Agenda

• Welcome – Introductions
• Recap of Previous Meeting
• Airport Authority Sea Level Rise Vulnerability Presentation
• Sea Level Rise Adaptation Planning
  – US Army Corps of Engineers
  – Port of San Diego Approach
• Non-Agenda Public Comment
• Next Meeting
Goals of the Sea Level Rise Ad Hoc Committee:

1. Review results of the Port’s sea level rise vulnerability assessment
2. Receive feedback on a sea level rise adaptation approach
3. Help to inform options for a monitoring strategy
Agenda

• Welcome – Introductions
• Recap of Previous Meeting
• Airport Authority Sea Level Rise Vulnerability Presentation
• Sea Level Rise Adaptation Planning
  – US Army Corps of Engineers
  – Port of San Diego Approach
• Non-Agenda Public Comment
• Next Meeting
Climate Resilience Plan Update
Port District SLR Ad Hoc
November 14, 2018

Ralph Redman
Manager, Airport Planning
Sustainability Management Planning

Main Topic Areas

- **Sustainable Energy**
  - Implementing

- **Water Stewardship**
  - Implementing

- **Carbon Neutrality**
  - Draft

- **Clean Transportation**
  - Draft

- **Zero Waste**
  - FY2019

- **Climate Resilience**
  - FY2019

- **Biodiversity**
  - FY2020
Airport Sustainability Management Plans are...

“a comprehensive and systematic framework for integrating sustainability into an airport’s long-range planning and operations.”

Strategic Value:

- Accomplishes Strategic Plan initiative (2B)
- Establishes achievable, non-binding goals
- Provides internal alignment
- Supports pursuit of grant funding
- Demonstrates continued leadership
Climate Resiliency Plan
Climate Resiliency Plan

1. Vision & Goals
2. Baseline Inventory Climate Science SLR Maps Vulnerability
3. Initiatives Adaptation Strategies
4. Implementation Performance Targets Monitoring
5. Draft Plan

Climate Resilience Plan (Jan. 2019)
Climate Resiliency Plan

Draft vision:
To deliver uninterrupted airport service in a changing climate and provide resilience leadership in the aviation industry

Draft goals:
• Reduce risks associated with climate change to ensure business continuity
• Integrate climate resilience into airport operations and development decisions
• Provide regional and industry leadership in climate resilience
• Maintain a quality passenger experience as climate changes
# Climate Stressors

<table>
<thead>
<tr>
<th>Climate Hazard</th>
<th>2050</th>
<th>2100</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLR</td>
<td>1.6 Feet</td>
<td>2.5 Feet</td>
<td>OPC 2018</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.9 Feet</td>
<td></td>
</tr>
<tr>
<td>Precipitation</td>
<td>No change (SAN Drainage Study)</td>
<td>+0.2” annual increase Less frequent, but slightly heavier rainfall</td>
<td>SAN Drainage Study CAL-Adapt</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat</td>
<td>+5.5 days extreme heat + 1 day heat wave duration</td>
<td>+23.5 days extreme heat + 3 days heat wave duration</td>
<td>Extreme &gt;89° CAL-Adapt CHAT</td>
</tr>
<tr>
<td>Other:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wildfire</td>
<td>Some data, still an area of active research</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wind/Fog</td>
<td>No strong future trends observed in data</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### SLR Coordination
- Projections chosen to match ongoing Port District efforts as part of AB 691
- Analysis prepared for years 2030, 2050, and 2100
- Mapping will be provided to Port for inclusion in report

### SLR Projections
- Projection were based of State of CA SLR projections
- Scenarios chosen to address median (50% probability) and 1-In-20 Chance (5% probability)

### SLR Model
- COSMOS 3.0 chosen as model to match Port District
- Model provides for analysis of future years
- Most commonly used for other local efforts

### SLR Mapping
- Airport Authority prepared 2016 LIDAR used in SLR modeling
- COSMOS uses 2010 LIDAR
Legend
- Airport Boundary
- 0.8 ft Sea Level Rise: Year 2030 (1-in-20 Chance)
- Daily Tide (Permanent Inundation)
- 100-Year Storm Surge (Temporary Flooding)

San Diego International Airport

Data Sources: Cosmos; San Diego Airport; AECOM; SANDAG & SanGIS.
4.9 ft. SLR with 100 year storm surge
Vulnerability Assessment

**EXPOSURE**
Level of Exposure (inundation, heat threshold)

*Example:* A low-lying area is more exposed than an area outside of a flood zone.

**SENSITIVITY**
Degree to which system is affected

*Example:* An asphalt roadway becomes malleable in the heat, but concrete does not.

**ADAPTIVE CAPACITY**
Ability to bounce back, redundancy

*Example:* A back up generator provides adaptive capacity.

= VULNERABILITY

**Consequences**
- Economic (operation disruptions, damage)
- Social (passenger experience)
- Environmental (Least Tern)
Questions
OVERVIEW OF ADAPTATION PLANNING FOR COASTAL PROJECTS

Heather Schlosser
US Army Corps of Engineers, Los Angeles District
Acting Assistant Chief, Planning Division
14 November 2018
TOPICS

- USACE’S SEA LEVEL CHANGE AND CLIMATE CHANGE ADAPTATION GUIDANCE
- INCORPORATING SEA LEVEL CHANGE INTO PLANNING AND DESIGN
- EXAMPLES OF ADAPTATION APPROACHES
Sea Level Change:
- 1986 guidance letter – consider changing sea levels
- 1989, EC 1105-2-186 – formulate on low scenario but consider the range of future sea level change
- 2000, ER 1105-2-100 – Appendix K sensitivity to historic and NRC high rate sea level change
- 2009, 2011, EC 1165-2-211 and 212 – use three scenarios
- 2013, ER 1100-2-8162 – use 3 scenarios
- 2014, ETL 1100-2-1, adaptation to changing sea levels, uses tiered approach with level of effort commensurate with scale of decision and consequences

“The committee concluded that the most appropriate present engineering strategy is not to adopt one particular sea level rise scenario, but instead to be aware of the probability of increasing sea level and to keep all response options open. In many engineering projects, it may be desirable to carry out sensitivity calculations, using specific sea level rise scenarios. If a particular structure is ill-suited for retrofitting, it will undoubtedly be appropriate to allow for an acceleration of sea level rise in the initial design.”
• Public Access
• NOAA Tide Gauges plus selected long-term non-NOAA tide gauges
• USACE and NOAA scenarios

Calculator and related pages:
http://www.corpsclimate.us/ccaceslcurves.cfm
“It is the policy of USACE to integrate climate change preparedness and resilience planning and actions in all activities for the purpose of enhancing the resilience of our built and natural water-resource infrastructure and the effectiveness of our military support mission, and to reduce the potential vulnerabilities of that infrastructure and those missions to the effects of climate change and variability”

Integrate best available and actionable climate science and climate change information at appropriate level of analysis into long-term planning, setting priorities, and making decisions

http://www.corpsclimate.us/adaptationpolicy.cfm
CLIMATE CHANGE ADAPTATION PLANS

- Focus on specific areas
  - Infrastructure Resilience
  - Vulnerability Assessments
  - Risk-Informed Decision-Making for Climate Change
  - Nonstationarity
  - Portfolio of Approaches
  - Metrics and Endpoints
  - Engage in meaningful external collaboration

- Improve USACE knowledge for water resources management and systems resilience

- Develop policy and guidance supporting system resilience

http://www.corpsclimate.us/adaptationpolicy.cfm
STRATEGIC DECISION-MAKING USING MULTIPLE SCENARIOS AND SCREENING STEPS

- Climate Sensitive
- Robust solutions

- Non-climate sensitive

- Uncertainty
- Risk

- Adaptive Management
- Best Management Practices
- Scenario Planning
- Preparedness and Response
TIPPING POINTS: THRESHOLDS, LEAD TIMES AND DECISION POINTS

<table>
<thead>
<tr>
<th>Indicator value</th>
<th>Threshold value of indicator when intervention is needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>(e.g. sea level rise)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date of review</th>
<th>Recorded values of indicator</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Decision point based on best estimate</th>
<th>Predicted values of indicator based on rate of change</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Lead time for planning and construction</th>
</tr>
</thead>
</table>

Source: United Kingdom Climate Impacts Program
UK CWTL Team Members: Jonathan Simm, Robert Nicholls
**POTENTIAL STRATEGIES OF APPROACH FOR ALTERNATIVES**

**Anticipatory Strategy**
Implements features and design robustness now; for example, increases design parameters for engineered features.

**Adaptive Management Strategy**
Uses sequential decisions and implementation based on new knowledge; implementation prior to SLC impacts. Requires advance planning to maintain the ability to adapt.

**Reactive Strategy**
Can be planned or ad-hoc, but in either case no actions would be implemented until the impacts of SLC begin.

---

CWTL Team Members: Brian Harper, Matt Schrader, Tom Smith
EXAMPLE: GREAT LAKES COASTAL RESILIENCY STUDY
• **Study Goal**
  - To develop a collaborative risk-based decision framework that utilizes a systems approach to identify potential opportunities to improve coastal resilience over a range of future conditions across the Great Lakes built and natural environments.

• **USACE Approach**
  - Approach inspired by recently completed North Atlantic Coast Comprehensive Study (NACCS)

• **Partnerships**
  - Federal partners: NOAA, USGS, USEPA, FEMA, etc.
  - Regional partners: Great Lakes states, CSO, GLC, IJC, Conference of Great Lakes and St. Lawrence Governors and Premiers, etc.

**EXAMPLE: GREAT LAKES COASTAL RESILIENCY STUDY**

- ~5,200 miles of shoreline
- ~4.2 million people
Coastal Resilience - the ability of a coastal environment to withstand, recover from, and adapt to disturbances and underlying stresses in order to maintain and improve economic, environmental, and social/cultural values over time. Coastal resilience applies to both built and natural environments.

- **Built Environment**
  - Populations
  - Buildings
  - Infrastructure
  - Social/Cultural Resources

- **Natural Environment**
  - Ecosystems
  - Coastal Landscapes
  - Natural Processes

- **Future Conditions to Consider**
  - Climate Variability
    - Coastal storm damage/frequency
    - Precipitation
    - Temperature
  - Development and Land Use Patterns
    - Stormwater
    - Agricultural runoff
  - Natural Processes
    - Littoral transport
    - Lake level fluctuations
Matchers to Reduce Vulnerability -
The GLCRS will assess measures for their ability to reduce vulnerability. Resilient coastlines utilize a variety of measures:
- Structural
- Non-Structural
- Natural and Nature-Based
- Institutional/Regulatory

Risk -
- Considers both the likelihood of an event occurring and its impact.
- Risk is additive and affects vulnerability. Coastal areas are more vulnerable when they are exposed to more risks.
GREAT LAKES COASTAL RESILIENCY STUDY: FRAMEWORK

Major activities

- Identify problems and opportunities in each of the five Great Lakes
  - Collaboration with Federal, State and Regional stakeholders

- Inventory and analysis of Great Lakes coastal environments
  - Use and build on existing datasets
  - Identify information gaps to be filled

- Conduct technical studies to fill in identified data gaps

- Assess risk and vulnerability within the built and natural coastal environment
  - Forecast future conditions
  - Risk and vulnerability mapping
  - Identify ‘hotspots’

- Formulate measures to improve coastal resilience (including benefits, impacts, parametric costs)
  - Structural, non-structural
  - Beneficial use of dredged material
  - Living shoreline restoration, natural and nature-based features
  - Institutional/regulatory

- Reach-specific multi-criterial evaluation of measures to improve coastal resilience
  - Develop metrics
  - Suitability assessment (siting)
  - Specify reach extents

- Programmatic Great Lakes Coastal Resiliency Plan
  - Includes risk communication tools
GOALS

- Provide a Risk Management Framework, consistent with USACE-NOAA Rebuilding Principles
- Support Resilient Coastal Communities and robust, sustainable coastal landscape systems, considering future sea level rise and climate change scenarios, to reduce risk to vulnerable population, property, ecosystems, and infrastructure

EXAMPLE: NORTH ATLANTIC COAST COMPREHENSIVE STUDY
RESILIENT ADAPTATION TO INCREASING RISK
OPPORTUNITIES

- Mitigate future risk with **improved pre-storm planning**
- Identify acceptable **flood risk at a community** and state scale
- **Prioritize** critical infrastructure
- **Rebuild with redundancy**
- Develop **creative incentives** to promote use of resilience measures
- Utilize a **collaborative regional governance structure**
- Develop **Public-Private Partnerships** for coastal risk management
- Integrate **nature-based features** in coastal risk management systems
- Encourage design **flexibility and adaptive management**
FINDINGS

- Address the legislative direction for a **comprehensive plan** to address vulnerable coastal communities
- Formalized and **consistent approach/framework** for more detailed, site specific coastal evaluations
- **Integration** of state-of-the-science techniques and collaboration
- Equip and link a broad audience and all levels of government with data, tools, and other stakeholders to make **INFORMED coastal risk management decisions**
Managing coastal storm risk is a shared responsibility and requires:

- Shared tools
- Common methodology that all parties can follow together to assess risk and identify solutions

The framework is:

- A 9-step process
- Customizable for any coastal area or watershed
- Repeatable at state and local scales
- Transferable to other areas of the country
COASTAL STORM RISK MANAGEMENT FRAMEWORK

➢ **Structural**
  - Storm surge barriers
  - Levees, breakwaters, shoreline stabilization
  - Natural and Nature-Based Features (e.g., beaches and dunes, living shorelines, wetlands, oyster reefs, SAV restoration)

➢ **Non-Structural** (e.g., floodproofing, acquisition and relocation, flood warning, etc.)

➢ **Programmatic** (e.g., floodplain management, land use planning, State/municipal policy, natural resources, surface water management, education, flood insurance programs, etc.)
## COASTAL STORM RISK MANAGEMENT FRAMEWORK

<table>
<thead>
<tr>
<th>Measures</th>
<th>Rocky shores (Exposed)</th>
<th>Rocky shores (Sheltered)</th>
<th>Beaches (Exposed)</th>
<th>Beaches (Sheltered)</th>
<th>Manmade structures (Exposed)</th>
<th>Manmade structures (Sheltered)</th>
<th>Scars (Exposed)</th>
<th>Scars (Sheltered)</th>
<th>Vegetated low bluffs (Exposed)</th>
<th>Vegetated low bluffs (Sheltered)</th>
<th>Wetlands/Marshes/ Swamps (Exposed)</th>
<th>Wetlands/Marshes/ Swamps (Sheltered)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Structural</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storm Surge Barrier(^1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beach Restoration(^2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breakwaters and Beach Restoration(^3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Groins and Beach Restoration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shoreline Stabilization</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deployable Floodwall</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floodwall/Levee</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drainage Improvements</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Natural and Nature-Based Features</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Living Shoreline</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wetlands</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reefs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Submerged Aquatic Vegetation (SAV) (^4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overwash Fan(^4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drainage Improvements</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) The applicability of storm surge barriers cannot be determined based on shoreline type. It depends on other factors such as coastal geography.

\(^2\) Beaches and dunes are also considered Natural and Nature-Based Features.

\(^3\) SAV restoration is not associated with any particular shoreline type. It is initially assumed to apply to wetland shorelines.

\(^4\) Overwash fans may apply to the back side of barrier islands, which are not explicitly identified in the NOAA Environmental Sensitivity Index Shoreline Classification dataset.
Integration of Measures
COASTAL STORM RISK MANAGEMENT FRAMEWORK

Integration of Measures

<table>
<thead>
<tr>
<th>SB1</th>
<th>NBI 1</th>
<th>NBI 2</th>
<th>NBI 3</th>
<th>ALL</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S2</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S5</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S6</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
COASTAL STORM RISK MANAGEMENT FRAMEWORK

Integration of Measures

<table>
<thead>
<tr>
<th>SB1</th>
<th>NBI 1</th>
<th>NBI 2</th>
<th>NBI 3</th>
<th>ALL</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S2</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>S3</td>
<td></td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>S4</td>
<td></td>
<td></td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>S5</td>
<td></td>
<td>✔</td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>S6</td>
<td></td>
<td>✔</td>
<td></td>
<td>✔</td>
</tr>
</tbody>
</table>

Submerged Breakwater (Nearshore Berm/Oyster Reef/Sill) (GI 2)

Submerged Aquatic Vegetation (GI 3)
SYSTEMS APPROACH AND RESILIENCE

- Coastal change occurs over large temporal and spatial scales
- Complex social, economic, and environmental interactions
- Multiple/possibly competing stakeholder objectives
- Systems Approach:
  - Broad view of interactions and objectives to develop potential solution sets
  - Intentionally aligns engineering and natural systems

Restoration of Deer Island, MS
Barrier Island and Marsh
QUESTIONS?
Port of San Diego
Sea Level Rise Approach
Sea Level Rise Approach

- Strengths
- Areas of Improvement
- Actions
Adaptive Management

Decision-making strategy made up of a sequence of:

- Manageable steps
- Decision-points
- Opportunities to learn

Advantages:

1. Manages uncertainty by relying on events, not time
2. Guided by science and collective action
3. Allows for greater flexibility at project-specific scale
Sea Level Rise Approach

1. Vulnerability Assessment
2. Adaptation Planning
3. Strategy Implementation

Inform
Evaluate
Monitor
Threshold
1. Vulnerability Assessment

A. Select Sea Level Rise Projections
B. Identify Assets
C. Run Model and Produce Hazard Maps
D. Evaluate Vulnerability and Risk
A. Select Sea Level Rise Projections

### Projected Sea Level Rise (in feet) for District Tidelands

<table>
<thead>
<tr>
<th>Year/Percentile</th>
<th>Feet (Meters) above 1991-2009 mean</th>
<th>Median</th>
<th>Likely Range</th>
<th>1-in-20 Chance</th>
<th>1-in-200 Chance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Feet/Meters</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2030</td>
<td>0.5/0.15</td>
<td>0.4–0.6</td>
<td>0.12–0.18</td>
<td>0.7/0.21</td>
<td>0.9/0.28</td>
</tr>
<tr>
<td>2050</td>
<td>0.9/0.27</td>
<td>0.7–1.2</td>
<td>0.21–0.37</td>
<td>1.4/0.43</td>
<td>2.0/0.61</td>
</tr>
<tr>
<td>2100 (RCP 8.5)</td>
<td>2.6/0.79</td>
<td>1.8–3.6</td>
<td>0.55–1.10</td>
<td>4.5/1.40</td>
<td>7.1/2.16</td>
</tr>
</tbody>
</table>

1. Vulnerability Assessment
A. Select Sea Level Rise Projections

<table>
<thead>
<tr>
<th>CoSMoS* Model Levels in Meters</th>
<th>Recommended Ocean Protection Council(^1) Sea Level Rise Probabilistic Projections</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Increase Above Current Levels</td>
</tr>
<tr>
<td>0.25 meters</td>
<td>0.7 feet (0.21 meters)</td>
</tr>
<tr>
<td>0.5 meters</td>
<td>1.4 feet (0.43 meters)</td>
</tr>
<tr>
<td>0.75 meters</td>
<td>2.6 feet (0.79 meters)</td>
</tr>
<tr>
<td>1.5 meters</td>
<td>4.5 feet (1.4 meters)</td>
</tr>
</tbody>
</table>

Low Emission = Median or 50% probability SLR meets or exceeds...
High Emission = 5% probability meets or exceeds...

## B. Identify Potentially Impacted Assets

**Sea Level Rise Vulnerability Assets**

<table>
<thead>
<tr>
<th>Proposed Land Use Designations</th>
<th>Transportation</th>
<th>Built Infrastructure</th>
<th>Natural Resources/Environmental</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Aviation Industry</td>
<td>• Roads</td>
<td>• Stormwater</td>
<td>• Beach Accessible Areas</td>
</tr>
<tr>
<td>• Marine Sales &amp; Services</td>
<td>• Rail</td>
<td>• Sewer Lifts</td>
<td>• Habitats</td>
</tr>
<tr>
<td>• Maritime Services &amp; Industrial</td>
<td></td>
<td>• Sanitary Pump Outs</td>
<td></td>
</tr>
<tr>
<td>• Marine Terminal</td>
<td></td>
<td>• Port Operated Docks and Piers</td>
<td>• Contaminated uplands</td>
</tr>
<tr>
<td>• Visitor-Serving Marine Terminal</td>
<td></td>
<td></td>
<td>• Sensitive Species Nesting Areas</td>
</tr>
<tr>
<td>• Institutional/Roadways</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Commercial Fishing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Sportfishing</td>
<td></td>
<td>• Fuel Docks</td>
<td>• Commercial Fishing Berthing</td>
</tr>
<tr>
<td>• Recreational Open Space</td>
<td></td>
<td>• Boat Launch Ramps</td>
<td>• Sportfishing Berthing</td>
</tr>
<tr>
<td>• Conservation Inter-Tidal</td>
<td></td>
<td>• Critical Infrastructure (ie, Harbor Police, Port Operations Buildings, Marine Terminals, etc)</td>
<td></td>
</tr>
<tr>
<td>• Conservation Open Space</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Sportfishing Berthing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Recreational Berthing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Navigation Corridor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Anchorage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Open Bay/Water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Industrial &amp; deep water Berthing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Marine Services Berthing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Institutional Berthing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Commercial Fishing Berthing</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Vulnerability Assessment
C. Run Model and Produce Hazard Maps

1. Vulnerability Assessment
Sea Level Rise Approach

1. Vulnerability Assessment

2. Adaptation Planning

3. Strategy Implementation

Evaluate Inform

Monitor Threshold
Sea Level Rise Approach

2. Adaptation Planning

A. Identify Adaptation Strategies

B. Create/Refine Decision-Making Process for Selecting Strategies

C. Develop Monitoring Program and Indicators
# A. Identify Adaptation Strategies for Coastal Flooding

## Policy Considerations

<table>
<thead>
<tr>
<th>Protect</th>
<th>Accommodate</th>
<th>Adjust</th>
<th>Avert (Temporary Flooding)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Natural or Nature-Based Solutions</strong></td>
<td><strong>Shoreline Solutions</strong></td>
<td><strong>Building/Infrastructure Approaches</strong></td>
<td></td>
</tr>
<tr>
<td>• Cluster New Development</td>
<td>• Build dikes with habitat value</td>
<td>• Bulkheads</td>
<td></td>
</tr>
<tr>
<td>• Encourage Natural Solutions</td>
<td>• Living shorelines</td>
<td>• Embankments/Levees</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Floodwalls (Permanent)</td>
<td></td>
</tr>
<tr>
<td>• Allow Temporary and Occasional Flooding in Open Space</td>
<td>• Beach and sediment nourishment</td>
<td>• Upgrade Drainage Systems</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Restore wetlands</td>
<td>• Floodable Open Spaces</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Upgrade Drainage Systems</td>
<td>• Permeable Pavers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Floodable Open Spaces</td>
<td>• Flood proofing</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Raise Structures</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Floodable Parking Structures</td>
<td></td>
</tr>
<tr>
<td>• Develop Adequate Setbacks</td>
<td>• Allow habitat migration</td>
<td>• Retractable Barriers</td>
<td></td>
</tr>
<tr>
<td>• Modify Redevelopment in At-Risk Locations</td>
<td>• Create buffers</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Relocate Critical Facilities</td>
<td></td>
</tr>
<tr>
<td>• Provide Emergency Signage During Events</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Sandbags</td>
<td>• Sandbags</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Floodwalls (Temporary)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Pumpouts (Temporary)</td>
<td></td>
</tr>
</tbody>
</table>
B. Create/Refine Decision Making Process for Selecting Strategies

**Step 1. Establish Scope and Characterize Impacts**
- Develop a problem statement
- Determine assessment scope
- Identify timeline
- Describe and characterize impacts

**Step 2. Identify and Screen Action Alternatives**
- Identify Potentially Suitable Adaptation Actions
- Compare benefits and limitations
- Evaluate the feasibility
- Evaluate appropriateness
- Determine how to deal with uncertainty

**Step 3. Calculate Benefit and Costs**
- Assess physical performance metrics and life cycle costs
- Economic costs effectiveness analysis

**Step 4. Assemble Portfolio of Action Alternatives**
- Summarize selected adaptation strategies
- Identify variables which may influence action
- Relate strategies to overall goals and agency policies
C. Develop Monitoring Program and Indicators

Monitor Annual Sea Level Changes

Monitor Frequency of Coastal Flooding Events per Geographic Location

Monitor Cost to Respond to Coastal Flooding Events per Geographic Location

2. Adaptation Planning
Sea Level Rise Approach

1. Vulnerability Assessment

Evaluate

3. Strategy Implementation

Inform

2. Adaptation Planning

Monitor

Threshold
A. Perform Site-Specific Vulnerability Assessment

B. Apply Decision Making Framework

C. Institute Implementation Plan
A. Perform Site-Specific Vulnerability Assessment

Hazards

- Sea Level Rise
- Storm Frequency
- Flooding Extent
Sea Level Rise Approach

B. Apply Decision Making Process for Selecting Strategies

Step 1. Establish Scope and Characterize Impacts

Step 2. Identify and Screen Action Alternatives

Step 3. Calculate Benefit and Costs

Step 4. Assemble Portfolio of Action Alternatives

<table>
<thead>
<tr>
<th>Policy Considerations</th>
<th>Natural or Nature-Based Solutions</th>
<th>Shoreline Solutions</th>
<th>Building/Infrastructure Approaches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protect</td>
<td>Cluster New Development</td>
<td>Build dikes with habitat value</td>
<td>Bulkheads</td>
</tr>
<tr>
<td></td>
<td>Encourage Natural Solutions</td>
<td></td>
<td>Embankments/Leveses</td>
</tr>
<tr>
<td></td>
<td>Living shorelines</td>
<td></td>
<td>Flooding (Permanent)</td>
</tr>
<tr>
<td>Accommodate</td>
<td>Allow Temporary and Occasional Flooding in Open Space</td>
<td>Beach and sediment Nourishment</td>
<td>Upgrade Drainage Systems</td>
</tr>
<tr>
<td></td>
<td>Restore wetlands</td>
<td></td>
<td>Floodable Open Spaces</td>
</tr>
<tr>
<td>Adjust</td>
<td>Develop Adequate Setbacks</td>
<td>Allow habitat migration</td>
<td>Retractable Barriers</td>
</tr>
<tr>
<td></td>
<td>Modify Redevelopment in At-Risk Locations</td>
<td>Create buffers</td>
<td></td>
</tr>
<tr>
<td>Avert (Temporary Flooding)</td>
<td>Provide Emergency Signage During Events</td>
<td></td>
<td>Sandbags</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sandbags (Temporary)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pumpouts (Temporary)</td>
</tr>
</tbody>
</table>
Strategy Implementation

Site-Specific Implementation

Site-Specific Vulnerability Assessment → Apply Decision-Making Process → Institute Implementation Plan

Strategy 1 → Strategy 2 → Strategy 3

Monitoring and Triggers
Sea Level Rise Approach

1. Vulnerability Assessment

3. Strategy Implementation

2. Adaptation Planning

Evaluate
Inform
Monitor

Threshold
Discussion
Sea Level Rise Approach

- Strengths
- Areas of Improvement
- Actions
Non-Agenda Public Comment
### Sea Level Rise Ad Hoc Committee

<table>
<thead>
<tr>
<th>Date</th>
<th>Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>September 18, 2018</td>
<td>• Purpose, goals, and schedule</td>
</tr>
<tr>
<td></td>
<td>• Results of Vulnerability Assessment</td>
</tr>
<tr>
<td>November 14, 2018</td>
<td>• Background on Adaptive Management Approach</td>
</tr>
<tr>
<td>December 6, 2018</td>
<td>• Options for Monitoring and Indicators</td>
</tr>
</tbody>
</table>
Adjourn

Thank You