

# Morro Bay Revetments and Seawalls



**BRADY**

# SCOPE OF WORK SUMMARY

- ◆ Visual Inspection of 12 revetments and 3 seawalls
- ◆ Survey above and below water
- ◆ Geophysical exploration
  - ◆ Ground Penetrating Radar and exploratory test pits
- ◆ Geotechnical Assessment
- ◆ Condition Assessment and Prioritized Recommendations
- ◆ Very Rough Order of Magnitude Cost Estimates

# Project Manager - Amanda Del Bello, PE



**18**

years of  
experience

**Civil  
Engineer  
- CA**

**ADCI  
Diving  
Supervisor**

**100 Ton  
USCG  
Master**

Inspection & Condition Assessment Reports, Repair Recommendations, and Cost Estimating for a variety of structures including bridges, piers, retaining walls, rock revetments, and underground structures.

Design experience for rehabilitation and new waterfront structures.

Plans, specs, estimates, and construction support.

# Seawall and Revetments – BACKGROUND

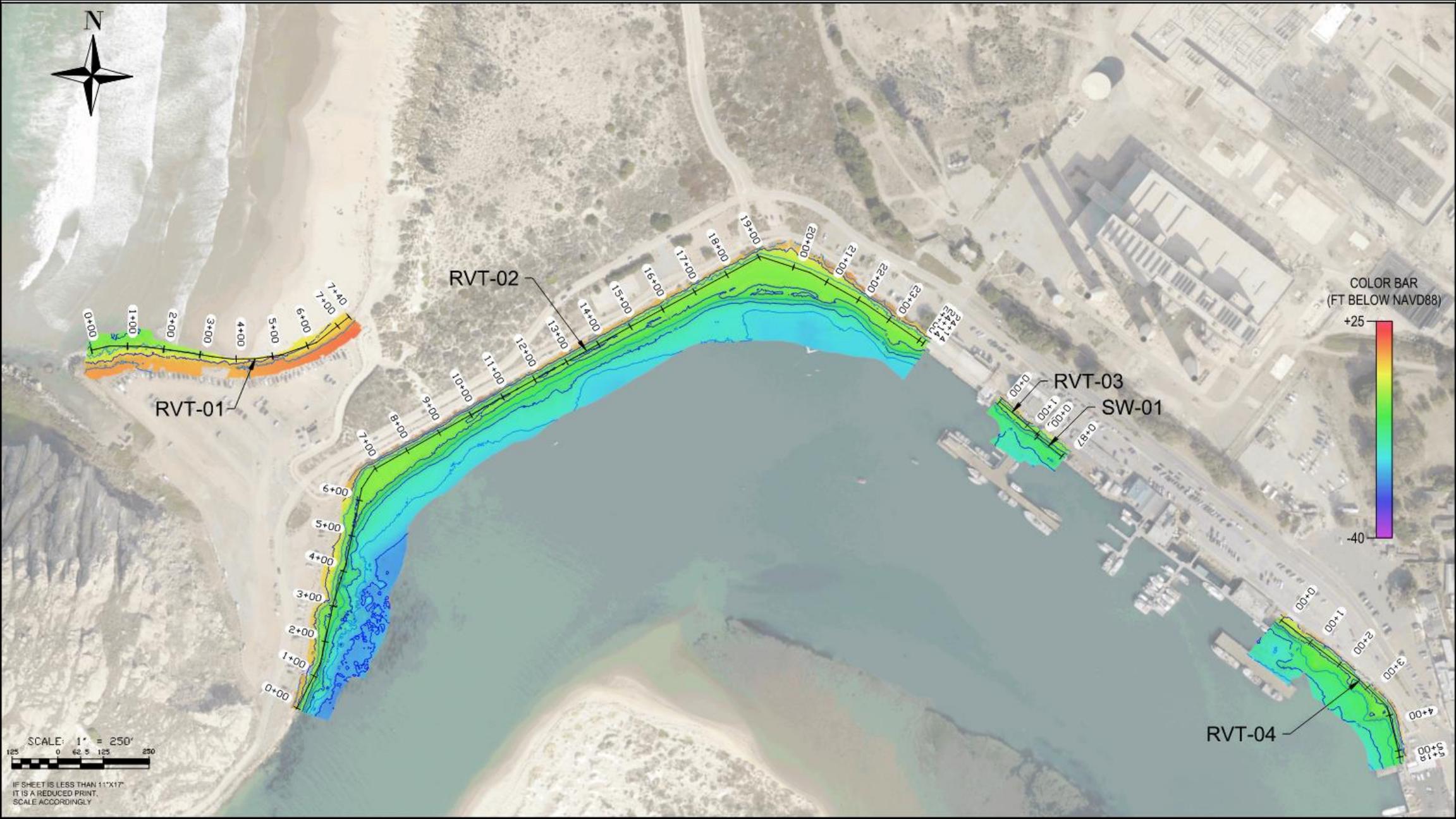
- ◆ Original construction ~ 1935 and post WWII with little/no maintenance since
- ◆ Three seawalls – 384 LF
  1. Retaining wall under timber wharf – south of North-T Pier, continuing under Tognazzini’s Dockside Too
  2. Concrete retaining wall – south of public boat launch
  3. Timber sheet pile wall – behind the Inn at Morro Bay
- ◆ 12 sections of revetment – 6,239 LF from Morro Rock Beach to southern most end of the parking lot near the end of the Embarcadero.



# Inspection – Location Map

**BRADY**

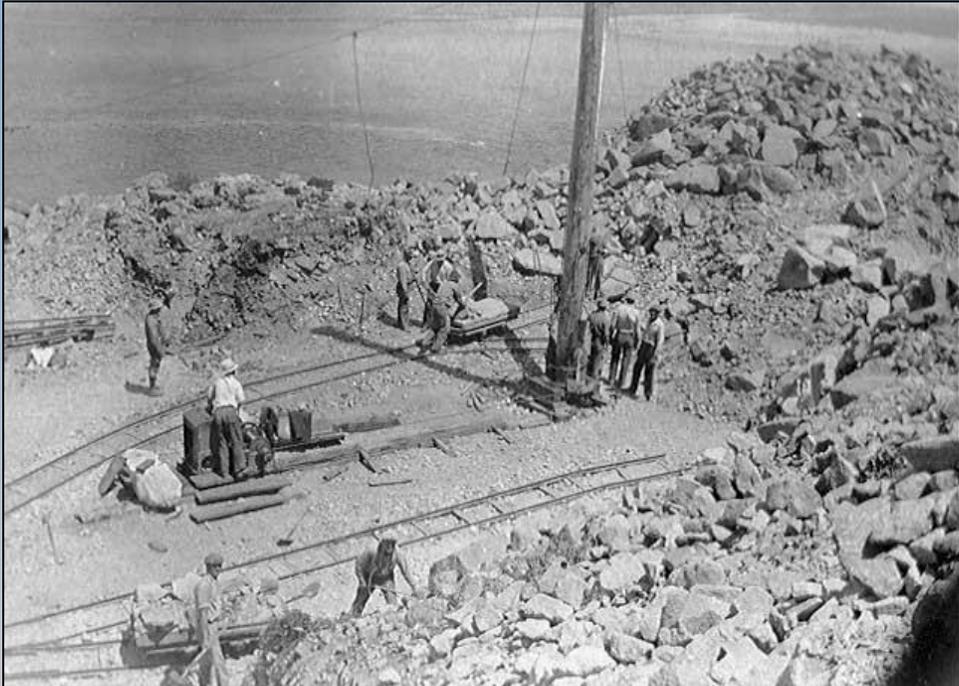








- ◆ Before WWII, Morro Rock was a stand-alone island and used as a rock quarry (see right).



- ◆ In 1936 a causeway connecting Morro Rock to the shore was constructed (see left). Shortly after, the US Navy began using the bay for training operations.

# History

- ◆ By 1937, the construction of the causeway was complete (see left). After WWII, the U.S. Navy and Army Corps of Engineers led major developments within the bay, including the construction of the revetments, North and South T-Piers and dredging to create the existing Embarcadero (see right).



# Condition Assessment Rating Definitions

- **“Good”** – No problems / minor problems noted. Minor deterioration, but no overstressing observed.
- **“Fair”** – Minor to moderate defects and deterioration, no overstressing observed.
- **“Poor”** – Advanced deterioration or overstressing observed on widespread portions of the structure.
- **“Serious”** – Advanced deterioration, overstressing, or breakage may have significantly affected the load-bearing capacity of primary structural components. **Local failures are possible.**
- **“Critical”** – Very advanced deterioration, overstressing, or breakage has resulted in localized failure(s) of primary structural components. More widespread failures are likely.

# Seawall Inspection

## Scope of Work



- ◆ Perform visual inspections for condition and current configuration.
- ◆ Provide a written record of defects with photos.

# Seawall 1 Inspection

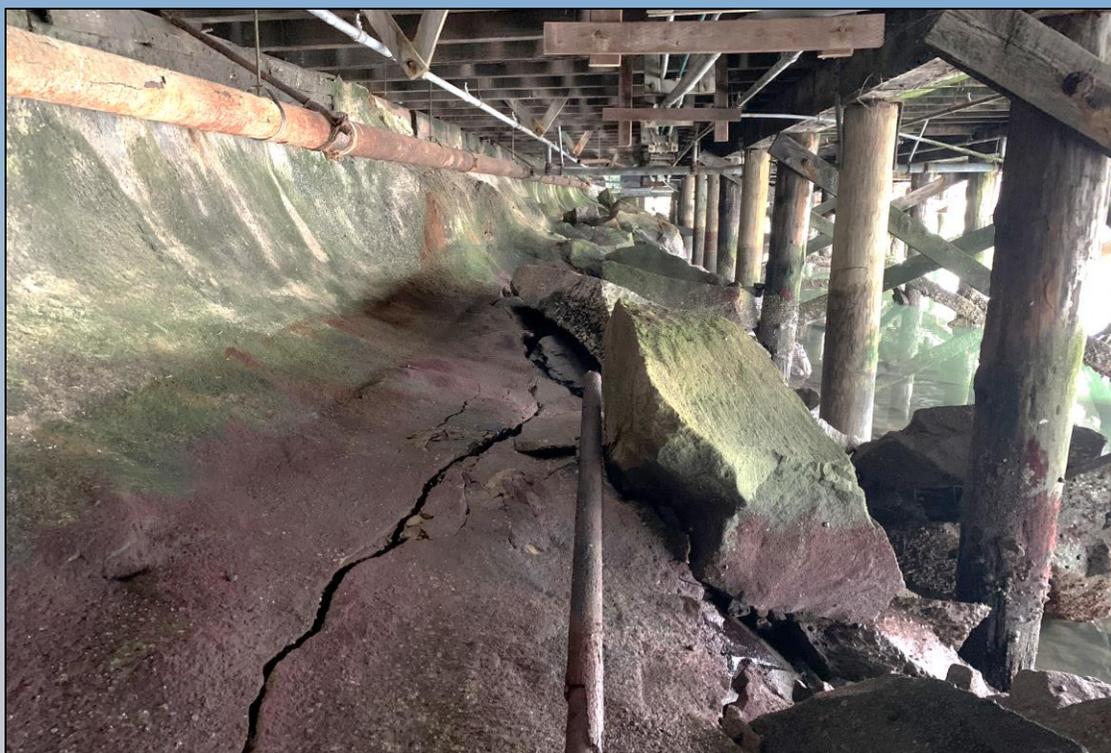
- ◆ Starts at the south side of the North-T Pier, following Revetment 3, and continues 87 feet under Tognazzini's Dockside wharf which supports a building and outdoor dining area.



- ◆ The wall is covered with a layer of shotcrete in *fair* condition, however further investigation is required to properly assign a condition to the tie-back wall structure.

# Seawall 1 Inspection – Typical Defects

- ◆ Undermining of the shotcrete layer placed in front of the seawall was typical (see right).



- ◆ Cracks in the shotcrete layer were typical (see left).

## Seawall 1 Inspection (Out of Scope)

- ◆ Several timber piles show significant damage due to marine borers. Pile shown at right has 100% section loss.



- ◆ 14-inch-high timber cap, extending the length of the wall, exhibits severe decay and section loss due to marine borers (see left).

# Seawall 2 Inspection

- ◆ Concrete structure south of Revetment 12 and public boat launch, extending 84 feet (see right).



- ◆ Seawall 2 is in **critical** condition, with various stages of construction/repairs. The original wall has failed and the repairs have also failed (see left).

## Seawall 2 Inspection

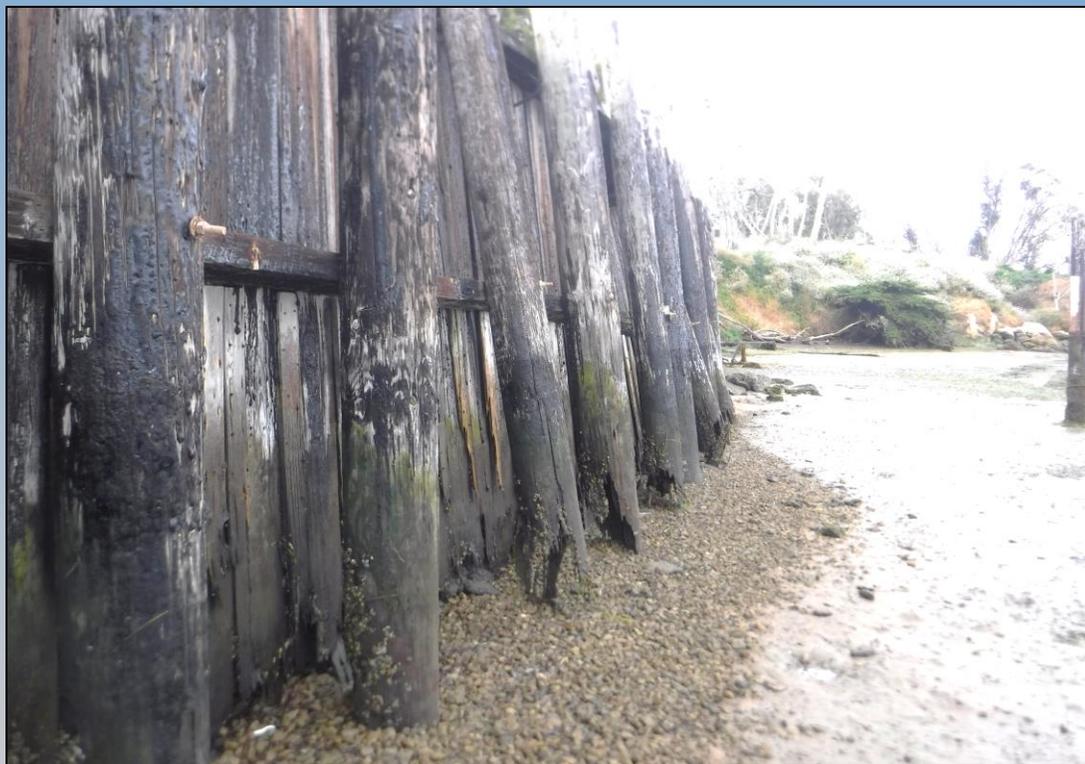
- ◆ **Failed** section of the wall, various sections of concrete have been placed in the void to retain the soil (see right).



- ◆ Undermining of the wall up to 2 feet deep can be seen (see left).

## Seawall 3 Inspection

- ◆ Located behind the Inn at Morro Bay extending the length of the parking lot and is 213 feet long (see right).



- ◆ In ***critical*** condition as decay and marine borer damage has degraded the lower portion of the sheet piles (see left).

# Seawall 3 Inspection

- ◆ Retained soils migrating through the wall (see right).



- ◆ Significant voids behind the wall and failure of the AC paving (see left).

# Revetment Inspection

## Scope of Work



- ◆ Perform visual above water inspection for condition and current configuration.
- ◆ Provide a record of inspection with photos every 100-ft and a damage rating with description of defects.

# Revetment Inspection

## Typical Defects – Damage Ratings

Every 100ft gets a damage rating and based on these ratings an overall condition is assigned to the revetment.

### MAJOR DEFECTS

- ◆ Displaced or lost armour stone
- ◆ Voids exposing large areas of subgrade, filter layer, or soil and loss of this material noted.
- ◆ Significant undermining
- ◆ Slope is too steep

### MODERATE DEFECTS

- ◆ Some loss of armour stone leaving areas exposed the size of the armour stone or smaller
- ◆ Some migration or displacement of armour stone and loss of subgrade.
- ◆ Some undermining

### MINOR OR NO DEFECTS

- ◆ Slight movement of armour stone

## Revetment Inspection – *Major Defects*



- ◆ **Makeshift portion Revetment 9 made up of miscellaneous pieces of concrete and timber debris.**



- ◆ **A portion of the wall is undermined by up to 3.5 feet.**

# Revetment Inspection – *Major Defects*



- ◆ Significant void up to 6 feet deep at Revetment 3, which is in serious condition.



- ◆ Significant 2-foot-high void, extending 15 feet along Revetment 4.

# Revetment Inspection – *Major Defects*

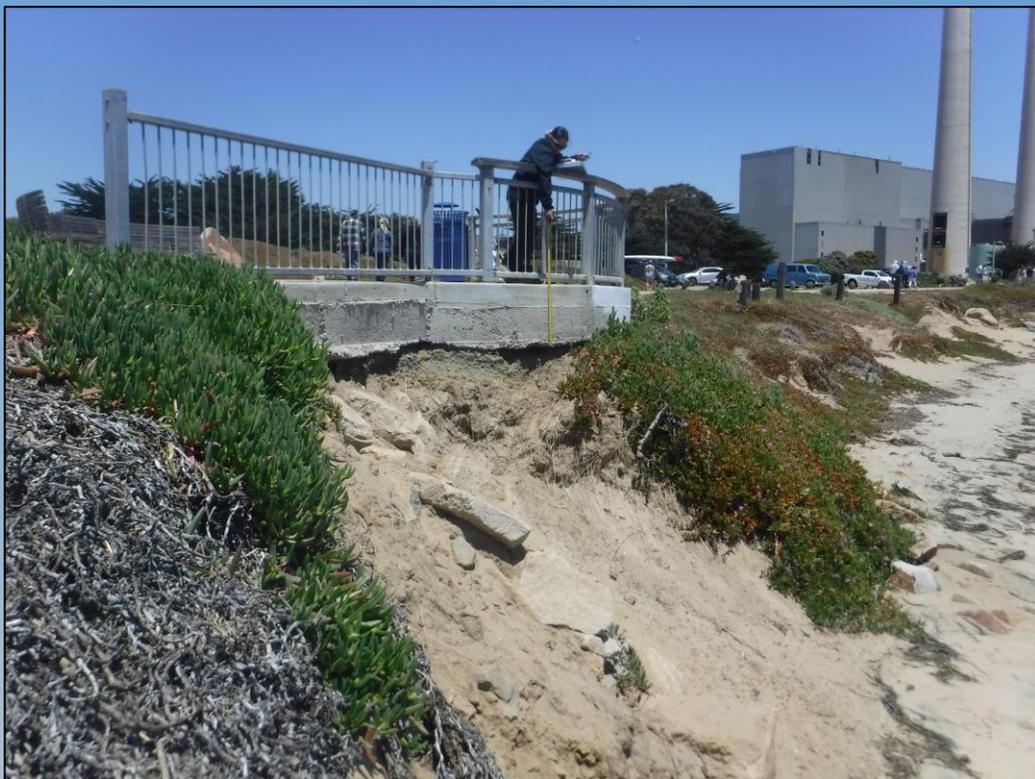


- ◆ Settlement observed at the sidewalk, and the sidewalk and railing are rotated towards the water at Revetment 10.



- ◆ Sections of large voids, heavy vegetation, and erosion of fine material at Revetment 10.

## Revetment Inspection – *Major Defects*



- ◆ Missing rock revetment, erosion, and undermined observation deck footing at Revetment 2.

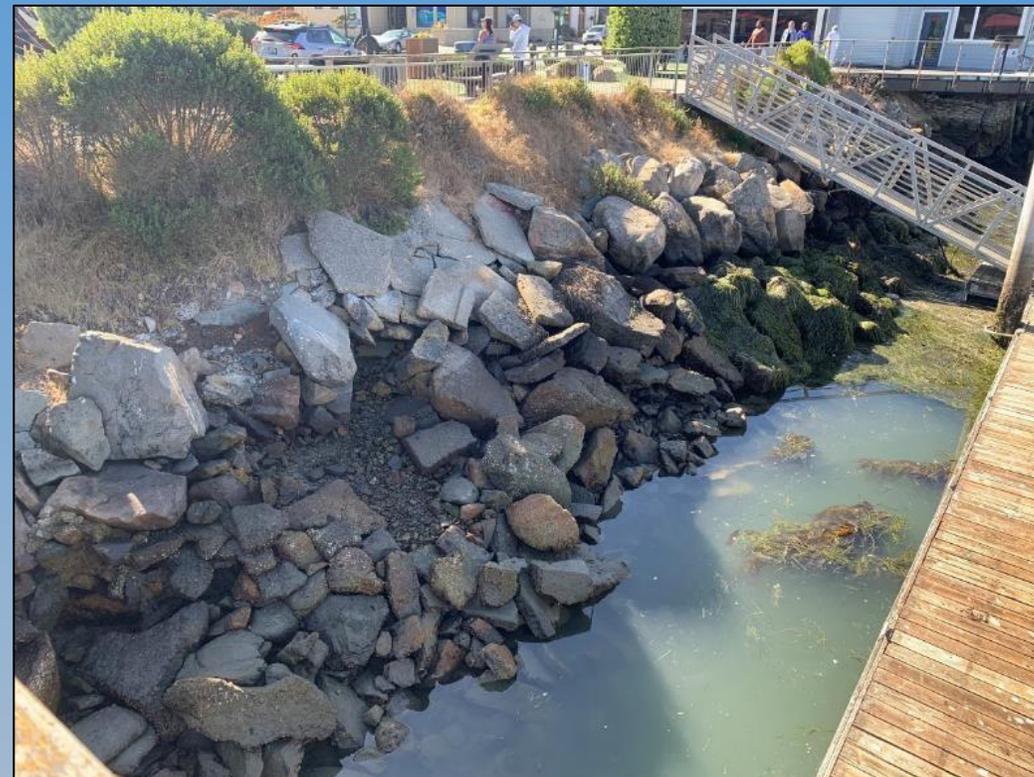


- ◆ Sections of large voids, leaving upper section of rock and drain pipe unsupported at Revetment 7.

# Revetment Inspection – *Moderate Defects*



- ◆ Top of slope is not protected. Erosion of fine material and missing rock is noted at Revetment 1.



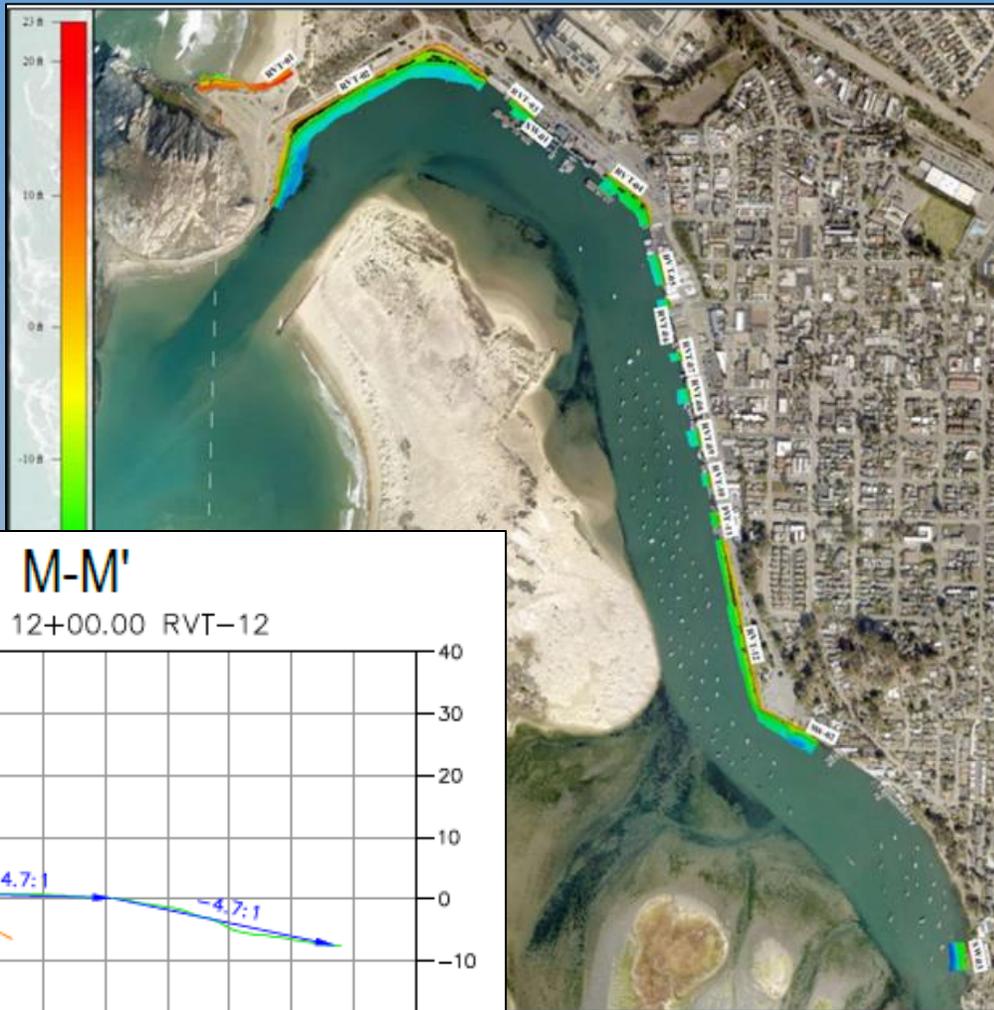
- ◆ Missing armour stone exposes the subgrade at Revetment 7.

# Revetment Inspection – *Minor Defects / No Defects*



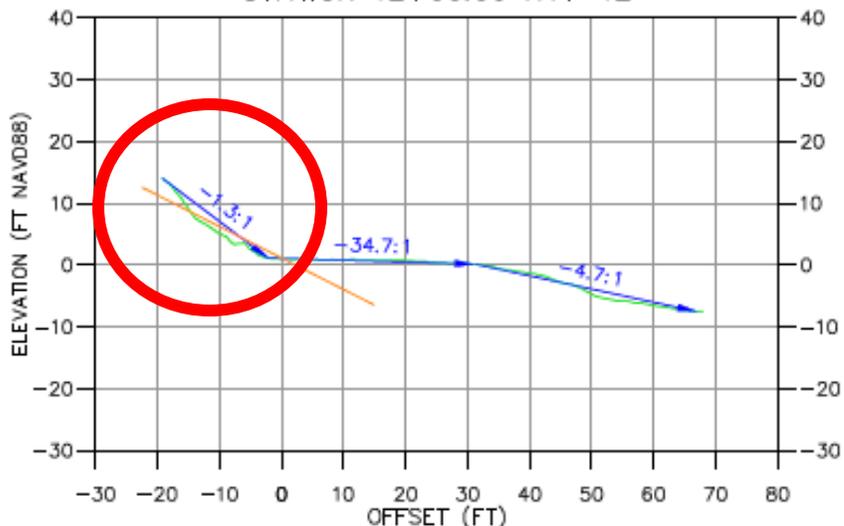
- ◆ Rehabilitated section of revetment transitions to a steeper slope with inconsistent rock sizes and concrete debris at Revetment 4.

# Survey Inspection – *eTrac* - Scope of Work



M-M'

STATION 12+00.00 RVT-12



- ◆ Survey 12 revetments and three seawall sections to show slope profile every 100ft.
  - ◆ Combined use of multibeam and LiDAR to collect data below and above the waterline along the shoreline.
  - ◆ Use data to help identify steep sections and instability.
  - ◆ Minimum slope is 1.5:1 for a well constructed revetment however 2:1 is recommended.

# Geophysical Inspection – *GeoVision*

## Scope of Work



- ◆ Identify subsurface voids in revetments and seawalls
- ◆ Ground penetrating radar
- ◆ Pothole suspect areas – no voids found

# Geotechnical Assessment – *Engeo*

## Scope of Work

**BRADY**



- ◆ Review data from the visual and geophysical inspection and provide conceptual geotechnical recommendations for maintenance, rehabilitation and repair.

# Recommendations – BRADY/Engeo

## Overview

### SEAWALLS

- ◆ **Seawall 1:** Further investigation needed
- ◆ **Seawalls 2 and 3:** Replace in-kind or build new revetment.

### REVETMENTS

- ◆ Improvements for revetments includes **adding rock, refurbishing, and rebuilding.**
- ◆ Control surface runoff behind revetments to reduce erosion occurring at the top of the slope.
- ◆ Further investigation to determine revetments construction to justify improvements, such as adding rock repair compared with refurbishing or rebuilding.

# Damage Ratings and Recommendations

Areas identified with the following defects are estimated for the following repairs:

## **MAJOR DEFECTS**

- ◆ Rebuild

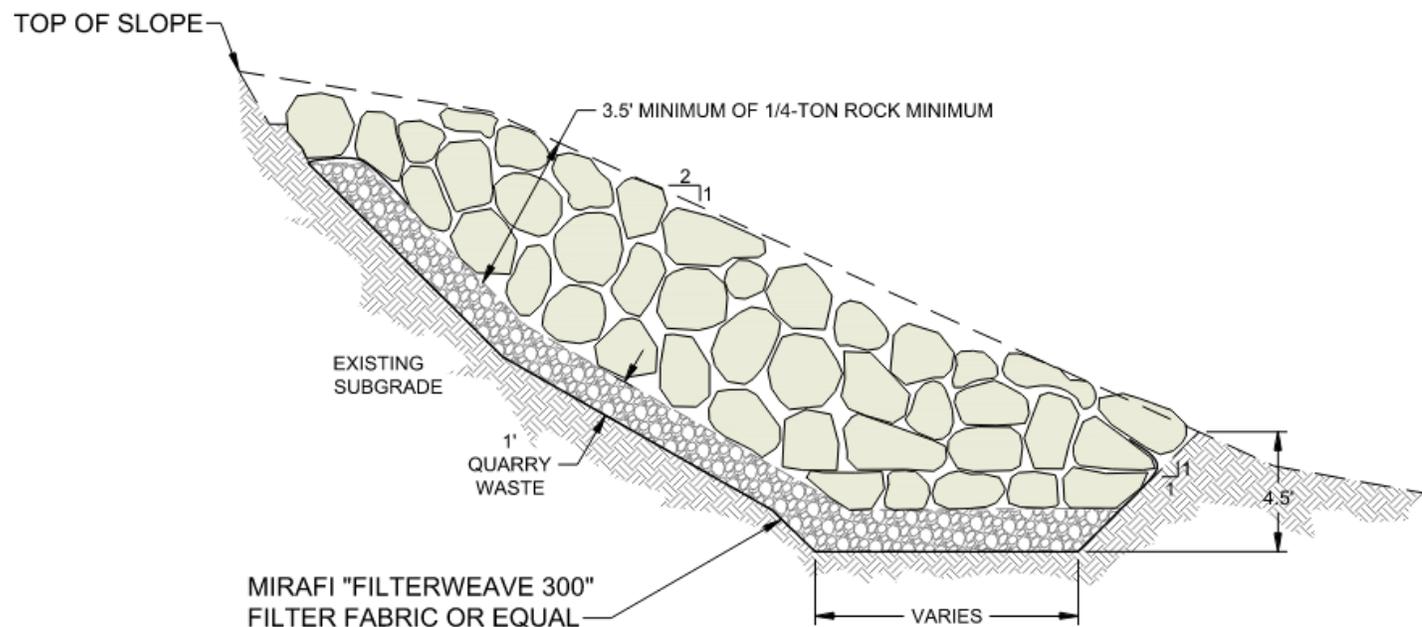
## **MODERATE DEFECTS**

- ◆ Refurbish

## **MINOR OR NO DEFECTS**

- ◆ Add Rock or No Action

# Recommendations – BRADY/Engeo Refurbish

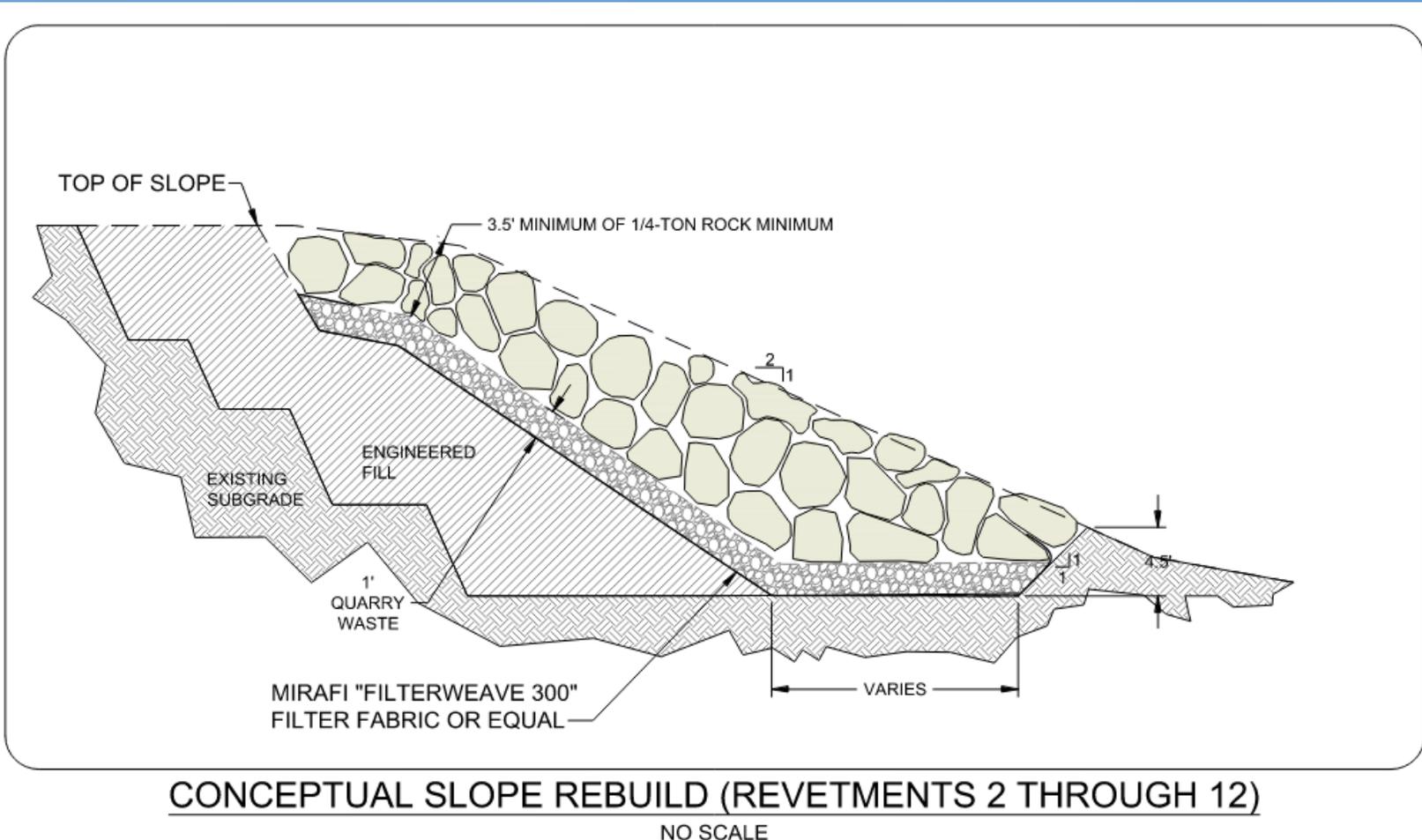


CONCEPTUAL REVETMENT REFURBISHMENT (REVETMENTS 2 THROUGH 12)

NO SCALE

- ◆ Stockpiling existing rock
- ◆ Excavation of a keyway for replacement of rock
- ◆ Smoothing existing subgrade to desired slope
- ◆ Filter fabric layer
- ◆ Protective layer – quarry waste
- ◆ Rip rap

# Recommendations – BRADY/Engeo Rebuild



- ◆ Similar to refurbishing with the added step of excavating a larger keyway and rebuilding the slope with an engineered fill.
- ◆ Recommended where slope instability was observed.

# Condition/Assessment and Prioritized Recommendations

Structure	Conceptual Recommendations	Condition	Priority
Seawall 1	Further investigation of seawall and wharf.	Fair	Short
Seawall 2	Replace in-kind or build revetment	Critical	Mid
Seawall 3	Replace in-kind or build revetment	Critical	Mid
Revetment 1	Add Rock and Refurbish	Fair	Long
Revetment 2	Add Rock, Refurbish, Rebuild	Poor	Mid
Revetment 3	Rebuild	Serious	Short
Revetment 4	Refurbish and Rebuild	Serious	Short
Revetment 5	Add Rock and Refurbish	Fair	Long
Revetment 6	Refurbish	Fair	Long
Revetment 7	Refurbish	Poor	Mid
Revetment 8	Refurbish	Poor	Mid
Revetment 9	Refurbish and Rebuild	Critical	Priority
Revetment 10	Rebuild	Serious	Short
Revetment 11	Refurbish	Poor	Mid
Revetment 12	Add Rock and Refurbish	Fair	Long

- **Priority Repairs** – repaired or replaced immediately/within one year. Or further investigation is needed.
- **Short-term Repairs** – repaired or replaced within 2 to 4 years.
- **Mid-term Repairs** – repaired or replaced within 5 to 7 years.
- **Long-term Repairs** – repaired or replaced within 8 to 10 years.

# Cost Estimates

- ◆ Based on recommended improvements.
- ◆ Includes:
  - ◆ General Conditions, Mobilization/Demobilization, Contractor Overhead and Profit.
  - ◆ Geotechnical investigations, engineering, compliance and permitting.
  - ◆ Construction engineering support and construction management

Item	Total
Geotechnical Study	\$ 300,000
Seawall 1 Study	\$ 235,000
Seawall 2	\$ 754,644
Seawall 3	\$ 2,233,011
Revetment 1	\$ 4,052,507
Revetment 2	\$ 10,182,160
Revetment 3	\$ 1,166,649
Revetment 4	\$ 3,096,446
Revetment 5	\$ 1,341,964
Revetment 6	\$ 488,221
Revetment 7	\$ 520,647
Revetment 8	\$ 598,922
Revetment 9	\$ 724,959
Revetment 10	\$ 759,616
Revetment 11	\$ 538,834
Revetment 12	\$ 9,427,999
<b>Total</b>	<b>\$ 36,421,579</b>

## Estimate Accuracy, Class 5 Conceptual

-30%	50%
<b>\$25,500,000</b>	<b>\$54,600,000</b>

# Key Points for Discussion

1. What funding is available now for repair of seawalls and assessments? What funding could the City pursue? Could Army Corps of Engineers help?
2. Additional geotechnical exploration is required to evaluate existing construction of revetment walls. How to fund? Findings will determine appropriate repairs. How to fund?
3. Additional structural exploration is needed to determine the condition of seawall 1 due to shotcrete covering structural wall behind. How to fund?
4. Phased repairs based on condition and priority will likely be required due to funding limits.
5. What responsibilities do leaseholders have? Does City have authority to mandate repairs?
6. Partnership opportunities with adjacent property owners or lease holders for repairs as condition of adjacent revetments and seawalls are likely similar to those assessed. Efficiency in combining adjacent repairs.
7. PWAB or HAB points of discussion.

**Questions?**