

The Whirlwind Whiplash Tour of Six Marin SLR “Innovative” Projects*



Restored bay beach, Aramburu Island 2012

Roger Leventhal, P.E.
Senior Engineer
Marin DPW Flood
Control

* ...in my opinion

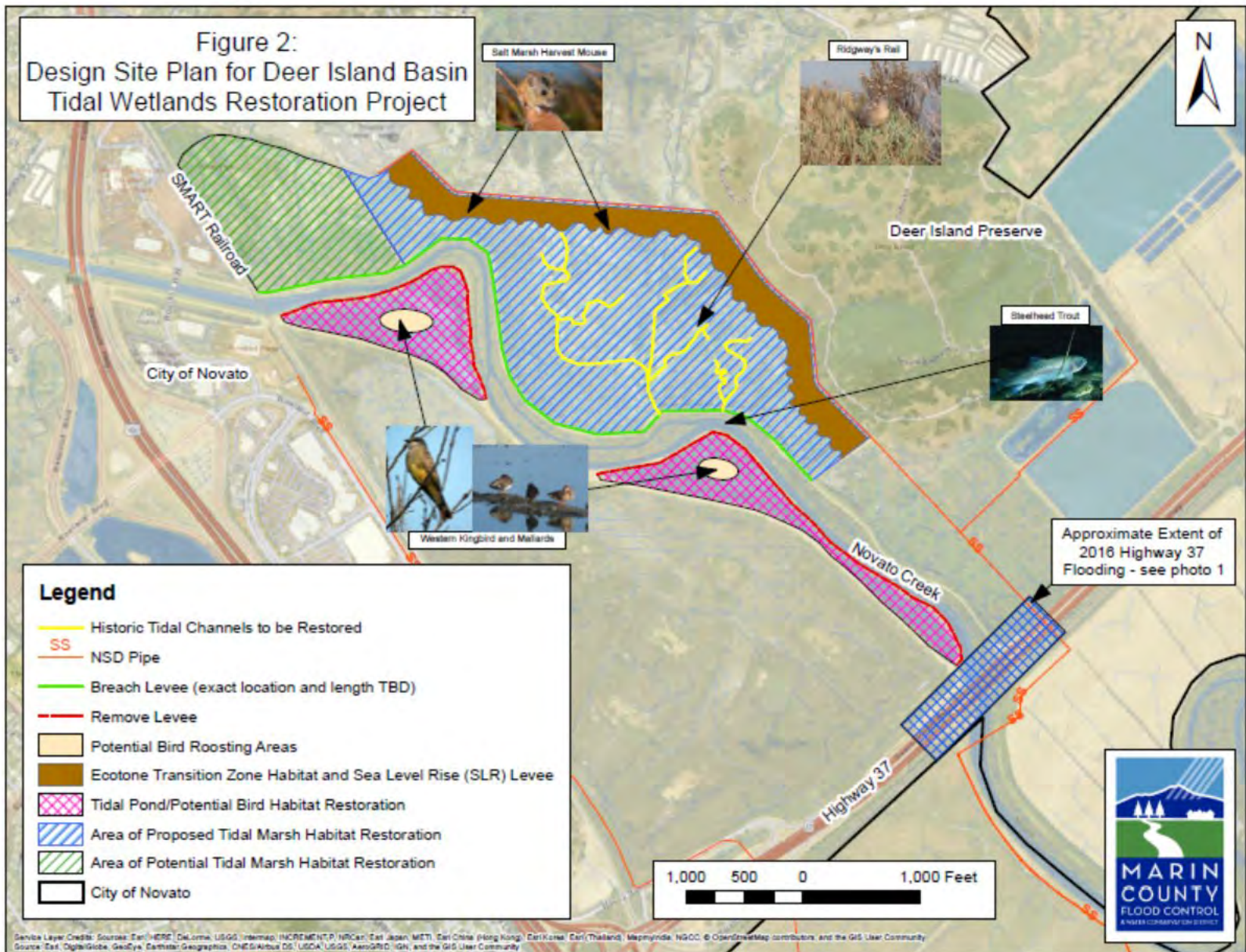
Deer Island Tidal Wetlands Restoration Project in the Novato Baylands



Conceptual design developed through the watershed program (L. Lewis and L. Williams managing)

Design Concept

Figure 2:
Design Site Plan for Deer Island Basin
Tidal Wetlands Restoration Project



Deer Island Tidal Wetlands Restoration Project

- 2018 - Awarded a \$690,000 Measure AA grant for final design and permitting - construction not funded
- Includes ecotone levees for habitat transgression under SLR conditions
- Demonstrate the ability of increased tidal flows (prism) to move sediment and widen and deepen the creek channel
 - Links to the “Geomorphic Dredge Design Project”, CSA 6, south fork, Gallinas Creek

Next...Dredge Sediment Reuse

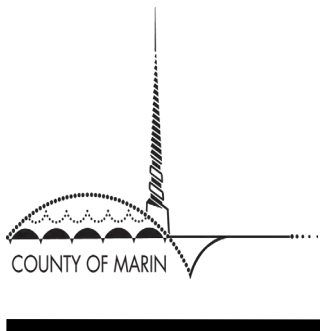
Natural Analogues for Thin-Lift Dredge

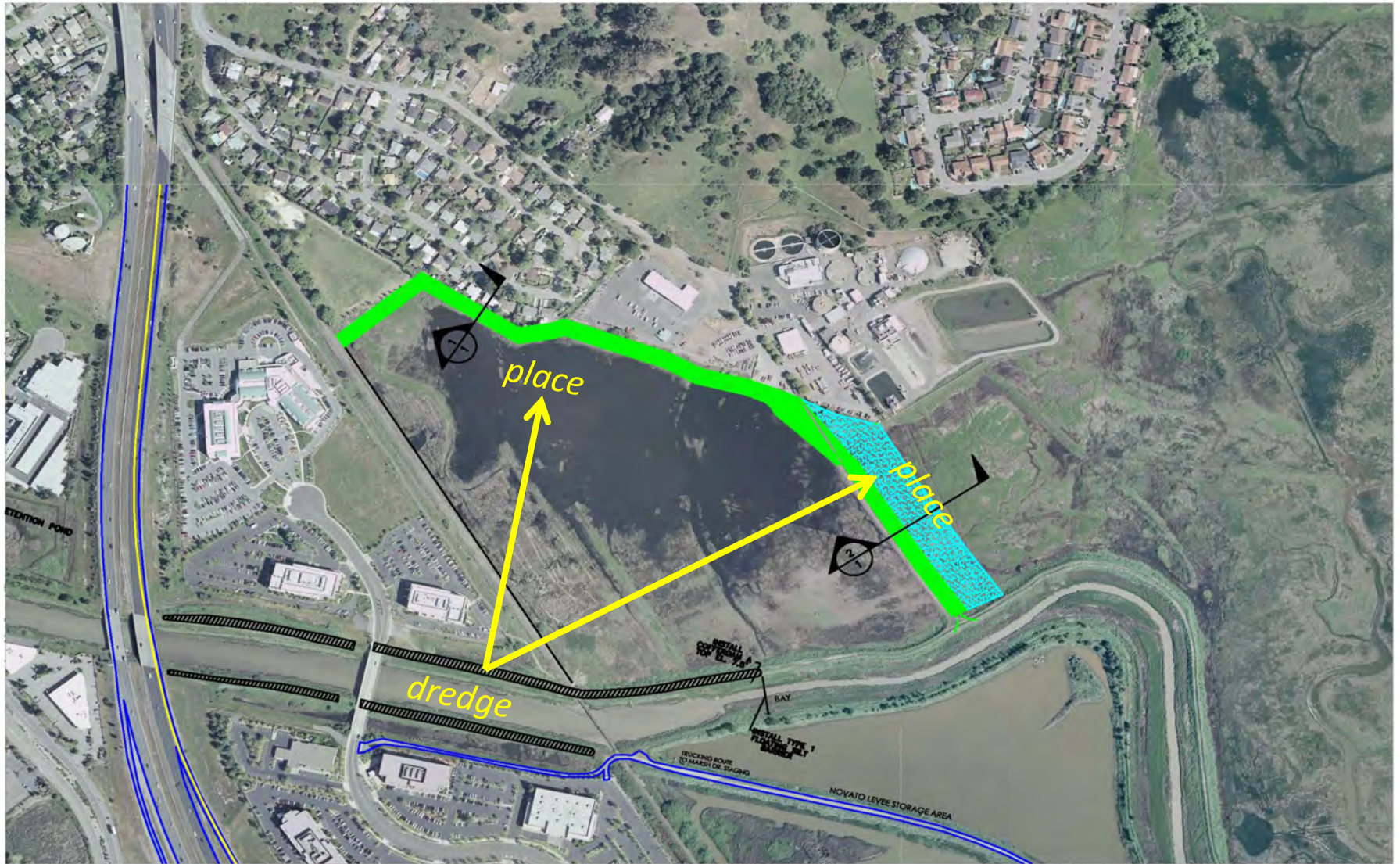



Sonoma Baylands 2006



Sonoma Baylands 2012





COUNTY OF MARIN DEPARTMENT OF PUBLIC WORKS 3501 CIVIC CENTER DRIVE, SAN RAFAEL, CA 94913	SCALE  0 500' 1000'			NOVATO CREEK SEDIMENT REMOVAL 2016 SPOIL DISPOSAL PLAN	COUNTY PROJECT NO. 2016-01	FLOOD CONTROL PROJECT NO. Z1-53
	1/8/16 DATE	J.C.D. DRAWN	D.N. CHECKED			



Novato Creek Dredged Sediment Beneficial Reuse Project

*A demonstration
project for the
reuse of dredged
sediments from
Novato Creek for
phased
construction of
ecotone levees for
adaptation to sea
level rise*

Briefing Presentation for RWQCB Project Consideration

Marin County Flood Control District
R. Leventhal

And Thanks to Christina Toms!

January 29, 2016







Bothin Thin-Lift Pilot Feasibly Study

Study
submitted
1/30/17

NBWA Grant
(thanks Harry,
Judy and
Chris!) - \$25k

*Prepared by
myself and
Peter Baye*



Coyote Creek to Bothin Marsh
Dredge Sediment Beneficial Reuse
Feasibility Study
January 30, 2017

Next...MCF Bay Beach “Living Shorelines” Design Grant

- 2018 - DPW awarded a \$200,000 MCF grant to prepare preliminary level designs at three sites in Southern Marin
- Designs further highlight Marin County Eastern Shoreline as a “living shorelines” laboratory (w/ Oyster project)
- Each site showcases a different design challenge
- Goal to bring design ready for final design and implementation funding at one or more sites

#1 Blackie's Pasture Beach Site – Full Beach Profile



Opportunity for full beach profile restoration with habitat and significant public access.

Address shoreline erosion and non-engineered rip-rap



#2 Paradise Beach Site

Demonstration Site
of a “hybrid living
shoreline” approach
with a beach
potentially fronting a
geotech retaining wall

Higher wave energies
and ferry wakes



Paradise Beach at high tide, July 25, 2015. There is no high tide beach access from the park to the gravel and sand beach. Slope is failing and design likely needs to integrate with “hard” engineering structure to protect the slope

#3 Seminary Road Site

Demonstration project
in a higher wave
environment with
limited space to
protect a roadway

Adjacent to rip-rap
allows for easy
comparison of
approaches



Eroded Seminary Drive shoreline east of the rock slope protection, with collapsed access structures. June 21, 2012

Wave Movies



Photo: Mark Taylor, EBRPD

Hayward Frank's Dump West – New Year's Eve 2005
8.9 ft tides; 40mph westerly winds

Next Goal is a “Bay Beach Design Manual”

- Collect data to allow for updating/refinement of Lorang and other wave runup equations
- Wave sensors and runup measurements
- RFID rocks to track movement
- Wave modeling
- ✓ Without data and proof of concept; liability will keep this living shorelines design approach from being adopted

Updated Marin Specific Hydrology for Climate Change

- Need to update and standardize Marin hydrology for coming climate changes
- Project 1 down this road- Develop Flood Triggers for Activating DOC (the “*Formula for Flooding*”)
- DOC is costly to open and staff
- DPW Currently using Contra Costa County trigger formula and doesn’t work well for Marin



Contra Costa County Flood Control & Water Conservation District

Flood Forecasting

CONDITIONS TO LOOK FOR

1. Compare the rainfall for the year and 24-hour forecast with the following criteria.

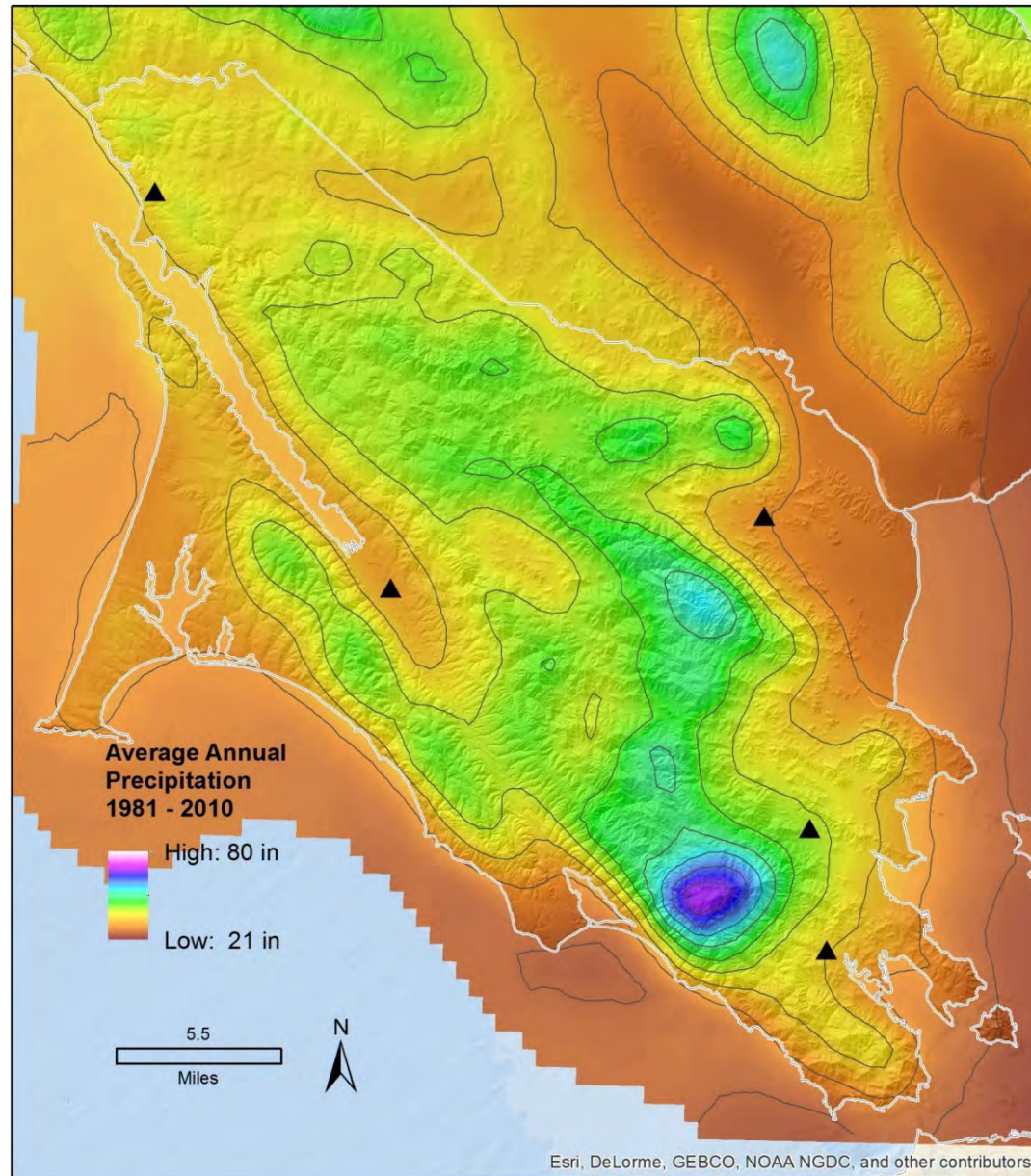
- a. **7"** of rain for the season starting on July 1 (year).
- b. **5"** of rain in the last 30 days (month).
3" of rain in the last 7 days (week).
- c. **2"** of rainfall is forecast in the next 24 hours (day).

2. If these conditions are met, flooding may occur sometime in the next 24 hours. Warnings on TV and radio should be monitored. Your [Personal Evacuation Plan](#)



Appears to be based on 2 or 3 large events

Huge spatial variability in Marin rainfall



Smaller Rainfall Intensity Matters for Marin Storms

10-minute rainfall

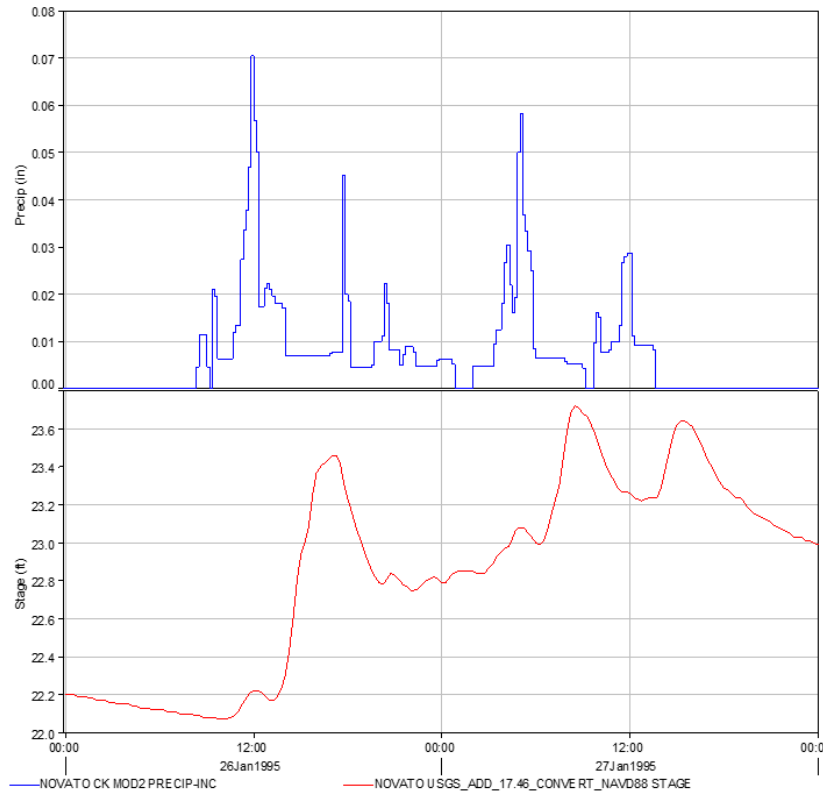


Figure 3: Event with multiple spikes - losing information only looking at one spike?

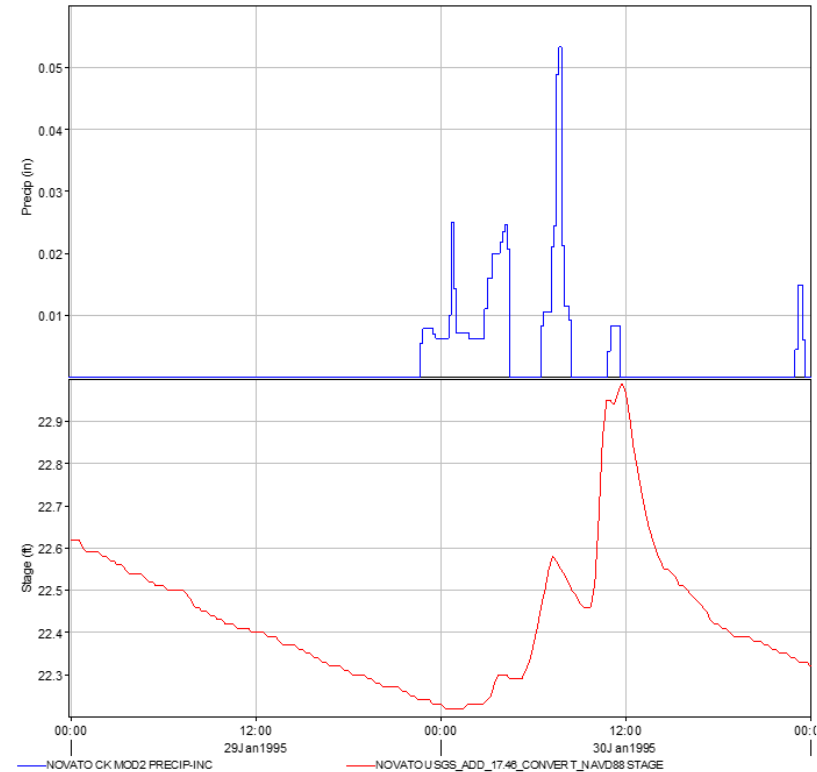
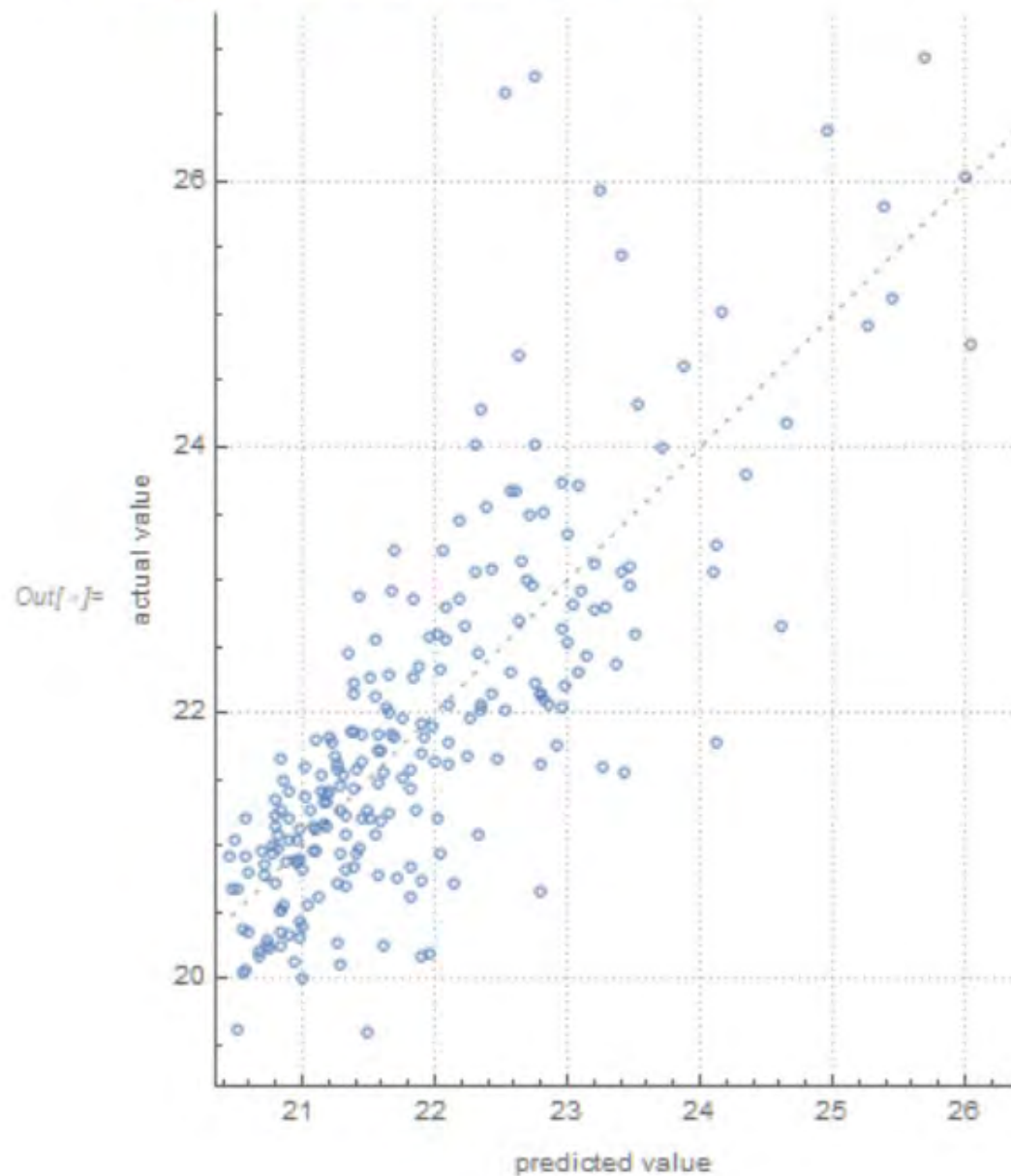


Figure 4: 10-minute peak intensity causes spike in stage. Does intensity matter more than antecedent rainfall?

Marin Specific Flood Triggers (the “formula for flooding”)

- Innovative statistically based approach
- Divided the entire 25 year rainfall record into user defined “events” – 300 to 700 events
 - Calcs depth, duration, antecedent rainfall, max intensities, tides, wind speed and direction for each event (storm database)
- Statistical analysis of all events to determine best predictive regression model with uncertainty bars

```
ln[-]:= comparisonPlot[{new[[-1, -1]]}]
```



All Storms Events – Novato Creek
1993 - present

○ predictions 1
- - - perfect predictions

The Formula for Flooding in Novato?

48 hours

N: 242

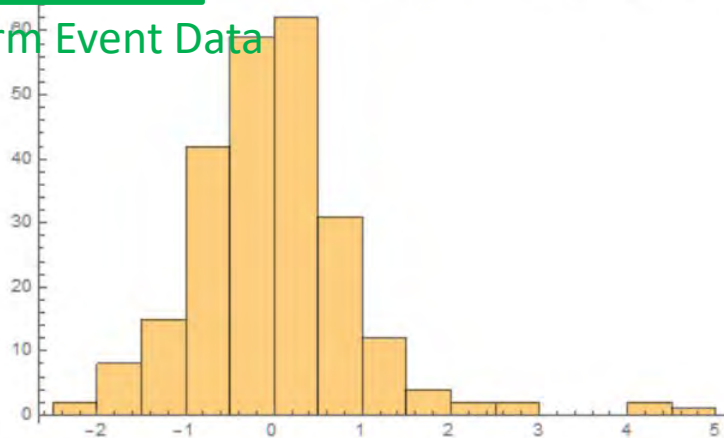
R²: 0.754839

Adjusted R²: 0.74086

Antecedent Rainfall

	Estimate	Standard Error	t-Statistic	P-Value
TotalStormDepth	0.719549	0.0889394	8.09034	3.52402 × 10 ⁻¹⁴
Duration30Days	0.0416591	0.039921	1.04354	0.297804
Duration20Days	-0.00425979	0.0592081	-0.071946	0.942708
Duration10Days	0.276136	0.0770099	3.58572	0.000411184
Duration5Days	0.00822838	0.1215	0.067723	0.946065
Duration3Days	0.244058	0.246345	0.990717	0.322874
Ten	-0.044429	2.67811	-0.0165896	0.986778
Thirty	0.635959	2.76663	0.229868	0.818401
Sixty	-1.22964	2.33503	-0.526603	0.598982
OneHundredTwenty	2.81487	1.40244	2.00712	0.0459176
TwoHundredForty	-0.695829	1.24541	-0.558715	0.576904
ThreeHundredSixty	-0.472137	0.78319	-0.602839	0.547215
Duration	-0.0179768	0.0482394	-0.372657	0.70975

Storm Event Data



FittedModel

20.2735 - 0.0179768 Duration + 0.276136 Duration10Days - 0.00425979 Duration20Days + 0.0416591 Duration30Days + 0.244058 Duration3Days +
 <<1>> + <<1>> - <<19>> Sixty - 0.044429 Ten + 0.635959 Thirty - 0.472137 ThreeHundredSixty + 0.719549 TotalStormDepth - 0.695829 TwoHundredForty

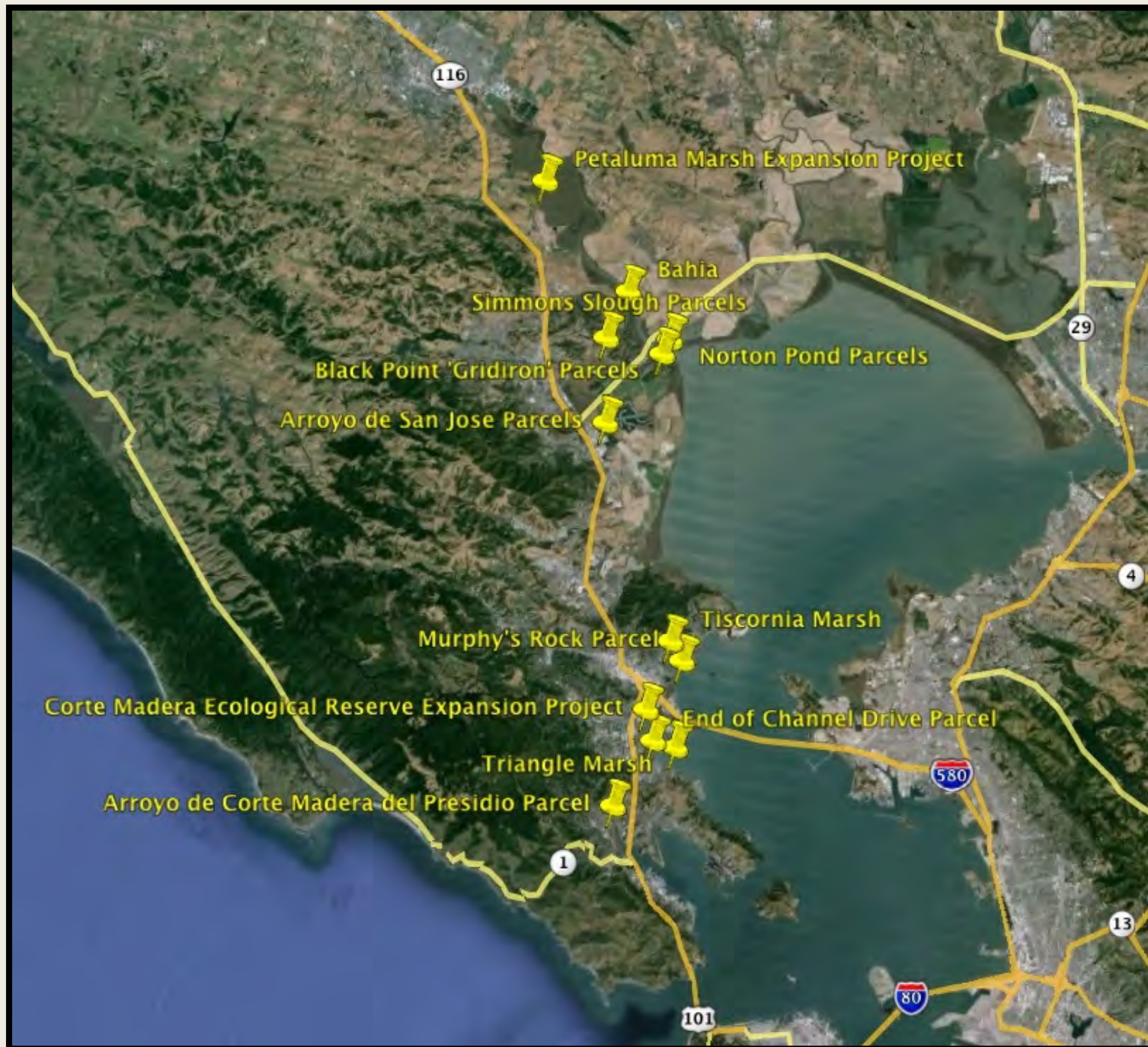
The Marin Audubon Society

Wetland Restoration Design for Sea Level Rise

A Presentation
for the
Marin Sea Level Rise Adaptation Workshop
March 21, 2019

Barbara Salzman
www.marinaudubon.org





Tiscornia Marsh



Google earth

800 ft

Tiscornia Marsh: Setting



Marsh Design Concept #1B: Restore Eroded and Diked Marsh



Tiscornia Marsh

Figure 3

Marsh Design Concept #1B: Restore Eroded and Diked Marsh





San Rafael Canal Mouth

23d.2

23d.1

Pickleweed Park



North Bay

Ridgway's Rail Survey Results for
the Invasive *Spartina* Project

- Ridgway's rails
- Black rails
- Station
- Presence confirmed
- Not detected
- Area surveyed (200 m buffer)
- Site surveyed by others

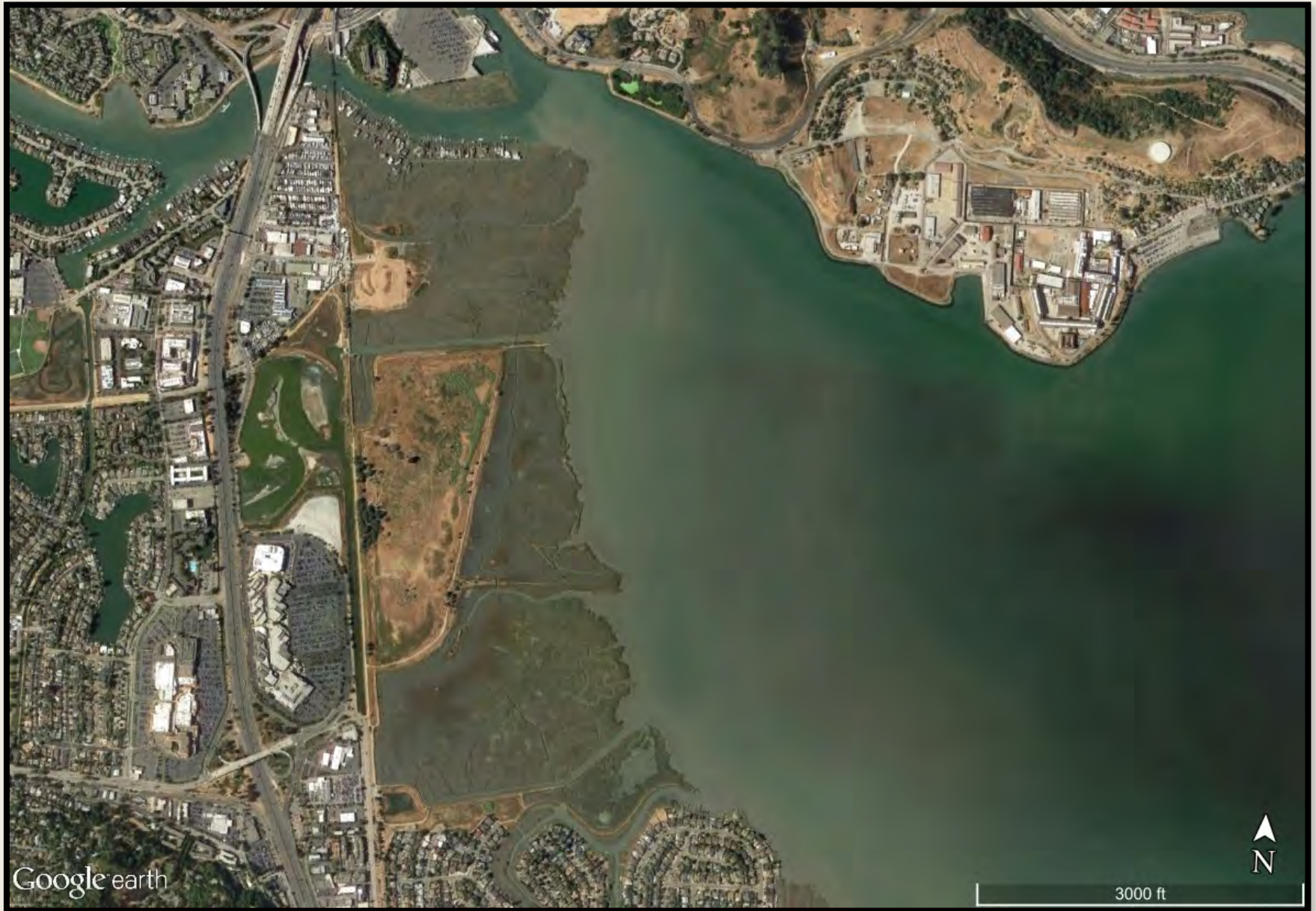
Bay Area Aquatic Resource Index (BAARI)
by San Francisco Estuary Institute (SFEI)

- | | |
|------------------|-----------------------|
| • Bay Deep | • Tidal Marsh Flat |
| • Bay Shallow | • Tidal Nascent Marsh |
| • Lagoon | • Tidal Pannet |
| • Tidal Bay Flat | • Tidal Marsh |
| • Tidal Channel | |

Background: ESRI Basemaps and World Imagery (ESRI)
Scale: 1:24,000



Corte Madera Ecological Reserve Expansion Project



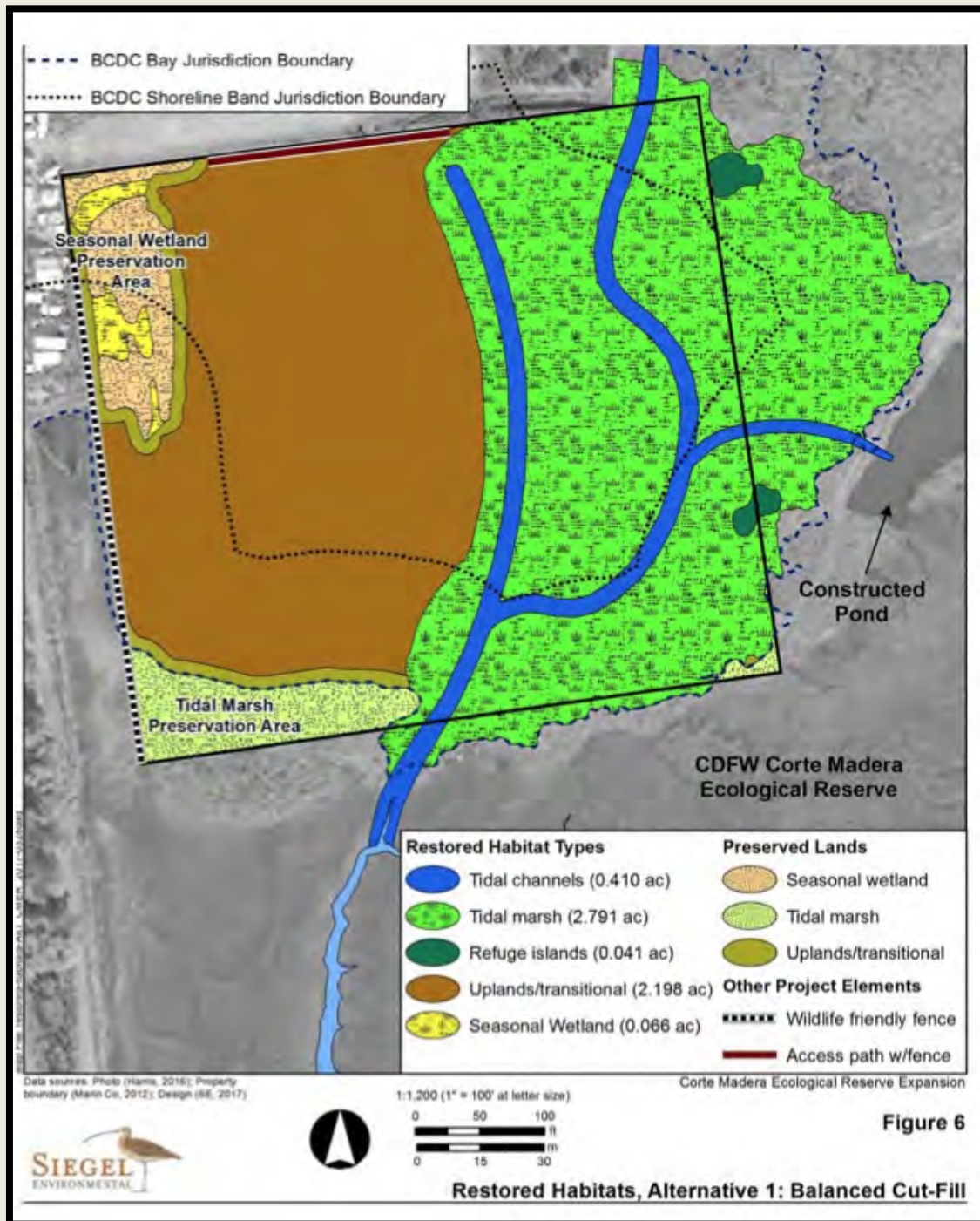


1948



2012





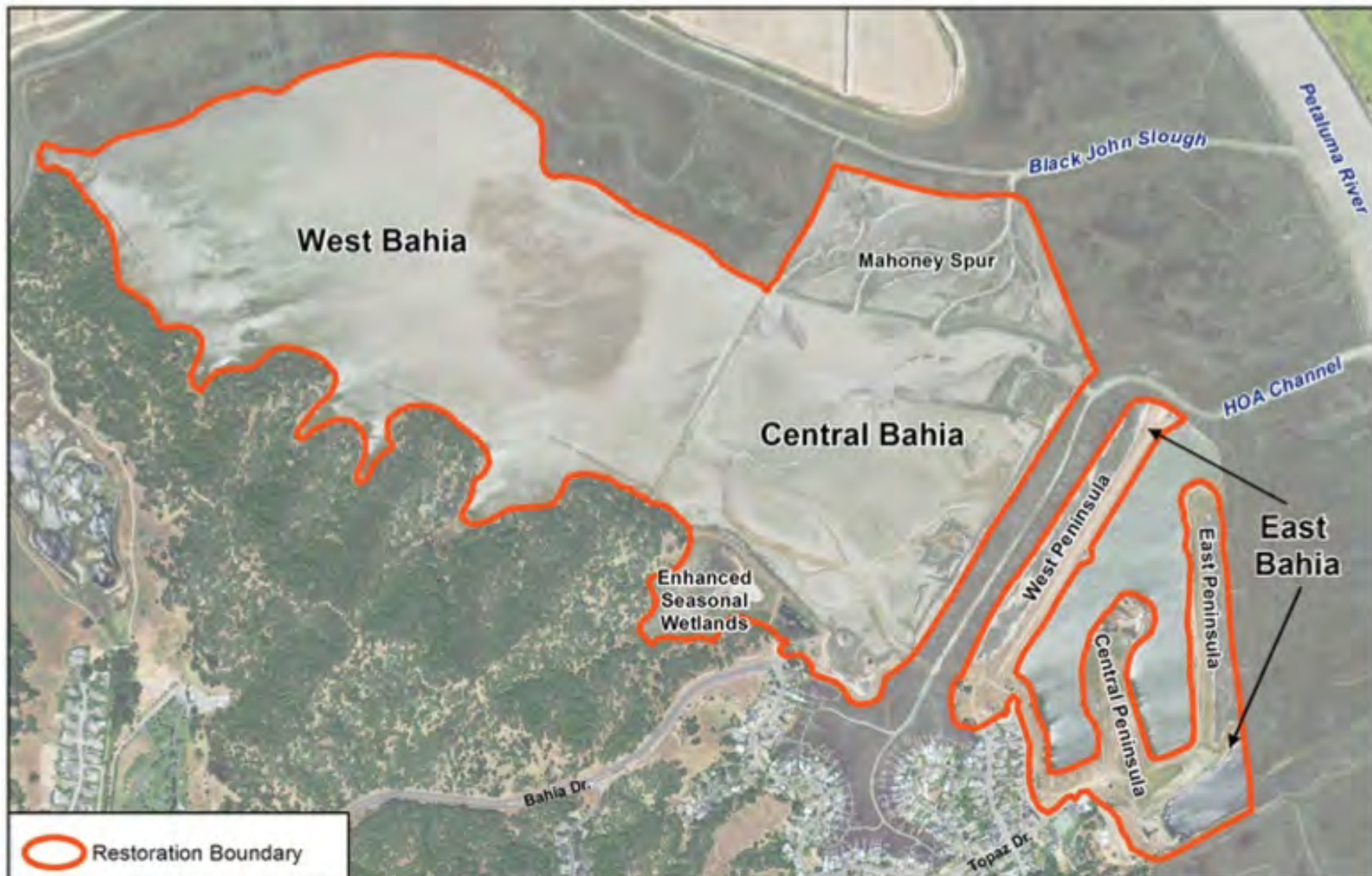







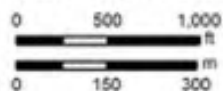
Bahia





 Restoration Boundary

1:12,000 (1" = 1,000' at letter size)



SITE FEATURES

Bahia Wetlands Restoration Project
Marin County, California
Marin Audubon Society

Data Sources: air photo (NAIP, 2012); Restoration Areas (WWR, 2012)
Produced by WWR: January 2013
Map File: site-features-veg-mon_AL_1156_2013-0130gal.mxd

January 2013

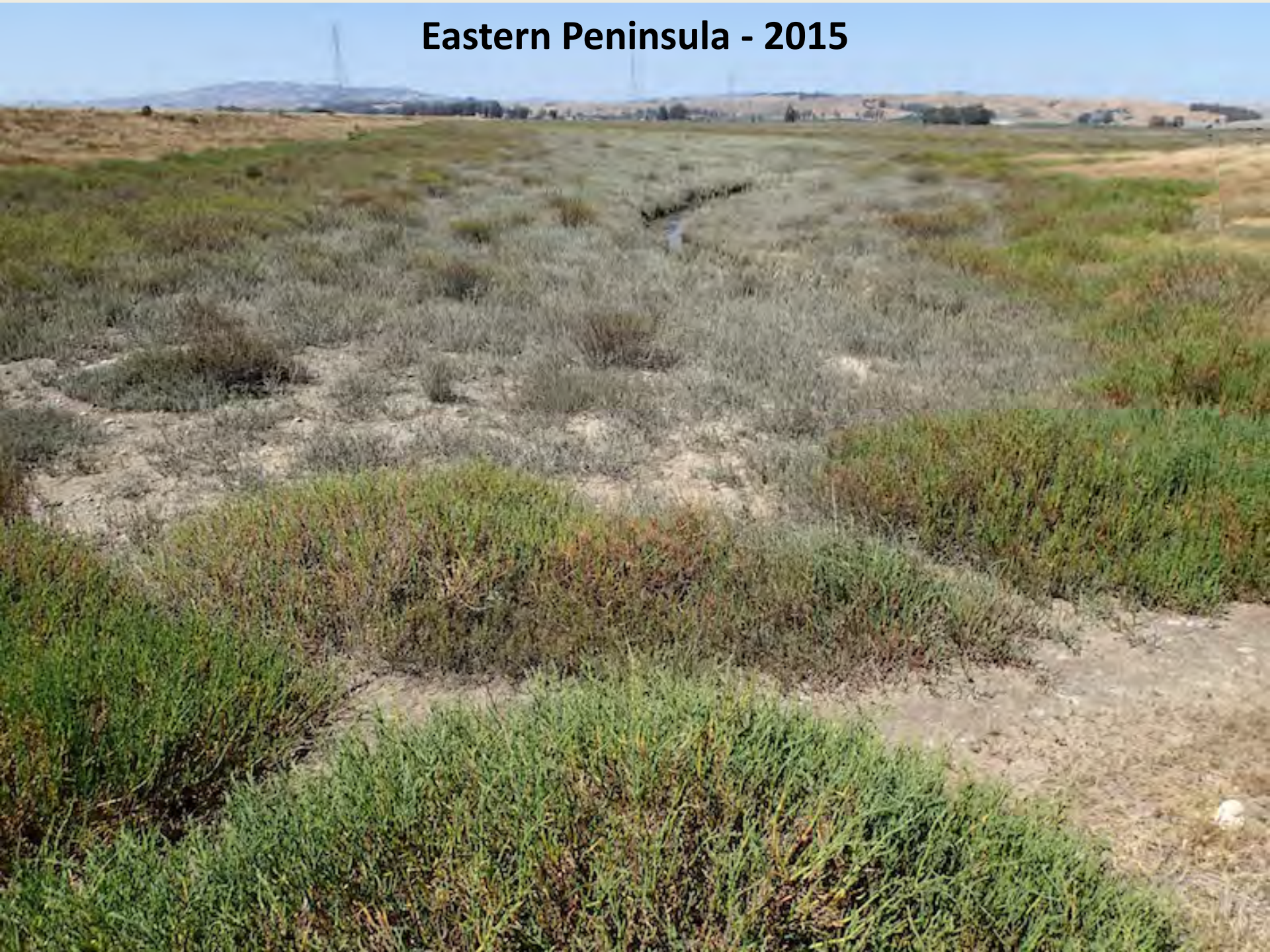
Project No. 1156

Figure 2





Eastern Peninsula - 2015





Petaluma Marsh Expansion Project

San Antonio Rd

Redwood

2005





9/30/2010 1:14pm

2007





Triangle Marsh



Triangle Marsh



2003

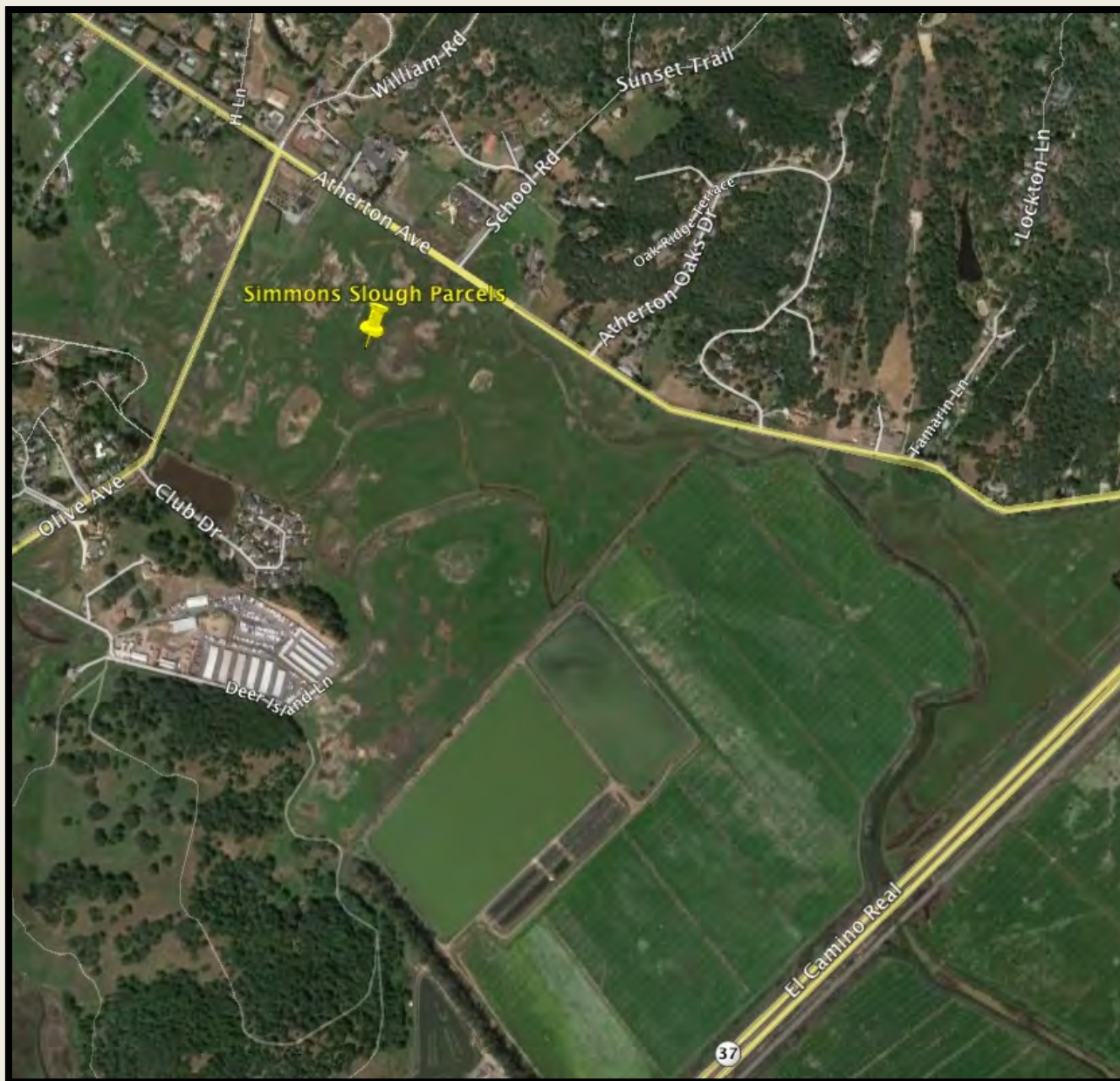
2
0
4



2
0



Simmons Slough





Other Marin Audubon Properties



Black Point Parcels- Novato



Arroyo de San Jose - Novato



**Arroyo de Corte Madera del Presidio
Mill Valley**



End of Channel – Corte Madera



Norton Pond - Novato



Murphy's Rock Tide Lot - San Rafael



Cal Park - San Rafael



Bahia Wildlife Habitat

Purchased by Marin Audubon Society

CONTRIBUTORS

- Marin County Open Space District
- Marin County Supervisors
- California Coastal Conservancy
- Wildlife Conservation Board
- CALFED Ecosystem Restoration Program
- Marin Community Foundation
- Marin Baylands Advocates
- Caltrans Environmental Enhancement & Mitigation Program
- Private donors to the Marin Baylands Fund
- North American Wetlands Conservation Council
- National Oceanic & Atmospheric Administration Coastal & Estuarine Land Conservation Program



IMPORTANT BIRD AREA

This site is part of a global
network of places recognized
for their outstanding value
to bird conservation.

Audubon

bird

Corte Madera Climate Adaptation Plan Overview



THE TOWN OF
Corte Madera
California

Marin Sea Level Rise Adaptation Workshop - March 21, 2019



Corte Madera,
Pop. 10,000
residents...who
ALL expect to be
protected

Corte Madera, California



Climate Adaptation Plan

- Purpose: become a resilient community
- Scope: all sectors, Town-wide, long-range
- Likely outcomes: significant investment and change

Corte Madera
Marsh 1926



Corte Madera
Marsh 1960

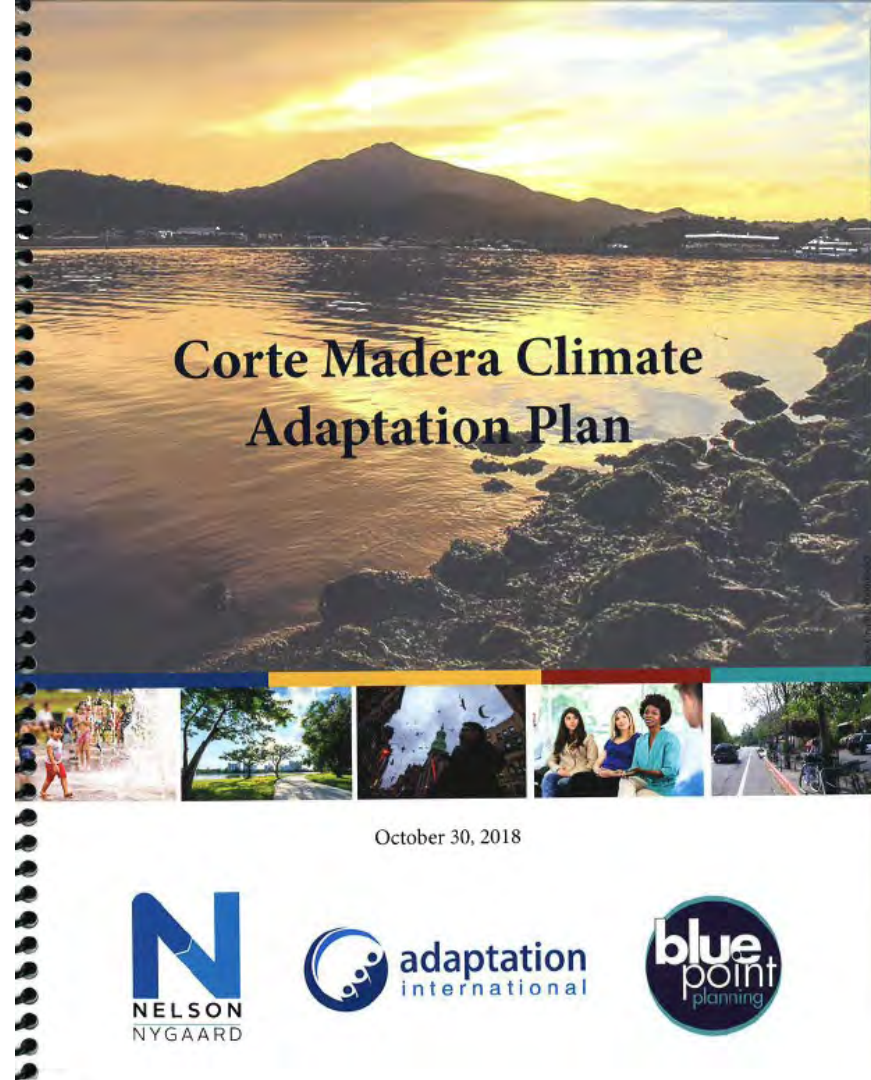


The Final Product....

A cutting-edge planning and guiding document

...that gives Town staff, elected
officials and citizens a 30- to 50-
year road map for how to
become a...

**RESILIENT AND CLIMATE-
READY TOWN!**

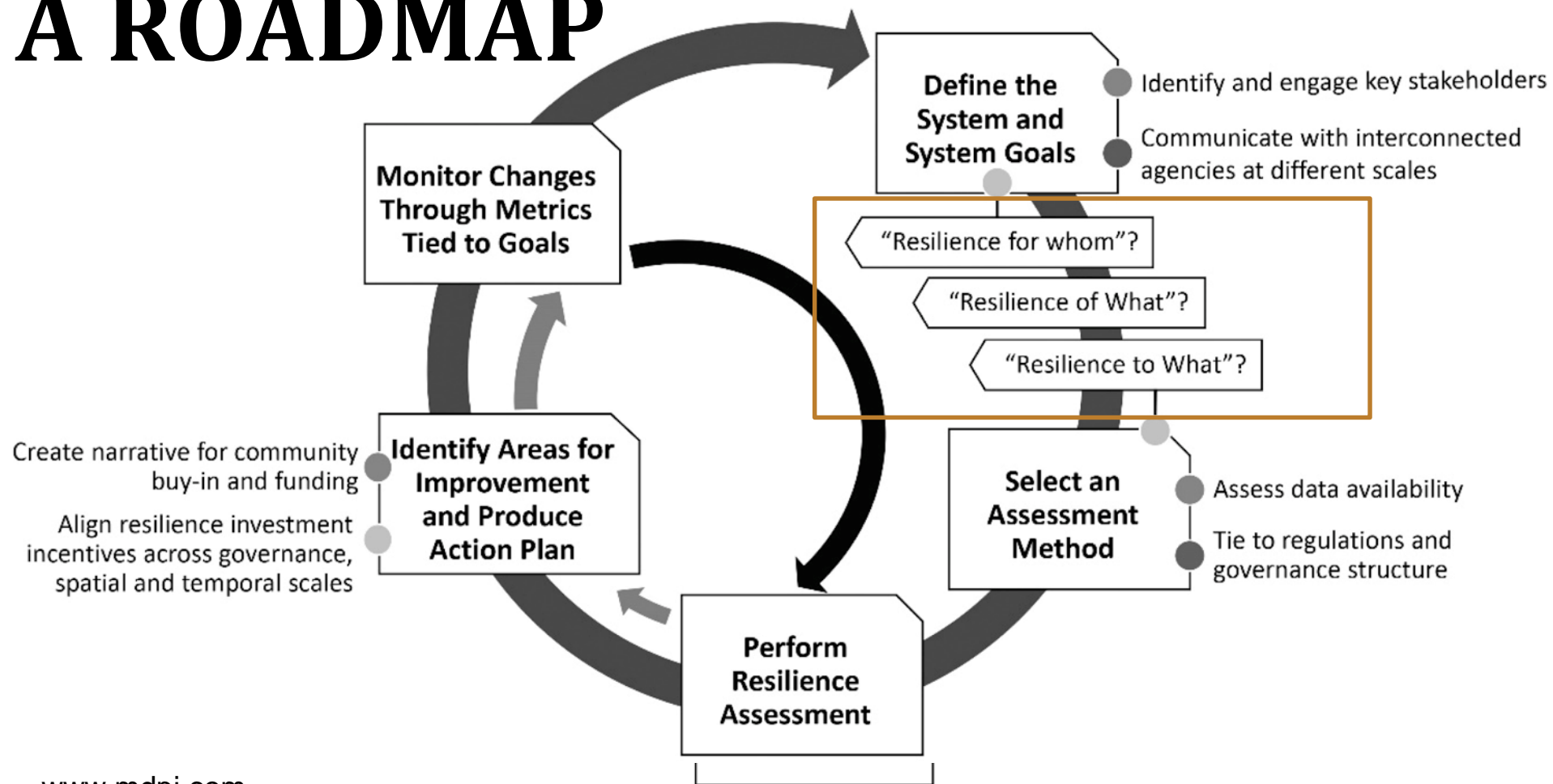


Corte Madera Climate Adaptation Plan

October 30, 2018

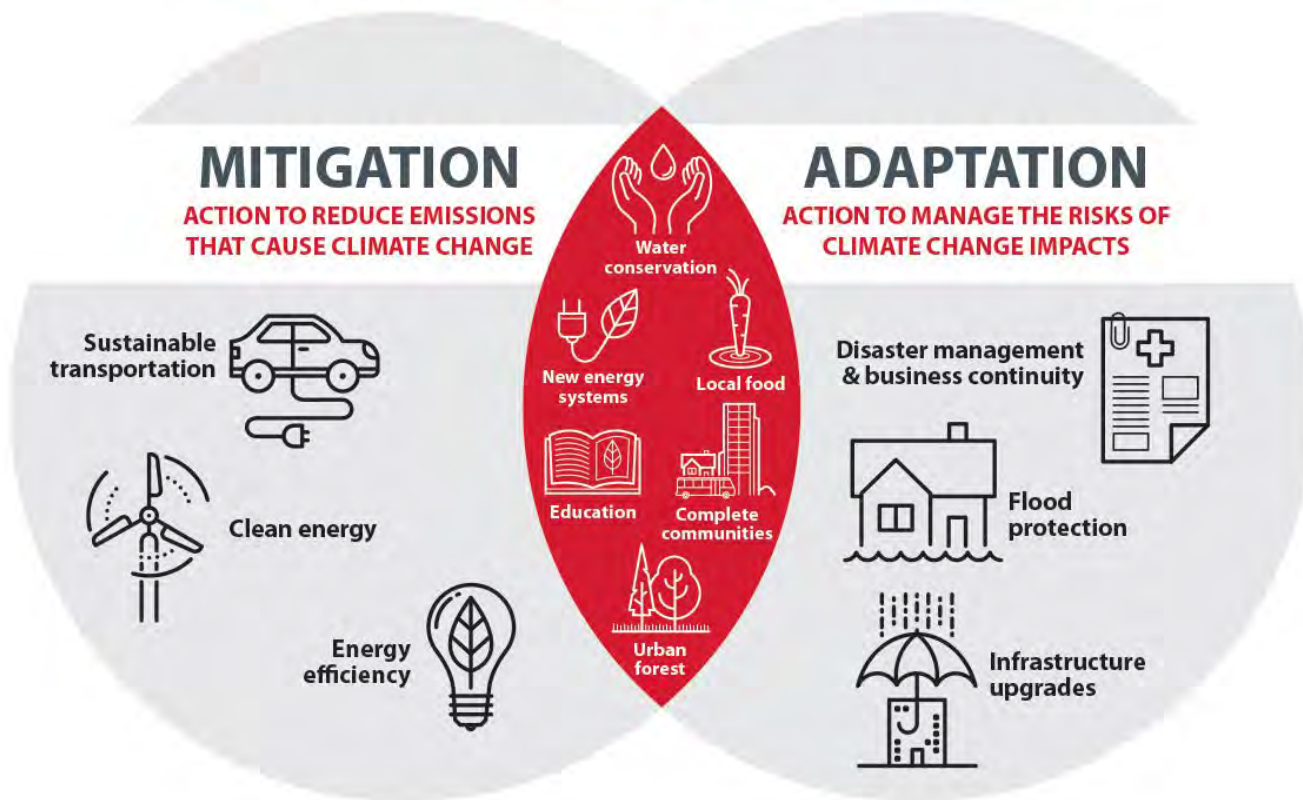


A ROADMAP

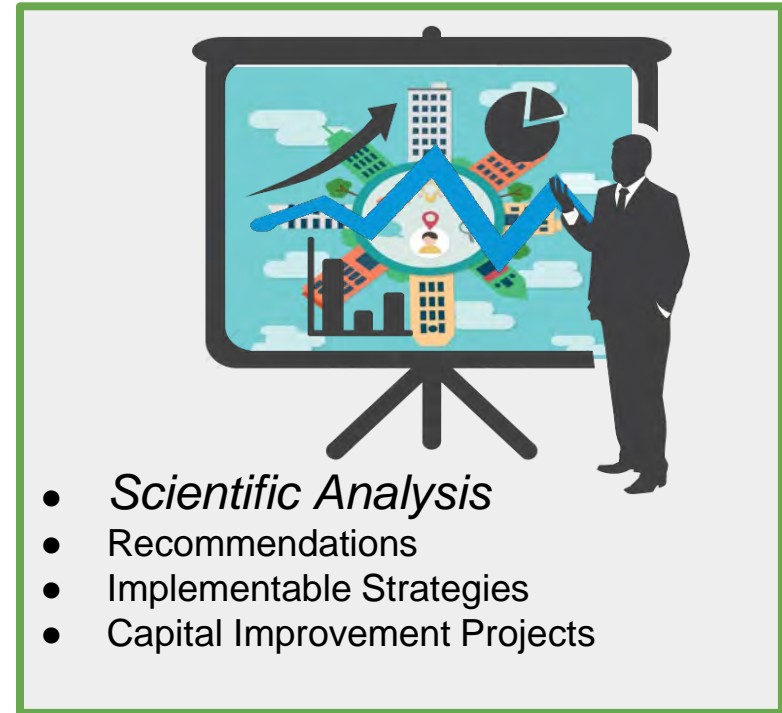
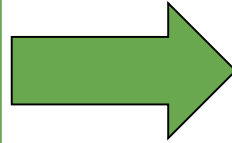


PURPOSE

Building Climate Resilience



Climate Adaptation Planning Process

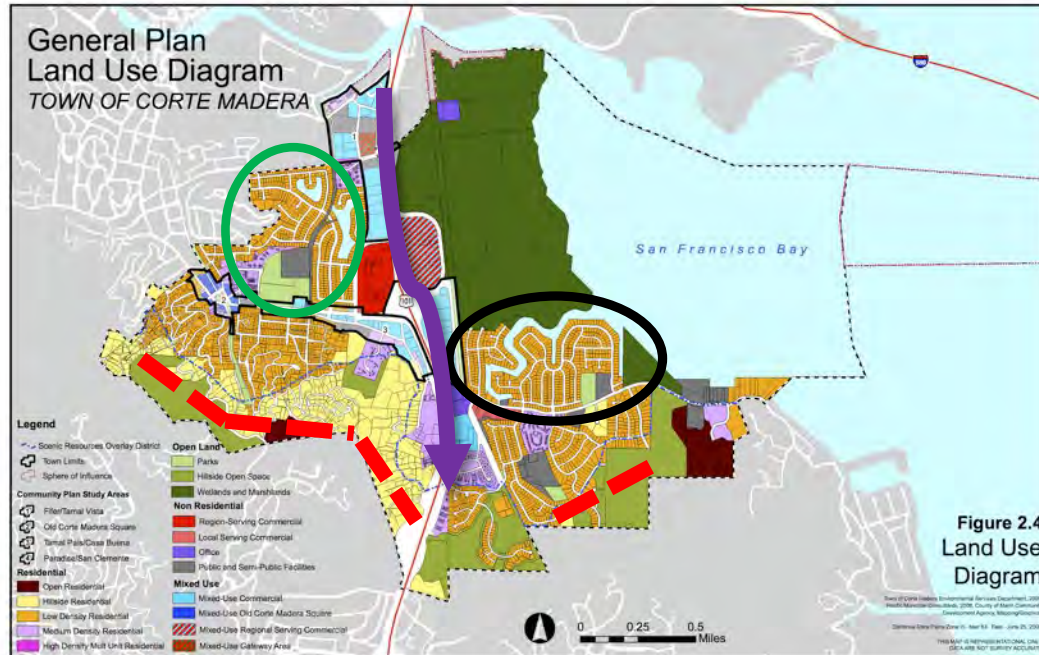


Caltrans Climate Adaptation Planning Grant \$200,000, plus about a 90 percent Town cash/staff time match.

The Climate Adaptation Plan will provide... Analysis for the Town's transportation/flood control infrastructure, land uses, economic centers and natural habitats for retreat, retrofit or reinforcement - **using AGILITY and FLEXIBILITY**

Corte Madera Climate Adaptation Plan

Address Climate Change Vulnerabilities: SLR, drought, wildfire, transport, economy



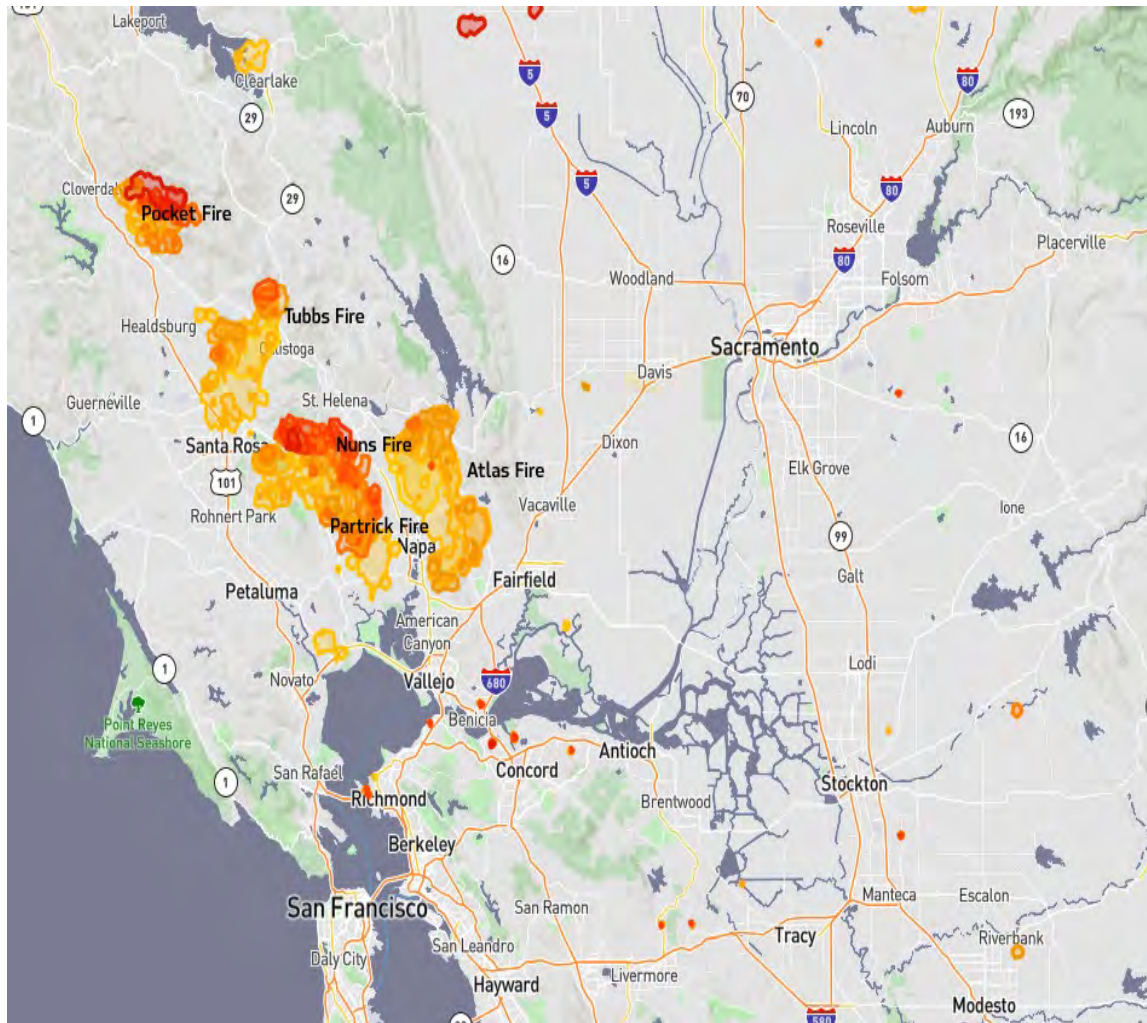
“CAP provides a framework for Town staff, Town’s elected officials, and a diverse community of stakeholders to make critical decisions that address the Town’s extensive range of climate change vulnerabilities.”

- Peter Brown, PW Director

Wildfire Causes?

- Forest management
- Urban expanse into Wildland Urban Interface (WUI)
- and 150 years of fire suppression which increases fuel loads...

Have combined with drought
and more extreme weather
to increase wildfire frequency



CAMP FIRE

113,000 ACRES BURNED

25% CONTAINED

UPDATED: NOVEMBER 12, 2018 7:32 AM

Source: fire.ca.gov



CHICO



PARADISE



PULGA

CONCOW





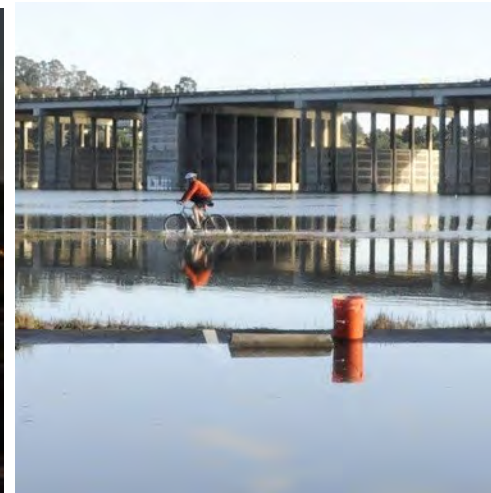
HIGH FIRE RISK

Into Thursday Night

- Gusty north winds
- Very dry vegetation
- Relative humidity 10-20%



Corte Madera CAP - Primary Focus: climate impacts of **SEA LEVEL RISE** and **FLOODING**



as well as **DROUGHT, WILD FIRE READINESS, TRANSPORTATION SYSTEM, and ECONOMY**

Sea level rise (SLR) infrastructure, increased precipitation, extreme weather events, King Tides, marsh restoration, water quality, ecological health, habitat restoration, and tidal flows. This project will evaluate the impacts of flooding and sea level rise scenarios, and wildfire/drought, to transportation infrastructure and access to transit, and changes in land uses and natural habitats.

Increase in Sea Level Rise Projections

California Coastal Commission

“Be prepared for the possibility that oceans will rise more than 10 feet by 2100”

Earlier Coastal commission guidance put top sea-level rise at 6 feet by 2100. But according to the new [report](#), there's the “potential for rapid ice loss to result in an extreme scenario of 10.2 feet of sea level rise” by the end of the century.



It is virtually certain that global mean sea level rise will continue for many centuries beyond 2100

April 2017 illustration showing wide swaths of southeastern San Francisco that could be flooded by 2100 if sea rise and storm surge reach 8 feet. New projections anticipate up to three times that during high tides. Illustration: Marcea Ennamorato and HyunJu Chappell // San Francisco Public Press. <https://sfpublicpress.org/news/2018-03/state-looking-to-require-cities-to-plan-for-rising-seas>

Surging Seas RISK ZONE MAP

English (US)



Enter a global coordinate



Water level



10

9

8

7

6

5

4

3

2

1

ft

m

Show current coast

See projections

Legend

Social vulnerability

Population

Ethnicity

More...



Elevation data courtesy of NOAA

2

Sea level tools and analysis by CLIMATE CENTRAL

About Us | Disclaimer | Terms | Privacy | Contact

3 Feet

Source: Climate Central,
<http://sealevel.climatecentral.org/> Climate Central's
[terms of use](#).

English (US) ▾

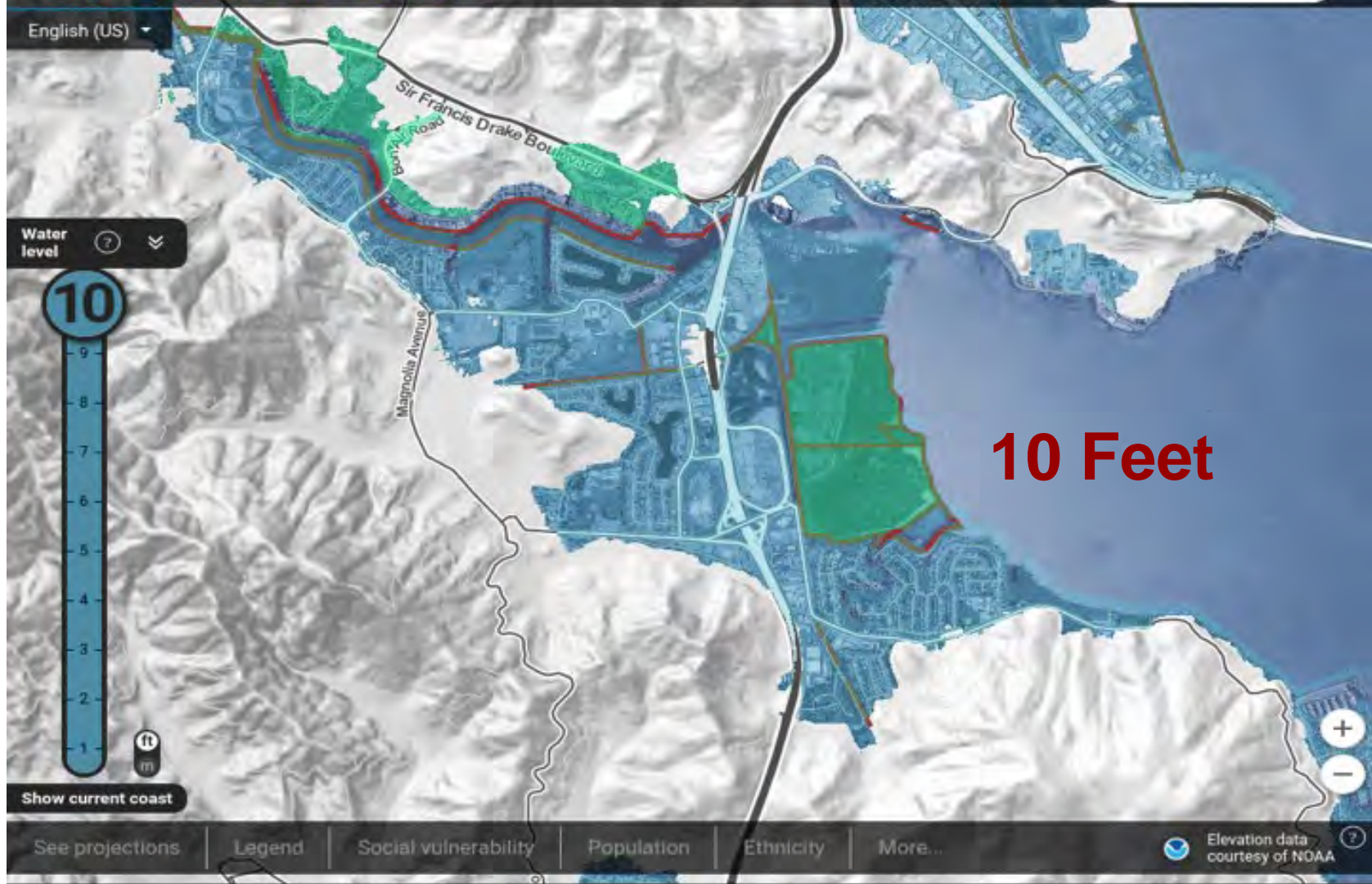
Water level ⓘ ⌵



ft
m

Show current coast

6 Feet



A Living Document for a Thriving Ecosystem

CAP should be updated every 5 years to ensure that the Town is keeping pace with current strategies, emerging technology and rates of climate change

Plan completion: Late 2020

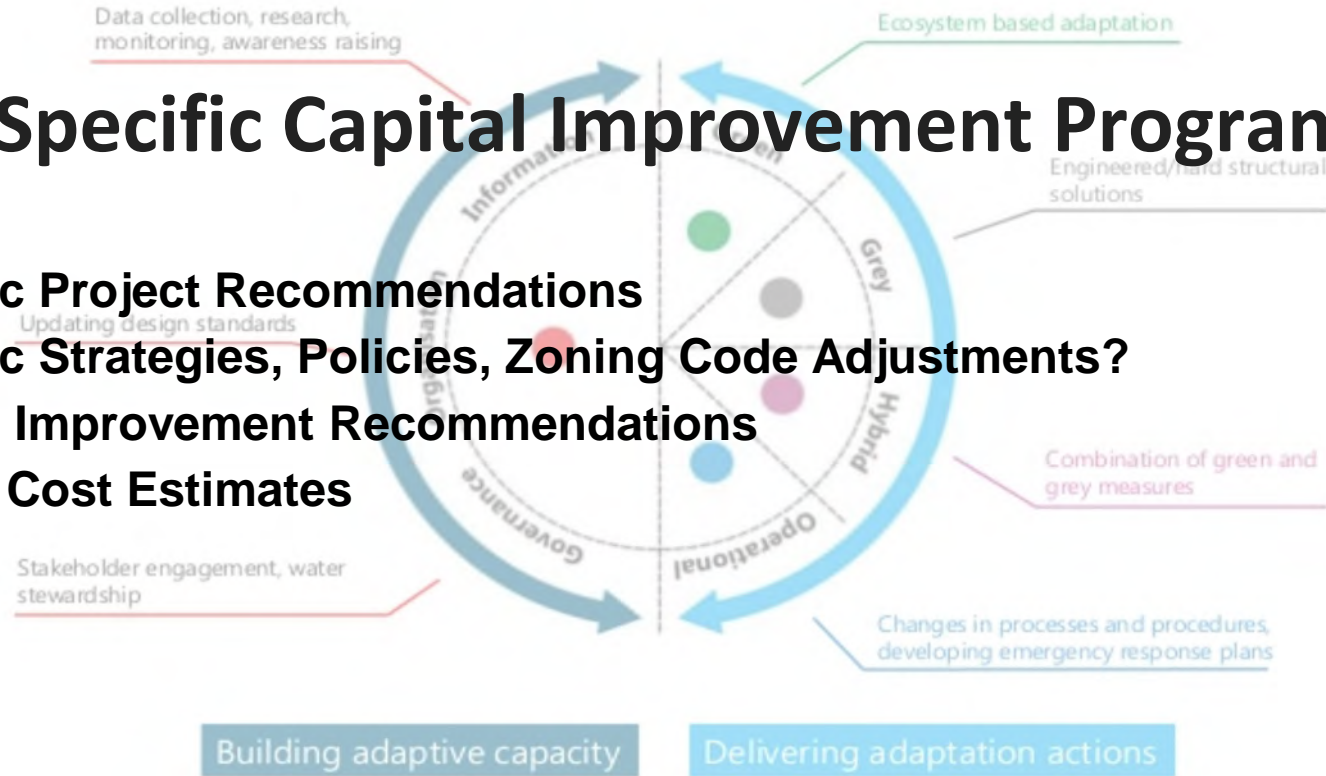


Adaptation and resilience measures

Outcomes

CAP-Specific Capital Improvement Program

- Specific Project Recommendations
- Specific Strategies, Policies, Zoning Code Adjustments?
- Capital Improvement Recommendations
- Rough Cost Estimates



CAP Cost Estimates will Include:

→ Cost Sharing Plans

→ Public Partnerships

- ◆ Caltrans and Town share costs to protect US101 and key land uses
- ◆ May identify opportunities to partner with other local agencies

→ Public-Private Partnerships

- ◆ The Village / Town Center partner with Town/Caltrans
- ◆ If residential areas that are heavily reliant on SLR protection systems are recommended for protection rather than restoration or retreat, those property owners may be required to contribute funding

Wetland Restoration, Corte Madera Marsh

- Wetlands = natural buffer against sea level rise
- Improve water quality
- Improve habitat quality and habitat connectivity
- Improve natural resilience of the baylands
- Wave attenuation
- Vegetation and root systems act as a trap for sediment accretion and reduce erosion
- Existing seawalls and other shoreline protective devices result in the loss of beaches, wetlands, and other habitats by preventing these areas from migrating inland.



Photo Credit: R.J. Suokko, Senior Civil Engineer, Town of Corte Madera, Public Works

CM's CAP will focus on creation of marshlands that can migrate upland as a buffer against sea level rise and King tides, and as protection of existing natural barriers – NBS.

Sensitive and Emotional Challenges

Nationally - complex systems are in play and combined with democracy - difficult decisions around selecting and prioritizing infrastructure investments will ultimately determine which neighborhoods, towns, and cities will thrive or fail in the next 50-100 years, and at what cost.



Questions, comments?



R.J. Suokko, Senior Civil Engineer

Peter Brown, Director of Public Works

David Kunhardt, Council Member

MARIN COUNTY
PARKS
PRESERVATION • RECREATION



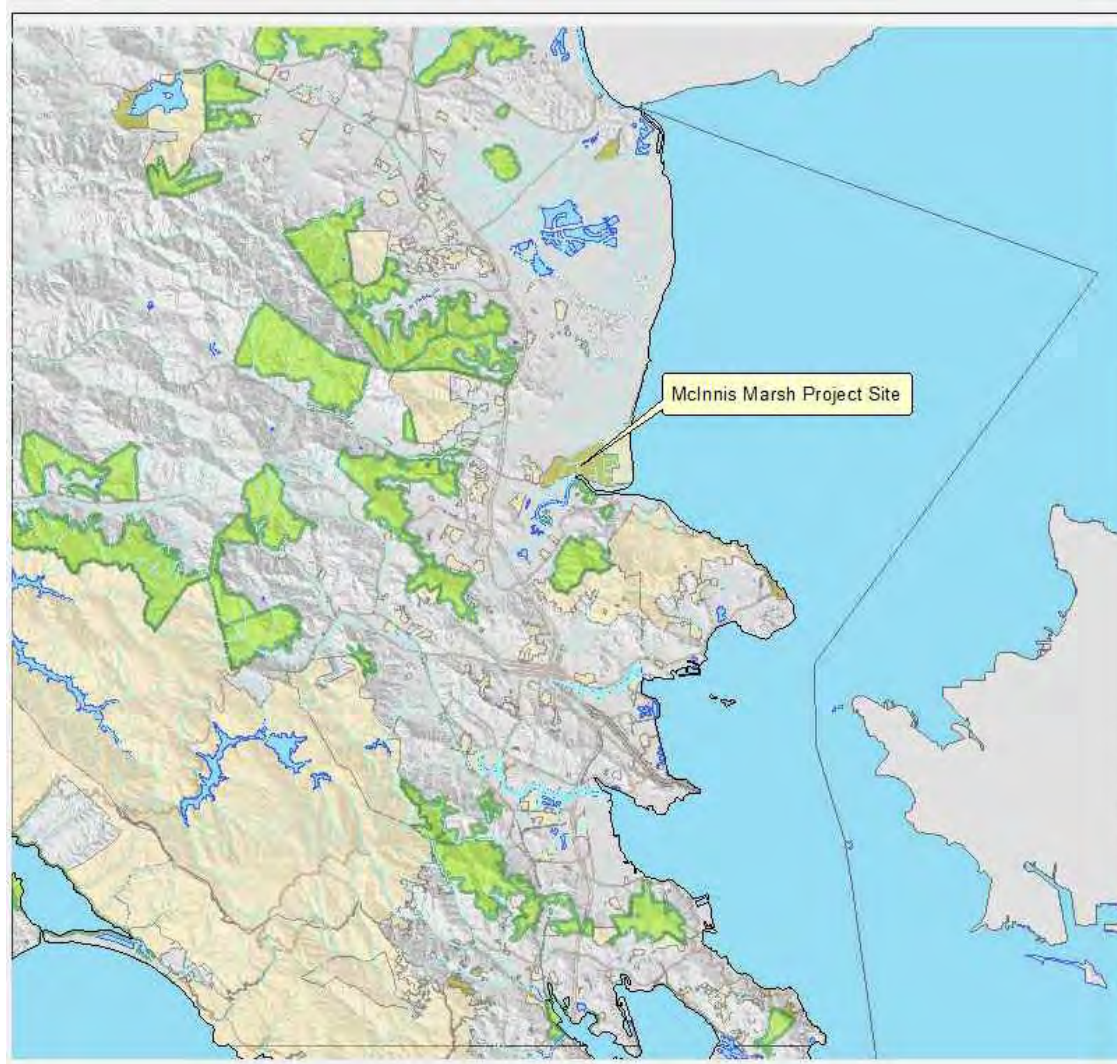
McInnis Marsh Restoration Project

MCINNIS MARSH



McInnis Marsh

Location Map

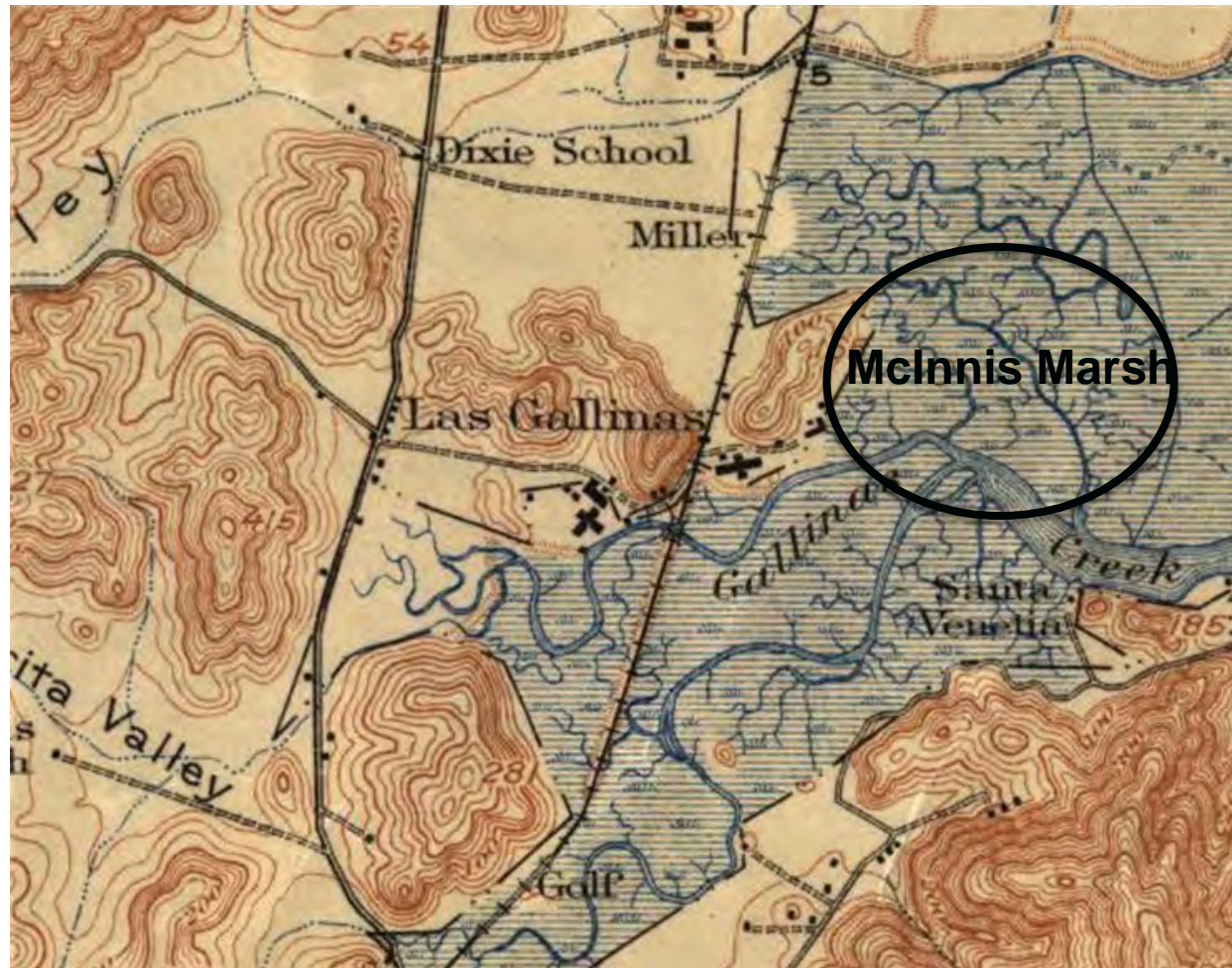


MCINNIS MARSH RESTORATION PROJECT



MCINNIS MARSH

HISTORIC BAYLANDS (1914)



MCINNIS MARSH

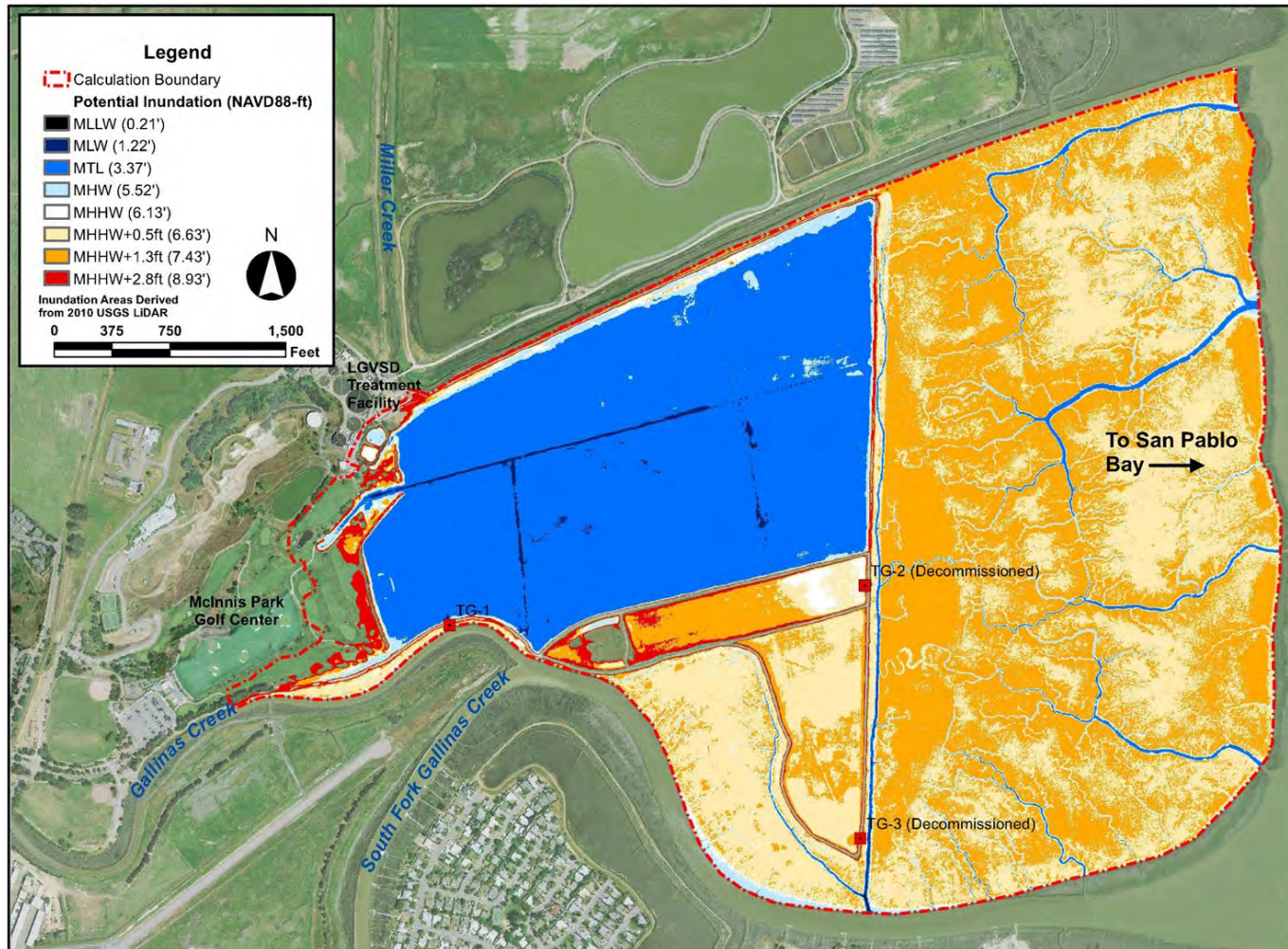
SPECIAL STATUS SPECIES



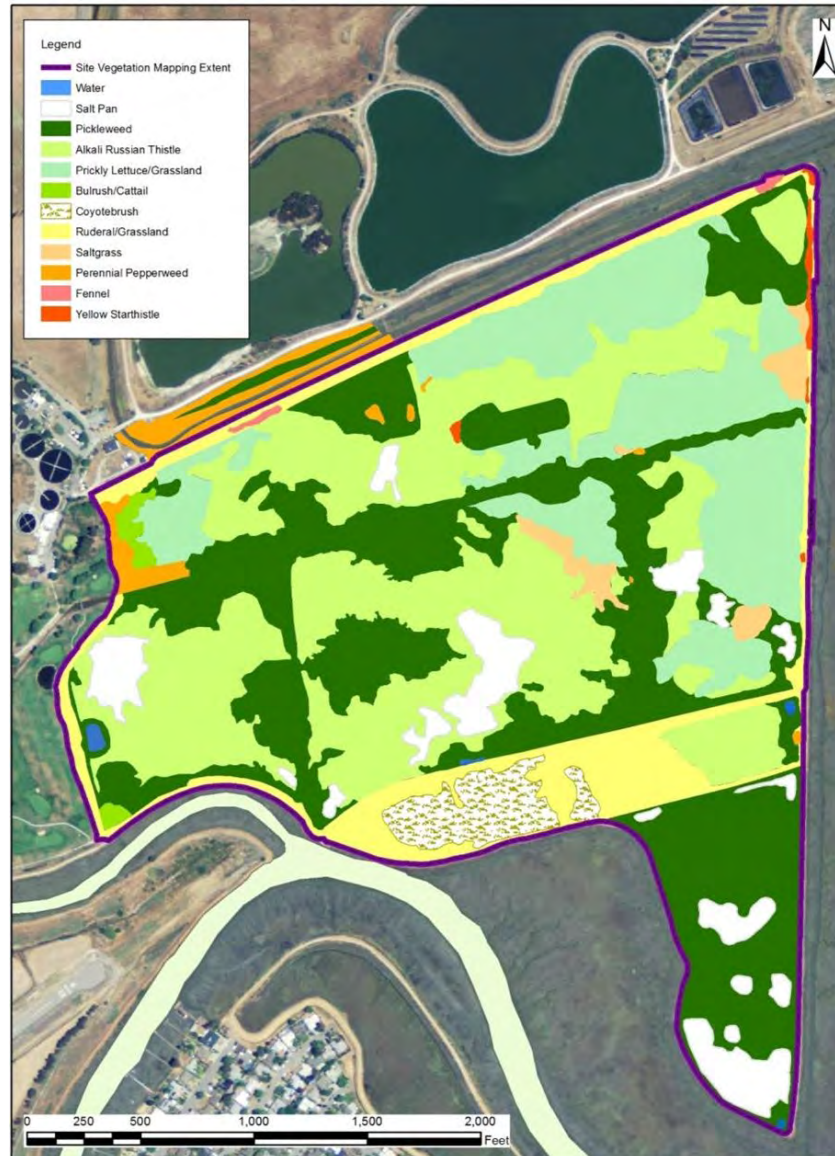
© Tara McIntire

- Ridgeway's Rail (*Rallus obsoletus*)
- Saltmarsh Harvest Mouse (*Reithrodontomys raviventris*)
- California Black Rail (*Laterallus jamaicensis coturniculus*)
- Central California Coast Steelhead (*oncorhynchus mykiss irideus*)

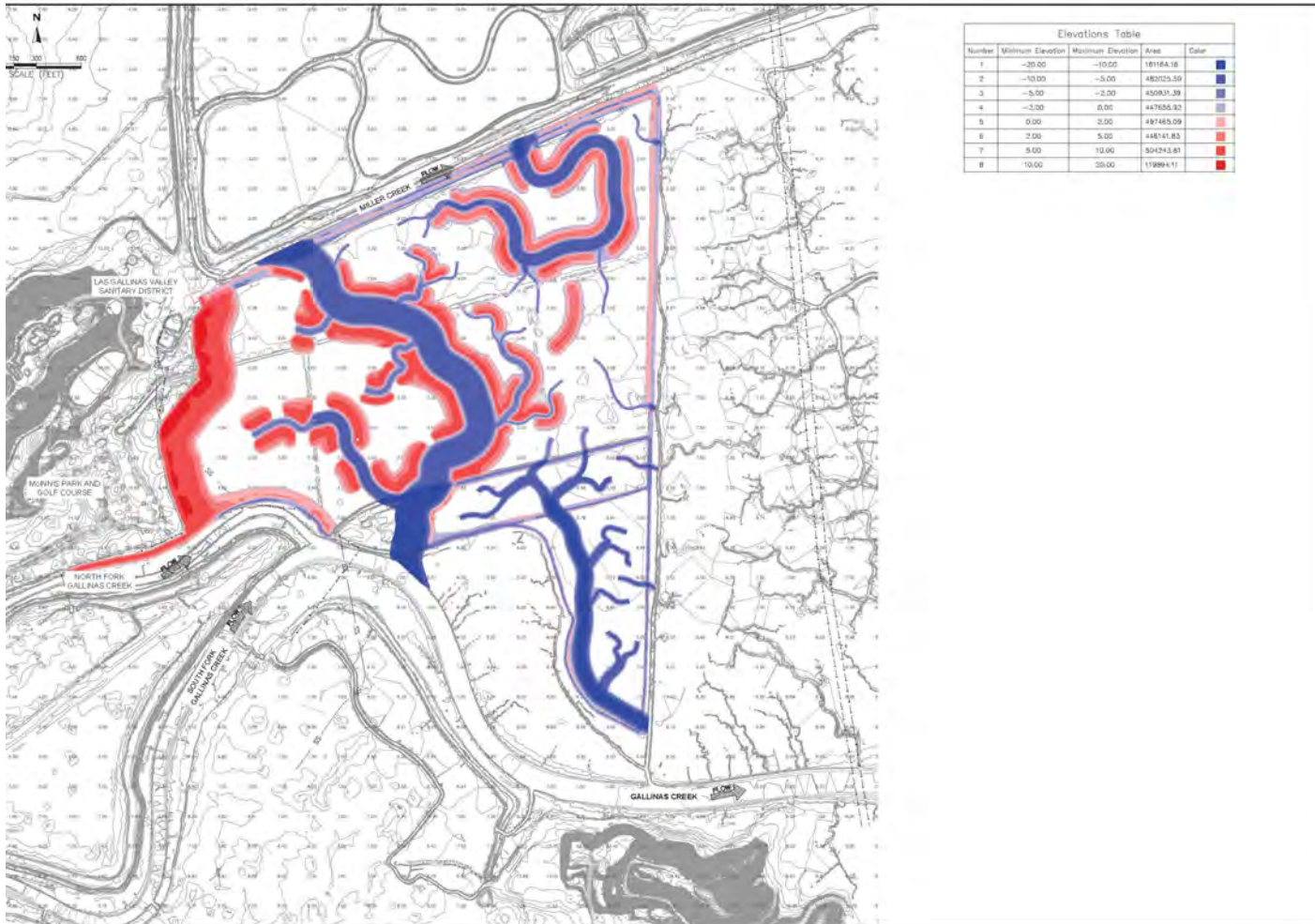
MCINNIS MARSH FLOOD ELEVATIONS



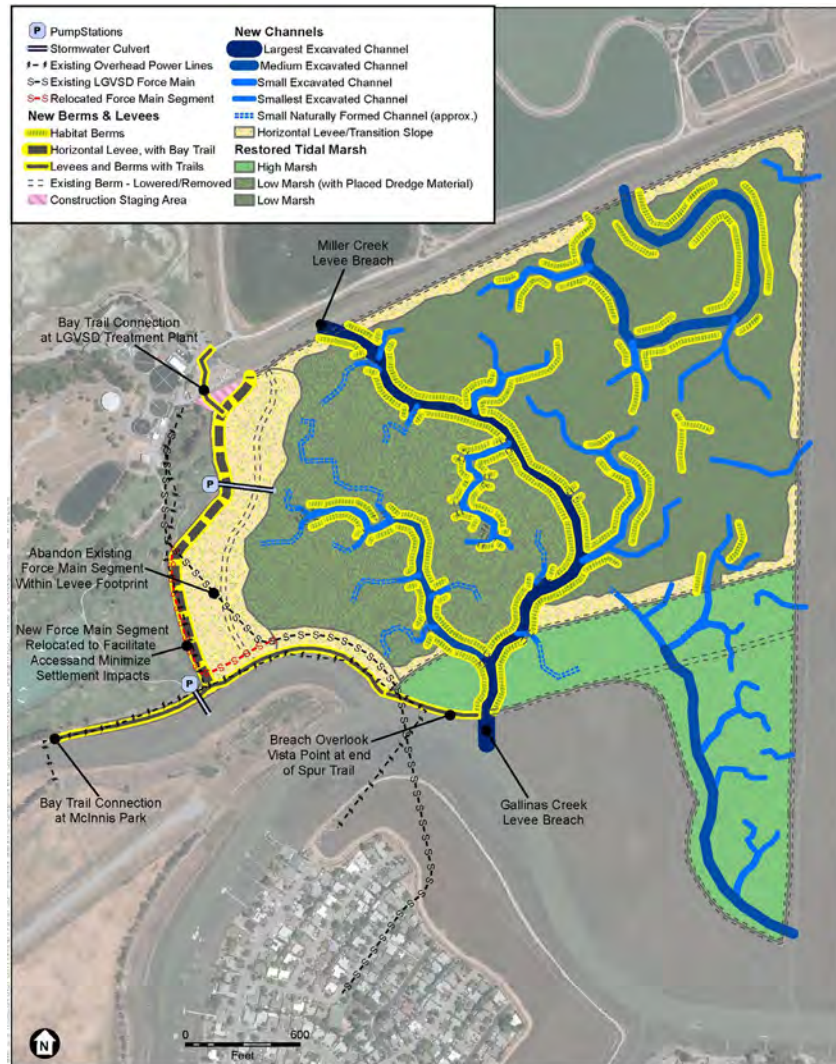
MCINNIS MARSH EXISTING VEGETATION



MCINNIS MARSH CUT AND FILL



MCINNIS MARSH CONCEPTUAL PLAN



SOURCE:

ESA (2018)

ESRI Aerial Imagery, 2017.



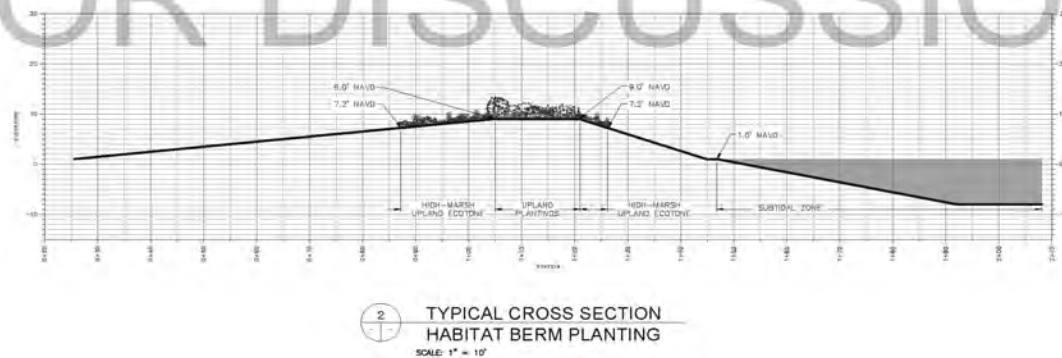
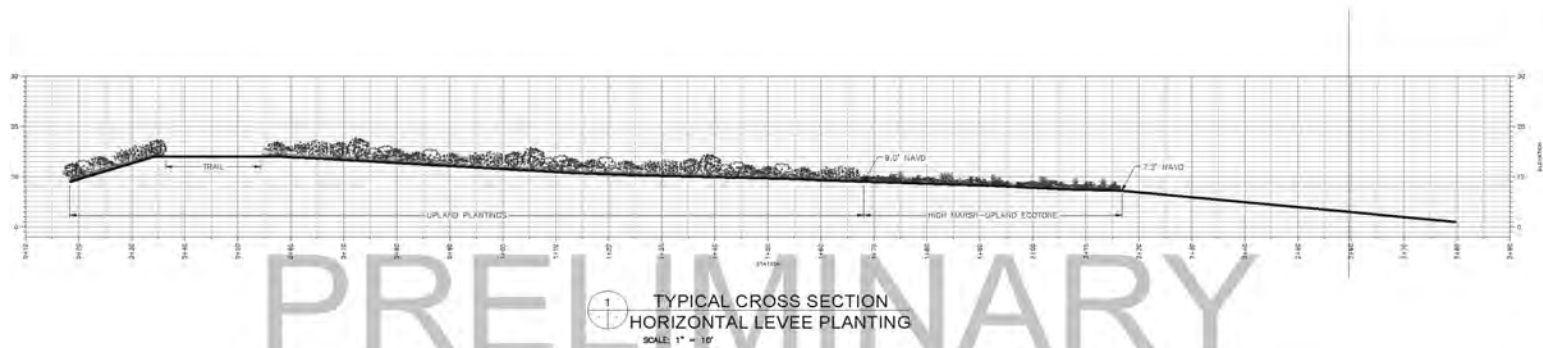
McInnis Marsh Restoration Project

Figure 3

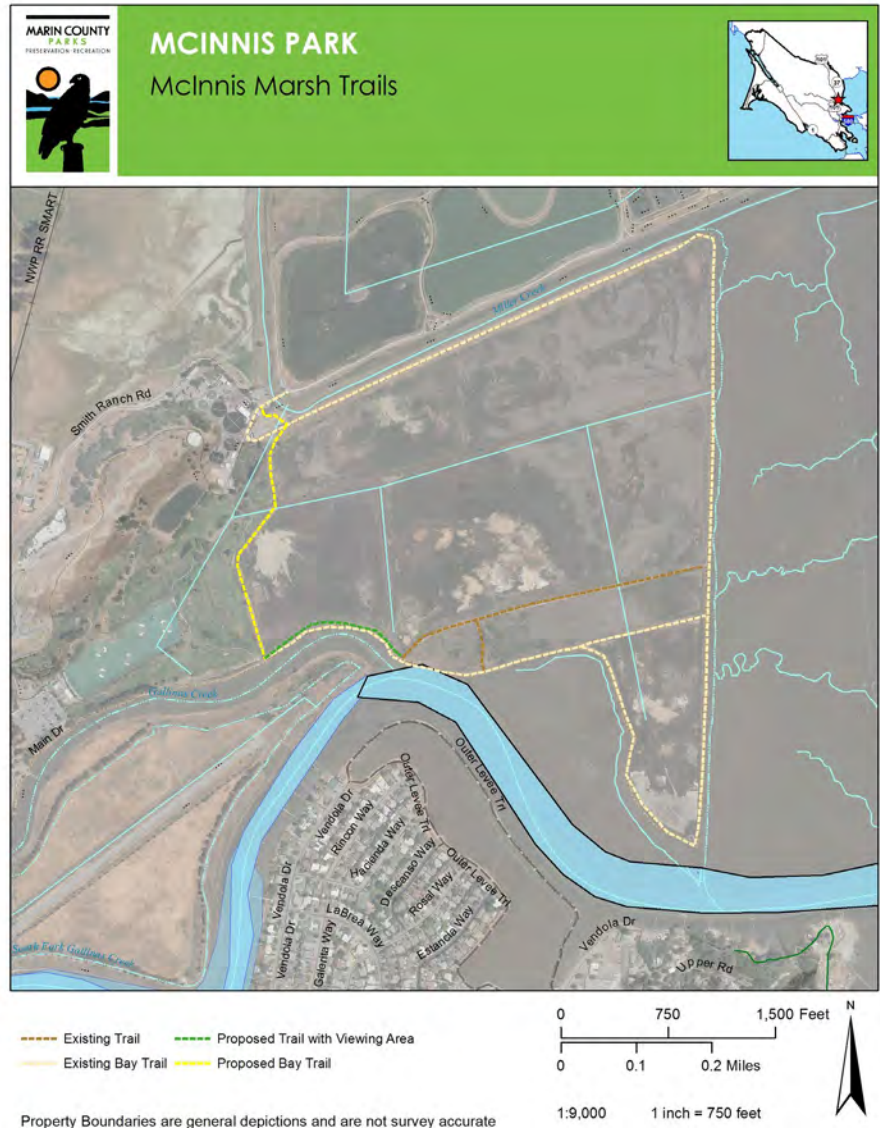
McInnis Marsh Restoration
Phase 2 Restoration Concept

**Conceptual, Subject to Change
DRAFT 9/10/2018**

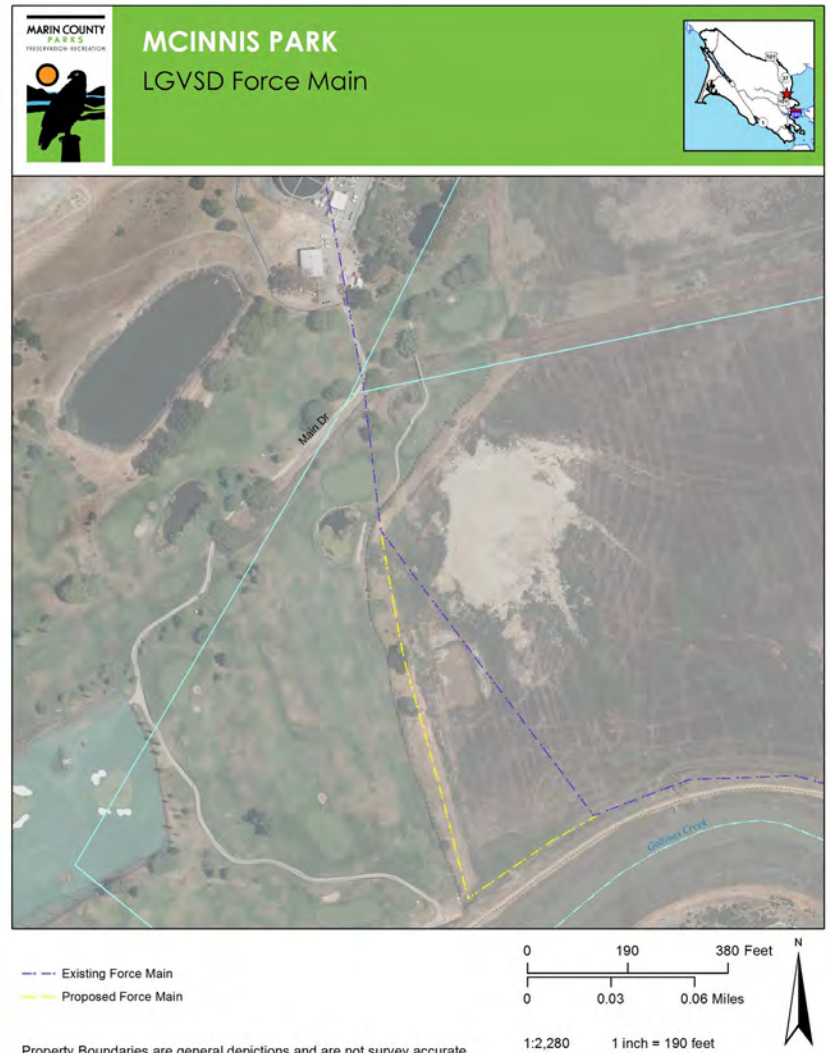
MCINNIS MARSH LEVEE/BERM CROSS-SECTIONS



MCINNIS MARSH TRAILS



LGVSD FORCE MAIN



MCINNIS MARSH



Main Office

3501 Civic Center Drive, Suite 260
San Rafael, CA 94903

Website: marincountyparks.org

Phone: (415) 473-6387



@marincountyparks



@marinparks



@marincountyparks



youtube.com/marinparks

San Francisco Bay Living Shoreline Project

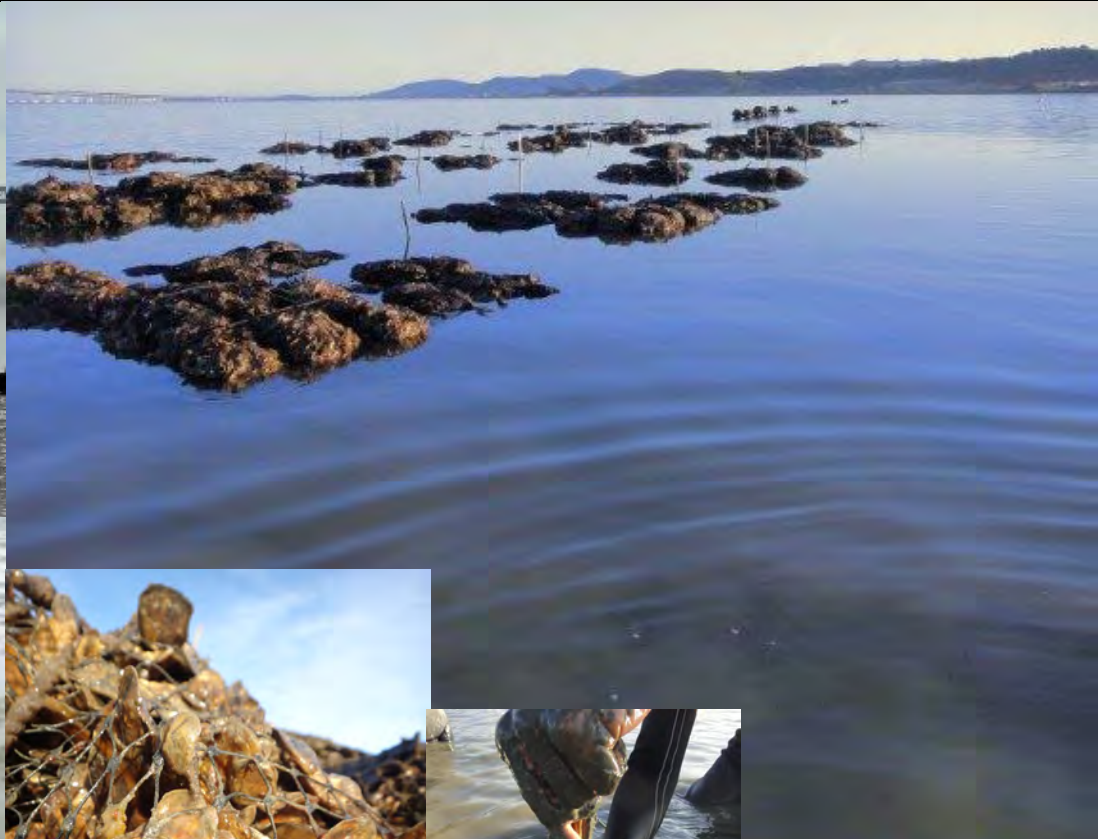


SAN FRANCISCO
STATE UNIVERSITY

UC DAVIS

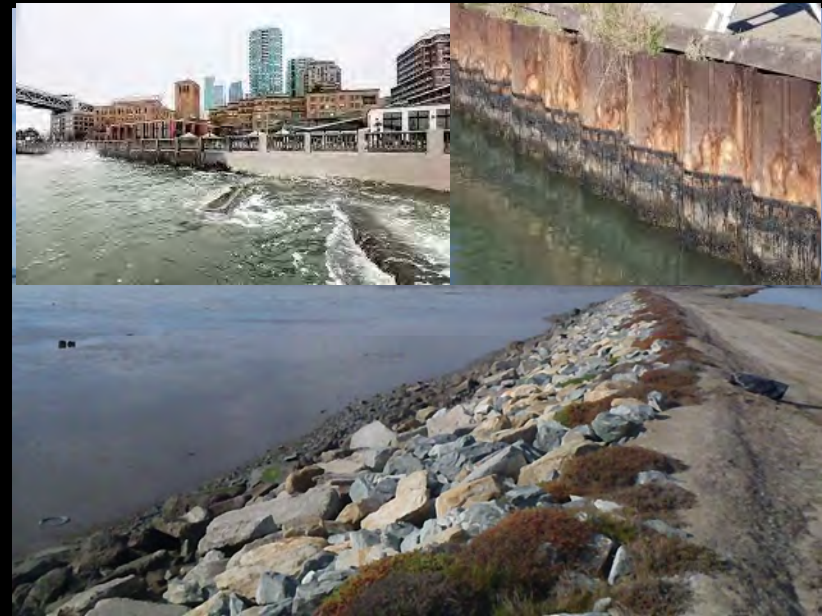


State of California
Coastal Conservancy



Hard Infrastructure

**Necessary in certain locations
Impacts to shorelines, wetlands
and subtidal habitats**



Nature-Based Infrastructure

**Biological and Physical Benefits
Habitat Connectivity
Climate Adaptation**



Living Shorelines

Living Shorelines can include any **shoreline management system** that is **designed to protect or restore natural shoreline ecosystems** through the use of natural elements and, if appropriate, manmade elements.



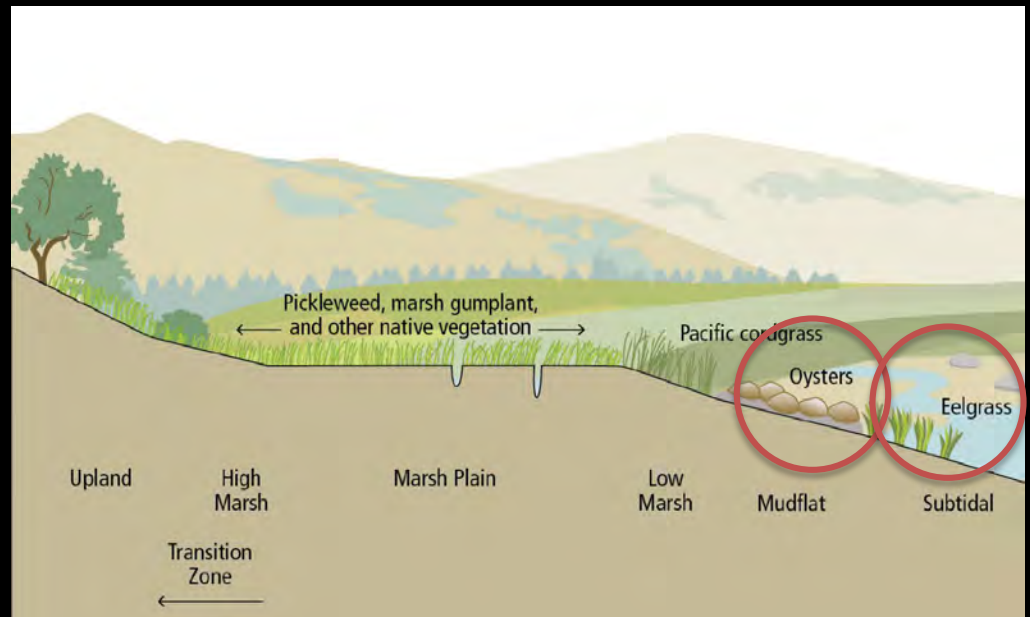
Living Shoreline Principles

- Restoration with multiple objectives
 - Reduce shoreline erosion
 - Maintain coastal processes
- Protect and enhance habitat values for fish and wildlife
- Adapt to sea level rise and climate changes
- Link to regional habitat recommendations



Overarching Project Goal

To create **biologically rich and diverse** subtidal and low intertidal habitats, including **eelgrass and oyster reefs**, as part of **a self-sustaining** estuary system that **restores ecological function** and is **resilient** to changing environmental conditions.



Site Specific Considerations

Existing Uses

Parcel Ownership

Bathymetry

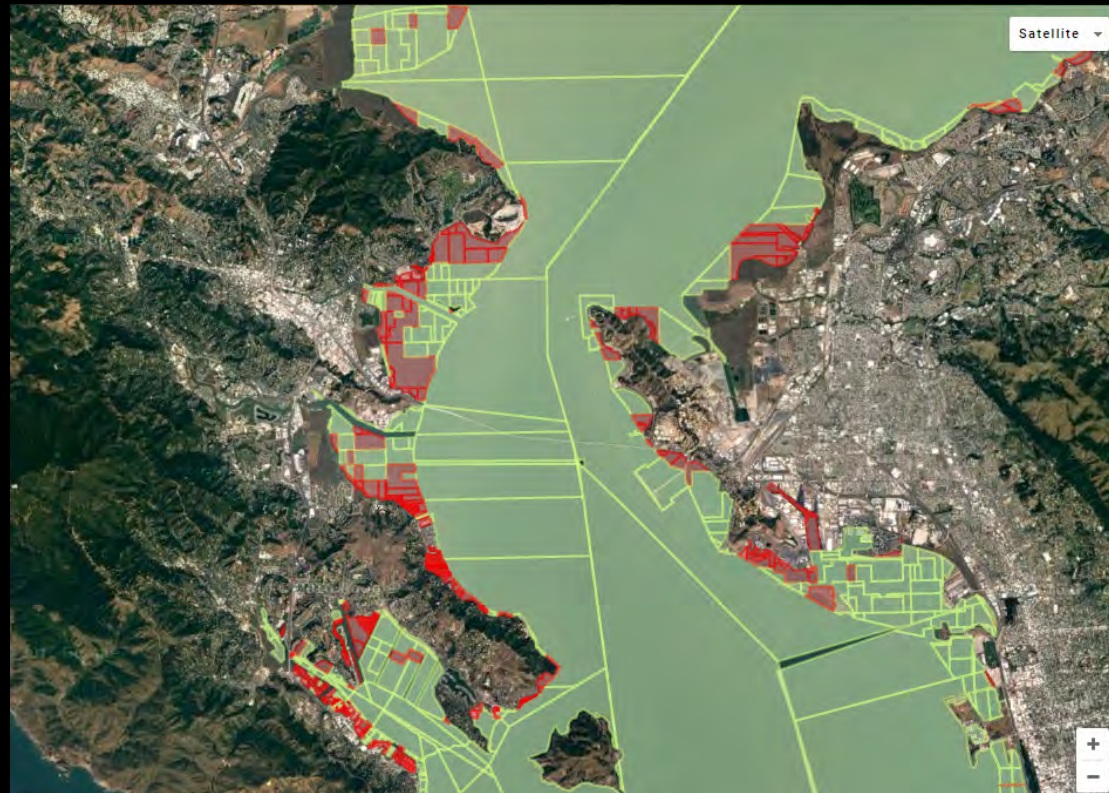
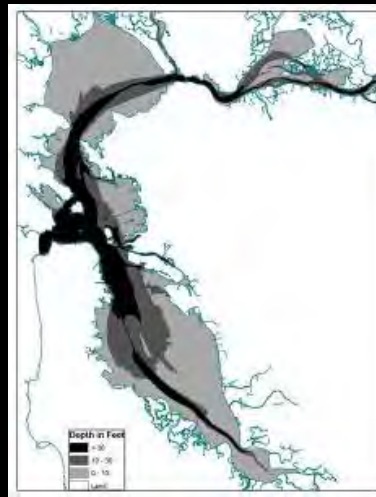
Depths for Habitat Restoration
Depths for Access

Orientation to Wind/Waves

Existing Species and Habitats

Sea Level Rise Modeling

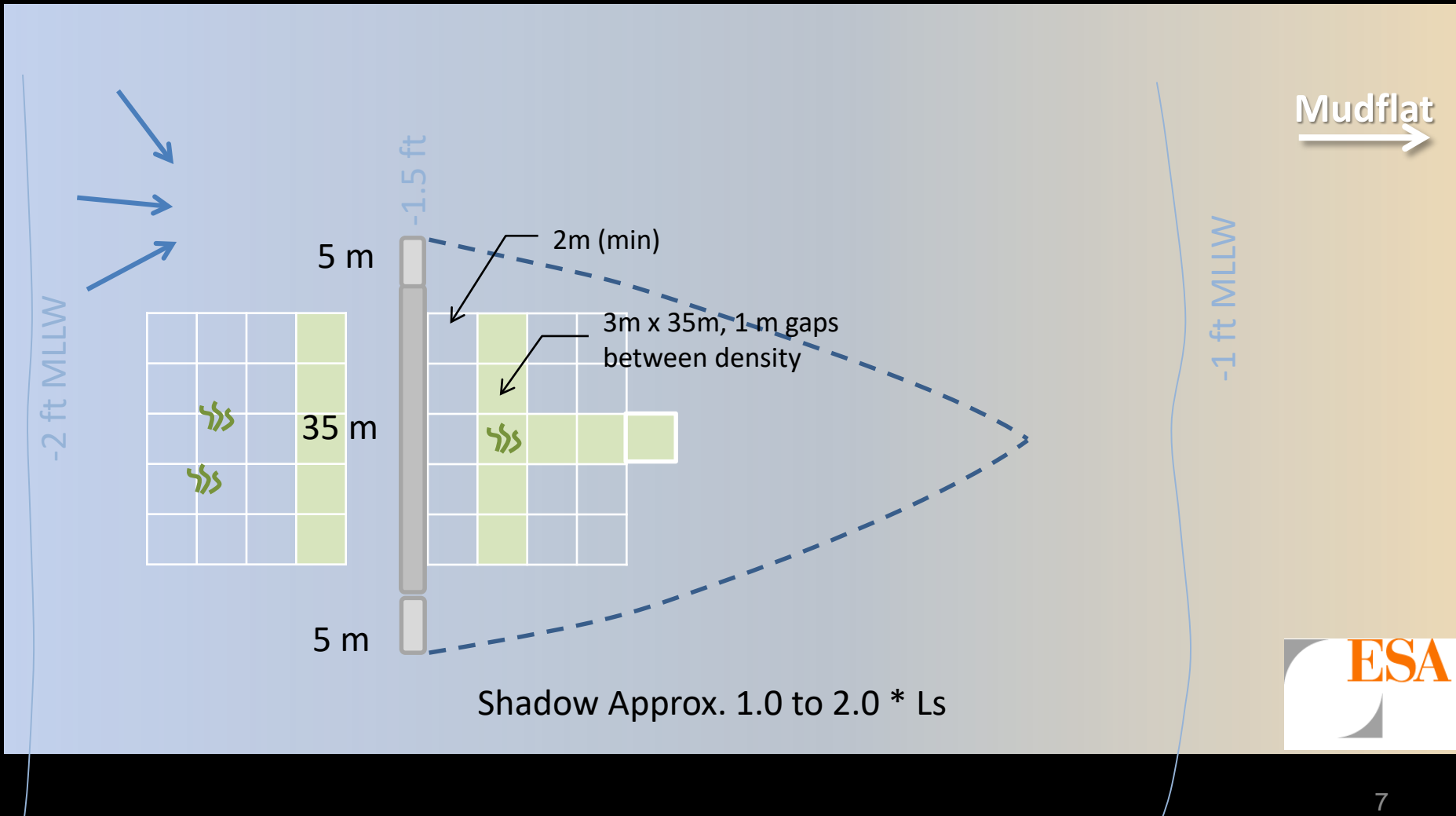
Physical Space Required

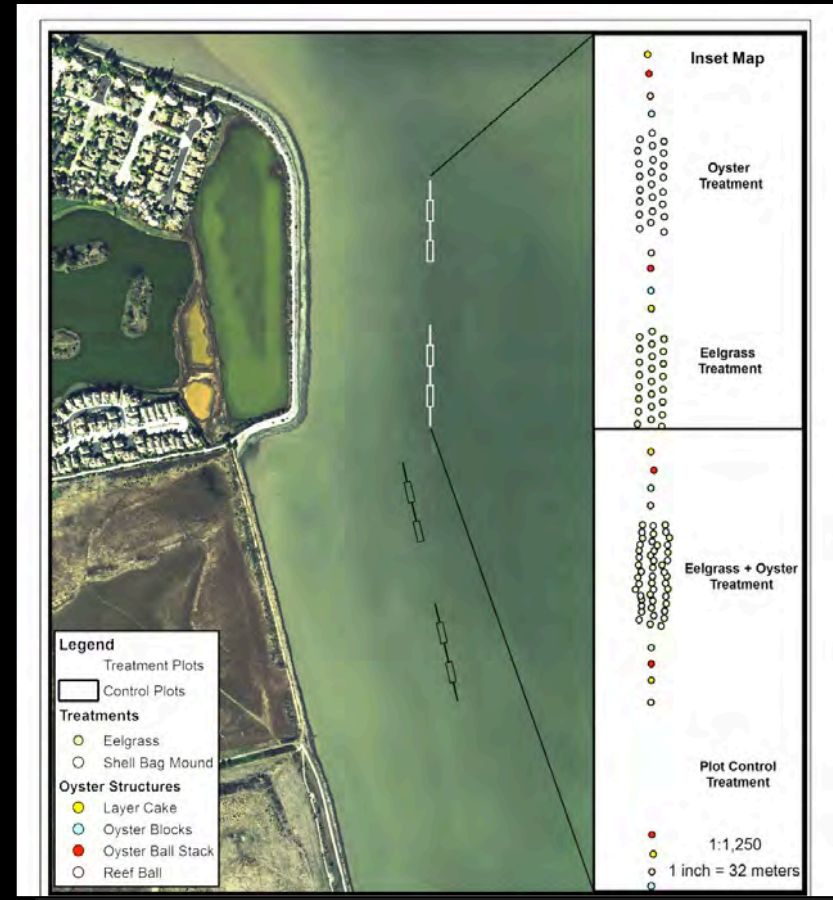
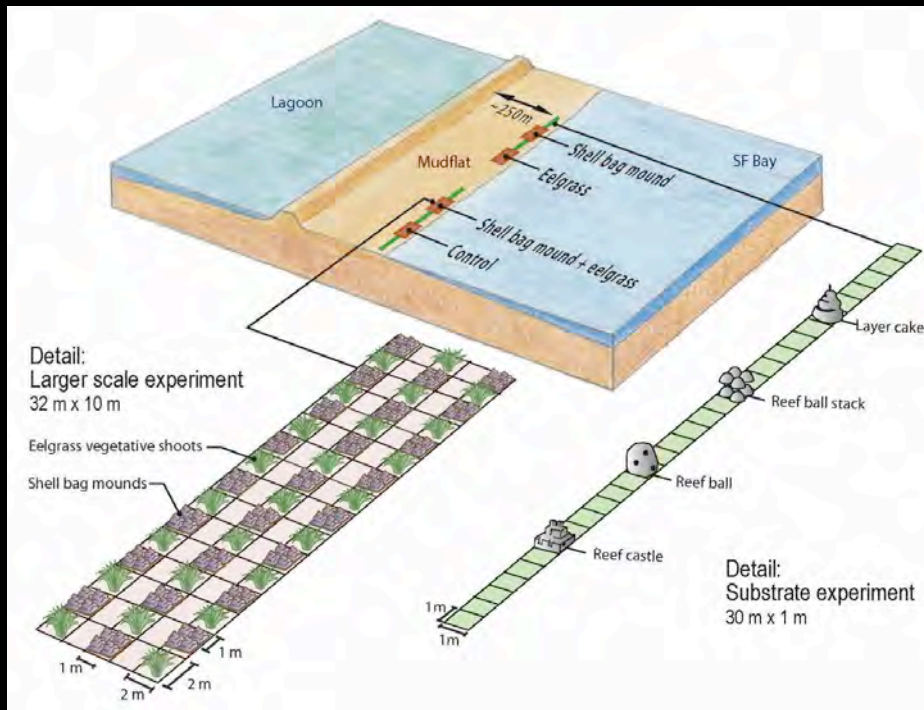
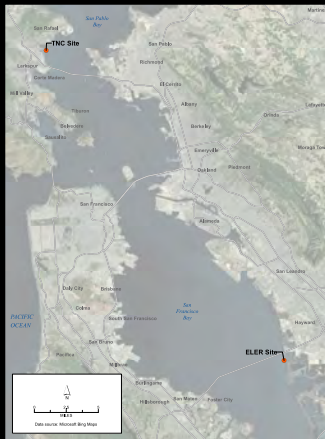


Wave modeling to inform design

Quantify wave shadow/area of oyster reef effect

Eelgrass offshore and inshore of oyster reefs





Olympia Oyster Settlement Substrates

Large plots: 10 x 32m

Series of shell bag mounds



“Baycrete” small scale substrates

Reef Balls



Oyster Blocks



Reef Ball Stacks



Layer Cake



GREEN - SOFTER TECHNIQUES

GRAY - HARDER TECHNIQUES

Living Shorelines

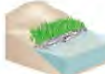
Coastal Structures



VEGETATION ONLY
Provides a buffer to upland areas and breaks small waves. Suitable for low wave energy environments.



EDGING - Added structure holds the toe of existing or vegetated slope in place. Suitable for most areas except high wave energy environments.



SILLS - Parallel to vegetated shoreline, reduces wave energy, and prevents erosion. Suitable for most areas except high wave energy environments.



BREAKWATER - (vegetation optional) - Offshore structures intended to break waves, reducing the force of wave action, and encourage sediment accretion. Suitable for most areas.



REVETMENT - Lays over the slope of the shoreline and protects it from erosion and waves. Suitable for sites with existing hardened shoreline structures.



BULKHEAD - Vertical wall parallel to the shoreline intended to hold soil in place. Suitable for high energy settings and sites with existing hard shoreline structures.

Construction Prep: Pacific Oyster Shell Bags



Photos, M. Latta

Construction Prep: “Baycrete” Reef Balls, Layer Cakes, Oyster Blocks

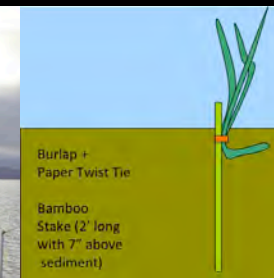


Construction



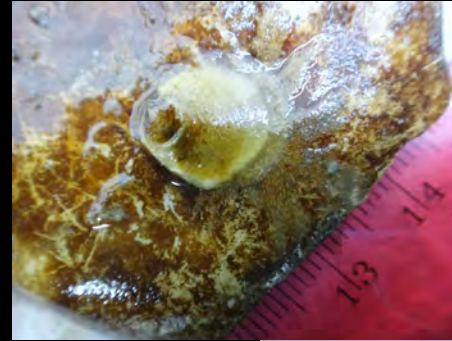
Eelgrass Collection and Transplanting

Two natural-bed donors for each site:
Point San Pablo, Pt. Molate

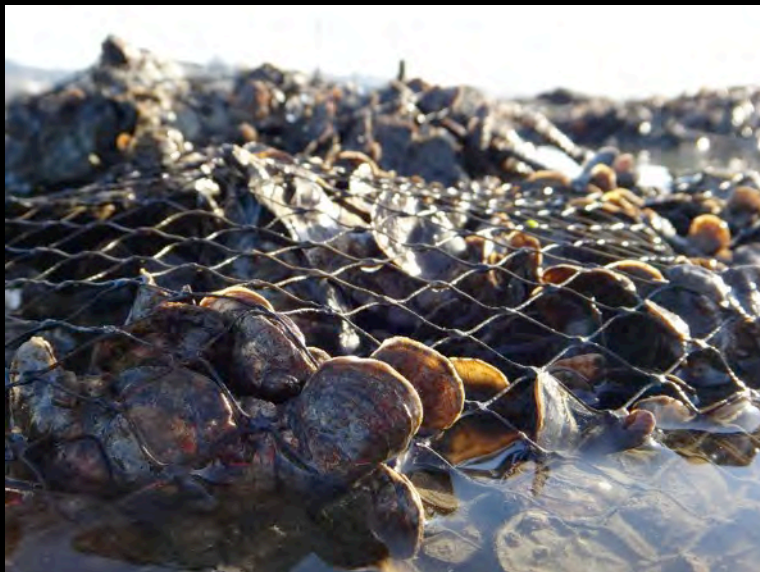


Intensive Monitoring

- Eelgrass and Oyster success
- Invertebrates- benthic and on reef
- Fish- acoustic, traps, seining
- Birds- shorebirds and waterfowl
- Physical-
 - bathymetry
 - sediment accretion and erosion
 - reef elements
 - water quality
 - wave attenuation



- **< 3.8 million oysters at height of recruitment**
- **Fluctuations in numbers by year**
 - **Survival rates, annual recruitment fluctuations**
 - **Food resource for many species**
 - **Heavy rain years can impact oysters/eelgrass**



Photos, S. Kiriakopoulos

Increase in Species Use – More than 10 New Taxa



15 cm sediment
accretion along reefs

Physical Benefits

- most energy lost on broad mudflat
- but reef extracts 30% more at MSL water levels



Recommendations to date

Add habitat structure on mudflat to quickly attract many species, including rare & valuable

Plant eelgrass early in the growing season

Co-locate eelgrass and oyster reefs to maximize invertebrate/fish use

Shell bag mounds and baycrete elements maximize native oyster recruitment

Consider accretion around reefs in future designs – don't waste valuable shell at base

Don't fret about reef subsidence, even in unconsolidated sediment

Test more locations, additional designs, to further evaluate wave attenuation potential

Add in additional habitat types – tidal marsh edge

Test in combination with creosote piling removal

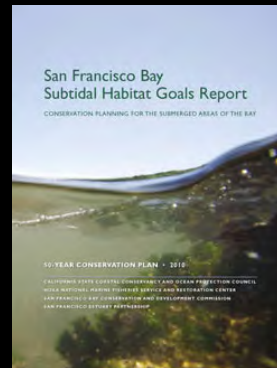
ACOE Nationwide Permit 54- Living Shorelines

Policy Support in California

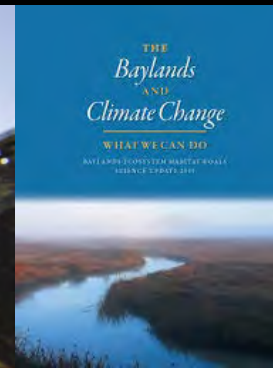
Exec Order B-30-15- Prioritize natural infrastructure solutions

SB 246: Integrated Climate Adaptation and Resiliency Program

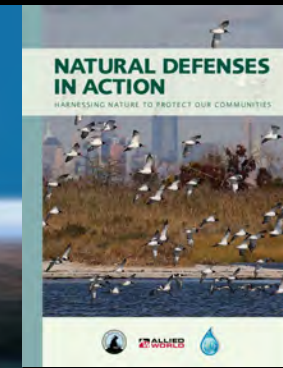
- Safeguarding CA Plan
- 4th Climate Assessment
- CA Coastal Commission
- CA Coastal Conservancy
- SF Bay BCDC



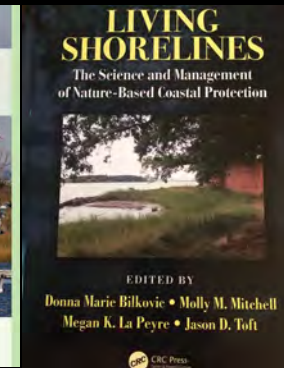
Subtidal Goals 2010
www.sfbaysubtidal.org



Baylands Goals 2015
www.baylandsgoals.org



NWF 2016
www.nwf.org



Bilkovic et al 2017
www.crcpress.com



Living Seawalls

Global Harbour Project

City of Seattle Seawall

City of Miami Seawall



Threading the Needle

Innovation and Feasibility

Barriers to Innovation:

- Science and data gaps
- Institutional Inertia
- Lack of broader context
- Lack of an advocate



Importance of Feasibility:

- Habitat and species
- Pilot projects – test
- Document success before scaling up
- Monitoring of short and long-term benefits and impacts



Climate Adaptation requires Multi-Objective Approaches

Shoreline Protection with Biological and Physical Goals

Design to address Sea level rise and erosion

Increased capacity needed on all fronts

- design
- permitting
- fabrication/construction
- monitoring

Policy changes- beneficial fill, experimentation

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www.sfbaylivingshorelines.org

