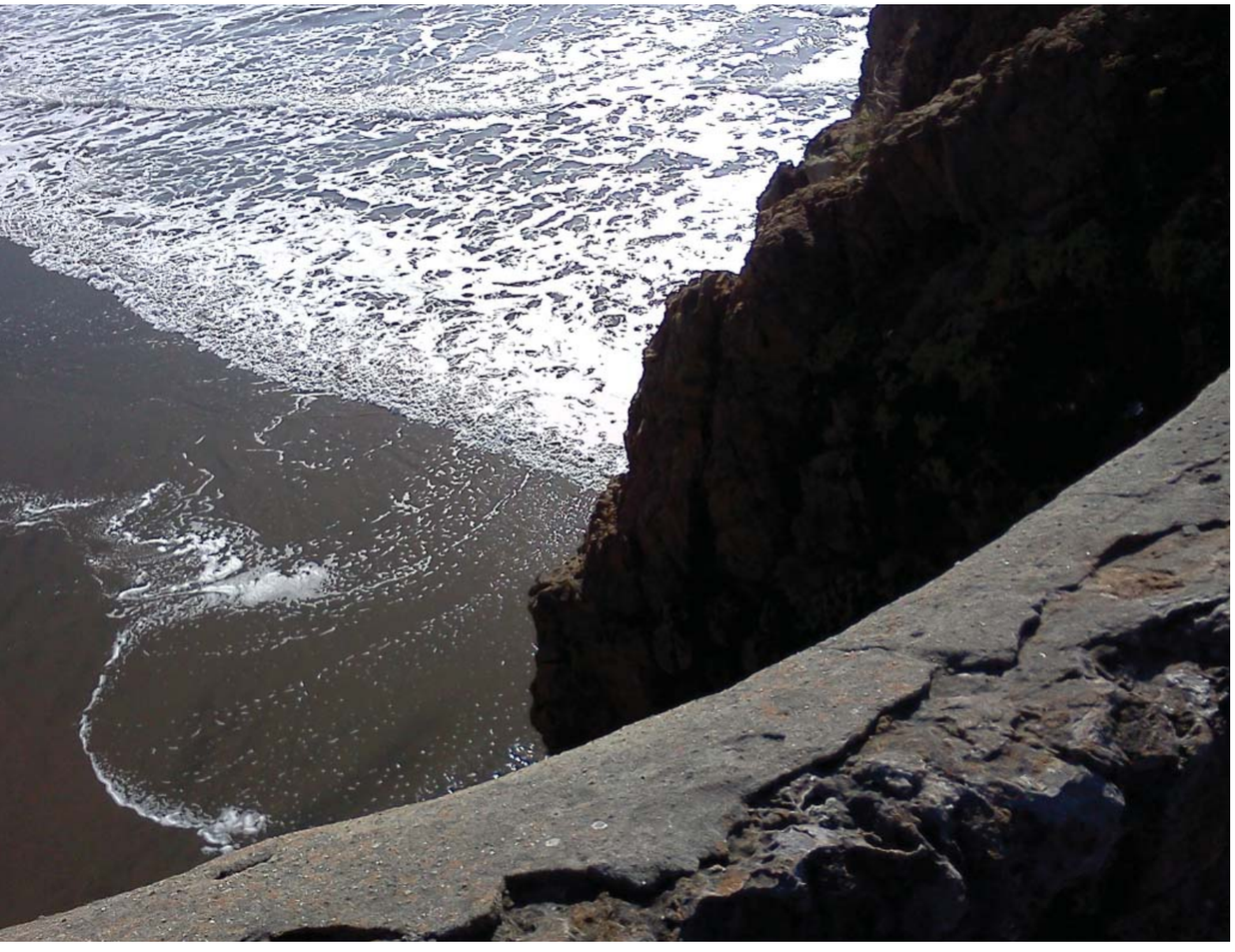
Figure V-29 (opposite):
North Reach | Key Move 6 Illustrative Plan

The final key move of the master plan proposes improved pedestrian and bicycle connectivity north of Golden Gate Park.

Key Move 6:

Introduce bicycle and pedestrian improvements north of Balboa Street.

- **6.1** Narrow Great Highway North of Balboa (from four lanes to two)
- **6.2** Keep diagonal Cliff House parking
- **6.3** Narrow Point Lobos Avenue from four lanes to two; add two-way separated bikeway on inland side and separated bikeway along cliff to prevent bicycle–vehicular conflict on steep slope
- **6.4** Connect bike lane to bike trail to Lands End and add “bicycle box” at Point Lobos and 49th Avenue



Benefits

> Improved pedestrian and bicycle safety, shortened crossings
> Improved aesthetics and street design
> Maintains Cliff House parking while reducing car-bike conflicts
> Enhances key recreational connection to Lands End, coastal trail

Constraints

> Possible modest traffic impacts

Outstanding Questions

> What is the optimal arrangement of bicycle lanes along Point Lobos Avenue?
> What are the traffic impacts, if any?

Next Steps

Conduct interagency circulation and access study, to include:

> Development of detailed roadway configuration options
> Detailed traffic analysis, to provide the basis for environmental review

Lead Agency: San Francisco Municipal Transportation Authority (SFMTA)
Partners: San Francisco Planning Department, San Francisco Recreation and Parks Department (SFRPD), San Francisco Department of Public Works (SFDPW)
Status: This study has been funded.

Gateway Element
(to be designed)

Various Alternatives for Interpretive and Informational Signage

Figure V-30:
View of Point Lobos "Road Diet" at 47th Avenue Intersection

This sketch illustrates the reduction of Point Lobos from 4 to 2 lanes, plus the addition of a two-way separated bikeway on the inland side.

Ocean Beach is an intensely energetic environment, frequently battered by powerful waves and storm surges.

Figure V-31 (opposite page):
Master Plan Aerial View

Artist's sketch of Ocean View Master Plan's vision from the southwest.

Figure V-32: Illustrative Plan

Six “key moves” outline the Ocean Beach Master Plan’s major recommendations. Each includes many individual recommendations or strategies, more than forty in all. They are organized by three geographical reaches as indicated, and will be implemented incrementally over a period of decades.


north reach
middle reach
Cliff House
Sutro Baths
See Figure V-21
4
See Figure V-24
5
O'Shaughnessy Seawall
Restored Dunes
Promenade + Parking
Beach Chalet
La Playa St
See Figure V-29
6
Noriega Seawall
The Great Highway
La Playa St
48th Ave
Lincoln Way
Golden Gate Park
Fulton St
48th Ave
Balboa St
Point Lobos Ave
Ortega St
Noriega St
Moraga St
45th Ave
OUTER RICHMOND
Geary Boulevard
The Presidio
Ocean Beach Master Plan Key Moves:
1 KEY MOVE 1: Reroute the Great Highway behind the zoo via Sloat and Skyline Boulevards
2 KEY MOVE 2: Introduce a multipurpose coastal protection/ restoration/access system
3 KEY MOVE 3: Reduce the width of the Great Highway to provide amenities and facilitate managed retreat
4 KEY MOVE 4: Restore the dunes along the middle reach
5 KEY MOVE 5: Create a better connection between Golden Gate Park and Ocean Beach
6 KEY MOVE 6: Introduce bicycle and pedestrian improvements north of Balboa Street

Management and Stewardship Recommendations

The preceding sections lay out recommendations that are primarily physical in nature, organized geographically. The following recommendations address challenges and opportunities in the realm of interagency cooperation and joint management of Ocean Beach (issues described in the "Management and Stewardship" Focus Area in Section III). They are designed to facilitate more seamless interagency management in both immediate day-to-day matters and long-term planning and stewardship, starting with the implementation of this plan's vision.

Steering Committee Continuity

The existing steering committee, drawn from agency directors and elected officials, has been effective in shepherding this project forward and establishing a strategic vision. The group has already agreed to continue meeting in support of implementation efforts.

Establish a Joint Management Working Group

This group — drawn from senior staff from the Recreation and Parks Department, Department of Public Works, Public Utilities Commission, Army Corps of Engineers, Golden Gate National Recreation Area, SF Zoo, Municipal Transportation Authority and Golden Gate National Parks Conservancy — would meet monthly to discuss matters of operations, maintenance and management, including:

- Sand management, including the development of a standing permit for the movement and placement of excess sand by the Department of Public Works
- Waste management and cleanup
- Public safety and policing
- Events management and cooperation
- Volunteer coordination
- Conservation efforts and resource awareness
- Maintenance and repair
- Parking management and revenue
- Amenities and concessions

Create a Joint Management Agreement

If it is determined that additional efficiencies could result, the joint management working group should be formalized through the creation of a Joint Powers Authority (JPA), Joint Operating Agreement (JOA) or Memorandum of Understanding (MOU).

Conduct Interagency Implementation Studies

The Ocean Beach Master Plan has already resulted in funding to pursue implementation of plan recommendations on three tracks, which are described in more detail later in this chapter. In addition, we recommend that this plan be revised and updated by 2030. These studies include:

- **Interagency Circulation and Access Study**
- **Joint Coastal Management Framework**
- **Joint Open Space Management Plan**
- **2030 Adaptive Revision**

Develop and Deepen Nonprofit and Philanthropic Partnerships

Numerous advocacy organizations participated in the development of this plan, and they should continue to have a seat at the table and a voice in managing Ocean Beach over the long haul. The Golden Gate National Parks Conservancy plays a unique role in the Golden Gate National Recreation Area, serving as a philanthropic partner in addition to its many other contributions. The significant improvements contemplated in this plan present the opportunity for a deeper engagement at Ocean Beach by the GGNPC. Alternatively, a dedicated Ocean Beach Conservancy might fulfill a similar role.

Update the Western Shoreline Plan

The Western Shoreline Area Plan is part of San Francisco's Local Coastal Program (LCP), the element of its General Plan that (once approved by the California Coastal Commission) regulates land use in the designated Coastal Zone. Although the Coastal Act requires that it be updated every five years, the Western Shoreline Plan is now nearly 30 years old. An LCP update would address this requirement and could codify Ocean Beach Master Plan recommendations.

Ongoing Adaptive Management

Adapting to coastal dynamics and sea level rise entails inherent uncertainties, and this plan includes ambitious and innovative concepts. It is essential that all parties engage in ongoing monitoring of conditions as they develop over time, and adjust management practices, designs, assumptions and expectations to reflect emerging conditions and data.

"Being able to go to the beach whenever I want really makes me appreciate living in San Francisco."

—Public Workshop Participant, Ocean Beach Master Plan, 2011

master plan implementation strategy

Section VI: Master Plan Implementation Strategy Table of Contents

Environmental Review
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- Interagency Circulation and Access Study
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master plan implementation strategy

This is a nonregulatory guidance document presenting SPUR's policy recommendations at a conceptual level. It does not have the force of law or public policy, but it does reflect a sustained partnership among the range of relevant agencies and stakeholders and thus represents a plausible and thoroughly vetted set of concepts. Achieving this vision will require the relevant agencies to implement the recommendations at their discretion and through the appropriate planning and regulatory processes. SPUR strongly encourages them to do so, and stands ready to serve as a partner, facilitator and advocate moving forward.

This section presents an approach to implementing OBMP recommendations. It maps out a series of studies and plans in several arenas, which represent key next steps. These steps will allow the relevant agencies to translate the plan concepts into policies and actions while navigating a complex regulatory and fiscal environment.

Implementation must begin with deeper studies of the feasibility, engineering, financing, interagency processes and environmental impacts of these recommendations. Although many conditions at Ocean Beach are pressing and cry out for quick action, this is at its core a long-term, strategic plan, and these ambitious recommendations must travel a considerable distance before they result in wholesale changes on the ground. In the meantime, the presence of a long-term vision, along with the engagement of SPUR and other stakeholders, can inform the near-term actions by responsible agencies.

Implementation for the Ocean Beach Maser Plan must begin with deeper studies of the feasibility, engineering, financing, interagency processes and enviornmental impacts of the recommendations included herein. The master plan recommends following four (potentially parallel) tracks to complete these necessary studies.

Environmental Review

Implementation of some of these recommendations will require public agencies to conduct environmental review under the California Environmental Quality Act (CEQA) or the National Environmental Policy Act (NEPA). They may also require a Coastal Development Permit under the California Coastal Act. The implementation actions recommended here are designed to facilitate environmental review by defining groups of related actions, conducting technical studies in support of environmental documents and identifying lead and partner agencies appropriate to each.

Funding Secured

In January 2012, the California State Coastal Conservancy board of directors approved an additional $400,000 in funding to support implementation of these recommendations. This grant is supported by matching pledges of $300,000 from the San Francisco Public Utilities Commission and $125,000 from the National Park Service. Additional SFPUC support for technical studies of coastal management recommendations is currently under discussion.

Four Implementation Tracks

The projects identified below represent four implementation tracks, each of which can move forward independently:

1 SPUR Leadership and Coordination

Because of the plan's breadth and nonregulatory nature, implementing it will necessitate sustained engagement and advocacy. SPUR's permanent presence as an advocate on planning issues in San Francisco gives it the capacity to remain involved, keeping plan recommendations in the spotlight over the long term.

SPUR will serve as the coordinator and manager, providing continuity of leadership and maintaining the key relationships developed to date, with partner agencies taking the lead on project elements as appropriate from a legal and regulatory standpoint. SPUR will coordinate closely with partner agencies to pursue and secure additional funding, build political momentum and maintain the focused engagement of all partners. SPUR will lead public communication and steward the core principles of the OBMP through the full range of implementation efforts.

Project Lead: SPUR
Preliminary Budget: $400,000

2 Interagency Circulation and Access Studies

The vision recommended for Ocean Beach will require significant reconfiguration of roadways, in particular the closure of the Great Highway south of Sloat Boulevard and the rerouting of traffic via Sloat and Skyline. This will require the reconfiguration of several intersections and the redesign of Sloat Boulevard into a multimodal coastal gateway. SPUR will assemble, scope and manage consultant teams in close coordination with city agencies, through the Mayor's Office of Economic and Workforce Development (MOEWD), as well as identifying any additional funds necessary to complete the scope of work.

Elements of this project will likely include:

> Development of roadway configuration and design
> CEQA-ready traffic analysis of Great Highway rerouting and other roadway and intersection reconfigurations
> Coordination with ongoing city transportation plans and studies, including the 19th Avenue Corridor Study
> Area-wide joint parking management plan
> L Taraval extension planning
> Zoo access reconfiguration
> Circulation and access EIR

Project Lead: SPUR
EIR Lead: SFMTA
Partners: SFCTA, SFZoo, SFRPD, MOEWD, GGNRA
Preliminary Budget: $300,000 (excluding EIR)

3 Coastal Management Framework and Technical Studies

The coastal management recommendations will require considerable study and analysis, and their implementation will depend on agreement among several affected agencies, including the National Park Service, Public Utilities Commission and Army Corps of Engineers. A joint coastal management framework will define an agreed-upon set of triggers and actions for adaptation to rising sea levels and associated coastal hazards at Ocean Beach.

SPUR will facilitate the development of a joint coastal management framework, in line with the principles of the Ocean Beach Master Plan, to provide the basis of a formal agreement among the agencies responsible for coastal management and affected by coastal outcomes.

This project will likely include:

> Coastal engineering feasibility studies
> Definition of phasing, with climate and erosion triggers
> Economic analysis
> Coordination with access and surface restoration design and implementation
> Capital project planning and coordination
> Project EIR/EIS, Coastal Development Permit

Project Lead: SPUR
EIR/EIS Lead: SFPUC
Project Partners: GGNRA, SFPUC, SFDPW, ACOE
Preliminary Budget: $440,000 (excluding EIR/EIS)

4 Joint Open Space Management Agreement

Ocean Beach is experienced as a single place, but its management has long been divided among several entities, resulting in significant public frustration over the most basic needs, such as waste management and restrooms. SPUR will facilitate the creation of a joint management agreement or similar structure whereby responsible agencies collaborate both to improve day-to-day operations and management and to make significant improvements to public access and amenities in the future. Access improvements will include key segments of the California Coastal Trail.

This project will likely include:

> Open space planning and programming study
> Cost and revenue-sharing framework
> Dune restoration pilot study
> Schematic design for public access improvements
> Management agreement

Project Lead: SPUR
EIS/EIR Lead: GGNRA
Project Partners: GGNRA, SFRPD, GGNPC, SFPUC, SFZoo
Preliminary Budget: $200,000

Additional Funding Opportunities

The projects identified above represent a comprehensive set of next steps toward implementation of the OBMP. Each will include a strategy for funding both environmental review and capital projects. Several important sources of funds have already been identified that may be applied in whole or in part to implementation of OBMP recommendations.

Each implementation next step requires a funding strategy. Several important sources of funds have already been identified that may be applied to help realize the OBMP recommendations.

VI-1a : Implementation Planning Funds: Secured or In Process

Agency	Source	Purpose	Amount
SCC	Grant	Core Implementation Funds	$400,000
SFPUC	Grant Match	Core Implementation Funds	$300,000
SFPUC	Additional Grant (in process)	Coastal Management Studies	$440,000
NPS	Grant Match	Core Implementation Funds	$125,000

VI-1b : Implementation Planning and Capital Funds

Agency	Source	Purpose	Amount
CCSF	Cosco Busan Settlement	Recreational Amentities	$1,125,000
NPS	Cosco Busan Settlement	Recreational Amentities	$7,000,000
ACOE/CCSF	Section 2037 Cost-Share	Beach Nourishment	<$6,800,000
	SF Proposition K	Great Highway	$1,300,000
MTC/CTA	Transportation Improvement Plan (TIP)	Great Highway	$35,000,000
NPS	FLHP/TRIP	GH Corridor Public Access	$250,000
NPS	GMP Identified Projects	O'Shaughnessy Seawall Rehabilitation	$1,500,000
MTC/CTA	T-E Funds	Conservation Corps partnerships	TBD
MTC/CTA	One Bay Area Grant	Multimodal Access Improvements	TBD
CCSF/SGC	Prop 84 Strategic Growth Council Planning Grant	Various	TBD
GGNPC	Trails Forever	Public Access Improvements	TBD
CalTrans	Local Assistance Program	Storm Damage Recovery	TBD
FHWA	Public Lands Highways Grant Program	Open Space Access	TBD
DPW	CCSF Bond Programs	Roadway Tmprovements	TBD

Table VI-1: **Funding Opportunities Summary**

Source: SPUR, 2012

Coordination with Ongoing Plans and Studies

As noted throughout this document, many agencies are engaged in activities affecting Ocean Beach, and coordinating their many projects while keeping the long view in sight will be essential to implementing these recommendations.

Ongoing plans and studies that will require coordination include:

> GGNRA General Management Plan update
> GGNRA Dog Management Plan
> SFPUC Sewer System Improvement Program (SSIP)
> SFPUC Lake Merced Watershed Report
> SFPUC Infrastructure Condition Risk Assessment Study
> CTA/MTA 19th Avenue Corridor Study
> San Francisco Citywide Bicycle Plan
> San Francisco Better Streets Plan
> SF General Plan Recreation and Open Space Element
> SF General Plan Western Shoreline Plan (Local Coastal Program) revision/update
> SF 3-year capital planning process
> FEMA Flood Risk Update
> Army of Corps of Engineers/Association of Bay Area Governments Coastal Regional Sediment Management Plan

"Ocean Beach is still a gem but the lack of recreational infrastructure and the somewhat uninviting atmosphere diminishes its recreational value. Things that would improve [it include] friendlier regulations and enforcement and [the] recognition of historic public use and enjoyment value, [such as] off-leash dog walking, bonfires, night-time walks..."

—OBMP Workshop 2 Participant, June 2011

cost estimation and benefits evaluation

Section VII: Cost Estimation and Benefit Evaluation Table of Contents

Evaluation Criteria
Cost Analysis

VII

cost estimation and benefits evaluation

Evaluation Criteria

To develop objectives in each of the seven Focus Areas [Section III], and to help define what a successful approach need to accomplish, the Planning Advisory Committee developed a set of evaluation criteria [Table VII-1]. The results of each Test Scenario [Appendix B] were subject to these evaluation criteria and rated accordingly. Because they are "maximum scenarios" exaggerating singular priorities, none of the Test Scenarios were successful across all the Focus Areas. Nevertheless, their evaluation shed light in understanding stakeholders' priorities and helped the consultant team in developing the final set of recommendations.

Evaluation criteria were developed in consultation with the OBMP Planning Advisory Committee (PAC) to evaluate outcomes of Test Scenarios and Plan Recommendations.

focus areas	focus areas: setting the foundation		
	Ecology	**Coastal Dynamics**	**Utility Infrastructure**
			
aspiration	**Restore and establish conditions that support thriving biological communities.**	**Identify a proactive approach to coastal management, in the service of desired outcomes.**	**Evaluate utility plans and needs in light of coastal hazards and uncertainties, and pursue a smart, sustainable approach.**
evaluation criteria	1. Biodiversity & ecological functions on land, water, and intertidal zones -2 -1 0 1 2 (degrades) (improves) 2. Habitat for key species (plovers, bank swallows) -2 -1 0 1 2 (degrades) (improves) 3. Ecological connectivity -2 -1 0 1 2 (degrades) (improves)	1. Adaptable and effective response to erosion, storm surges and sea-level rise -2 -1 0 1 2 (degrades) (improves) 2. Requirement for on-going interventions -2 -1 0 1 2 (increases) (reduces) 3. Impact to other focus areas -2 -1 0 1 2 (negative) (positive)	1. Water quality management (stormwater, wastewater, combined-sewer overflows) -2 -1 0 1 2 (degrades) (improves) 2. Flooding prevention (stormwater run-off) -2 -1 0 1 2 (degrades) (improves) 3. Management of the investment in core utility facilities (treatment plant, transport box, Lake Merced tunnel…) -2 -1 0 1 2 (negative) (positive)

Table VII-1: **Evaluation Criteria**

As utilized during the development of the Test Scenarios and the final master plan recommendations.

	focus areas : place-making			focus area*
	Access and Connectivity	**Image and Character**	**Program and Uses**	**Management and Stewardship**
focus areas				
aspiration	**Provide seamless and fluid connections to adjacent open spaces, the city, and the region.**	**Preserve and celebrate the beach's raw and open beauty, while welcoming a broader public.**	**Accommodate the diverse activities people enjoy at the beach, managed for positive coexistence.**	**Provide an approach to long-term stewardship across agencies, properties, and jurisdictions.**
evaluation criteria	1. Pedestrian and bicycle circulation along north/south corridors -2 -1 0 1 2 (degrades) (improves) 2. Pedestrian & bike connections to adjacent open spaces, streets & transit network -2 -1 0 1 2 (degrades) (improves) 3. Traffic flow and parking system -2 -1 0 1 2 (degrades) (improves)	1. Image of Ocean Beach -2 -1 0 1 2 (degrades) (improves) 2. Natural feel and experience of the beach (dunes, wildlife, surf...) -2 -1 0 1 2 (degrades) (improves) 3. Experience and character of the urban edge along Ocean Beach -2 -1 0 1 2 (degrades) (improves)	1. Activities and amentities -2 -1 0 1 2 (degrades) (improves) 2. Surf conditions -2 -1 0 1 2 (degrades) (improves) 3. Compatibility of uses -2 -1 0 1 2 (degrades) (improves)	1. Day to day management and maintenance 2. Ability for agencies to work cooperatively 3. Funding in support of the vision

Cost Estimation

The long term implementation of some of the master plan recommendations and the lack of fully-developed engineering make the preparation of precise cost estimates for Ocean Beach impractical. However, it is possible to project an order of magitude cost for the main components of the key moves.

As suggested in Section VI of this report, the recommendations included in the OBMP will be implemented with an opportunity-based apporach, tapping into multiple funding sources. For this reason, Table VII-2 provides cost estimates for the major components of the Ocean Beach Master Plan recommendations, matching each of the “key moves” and their individual strategies or sub-projects. This should allow for future phased implementation of the distinct scope areas, in response to funding availability and environmental studies’ timeframes.

Costs provided are preliminary, “pre-feasibility” estimates based on standard methodologies and developed in collaboration with the relevant agencies. They reflect escalation factors intended to capture future increases in the cost of capital projects. These costs represent projects that would be undertaken by a variety of agencies over a forty year period, some of which would be likely to occur without having been recommended here. Not represented are the considerable economic benefits of avoiding emergency coastal protection, maintaining rates of visitation and recreational use, and maintaining or improving ecological and habitat functions at Ocean Beach.

Key Move and Strategy	Estimate of Probable Cost
KEY MOVE 1: Re-route Great Highway	**$48,917,077**
Phased demolition, South of Sloat	$998,244
Zoo Road Access	$1,996,600
Reconfigure Sloat and Intersecitons	$11,889,840
Streetscape, bikeway, and coastal amenities	$9,316,523
Extend Muni L-Taraval Line to Zoo	$22,972,248
Reconfigure Zoo Entrance	$892,798
Coastal Trail to Fort Funston	$850,824
KEY MOVE 2: Introduce Multipurpose Coastal System	**$147,052,260**
Removal of rubble, revetments	$25,808,328
Protection measures (cap and cobble), phase 1	$26,952,588
Protection measures (cap and cobble), phase 2	$35,936,784
Protection measures (secondary structure) phase 3	$18,322,200
Beach Nourishment at Southern Reach (Sand)	$24,433,920
Constructed wetland	$15,598,440
KEY MOVE 3: Reduce Great Highway	**$56,896,983**
Narrow Hwy from 4 to 2 lanes	$44,968,431
Promenade, restrooms.amenities	$11,928,552
KEY MOVE 4: Native Dune Restoration	**$35,240,000**
Beach Nourishment (Sand Placement)	$24,433,920
Native Dune Restoration	$5,000,000
KEY MOVE 5: Connect GG Park with Beach	**$46,090,797**
Roadway and Driveway Reconfiguration	$2,011,462
Parking Lot Improvements, Amenities	$44,079,336
KEY MOVE 6: Bicycle/Pedestrian Improvements	**$19,426,677**
Roadway and Intersection Improvements	$18,392,123
Bikeway	$1,034,554
TOTAL	**$353,623,794**

Sources and Assumptions

The cost estimate is provided for the final master plan recommendations included in Section V of this document.

The following sources were utilized to determine the project costs for the OBMP:

- Information provided by SFPUC for replacement values of utility infrastructure
- Information provided by ESA PWA for coastal protection elements, based on a study conducted for State Parks in 2007 for a comparable project
- Costs for Great Highway removal were extracted from a study developed by Moffatt & Nichol for SFPUC
- Miscellaneous cost for public amenities improvements were obtained from AECOM Cost Estimating team, based on comparable recent projects
- Cost of LID elements were derived from a detailed analysis conducted by the SFPUC and adapted to the project's conditions by Ben Grant (SPUR) and Sherwood Design Engineers.

Table VII-2: **Project Estimate of Probable Cost**

Based on a number of sources, the table presents an estimate of probable cost for each of the six key moves described in the master plan recommendations.

"The most important issue is that we must create an entirely new approach to nurture and sustain this extremely unique zone that is the matchline [or] seam between human urban infrastructure and wild open space that is the well spring of the earth's ecology. We are the largest city [in North America] closest to the ocean on the pacific rim, [and we have] the largest systems of Marin Sanctuaries in the world. There is little creative, environmental methodology for these two world's to coexist."

—Lewis Aimes (SFMTA), OBMP Workshop 1 Participant, January 2011

conclusion

VIII

Section VIII: Conclusion Table of Contents

Conclusion

conclusion

This plan addresses a wide range of challenging issues simultaneously, and the recommendations presented here strike a balance that is both ambitious and realistic, and, if implemented, will result in considerable improvements on most parameters identified in the Focus Areas section.

Ecology

Short of a wholesale retreat of the city of San Francisco, coastal recession is certain to put pressure on the ecological function of the beach and adjoining open spaces. However, these recommendations—including beach nourishment, roadway closure and narrowing, dune restoration, and wetland creation – would result in significant improvements in ecological function in what is now a severely degraded beach in come locations. This will help to support existing populations of threatened birds as well as migratory waterfowl in the coming decades.

Utility Infrastructure

At the heart of this scheme is a proposal that protects public infrastructure in place, while simultaneously delivering improvements in coastal access and ecological function. The public's investment in coastal water quality can be safeguarded in a targeted and thoughtful manner for a significant period of time, recouping ratepayer investments. Eventually, it will become necessary to examine the value of the most threatened elements of the infrastructure system relative to the cost of indefinite protection and our emerging understanding of coastal hazards.

Coastal Dynamics

Closing the Great Highway South of Sloat, using more flexible protection measures, and pursuing ongoing beach nourishment all reflect a more informed response to the specific coastal conditions at Ocean Beach. Above all, proactive planning that acknowledges the inevitability of coastal erosion and its likely increase due to climate change is a significant step forward for adaptive coastal planning in San Francisco and for the field at large.

Image and Character

The proposals in this plan are relatively non-prescriptive with respect to aesthetics, but reflect the light hand that the community of users and stakeholders clearly requested. Interventions are focused less on transformation – except where degraded or substandard conditions prevail today – than on restoration of and access to the rugged landscape so beloved of San Francisco. As designs are detailed in future phases, these qualities should be kept in mind.

Program and Uses

This plan honors and reinforces the variety of ways Ocean Beach is used today, and seeks above all to ensure that the beach remains healthy and generous enough to support all users. These recommendations improve access for all users, and significantly upgrade the Sloat area to an accessible and interpretive landscape with a strong connection to the Zoo and its conservation mission.

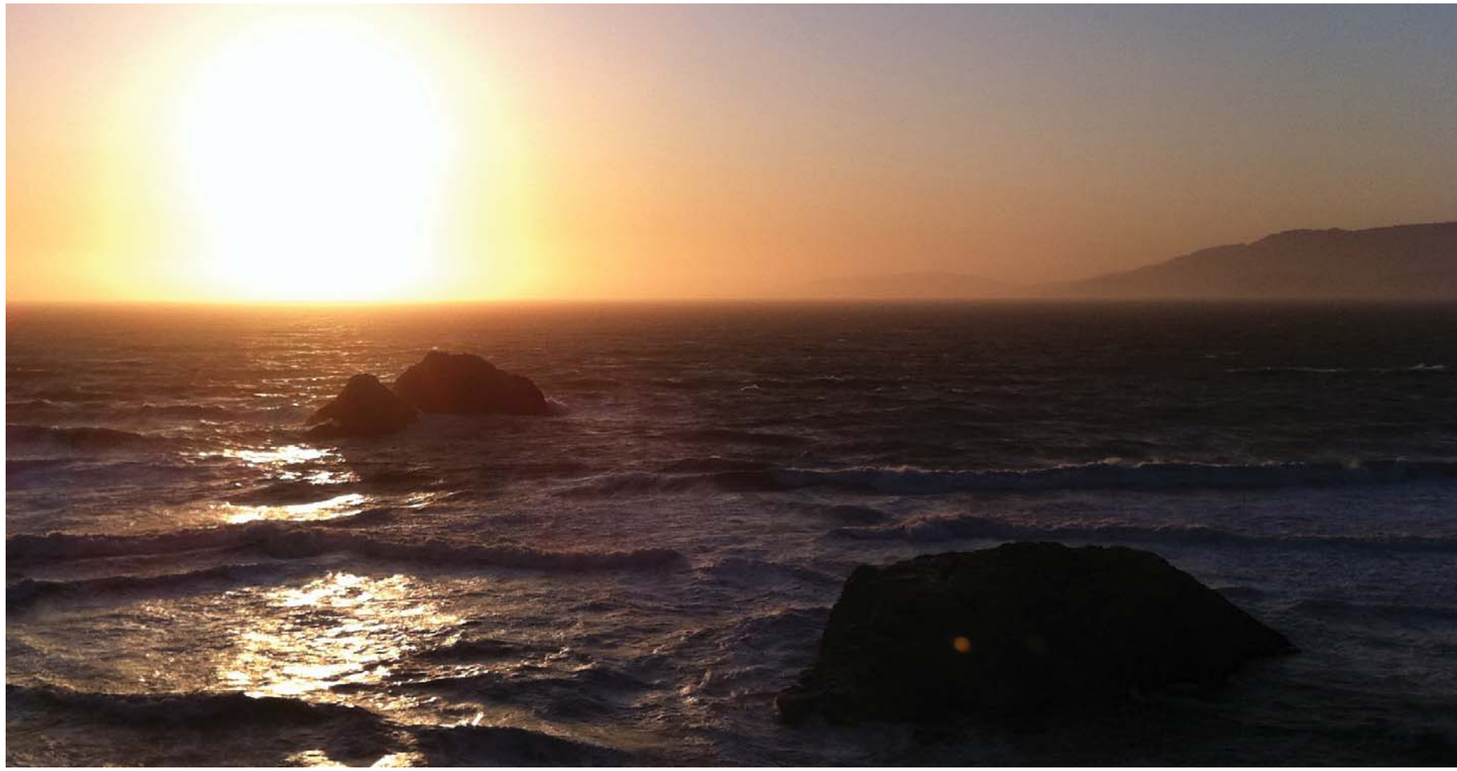
Access and Connectivity

While the most striking recommendations here involve removing a road, they are designed in concert with major improvements in access for all users. Drivers benefit from upgraded traffic management and reconfigured (but still generous) parking. Cyclists, pedestrians, and transit riders all see complete streets and coastal access designed to incorporate all modes safely and comfortably. The coastal trail south of Sloat Boulevard, with it regional open space connections, will be a spectacular addition to an enviable open space legacy in San Francisco.

Management and Stewardship

The most important impact on governance and interagency cooperation has already been achieved. It is the creation of this plan. The partnerships and vision that were forged through an honest exploration of challenging conditions at Ocean Beach set the stage for a more cooperative and proactive future. Already, significant implementation efforts are underway, which will continue to bring these agencies together moving forward.

This plan represents a turning point for Ocean Beach, and an innovative model for planning in an uncertain coastal context. It shows that with the concerted engagement of citizens, advocates, public agencies, and elected officials, the emerging challenges of adaptation to climate impacts can be turned into opportunities. With cooperation and vision, we can shape the coming changes, and as we adapt, become better stewards of our precious coast.



glossary and list of abbreviations

Glossary

Ammophila arenaria: the latin name for European Beachgrass, a non-native invasive dune species planted for its ability to stabilize sand.

Bank Swallow: a state-listed threatened bird species that lives in the bluffs at Ocean Beach.

Beach nourishment: the direct placement of sand on the beach to counteract erosion.

Carpobrotus sp.: the Latin name for Iceplant, a non-native invasive dune species.

Coastal armoring: hard structures such as seawalls or revetments that resist erosive forces.

Coastal dynamics: the processes by which beaches and coastlines accrete (grow) and erode (shrink), via the breakdown and movement of sediment, including sand.

Cobble: a naturally rounded rock fragment usually between 60 and 250 millimeters in diameter. Occurs naturally on cobble beaches and can be placed for coastal protection.

Cobble berm: an innovative coastal protection structure made of cobblestones that can be shaped dynamically while dissipating wave energy. Also known as a dynamic revetment.

Combined Sewer Discharge (CSD): an event in a combined sewer/stormwater system in which the capacity of the system is overwhelmed during wet weather and combined flow is released into nearby water. CSD occurs approximately seven times a year at Ocean Beach.

Climate change (global warming): a sustained change in the earth's climate, generally referring to increased global temperatures driven by carbon emissions from fossil fuels. Climate change is likely to be accompanied by rising sea levels.

Detention swale: A shallow, vegetated drainage course designed to convey surface runoff water while removing silt and pollution. A key component of Low Impact Development (LID) landscapes.

Dry back beach: The portion of a sandy beach above the typical high tide line and below any foredunes. It is the preferred habitat of the threatened western snowy plover.

Environmental Impact Report: A study required by the California Environmental Quality Act to assess the environmental impacts of a proposed project.

Fleishhacker Pool: A large saltwater swimming pool that was open from 1925-1971 on the site of the current Zoo parking lot. Its poolhouse, now abandoned, could be restored for interpretive or visitor uses.

Force mains: pipelines used to pump water uphill. At Ocean Beach, the pump station at Sloat and Great Highway pump wastewater through force mains to the Oceanside Treatment Plant.

Golden Gate littoral cell: The coastal sediment system surrounding the Golden Gate and bounded by an offshore sandbar, within which sand circulates, shaping Ocean Beach and other nearby beaches.

Golden Gate marine shipping channel: A channel dredged through the sandbar offshore of the Golden Gate which allows the passage of large ships. This dredging, conducted annually by the Army Corps of Engineers, produces a large volume of sand that could be used for beach nourishment.

Golden Gate National Parks Conservancy (GGNPC): the nonprofit partner that supports and assists the Golden Gate National Parks in research, stewardship and education.

Golden Gate National Recreation Area (GGNRA): A National Recreation Area administered by the National Park Service that includes numerous park units in the vicinity of the Golden Gate, including Ocean Beach.

Great Highway: the road that runs north / south adjacent to Ocean Beach.

Internal ballast: materials placed to give stability, and distribute loads, in this case as one approach to reinforcing the Lake Merced Tunnel.

Joint coastal management framework: A set of studies, plans, and policies recommended to guide management of the coastline at Ocean Beach by partners such as the SFPUC, Army Corps, and GGNRA.

Lake Merced Tunnel (LMT): A 14-foot diameter pipe, located under the Great Highway, that stores and conveys combined wastewater (sewage) and stormwater from the Lake Merced basin watershed to the pump station at Sloat and great Highway. The LMT is threatened by erosion at Ocean Beach.

Lands End: a portion of the GGNRA that is located to the north of Ocean Beach, wrapping around the northwest corner of San Francisco.

Low-Impact Development (LID): is an approach to land development and landscape design that works with nature to manage stormwater as close to its source as possible.

Managed retreat: The strategic relocation of structures threatened by erosion according to pre-determined triggers.

Non-native/exotic: a term for a species of plant or animal that did not originate locally and was typically introduced to the area by humans.

Oceanside Water Pollution Control Plant/Oceanside Treatment Plant: The major wastewater treatment facility on the west side of San Francisco, located on the Great Highway at the southern end of Ocean Beach. Its maximum capacity is 65 million gallons per day.

O'Shaughnessy Seawall: A 4,800-foot historic seawall between the Cliff House and Lincoln Boulevard, completed in 1929, along with the adjacent promenade and roadway.

Revetments: Large embankments of boulders or other materials used to protect coastal features from erosion. A form or coastal armoring.

Wave runup: A measure used by coastal scientists of the maximum vertical reach of waves during a storm event, including the combone effects of tides, storm surge, and wave setup.

Sea level rise: The increase in average sea levels attributed by scientists to warming of the earth's climate, via melting ice and thermal expansion of the oceans. The State of California directs its agencies to plan for sea level rise of 14 inches by 2050 and 55 inches by 2100.

Combined Sewer-stormwater system: An infrastructure system, like that in San Francisco, in which stormwater (rain) and wastewater (sewage) drain through the same structures. During heavy rains, these systems can be overwhelmed, resulting in overflows that pollute adjacent bodies of water.

Southwest Ocean Outfall (SWOO): The underwater pipe through which secondary-treated effluent is released from the Oceanside Treatment Plant, 4.5 miles into the Pacific Ocean.

Sunset Basin watershed: The area west of Twin Peaks whose combined sewer and stormwater system drains westward into the Westside Transport Box.

Test Scenarios: Scenarios developed through the Ocean Beach Master Plan process that examined different approaches to coastal management, maximizing single objectives to test their implications over a 100 year period.

Westside Transport Box: A large transport and storage structure underneath Great Highway between Lincoln and Sloat Boulevards. It is designed to store excess stormwater in wet-weather conditions to prevent overflows, and may eventually become exposed as the coastline recedes due to sea level rise.

List of Abbreviations

ACOE	Army Corps of Engineers
AECOM	AECOM Technical Services; landscape architecture/public communication consultants for this project
CCC	California Coastal Commission
CCSF	City and County of San Francisco
CEQA	California Environmental Quality Act
EA	Environmental Assessment
EIR	Environmental Impact Report under CEQA
EIS	Environmental Impact Study under NEPA
EQR	Emergency Quarry Revetment
ESA/PWA	Coastal engineering consultants for this project
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
GGNPC	Golden Gate National Parks Conservancy
GGNRA	Golden Gate National Recreation Act
GGP	Golden Gate Park
JFK	John F. Kennedy Dr., which runs through GGP
LID	Low-impact development
LMT	Lake Merced Tunnel
MOB	Middle Ocean Beach
MOEWD	Mayor's Office of Workforce and Economic Development
NEPA	National Environmental Policy Act
N/N	Nelson/Nygaard
NOB	North Ocean Beach
NPS	National Park Service
OB	Ocean Beach
OBMP	Ocean Beach Master Plan
OTP	Oceanside Treatment Plant
PAC	Planning Advisory Committee
PUC	San Francisco Public Utilities Commission
SCC	California State Coastal Conservancy
SGC	California Strategic Growth Council
SFDPW	San Francisco Department of Public Works
SFDRP	San Francisco Department of Recreation and Parks
SFCTA	San Francisco County Transportation Authority
SFMTA	San Francisco Municipal Transportation Agency
SFPUC	San Francisco Public Utilities Commission
SFZoo	San Francisco Zoo
SOB	South Ocean Beach
SPUR	San Francisco Planning and Urban Research Association
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
USEPA	United States Environmental Protection Agency

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"Even while cleaning up, our volunteers are able to make the connection between the trash they are removing from the shore and the trash that they create in their daily lives. It's a powerful reminder that we can take simple steps to keep our coast clean every day of the year."

—Christiane Parry, Director of the California Coastal Commission's Public Education Program, 2011

appendix

section

A

Appendix A: Technical Memoranda

- Technical Memorandum 01: Coastal Engineering
- Technical Memorandum 02: Civil Engineering
- Technical Memorandum 03: Cost | Benefit Analysis

appendix A: technical memoranda

technical memorandum 01 : coastal engineering

Prepared by: ESA PWA

Cobble Berms: A Brief Summary in Support of the Ocean Beach Master Plan

Bob Battalio, PE
ESA PWA
January 20, 2012

The Ocean Beach Master Plan has identified an array of actions to mitigate coastal hazards and improve the public space. One of the elements in the Master Plan is a cobble berm to be installed in South Ocean Beach, from the vicinity of Sloat Boulevard southward to the limit of development at Fort Funston. The cobble berm is an innovative approach to allow erosion while protecting a sewer tunnel and providing public access. The report provides background information on cobble berms in support of the Master Plan report and other documents.

This report is not exhaustive in terms of identifying and considering all available knowledge. Nor is this work adequate to conclude the appropriateness of construction of a cobble berm at Ocean Beach. Additional work is needed prior to implementation.

Background:

The purpose of the cobble berm (dynamic revetment) at Ocean Beach is to "soften" the protrusion of the Lake Merced Transport Pipe that will result from shore recession. Under the Hybrid Scenario, the Lake Merced Pipe will be protected in place until it is replaced or no longer needed. Since the pipe crown is about even with the back beach elevation, it is likely that erosion will remove most of the overburden covering the pipe. The San Francisco PUC and DPW have indicated that this could allow vertical or lateral movement of the pipe, or otherwise change the loadings such that the pipe could rupture. Hence, the Hybrid plan includes a Taraval-type seawall (Figure 1) or a structural modification of the pipe itself (e.g. reinforcing the pipe internally or reducing its section and elevation).

Figure 1: Taraval Seawall. The picture shows the north end, near Santiago Street, during an extreme, eroded condition during the 1998 El Nino. Photograph © Bob Battalio, taken 1998.

Since the feasibility of these "protect-in-place" approaches have not been fully evaluated, the most intrusive to beach use is assumed, which is the Taraval-type Seawall, as depicted in the Master Plan graphics for South Ocean Beach (Figure 2).

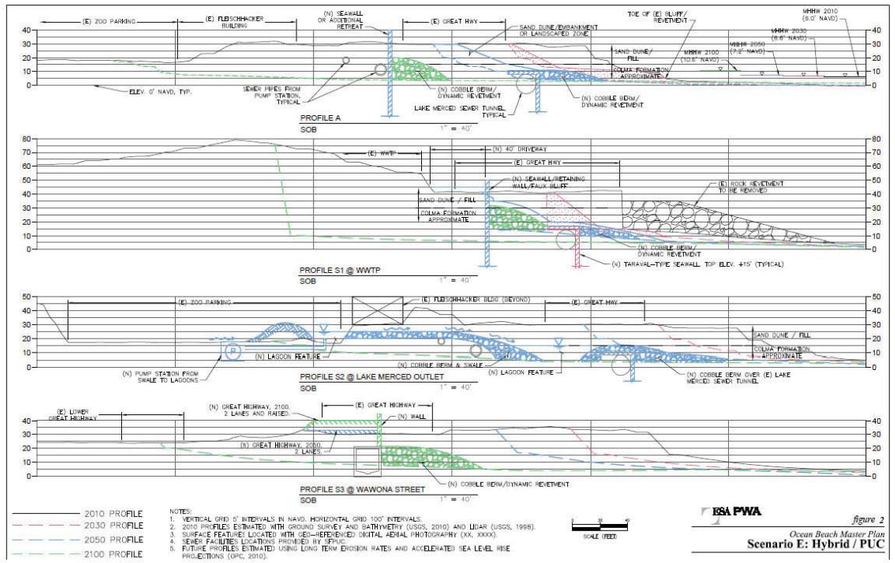

Figure 2: SOB Sections of Hybrid Scenario, Ocean Beach Master Plan.

The Lake Merced Pipe and protective structure(s) are likely to be exposed, and result in a vertical offset with the beach (similar to the condition shown in Figure 1). To mitigate this impact somewhat, a cobble berm is proposed in front of the wall. It is intended that the cobble berm would mitigate wave reflection and scour, provide a more accessible surface for people, and have a tolerable appearance. Also, the cobble berm is intended to provide a stable sill for a new outlet from Lake Merced to the beach (Figure 2, Profile S2).

In this application, the cobble berm is therefore a shore protection and hydraulic structure that is intended to provide a better balance with recreational and ecological objectives than more traditional quarry stone revetments and reinforced concrete seawalls. The cobble berm is not required to protect facilities, however, as the proposed Taraval-type seawall or structural modification of the pipe would be "stand-alone." Therefore, the proposed cobble berm could also be considered a landscaping element.

Finally, the cobble would replace the existing rubble and revetments at the site (Figure 3). The proposed extent of the cobble berm is in South Ocean Beach, generally from Sloat Boulevard southward to Fort Funston (Figure 4).

Figure 3: Picture(s) of existing rubble, SOB. Photograph © Bob Battalio, taken February 1, 2010.

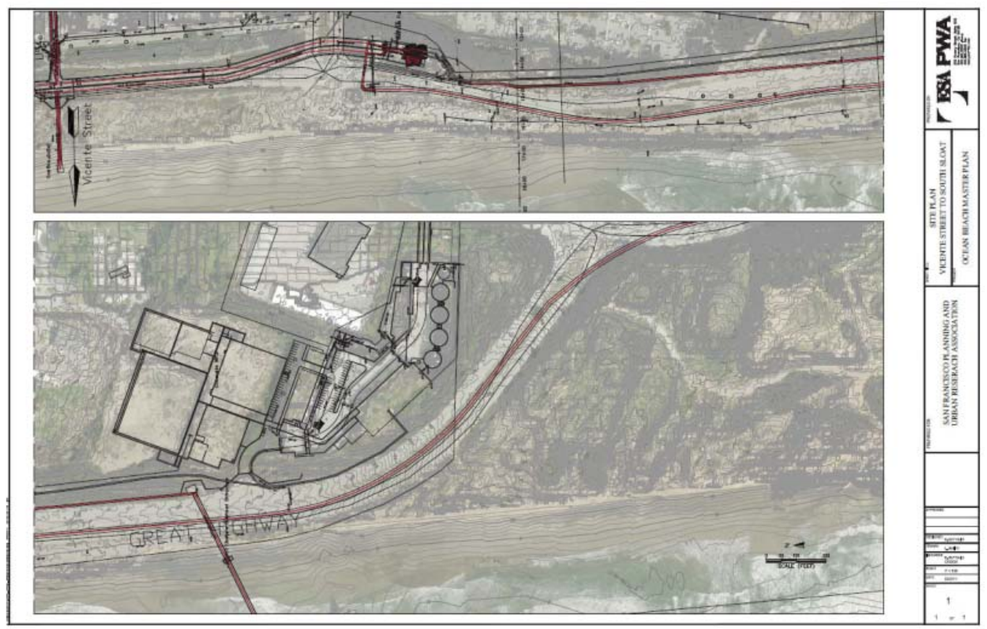

Figure 4: Plan extents of the proposed cobble berm are generally from Sloat Boulevard to the south end of the Southwest Sewer Treatment Plant, in the Master Plan region called South Ocean Beach (SOB).

Definition of a Cobble Berm, aka Dynamic Revetment

Cobble berms are mounds of rounded rock sorted and shaped by waves (Allen et al, 2005; Everts et al, 2002; Lorang, 1997; Bauer, 1974). These features are naturally occurring at locations where rock exists, such as the toe of coastal cliffs and at the mouths of creeks and rivers, and are often covered by sand some or most of the time. These features have been installed by man as a component of restoring beach morphology and ecology, and also for erosion and flood mitigation. When installed as a erosion control structure where they wouldn't otherwise exist, cobble berms are often called dynamic revetments. The term "dynamic revetment" is intended to hearken to a traditional revetment of rough, angular quarry stone that has the appearance of an engineered rock slope, like a breakwater. The term "dynamic" is intended to contrast with traditional quarry stone revetments and convey that the smaller, rounded rock (cobble) is expected to move in response to wave action. At Ocean Beach, San Francisco, the term dynamic revetment is probably more applicable. This is because the cobble berm would be introduced – cobble deposits are not known to exist at Ocean Beach.

Examples

Cobble berms and dynamic revetments have been constructed in several locations.

- Cape Lookout Oregon: A dynamic revetment was installed at Cape Lookout State Park (CLSP), Oregon, in 2000 (Allan and Komar, 2004; Allan et al., 2005; Allan et al., 2006; Allan and Hart, 2007). Allen and Komar (2004) described the design of the cobble berm, backed by artificial sand dunes, and report success in accomplishing the goal to minimize overtopping events and erosion problems at the park. The cobble berm was placed in the back of the beach with a seaward slope of 5:1 (H:V) with artificial dunes located directly behind the berm (Figure 5). Monitoring efforts have demonstrated that seasonal variations in the level of sand significantly affect the activity and transport of cobble and gravel. In the summer, when moderately gentle surf deposits sand on the beach face, the gravel-sand intercept increases and covers the larger size sediment, inhibiting the movement of cobble and gravel. In contrast, during winter months when large waves remove sand from the beach and expose underlying cobble and gravel, significant cross-shore and along-shore transport of gravel and cobble is evident. We have heard but not verified that some damage may have occurred recently (winter 2011-12).

Figure 5: Cape Lookout Cobble Berm. Source: Allan et al, 2005.

- Pacifica state beach: Pacifica State Beach is located in Pacifica, CA, just south of San Francisco. The project is an often-referenced example of managed shore retreat and realignment (NOAA, 2007a). Cobble berm and beach nourishment (cobble and sand placement) were proposed as part of a design for the Pacifica State Beach Enhancement (PWA, 2005). Funding was not sufficient to import cobble to "recharge" the degraded cobble berm (Figure 6). There was some grading of cobble after removal of fill and structures, in particular at the mouth of the restored San Pedro Creek. Figure 7 shows the cobble sill at the restored mouth of San Pedro Creek.

Figure 6: Pacifica State Beach. Photograph April 15, 2005, Courtesy, City of Pacifica.

Figure 7: Picture of Cobble berms at Pacifica State Beach before the restoration project. Note the "double berm" which implies landward motion of the lower cobble berm. The house in the background was purchased by the State and demolished. San Pedro Creek mouth is on the far side of the next house, which was also demolished. Photograph © Bob Battalio, taken March 9 2002.

Figure 8: Picture of San Pedro Creek Mouth with cobble sill. Photograph © Bob Battalio, taken December 20, 2011.

- Surfers point: Surfers Point is project with erosion mitigation and managed retreat objectives at the mouth of the Ventura River, California (NOAA, 2007b). The project entails removal of fill and pavement, and placement of cobble and sand to restore the back beach for public recreation, ecology, and storm damage reduction. Cobble underlays the entire area owing to its location at the mouth of the Ventura River. Therefore, cobble placement was considered restoration of the disturbed backshore. The project was designed using a reference site from a less disturbed shore on the other side of the river mouth at Emma Wood State Beach, as well as consideration of the available design guidance and analysis of water levels, waves and runup (PWA, 2005). Figure 9 is a picture of the reference site, showing the cobble berm and the dunes and wetlands behind it. The water side (beach restoration, cobble and sand placement) was designed by PWA and Phase 1 was constructed in 2010-2011. PWA is presently monitoring the project. Figure 10 is a picture of the constructed portion (Phase 1).

Figure 9 Emma Wood reference site for Surfers Point. This reference site is on the west side of the Ventura River Mouth, and the Surfers Point site is on the east side. The dead trees are casualties of coastal erosion, as the shore, with cobble berm, migrates landward. Source: PWA, 2005.

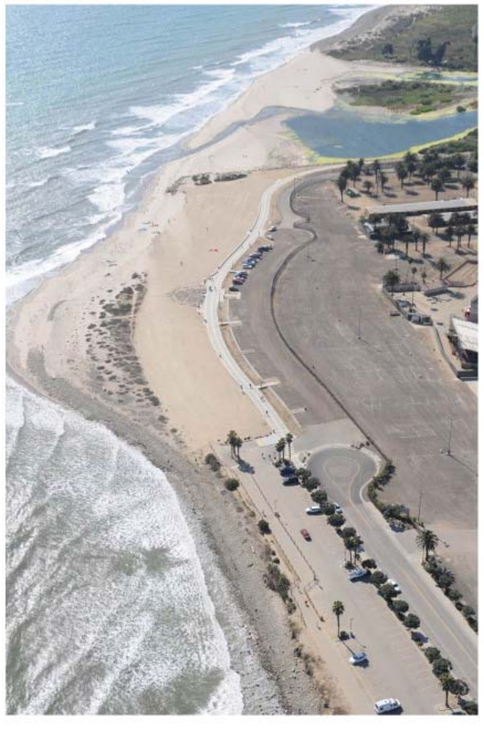

Figure 10 Surfer s Beach post construction phase 1. The new cobble berm is buried beneath the sand. Cobble is exposed along the shore. Phase 2 will include the renovation of the shore in the forefront of the photograph. Photograph courtesy of the City of San Buenaventura and Rasmussen (construction contractor), taken fall, 2011.

- Puget Sound: There are many gravel and some cobble beaches along the shore of Puget Sound. Several projects have been pursued, resulting in several documents addressing the overall concept and design of shore form enhancements (ESA, 2010), and cobble – gravel berms in particular (ESA PWA, 2010). An example of a constructed gravel-cobble system is at Birch Bay, Whatcom County (CGS, 2004). This project entailed a shore section as a demonstration project, to test the concept developed by Bauer (1974) for the remainder of the shore. The project was constructed in 1986 and has been re-nourished with sediments ten times since then. Figure 11 shows the site from a monitoring report (CGS, 2004). Figure 12 shows a proposed enhancement for the adjacent shore (PWA, 2002; 2007)

Figure 1. Oblique aerial photo mosaic of the study site, located immediately left (north) of the mouth of Terrill Creek (at right). Photos taken May 24, 2001 for WA Dept. of Ecology.

Figure 11: Birch Bay Demonstration Project: Source: CGS, 2004.

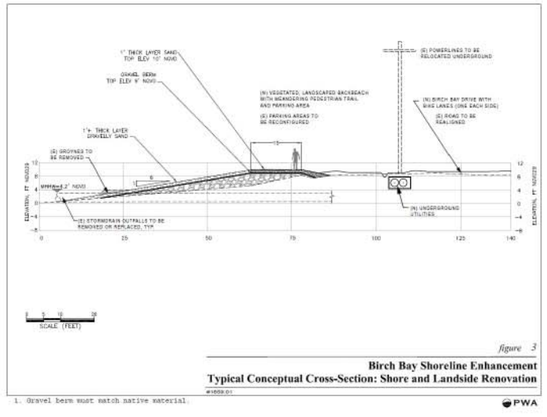

Figure 12: Birch Bay Typical Section, showing conceptual design cross-section of new gravel-cobble berm with sand cover. Source: PWA, 2007.

Description of Behavior and Design Considerations:

Cobble berms (aka Dynamic Revetments) respond differently to waves than shores comprised of smaller sediments and engineering structures composed of large quarry stone boulders.

Function – Berm morphology and processes

Cobble berms exist because of the natural sorting of wave runup processes. The momentum of breaking waves results in wave runup and rundown on a beach. The runup will entrain and transport sediment landward and the following rundown carries sediment seaward. The extent that sediment is moved depends also on the sediment size, density and distribution of sediment, among other factors. Sand tends to have a net movement landward during gentle surge induced by low-steepness waves (typical of summer conditions in California), and move offshore in storm waves which are steep and very energetic. Large sediments such as gravels and cobbles react differently than sand because of their size. Larger particles settle more rapidly and can stand on a steeper slope, but also respond disproportionately to acceleration versus drag. Hence, cobble tends to move onshore under the abrupt wave runup but tends to not move as far offshore under the longer duration but slower wave rundown. Therefore, relative to sand, cobble tends to move onshore during large wave events while sand tends to move offshore more often. This results in a typical winter-time sorting and exposure of cobble and gravel underlying beaches that are sandy in the summer time.

Cobble and gravel berms tend to have a larger voids and hence dissipate the extent of wave runup and rundown. However, the morphology of coarse sediment beaches results in overtopping that can be extensive during extreme conditions. Hence, cobble berms in their natural configuration are not complete barriers to wave runup and erosion. In fact, most natural cobble shores include driftwood and other wrack on the crest of the berm.

Gravel and cobble also move along shore under oblique wave action but the transport is also different than sand. In generally, the along shore transport is less rapid than sand and not as uniform.

Cobble and gravel berms processes are not manifested unless the deposits are large enough to interact and respond to wave runup as a mass. Therefore, designs typically include a minimum thickness, extent and volume. Also, if the voids are filled with sand, the cobble will tend to react to storm wave similar to sand until the sand is sorted out and the high porosity of a cobble deposit can interact with the waves and affect cobble movement.

Function – public access

A dynamic revetment / gravel -cobble berm can be traversed on foot more easily than a quarry stone revetment or a vertical seawall. The mass of rock will also reduce and adjust to scour that occurs when wave action reaches a wall or cliff.

Function – Lake Merced Outlet and Lagoon Sill

Cobble deposits are often found at river and creek mouths. The discharge from the rivers and creeks degrades the elevation of the cobble berm that forms under wave action alone, resulting in a lowering of the berm elevation in the vicinity of the mouth and specifically in the channel(s). However, the cobble tends to reduce down-cutting, thereby acting as a weir or sill. Therefore, the low point in the channel and the elevation of the water upstream are typically higher where a cobble deposit exists in comparison to a stream mouths on sandy shores without cobble. This function of a cobble sill will be beneficial for a restored mouth of Lake Merced, in order to inhibit wave overtopping and salt water intrusion, and provide a hydraulic control for a lagoon-like feature. This feature would be ephemeral, and filled with sand during low rainfall conditions. Profile 2 in Figure 2 is a schematic of the Lake Merced discharge and coastal lagoon feature. This type of managed system will not provide full ecological benefits and is not sustainable over the long term without intervention. Future restoration, if it occurs, that removes development from the flood plain and allows higher water levels in Lake Merced would not require a cobble sill to inhibit salt water intrusion and pumping would not be needed.

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memorandum

date January 20, 2012

to Ben Grant (SPUR)

from Louis White, PE

subject Ocean Beach Master Plan: Extreme Wave Runup Results

Introduction

ESA PWA is assisting the San Francisco Planning and Urban Research group (SPUR) to develop the Ocean Beach Master Plan (OBMP). The OBMP is intended to recommend strategies for managing the coastal resources in the face of sea level rise and effects of climate change. ESA PWA estimated the limits of extreme wave runup for existing and future conditions as part of the analysis of the coastal physical dynamics. This memorandum is intended to summarize the results and document the methodology used in estimates of the extreme wave runup limits as part of the OBMP. The work described in this memorandum was accomplished by Louis White and To van Dang with oversight by Bob Battalio.

Wave Runup Model

Wave runup was modeled using a program developed by PWA. The program uses several published methods to assess the extent of wave runup on beaches and shores with irregular topography and surface conditions. Wave runup is computed using the method of Hunt (1959) which is based on the Irrabarren number (also called the Surf Similarity Parameter), a non-dimensional ratio of shore steepness relative to wave steepness. The program also uses the Direct Integration Method (DIM) to estimate the static and dynamic wave setup and resulting water surface profile (FEMA 2005; Dean and Bender 2006; Stockdon 2006). The methodology is consistent with the FEMA Guidelines for Pacific Coastal Flood Studies for barrier shores, where wave setup from larger waves breaking farther offshore, and wave runup directly on barriers combine to form the highest total water level and define the flood risk (FEMA 2005). This program also incorporates surface roughness which acts as friction on the uprush of the waves and uses a composite slope technique as outlined in the Shore Protection Manual (USACE 1984) and Coastal Engineering Manual (USACE 2002).

Four cross-shore profiles were used to estimate the wave runup along Ocean Beach: Profile A was located south of Sloat Boulevard; Profile B was located near Rivera Street; Profile C was located near Moraga Street; and Profile D was located at the western end of Golden Gate Park. The existing profiles were based on nearshore bathymetry and beach surveys collected by the USGS in January 2010, and LIDAR flown in 1998 that was collected by NOAA. Profiles for future scenarios in year 2100 were modified based on assumptions of the rate of sea level rise, shore erosion and accretion due to sand budget, and other management treatments as determined by the SPUR working group. This resulted in future profiles differing substantially from existing profiles. First, continuation of erosion in the southern profiles (A, B and C) and accretion in the northern profile (D) was projected. Second, the transgression of the shore in response to sea level rise was modeled as an upward and inward transgression. Third, the effects of management actions were added in terms of widening from sand placement and armoring to prevent erosion.

The still water level (SWL) elevation for existing conditions was assumed to be 9 feet NAVD[1], which is about 2 feet above an astronomic high tide with an annual recurrence, and about 3 feet above the mean higher high water tidal elevation. For future conditions with sea level rise, the SWL was assumed to be 13 feet NAVD. These water levels are rounded to the nearest whole foot in elevation relative to NAVD for simplicity and in recognition of the large uncertainty in wave runup and future conditions.

Four offshore wave conditions representative of an event with a 100-year recurrence interval were selected based on other studies and professional judgment (Table 1). The four wave scenarios used as input to wave runup calculations were characterized by offshore significant wave height in feet and the wave period in seconds. The wave conditions for existing and future conditions were assumed to be the same.

Table 1. Offshore wave conditions representative of a 100-year event.

Wave height, H (feet)	Wave Period, T (s)
36	13
32	17
28	21
24	25

Results

Maximum values of wave runup heights typically exceeded the height of the fronting dune or seawall at the 100-year recurrence, which indicates that overtopping will occur. The wave runup analysis was accomplished to ascertain both the potential elevation of wave runup on the Great Highway embankment and the landward extent of wave runup that overtops the embankment. The primary difference in runup with the scenarios was seen in the elevations at the roadway barrier: The retreat scenarios resulted in lower elevations at the barrier because it was located farther landward (retreat), while the "hold the line" scenarios (Max Infrastructure and Max Recreation) resulted in much higher runup elevations over time as the shore seaward of the armoring erodes and recedes. There was not much difference in the inland extent of runup predicted for the different scenarios. These results follow from the fundamental physics of wave runup: The momentum of wave runup is dissipated by friction and turbulence with inland travel and by gravitational acceleration with vertical travel. Therefore, barriers that impede inland travel will result in the highest potential runup elevation and low, overtopped profiles will result in the farthest inland propagation.

Maximum Runup Elevation at Great Highway: Existing elevations of the dunes and seawalls for the four locations along Ocean Beach generally range between 25 and 30 feet NAVD. Maximum wave runup elevations for existing conditions were typically estimated to be between 24 and 42 feet NAVD, up to approximately 10 feet above the existing elevation at the Great Highway at some locations. The potential wave runup elevations are much higher for future conditions, where the elevation was estimated to range between 30 feet NAVD and over 60 feet NAVD for some cases. Typically, the future wave runup exceeded the existing wave runup on the order of 10 to 50 feet. These high values are theoretical projections above the high point (e.g. the top of a seawall), and provide an estimate of the potential energy rather than the height that would actually occur: In reality, runup above a barrier becomes a mass of water flowing inland and dissipates via turbulence and surface friction rather than elevation. The main point is that the wave runup during an extreme event exceeds the elevation of the existing dunes and seawall , and by 2100 will exceed elevations of structures or barriers that might be considered

[1] NAVD refers to the North American Vertical Datum of 1988.

for future conditions. Difficulties in increasing the elevations of the Great Highway and / or other barriers along the beach is expected for several reasons, including concerns related to high cost of maintaining infrastructure, habitat impacts, decrease in recreational value, and visual impacts on existing properties. In other words, the increased wave runup elevations are substantially higher than the Great Highway and it probably isn't publically acceptable to raise the roadway to an elevation necessary to prevent increased flood and damage risk.

Maximum Inland Extent of Wave Runup: Allowance of some amount of overtopping behind the Great Highway shifts the solution to the problem from one of height at the existing "barrier," to one of planning for extreme overtopping and flooding referred to here as the "inland extent" of runup. The inland extent of the wave runup was measured for each profile relative to the location of the existing 0 feet NAVD contour. Table 2 presents the inland extents and ground elevations and the inland extent of the wave runup for existing and future conditions at each profile.

Table 2. Inland extent of wave runup for existing and future conditions.

Profile	Existing Conditions		Future Conditions		Difference	
	Inland Extent from 0 feet NAVD Contour (feet)	Ground Elevation at Inland Extent (feet NAVD)	Inland Extent from 0 feet NAVD Contour (feet)	Ground Elevation at Inland Extent (feet NAVD)	Inland Extent from 0 feet NAVD Contour (feet)	Ground Elevation at Inland Extent (feet NAVD)
A	475	16.9	780	18.2	305	1.3
B	494	31.2	872	26.9	378	-4.3
C	422	35.4	883	26.7	461	-8.7
D	746	26.0	912	27.0	166	1.0

Figure 1 presents a graphical map of the approximate wave runup limits from extreme coastal flooding events for existing and future conditions. The limits of the wave runup shown in the figure are similar to the limits of coastal erosion presented by the Pacific Institute (2009) in a study of potential impacts of sea level rise on the California Coast (Heberger et al. 2011; Revell et al. 2011): See Figures 2 and 3. However, the flood mapping developed in the Pacific Institute study did not account for dissipation by inland propagation, and over-predicts the coastal flood extents (Figure 3). The results shown by the Pacific Institute (2009) is based on work performed by PWA (2009) in a supporting study to determine erosion and flood hazard zones due to sea-level rise along the coast of California from California to Santa Barbara. Furthermore, the flood mapping shown in Figure 3 was also used in recent FEMA preliminary coastal flood mapping (see Figure 4). We consider the wave runup limits presented here to be superior to previous estimates of coastal flooding and erosion including those available via the Pacific Institute and FEMA.

While these maps are the best available mapping of coastal flood hazards, they are still approximate and not intended to assess property values, insurance rates or development potential. Any use of the information presented here except for the Ocean Beach Master Plan is at the user's sole risk and is not authorized by ESA PWA.

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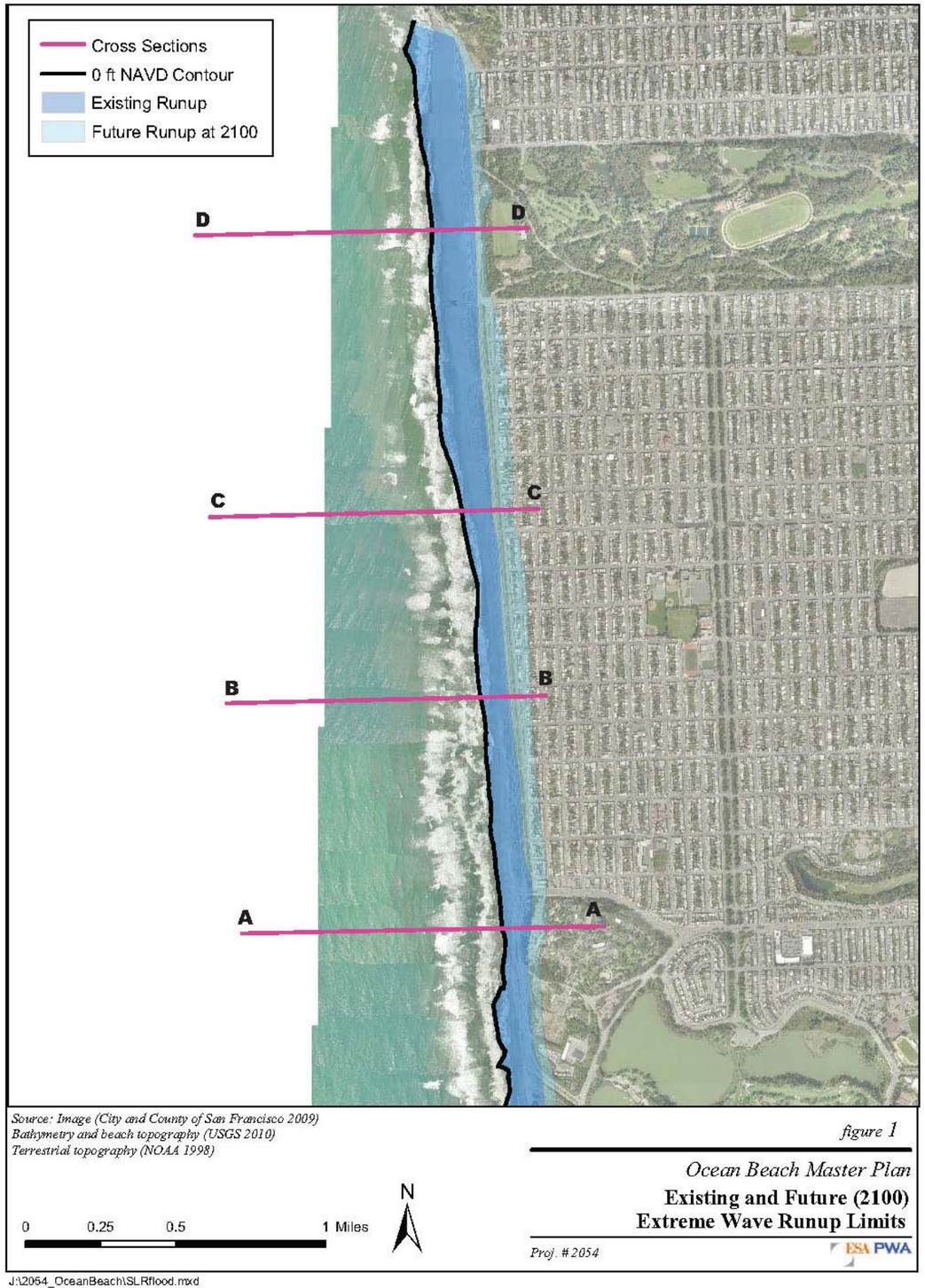

Figure 2. Bluff and dune erosion hazard zones predicted with 4.6 feet of sea level rise (after Pacific Institute 2009).

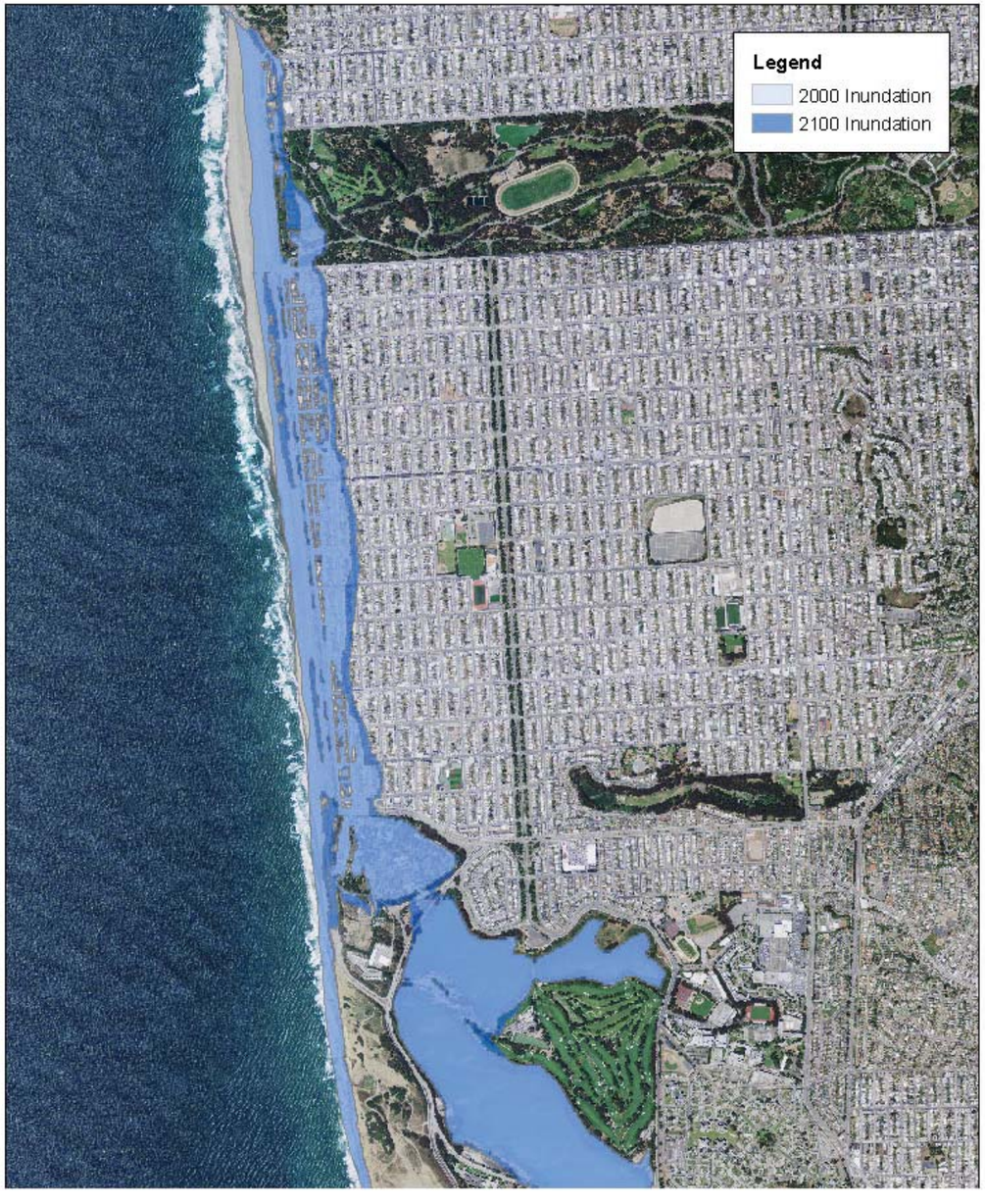

Figure 3. Areas of coastal flooding with 4.6 feet of sea level rise (after Pacific Institute 2009).

Figure 4. Preliminary FEMA flood map (source: Baker-AECOM).

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memorandum

date May 27 2011 – revised Oct 14 2011

to Phil King, Ph.D, VooDoo Economist

from Bob Battalio, PE, Defier of the Edifice

copy Ben SPUR
Alma Du Patricia EDAW

subject UPDATE FOR SCENARIO E – HYBRID PUC SCENARIO
Scenario Analysis – Coastal Costs
Ocean Beach Master Plan
ESA PWA #2054

UPDATE October 2011: This memorandum was updated to include a new, hybrid scenario herein called SCENARIO E – HYBRID PUC. This scenario includes elements from the other scenarios, but maintains PUC infrastructure in place at least through 2040, while keeping options open for subsequent changes to carry through 2100. The overall concept is managed retreat, with retreat for sewage infrastructure delayed until 2040 or beyond owing to the PUC's need to have time to plan for future conditions, and to get more years of service from their existing facilities.

Per discussions with you and Ben, here is an explanation of the revised beach and dune widths, and descriptions of coastal actions.

Revisions to Scenarios: I revised the scenario modeling to better represent the intent of the scenario descriptions. This was done based on a discussion with Ben. Basically, we revised scenario modeling:

1. Middle Ocean Beach: Beach nourishment is included with B. Max Recreation and D. Max Infrastructure, but not with the others.
2. Middle Ocean Beach: The sewer box is either relocated (A. Max Habitat) or left in place and modified to be a seawall (all the others, ***including E. Hybrid PUC***). ***The Sewer Box Sewall Modification includes reconstructing the UGH to about elevation +40' NAVD which is about 10' higher than it is now.***
3. South Ocean Beach: I modified the beach nourishment as follows:
   A. Max Habitat: 50' beach and 50' barrier dune every 20 years
   B. Max Rec: 50' beach and 50' barrier dune every 20 years
   C. Green Infrastructure: 50' beach and 50' barrier dune every 20 years
   D. Max Infrastructure: 50' beach and 50' barrier dune every 20 years, plus additional 300,000 cyy to maintain some beach in winter seaward of existing bluff.
   E. Hybrid PUC: 50' beach and 50' barrier dune every 20 years .

Erosion Management for Scenarios: Here are descriptions of the erosion management for each scenario over time:

A. Max Habitat: Shore retreat and realignment are emphasized. In SOB, sand placement is accomplished to widen the beach and sacrificial sand berm, and armor and fill removal are accomplished to provide room for a more natural shore. Dune construction is accomplished in MOB and NOB.

South Ocean Beach (SOB)

- Year 2020: Remove about 260,000 cubic yards (cy) of rubble and dispose for about $35/cy or about $9M. Add sand to widen the beach and barrier dune 50' each (100' total) using about 560,000 cy @ $20/cy totaling about $11m. These two items cost about $20M.
- Year 2040: Remove more rubble and earth fill totaling about $2M. Place another $11M worth of sand.
- Years 2060, 2080, 2100: Each another $11M for sand.

Middle Ocean Beach (MOB)

- No sand placement for beach – retreat.
- Remove box culvert year 2070.
- Build dunes: Assume an average dune field depth of about 370', over a length of 10,300', which amounts to about 3.8M square feet. Based on a sand thickness of about 15' and a total cost of about $30/cy, I suggest using about $26/sf. For 3.8M sf, you get about $100M. This should cover purchase, transport, placement, planting, etc. This is very rough, so lets look at it as an allowance or budget for building a dune field that is several hundred feet wide along MOB.
- Relocate road, buy property, etc. form others.

B. Max Recreation: A mix of retreat, nourishment and armoring. In SOB, retreat is limited in order to maintain a public corridor in front of the sewer plant, initially with sand placement and ultimately with an offshore surfing reef system. In MOB, there is some retreat and reconfiguration but beach nourishment is emphasized.

South Ocean Beach (SOB)

- Year 2020: Same as A Max Habitat.
- Year 2040: Same as A Max Habitat
- Years 2060, 2080, 2090: Same as A Max Habitat (three placements of $11M). Also, add offshore rock reefs as sand retention structures (low crested breakwaters): Estimate about $40M for the one kilometer reach.

Middle Ocean Beach (MOB)

- Sand placement to maintain beach. Assume 50' beach and 50' dune widening every 20 years amounting to about to about 1.5M cy. Assume $20/cy for a cost of $30M every 20 years.
- Year 2070 the box culvert is modified to be a seawall.
- Year 2070 the road is setback an additional 50' and converted to dunes (behind the seawall).
- Other costs by others.

C. Green Infrastructure: Retreat until the shore reaches "immoveable" infrastructure, while losing beach and dunes in SOB and MOB. Sand placement and retreat in SOB until need to armor sewer treatment plant.

South Ocean Beach (SOB)

- Year 2020: Same as A Max Habitat.
- Year 2040: Same as A Max Habitat
- Years 2060, 2080, 2090: Same as A Max Habitat (three placements of $11M). Also, add seawall / revetment in front of sewer treatment plant: Assume about 2,000 linear feet @ $10,000 / lf = $20M.

Middle Ocean Beach (MOB)

- Dunes and beaches mostly lost by 2070.
- Year 2070 the box culvert is modified to be a seawall.
- Other costs by others.

D. Max Infrastructure: Holding the line with armor and extensive sand placement.

South Ocean Beach (SOB)

- The entire reach is armored: Assume 3,600 LF @ $10,000 / lf = $36M.
- Sand placement the same as others ($11M every 20 years).
- Plus additional sand placement to maintain some winter beach in front of armor (which is at existing bluff location, +/-), amounting to an additional sand placement of 300,000 cy / yr @ $20/cy = $600,000/ year (this can be modeled as $1.2M every 2 years). This excess sand placement stops once the breakwaters are constructed in 2070.
- An offshore breakwater field is constructed in year 2070. The cost is estimated to be about $40M.

Middle Ocean Beach (MOB)

- Sand placement to maintain beach. Assume 50' beach and 50' dune widening every 20 years amounting to about to about 1.5M cy. Assume $20/cy for a cost of $30M every 20 years.
- Year 2070 the box culvert is modified to be a seawall.
- Year 2070 the road is setback an additional 50' and converted to dunes (behind the seawall).
- Other costs by others.

E. Hybrid PUC: A mix of retreat, nourishment and armoring. In SOB, retreat is limited in order to maintain a public corridor in front of the sewer plant, initially with sand placement and ultimately with a multi-terraced-armor concept. The first "hard line" is a low armoring for the Lake Merced Tunnel that can be overtopped by waves. The second hard line is a seawall to protect the sewer plant and potentially northward to the Fleishhhaker Building. In MOB, there is some retreat and reconfiguration but beach nourishment is emphasized.

South Ocean Beach (SOB)

- ***Year 2020: Same as A Max Habitat.***
- ***Year 2040: Same as A Max Habitat.***
- ***Year 2050, add 2,600 LF of seawall to protect the sewer treatment plant, pipes between plant and pump station, and Fleishhaker building). Assume about 2,600 linear feet @ $10,000 / lf = $26M.***
- ***Years 2060, 2080, 2090: (three placements of $11M).***

Middle Ocean Beach (MOB)

- ***Sand placement to maintain beach. Assume 50' beach and 50' dune widening every 20 years amounting to about to about 1.5M cy. Assume $20/cy for a cost of $30M every 20 years.***
- ***Year 2070 the box culvert is modified to be a seawall.***
- ***Year 2070 the road is setback an additional 50' and converted to dunes (behind the seawall).***
- ***Other costs by others.***

END

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Memorandum – draft

date May 13 2011, revised January 20, 2012

to Ben Grant, SPUR

from Bob Battalio, PE
Phil King, Ph.D,

subject Scenario Analysis – Coastal
Ocean Beach Master Plan
ESA PWA #2054

The Spur team has developed scenarios to inform the Ocean Beach Master Plan. ESA PWA (PWA) and Phil King (King) will analyze the coastal conditions for each scenario. This memorandum describes the analysis methodology.

Analysis Methodology Overview

PWA will estimate the change in beach and dune widths over time, and the width where key triggers occur (triggers are thresholds of damage or action). King will translate this input to costs (e.g., infrastructure loss, nourishment costs) and benefits (e.g., recreational benefits) over time. The estimated costs and benefits will be used by SPUR and team in the evaluation of the scenarios.

PWA will estimate coastal change by translating representative shore profiles based on estimated shore change rates, and transgressing shore profiles landward and up in response to sea level rise. Where profiles intersect shore protection and other substantial structures, the landward migration will be halted and the profile modified to include the exposed structure. When other less substantial structures are encroached upon, damages will be triggered. Beach nourishment will be accommodated as a seaward translation of the profile.

PWA will extract the beach and dune widths from the profiles, and tabulate as output to King's analysis of ecological and recreational benefits. King will identify the time frames at which damage and action triggers are achieved, based on when the profiles encroach upon particular features and locations.

The PWA output will be profiles, beach and dune widths, encroachment into developed areas, and the estimated width for triggers. King output will be tabulated costs and benefits and time of trigger. In general, infrastructure triggers and responses have been developed with the SF PUC and DPW: At the time of this memorandum, we anticipate further attention will be required to attain or estimate all the infrastructure related parameters. Ecological criteria have been discussed with the National Park Service, GGNRA. The ecological criteria are less well defined and the methodology for valuing ecological conditions requires further attention. The recreational valuations will be developed using methods previously used by King, with local data.

In addition to the profile analysis discussed above, PWA will also calculate the landward extent of wave runup during an extreme event approximating a recurrence frequency of 1% per year (i.e. the 100-year runup event). The limits of runup will provide a sense of coastal flooding potential landward of the coastal dunes and bluffs. These data may be used to estimate potential flood damages or used as a qualitative estimate of damage hazard.

Scenarios

Scenarios have been developed by the SPUR Team with input from the Management and Advisory Committees. These are described in documents produced by AECOM, attached (110506-Scenarios Board-PAC mtg.pdf and 110509-Evaluation Criteria - revisions mtg.pdf). The scenarios have different responses at different triggers, which will result in different outcomes. There are four scenarios:

A. Maximum Habitat;
B. Maximum Recreation;
C. Maximum Green Infrastructure;
D. Maximum Infrastructure.

The scenarios include treatments at four time periods:

+ 0 Years (2010);
+ 20 years (2030);
+ 40 years (2050);
+ 90 years (2100).

The scenarios are divided into three shore reaches (Figure 1):

A. North Ocean Beach (NOB) from Point Lobos-Cliff House south to Lincoln Boulevard;
B. Middle Ocean Beach (MOB) from Lincoln Boulevard to Sloat Boulevard;
C. South Ocean Beach (SOB) from Sloat Boulevard to Fort Funston.

The above results in approximately 48 permutations (four scenarios x four time periods x three reaches).

Profiles

Profiles are constructed from survey data collected in January 2010 and provided by the USGS, and lidar collected by NOAA in April, 1998, and downloaded and converted to topographic contours. The profiles were therefore constructed from three data sets with different collection methods:

A. Offshore bathymetry (fathometer and kinematic GPS surveys from jet skis);
B. Beach topography (kinematic GPS from ATVs);
C. Airborne lidar remote sensing.

PWA compiled the data into one digital file. The lidar and beach survey data diverged due to the different dates (2010 and 1998), requiring interpolation between the end of the USGS beach survey and a selected point on the lidar.

Profiles were selected to represent each of the three reaches:

A. Golden Gate Park – NOB;
B. Moraga – MOB, with dune backshore;
C. Rivera – MOB, with seawall backshore;
D. North Parking Lot, south end – SOB.

Beach widths will be calculated from the Mean Higher High Water (MHHW) elevation (i.e., "dry beach"), rounded to +6' NAVD, to the back beach. The back beach is defined as the junction with the toe of a dune, bluff or structure. These profiles are considered to represent winter beach conditions, and useful to indentify when the receding shore will impact landside development. However, the recreational and ecological values are better attributed to yearly average beach conditions, which are wider than typical in the winter. The average beach width is approximated as the beach width indicated in the profiles plus an average seasonal change as follows:

A. NOB - 150' (Reaches 9A and 9B);
B. MOB Moraga – 100' (Dune-backed Reaches 3,4,5,7 and 8);
C. MOB Rivera – 100' (Seawall-backed Reach 6);
D. SOB – 50' (Reaches 1 and 2).

The above were derived from Table 3.1-3 Summary of Analysis for Shoreline Change (M&N, 1995) by averaging the seasonal width changes for the shore reaches indicated. The averages were rounded to the nearest 50'.

Dune widths will be calculated as the distance between the beach and development. For each profile, an average value will be used for the shore reach it represents.

Profile Translation

Profiles will be translated using a shore movement rate (accretion is seaward and erosion is landward), and a response to sea level rise as follows:

Shore horizontal translation = (Shore Movement Rate) * (time) - Seal Level Rise recession;
Shore vertical translation = Sea Level Rise.

Shore movement rate

The shore movement rate is estimated using judgment, consistent with limited funding available for our analysis as well as the author's extensive experience with the topic. Table 1 summarizes the basis for the estimates.

The data used are based on careful analysis of maps and aerial photographs from 1929 to 1995 produced under the author's supervision (M&N, 1995; 1994; Battalio and Trivedi, 1996). The rates for the ten shore reaches (1-9B) are tabulated and averaged for the four profile and three shore reaches used in this study. These averaged rates are listed in Table 1 in the column labeled "averages." These averages are not the selected values because we anticipate different conditions going forward resulting in future rates that are different than historic rates. The recent more eroded conditions and trends discussed in the Ocean Beach Littoral Congress indicates that Ocean Beach will likely be more erosional in the future (ESA PWA, 2011 in press). The implication is that Ocean Beach is expected to become more "erosional" due to reduced sediment supply and geomorphic changes. The selected more erosional rates for application in this study are in Table 1, and described below.

Table 1: Selection of Shore Movement Rates

Reaches, Master Plan	Reaches, Analysis[1]	Linear Trend (feet / year)[1]	Averages (feet / year)[2]		Selected (feet / year)	Comment
	9A	-3				
A. NOB	9B	+5	+2		+1	Expect accretion rate to slow due to saturation of fillet and reduction of sand supply
	8	+2				
B. MOB Moraga	7	0	+1.6	+1.2	-1	Expect change to erosion due to reduction in sand supply
C. MOB Rivera	6	-1	-1	+1.2	-1	Expect change to erosion due to reduction in sand supply and shore rotation associated with bar shrinkage
	5	+3				
	4	+2				
	3	+1				
D. SOB North Lot	2	+1	0		-1	Use Fort Funston bluff recession rate as long term control.
	1	-1				

1. Source: M&N, 1995.
2. Average by reach (not length).

The Littoral Congress participants noted the more eroded shore conditions that have existing since the 1997-1998 El Nino winter. Battalio and Bromirski noted the possibility that these eroded conditions may have some relationship to the Pacific Decadal Oscillation (Figure 2). Figure 2 indicates that OB may be in an erosional phase and an accretionary period may occur in the near term. However, this possibility is not emphasized given the high level of uncertainty in climate at the present time. Moreover, recent analysis indicates that sea level rise may accelerate in the very near term on the Pacific Coast as it "catches up" with global trends (Bromirski et al, 2011). In summary, it is difficult to predict the effect of climate on erosion rates, with the exception of sea level rise (discussed later).

The USGS have postulated that the radial "shrinking" of the SF Bar planform is resulting in a counter-clockwise rotation of the shore, with accretion at the north end transitioning to erosion south of Noriega Street and increasing southward, indicating increased erosion rates in MOB and SOB. Battalio and Trivedi postulate that the reduction in dredged sand discharge onto the SF Bar would diminish onshore transport and sand supply, thereby reducing the supply to MOB and NOB. Battalio concludes that a reduction in dredged sand supply is likely due to:

(1) reduction in dredging rate is demonstrated in the dredging records, primarily due to the lack of channel deepening and widening since the 1970s and reduced sedimentation rates as the side slopes of the channel reach equilibrium and deposition becomes dominated by only ebb tidal currents;
(2) the sand placement has not been on the bar for about 5 years (Barnard, et. al, 2009), and rather has been placed offshore of SOB, and hence not available to MOB and NOB; the effect of changed dredging practice will eventually result in decreasing onshore sand transport if it hasn't already; and,
(3) Sea level rise will reduce the required dredge depth.

In addition, the USGS notes that the grain size of dredged sands is significantly smaller than the native beach sands, and hence the effectiveness of beach nourishment is expected to diminish. The above discussion leads to a more erosional condition at all shore reaches.

While NOB has accreted, this accretion has been attributed to dredging practice between the early 1970s to 2005, which increased sand supply to the MOB and NOB (M&N, 1995; Battalio and Trivedi, 1996). While other explanations have been provided (i.e.bar rotation (Hansen and Barnard, 2010), climatic fluctuations (Battalio)), the evidence of linkage between the SF Bar and OB via onshore sand transport and dredging is too strong to dismiss (Hanes, et. al, 2011). This indicates that reduced dredging will eventually translate into reduced accretion and possibly erosion. Secondly, the widening of NOB is attributed partly to the groin-effect of Point Lobos. Therefore, there is a maximum amount of accretion that can be anticipated in this fillet plan form, indicating that the rate of accretion should slow.

Hansen and Barnard (2010) measured changes from 2004-2009 and found MOB to be eroding (except from Lincoln to Noriega which was relatively stable) at a rate of over 2 m/yr +/- 2m yr

Battalio notes that the Funston Bluffs form a control on shore position south of the SF Bar (generally south of Sloat Blvd.), and hence the historic rate of erosion at Reach 1 is considered more indicative of the future natural rate of erosion in the SOB area. Therefore, and erosion rate of -1 fpy is estimated for SOB. For comparison, the stretch of coastline immediately surrounding the Daly City Outfall site, to the south of SOB in Fort Funston, appears to exhibit a long-term erosion rate on the order of 1.3-1.6 ft/yr (Hapke et. al, 2006), although much of this erosion presumably occurs in the form of episodic slumps and landslides. In addition, for those scenarios where armor is removed, the northern part of SOB will likely adjust with a limited but rapid recession before taking a more uniform rate: An initial recession of 40 feet is estimated based on the geometry of the existing planform and specifically the location of the bluffs and dunes to the north and south.

With the erosion rate in SOB estimated to be -1fpy, the historic rates in MOB of between -1 to +1.6 fpy (se averages in Table 1) are too accretionary, and an erosion rate of -1 fpy is selected for this study. Similarly, the historic average rate of accretion in NOB of +2 fpy is reduced to +1 fpy for this study. While somewhat arbitrary (obviously different rates could be "selected"), these are the only estimates of future erosion available for Ocean Beach. For comparison, the rates selected here are generally consistent with the "short term" erosion rates of Hapke et al (2006), except for SOB where greater erosion rates were documented. The pattern (accretion / stability in the north and erosion in the south) is also generally consistent with Hansen and Barnard (2010) but their short term rates (2004-2009) are higher.

Response to Sea Level Rise

Sea level rise estimates will follow the interim state guidance (OPC, 2010):

+ 14" 2050 (+40 years);
+ 55" 2100 (+90 years).

Shore response is presumed to be transgression, which is the "rollover" of the shore face to the higher sea level and higher elevation of wave action. The response is estimated generally following the "Bruun Rule" with the shore recession estimated to be the sea level rise divided by the overall slope of the profile. The overall slope of the profile is calculated as the shore face height divided by the shore face width. A slope of 1:60 (horizontal:vertical) is selected based on historic profiles (Figure 2). This results in the following changes:

+ 40 years, 70 feet of recession and 1.2 feet (14") of shore rise;
+ 90 years, 275 feet of recession and 4.6 feet of shore rise.

Nourishment

Beach nourishment is the act of placing sand to widen the beach. Beach nourishment has occurred frequently at Ocean beach. In the scenarios, beach nourishment is included in SOB and MOB.

Beach nourishment in SOB will be included consistent with the intentions of the USACE and CCSF to beneficially reuse sand dredged from the Bar Channel to widen the beach. The dimensions and performance of this sand placement will be developed from information provided by the USACE and or CCSF, or will be estimated by ESA PWA if no information is provided (a report exists but has not been provided).

Beach nourishment in MOB will be estimated by ESA PWA based on a review of prior studies, as discussed in the Littoral Congress (ESA PWA 2011). It is assumed that the conversion between volume and area is about 2.0 cy/sf of beach and dune. This is based on 1.3 cy/sf for the beach (35' profile height) and 0.7 cy/sf for dunes (20' dune height). Also, an "overfill" factor of about 1.3 due to finer sand source (about 0.15 mm instead of 0.3 mm d_{50}) is assumed. Assume 20% losses due to increased transport away from nourishment area. The total conversion is therefore 2.0 x 1.3x1.2 = 3.1 cy / sf of shore profile. Assume 2.5 mile length of nourishment (Lincoln to Sloat). This amounts to about 2 M cy to rebuild the linear barrier dune and beach. This is assumed to be required once every 10-30 years.

This amounts to about 5 M cy in 50 years. San Francisco Bar Channel maintenance dredging has averaged about 300,000 cubic yards per year over last few years (Peter Mull, USACE; referred to DMMO records). Therefore, the proposed beach nourishment of 5 M cy in 50 years is generally within the range of the rate of sand maintenance dredging of the SF Bar Channel by the USACE, indicating that the existing dredging operation can be considered as a sand source. However the desired placement period is shorter (2 Mcy in 1 – 2 years) vs the navigation-based dredging frequency (about 0.6 Mcy in 1-2 years) and hence there will be a cost premium associated with advance maintenance dredging or sand borrow from outside the navigation channel. To the extent that the USACE places sand in SOB, it will not be available to MOB and NOB.

Wave Runup

Wave runup will be calculated for the profiles in order to estimate the landward extent of velocity coastal flooding. Special methods are required to estimate the limit of runup over the coastal barrier formed by the linear dunes, walls and roadways at Ocean Beach. The overall methodology follows that in the Guidelines for Pacific Coastal Flood Studies (FEMA, 2005). Runup is calculated using the surf similarity parameter which is essentially the ratio of beach slope to wave steepness, or relative shore steepness. The average slope is used, following the composite slope method described in the USACE coastal engineering manuals. Wave setup is calculated based on the largest waves, and the maximum runup is selected from sampling a range of breaker heights through the surf zone. Setup is calculated using the parameterized "DIM" (Direct Integration Method). The runup limits provide an indication of coastal flooding potential that is expected to extend inland of the erosion limits, and vary somewhat by scenario.

Coastal Hazard Zone

The coastal hazard zone is defined as the inland from the ocean to the limit of coastal flooding and erosion possible during the planning horizon. Figure 4 is an approximate estimate derived from a State-wide study of sea level rise effects on erosion and flooding (PWA, 2008). The figure shows the estimated extent of the coastal hazard zone in year 2100 using a the same sea level rise scenario listed above, with a 100-year coastal runup event.

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Attachments:
Scenario Descriptions: 110506-Scenarios Board-PAC mtg.pdf
Scenario Evaluation Criteria: 110509-Evaluation Criteria - revisions mtg.pdf

Figures:

1. Ocean Beach – Map with reaches and profile locations.
2. SOB historic shore line positions showing multi-decade oscillations and long term erosion trend.
3. Ocean Beach Profile showing shore face geometry and slope.
4. Approximate coastal hazard zones from prior study, year 2100.

technical memorandum 02 : civil engineering

Prepared by: Sherwood Design Engineers

SHERWOOD
DESIGN ENGINEERS

Riparian Zone
330,850 sf (7.6 ac)

Wetland
145,375 sf (3.3 ac)

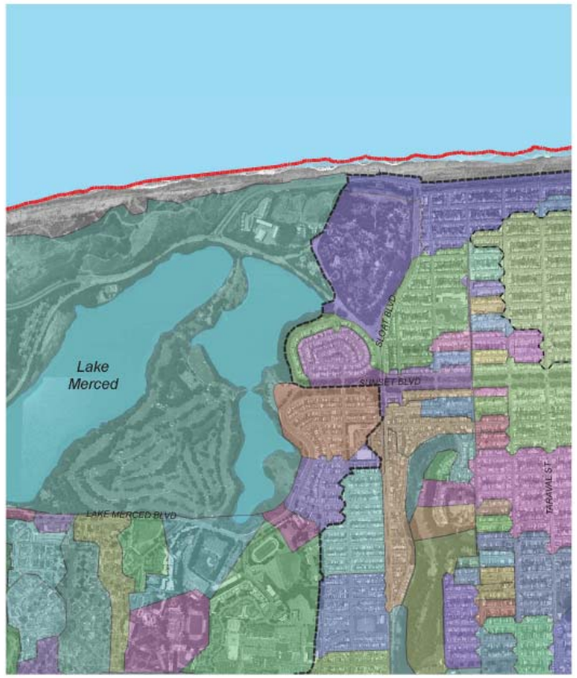
Zoo Catchment
1,864,034 sf (43 ac)

Green Street Collection
1,525,600 sf (35 ac)

Lake Merced Connection
2,322,350 sf (53 ac)

Zoo Parking Lot
183,155 sf (4.2 ac)

SHERWOOD
Design Engineers



LEGEND

City of San Francisco
SF Major Sewershed
SF Minor Sewershed

SHERWOOD
Design Engineers

From: "Bry Sarte" <bsarte@sherwoodengineers.com>
Date: January 20, 2012 8:30:14 AM PST
To: "Ben Grant" <bgrant@spur.org>
Subject: Re: OB

Ben,
I assume the pieces to desribe the zoo intvention are mutifaceted. I am happy to fill in / review other descriptive language where there are any holes. Just ket me know. Below is the romantic and the technical text you requested. Our exhibit that shows the watersheds described will follow.

Intro, why?
Building off of San Francisco citywide momentum to reduce stormwater flows to the bay and ocean and to simultaneously improve public spaces and ecological amenities, we have advanced a concept that provides all of these functions in a simple and powerful gesture at the zoo parking lot and along Sloat Boulevard. This intervention is composed of a living system for moving storm water flows and directing the water to seep into the ground to recharge groundwater and combat saltwater intrusion into San Francisco's freshwater aquifer. (ben, thats the quick summary. Let me know if you have room for more here about the city's system, ecological storm water management, the role of green streets on Sloat and the side streets, the possible connection from Lake Merced, or other details)

Wetland Treatment System
Description: The system will treat and store stormwater in a shallow wet pond with vegetation planted throughout in order to provide the ecological and biological function, and enhanced habitat of a natural wetland. Runoff will pond up within the wetland allowing the water to settle and infiltrate into the soils. Water quality improvements are achieved through particle settling, nutrient uptake and filtration as water soaks into the ground. Stormwater quantity control is achieved through ponding, infiltration and void storage within drain rock layers. The wetlands have sloped sides (a max of 3:1) and a minimum depression depth of 6 inches. The bottoms gently slope to allow for infiltration across the entire surface area.

Contributing Areas: Runoff from areas within the San Francisco Zoo, along Sloat Boulevard, and near and within Lake Merced will be re-directed to the newly constructed wetland via sheet flow from a proposed riparian stream, structural conveyance mechanisms, and retrofitted low impact development conveyance structures. These areas are currently directed to the wastewater treatment plant.

Sloat Boulevard Area	= 1,525,600 sf (35 ac)
San Francisco Zoo	= 1,864,034 sf (43 ac)
Zoo Parking Lot	= 183,155 sf (4.2 ac)
Lake Merced	= 2,322,350 sf (53 ac)
Riparian Area	= 330,850 sf (7.6 ac)
Wetlands (minimum area)	= 43,612 sf (1.1 ac)
Wetlands (maximum area)	= 145,375 sf (3.3 ac)

2yr 24 hr Design Storm Quantities (Minimum Wetland Area):
Total 24-hr Storm Volume = 842,088 cf
Weighted C-Value for Entire Area = 0.75
Total Annual Volume = 8,973,588 cf
Total Peak Runoff = 190 cfs

2yr 24 hr Design Storm Quantities (Maximum Wetland Area):
Total 24-hr Storm Volume = 848,481 cf
Weighted C-Value for Entire Area = 0.74
Total Annual Volume = 9,039,786 cf
Total Peak Runoff = 191 cfs

Wetland Capture (Minimum)
24-hr volume = 126,475 cf (infiltrates into native soils)
Annual volume = 1,349,490 cf (infiltrates into native soils)
Peak Runoff = 161 cfs (reduces current peak runoff by approximately 16%)

Wetland Capture (Maximum)
24-hr volume = 421,588 cf (infiltrates into native soils)
Annual volume = 4,498,345 cf (infiltrates into native soils)
Peak Runoff = 96.3 cfs (reduces the peak runoff by approximately 50%)

Conclusions: The proposed constructed wetland and vegetated swales will reduce the overall 2-yr 24hr design storm peak runoff rate and the annual storm volume by a maximum of 50%. Intercepting the runoff from the above areas and directing it to the wetlands, reduces the amount of water entering the wastewater treatment by a maximum of approximately 4.5 million cf (33,750,000 gallons).

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technical memorandum 03 : cost | benefit analysis

Prepared by: Phil G. King, PhD

Memo January 3, 2012

To: Ben Grant, SPUR

From: Philip King, Ph.D.

Re: Assumptions used for Benefit/Cost Analysis applied to Ocean Beach San Francisco

A benefit/cost analysis is only as good as the assumptions that lie behind it. This analysis was performed on a very limited budget and involves a large number of variables, many not well known. The analysis also involves forecasting future costs and benefits—the farther any benefit or cost is projected into the future, the more speculative the analysis. Despite these difficulties, it is useful to see which variables are critical in the analysis and which are less so and to see which alternatives yield the best benefit/cost ratio, particularly if these differences are very large. The economic analysis for this project is best classified a pre-feasibility; in other words, the purpose of the analysis is to eliminate options that are clearly not feasible or which are dominated by other options which are significantly cheaper or which convey much higher benefits.

The discussion below groups assumption into various categories and discuss how the estimates were made, what sources were used, and the degree of confidence in these sources.

Recreational Value: The recreational value of Ocean Beach was determined by estimating the attendance, type of recreational activity, and the value of these activities per person per day (day use value).

- **Attendance** was estimated from detailed survey data conducted by the San Francisco Public Utilities Commission (SFPUC) from 1998-2000 (SFPUC, 2002) and confirmed by a number of independent observations of Ocean Beach and conversations with people familiar with recreational use patterns. Although this data is over a decade old, attendance at Ocean Beach has remained relatively stable over time, as has San Francisco's population. The one area that was adjusted was surfing, particularly south of Sloat Blvd., which has increased significantly since the survey was taken.

  The SFPUC survey was conducted at a number of specific sites at Ocean Beach and these site estimates were translated into the three reaches--North Ocean Beach (NOB), Middle Ocean Beach (MOB) and South Ocean Beach (SOB) used throughout the analysis. Overall we estimated that 334,748 people visit Ocean Beach (on the sand or in the water) every year; 48% in NOB, 42% in MOB, 11% in SOB (by far the shortest reach—attendance is fairly evenly distributed). 70% recreate on the sand only, 11% are surfers, 15% go into the water but are not surfers; 3% are fishermen. More detail is contained in the Excel tables.

  The SFPUC survey was well thought out and detailed, so we are confident in these estimates. The main area of uncertainty concerns potential increases in recreational activity as well as yearly differences. Beach attendance varies depending upon the weather, though the weather at Ocean Beach is reasonably consistent from year to year.

- **Recreational Value per Day** was estimated using the CSBAT model developed for the State of California and the USACE (e.g., see King, McGregor and Whittet 2011). The recreational value per day depends upon the type of recreation (in particular surfing is considered to be higher value) and the amenity value. Changes in beach width influence amenity value—wider beaches are preferred up to a point (about 250-300 ft).
- **Economic Impact** estimates used spending per visitor per day from King and Symes (2004) with attendance data.

Water/Sewage/Highway Infrastructure Values were estimated from various sources. Wherever possible, official sources from government agencies were used, in particular from the SFPUC. Previous studies of Ocean Beach, such as one conducted by Moffatt and Nichol for the USACE, were also incorporated.

- **SFPUC water/sewage infrastructure costs** of replacement/repair were obtained directly from the SFPUC. Insert table
- The costs of **removing/rerouting the Great Highway** were estimated from a study conducted by Moffatt and Nichol for the SFPUC (cite). They used an estimate of $770 per foot per lane for highway removal/replacement.
- Several smaller but by no means insignificant infrastructure issues were ignored due to lack of insufficient data.

The costs of **shoreline protection** and periodic **beach nourishment** were estimated by PWA and incorporated into the analysis. The costs of non-native plant removal and placement of native vegetation were derived from a study conducted by California State Parks (2007) at Little River State Beach. These figures imply a cost of approximately $6000 to $7000 per acre. Given that construction/demolition costs are higher in San Francisco and to be conservative, this figure was increased to $10,000 per acre.

The costs of **Low Impact Development** (LID) were derived from a detailed analysis conducted by the SFPUC (2010) and modified by Ben Grant, coordinator for the project and Bry Sarte (affiliation, title). Benefits…$2 gallon (cite?)

References

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appendix

section

B

Appendix B: Test Scenarios

- Purpose
- Methodology
- Four Maximum Scenarios
- Evaluating the Test Scenarios

appendix B: test scenarios

Purpose

These Test Scenarios were developed to explore a range of possible interventions at Ocean Beach and model their outcomes through the year 2100, based on the best available current understanding of climate change, sea level rise and coastal dynamics at Ocean Beach. The Test Scenarios represent "extreme cases" with the intent of illustrating the broadest possible range of outcomes. They are not proposals or alternatives.

The Test Scenarios served to organize technical work by the project team's coastal and civil engineers and economist. They were also intended to examine the wide range of ideas and proposals expressed by the public and stakeholders. Testing very different directions allowed the team to illustrate the ramifications of various single-objective approaches whose outcomes fall short in some areas, encouraging an understanding of tradeoffs and a balanced approach.

The Test Scenarios were presented at a public workshop. Participants were then invited to assemble a hybrid scenario drawing from their preferred elements of the Test Scenarios. While not all of the hybrid scenarios were feasible, the exercise revealed a great deal about the tradeoffs involved and the effects of near-term actions over a long time horizon.

Methodology

The project team developed the Test Scenarios by assembling packages of interventions drawn from public and stakeholder suggestions and grouping them according to key priorities, such as maximizing access or allowing a naturally eroding coastline. Many interventions were related to the placement and selection of amenities like roads, trails, restrooms and parking lots, but the most critical actions related to the management of coastal dynamics and hazards such as beach nourishment, the relocation of infrastructure and the placement of seawalls or other hard structures.

These actions provided the basis for physical modeling of the evolving coastline at several time periods through 2100. Four coastal cross-sections, or profiles, showing the location of the water's edge and the width, position and elevation of the beach, dunes and hard structures were altered according to historical erosion rates projected forward and coupled with the likely impacts of sea level rise. The effects of hard structures like seawalls and the placement of sand were incorporated as dictated by each scenario, and the resulting profiles showed the evolving beach and dune width over time. Beach and dune width provide proxies for both recreational and ecological value, both of which are compromised as these erode.

The scenarios, which were developed by the SPUR team with input from the master plan Steering and Advisory Committees, are described in documents produced by AECOM.

The scenarios have different responses at different triggers, which will result in different outcomes. There are four scenarios:

I. Maximum Habitat
II. Maximum Recreation
III. Maximum Green Infrastructure
IV. Maximum Infrastructure

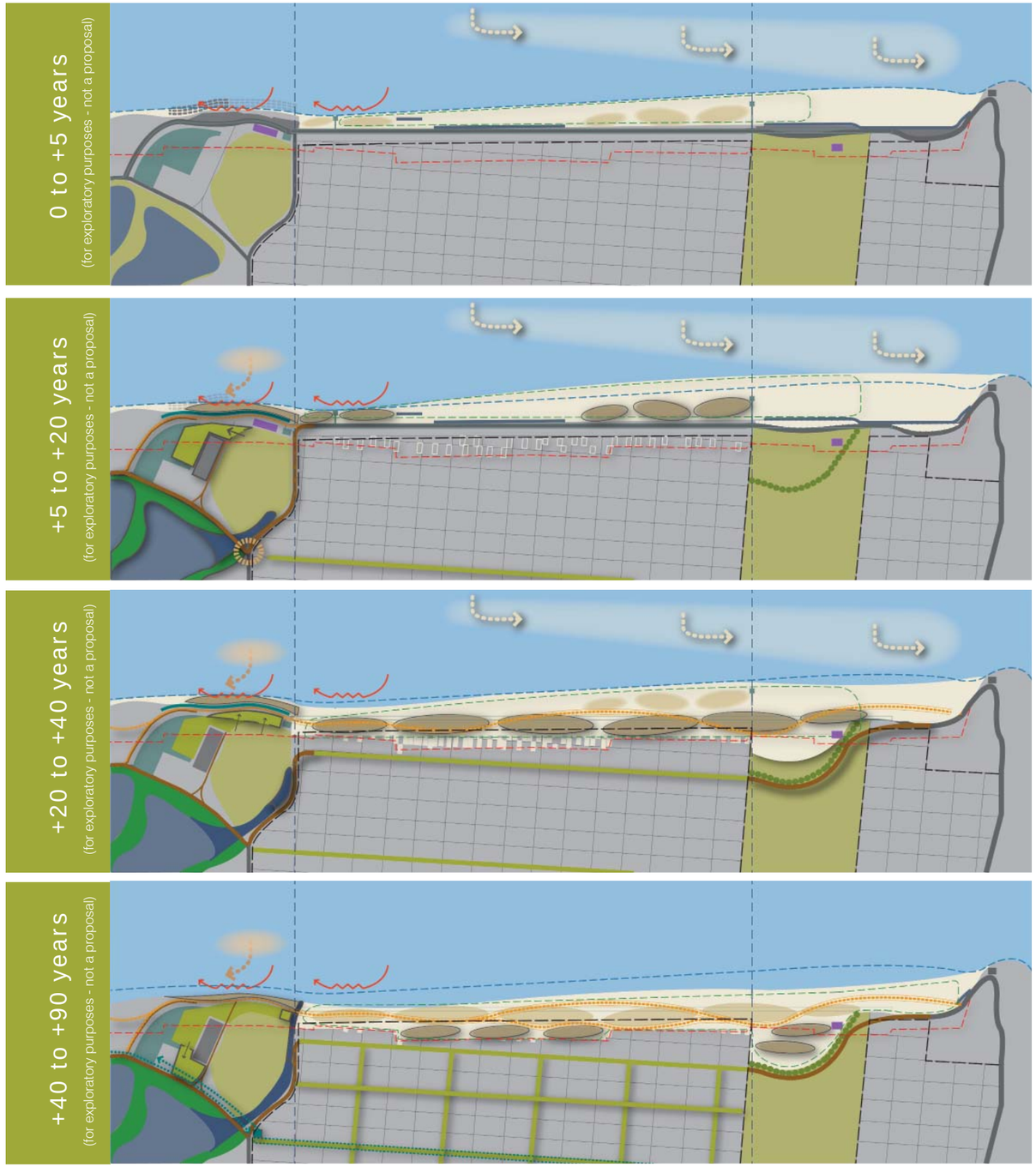
Each scenario includes treatments at four time periods:
> 0 years (2010)
> 20 years (2030)
> 40 years (2050)
> 90 years (2100).

Each scenario is also divided into three shore reaches (Figure 1):
> North Ocean Beach (NOB) from Point Lobos/Cliff House south to Lincoln Boulevard
> Middle Ocean Beach (MOB) from Lincoln to Sloat
> South Ocean Beach (SOB) from Sloat to Fort Funston

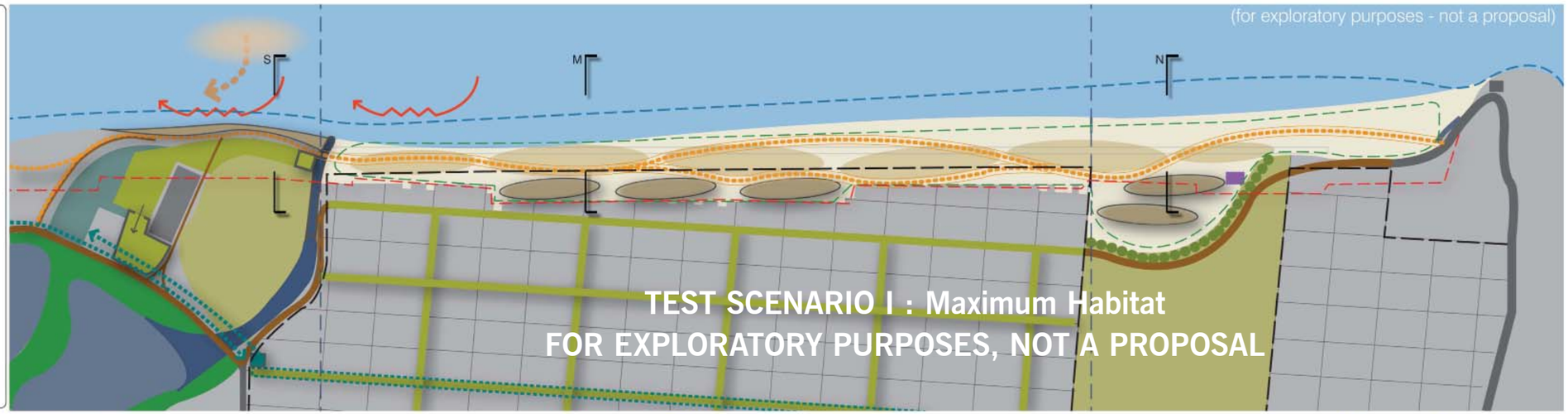
The above scenarios result in approximately 48 permutations (four scenarios x four time periods x three reaches).

I. **Maximum Habitat** Test Scenario

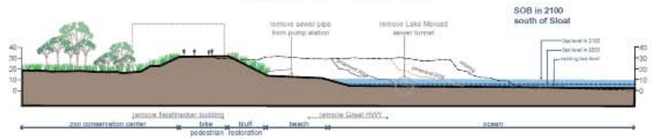
This scenario explores the possibilities of an ambitious and comprehensive program of managed retreat to allow a natural, wild coastline to develop and persist into the future, including wide, sandy beaches, an extensive native dune system and the improved habitat and ecological function these elements suggest. Visitor services are limited and emphasize wildlife experience. This is the only Test Scenario in which the inland project boundary is removed and space is converted from urban to natural uses, including the removal and relocation of infrastructure, the gradual acquisition of private property in the coastal hazard zone and the restoration of Golden Gate Park to native conditions.



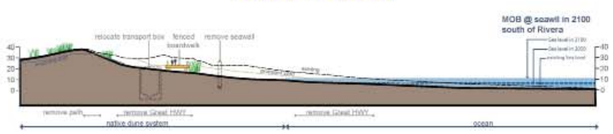
ocean beach at 2100



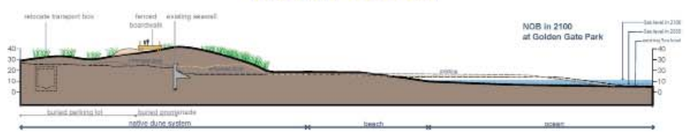
south reach



mid reach



north reach



outcomes

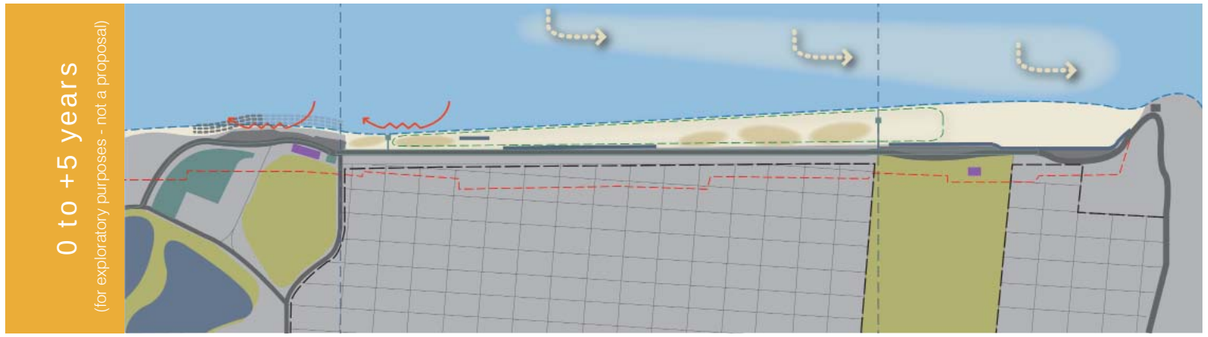
- Lake Merced connected to the ocean as an ecological corridor
- Zoo is reconfigured to higher elevation
- Bank swallow habitat may be limited by bluff erosion
- Lake Merced tunnel is rerouted inland of treatment plant, Great Highway eliminated.
- Natural bluff morphology develops up to treatment plant
- Beyond 2100 - Oceanside Treatment Plan will be exposed to coastal hazards and need to be armored or relocated.

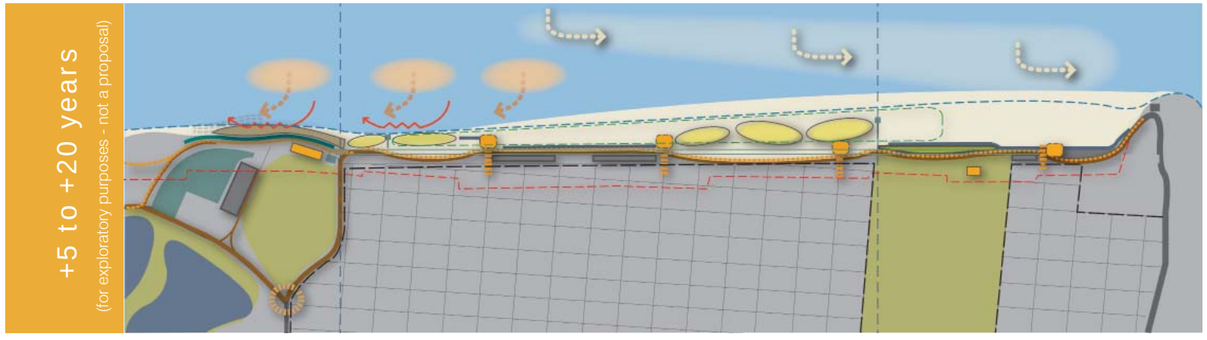
- City has purchased hundreds of homes along western most blocks to allow for coastal retreat
- Westside Transport Box and pump station is reconstructed inland (38th Avenue or Sunset Boulevard)
- Native dune system is restored and expanded into coastal retreat area
- New Great Highway reconstructed inland
- Habitat protection areas are expanded and recreational uses are limited to minimize impacts.

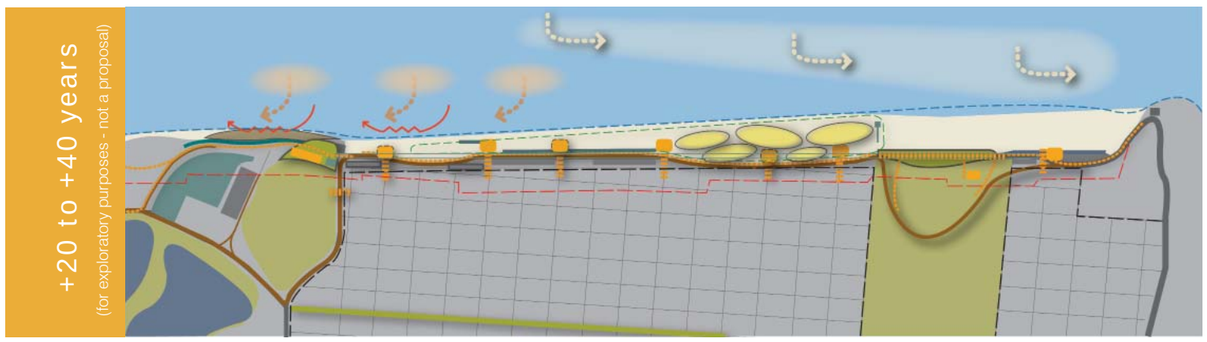
- Great Highway rerouted using existing Golden Gate Park road system
- Native dune system allowed to expand into the park toward a new windbreak
- The Beach Chalet is now directly on the beach

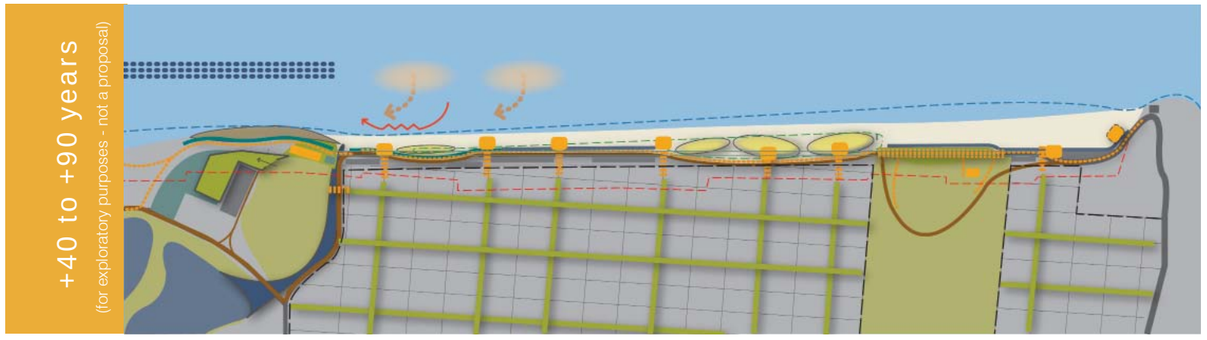
II. Maximum Recreation Test Scenario

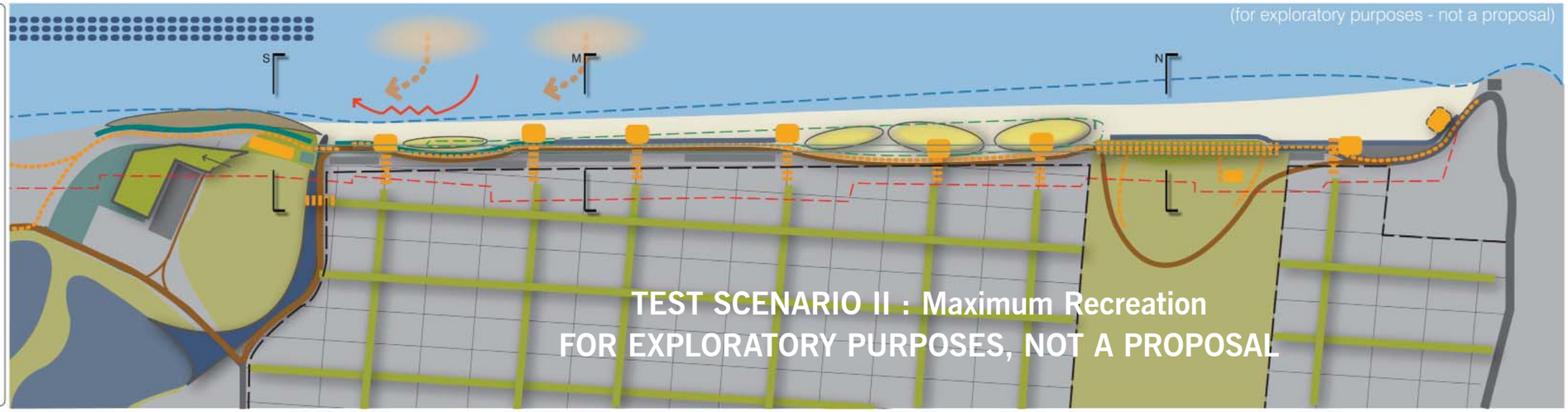
This scenario emphasizes Ocean Beach's function as a park and open space for people, with considerable improvements made to access and amenities and coastal management geared toward maintaining the beach in place to the extent possible. Natural features are protected as a visitor amenity, but wholesale restoration is limited. South Ocean Beach is protected with an artificial reef designed as a surfing break.



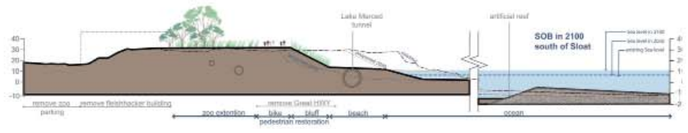






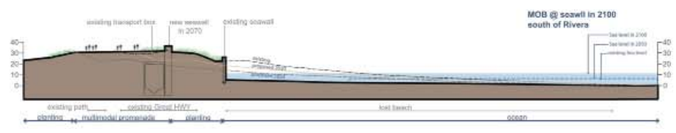


south reach



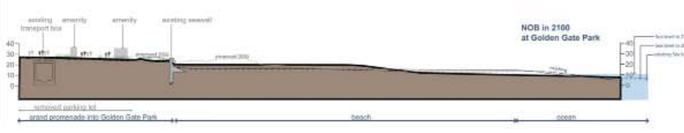
- Lake Merced is connected to the ocean as a new zoo feature and trail connection
- Zoo is reconfigured to Treatment Plant's green roof
- South Great Hwy rerouted inland, leaving trail corridor
- Artificial reef protects bluffs, creates surfing opportunity
- Fleishhacker Poolhouse restored as restaurant/interpretive center

mid reach



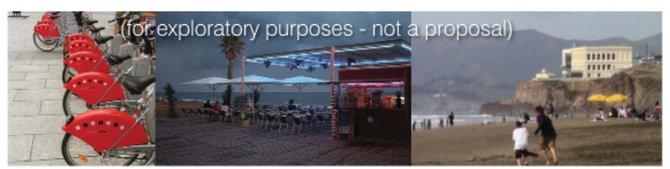
- Great Hwy narrowed to create a multi-modal promenade along the beach
- Access improvements, restrooms, and concessions built at key intersections
- Transport box reinforced with seawall, largely concealed by ongoing nourishment
- Dunes revegetated and improved, accessible via trails
- Beyond 2100, a seawall or artificial offshore reef will likely be needed to protect low-lying areas from storm surge flooding

north reach



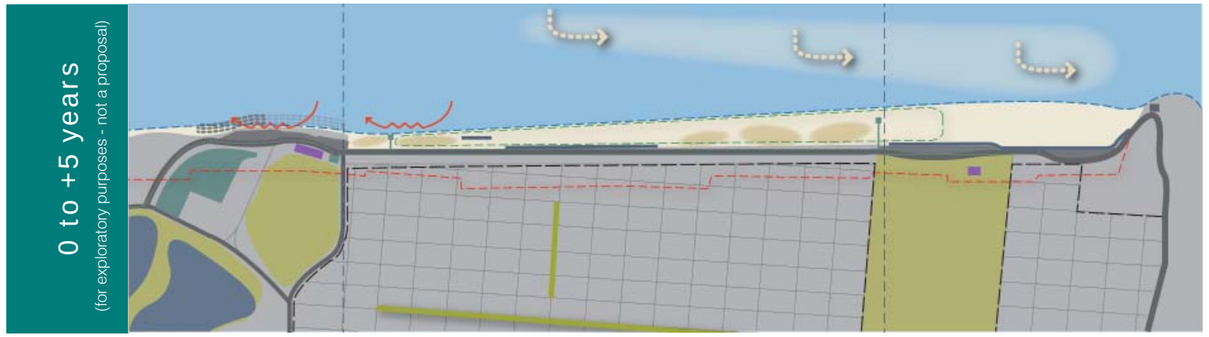
- At Golden Gate Park, the Great Hwy is re-routed through park to allow for a great beach-park connection.
- Attractions, concessions, and public realm improvements create an urban "sea strand" along Golden Gate Park and promenade.

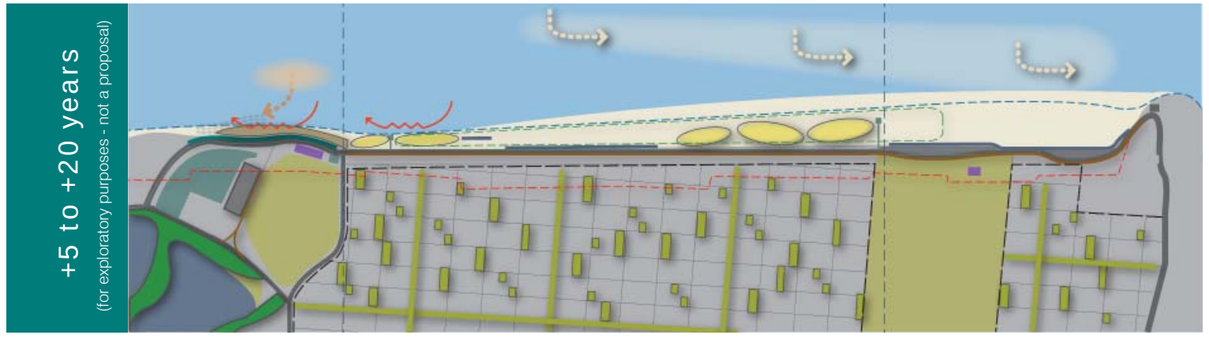
outcomes

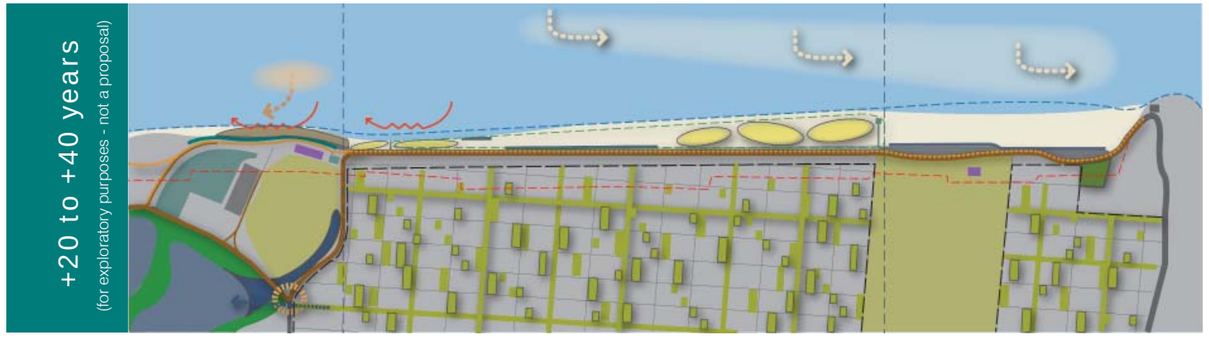


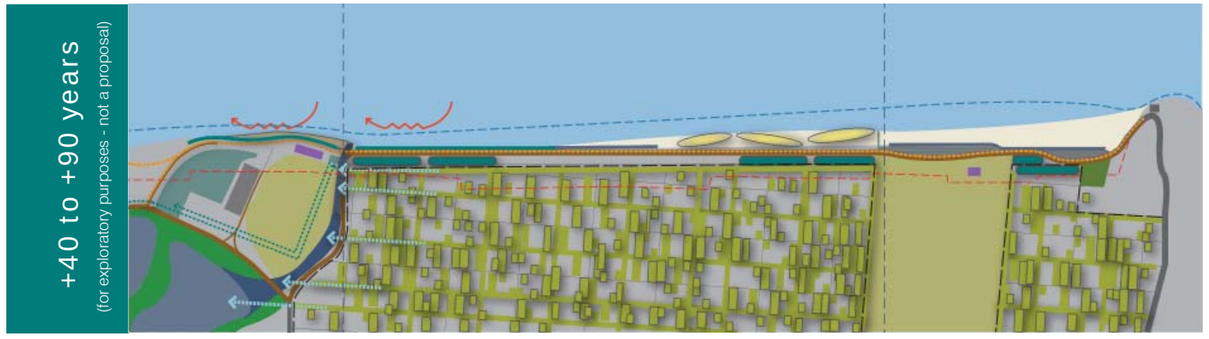
III. Maximum Green Infrastructure Test Scenario

This Test Scenario maximizes the stormwater-management potential of the watershed in order to take pressure off the combine sewer-stormwater system to protect water quality and allow some modification to elements exposed to coastal hazards. This was somewhat problematic as a distinct scenario, as the key concepts could be (and were) layered onto any of the other scenarios.



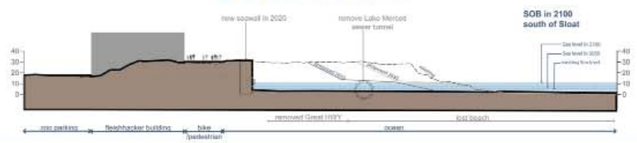




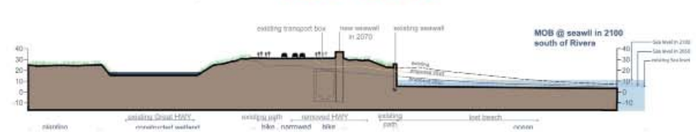


ocean beach at 2100

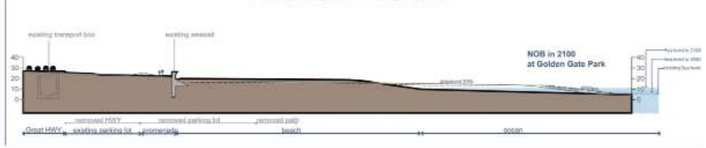
south reach



mid reach



north reach



outcomes

- Reduced stormwater load on utility infrastructure
- Lake Merced Tunnel rerouted inland, possibly smaller
- South Great Hwy rerouted inland, leaving coastal trail corridor
- Bluffs continue to erode
- Lake Merced integrated into watershed, fed by stormwater, and connected to the ocean via constructed wetland.
- Beyond 2100 - Pump station, Zoo and Treatment Plant will be exposed to coastal hazards.

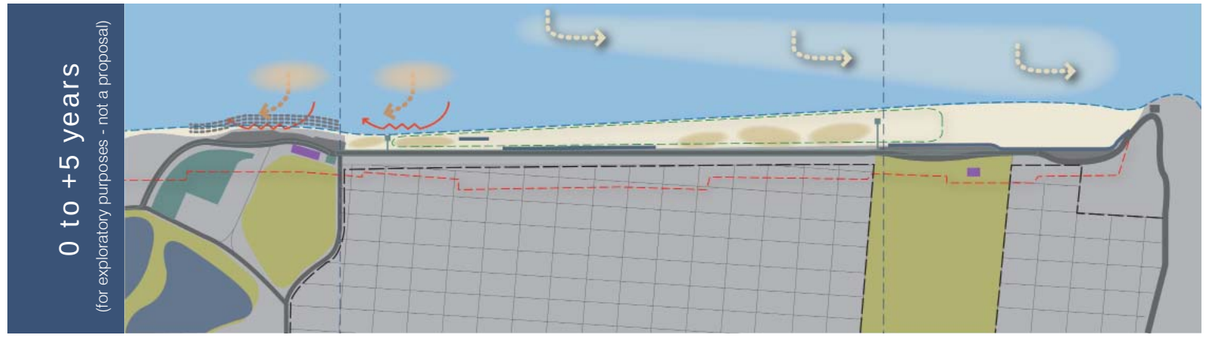
- Extensive stormwater retention reduces or eliminates CSDs
- Throughout watershed: Improved public realm, biodiversity, temperatures
- Improved groundwater levels, water supplies
- Stable precipitation: Overflow structures removed
- Increased Precipitation: water quality maintained
- Transport Box reinforced by a seawall
- Constructed wetlands/lagoons store floodwaters in low-lying areas
- North of Sloat has limited or no beach

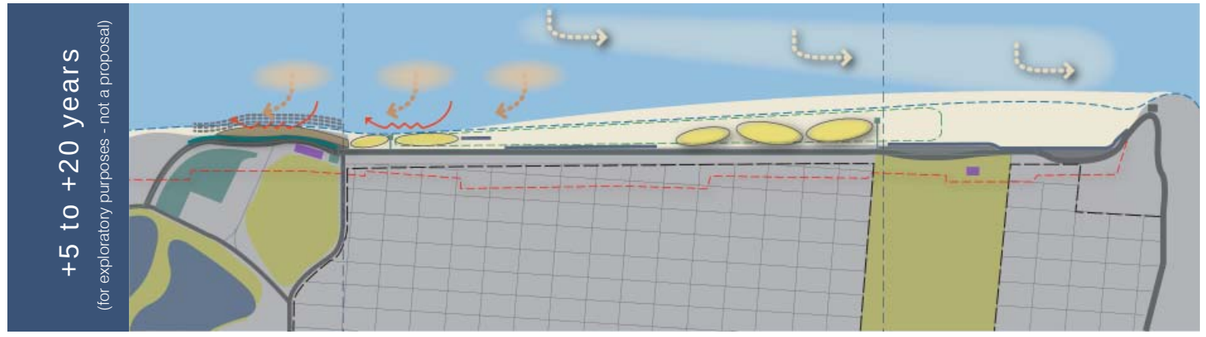
- Stormwater bio-retention basins incorporated into the west end of Golden Gate Park and Sutro Dunes

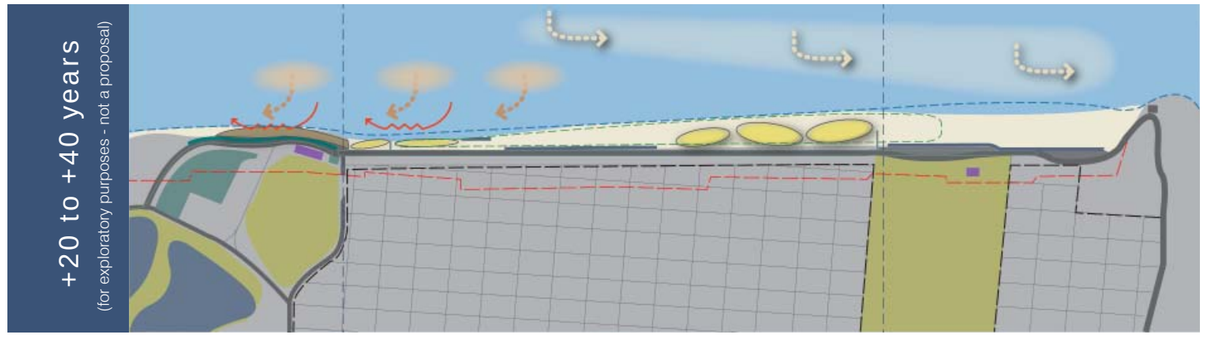
- *All reaches - groundwater and Lake Merced levels are raised; improved bio-diversity and beautification in public realm; stormwater is pre-treated for water quality and can be routed directly to Lake Merced*

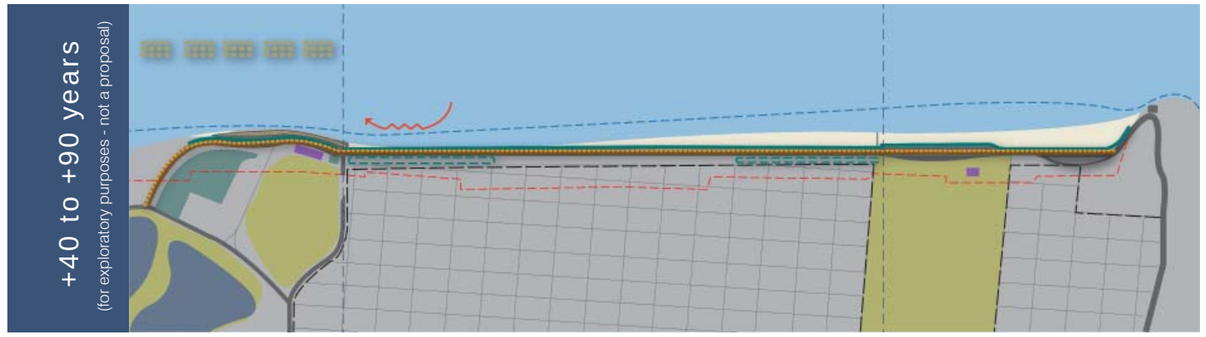
IV. Maximum Infrastructure Test Scenario

This Test Scenario is organized around the protection of existing infrastructure, both for its pollution-control functions and for the stewardship of recent public investments. This replicates the recent pattern to a great extent, with revetments installed to armor the coast as needed in response to erosion events and seawalls added in chronic trouble spots. Environmental and recreational considerations are secondary.

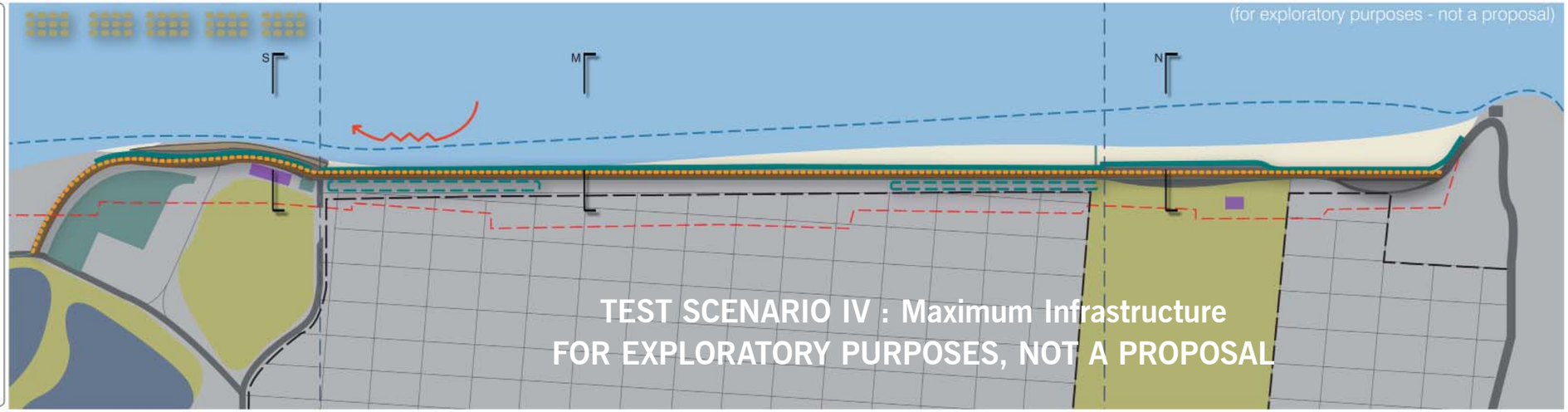




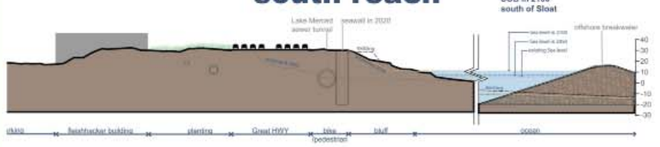




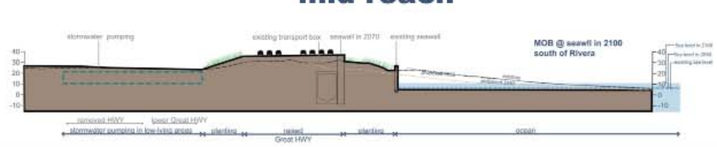
ocean beach at 2100



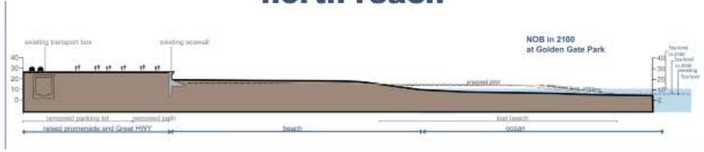
south reach



mid reach



north reach



outcomes

- Limited or no beach
- Raised seawall topped with a promenade provides flooding
- and erosion protection for Treatment Plant, Zoo and Pump Station
- Off-shore breakwater further protects from storm surges
- Loss of bank swallow habitat in bluffs

- Great Highway is raised, reinforced with a seawall, and topped with a multi-modal promenade or boardwalk
- Limited or no beach North of Sloat
- Pumping required to mitigate coastal and stormwater flooding
- Private homes protected by transport box/seawall

- No changes

Evaluating the Test Scenarios

To develop objectives in each of the seven Focus Areas, and to help define what a successful approach needs to accomplish, the Planning Advisory Committee developed set of evaluation criteria presented in page VII-2 of this document.

The results of each Test Scenario were subject to these evaluation criteria and rated accordingly. Because they are “maximum scenarios” exaggerating singular priorities, none of the Test Scenarios were successful across all the Focus Areas.

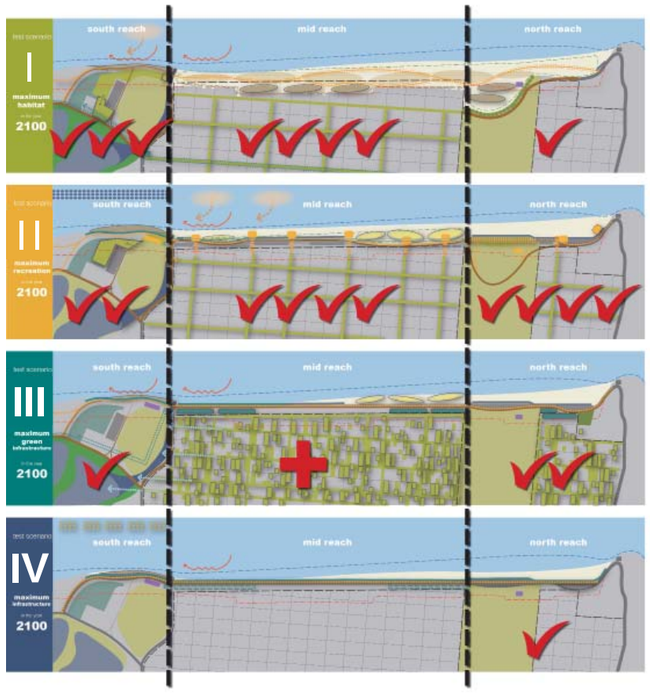


Table B-1 (opposite and following page):
Applying the Evaluation Criteria to the Test Scenairos

To evaluate the test scenarios, each was analyzed with the Evaluation Criteria as described in Section VII.

I. Maximum Habitat Test Scenario

evaluation criteria

focus areas: setting the foundation

Ecology

Restore and establish conditions that support thriving biological communities.

1. Biodiversity & ecological functions on land, water, and intertidal zones

-2 -1 0 1 **2** (degrades) (improves)

2. Habitat for key species (plovers, bank swallows)

-2 -1 0 **1** 2 (degrades) (improves)

3. Ecological connectivity

-2 -1 0 1 **2** (degrades) (improves)

Coastal Dynamics

Identify a proactive approach to coastal management, in the service of desired outcomes.

1. Adaptable and effective response to erosion, storm surges and sea-level rise

-2 -1 0 1 **2** (degrades) (improves)

2. Requirement for on-going interventions

-2 -1 0 1 **2** (increases) (reduces)

3. Impact to other focus areas

-2 **-1** 0 1 2 (negative) (positive)

Utility Infrastructure

Evaluate utility plans and needs in light of coastal hazards and uncertainties, and pursue a smart, sustainable approach.

1. Water quality management (stormwater, wastewater, combined-sewer overflows)

-2 -1 **0** 1 2 (degrades) (improves)

2. Flooding prevention (stormwater run-off)

-2 -1 **0** 1 2 (degrades) (improves)

3. Management of the investment in core utility facilities (treatment plant, transport box, Lake Merced tunnel...)

-2 -1 0 1 2 (negative) (positive)

focus areas : place-making

Access and Connectivity

Provide seamless and fluid connections to adjacent open spaces, the city, and the region.

1. Pedestrian and bicycle circulation along north/south corridors

-2 **-1** 0 1 2 (degrades) (improves)

2. Pedestrian & bike connections to adjacent open spaces, streets & transit network

-2 **-1** 0 1 2 (degrades) (improves)

3. Traffic flow and parking system

-2 **-1** 0 1 2 (degrades) (improves)

Image and Character

Preserve and celebrate the beach's raw and open beauty, while welcoming a broader public.

1. Image of Ocean Beach

-2 -1 0 **1** 2 (degrades) (improves)

2. Natural feel and experience of the beach (dunes, wildlife, surf...)

-2 -1 0 1 **2** (degrades) (improves)

3. Experience and character of the urban edge along Ocean Beach

-2 **-1** 0 1 2 (degrades) (improves)

Program and Uses

Accommodate the diverse activities people enjoy at the beach, managed for positive coexistence.

1. Activities and amentities

-2 **-1** 0 1 2 (degrades) (improves)

2. Surf conditions

-2 -1 **0** 1 2 (degrades) (improves)

3. Compatibility of uses

-2 -1 0 1 2 (degrades) (improves)

II. Maximum Recreation Test Scenario

evaluation criteria

focus areas: setting the foundation

Ecology

Restore and establish conditions that support thriving biological communities.

1. Biodiversity & ecological functions on land, water, and intertidal zones

-2 **-1** 0 1 2 (degrades) (improves)

2. Habitat for key species (plovers, bank swallows)

-2 **-1** 0 1 2 (degrades) (improves)

3. Ecological connectivity

-2 **-1** 0 1 2 (degrades) (improves)

Coastal Dynamics

Identify a proactive approach to coastal management, in the service of desired outcomes.

1. Adaptable and effective response to erosion, storm surges and sea-level rise

-2 -1 **0** 1 2 (degrades) (improves)

2. Requirement for on-going interventions

-2 -1 0 1 2 (increases) (reduces)

3. Impact to other focus areas

-2 -1 0 **1** 2 (negative) (positive)

Utility Infrastructure

Evaluate utility plans and needs in light of coastal hazards and uncertainties, and pursue a smart, sustainable approach.

1. Water quality management (stormwater, wastewater, combined-sewer overflows)

-2 -1 **0** 1 2 (degrades) (improves)

2. Flooding prevention (stormwater run-off)

-2 -1 **0** 1 2 (degrades) (improves)

3. Management of the investment in core utility facilities (treatment plant, transport box, Lake Merced tunnel...)

-2 -1 0 **1** 2 (negative) (positive)

focus areas : place-making

Access and Connectivity

Provide seamless and fluid connections to adjacent open spaces, the city, and the region.

1. Pedestrian and bicycle circulation along north/south corridors

-2 -1 0 1 **2** (degrades) (improves)

2. Pedestrian & bike connections to adjacent open spaces, streets & transit network

-2 -1 0 1 **2** (degrades) (improves)

3. Traffic flow and parking system

-2 -1 **0** 1 2 (degrades) (improves)

Image and Character

Preserve and celebrate the beach's raw and open beauty, while welcoming a broader public.

1. Image of Ocean Beach

-2 -1 **0** 1 2 (degrades) (improves)

2. Natural feel and experience of the beach (dunes, wildlife, surf...)

-2 **-1** 0 1 2 (degrades) (improves)

3. Experience and character of the urban edge along Ocean Beach

-2 -1 0 1 **2** (degrades) (improves)

Program and Uses

Accommodate the diverse activities people enjoy at the beach, managed for positive coexistence.

1. Activities and amentities

-2 -1 0 1 **2** (degrades) (improves)

2. Surf conditions

-2 -1 0 **1** 2 (degrades) (improves)

3. Compatibility of uses

-2 -1 0 **1** 2 (degrades) (improves)

III. Max Green Infrastructure Test Scenario

evaluation criteria

focus areas: setting the foundation

Ecology

Restore and establish conditions that support thriving biological communities.

1. Biodiversity & ecological functions on land, water, and intertidal zones
   -2 -1 0 **1** 2 (degrades) (improves)
2. Habitat for key species (plovers, bank swallows)
   -2 **-1** 0 1 2 (degrades)
3. Ecological connectivity
   -2 -1 0 **1** 2 (degrades) (improves)

Coastal Dynamics

Identify a proactive approach to coastal management, in the service of desired outcomes.

1. Adaptable and effective response to erosion, storm surges and sea-level rise
   -2 **-1** 0 1 2 (degrades) (improves)
2. Requirement for on-going interventions
   -2 **-1** 0 1 2 (increases) (reduces)
3. Impact to other focus areas
   -2 -1 0 1 **2** (negative) (positive)

Utility Infrastructure

Evaluate utility plans and needs in light of coastal hazards and uncertainties, and pursue a smart, sustainable approach.

1. Water quality management (stormwater, wastewater, combined-sewer overflows)
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2. Flooding prevention (stormwater run-off)
   -2 -1 0 1 **2** (degrades) (improves)
3. Management of the investment in core utility facilities (treatment plant, transport box, Lake Merced tunnel...)
   -2 -1 0 **1** 2 (negative) (positive)

focus areas : place-making

Access and Connectivity

Provide seamless and fluid connections to adjacent open spaces, the city, and the region.

1. Pedestrian and bicycle circulation along north/south corridors
   -2 -1 **0** 1 2 (degrades) (improves)
2. Pedestrian & bike connections to adjacent open spaces, streets & transit network
   -2 -1 0 **1** 2 (degrades) (improves)
3. Traffic flow and parking system
   -2 -1 **0** 1 2 (degrades) (improves)

Image and Character

Preserve and celebrate the beach's raw and open beauty, while welcoming a broader public.

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2. Surf conditions
   -2 -1 **0** 1 2 (degrades) (improves)
3. Compatibility of uses
   -2 -1 **0** 1 2 (degrades) (improves)

IV. Maximum Infrastructure Test Scenario

evaluation criteria

focus areas: setting the foundation

Ecology

Restore and establish conditions that support thriving biological communities.

1. Biodiversity & ecological functions on land, water, and intertidal zones
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Coastal Dynamics

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focus areas : place-making

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3. Compatibility of uses
   -2 -1 **0** 1 2 (degrades) (improves)

Project Funders

State of California Coastal Conservancy

San Francisco Water Power Sewer
Services of the San Francisco Public Utilities Commission

National Park Service
U.S. Department of the Interior

Project Partners

San Francisco Water Power Sewer
Services of the San Francisco Public Utilities Commission

National Park Service
U.S. Department of the Interior
Golden Gate National Recreation Area

San Francisco Department of Recreation and Parks

California Coastal Commission

US Army Corps of Engineers

City and County of San Francisco
Department of Public Works

Consultant Team

SPUR

AECOM

ESA PWA

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Department of Economics
San Francisco State University

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