Identifying and Adapting to Sea-level Rise Vulnerabilities

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“I’ve been dumping bodies here for years, and it seems to me that the sea level is rising.”
Evolution of Sea-Level Rise Projections

FEMA + Sea-Level Rise

Legend
Contra Costa (Effective 9/30/2015)
Coastal Transects

Increased Flooding Scenarios
Increase: +1ft

Increase: +2ft

Increase: +3ft

Coastal Special Flood Hazard Areas
AE
VE

0.2 Pct Annual Chance Flood Hazard
Wave Run-up Can May Faster Than Sea-Level Rise

Total water level = Still water level + wave run-up

<table>
<thead>
<tr>
<th>Increase in sea level</th>
<th>Increase in total water level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.2</td>
</tr>
<tr>
<td>2</td>
<td>4.3</td>
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<tr>
<td>3</td>
<td>6.3</td>
</tr>
<tr>
<td>4</td>
<td>9.6</td>
</tr>
<tr>
<td>5.5</td>
<td>12.9</td>
</tr>
</tbody>
</table>

Source: FEMA
Coastal Erosion: Sea-level Rise Accelerated Hazard

Effective FEMA DFIRM published 2008

Estimated – ESA PWA, potential erosion by 2100, published 2009

2010 - Buildings uninhabitable
Bay flooding increases with sea-level rise …

… and so might precipitation & creek flooding!
Different Shorelines Face Different Hazards
Approaches to Adaptation

**Accommodate:**
- Siting and design standards
- Retrofit existing structures
- Stormwater management

**Protect:**
- Hard protection
- Soft protection/living shorelines
- Protect agricultural barriers for flood protection

**Hybrid:**
- Accommodate over short-term, relocate over long-term
- Update land use designations and zoning ordinances
- Redevelopment restrictions
- Permit conditions

**Retreat:**
- Limit new development in hazardous areas and areas adjacent to wetlands, ESHA, other habitats
- Removal of vulnerable development
- Promote preservation and conservation of open space

**INTERVENTION OPTIONS**

- **Accommodate**
  - Future sea level + extreme tide/storm
  - Existing sea level

- **Protect | Engineered**
  - Future sea level + extreme tide/storm
  - Existing sea level

- **Protect | Natural**
  - Future sea level + extreme tide/storm
  - Existing sea level

- **Retreat**
  - Future sea level + extreme tide/storm
  - Existing sea level
Protecting with Green & Gray

Example of Green/Gray Hybrids

Hayward Shoreline (ESA PWA, 2010)

Oro Lomo Sanitary District Pilot project (2016)

Corte Madera, Greenbrae

Phase 1: Recharge mudflat and marsh

Phase 2: Increase transition zone

Menlo Park

Phase 1: Stabilize with coarse beach

ESA (2013), for BCDC

SAFER Ecotone Levee

E. Palo Alto
Intentional & Phased Adaptation Planning

Increasing sea-level rise

- Existing levees
- Restore marshes, flood-proofing buildings
- Upgrade pump station, community-scale levee upgrades
- Realign functions?

Threshold - Decision - Lead Time - Effective
Where to Learn More

• At AEP 2017:
  – Ocean Beach MP: Multi-Objective Adaptation to Sea Level Rise along San Francisco's Pacific Ocean Shore
    • Friday, May 19 @ 9-10:30am
  – Sea Level Rise Mapping: The Past, the Present, and the Future
    • Saturday, May 20 @ 1:45-3:15pm

• State
  – OPC
    • [www.opc.ca.gov/climate-change](http://www.opc.ca.gov/climate-change)
  – California Coastal Commission
    • [www.coastal.ca.gov/climate/slrguidance.html](http://www.coastal.ca.gov/climate/slrguidance.html)

• Bay Area
  – Bay Conservation & Development Commission
    • [www.adaptingtorisingtides.org](http://www.adaptingtorisingtides.org)