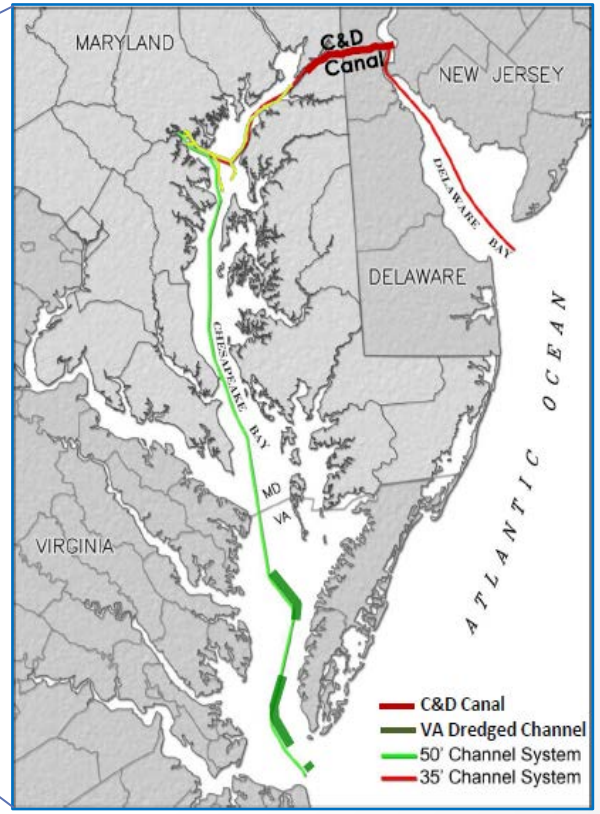
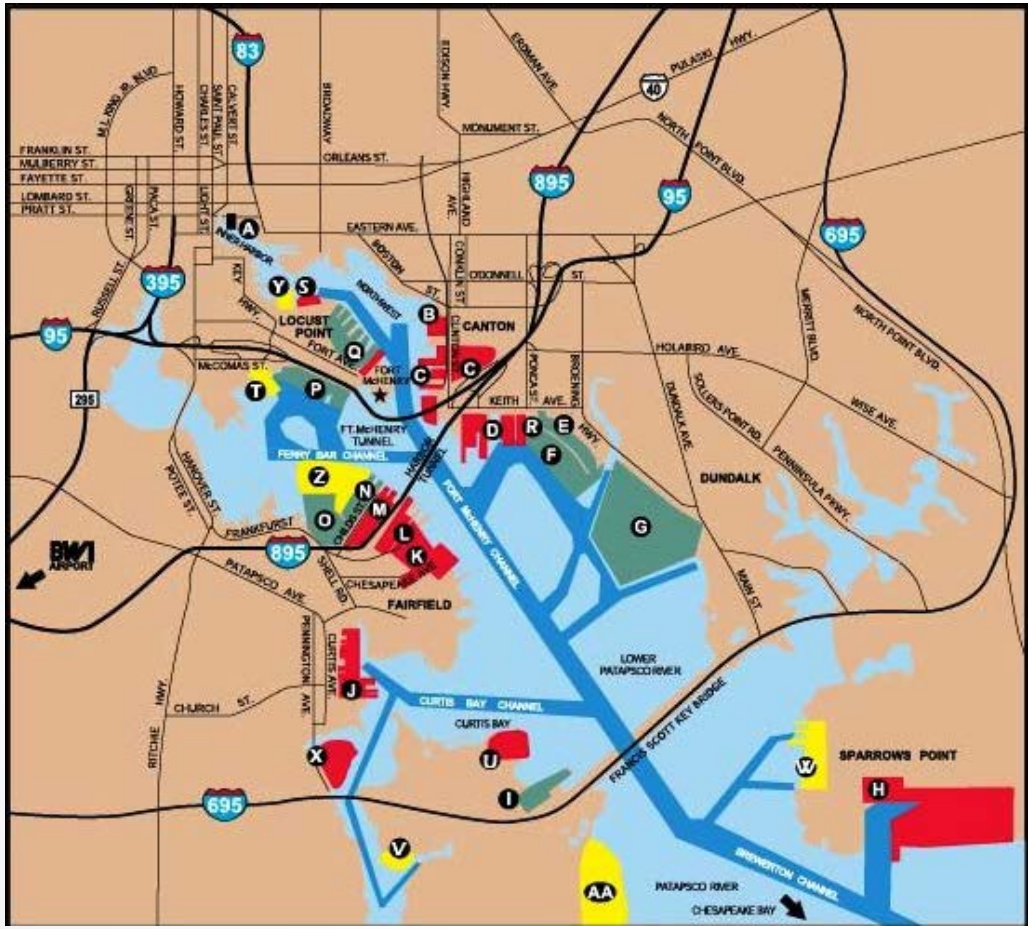
Climate, Extreme Weather & Port Resilience:

An Ongoing Dialogue



Who we are:
The Port of Baltimore - A Diverse Collection of Private and Public Terminals



Channels

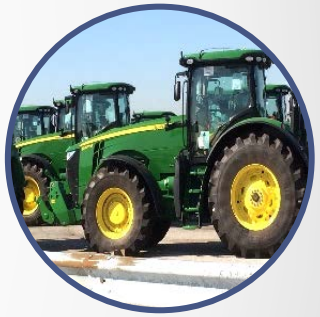
Private Terminals

MPA Terminals

Other Port Facilities

Containers

Automobiles



RoRo
(equipment)

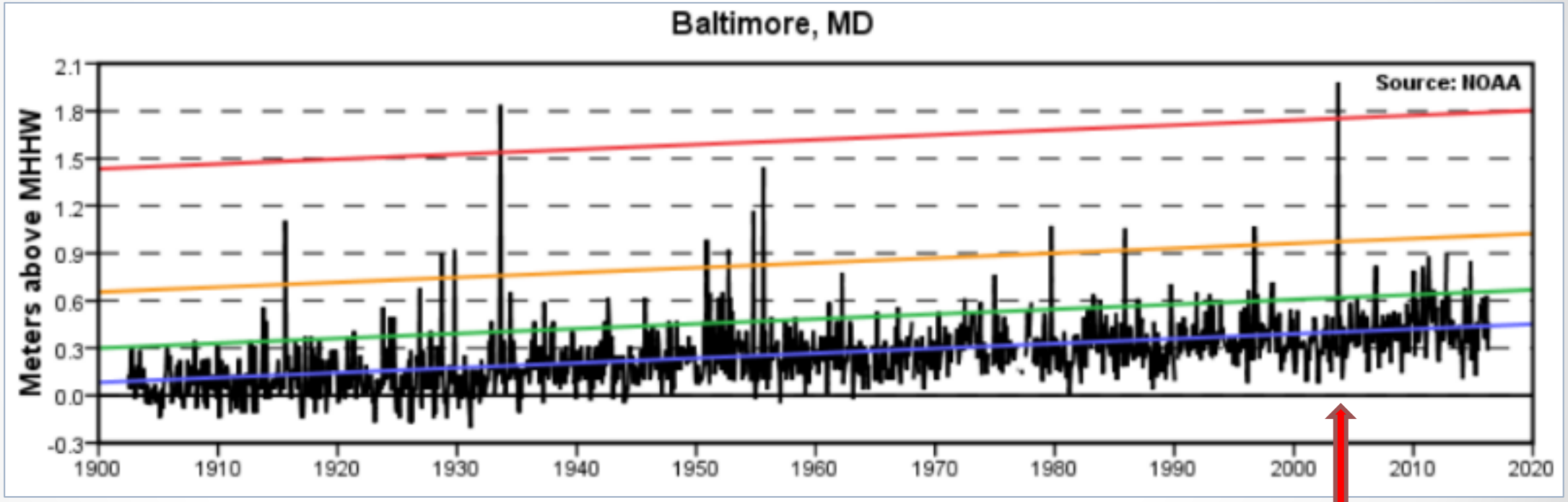
Bulk
(Coal, Sugar, etc.)

Pulp/Paper

Cruise

Marine Terminals have learned to deal with weather variability as part of normal operations.

To plan for future climate impacts we look at historical trends, climate change prediction models, and lessons learned from past events.



Historical Trends – High Water in Baltimore
1900 - 2017

Critical Vulnerability:
Sea Level Rise and Flooding from Storm Surge.

Lessons from Hurricane Isabel

8.5 foot storm surge plus waves topped the deck height at many of the Port's berths.

Resilience Vulnerability:
Post-Storm Debris and Cleanup.

Lessons from Hurricane Isabel

Debris from storm surge required cleanup; physical damage to terminals and structures was limited.

Resilience Vulnerability:
Damage to Underground Electrical Systems

Lessons from Hurricane Isabel

Resilience Vulnerability:
Flooding & Debris Blocking Highway and Rail Access

Lessons from Hurricane Isabel

Several access routes to/from the Port are located in flood prone areas.

Debris needed to be cleared from roadways and rail lines.

Marine Terminals are vulnerable to a variety of other Climate Change risks:

- Extreme Temperatures
- Extreme Rain Events
- High Winds
- Snow, Ice and Hail Events
- Increased Sedimentation

Less is known about the potential severity and frequency of these risks as they relate to Climate Change, and are therefore more difficult to plan for.

Resilience Vulnerability:
Flash Flooding from Extreme Rainfall Events

A severe thunder storm in 2016 raised water levels in the Patapsco River by **14 feet in 90 minutes**, destroying part of Ellicott City, MD and killing 2 people.

MPA has prepared a Vulnerability Analysis to prepare for Climate Change.

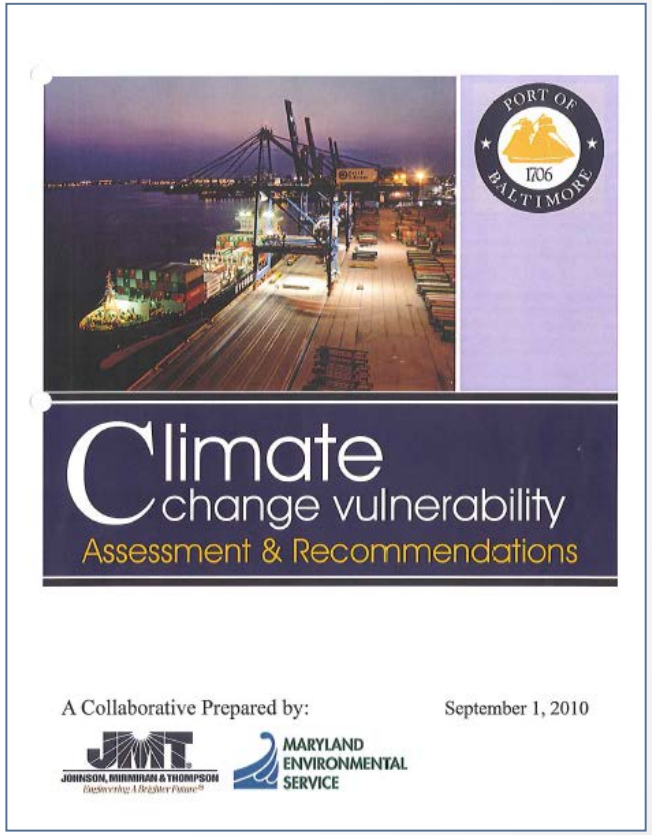
Strategic Approach:

Migrate (non-essential uses) out of flood prone areas;

Elevate new structures +2 feet;

Mitigate by strengthening essential uses in place; and

Operate with Climate Change plans, emergency management, and other contingencies.



Preparing for Resilience
Potential Future Actions

- Raise the terminal/berth elevations when feasible.
- Enhance storm water management infrastructure.
- Update Emergency Management and Recovery Plans and SOPs.
- Require corrosion resistant reinforcement, durable materials, and enhanced quality control of production and installation of marine infrastructure.
- Help meet MD's greenhouse gas emission reduction targets.
- Identify options for maintaining resilience to climate change with State and local partners.

Preparing for Resilience
Potential Future Actions

- Expand & enhance Dredge Material Containment Facilities.
- Explore reuse of dredge material for resilience projects (i.e. terminal raising, wetland restoration, shoreline/island restoration).
- Investigate electric/micro-grid improvements, redundancies, and emergency power generation options.
- Consider resiliency in all capital project designs and prioritize investments by level of risk and potential impacts.

Ports Preparing for Climate Change Resilience & Adaptation

Discussion/Questions?

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