



# Levee and Shoreline Analysis Task

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*SR 37 Design Alternatives Assessment*  
*SR 37 Policy Committee – March 1, 2018*

# Introduction & Approach

## Shoreline Analysis Task Goal

- Identify potential strategies to mitigate near-term flood risks to SR 37 prior to implementation of the corridor-wide project
- Educate stakeholders about near-term flood vulnerabilities along the SR 37 corridor and potential mitigation actions

## Approach

- Identify locations of potential shoreline overtopping for various SLR/storm scenarios
- Identify potential for other shoreline deficiencies (erosion, instabilities, seepage)
- Develop toolbox of conceptual design strategies
- Evaluate applicability of each strategy to different shoreline types
- Develop cost estimate to meet different levels of near-term flood protection

# What is included in this evaluation?



- High level evaluation of levee and shoreline elevations relative to Bay flood levels
- Identification of potential flood mitigation strategies to address near-term flood vulnerabilities
- Estimation of magnitude and extent of necessary levee and shoreline crest elevation improvements
- Rough order of magnitude cost estimate to address levee and shoreline elevation deficiencies along SR 37 corridor

# What is NOT included in this evaluation?



- Geotechnical evaluation of levee and shoreline condition and stability
- Estimation of costs to address potential geotechnical issues
- Site-specific engineering design or a specific project recommendation
- Estimation of environmental mitigation or land acquisition costs
- Assessment of combined riverine-coastal flooding

# Levees protect low-lying portions of SR 37



# Levees protect low-lying portions of SR 37

- Completed review of levee ownership
  - Private
  - Public
- Approximately 20 different land owners/managers
- No single coordinating entity
- Levees protect existing land uses
  - Agricultural
  - Biosolids/soil amendment
  - Shallow pond habitat
  - Road and railway
  - Other



# Critical Shoreline

Shoreline segments that provides direct flood protection to SR 37

- A1: Novato Creek levees
- A2: Petaluma River levees & Port Sonoma shoreline
- B1: Tolay Creek/Tubbs Island levees
- B2: SR 37 from Sonoma Creek to Napa River (incl. Mare Island)
- C: SR 37 from Novato Creek to I-80

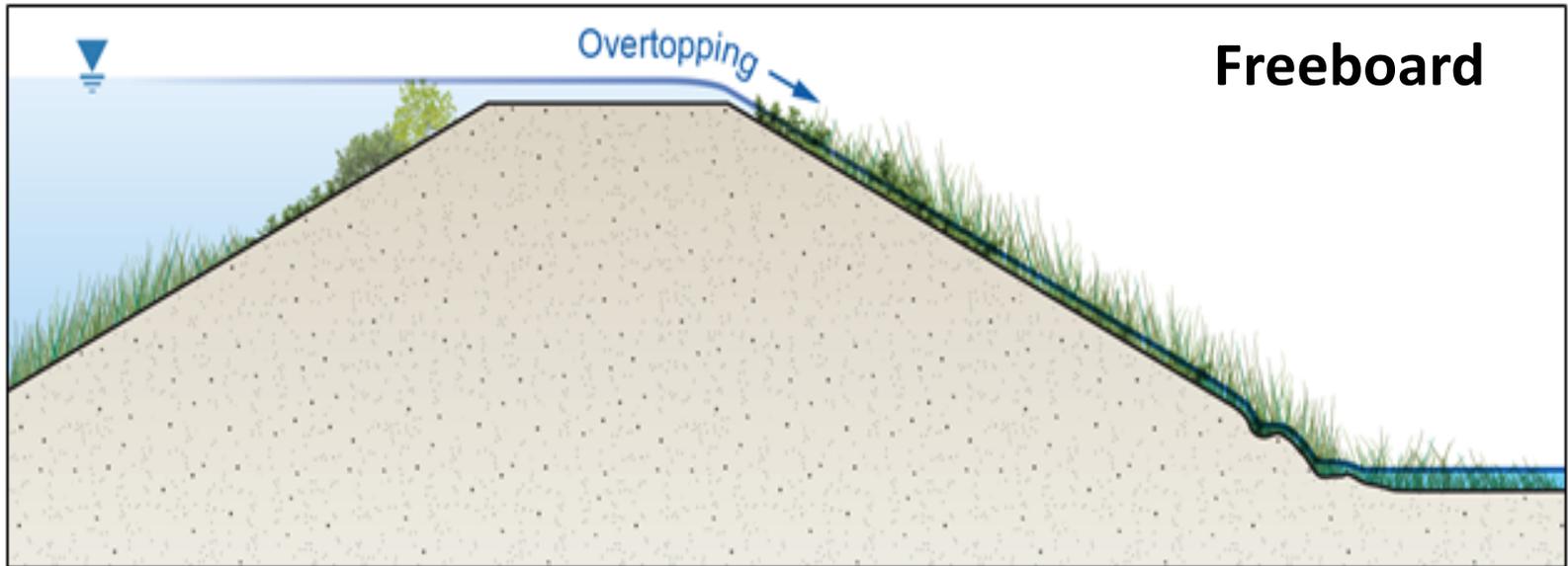


# Potential Shoreline Deficiencies

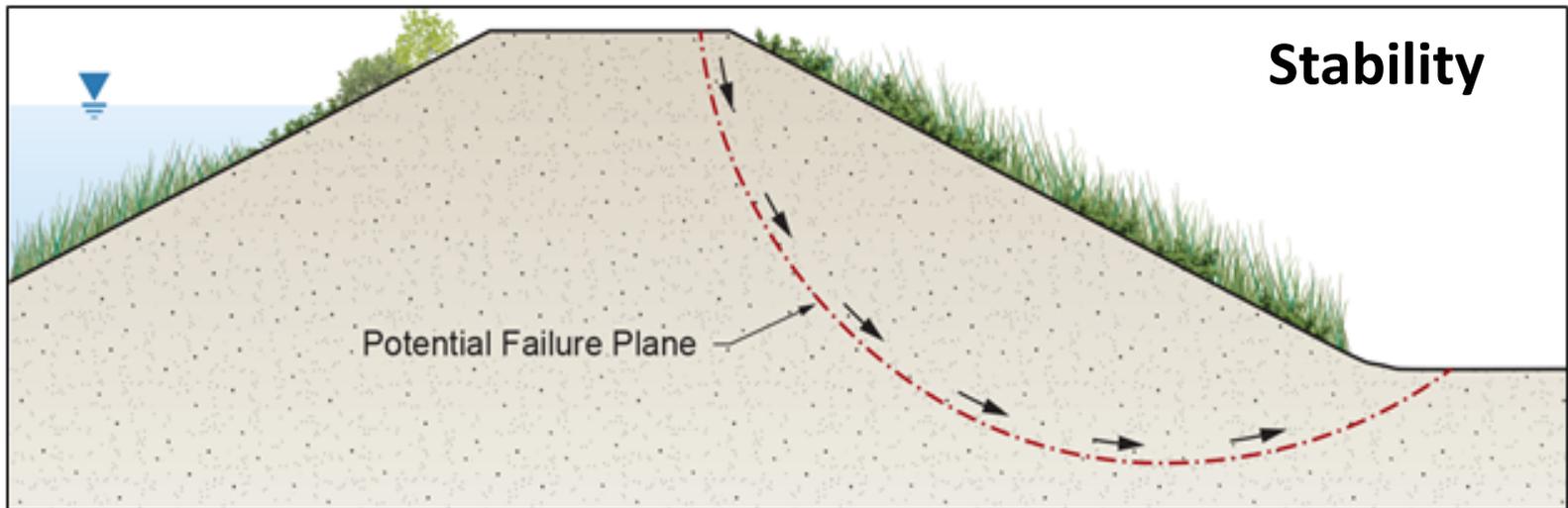
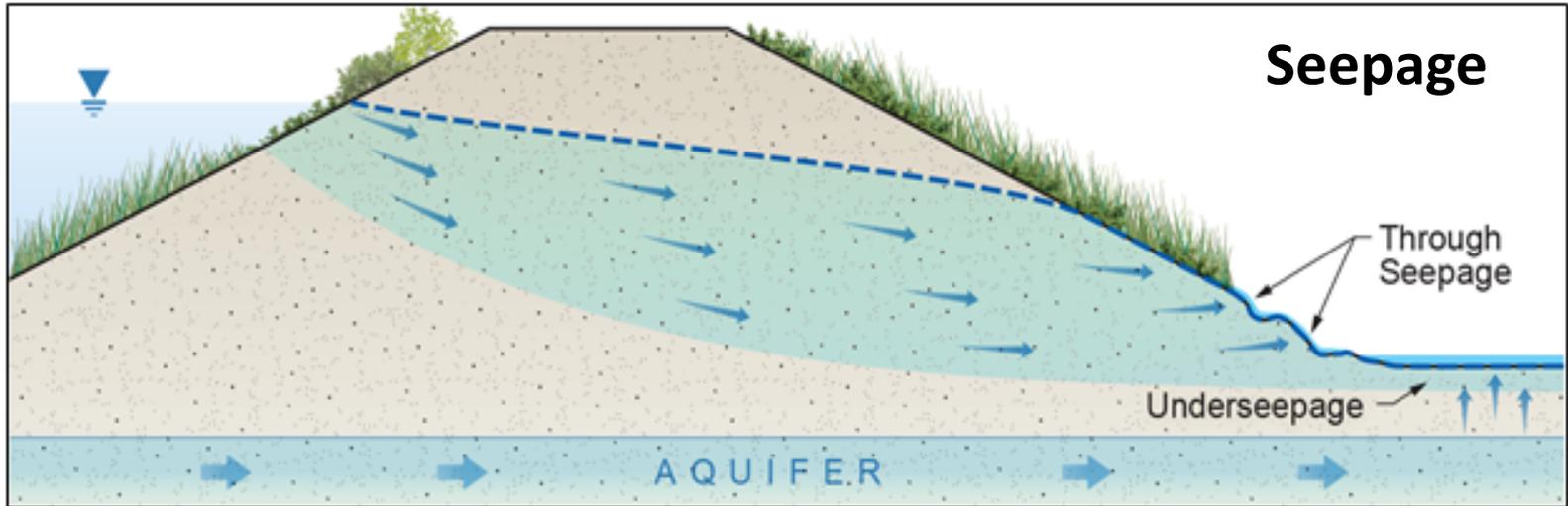
- **Freeboard** – Is the shoreline, levee, or roadway high enough to prevent overtopping by floodwaters?  
[focus of this evaluation]
- **Erosion\*** – Have waves or high flows eroded the shoreline or levee?
- **Seepage\*** – Is the shoreline or levee an effective barrier to flow through or underneath?
- **Stability\*** – Is the shoreline or levee stable from a geotechnical standpoint?

\*Not evaluated in detail in this assessment and not included in cost estimate

# Levee Deficiencies



# Levee Deficiencies



# Overtopping Deficiencies

- Evaluate length of shoreline exposed to overtopping
- Multiple storm and SLR scenarios for present day and 2050
- Differentiated between roadway and levee segments

## Roadway

*Deficient*



*Not Deficient*

The diagram shows a cross-section of a roadway. On the left, a blue area represents water. A blue inverted triangle symbol indicates the water level. A vertical double-headed arrow is positioned between the water level and the roadway surface. The top half of the arrow is red and labeled 'Deficient', while the bottom half is green and labeled 'Not Deficient'. The roadway surface is shown with two cars and a utility pole. The roadway is supported by a concrete structure with a grassy embankment on the right side.

## Levee

*Deficient*



*Not Deficient*

The diagram shows a cross-section of a levee. On the left, a blue area represents water. A blue inverted triangle symbol indicates the water level. A vertical double-headed arrow is positioned between the water level and the levee crest. The top half of the arrow is red and labeled 'Deficient', while the bottom half is green and labeled 'Not Deficient'. The levee crest is shown with a 1-foot drop-off on the left side, indicated by a vertical arrow and the number '1''. The levee is supported by a concrete structure with grassy embankments on both sides. On the right side, there are two cars and a utility pole.

# Overtopping Deficiencies for A1

Present Day 10-yr Storm/2050 1-yr Storm

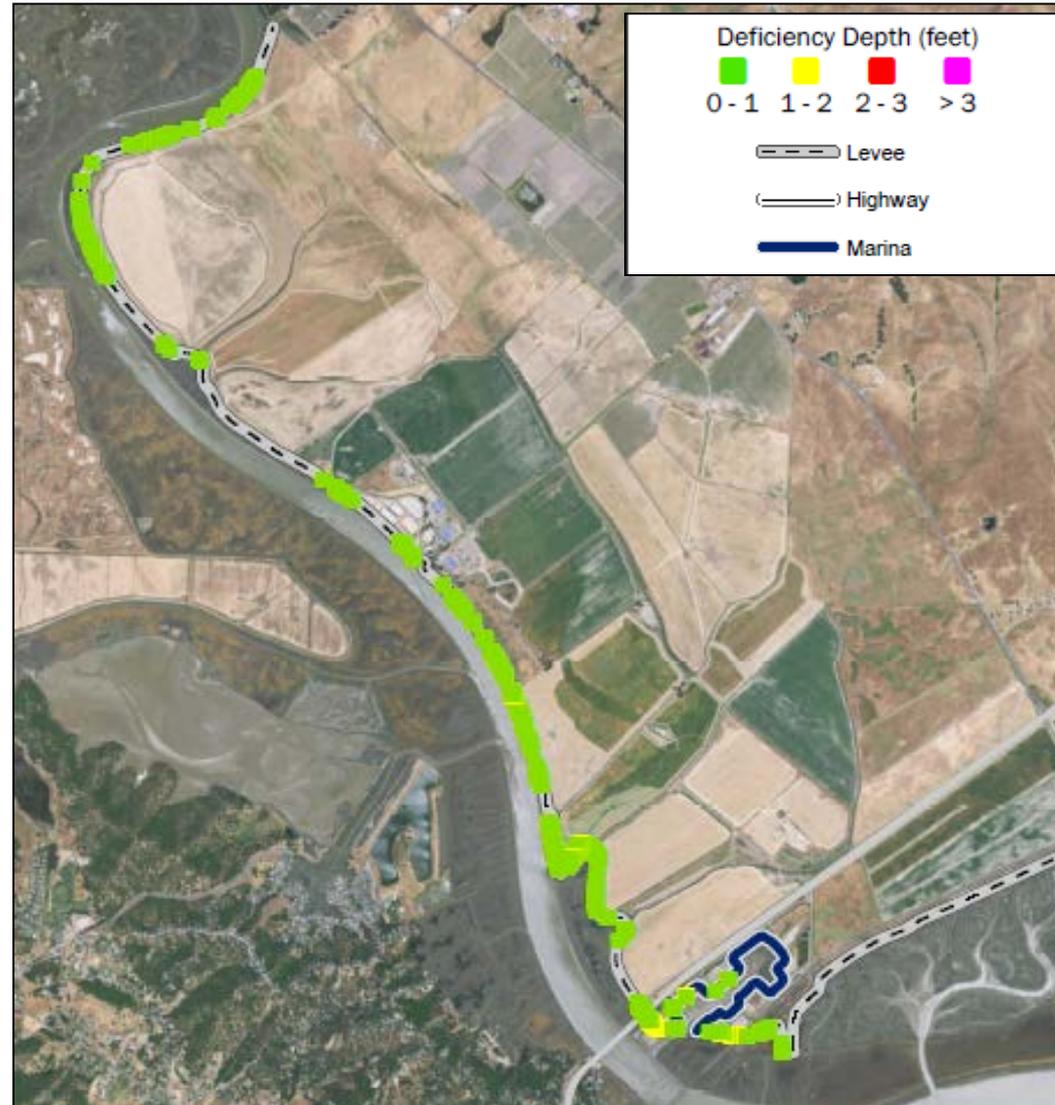
- 2% of shoreline is deficient
- 45% of shoreline is deficient during 100-yr storm in 2050



# Overtopping Deficiencies for A2

Present Day 10-yr Storm/2050 1-yr Storm

- 11 miles of levee protect 4 miles of highway
- 11% of shoreline is deficient
- 80% of shoreline is deficient during 100-yr storm in 2050



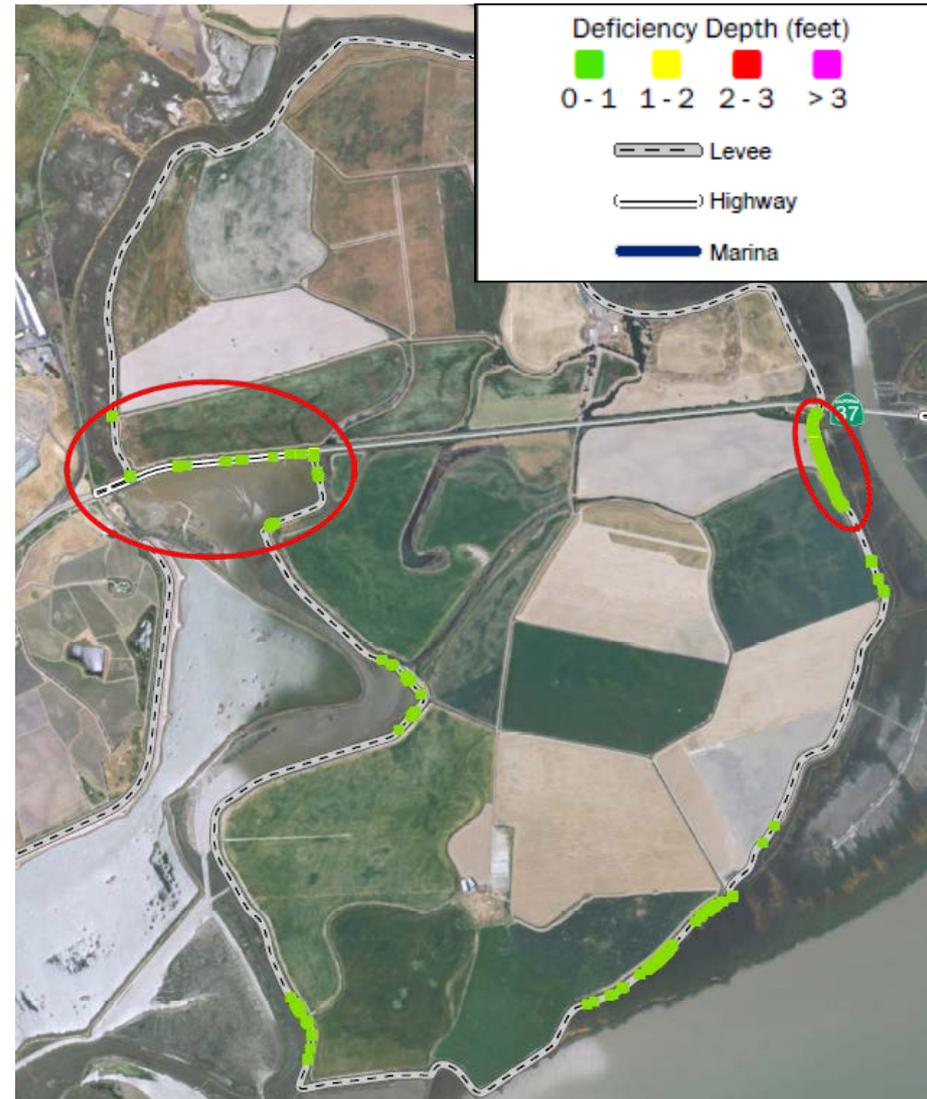
# Overtopping Deficiencies for B1

Present Day 10-yr Storm/2050 1-yr Storm

- 11 miles of levee protect 2 miles of highway
- 6% of shoreline is deficient
- 80% of shoreline is deficient during 100-yr storm in 2050

Tolay Lagoon:

- 2800 ft flood wall along roadway
- 3500 ft levee improvement along adjacent levee segments



# Overtopping Deficiencies for B2&C

Present Day 10-yr Storm/2050 1-yr Storm

- 5% of shoreline is deficient
- 40% of shoreline is deficient during 100-yr storm in 2050

Mare Island:

- 1600 ft flood wall along south side of roadway
- Flood waters come from south side

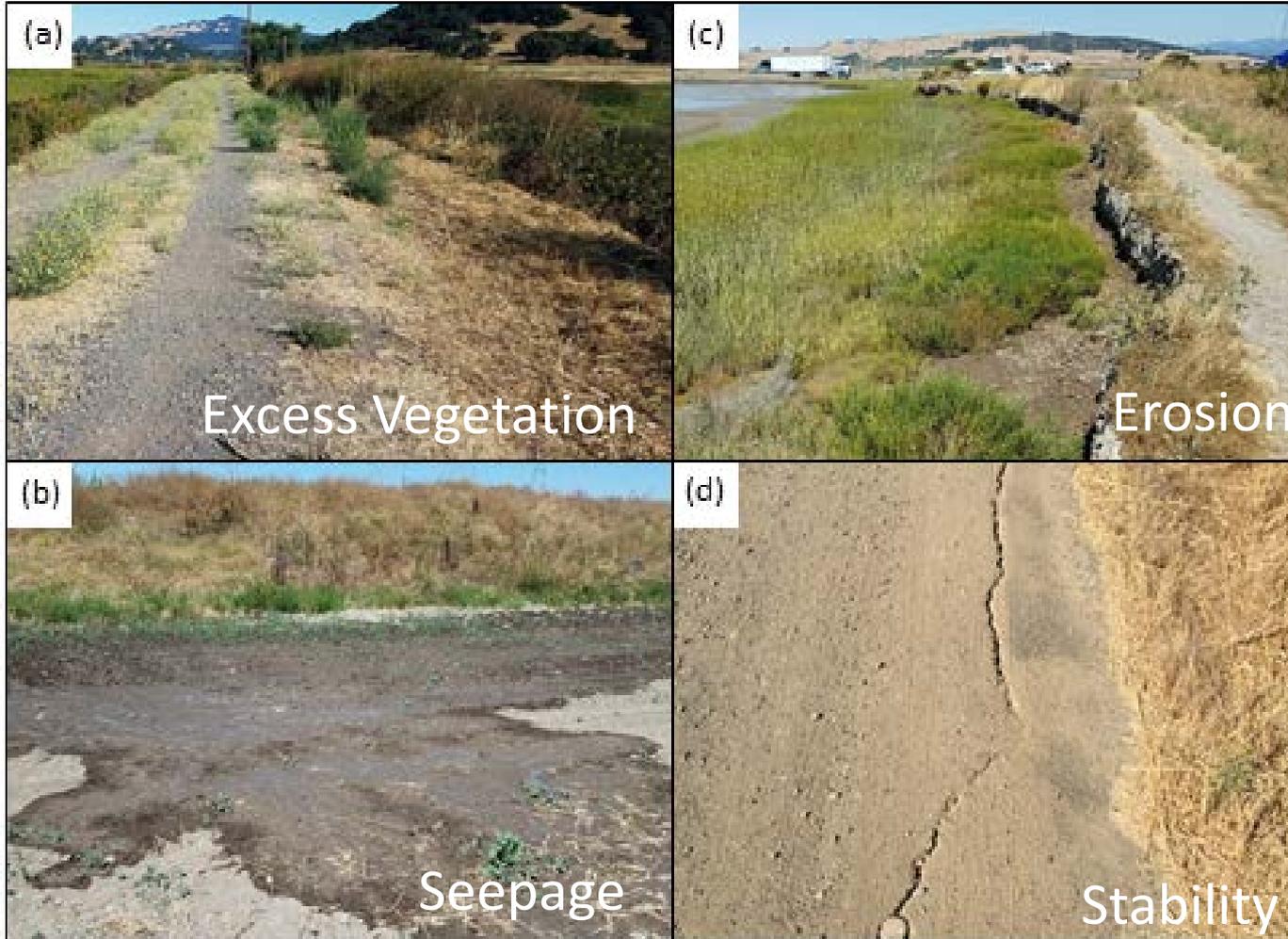


# Minor Shoreline Deficiencies

- Lack of patrol road
- Insufficient geometry
- Excess vegetation
- Animal burrows

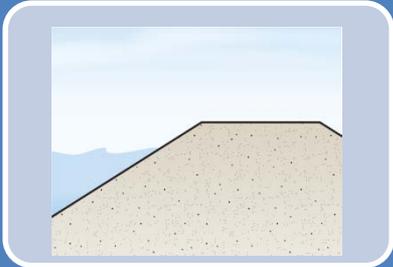


# Field Visit Observations



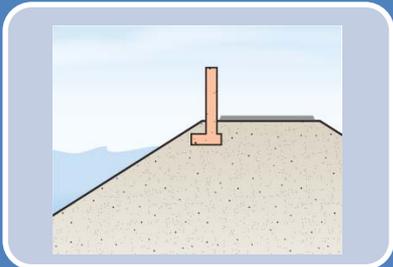
# Potential Adaptation Strategies

## Levee Improvements



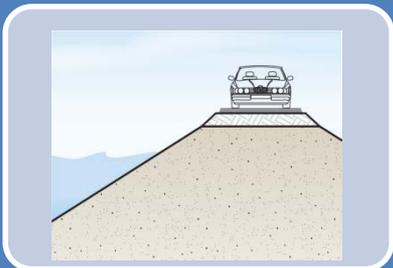
- Raise elevation of existing levee
- Stability berm on landside slope
- Seepage berm on landside slope
- Erosion protection on waterside slope

## Shoreline Improvements



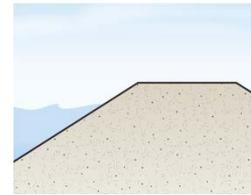
- Concrete wall along edge of roadway
- Sheet pile wall along edge of roadway
- Install drainage

## Roadway Improvements

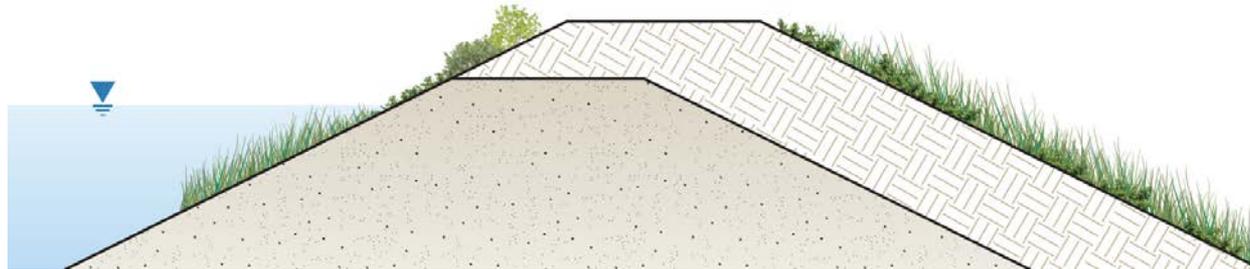


- Raise elevation of roadway surface

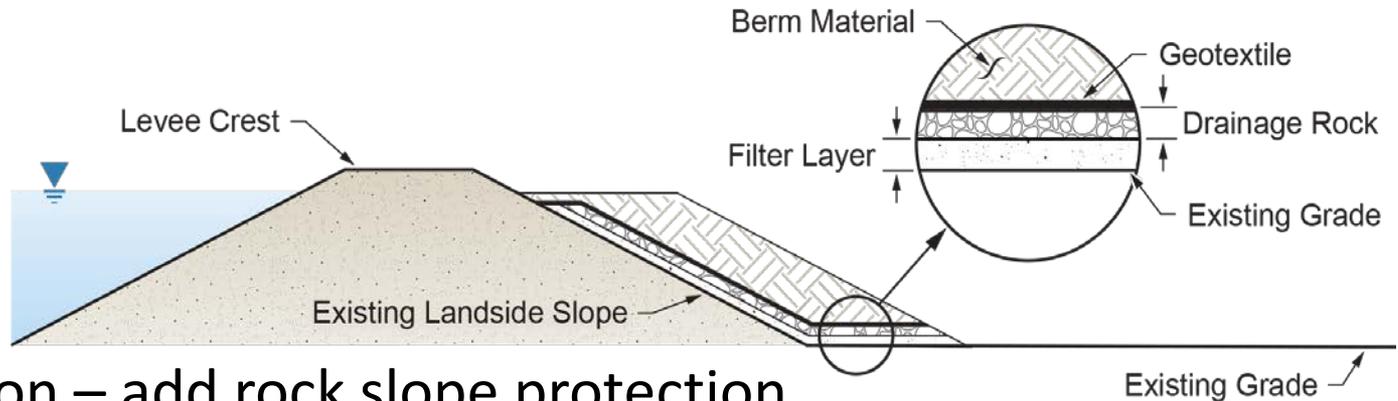
# Levee Improvements



Overtopping – raise crest



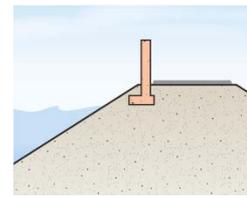
Stability and seepage – add stability berm



Erosion – add rock slope protection



# Shoreline Improvements



## Concrete wall



## Sheet pile wall

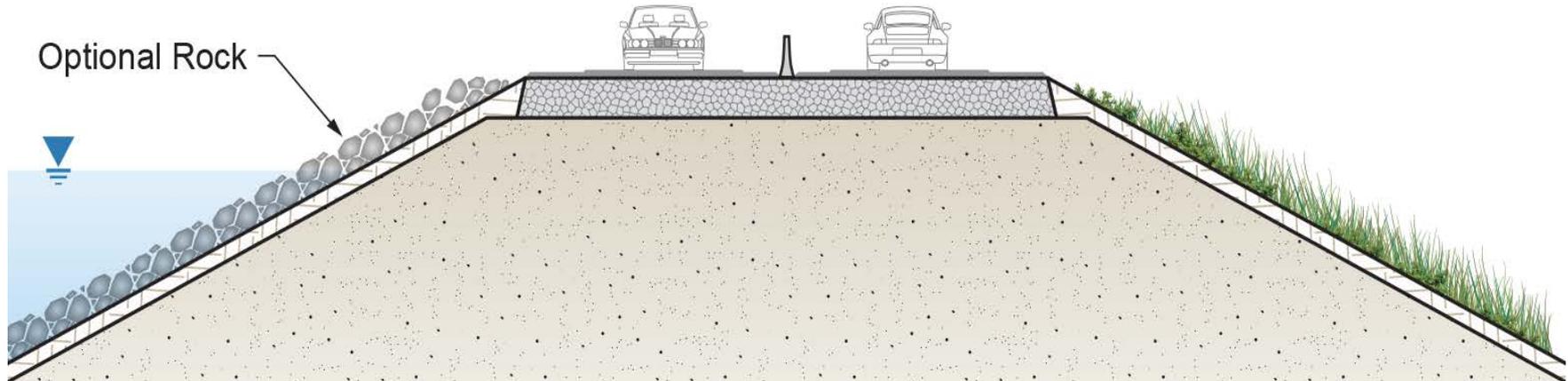
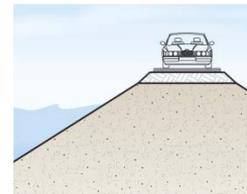


Applicable to roadway shoreline:

- Mare Island
- Tolay Creek
- Erosion protection in areas exposed to waves
- Potential drainage improvements

Not applicable to roadway in A1 & A2 because road surface too low

# Raise Roadway



- Need to tie into existing roadway elevation
- Only appropriate where overtopping deficiencies are small
- May not be feasible due to traffic impacts

Applicable to Mare Island and Tolay Lagoon low spots

# Estimating Costs

Estimated average dimensions for existing levee and roadway  
Assumed an average raised height of 2 ft for all strategies

Costs include:

- Direct unit costs
- Indirect unit costs (15%)
- Overhead and profit (21%)
- Construction contingency (25%)
- Design fee and contingency (25%)
- Environmental clearance (10%)

Not included:

- Environmental mitigation
- Land acquisition costs

Adaptation Strategy	Cost	Unit
Raise levee	\$1000	LF
Concrete wall	\$1610	LF
Sheet pile wall	\$1880	LF
Raise roadway	\$970	LF

LF = linear feet (cost per foot of improvement)

Costs developed for overtopping strategies only (not seepage, erosion, stability, etc.)

# Shoreline Protection Cost Estimate

For 2050 flood protection (12" of SLR)

Scenario	Segment A1	Segment A2	Segment B1	Segment B2
High tide	\$ -	\$ 0.5M	<\$ 0.5M	\$ 0.5 – 1 M
1-yr	\$ 1M	\$ 6 – 7M	\$ 3M	\$ 3 – 7M
10-yr	\$ 11M	\$ 23 – 25M	\$ 25 – 26M	\$ 10 – 19M

Ranges in cost due to alternative options

Costs to mitigate overtopping deficiencies only

# Shoreline Protection Cost Estimate

Scenario	Existing Conditions	2050 (1 ft SLR)
High tide	\$ -	\$ 1 – 2M
1-yr	\$ 2 – 3M	\$ 14 – 18M
10-yr	\$ 14 – 18M	\$ 69 – 81M

Ranges in cost due to alternative options

Costs to mitigate overtopping deficiencies only

# Cost Estimate Assumptions

- Does not include environmental mitigation or land acquisition costs
- Does not address potential levee erosion, seepage, or stability issues, which could increase costs above estimates
- Represents a minimum level of investment needed to provide flood protection
- Evaluated strategies would likely provide up to 10-year flood protection with 1 ft of SLR

# Substantial investment required to maintain adequate level of flood protection

- Evaluation considered concept level strategies to address weak links in levee and shoreline elevations
- Further geotechnical evaluation would likely identify need for additional levee improvements beyond those identified in this study
- Small-scale fixes can only address near-term flood vulnerabilities for small amounts of SLR (up to 12")
- Long-term corridor-wide solution needed to address higher amounts of SLR