Town of Wareham
Climate Change Flood Vulnerability Assessment and Adaptation Planning

Board of Selectmen Update

December 18, 2018

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Outline

- **Overview of Project**
  - Project Goals & Objectives
  - Project Methodology
- **Selected Scenarios**
  - Sea-Level Rise Scenarios
  - Time Frames
  - Risk Probabilities
- **Schedule**

Overview of Project

Project Goals & Objectives

- Provide data on likely future flooding scenarios
- Identify potential flooding impacts to municipally-owned infrastructure
- Identify potential flooding impacts to specific demographics
- Identify potential sea-level rise impacts to natural resources
- Identify potential adaptation strategies to reduce risk
- Prioritize investments in adaptation strategies
- Produce high-quality maps/graphics
- Public outreach and education

Overview of Project

Project Methodology

1. Determine Town assets
2. Determine critical elevations

Phase I

3. Obtain probability of exceedance data
4. Determine consequence of flooding score
5. Calculate risk scores and rankings

Phase II

6. Prioritize assets
7. Develop adaptation strategies
8. Public Outreach

Phase III

Vulnerability Assessment and Adaptation Planning

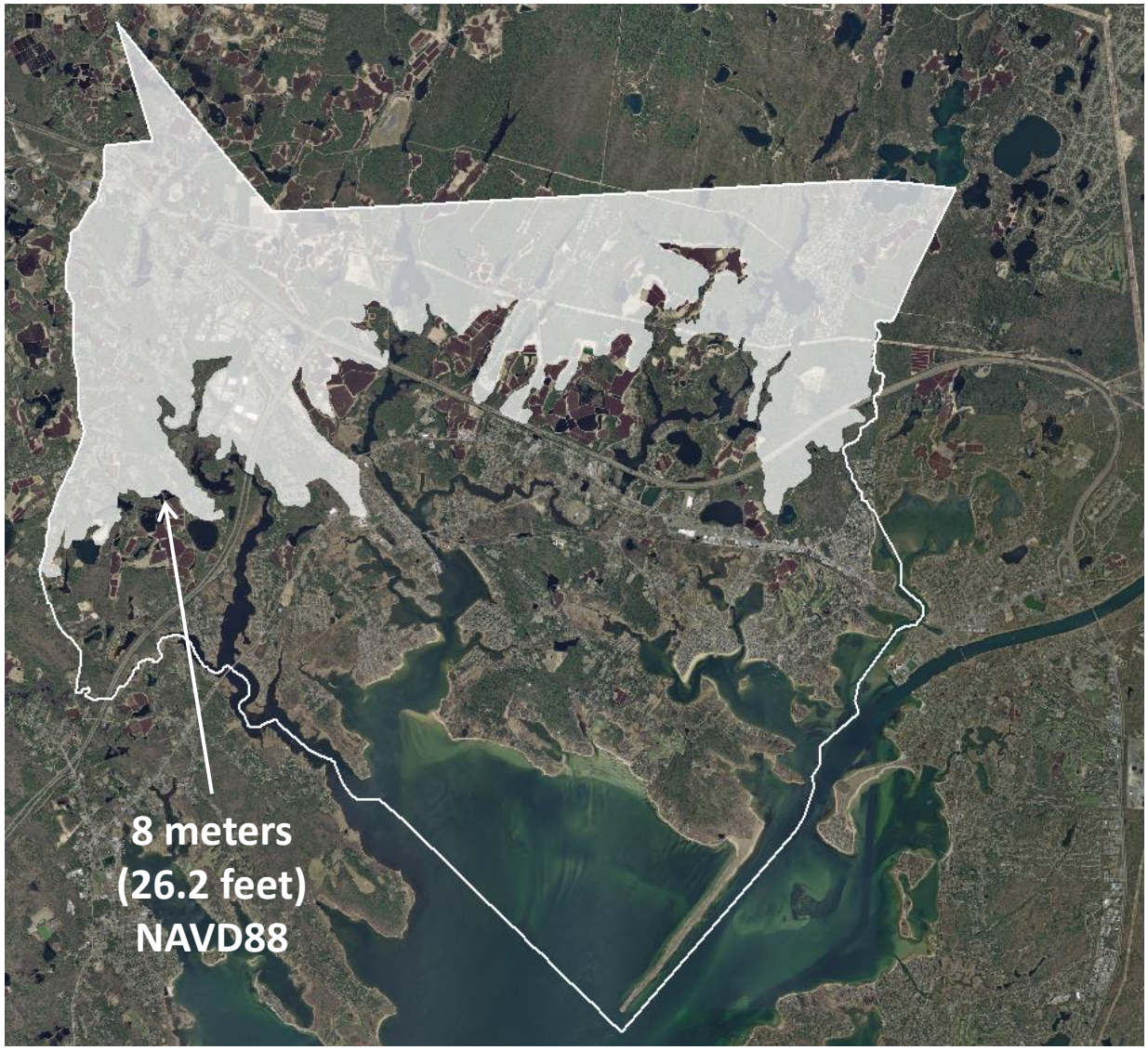
Step 1: Determine critical assets

Based on the December 6th Steering Committee discussion, we will be including the following municipally owned assets within the model grid:

- Buildings
- Above ground utilities (e.g., wastewater pumping stations)
- Boat ramps, docks/piers, and aquaculture facilities
- Recreational facilities (e.g., baseballs fields, tennis courts, etc.)
- Select coastal parking lots
- Roads/bridges

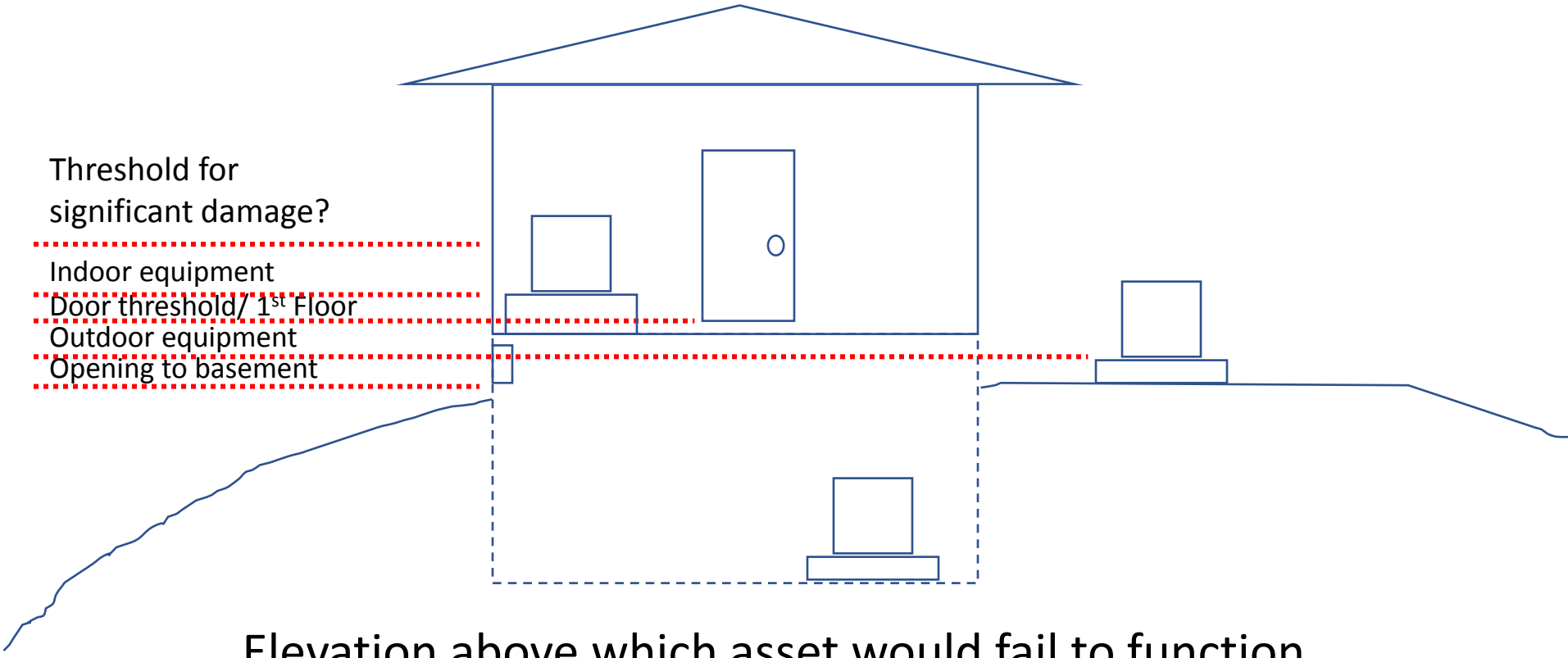
Vulnerability Assessment and Adaptation Planning

Step 1: Determine critical assets



Vulnerability Assessment and Adaptation Planning

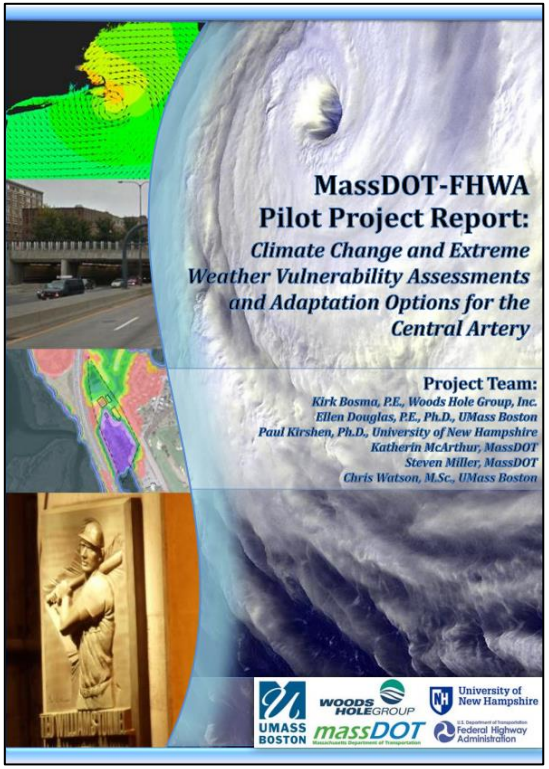
Step 2: Determine critical elevations

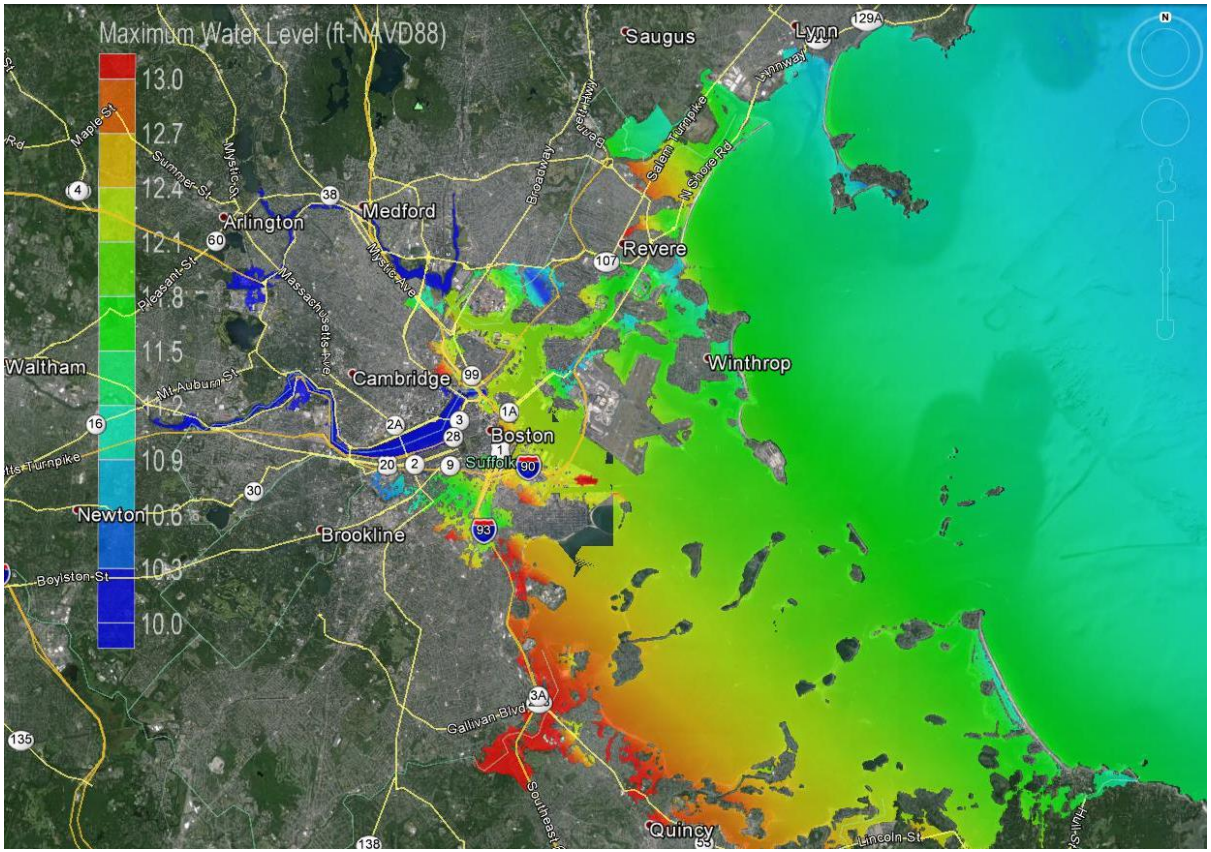


Elevation above which asset would fail to function

Vulnerability Assessment and Adaptation Planning

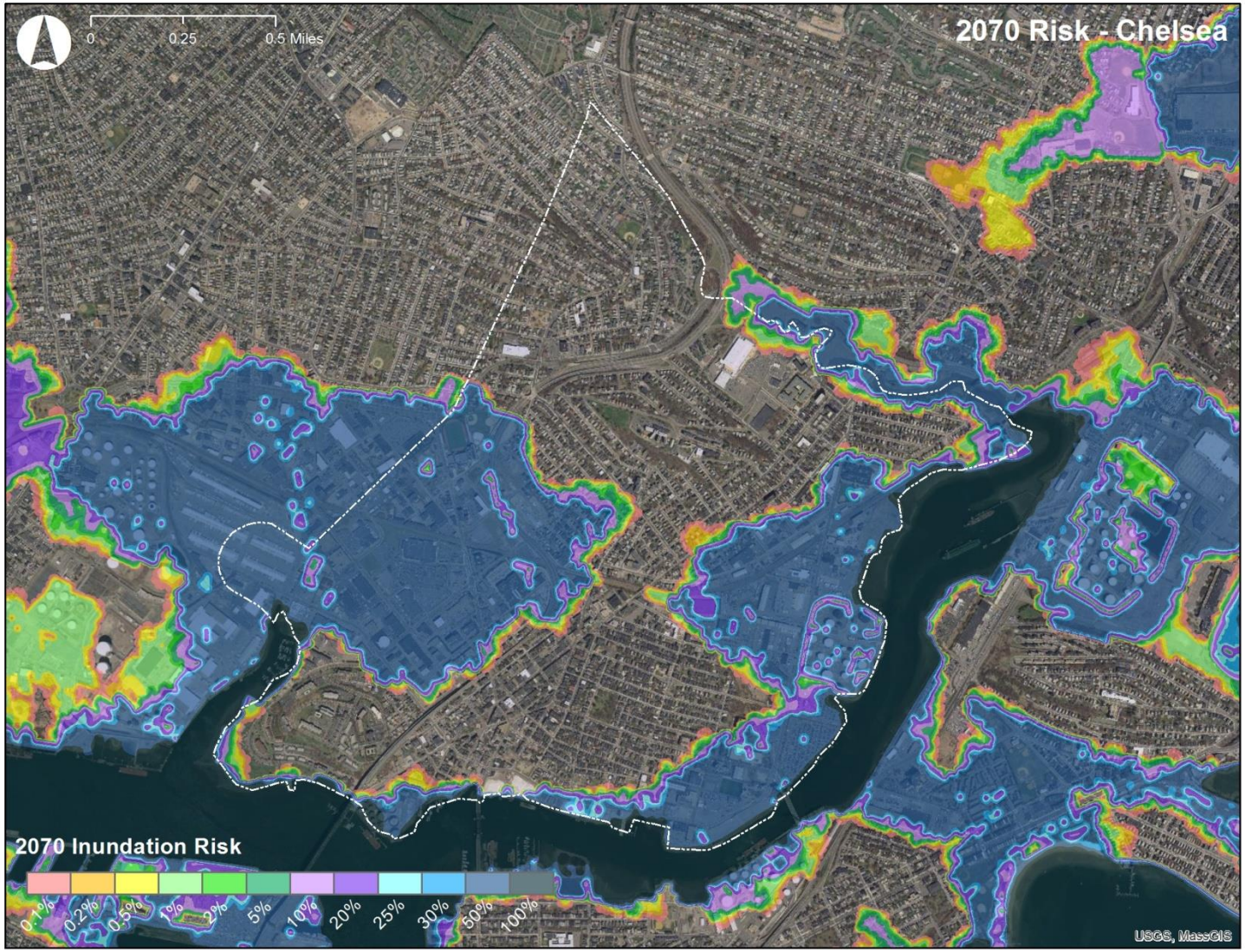
Step 3: Obtain probability of exceedance data





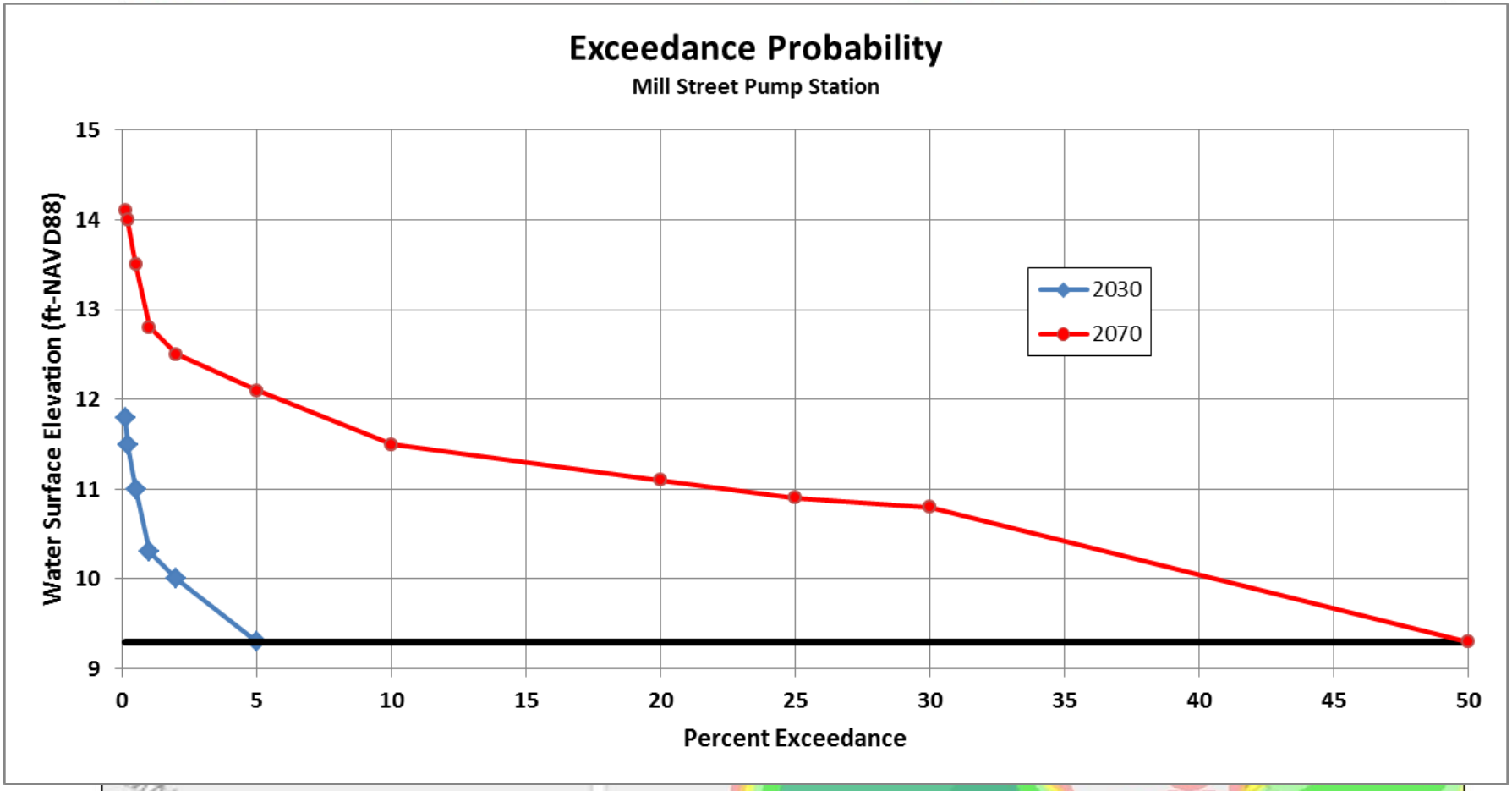
Vulnerability Assessment and Adaptation Planning

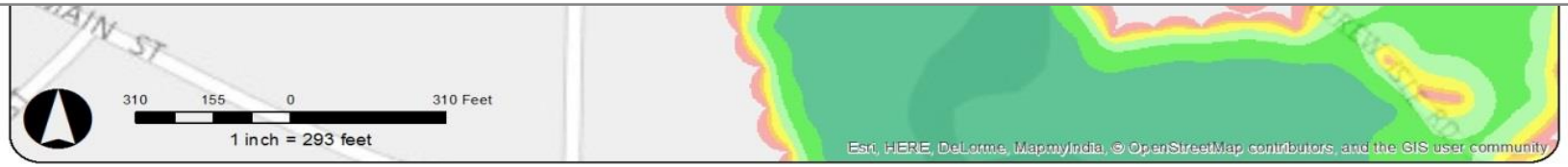
Step 3: Obtain probability of exceedance data



Vulnerability Assessment and Adaptation Planning

Step 3: Obtain probability of exceedance data





Vulnerability Assessment and Adaptation Planning

Step 3: Obtain probability of exceedance data

Pump Station: Critical Elevation Threshold = **8.69 ft. NAVD88**

	2030		2070	
% Probability	Flood elevation	Depth above critical elev.	Flood elevation	Depth above critical elev.
0.1	11.8	3.11	14.1	5.41
0.2	11.5	2.81	14	5.31
0.5	11	2.31	13.5	4.81
1	10.3	1.61	12.8	4.11
2	10	1.31	12.5	3.81
5	9.3	0.61	12.1	3.41
10	dry	0	11.5	2.81
20	dry	0	11.1	2.41
25	dry	0	10.9	2.21
30	dry	0	10.8	2.11
50	dry	0	9.3	0.61
100	dry	0	dry	0

Risk (R) = **Probability of Flooding (P)** x Consequence of Flooding (C)

Vulnerability Assessment and Adaptation Planning

Step 4: Determine consequence of flooding score

Rating	Area of Service Loss	Duration of Service Loss	Cost of Damage	Impact on Public Safety & Emergency Services	Impact on Important Economic Activities	Impact on Public Health & Environment
5	Whole town/city	> 30 days	> $10m	Very high	Very high	Very high
4	Multiple neighborhoods	14 - 30 days	$1m - $10m	High	High	High
3	Neighborhood	7 - 14 days	$100k - $1m	Moderate	Moderate	Moderate
2	Locality	1 - 7 days	$10k - $100k	Low	Low	Low
1	Property	< 1 day	< $10k	None	None	None

	Area of Service Loss	Duration of Service Loss	Cost of Damage	Impacts to Public Safety Services	Impacts to Economic Activities	Impacts to Public Health/ Environment	Consequence score
Rating	2	4	2	1	5	5	63

Risk (R) = Probability of Flooding (P) x **Consequence of Flooding (C)**

Vulnerability Assessment and Adaptation Planning

Step 5: Calculate risk scores and rankings

Step 6: Prioritize assets by composite risk score

Facility	Consequence Score	2030 Probability (%)	2030 Risk Score	2070 Probability (%)	2070 Risk Score	Composite Risk Score
Bel Air Pump Station	50	50	2500	100	5000	3250
William L Foster Elementary School	63	10	630	100	6300	2331
Howe St Pump Station	47	25	1175	100	4700	2233
West Corner Pump Station	50	5	250	100	5000	1675
Broad Cove Sewer Pump Station	53	2	106	100	5300	1664
Hingham Bathing Beach (Parking Lot)	43	5	215	100	4300	1441
Mill St. Pump Station	63	5	315	50	3150	1166
Heliport at Bathing Beach	27	10	270	100	2700	999
Whitney Wharf	27	0	0	30	810	243
Downer Ave Sewer Pump	50	0	0	10	500	150
Beal St Sewer Pump Station (UNG)	50	0	0	0	0	0
Walton Cove Sewer Pump Station	50	0	0	0	0	0
Foundry Pond Dam	27	0	0	0	0	0

Vulnerability Assessment and Adaptation Planning

Step 7: Develop adaptation strategies

- Recommendations for adaption strategies will be developed
  - With order-of-magnitude cost estimates
- Types of potential adaptation strategies
  - Protect: Prevent damage to infrastructure by creating barriers; protection of natural resources
    - Examples: Sea walls, flood gates, hurricane barriers, beaches
  - Accommodate: Minimize and control damage to infrastructure.
    - Examples: Flood-proofing structures, sacrificial structures designed to absorb energy.
  - Mitigate: Reduce the chance of future harm/risk
    - Examples: possible changes to local zoning/permitting regulations
  - Retreat: Remove and relocate susceptible infrastructure from harm's way.
    - Examples: Property buyouts, new zoning limiting reconstruction, relocation of structures.

Vulnerability Assessment and Adaptation Planning

Step 8: Public education and outreach

- Presentation to Board of Selectmen (3 meetings budgeted)
- Hold additional public information sessions
- Utilize local radio, access cable TV, and social media to get message out

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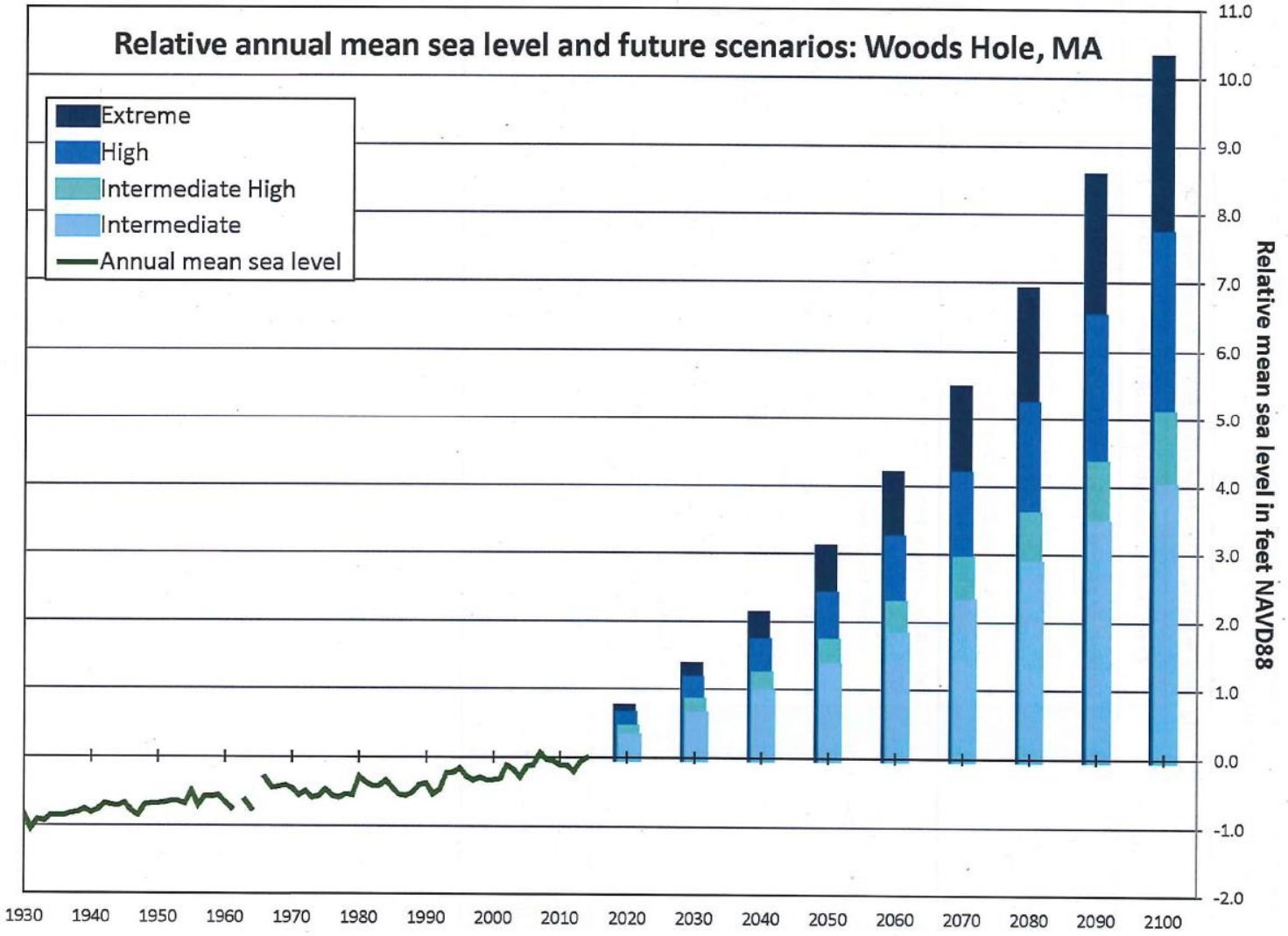
Selected Scenarios

Sea-Level Rise



Selected Scenarios

Sea-Level Rise

Relative mean sea level (feet NAVD88) for Woods Hole, MA					
Scenario	**Cross-walked probabilistic projections**	**2030**	**2050**	**2070**	**2100**
Intermediate	Unlikely to exceed (83%) under RCP8.5	0.6	1.3	2.3	4.0
	• Extremely unlikely to exceed (95%) under RCP4.5 • Unlikely to exceed (83%) under RCP4.5 • About as likely as not to exceed (50%) under RCP4.5 when accounting for possible ice sheet instabilities				
Intermediate - High	Extremely unlikely to exceed (95%) under RCP8.5	0.8	1.7	2.9	5.1
	• Unlikely to exceed (83%) under RCP4.5 when accounting for possible ice sheet instabilities • About as likely as not to exceed (50%) under RCP8.5 when accounting for possible ice sheet instabilities				
High	Extremely unlikely to exceed (99.5%) under RCP8.5	1.1	2.4	4.2	7.7
	• Unlikely to exceed (83%) under RCP8.5 when accounting for possible ice sheet instabilities • Extremely unlikely to exceed (95%) under RCP4.5 when accounting for possible ice sheet instabilities				
Extreme (Maximum physically plausible)	Exceptionally unlikely to exceed (99.9%) under RCP8.5	1.3	3.1	5.4	10.3
	• Extremely unlikely to exceed (95%) under RCP8.5 when accounting for possible ice sheet instabilities				

For reference: Mean sea level in 2000 was -0.3 ft (NAVD88)

Selected Scenarios

Time Horizons and Risk Probabilities

- Model results will be developed for two (2) planning horizons
  - **2030** (results complete)
  - **2070** (results scheduled for Feb 2019)
  - Probability of inundation maps developed for both time horizons

- Depth of Inundation maps will be developed for two (2) probability levels
  - **1%** (100-year event)
  - **2% or 5%** (50- or 20-year event; TBD following review of results)

Schedule

Task	Schedule
Task 1. Establish Study Parameters	
Steering Committee Meeting 1 - Kick-off meeting	Nov 2018
Collect data sets (GIS Asset Data)	Nov/Dec 2018
Determine parameters	Nov/Dec 2018
Steering Committee Meeting 2 (Working Meeting - Review Data/Parameters/Assets)	late Nov. 2018
Draft Tech Memo	Dec 14, 2018
Board of Selectmen Meeting (Review parameters; introduce goals and objectives)	Dec 18, 2018
Final Tech Memo	Dec 31, 2018
Task 2. Vulnerability Assessment	
Inventory and Assess Condition and Elevation of Town Assets	Nov/Dec 2018
Inventory and Assess All Key Natural Resources	Nov/Dec 2018
Asset Consequence Scoring	Dec 2018-Jan 2019
Steering Committee Meeting 3 (Working Meeting - Asset Consequence Scoring)	Jan 2019
Develop inundation maps/vulnerability assessment (2030)	Jan 2019
Develop inundation maps/vulnerability assessment (2070)	Jan 2019
Natural resources migration mapping	Jan-Feb 2019
Steering Committee Meeting 4 (Working Meeting - Review Results)	early Feb 2019
Site specific maps for 3 assets	Feb 2019
Draft Tech Memo	Feb 15, 2019
Public/Board of Selectmen Meeting (Working Meeting - Present Vulnerability Assessment)	late Feb 2019
Final Tech Memo	Mar 1, 2019
Task 3. Develop Adaptation Strategies and Prepare Final Report	
Develop prioritization	Mar 2019
Develop short, mid, and long term adaptation strategies	Mar-Apr 2019
Steering Committee Meeting 5 (Working Meeting - Review/Prioritize Strategies)	early Apr 2019
Develop order of magnitude costs	Apr 2019
Recommendations for Town policies and regulations	Apr 2019
Steering Committee Meeting 6 (Working Meeting - Review/Finalize Strategies)	early May 2019
Draft Report	May 31, 2019
Board of Selectmen Presentation	early June 2019
Final Report	Jun 30, 2019

← Comments due by noon on Dec 27th
Email: kbuckland@wareham.ma.us

Hard deadline

Questions?