Port of
LONG BEACH
THE PORT OF CHOICE

Climate Adaptation and Coastal Resiliency Plan

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Director of Environmental Planning

Importance of Resiliency

- Climate impacts already impacting the Port/SoCal
  - Sea level rise
  - Greater frequency & magnitude of storms
  - Greater number of hot weather days
- Decision making for port and port tenants & stakeholders
  - Prioritization of resource allocations
  - Investing in maritime infrastructure
- State Compliance
  - AB 691
  - SLR assessment on public trust lands
- Hurricane Marie—August 2014
  - Demonstrated relevance & importance of adaptation planning

Hurricane Marie – A Case Study

- Damage at Navy Mole and Pier F shorelines & rock dikes
  - $7M in repairs
- Significant damage to breakwater
  - 3 large holes & many other breeches
  - $21M in repairs
- Access restricted to rail operations, critical facilities, fueling stations, etc.

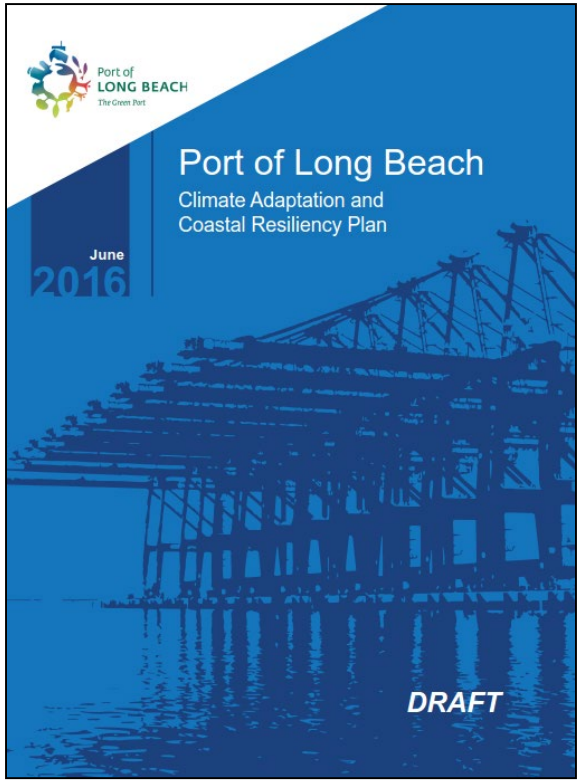
Climate Adaptation and Coastal Resiliency Plan

Project Goals

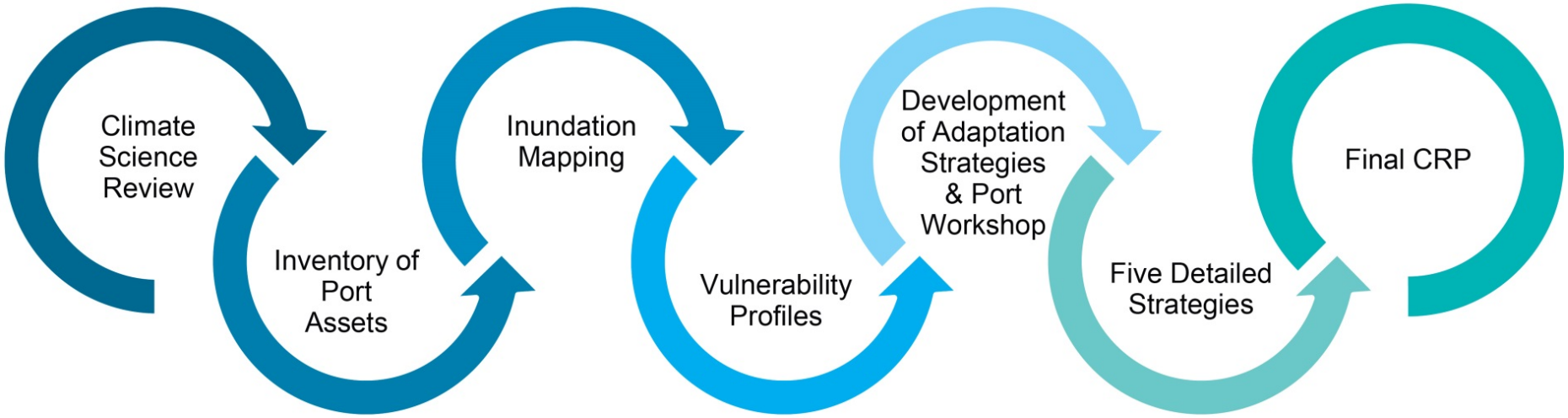
- Ensure resilience and business continuity
- Manage risks associated with climate change
- Identify most vulnerable assets
- Identify adaptation strategies to protect port infrastructure

Project Benefits

- A more resilient port able to maintain operations under changing conditions
- More future-looking risk assessment process
- Long-term sustainable development
- A port ready to adapt



CRP – Project Approach



Phase 1: Data Gathering

Phase 2: Adaptation Strategies

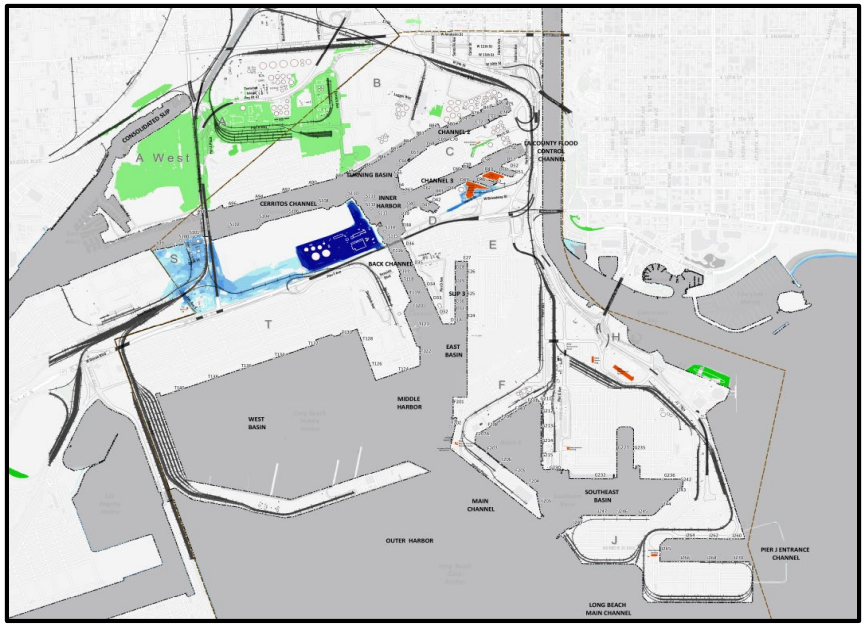
Climate Science Review

Stressors

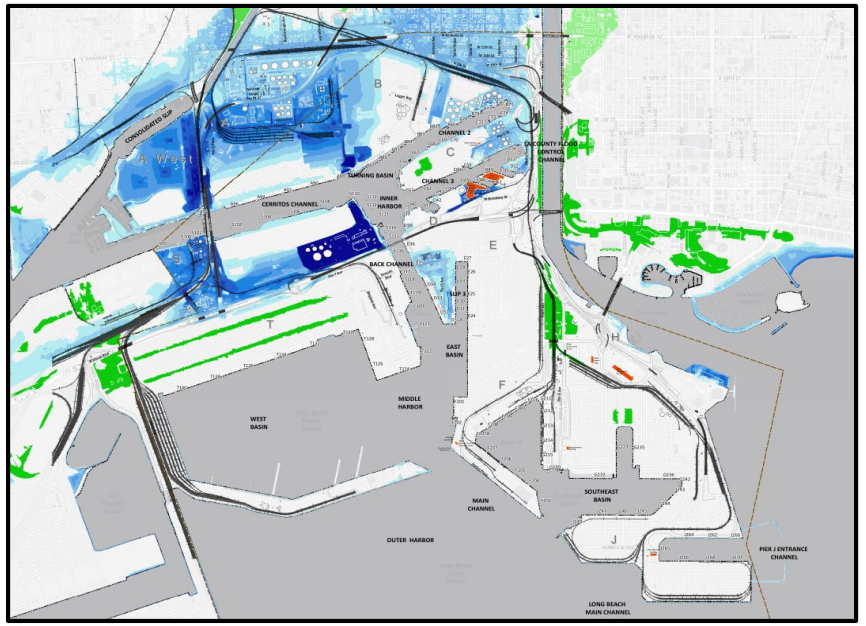
Climate Stressors	Mid-Century	End-of-Century
Temperature	▪ +0.6°F–6.4°F in Long Beach ▪ +two- to threefold extremely hot days	▪ +4.1°F–8.6°F in California
Precipitation	▪ −9% total rainfall on California Coast ▪ −13% days of rainfall on California coast	▪ Increased storm frequency/severity (20-year storm becomes 4–15-year storm) in California ▪ +10–25% total rainfall per storm in California
Sea Level Rise (SLR)	▪ 11–24 in. of SLR in Los Angeles	▪ 37–66 in. of SLR in Los Angeles
Extreme Wind	▪ Limited data available	▪ Limited data available
Ocean Acidity + Temperature	▪ −0.5 units pH in California waters ▪ Warming of coastal waters	▪ Warming of coastal waters

And Storm Surge!

SLR Inundation Mapping



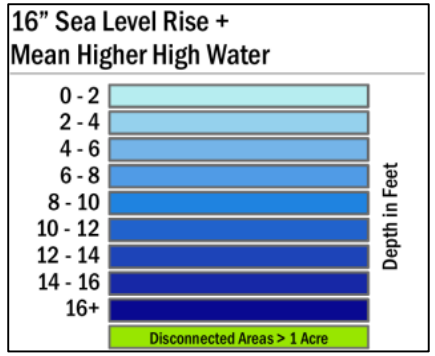
Least Extreme (16” SLR)



Most Extreme (55” SLR + 100yr Storm Surge)

Scenario		Year
16” SLR	16” SLR + Storm Surge	2050
36” SLR	36” SLR + Storm Surge	2070
55” SLR	55” SLR + Storm Surge	2100

These scenarios are most appropriate for the Port based on lifespan of assets.



Vulnerability Profiles

Profiles created for

- Pier Infrastructure
- Transportation Network
- Critical Facilities
- Utilities
- Breakwater

What's included in each Vulnerability Profile

Introduction: Review of asset location, photograph, summary, and site characteristics

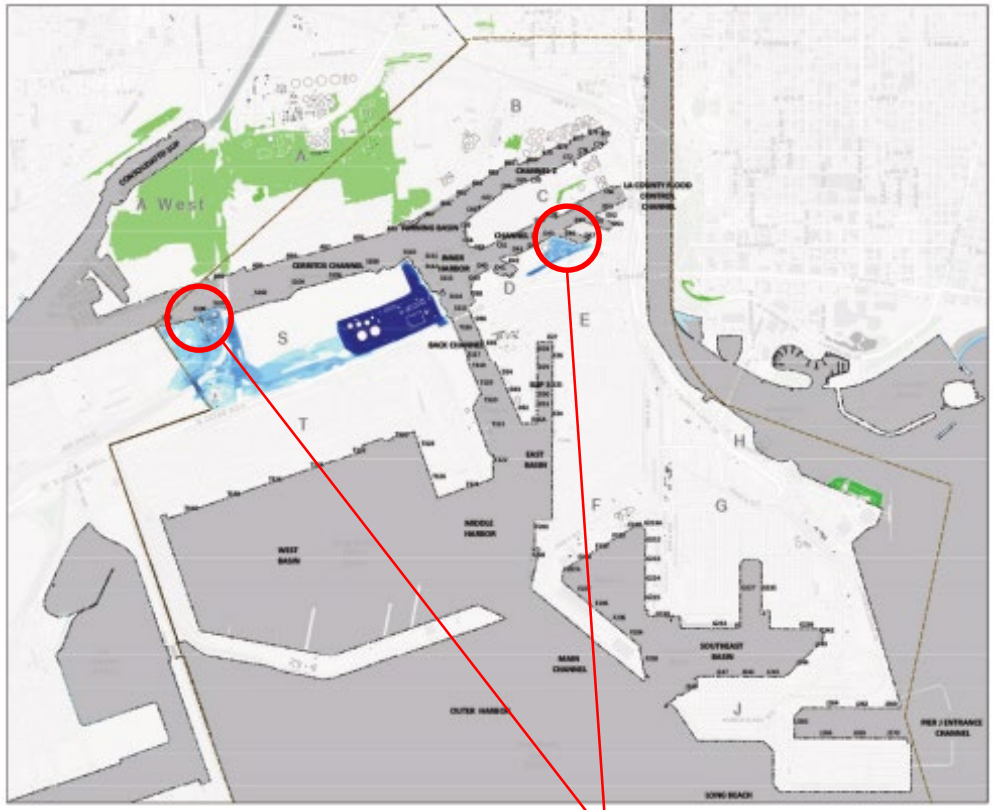
Climate Stressors: Description of asset vulnerabilities due to potential SLR and storm surge, extreme temperatures, extreme winds, increased precipitation, and ocean acidity change

Thumbnail Inundation Maps: Thumbnail inundation maps illustrating the following scenarios:

- 16-inch, 36-inch, 55-inch SLR
- 16-inch, 36-inch, 55-inch SLR + 100-year Storm Surge

Pier Infrastructure

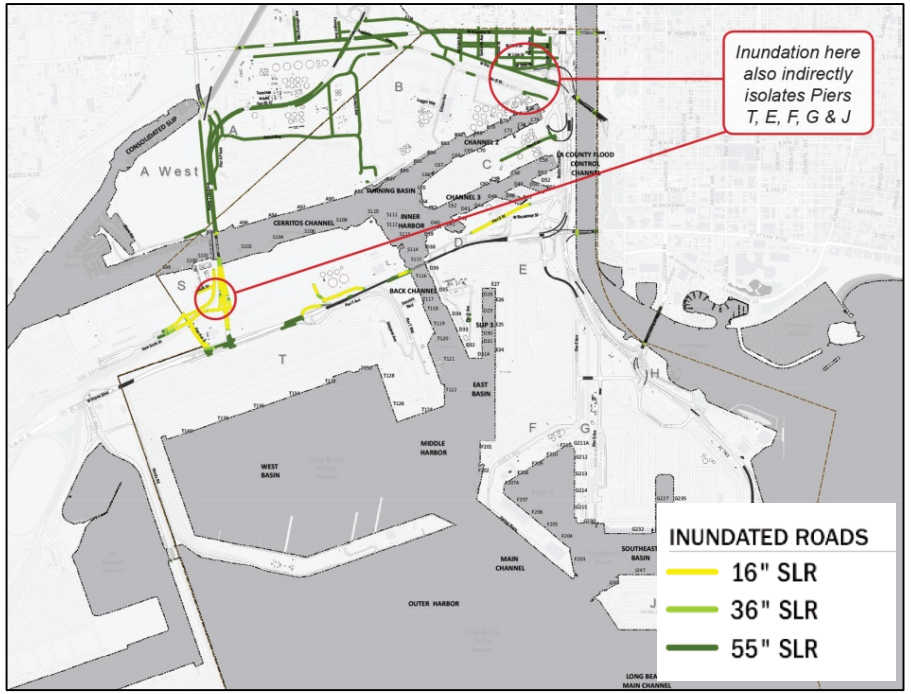
- Piers S and D are first to be inundated (16” SLR).
- Piers A and B include low lying areas that could flood if overtopping occurs.
- Piers F, G, J, and T not inundated, but may be isolated.



16” SLR

Transportation Network: Road

- Road traffic stops after few inches of inundation (pending vehicle type).
- Piers S and D roadway first impacted (16” SLR) and may prevent movement of cargo and access to facilities.
- Under most extreme conditions, roadways within Piers A, B, C, and tip of E would also be directly inundated as well as the SR-47 that connects to Terminal Island.

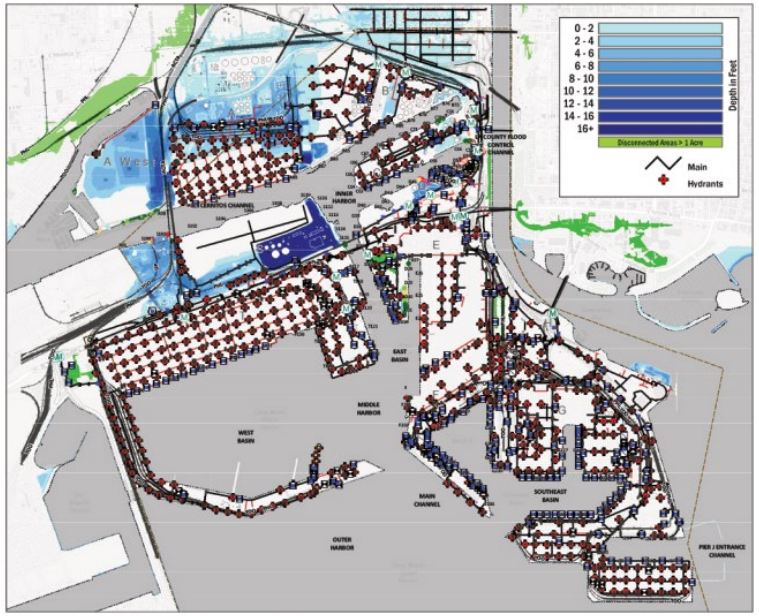


SLR Roads Overview

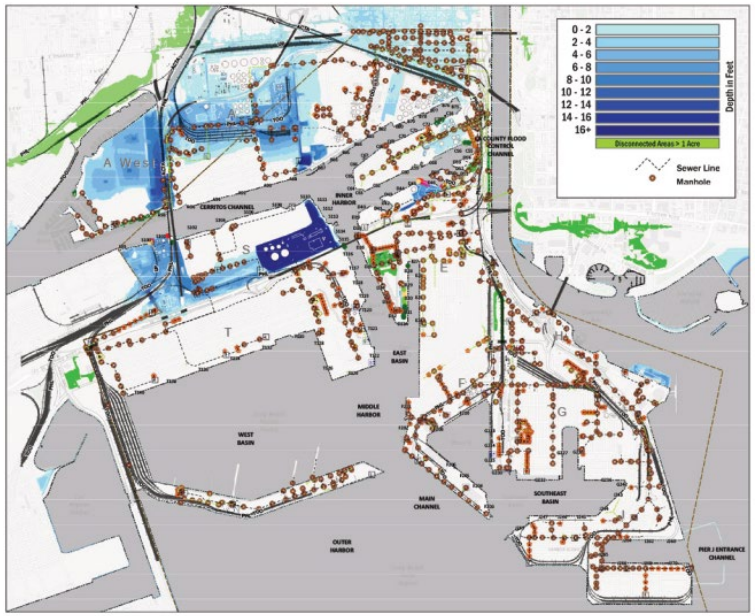
Utilities

Least vulnerable

- Freshwater: valve vaults could be impacted.
- Sewer System: lift/pump stations could be impacted.
- Communications: cables, joints, and splices could be impacted.



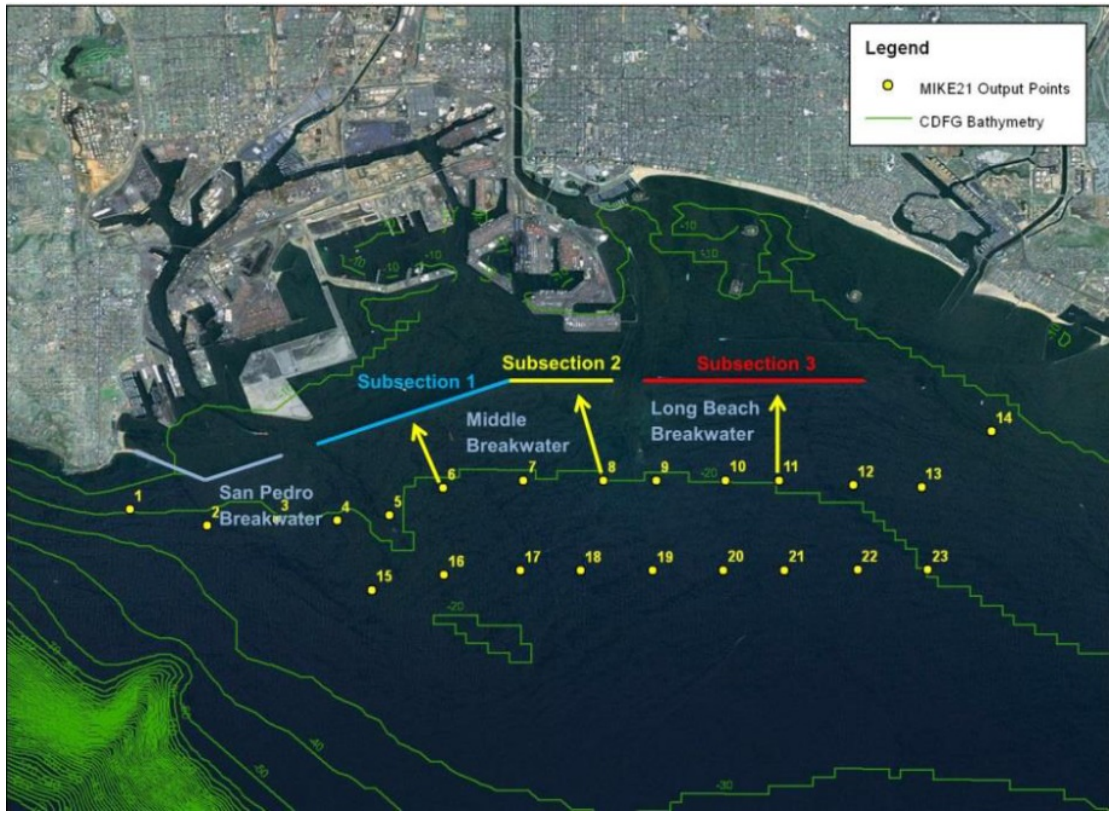
16-inch SLR + 100-year Storm Surge



16-inch SLR + 100-year Storm Surge

Breakwater

- USACE owned & maintained
- 9 miles long – 3 sections
- 200 feet wide at bottom, 23 feet wide at top
- Long Beach breakwater most vulnerable section
  - lower crest elevations
  - greater wave exposure
- Hurricane Marie included unusual wind and wave direction which caused damage to the Middle Breakwater, leading to infrastructure damage and an impact to Port operations.



Prioritized Adaptation Strategies

Four Prioritized Strategies – concept design

Governance

1. Addressing climate change impacts through various Port policies, plans, and guidelines

2. Adding climate change analysis to the Harbor Development Permit process

Initiative

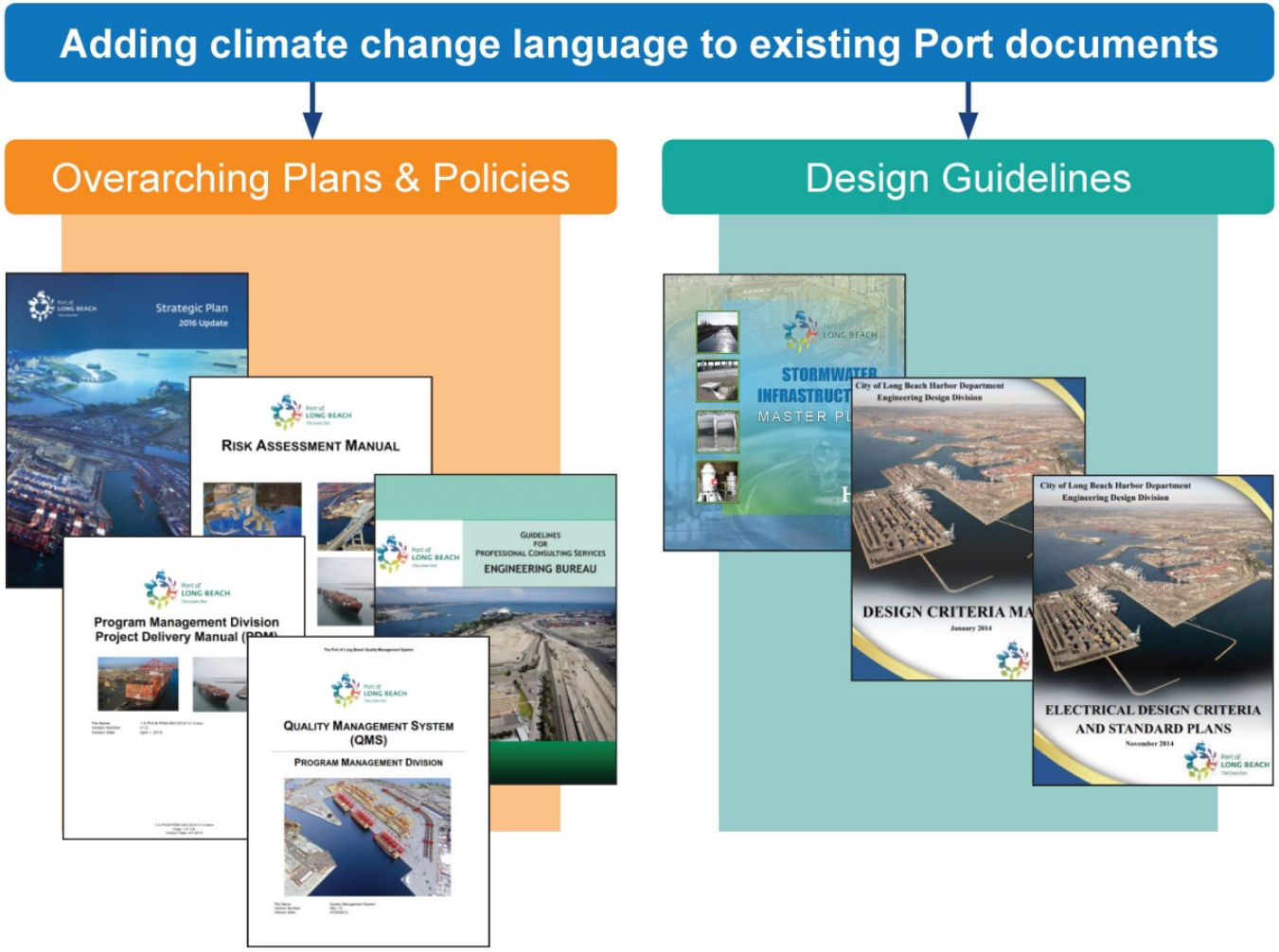
3. Piers A & B Study – combined impacts of riverine and coastal flooding around Dominguez Channel

Physical Infrastructure

4. Pier S Shoreline Enhancement (short & long term solutions)

*Additional future strategies to consider were also analyzed, but to a lesser degree.

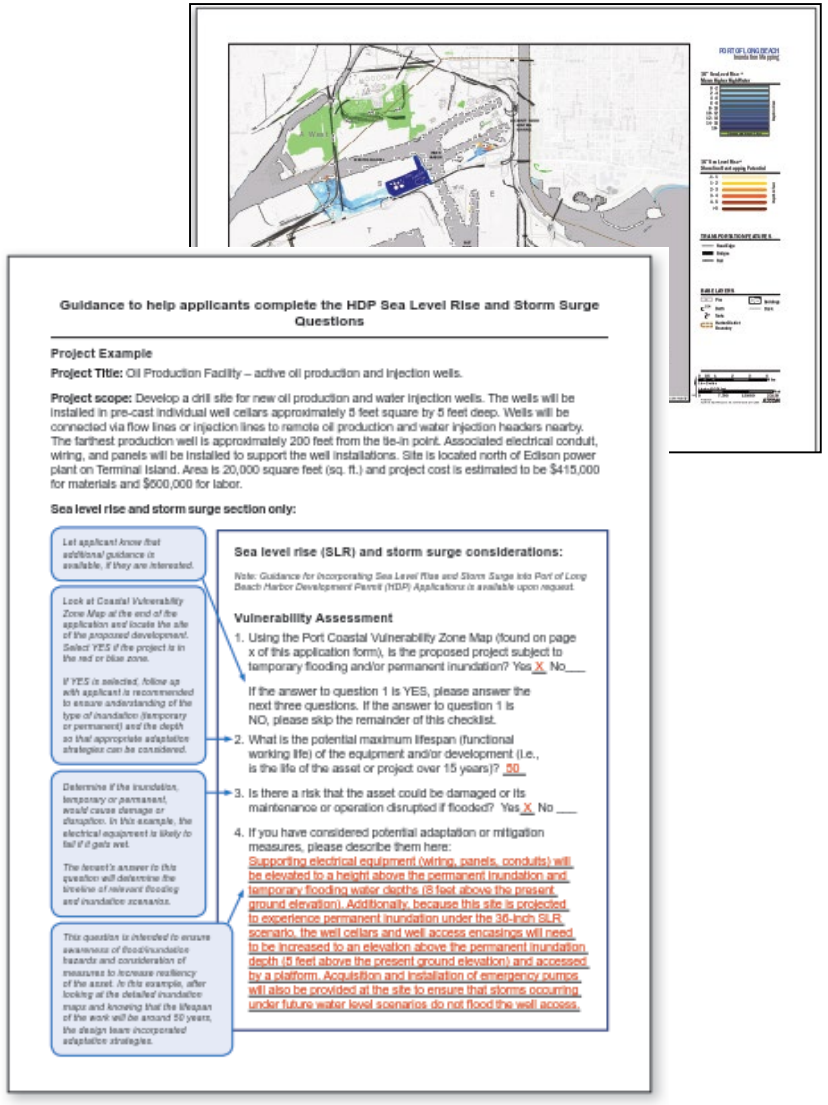
Strategy #1: Addressing Climate Change through Port Policies, Plans, & Guidelines



Strategy #2: Adding Sea Level Rise Analysis to Harbor Development Permit Process

Staff Guidance Document

- Introduction
- SLR/storm surge projections
- Definitions (vulnerability, risk, adaptation strategies)
- Forms, example project, and internal checklist for staff reviewing applicable projects



Guidance to help applicants complete the HDP Sea Level Rise and Storm Surge Questions

Project Example

Project Title: Oil Production Facility – active oil production and injection wells.

Project scope: Develop a drill site for new oil production and water injection wells. The wells will be installed in pre-cast individual well cellars approximately 5 feet square by 5 feet deep. Wells will be connected via flow lines or injection lines to remote oil production and water injection headers nearby. The farthest production well is approximately 200 feet from the tie-in point. Associated electrical conduit, wiring, and panels will be installed to support the well installations. Site is located north of Edison power plant on Terminal Island. Area is 20,000 square feet (sq. ft.) and project cost is estimated to be $415,000 for materials and $600,000 for labor.

Sea level rise and storm surge section only:

Let applicant know that additional guidance is available, if they are interested.

Look at Coastal Vulnerability Zone Map at the end of the application and locate the site of the proposed development. Select YES if the project is in the red or blue zone.

If YES is selected, follow up with applicant is recommended to ensure understanding of the type of inundation (temporary or permanent) and the depth so that appropriate adaptation strategies can be considered.

Determine if the inundation, temporary or permanent, would cause damage or disruption. In this example, the electrical equipment is likely to fail if it gets wet.

The lessee's answer to this question will determine the timeline of relevant flooding and inundation scenarios.

This question is intended to ensure awareness of flood/inundation hazards and consideration of measures to increase resiliency of the asset. In this example, after looking at the detailed inundation maps and knowing that the lifespan of the work will be around 50 years, the design team incorporated adaptation strategies.

Sea level rise (SLR) and storm surge considerations:

Note: Guidance for Incorporating Sea Level Rise and Storm Surge into Port of Long Beach Harbor Development Permit (HDP) Applications is available upon request.

Vulnerability Assessment

1. Using the Port Coastal Vulnerability Zone Map (found on page x of this application form), is the proposed project subject to temporary flooding and/or permanent inundation? Yes X No___

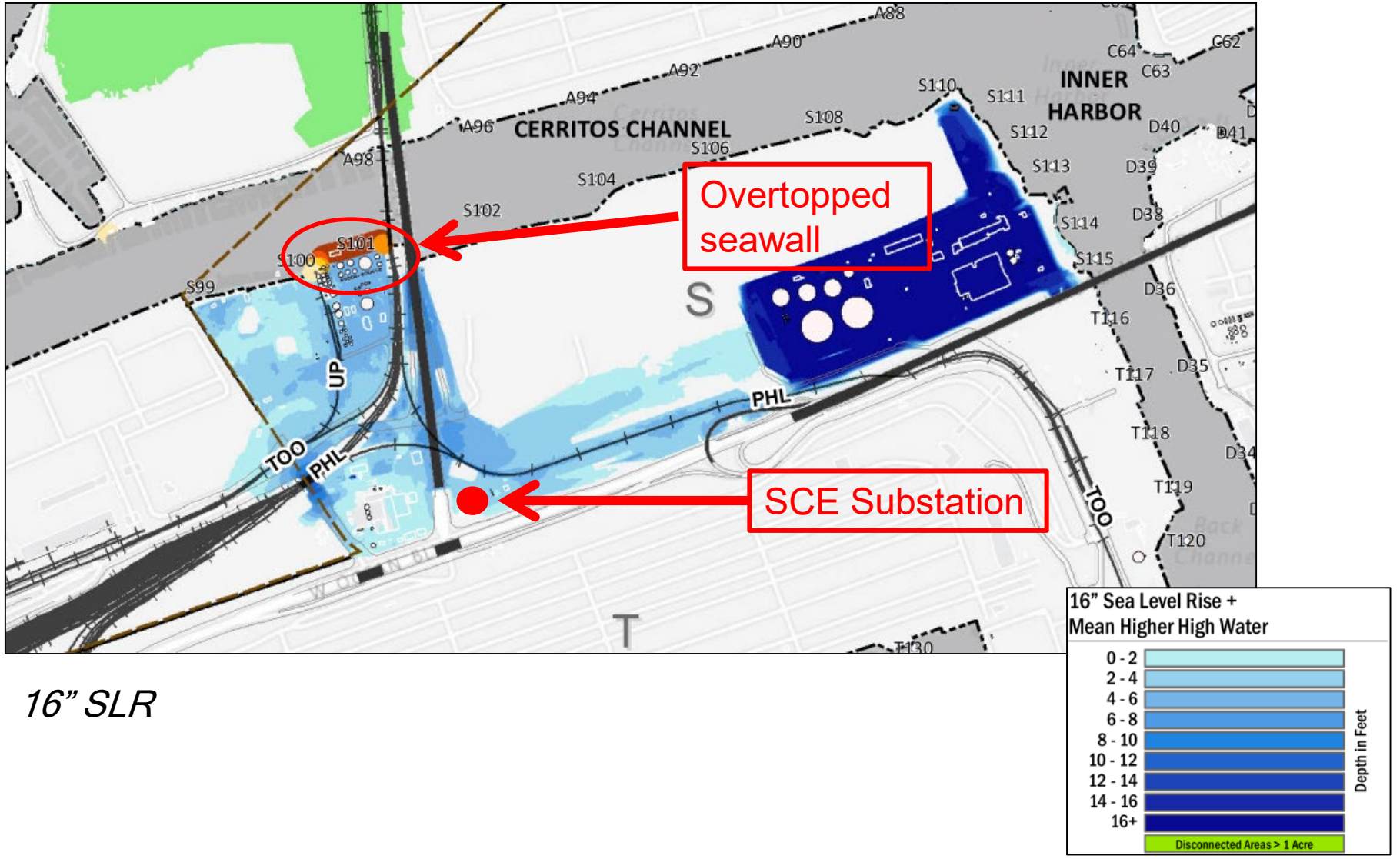
   If the answer to question 1 is YES, please answer the next three questions. If the answer to question 1 is NO, please skip the remainder of this checklist.

2. What is the potential maximum lifespan (functional working life) of the equipment and/or development (i.e., is the life of the asset or project over 15 years)? 50

3. Is there a risk that the asset could be damaged or its maintenance or operation disrupted if flooded? Yes X No ___

4. If you have considered potential adaptation or mitigation measures, please describe them here:
   Supporting electrical equipment (wiring, panels, conduits) will be elevated to a height above the permanent inundation and temporary flooding water depths (6 feet above the present ground elevation). Additionally, because this site is projected to experience permanent inundation under the 36-inch SLR scenario, the well cellars and well access encasings will need to be increased to an elevation above the permanent inundation depth (5 feet above the present ground elevation) and accessed by a platform. Acquisition and installation of emergency pumps will also be provided at the site to ensure that storms occurring under future water level scenarios do not flood the well access.

Strategy #4: Pier S Shoreline Enhancement & Substation Protection



16" SLR

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THANK YOU