NEW ENGLAND WATER ENVIRONMENT ASSOCIATION
NEWEA
WORKING FOR WATER QUALITY

July 12, 2017

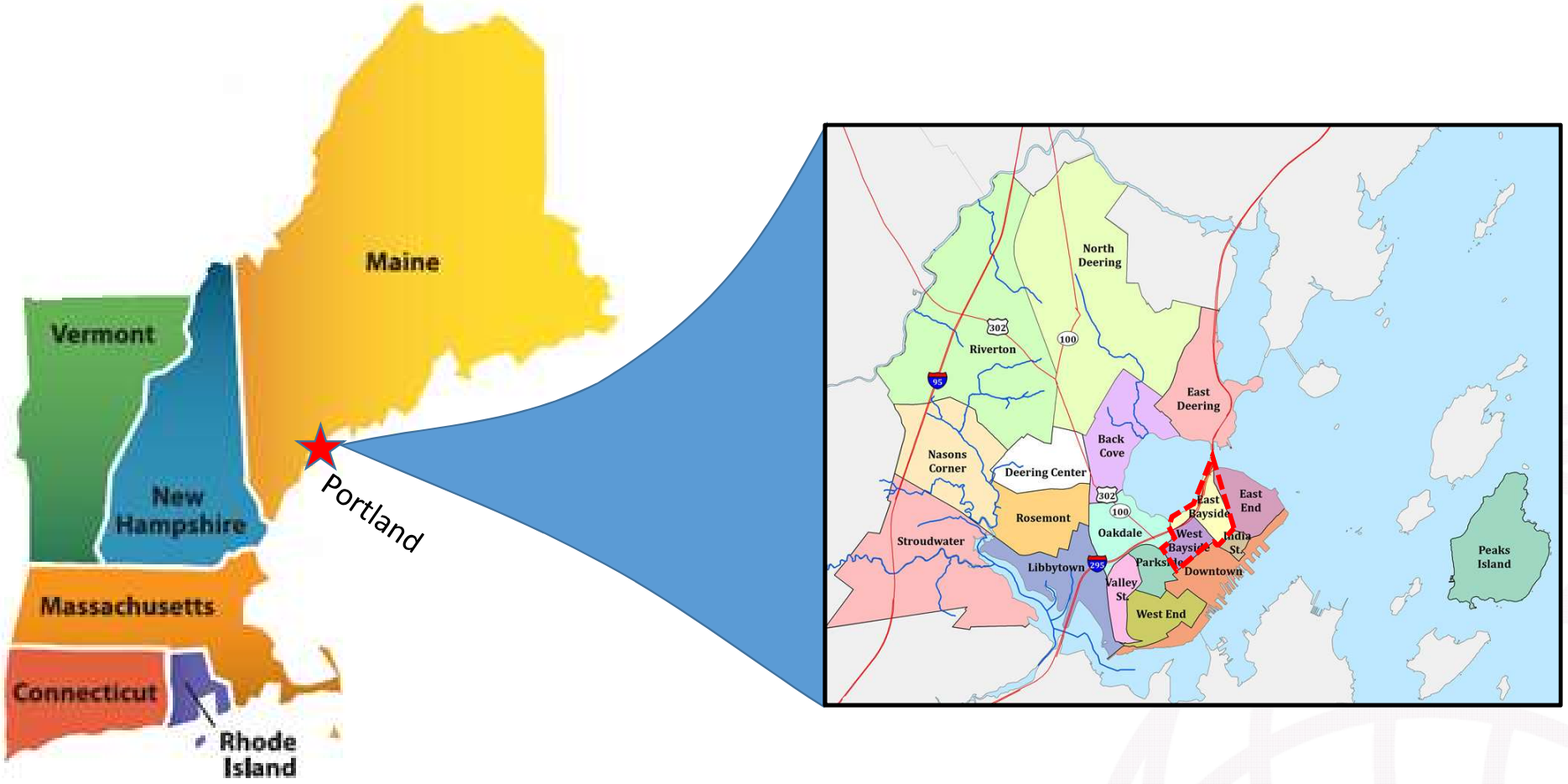
Creating Resilient Infrastructure & Watershed Specialty Conference

Troy Moon, Sustainability Coordinator
Portland, Maine

David Senus, Project Manager
Woodard & Curran, Inc.

Step 0: How Portland Maine Is Working to Protect a Low-lying Neighborhood

Portland, Maine

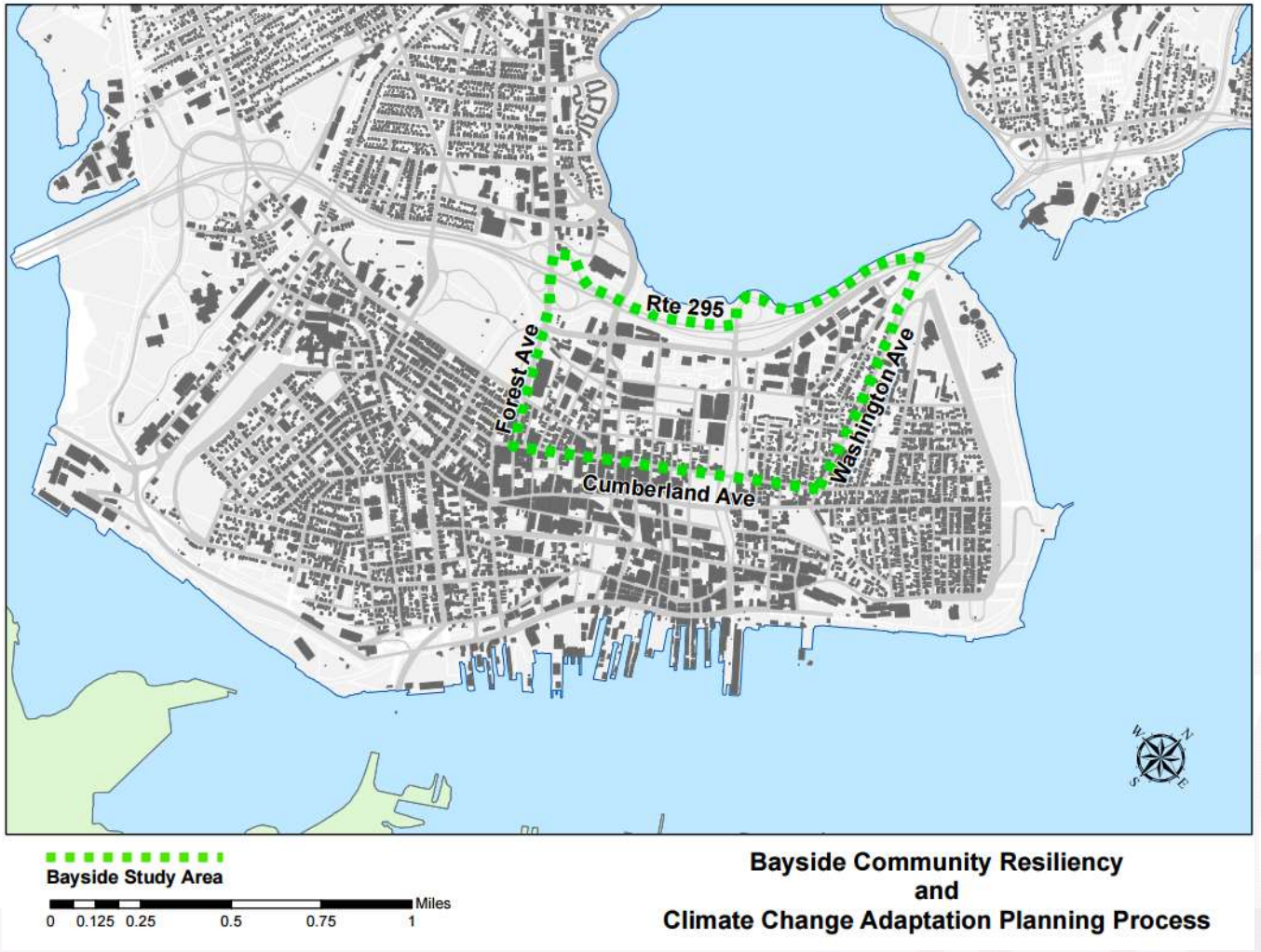


Portland, Maine

Portland, Maine

- 69.4 square miles
- Population is almost 70,000 | 200,000 during the day
- Portion of City on a peninsula in Casco Bay/Atlantic Ocean
- 19 neighborhoods
- Busy summertime activity

Bayside Neighborhood

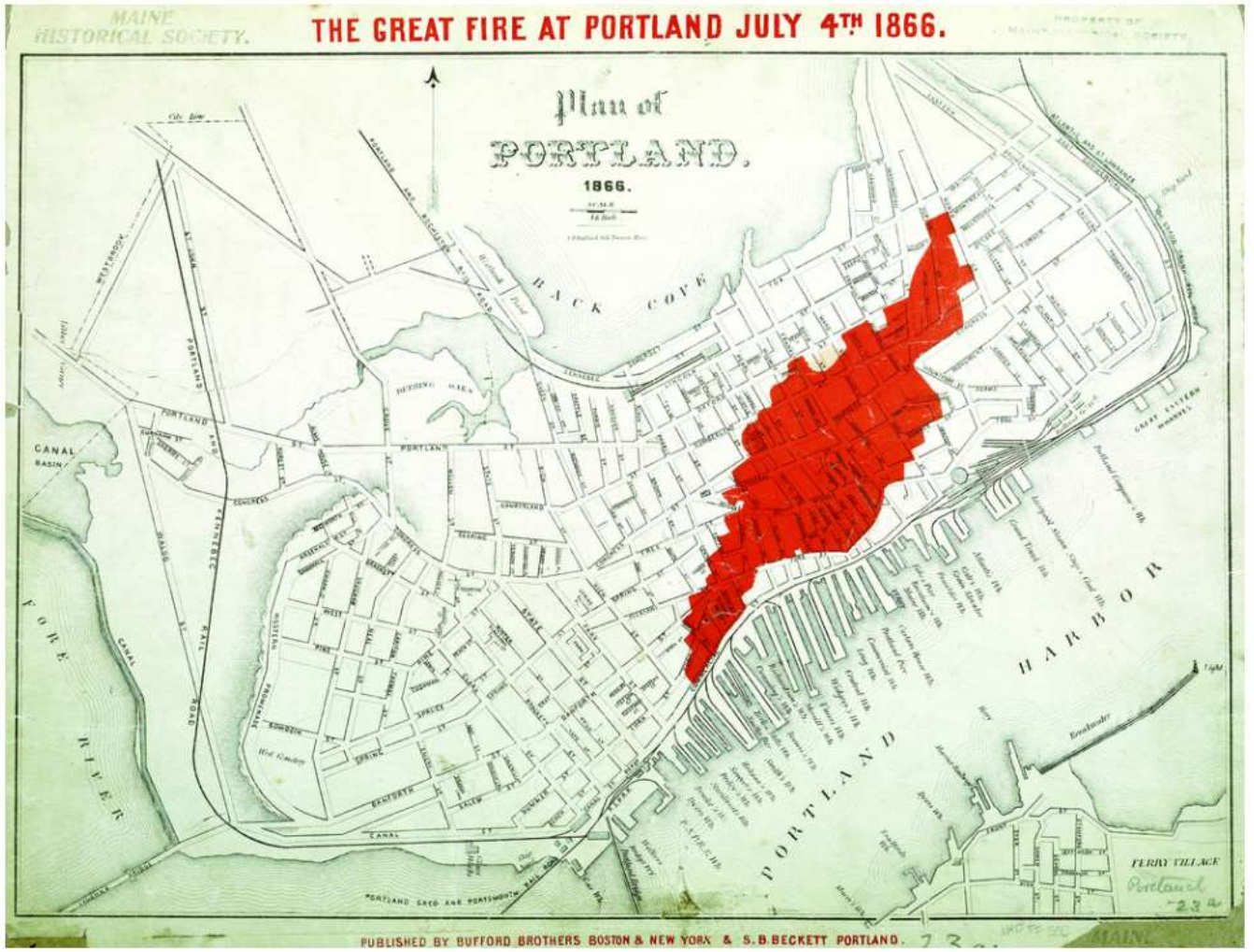


Bayside Neighborhood

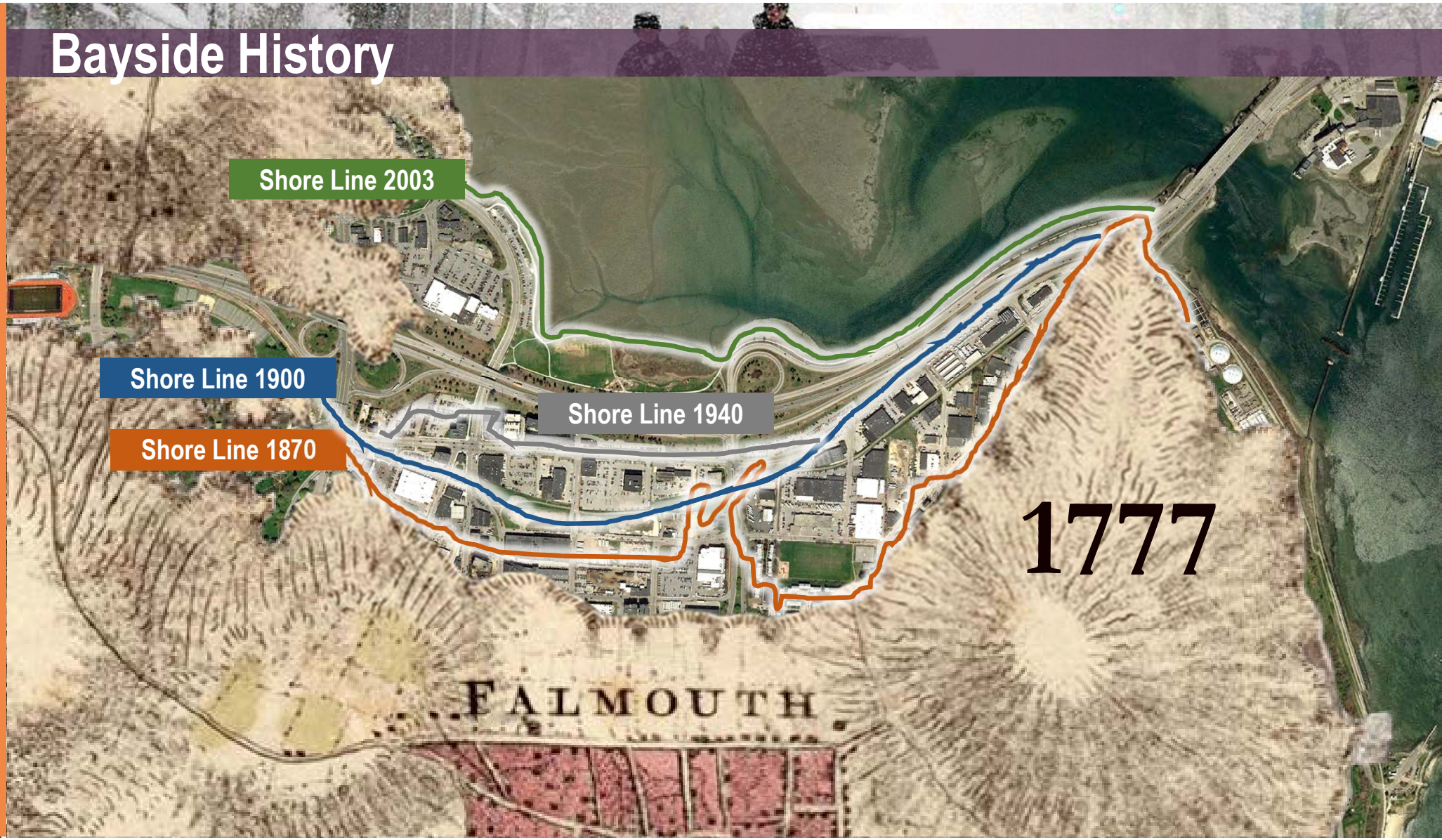
- Minutes from downtown Portland, the beach, the working waterfront and Back Cove
- Historically home to warehouses, scrapyards, manufacturing, small businesses, and generational families
- Today, a mix of families and singles, young and old, immigrants and Mainers, old and new development, social services, businesses, offices, light industrial
- Most diverse Census Tracts in Maine

Bayside Neighborhood

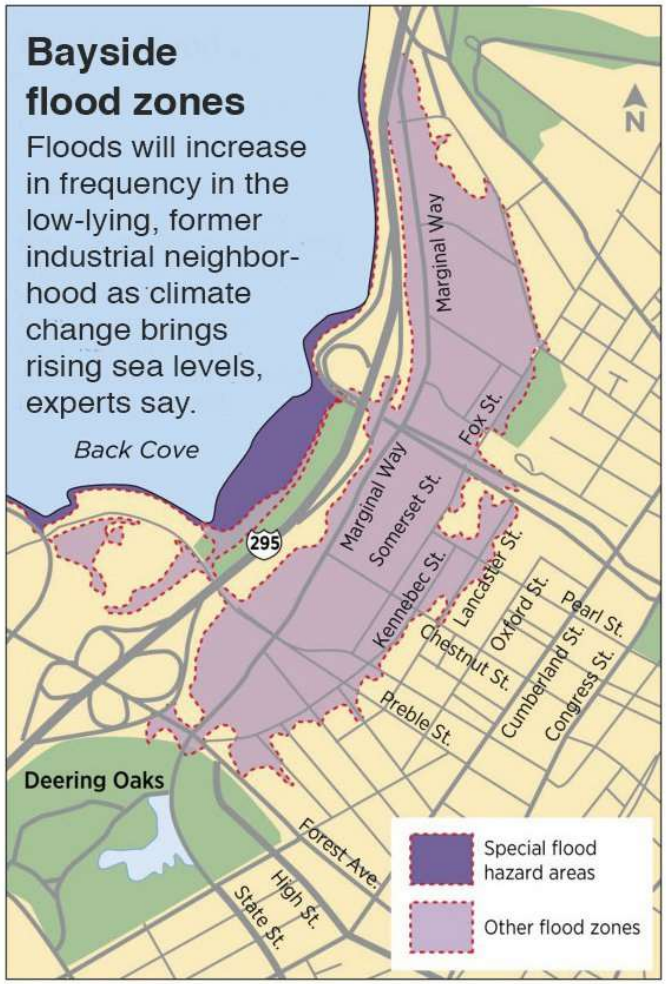
- Most of Bayside today was in a section of Back Cove filled with debris from the Great Fire of 1866 — which burned most of the Old Port.
- More fill was added in the 1960s to build Interstate 295.

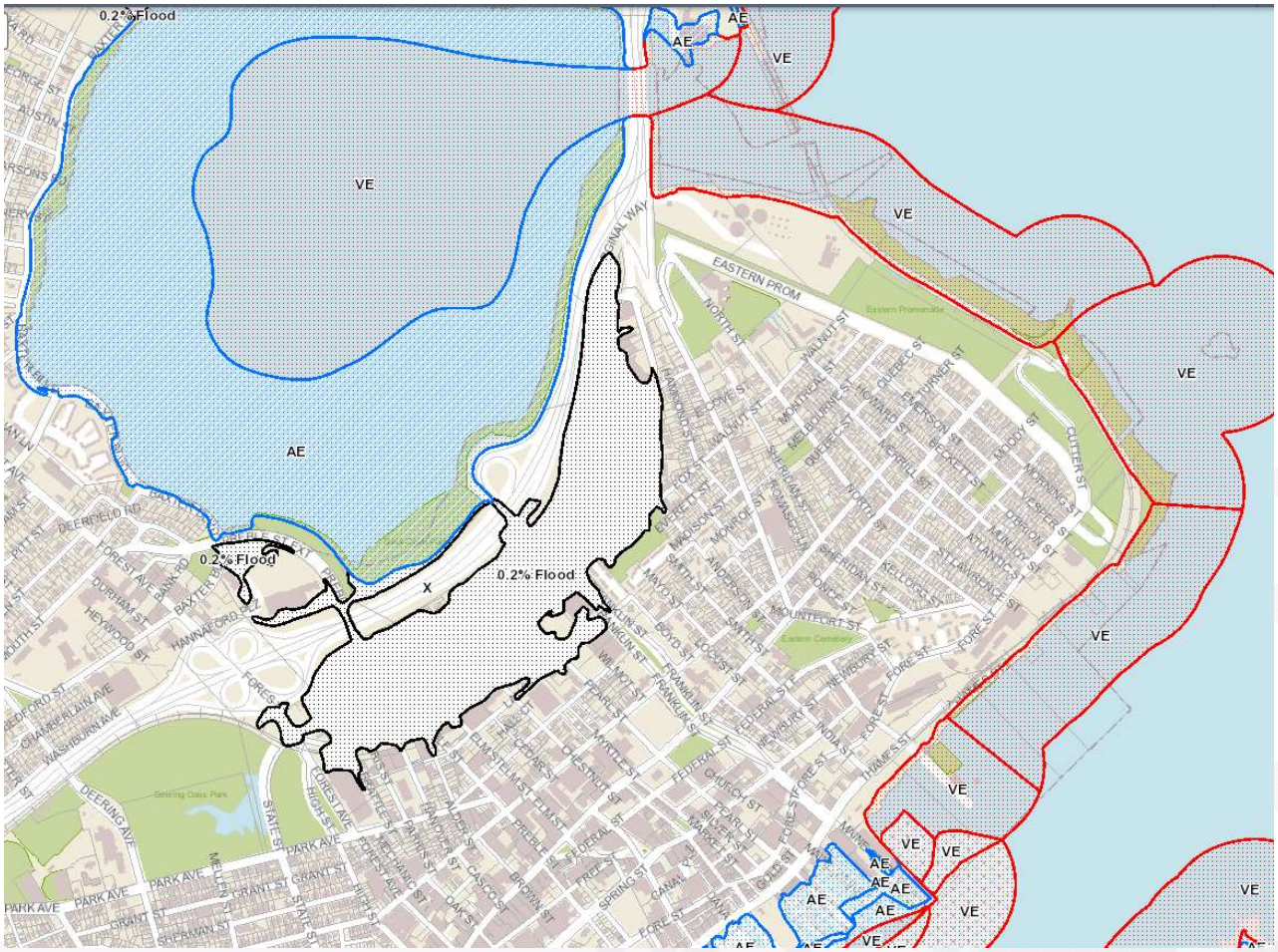


Bayside History



Bayside Adapts Project Area





Great Resiliency Foundation

The City of Portland

MUNICIPAL CLIMATE ACTION PLAN

Prepared by the Portland Municipal Climate Change Working Group

March, 2008

A ULI Advisory Services Panel Report

Waterfronts of Portland and South Portland Maine

May 11–16, 2014

Urban Land Institute

SUSTAIN SOUTHERN MAINE

Partnering to strengthen our economy, environment and community

Sea Level Rise Vulnerability Assessment

A Report for Sustain Southern Maine

Greater Portland Council of Governments

December, 2013

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Pubic Engagement Process

Bayside Area Working Group (BAWG)

New England Environmental Finance Center and the City identified and recruited representative members of the BAWG:

- Residents
- Business owners
- Neighborhood organization members
- Non-profits

Pubic Engagement Process

Focused discussion topics of BAWG meetings (which were open to the public):

- Basic Information/Process
- Bayside Conditions & What Other Cities Are Doing
- Information Needs for Resiliency Planning
- Drafting Bayside Adaptation Principles

Pubic Engagement Process

Produce a Final Report from BAWG to City of Portland to report on adaptation principles identified during public engagement process including areas of convergent and divergent input

Bayside Adapts

DESIGN CHALLENGE
PORTLAND, MAINE
FEBRUARY–MAY 2017

Portland's Bayside neighborhood faces an uncertain future with rising levels of water. How should we as a community respond? Join us to view the conceptual design proposals in response to this challenge.

DESIGN CHALLENGE EVENT
May 3, 2017
Portland Public Library, Rines Auditorium

4:30–6:00PM	**Public viewing of submissions**
6:00–7:15PM	**Speaker & public discussion**
	Julie Wormser, Boston Harbor Now
7:15–7:45PM	**Presentation of awards**

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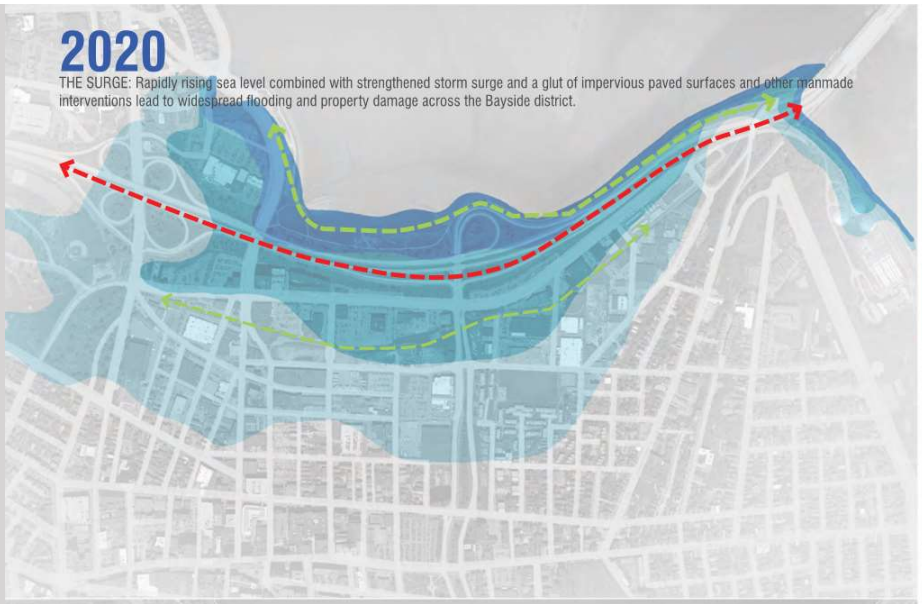
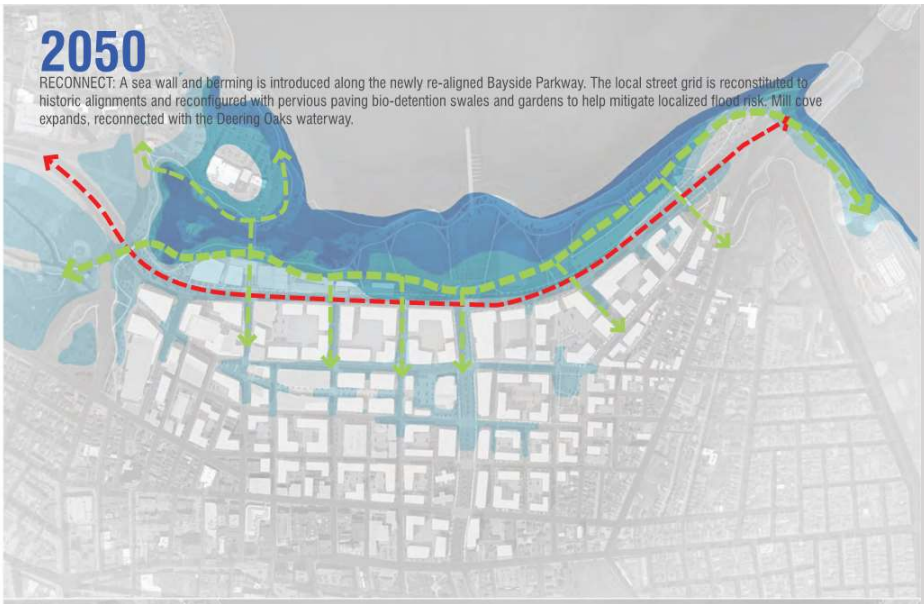


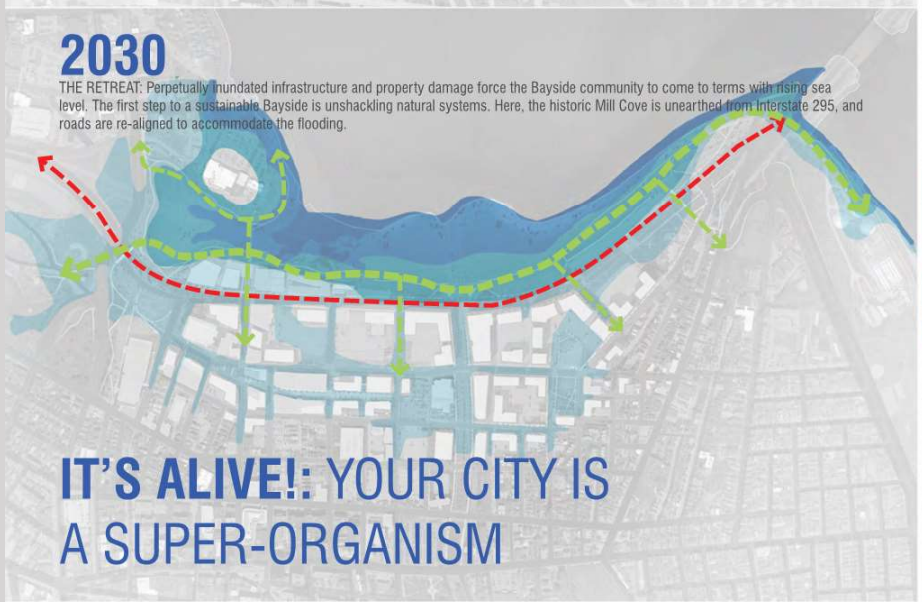
2020

THE SURGE: Rapidly rising sea level combined with strengthened storm surge and a glut of impervious paved surfaces and other manmade interventions lead to widespread flooding and property damage across the Bayside district.



2050

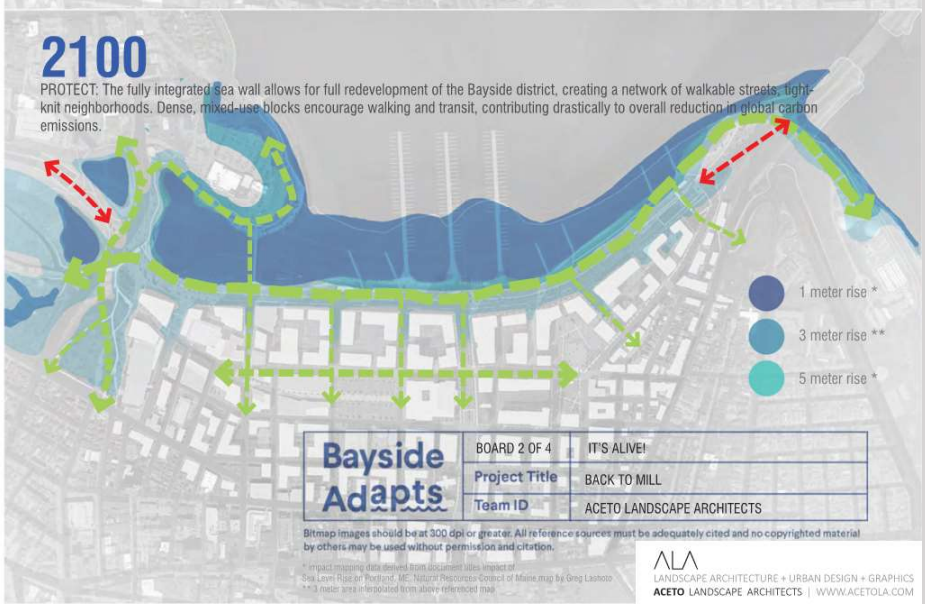
RECONNECT: A sea wall and berming is introduced along the newly re-aligned Bayside Parkway. The local street grid is reconstituted to historic alignments and reconfigured with pervious paving bio-detention swales and gardens to help mitigate localized flood risk. Mill cove expands, reconnected with the Deering Oaks waterway.



2030

THE RETREAT: Perpetually inundated infrastructure and property damage force the Bayside community to come to terms with rising sea level. The first step to a sustainable Bayside is unshackling natural systems. Here, the historic Mill Cove is unearthed from Interstate 295, and roads are re-aligned to accommodate the flooding.

IT'S ALIVE!: YOUR CITY IS A SUPER-ORGANISM



2100

PROTECT: The fully integrated sea wall allows for full redevelopment of the Bayside district, creating a network of walkable streets, tight-knit neighborhoods. Dense, mixed-use blocks encourage walking and transit, contributing drastically to overall reduction in global carbon emissions.

Bayside Adapts	BOARD 2 OF 4	IT'S ALIVE!
	Project Title	BACK TO MILL
	Team ID	ACETO LANDSCAPE ARCHITECTS

* Impact mapping data derived from document titles Impact of Sea Level Rise on Portland, ME. Natural Resources Council of Maine map by Greg Lashoto
** 3 meter area interpolated from above-referenced map

ALA
LANDSCAPE ARCHITECTURE + URBAN DESIGN + GRAPHICS
ACETO LANDSCAPE ARCHITECTS | WWW.ACETOLA.COM

Data Gaps – What We Know / What We Don't Know

- Identify the data gaps and the means of closing those data gaps to allow the City to analyze flooding caused by rainfall, tides, surge, and sea level rise
  - Define planning scenarios for sea level rise / storm surge / storm events
  - Review the City's sewer and stormwater system to ID gaps
  - Contribute to / learn from public engagement
  - Provide recommendations / budgets for closing the data gaps

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Climate Uncertainty & Scenario Based Planning

- Guiding principles
  - What is most likely to occur?
  - How bad can things get?

- Using these principles
  - What scenarios should Portland commit to managing?
  - What scenarios should they plan to manage?
  - What (low probably/high consequence) scenarios should the group be aware of?

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Defining Local SLR Planning Scenarios

- Commit to Manage
  - Intermediate
- Prepare to Manage
  - 2050 – Extreme
  - 2100 – High
- Be aware of and monitor for
  - 2100: Extreme (low probability, high consequence)

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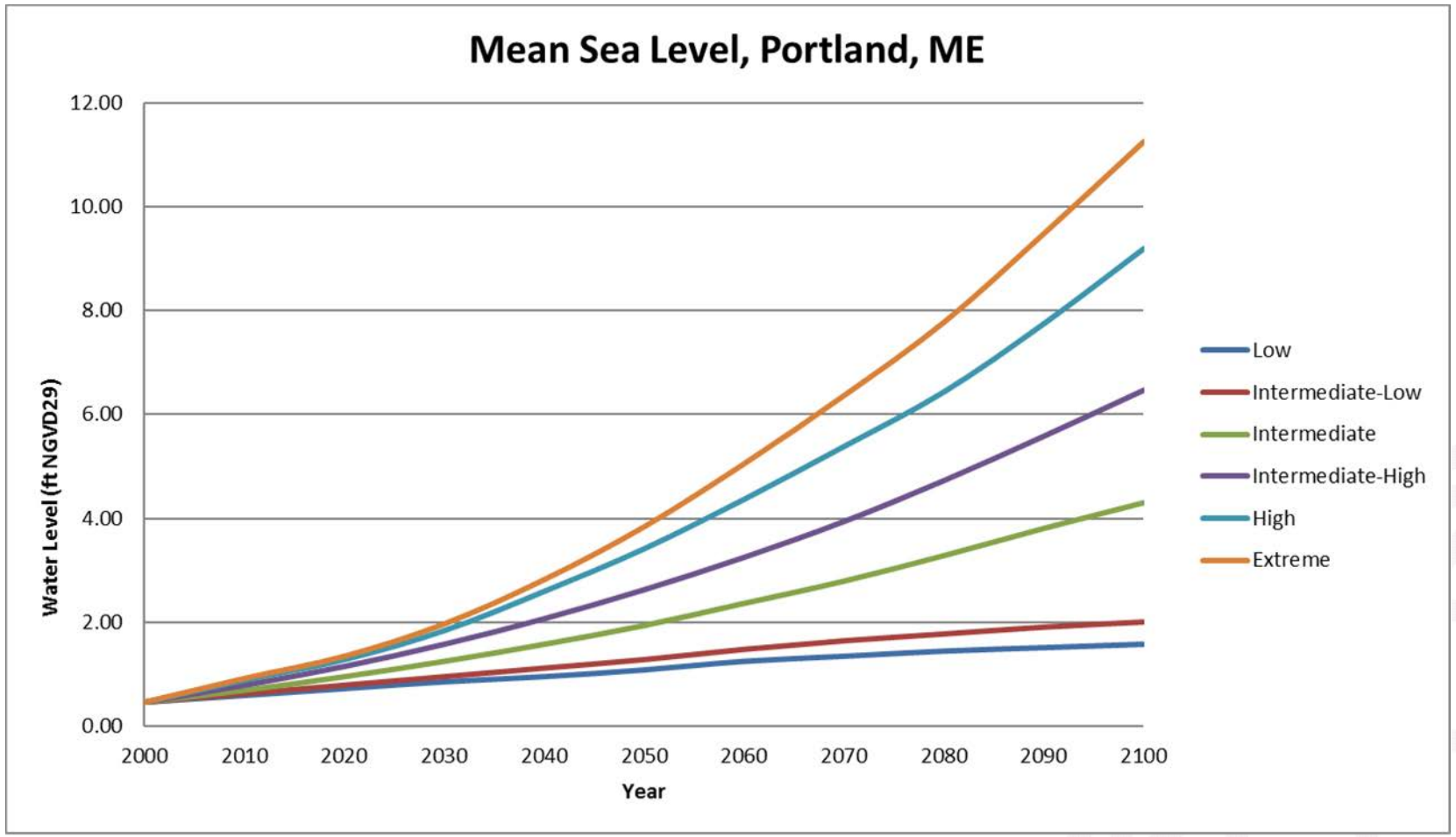
Defining Local SLR Planning Scenarios



Defining Local SLR Planning Scenarios

	2050			2100		
	Scenario	RSL (ft)	MHHW, ft NGVD29	Scenario	RSL (ft)	MHHW, ft NGVD29
Commit to Manage	Intermediate	1.5	6.93	Intermediate	3.8	9.3
Prepare to Manage	Extreme	3.4	8.8	High	8.8	14.2
Be Aware of	n/a	n/a	n/a	Extreme	10.8	16.2

- NWS Minor Flood Threshold: 7.5 ft NGVD29
- NWS Moderate Flood Threshold: 8.5 ft NGVD29
- NWS Major Flood Threshold: 9.5 ft NGVD29
- Blizzard of '78: 9.6 ft NGVD29

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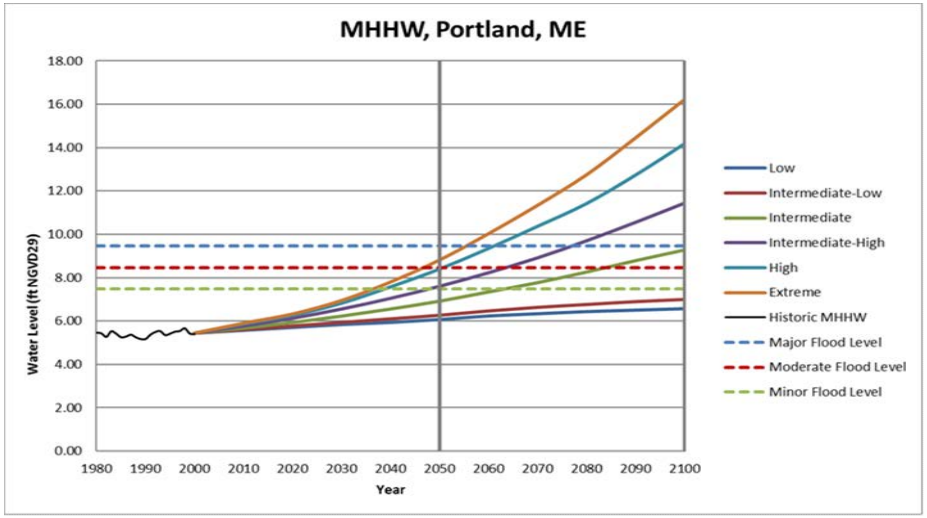
Impacts of Local SLR Scenarios



		Decade of Daily Exceedance			
NWS Threshold	Water Level (ft NGVD29)	Intermediate	Intermediate-High	High	Extreme
Minor Flooding	7.5	2060	2040	2030	2030
Moderate Flooding	8.5	2080	2060	2050	2040
Major Flooding	9.5	2100	2070	2060	2050

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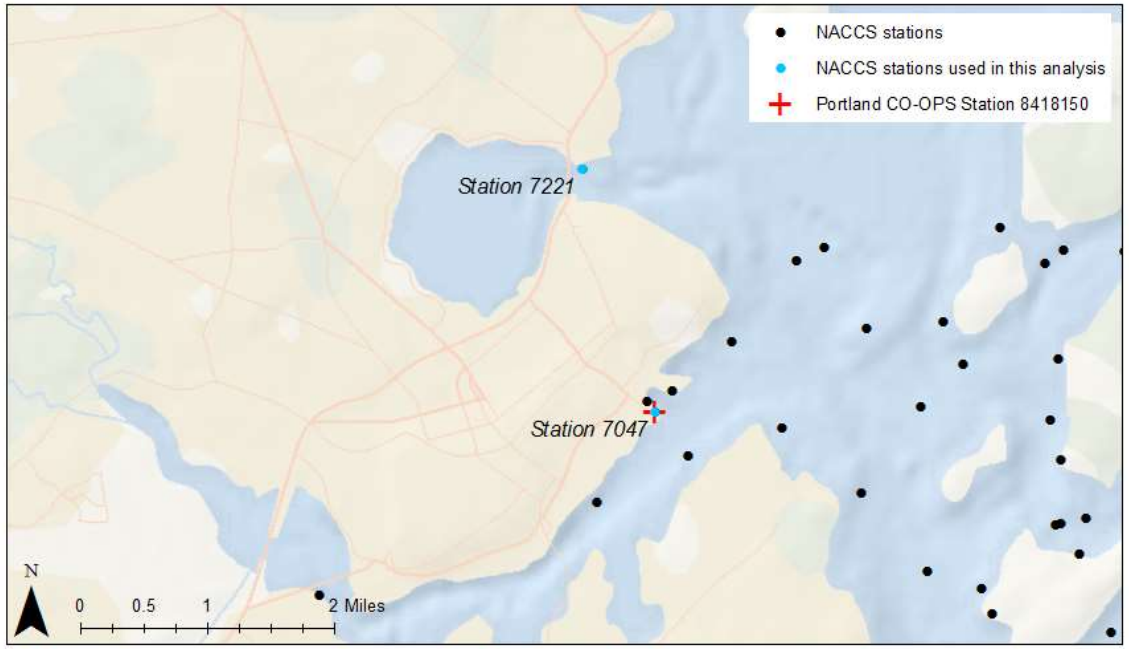
Storm Surge Scenarios



Location	100-Year Return Period Water Level (ft NGVD29)
NACCS Back Cove Station (Station 7221)	11.13
NACCS Maine State Pier Station (Station 7047)	9.32
Portland Tide Station (8418150)	9.53

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Storm Surge Scenarios

- 10-year, **20-year, 100-year,** and 500-year Water Levels

NACCS Station	Water Level Return Period	NACCS Storm Surge Water Level (ft NGVD29)	Potential Storm Surge Water Levels above MSL 2050 (ft NGVD29)	Potential Storm Surge Water Levels above MSL 2100 (ft NGVD29)
7221 Back Cove	20-yr	9.13	10.66 – 12.57	13.03 – 19.98
	100-yr	11.13	12.67 – 14.57	15.03 – 21.98

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Storm Surge Scenarios

- By 2050, today's 100-year water level
  - Will occur > 5x as frequently (20-year storm) under the intermediate-high scenario
  - Will occur > 10x as frequently (10-year storm) under the high and extreme scenarios
- By 2100, today's 100-year water level
  - Will occur > 10x as frequently (10-year storm) under all recommended scenarios

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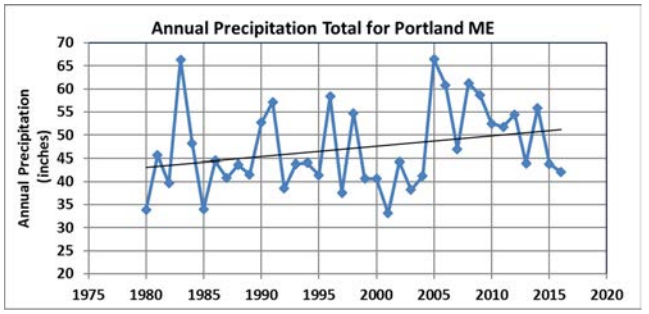
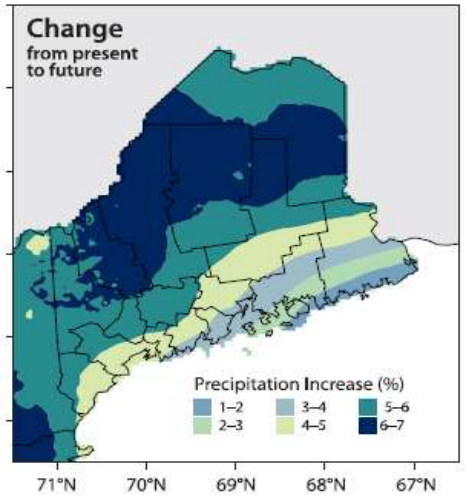
Precipitation: Climate Change

- Expected increase total annual precipitation
  - Present annual total average is 46.6 in (1985-2009)
  - Rate of increase is increasing
    - 0.0042 in/yr. from 1895-2014
    - 0.0349 in/yr. from 1960-2015
- CSNE Projected annual totals for various emissions scenarios and timeframes
  - Present study used an average of high/low emissions
  - Applied percentage to present day design storm totals

Representative Scenario	Range	Low Emission Annual Total Percent Change (%)	High Emission Annual Total Percent Change (%)	Average Percent Change (%)	Average Total Annual Precipitation (in)
2050	2040-2069	10.9	13.1	12	52.2
2100	2070-2099	13.7	20.8	17.3	54.7





Projected Precipitation Increase from 2015-2050 (Fernandes et al 2015)

Precipitation: Climate Change

- Expected increased intensity
  - Derived using new design storm totals
- Expected increase in number of extreme events
  - Many sources site an increase in number of extreme events
    - this does not necessarily influence the degree of flooding
    - increases the number of times/days flooding may occur

Description	RI	Entire Event Duration	Historic	Mid Term (2050)	Long Term (2100)
Total Precipitation (in)	25 yr.	24 hr.	6.19	6.93	7.26
Peak 6-min Using NRCC- New (in/6 min)	25 yr.	24 hr.	0.61	0.68	0.71
Peak Hourly - Using NRCC New (in/hr.)	25 yr.	24 hr.	2.02	2.26	2.37

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Infrastructure and Model Data Reviewed

Dataset (Received from City)	Format	Date Received	Description
Stormwater and Sewer Infrastructure Data	GIS Geodatabase, Map Package	March 13, 2017	• Geographic and attribute information on sanitary sewer, combined sewer, and separate storm drain infrastructure • Sewer and stormwater pipes recently inspected for structural and operational condition.
I&I Maps (Infiltration-Inflow Analysis maps)	PDF	2004	• 1960's Infiltration-Inflow Analysis maps of Portland Sewer System • Approximate geographic locations and connectivity of pipes and structures. Including invert elevations. • Vertical datum: NGVD 29. • Schematics of Special Structures in the drainage system
Surface Elevation Data (From 2015 LiDAR aerial survey)	Multiple: • GIS LiDAR (LAS) • GIS raster Digital Elevation Model (DEM)	March 28, 2017	• Detailed surface elevations for the entire Bayside area. • Vertical datum: NGVD29
SWMM Model	ASCII	March 17, 2017	• Hydraulic and hydrologic computer model of the sewer and combined sewer system servicing the Bayside

Other Data Reviewed:

- City's 2016 Flood Response Map
- Listing of flood event reports that occurred from 2013 to 2016
- *Separation and Green Projects for the Back Cove South Storage Conduit*, dated November 2014, and prepared by Wright-Pierce

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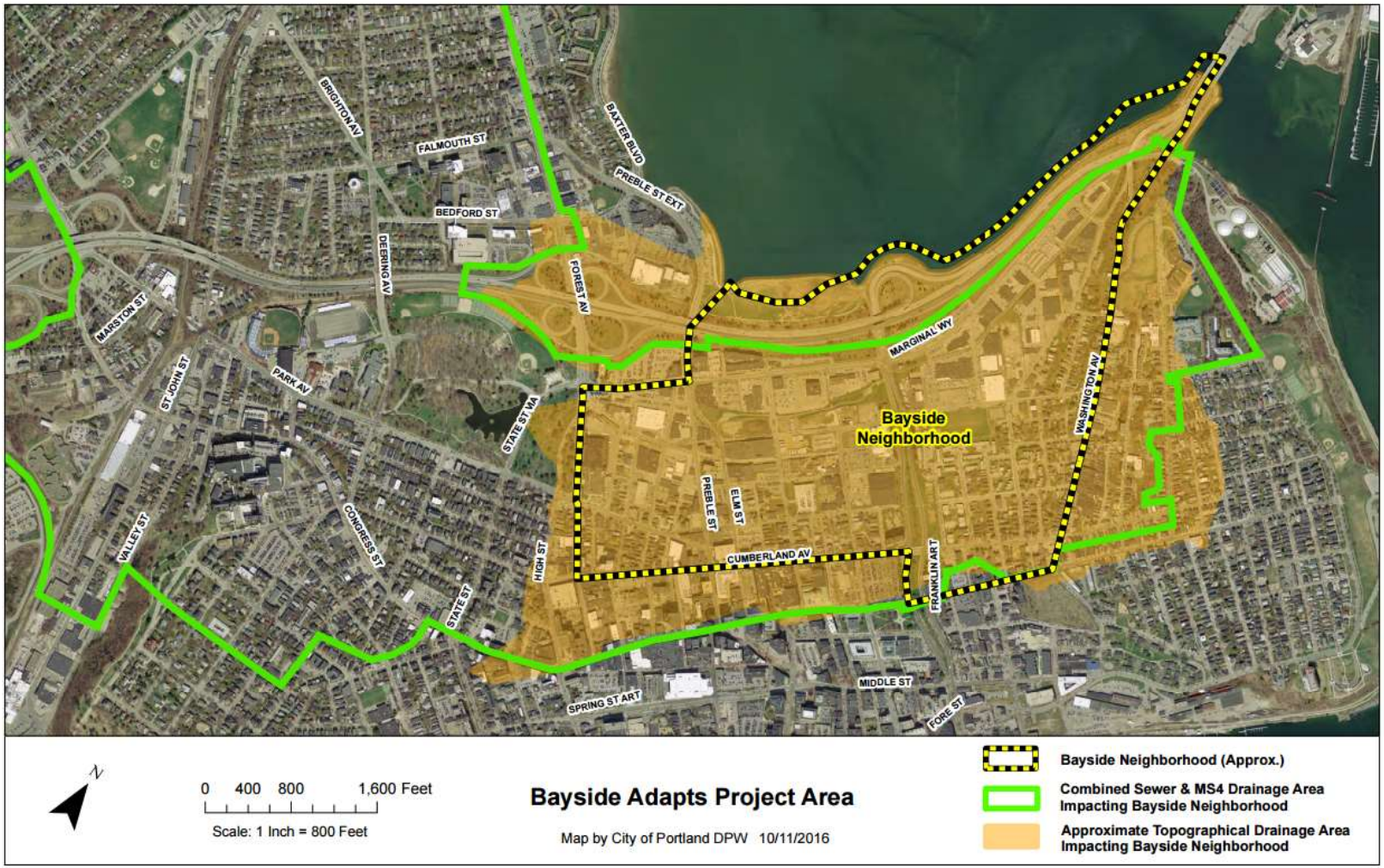
Bayside Adapts Project Area



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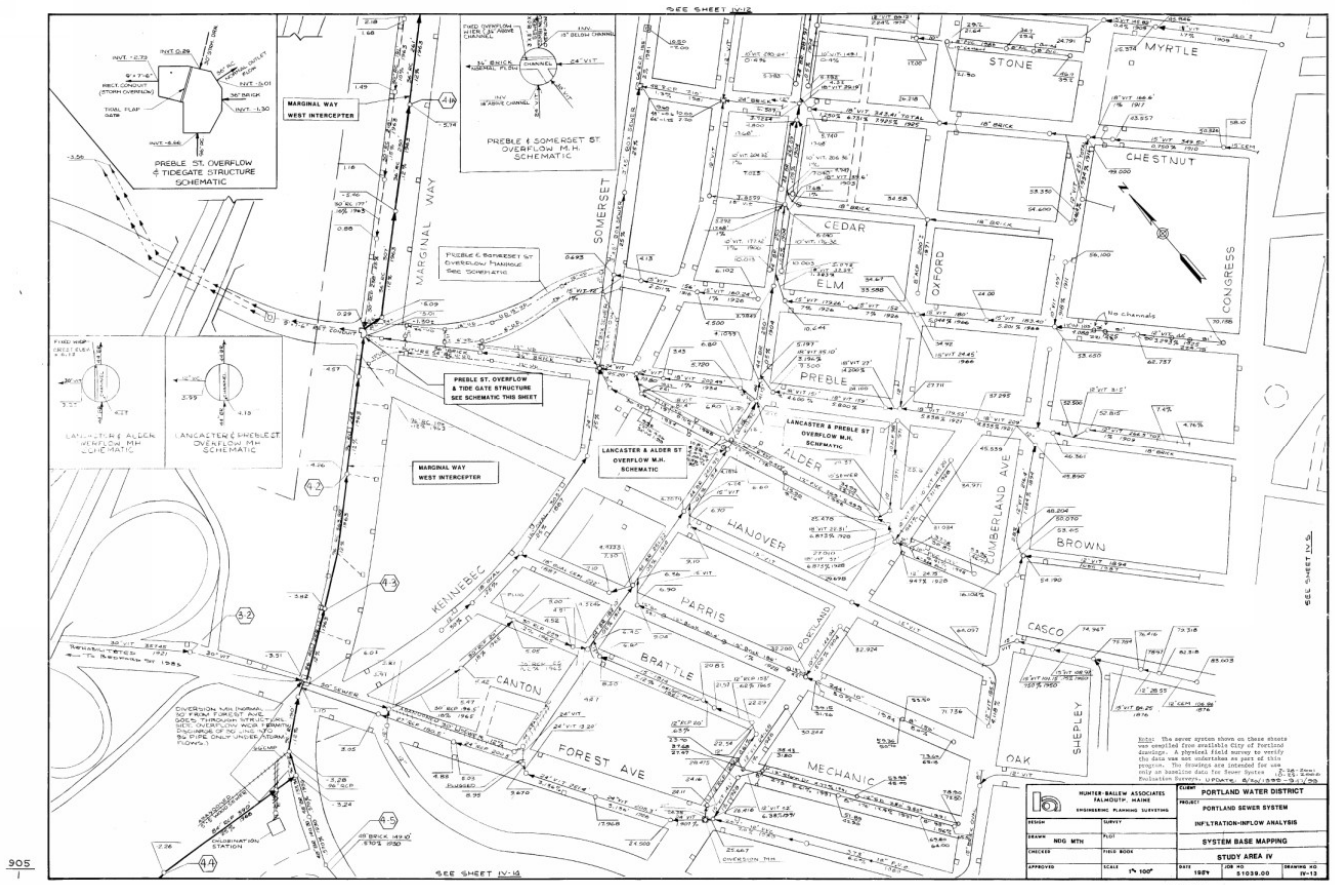
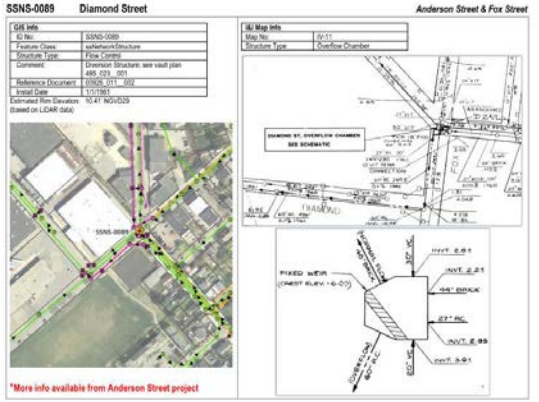
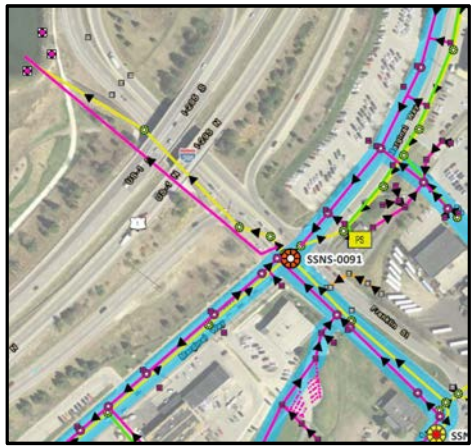
Infrastructure and Model Data Reviewed – I & I Map Data



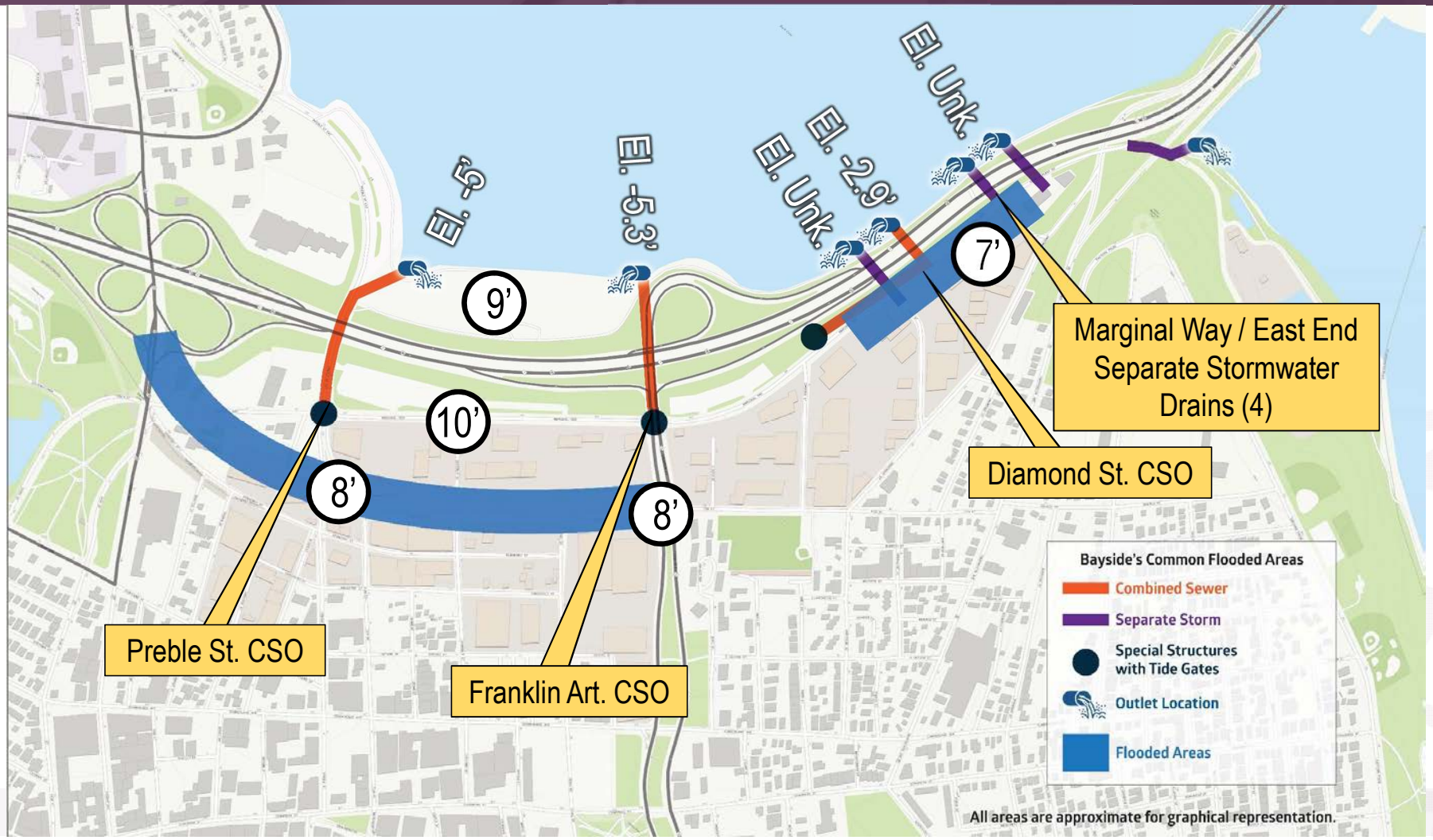


Infrastructure and Model Data Reviewed – GIS Data



Infrastructure and Model Data Reviewed – SWMM Data

Primary Drainage Outfalls / Flooded Areas



Infrastructure Data Gaps

Data Gap	Description
GIS Database	• Ground survey data not integrated into the GIS • Important attribute data not completely populated in the GIS (although largely available)
Surveys	• Survey data does not exist for certain critical drainage infrastructure
Condition Assessments	• Little to no condition information available for separate stormwater drainage
Condition, Form & Function of Special Structures	• Special Structures in the Bayside have not been recently assessed for condition and functionality.
Maine DOT Infrastructure	• Attribute data, condition and location of drainage infrastructure needs to be verified with input from DOT • Collaboration and partnership between the City and DOT regarding maintenance and rehabilitation of drains that pass under I-295

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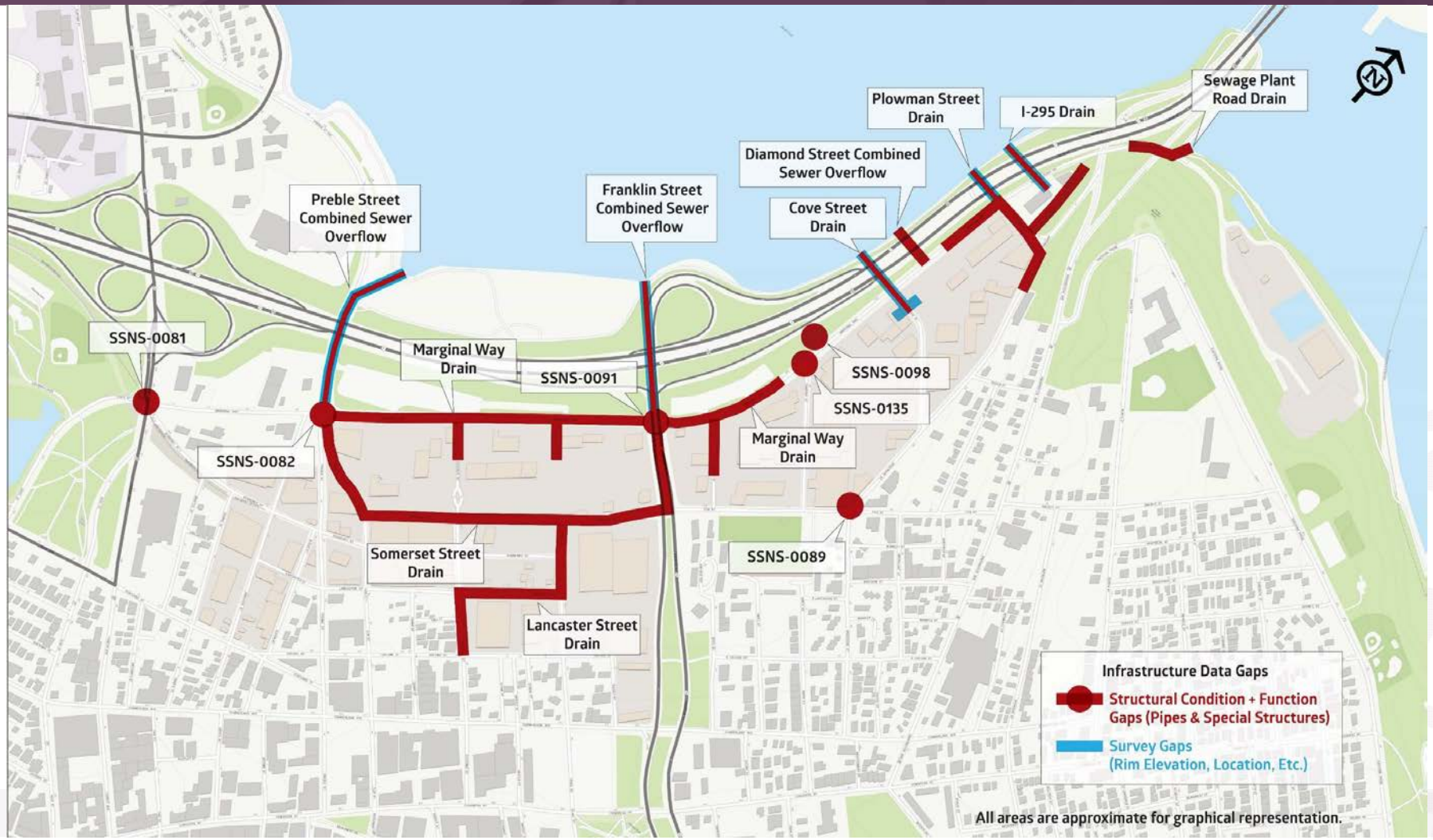
Infrastructure Data Gaps



Model Data Gaps

Data Gap	Description
Model Components	• Model lacks separated storm drain systems in the Bayside that are likely to contribute to local flooding
Data Sources	• Source data is not documented in model on a point-by-point basis • Changes or updates to the model are not well documented in the model (by who, what and when)
Data Accuracy	• Special structure condition, form, and function outdated • Incorrect structure elevations input to account for calibration needs
Model Calibration and Validation	• Calibration and validation has focused on CSO's to date
Model Capabilities	• SWMM5 does not account for surface flooding evaluation but can be updated and integrated with other modules that can account for surface flooding.

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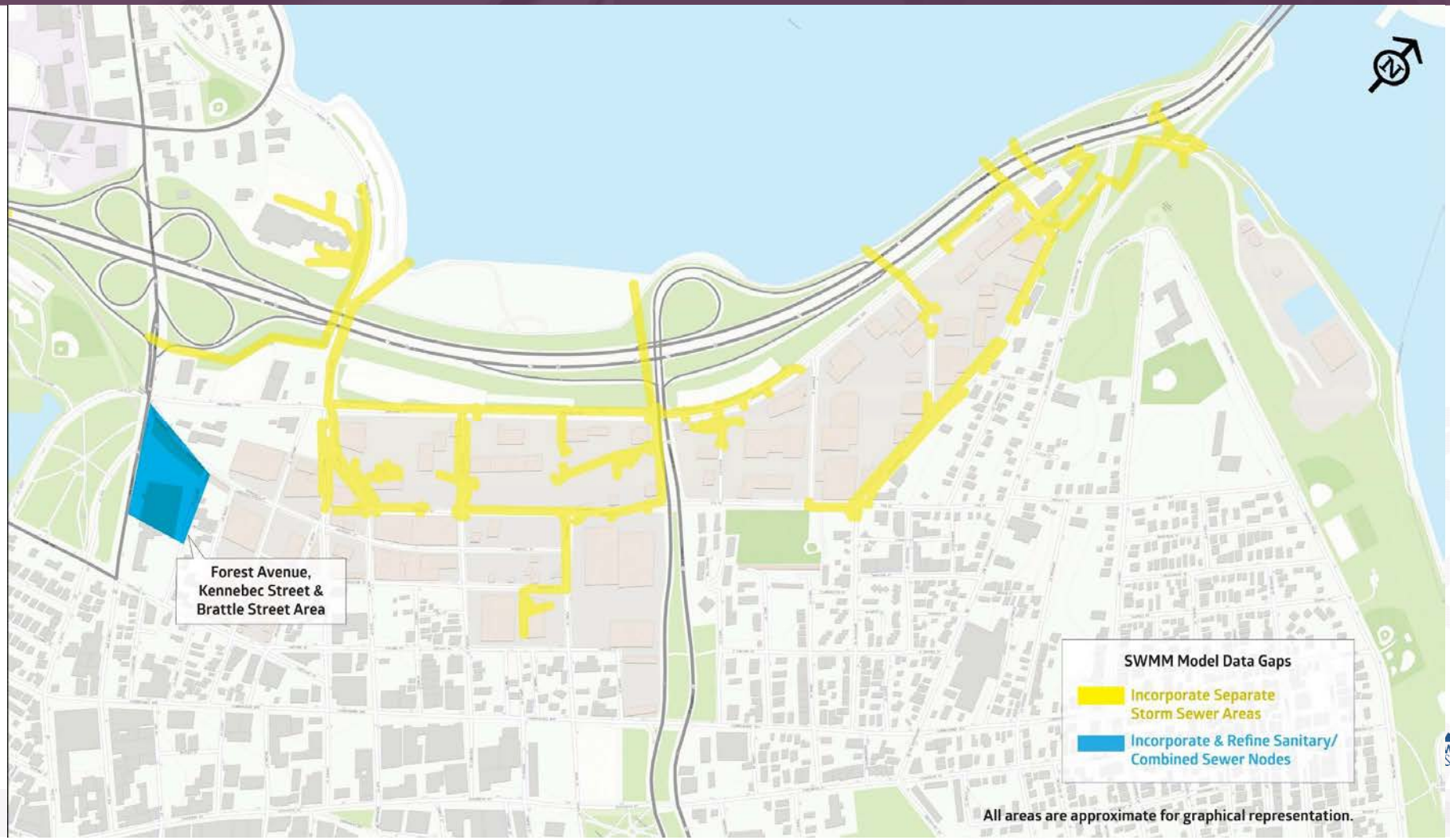
Model Data Gaps



Infrastructure / Model Data Gap Recommendations

1. Compile and Extract Existing Data, Integrate into City GIS
2. Targeted Field Data Collection Program
3. Explore Additional Model Capabilities / Options for Adaptation Planning
4. Update / Calibrate / Validate Model(s)

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Troy Moon |
thm@portlandmaine.gov

David Senus, PE |
dsenus@woodardcurran.com

Thank You! Questions?