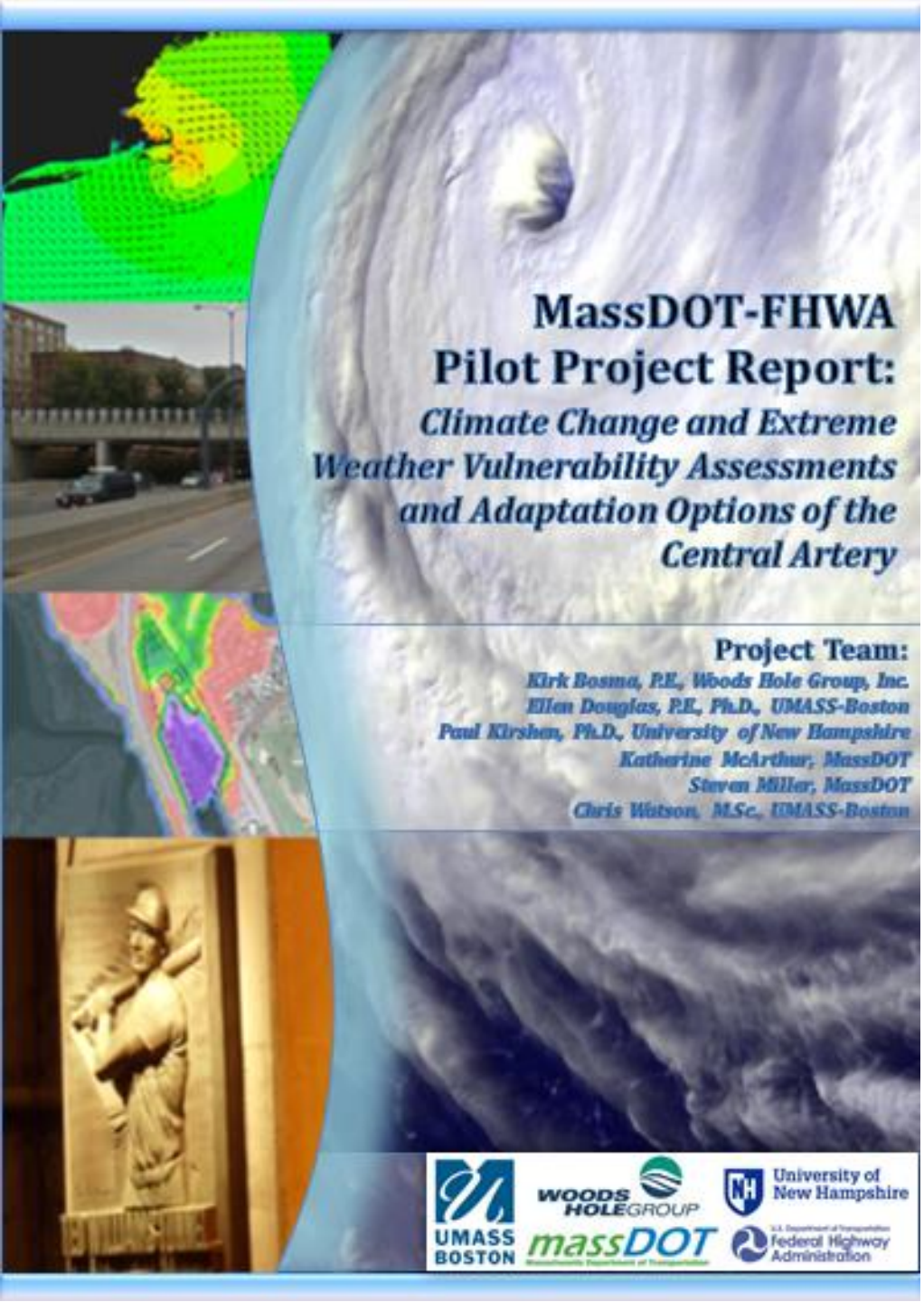

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MassDOT-FHWA Pilot Project:

Climate Change and Extreme Weather Vulnerability Assessments and Adaptation Options of the Central Artery

ARC/FHWA Climate Resilience Peer Exchange

Atlanta, GA

October 4-5, 2016

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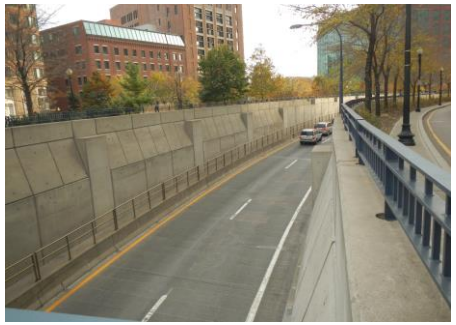
Atlantic Avenue and the Seaport District could resemble this dramatic rendering one day if we don’t start preparing now. / Illustrations by Peter Crowther Boston Magazine September 2016

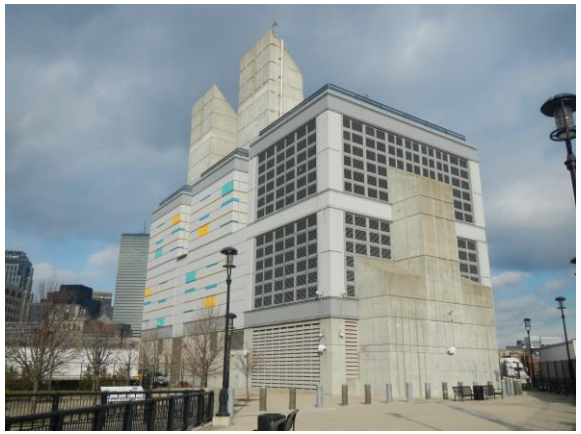
The Central Artery/Tunnel (CA/T) system is a critical link in regional transportation and a vitally important asset in the Boston metropolitan area. It is potentially vulnerable to flooding from an extreme coastal storm under present and future climate.

Tip O'Neill Tunnel Exit & Entrance Ramps

Tip O'Neill Tunnel Exit & Entrance Ramps



Tip O'Neill Tunnel Exit Ramp



Vent Building 1

Vent Building 4– Detail of 15KV Electrical Conduit

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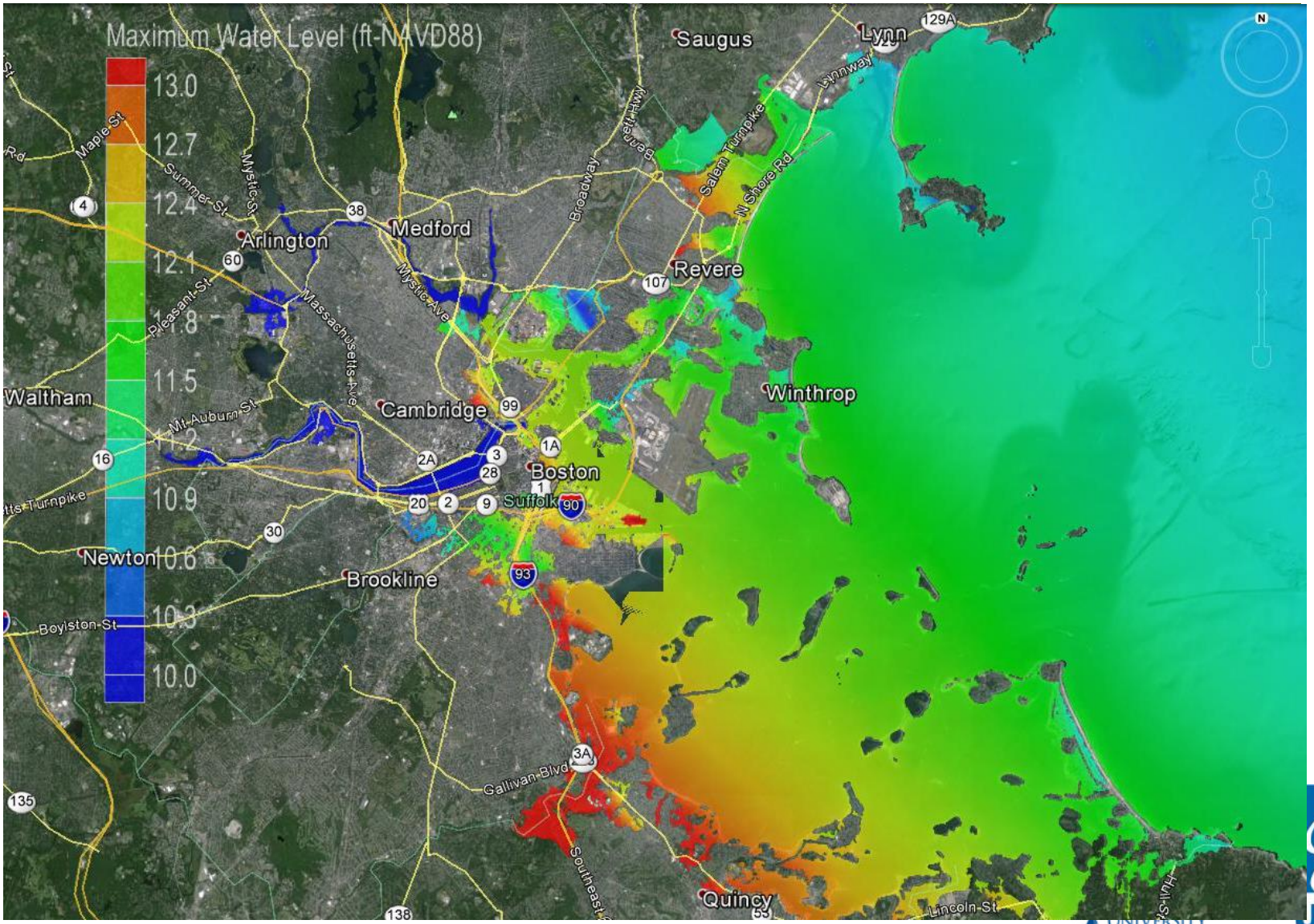
Why existing maps are not good enough



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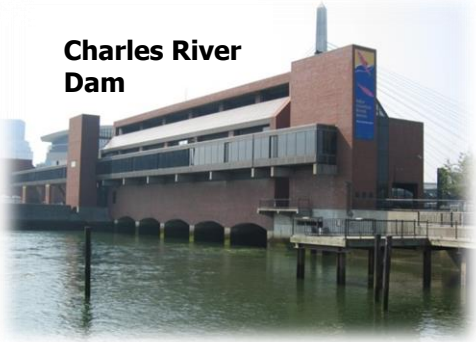
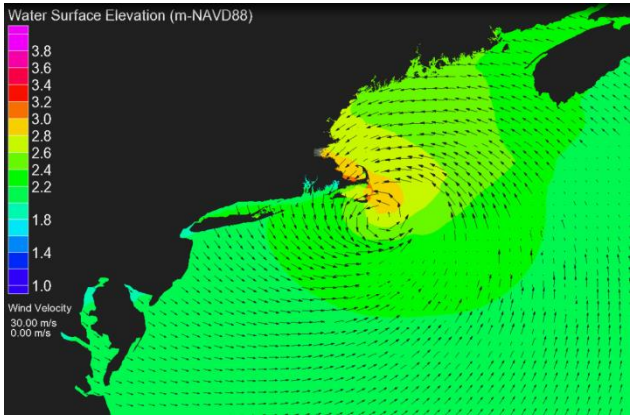
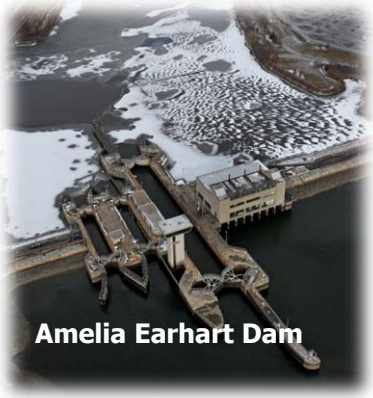
High Resolution Hydrodynamic Modeling

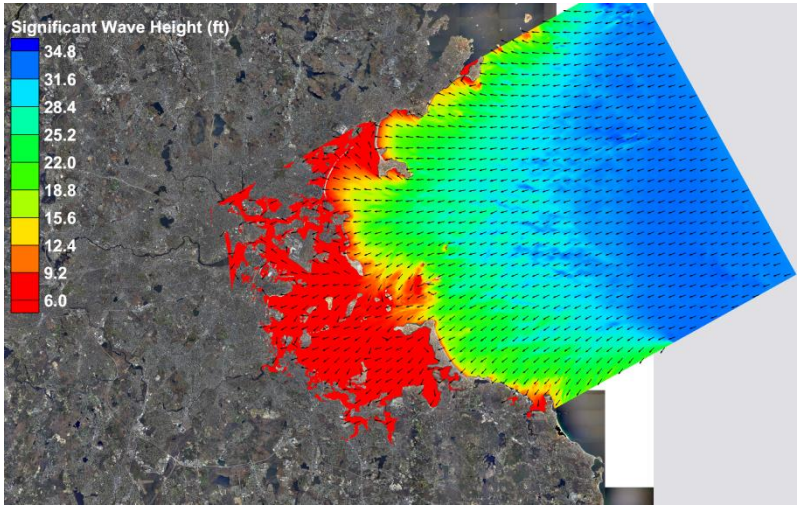
- Includes relevant physical processes (tides, storm surge, wind, waves, wave setup, river discharge, sea level rise, future climate scenarios)





- Currents
- Storm Surge
- Tides
- Water Levels
- Winds
- SLR
- Discharge
- Infrastructure





- Waves
- Wave Setup

Tightly Coupled

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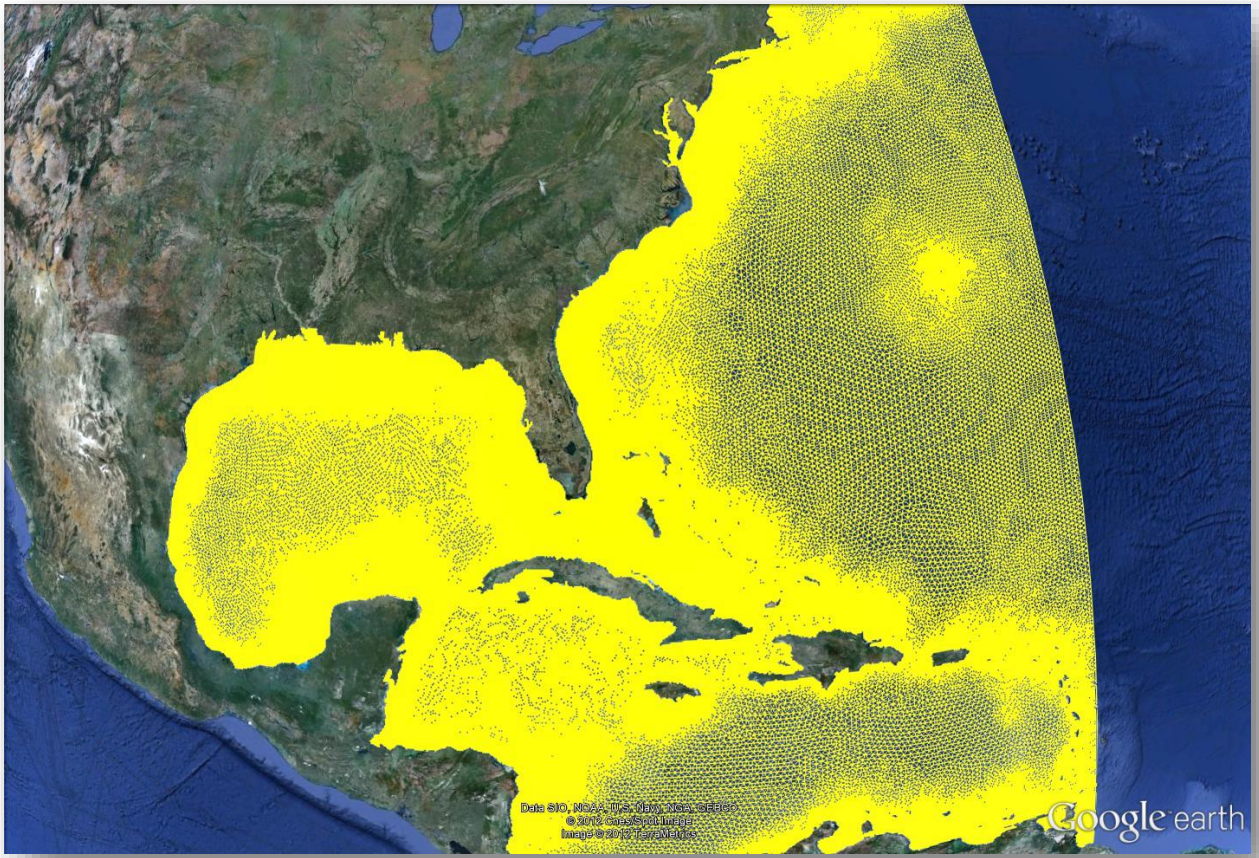
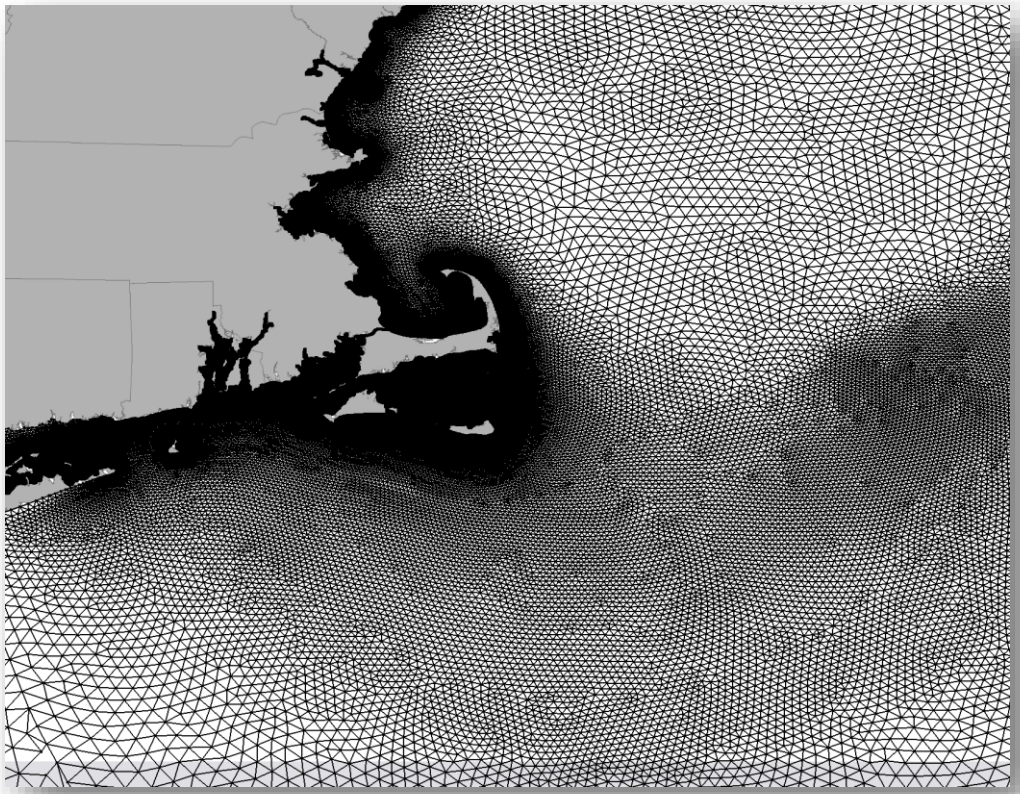
Grid Development

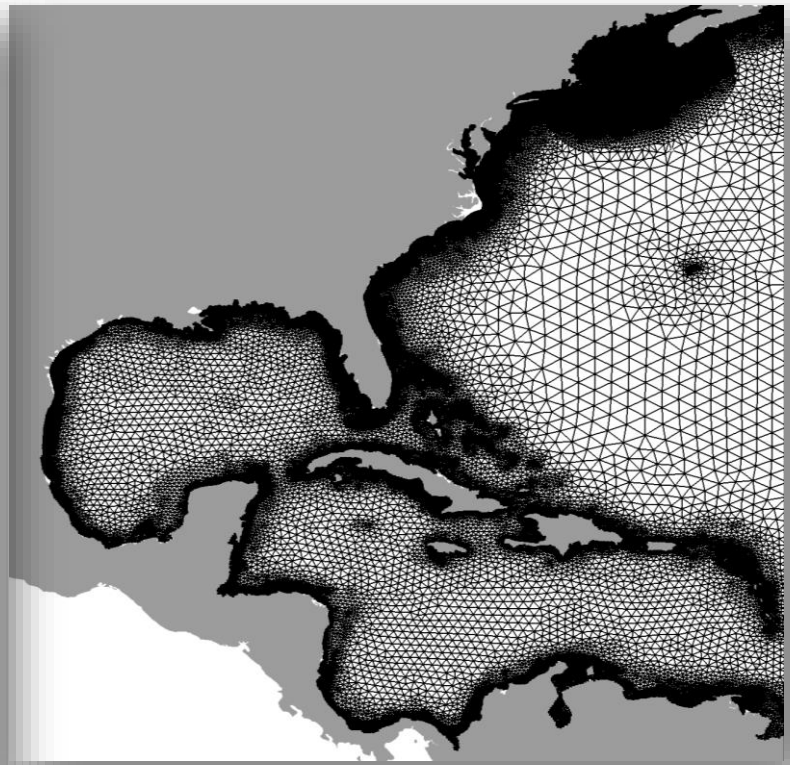
- Grid covers a large regional area (North Atlantic) to capture large-scale storm (hurricane, nor'easter) dynamics.



Grid Development

- Unstructured grid = varying resolution with high resolution in areas of interest (Central Artery)





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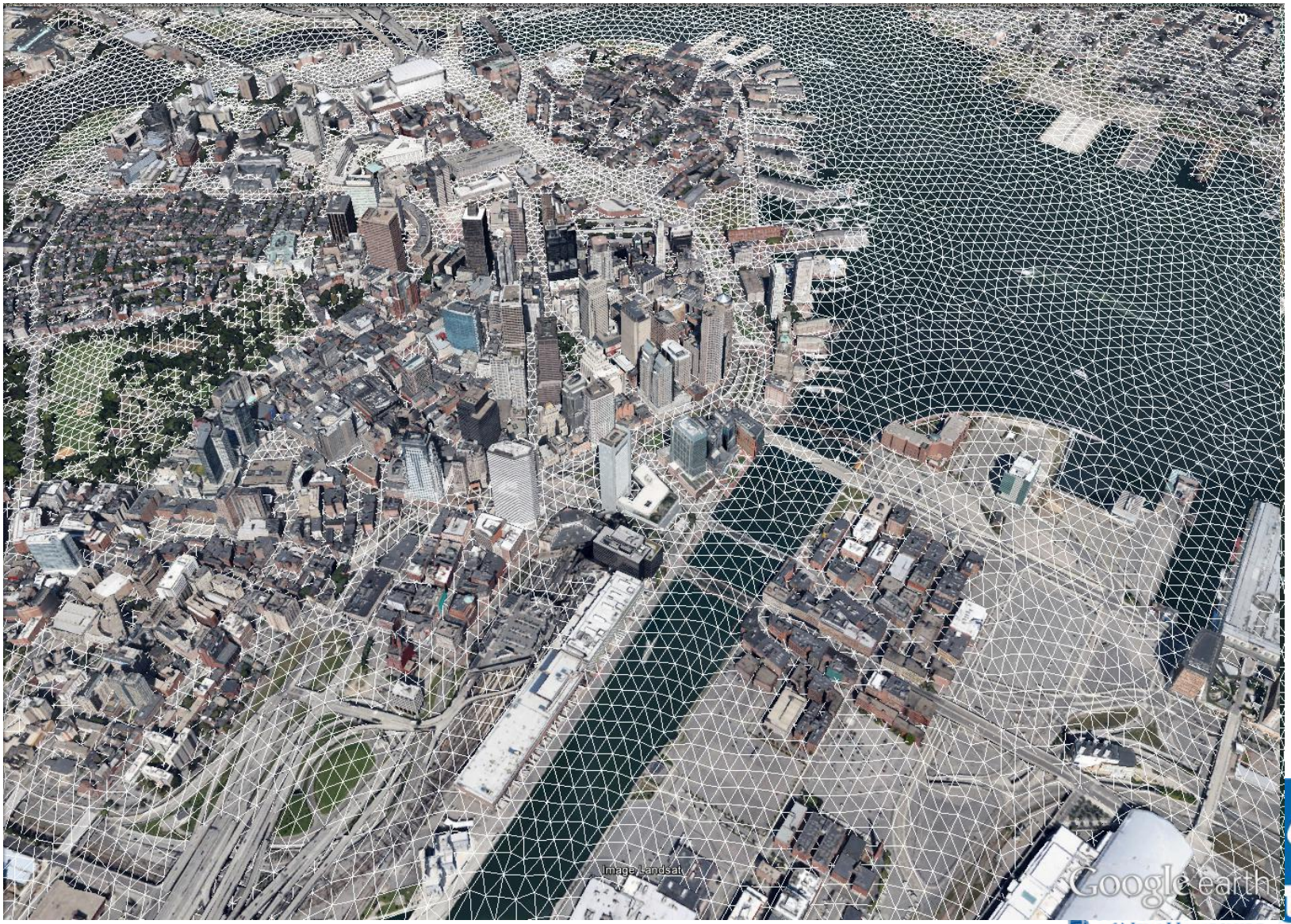

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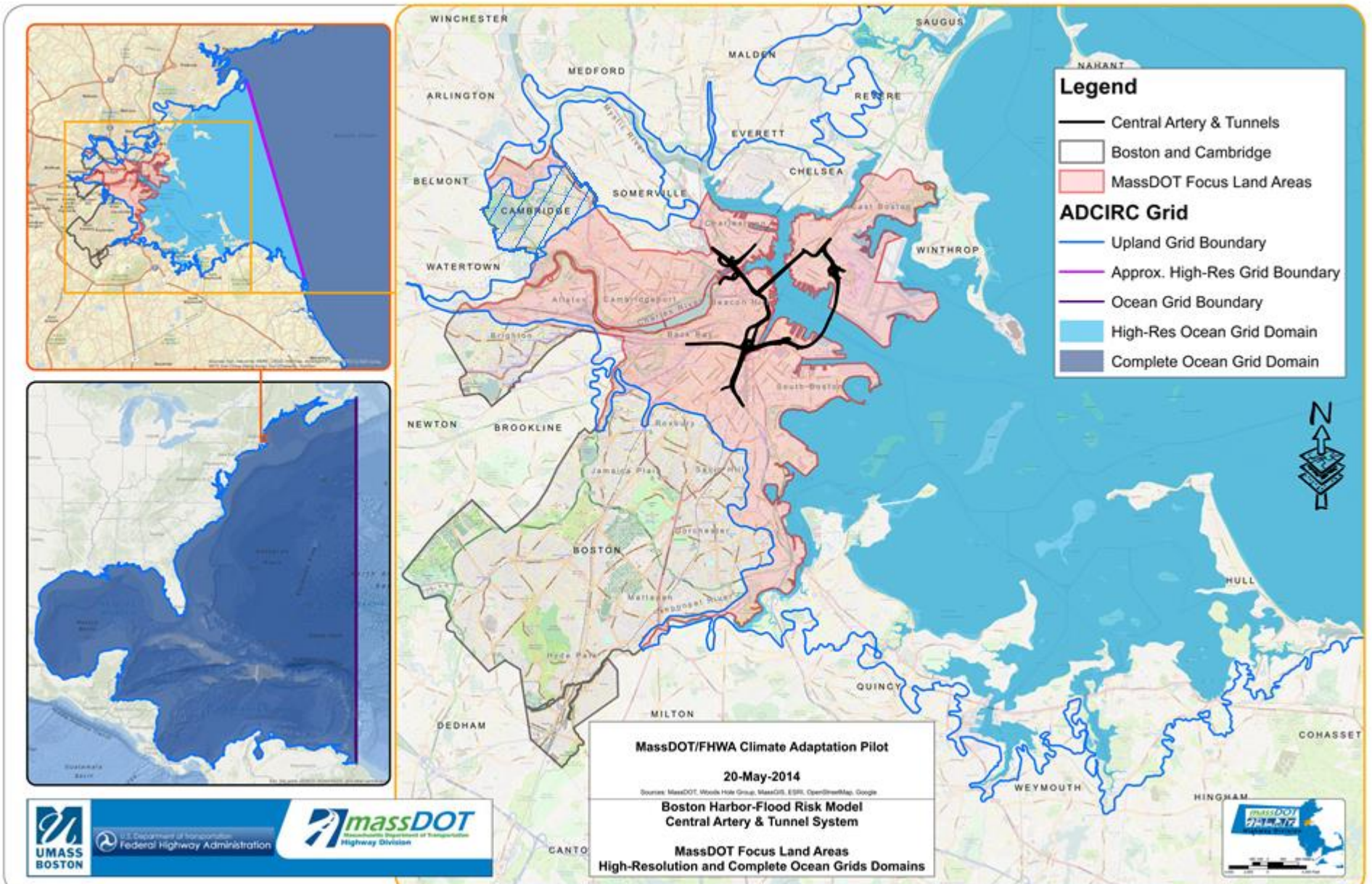

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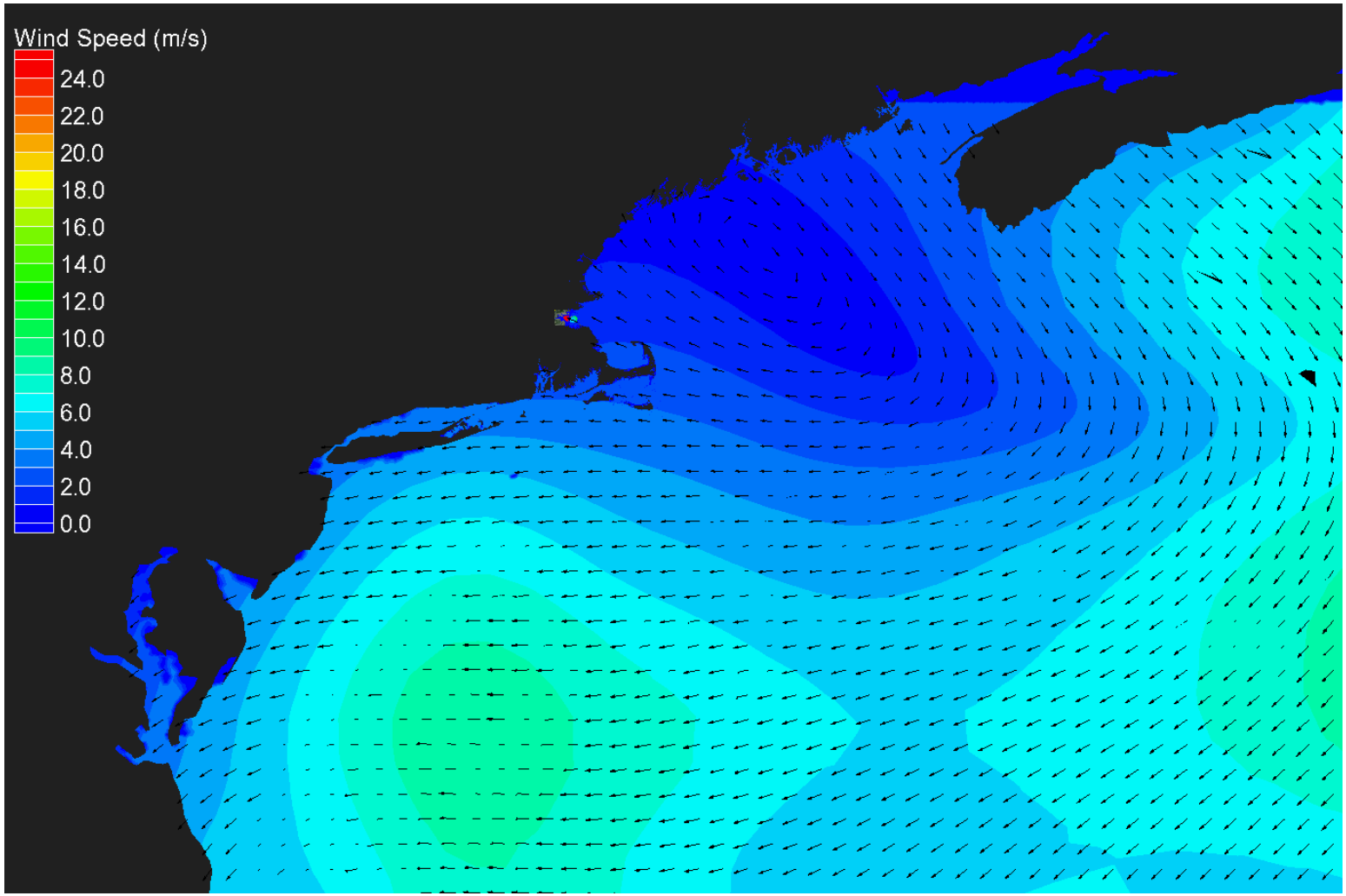
Model Results – Winds (Nor'easter)



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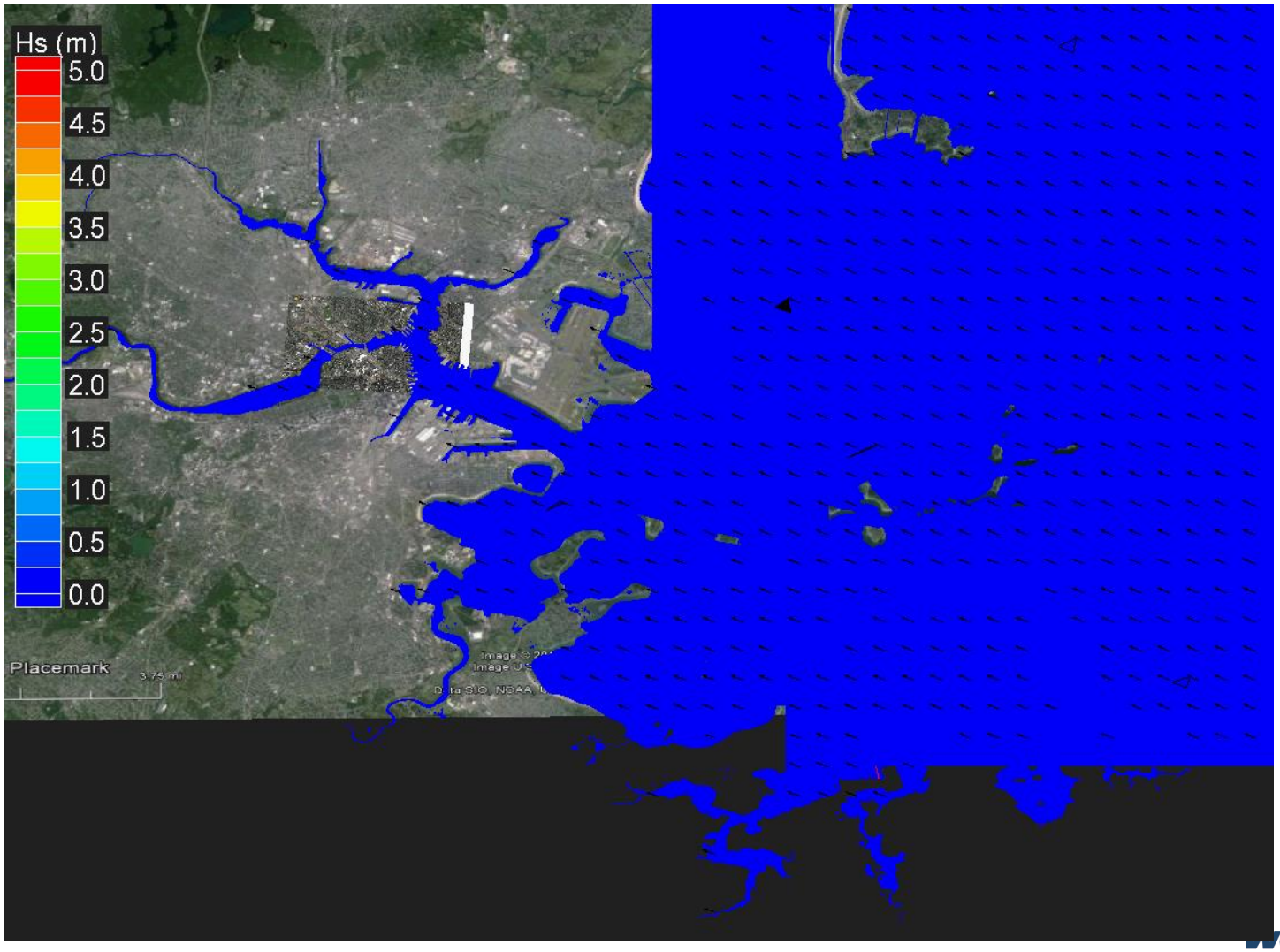
Model Results – Waves (Nor'easter)



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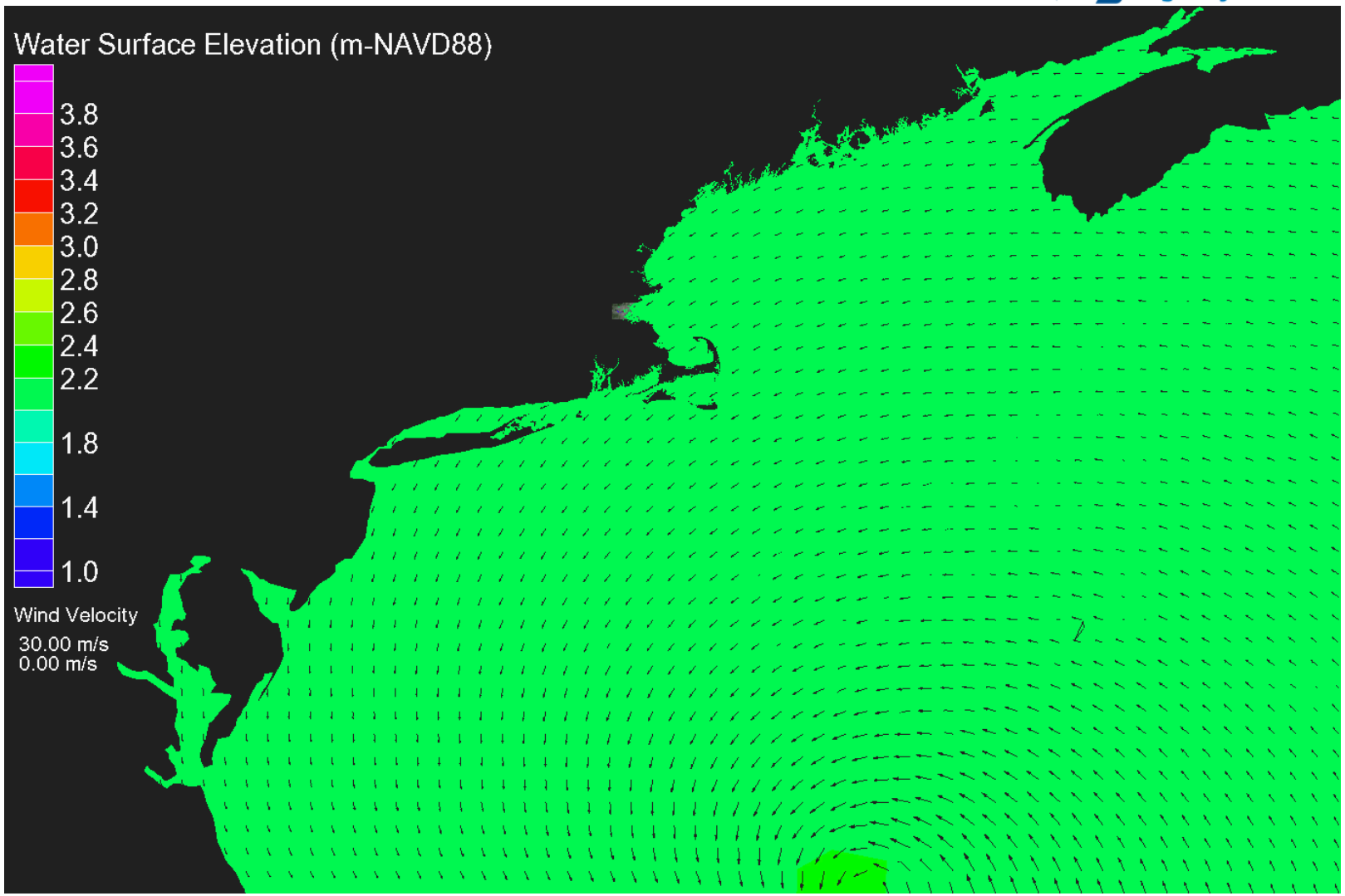

Example Model Results – 2070 (Hurricane)

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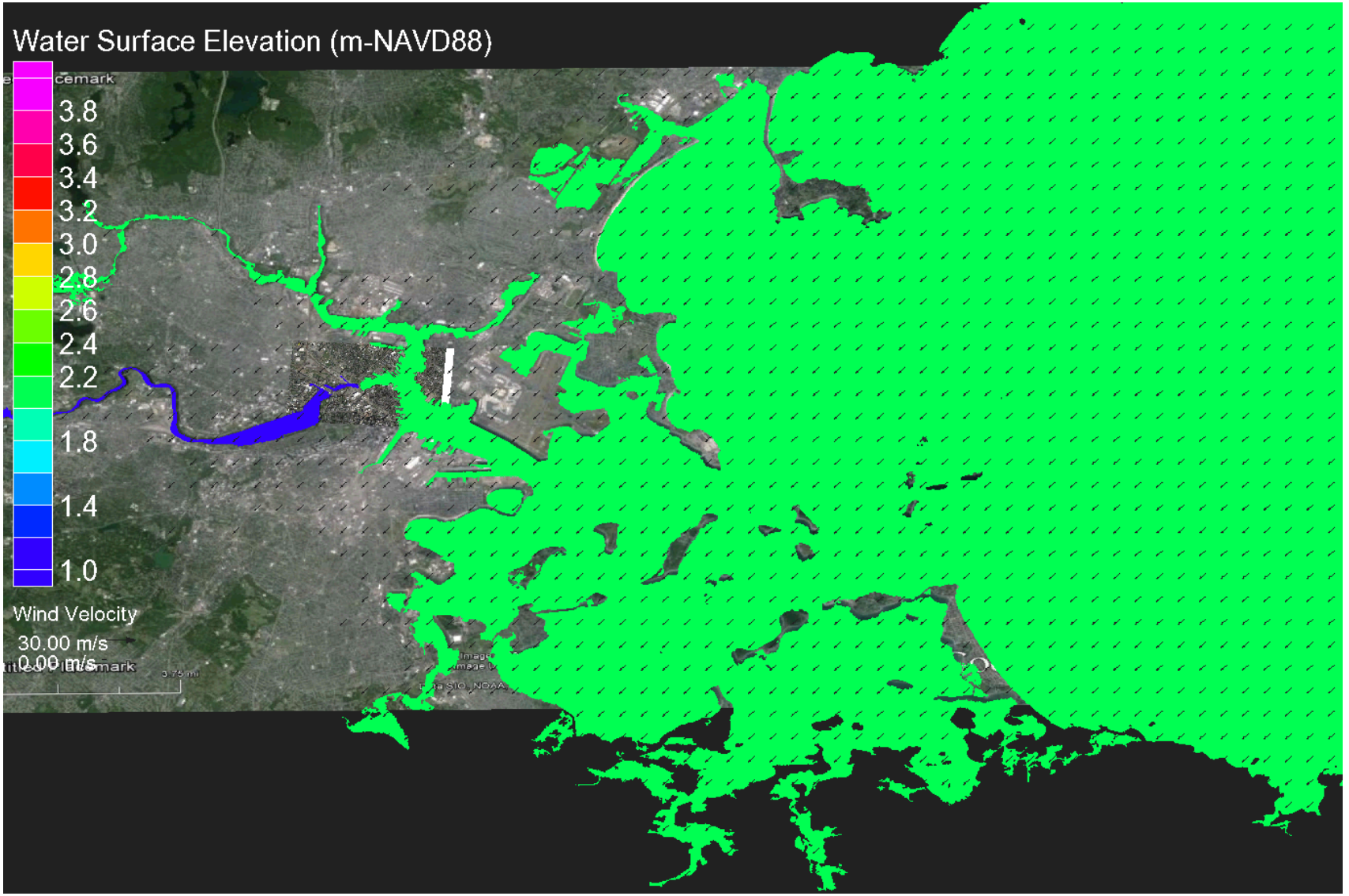
Model Results – Water Surface Elevation (Hurricane)



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CA/T Flood Depths and Parcel 6, 12, 18 Project

Table 5-3. Flood depths of the at-grade land around Boat Sections with Portals: "2013" indicates present vulnerability, "2013 to 2030" indicates vulnerability over the period from the just past the present to 2030, "2030 to 2070 or to 2100" indicates vulnerability over the period just past 2030 to 2070 under a higher SLR scenario, or over the period just past 2030 to 2100 under a lower SLR scenario.
Notes: * = majority of depth exceeds 0.5 ft around perimeter; when a range of depths is shown, it means that flood depth varies along the perimeter of the Boat Section.

Structure_ID	2013 0.1 Depth (ft)	2013 to 2030 0.1 Depth (ft)	2030 to 2070/2100 0.1 Depth (ft)	Ramp Area or Roadway Area and Notes
BIN5UR -POR	0	0	*0 to 3.2	Ramp CS-SA Central Artery Southbound to Surface Artery
BIN5VQ-POR	0	0	*0 to 1.4	Rose Kennedy Greenway Parcel 18: Ramp A-CN Atlantic Avenue to I-93 Northbound
BIN5VA-POR	*0 to 1.0	*0 to 1.7	*0 to 4.4	Rose Kennedy Greenway Parcel 12: Ramp CN-SA Central Artery Northbound to Surface Artery
BIN59Y-POR	0	0	*0 to 2.3	Ramp CN-S Central Artery Northbound to Storrow Drive
BIN5AF-POR	0	0	*0 to 1.6	Storrow Drive Northbound entrance to Leverett Circle Tunnel
BIN5K2-POR	0	0	*0 to 1.5	Storrow Drive Northbound exit from Leverett Circle Tunnel
BIN59K-POR	0	0	*0 to 1.7	Ramp L-CS Leverett Circle to Central Artery Southbound
BIN7BC-POR	0	0	*0 to 2.8	Ramp B Massport Haul Road to I-90 Westbound
BIN7BB-POR	0	0	*2.2 to2.8	Ramp D Congress Street to I-93 from Ramp Area F
BIN7BL-POR BIN7BM	0	0	*0 to 2.8	Ramp L I-93 North Bound to I-90 Eastbound – includes a short underpass from BIN7BM to BIN7BL
BIN7DE-POR BIN7D5-POR BIN7DX-POR BIN7BN-POR	0	0	*0 to 3.4	I-90 / I-93 Interchange: Ramp D tunnel exit to I-93 Southbound, I-90 West Bound tunnel exit, I-90 East Bound tunnel entrance and Ramp C entrance to I-93 Northbound / Tip O'Neill Tunnel
BIN7GA-POR BIN7FX-POR BIN7FL-POR	0	0	*0 to 1.9	Sumner Tunnel Exit: Ramp ST-CN to Central Artery Northbound, and Ramp ST-S to Storrow Drive Also, door to D6-SW25-FAC is located in the Boat Section outside (upstream) of BIN7GA-POR
BIN7HV-POR	0	0	*0 to 3.3	I-93 Northbound entrance to Ted Williams Tunnel
BIN7EK-POR BIN7E7-POR BIN7F6-POR BIN7FQ-POR BIN7FN-POR	0	0	*0 to 3.0	Rose Kennedy Greenway Parcel 6: Ramp SA-CS Surface Artery to Central Artery South, Ramp SA-CN Surface Artery to Central Artery North, Ramp SA-CT Surface Artery to Callahan Tunnel Ramp ST-SA Sumner Tunnel to Surface Artery Ramp ST-CN Sumner Tunnel to Central Artery North
BIN6HB	0	0	*0 to 3.3	I-93 Southbound exits from Ted Williams Tunnel and I-90 Collector

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Table 6-2. Number of lanes and dimensions, and material and installation costs, for the Portals requiring gates in listed Table 5 -3: "2013" indicates installation recommended now, "<2030" indicates installation recommended during the period from the just past the present to 2030, "<2070 or <2100" indicates installation recommended over the period just past 2030 to 2070 under a higher SLR scenario, or over the period just past 2030 to 2100 under a lower SLR scenario.

Portal Locations	No. of Lanes	Est. Total Width (feet)	Year Installed	Gate Material ($Million)	Installation ($Million)	Total Cost ($Million)
BIN5VA	2	38	2013	1.7	1.1	2.8
BIN7J8/7J9/7JD/7JE/7JF/7RX (also need watertight door for D6-SW04-FAC)	4,2,1, 2,2,1	308	2013	14.9	9.7	24.6
BINA07	2	29	≤2030	1.5	1.0	2.5
BINC00	2	28	≤2030	1.5	1.0	2.5
BIN7UG/BIN7MD/BIN7GC	2,4,5	181	≤2030	8.7	5.7	14.4
BIN5UR	2	35	≤2070 or ≤2100	1.5	1.0	2.5
BIN5VQ	2	37	≤2070 or ≤2100	1.7	1.1	2.8
BIN59Y	2	52	≤2070 or ≤2100	2.6	1.7	4.3
BIN7DE/7D5/7DX/7BN	1,2,2,1	198	≤2070 or ≤2100	9.8	6.4	16.2
BIN7HV	3	60	≤2070 or ≤2100	3	2.0	5.0
BIN9P8	4	61	≤2070 or ≤2100	3	2.0	5.0
BINC01	2	38	≤2070 or ≤2100	2	1.3	3.3
BIN7EK/7E7/7F6/7FQ/7FN	1,2,1, 2,1	196	≤2070 or ≤2100	9.1	5.9	15.0
BIN7GA/7FX/7FL	2,1,2	124	≤2070 or ≤2100	6.3	4.1	10.4

Bin5VA =Parcel 12

Bin5VQ = Parcel 18

Bin7EK/7E7/7F6/7FQ/7FN = Parcel 6

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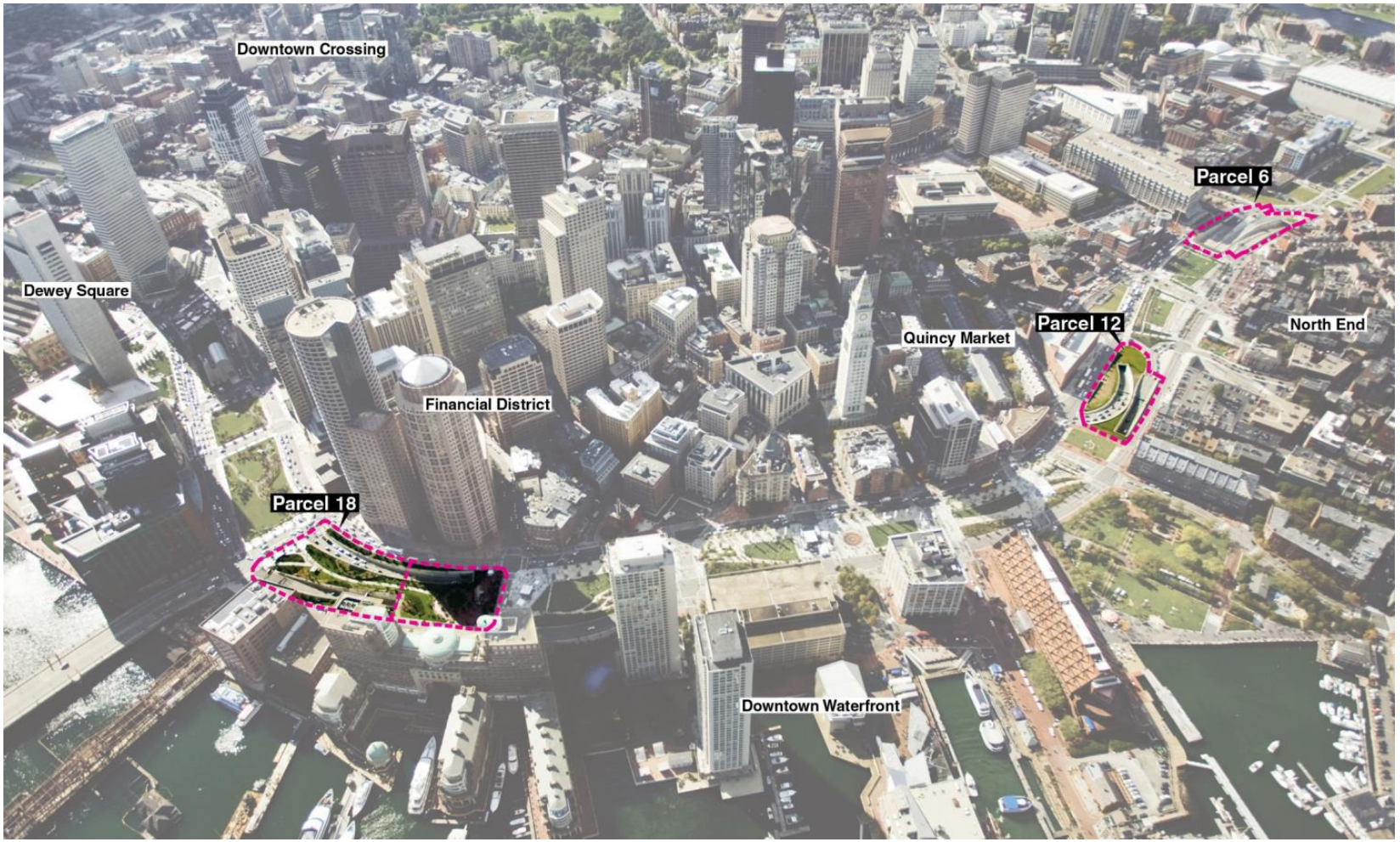

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Possible Regional Adaptation Strategies

Figure 6-1. Flood entry point locations that are viable sites for regional adaptations under the 2013 scenario (Milton site not shown).

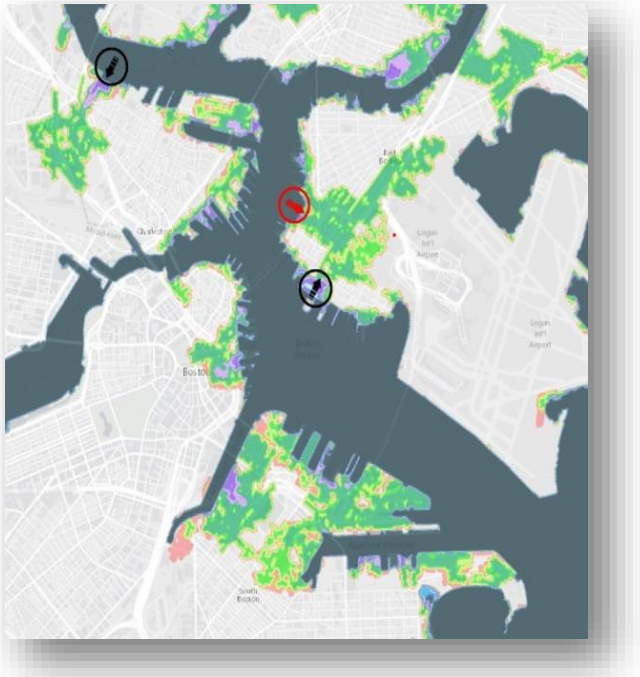

Figure 6-2. Flood entry point locations that are viable sites for regional adaptations under the 2030 scenario.

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Possible Regional Adaptation Strategies

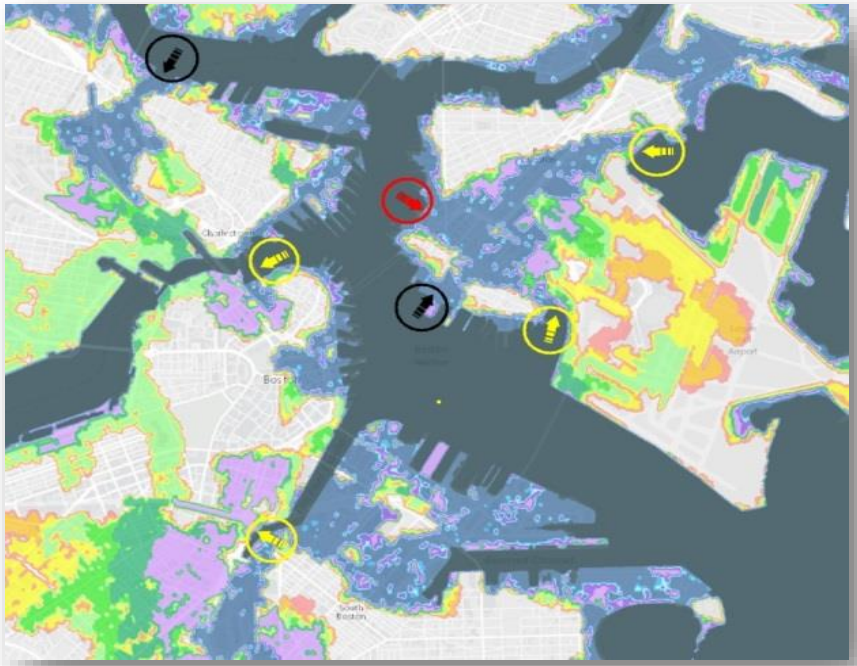

Figure 6-3. Flood entry point locations that are viable sites for regional adaptations under the 2070 scenario.

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Examples of Municipalities using BH-FRM Data

City of Boston
Cambridge
Chelsea
Gloucester
Hull
Oak Bluffs
Quincy
Swampscott

Examples of Organizations using BH-FRM Data

Harvard University
MassPort
Massachusetts Bay Transportation Authority
Massachusetts Emergency Management
Boston Water and Sewer Commission
Boston Redevelopment Authority
The Boston Harbor Association
Worcester Polytechnic Institute
Massachusetts Institute of Technology

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MassDOT is Expanding the model to entire coast and islands:

This work will assess the vulnerability of MassDOT's transportation systems (roads, bridges, railways, airports) along the entire Massachusetts coastline. This 2 year project has 3 main phases:

- Phase 1: Pilot-scale analysis to develop methodologies and test modeling schemes.
- Phase 2: Extension and refinement of BH-FRM to the entire coastline. The new model will be called the Massachusetts Coastline Flood Risk Model (MC-FRM) and will be used for the regional analysis.
- Phase 3: Regional scale vulnerability analysis and conceptual adaptation strategies.

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Thank you!

Find the full report and appendices here:

http://www.massdot.state.ma.us/highway/Departments/EnvironmentalServices/EMSSustainabilityUnit/Sustainability.aspx

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