



# Integrating Resilience into Remediation Sites: A Look into the Progress that Massachusetts has Made

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SUSTAINABLE REMEDIATION FORUM

# How we got where we are today...

2018

- Resilient Remediation: Addressing Extreme Weather and Climate Change, Creating Community Value Published in Remediation Journal

2019

- SURF TI/ Pilot: MA site-wide vulnerability assessment/ screening work completed

2020

2021

2022



SURF

# Assessing Vulnerability



**Site Vulnerability =  
Climate Change Related Exposure + Site Sensitivity**

## Climate data

Current

- Flooding
- Storm surge

Future

- Sea level rise



## Site data

- Open status
- Active remediation system
- Active exposure pathway mitigation measures
- Imminent hazard classification
- Critical exposure pathway for human risk

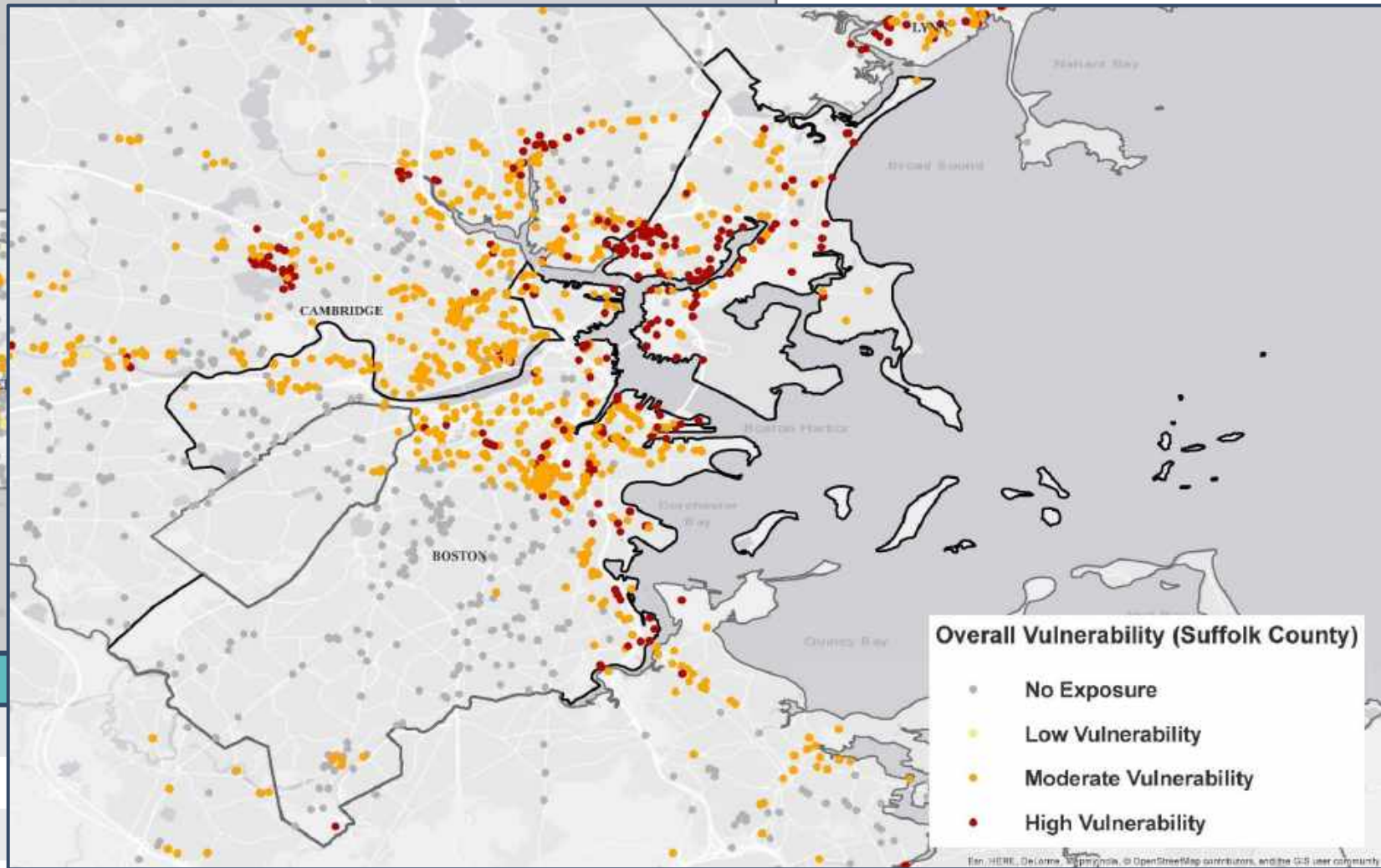
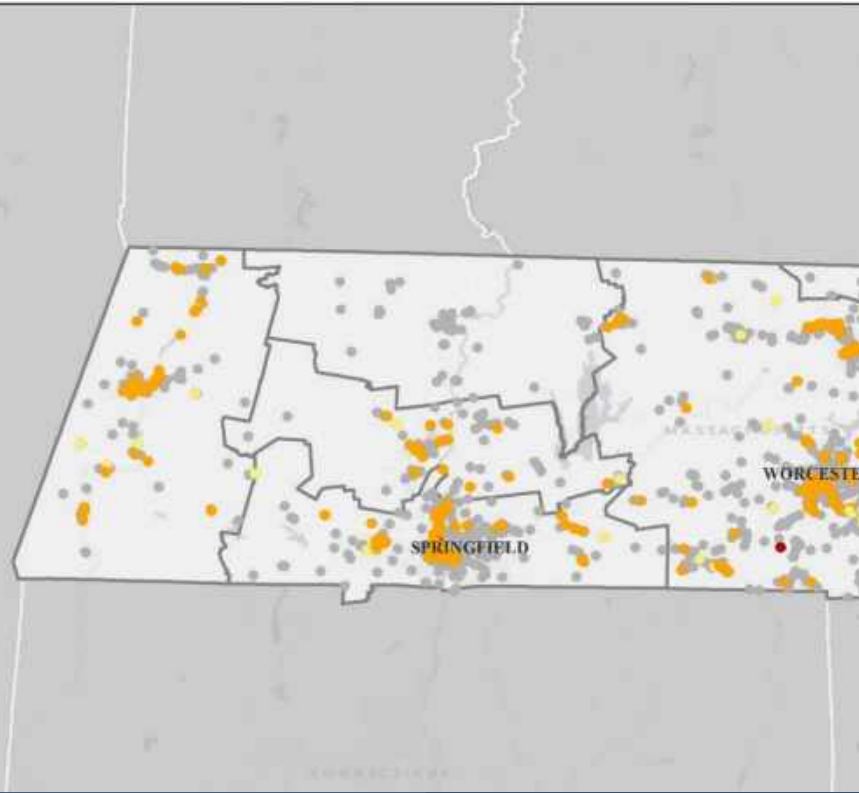


## Receptor data

- Vulnerable populations
- Sensitive infrastructure
- Drinking water resources
- Protected resource areas

**Overall Vulnerability =  
Site Vulnerability + Community  
& Environment Sensitivity**

# Overall Vulnerability



**Overall Vulnerability (Suffolk County)**

- No Exposure
- Low Vulnerability
- Moderate Vulnerability
- High Vulnerability

Overall Vulnerability	Sites	%
• No Exposure	3,613	60
• Low Vulnerability	89	1
• Moderate Vulnerability	1,914	32
• High Vulnerability	385	6

# How we got where we are today...

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- SURF TI/ Pilot: MA site-wide vulnerability assessment/ screening work completed
- **SRR ITRC team kicks off & draft amendments issued integrating climate change into the MCP**

2020

2021

2022

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# Integrating potential climate change impacts into regulations – *MCP proposed changes*



## **Integration into the CSM**

*current and foreseeable future*



## **Response Action Performance Standards**

*...anticipated climate change impacts upon disposal site conditions are relevant to the selection and maintenance of a Permanent Solution."*



## **Definition of foreseeable future**

*"...consider existing site conditions and reasonably foreseeable future changes... including anticipated impacts associated with climate change."*

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- SRR ITRC team kicks off & draft amendments issued

2020

- LSPA subcommittee on climate change assembled
- MVP grant submitted for flood study at a remediation site using SURF pilot results

2021

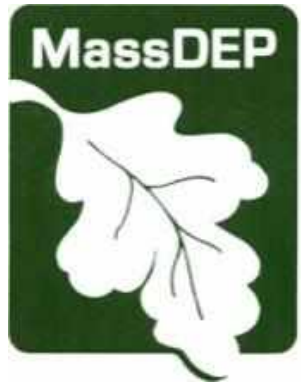
- ITRC SRR Guidance Published
- ASTM Standard Guide for Remedial Action Resiliency to Climate Impacts

2022

- LSPA climate change subcommittee – final draft of climate toolkit !

SURF

# MA Climate change tool kit



## ► Q&A

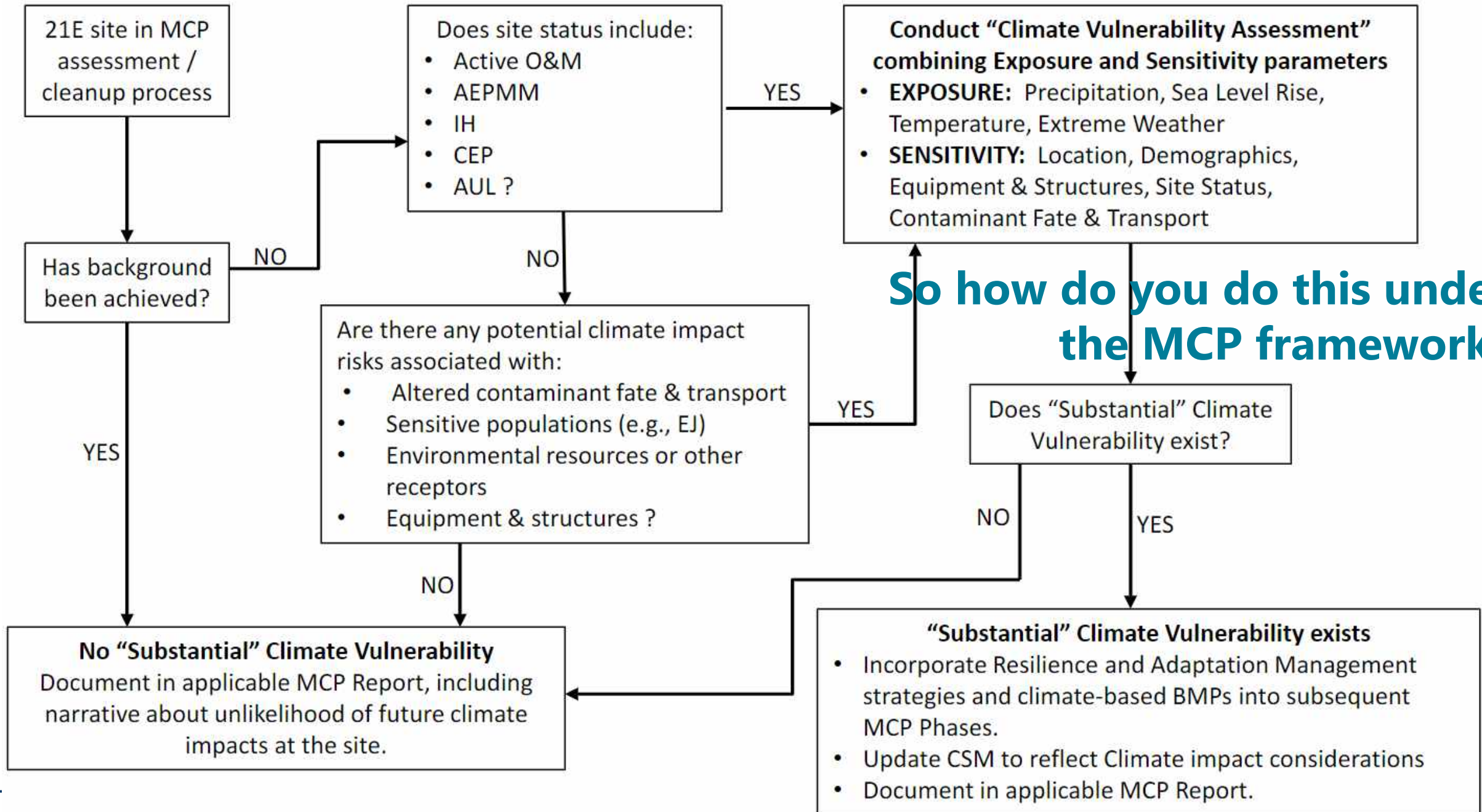
- 1) Why must climate impacts be assessed at 21E sites?
- 2) What are the climate impact assessment requirements in the MCP?
- 3) What timeframe would apply..?
- 4) How is vulnerability to climate impacts at 21E sites to be assessed?
- 5) Does MassDEP plan to re-visit previously closed sites?



- Flow Chart
- Glossary
- Updated Tools & Resources
- Vulnerability Assessment Checklist
- Case Studies



# Conceptual MCP Climate Impact Evaluation



So how do you do this under the MCP framework?

# Climate vulnerability assessment checklist

B.		SITE STATUS AND CLIMATE IMPACT RISKS			
		YES	NO	N/A	
1	Is or will the site be cleaned up to background? (If Yes, skip to Section F and select "Not Likely")				
2	Is the site in active operation and maintenance (O&M) or ROS?				
3	Does the site have or will the site require an AUL?				
4	Is there a containment cap/barrier or other engineered control?				
5	Does the site have or will the site require an AEPMM?				
6	Is the site characterized by an IH condition, a CEP or an SRM?				
7	Is the site in an environmental justice location or are sensitive populations present?				
8	Is the site in an ACEC and/or sensitive habitat?				
9	Is the site in an inland waterway?				
10	Are there essential remedial infrastructure, equipment, or structures present and at risk?				
11	Would potential climate impacts substantially alter the fate and transport of site contaminants of concern?				
12	Is the anticipated closure a Temporary Solution?				
13	All/a portion of the site has a history of coastal flooding and/or is located within a potential future storm surge area?				
14	All/a portion of the site is within an existing FEMA 1% flood hazard area?				
15	All/a portion of the site has a history of flooding during precipitation events?				
<p align="center">** If any answers to Questions 2 through 15 above are "Yes," proceed to Sections C - E **</p> <p align="center">** If all answers to Questions 2 through 15 are "No," proceed to Section F to document no anticipated climate change risk **</p>					

# Developed state specific remediation focused tools using current state datasets



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# Checklist evaluates each of the hazards identified in the SHMCAP



Changes in precipitation (flooding/ drought)



Sea level rise (coastal flooding/ erosion)



Rising temperatures



Extreme weather events (winter storms, hurricanes/tropical storms, tornadoes)





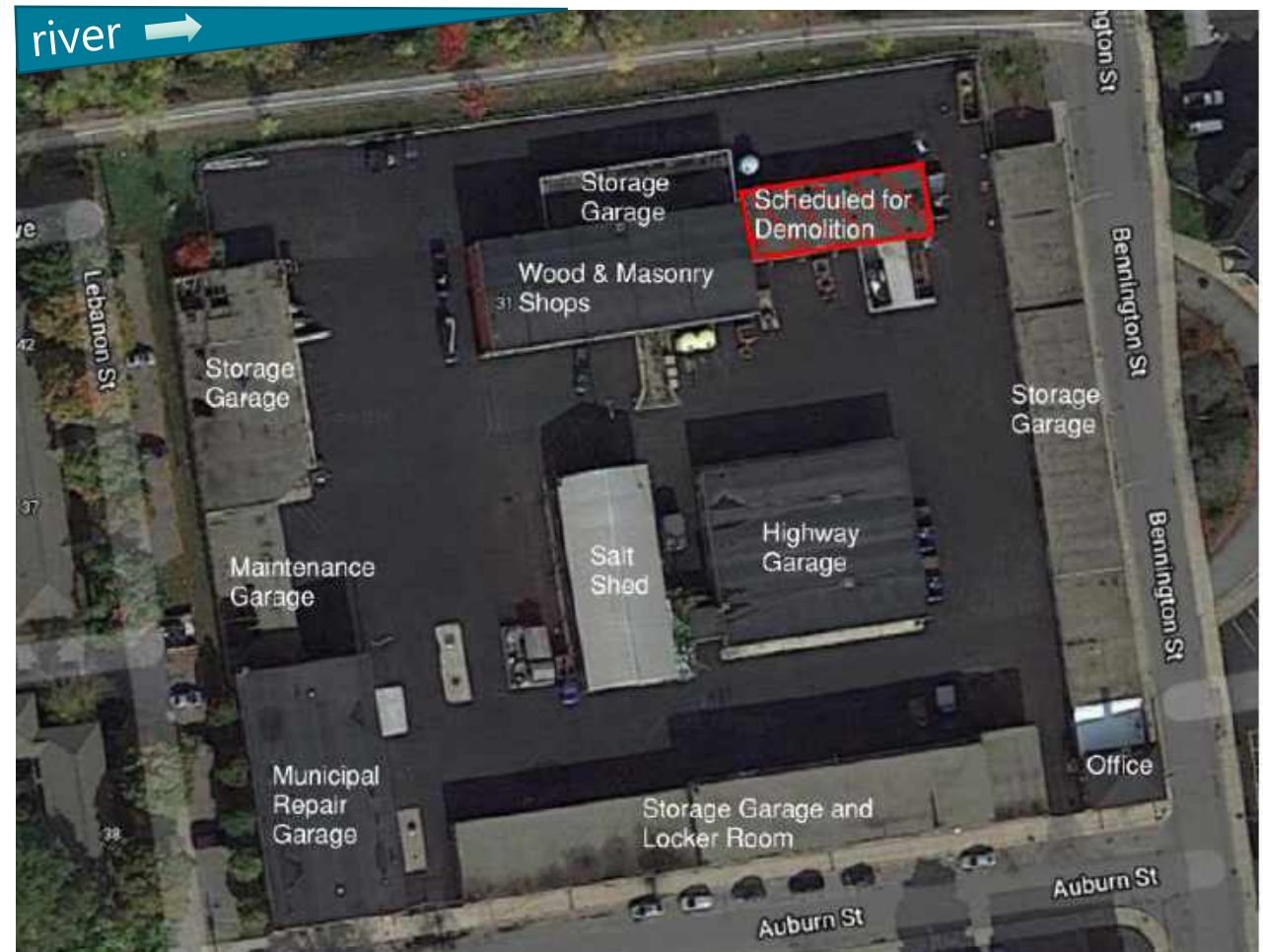
# Case Study

*Gasoline/ diesel/ fuel oil release site along river  
prone to flooding*

# CASE STUDY:

## *Gasoline/ diesel/ fuel oil release site along river prone to flooding*

- ▶ DPW yard, owned by municipality
- ▶ Base for city maintenance equipment and includes fuel pumps for city vehicles
- ▶ Located within the floodplain of the adjacent river; close proximity to the river
- ▶ Site has flooded in the past
- ▶ ASTs and other material storage impacted by flooding
- ▶ LNAPL in subsurface from leaking USTs
- ▶ Oil and groundwater recovery system in place through 2016



# Leveraging a site's vulnerability for grant funding



During major flood events, flooding prevents access to the site, hampering city response



In addition to concern for potential spread of any stored materials/ chemicals, also a release site driven by oil from former USTs



Identified in the city's MVP Action Plan – short and long term evaluation recommended



MVP grant awarded to conduct Flood Study and Department of Public Works (DPW) Yard Adaptation Plan



# Flood model predictions



**73% of city modeled**

*Checked against 2006 flood*



**2070 Projections**

*4.11 inches or 9.1% increase in  
total annual rainfall*

# Site specific flood study

- ▶ 4 alternatives evaluated during the study
  - **Construction a berm or floodwall**
    - not sufficient protection for the 100-yr 2070 storm
  - **Flood barrier around entirety of DPW yard**
    - provides protection but causes increase in flood depths (0.3 ft) at properties adjacent to the site, no access to site during the events
  - **Install wet and dry floodproofing measures to protect critical facilities from damage**
    - onsite inundation still occurs but floodproofing minimizes damage to operations
  - **Relocate site outside of the 100 yr future floodplain**
    - 10x cost of options 2 and 3
- ▶ Actions being taken
  - Short term
    - Update to emergency response procedures, implement measures to prepare for flood events

# Shifting to th



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<b>C.</b>	
<b>1</b>	<b>Applied forecast duration [check]</b> <i>Based on Resilientma.org</i>
<b>2</b>	<b>SEA LEVEL RISE Impacts</b> <i>(based on resilientma.org clima</i>
a.	All/a portion of the site will ch
b.	All/a portion of the site will ch
<b>3</b>	<b>EXTREME WEATHER EVENT imp</b> <i>(based on resilientma.org clima</i>
a.	Erosion or slope stability dam
b.	Ice dams, frozen utilities, snow
c.	Wind hazards/tree uprooting
<b>4</b>	<b>PRECIPITATION</b> <i>(based on resilientma.org clima</i>
a.	All/a portion of the site will in
b.	Remediation of the site is likel
c.	All/a portion of the project is v
d.	Changes in precipitation lead t

Layers Controls & Legends 1 Quick Zoom

Collapse All Hide All Remove All

Flood Zones (DFIRM)

Opacity: 61%

Legend:

- A: 1% Annual Chance of Flooding, no BFE
- AE: 1% Annual Chance of Flooding, with BFE
- AE: Regulatory Floodway
- AH: 1% Annual Chance of 1-3ft Ponding, with BFE
- AO: 1% Annual Chance of 1-3ft Sheet Flow Flooding, with De
- VE: High Risk Coastal Area
- D: Possible But Undetermined Hazard
- X: 0.2% Annual Chance of Flooding
- X: 1% Drainage Area < 1 Sq. Mi.
- X: Reduced Flood Risk due to Levee
- Area Not Included
- Area with no DFIRM - Paper FIRMs in Effect



	<b>Impacts</b>
	N/A
	X
	X
	N/A
	X
	N/A

D.		SENSITIVITY CONSIDERATIONS		
<b>1</b>	<i>Altered contaminant fate and transport</i>	<b>LOW</b>	<b>MEDIUM</b>	<b>HIGH</b>
a.	Physical characteristics of site contaminants of concern (COCs) support increased risk of transport due to climate change (such as solubility, absorption, etc.)			✗
b.	Chemical characteristics of site COCs support increased transport due to climate change	✗		
c.	Site specific biological/environmental characteristics increase risk of climate enhanced transport	✗		
d.	Climate triggered substantial changes in groundwater elevation may impact fate and transport (including LNAPL)	✗		
<b>2</b>	<i>Moderate to severe equipment/building/infrastructure impacts</i>	<b>LOW</b>	<b>MEDIUM</b>	<b>HIGH</b>
a.	Climate impacts may affect/alter the functioning of remedial components			✗
b.	Impacts to utilities and infrastructure at the site or essential to the remedy			✗
c.	Site conditions limit ability for adaptive site management to mitigate climate risk			✗
<b>3</b>	<i>Moderate to severe human health/demographic impacts</i>	<b>LOW</b>	<b>MEDIUM</b>	<b>HIGH</b>
a.	Localized impacts to health and safety of site occupants and abutters as a result of climate-based changes at the site		✗	
b.	Increase in airborne dust exposure due to drought and/or temperature increase	✗		
c.	Cumulative effects on local environmental justice community as a result of climate change impacts on the remedial action	✗		
<b>4</b>	<i>Moderate to severe wildlife/ecosystem impacts</i>	<b>LOW</b>	<b>MEDIUM</b>	<b>HIGH</b>
a.	A climate impact on the remedial solution may result in new risks to sensitive habitat(s).	✗		

<b>E. CONSIDERATIONS FOR CLIMATE CHANGE IMPACTS ON GROUNDWATER</b>				
<b>1</b>	<i>Significant impacts to groundwater elevation</i>	<b>LOW</b>	<b>MEDIUM</b>	<b>HIGH</b>
a.	Increased or decreased rainfall			
b.	Increases/decreases in water levels at hydrologic boundaries			
c.	Impact of future off-site mitigation measures			
d.	Increased evapotranspiration/decreasing recharge			
e.	Episodic elevated groundwater elevation due to high precipitation events			
f.	Impact on groundwater monitoring wells			
g.	Saltwater intrusion			
h.	Potential long term regional changes			
<b>2</b>	<i>Significant impacts to direction of flow</i>	<b>LOW</b>	<b>MEDIUM</b>	<b>HIGH</b>
a.	Increases/decreases in water levels at hydrologic boundaries			
b.	Impact on sources or sinks in area			
c.	Creation/elimination of preferential pathways			
d.	Impacts of changes in stormwater management			
<b>3</b>	<i>Significant impacts to fate and transport of contamination</i>	<b>LOW</b>	<b>MEDIUM</b>	<b>HIGH</b>
a.	Inundation of previously unsaturated soils			
b.	Increased temperatures resulting in enhanced vapor migration			
c.	Changes in groundwater chemistry			
<b>4</b>	<i>Likelihood of significant impacts to effectiveness of remedy</i>	<b>LOW</b>	<b>MEDIUM</b>	<b>HIGH</b>
a.	Impact on capture zone			
b.	Changes in effectiveness of vadose zone treatment (SVE, bioventing)			
c.	Impacts on in-situ treatment - groundwater chemistry, saturated thickness, natural attenuation			

# At the end...determine if site/ remedy is vulnerable to climate change

F.		CONCLUSION		
1	Based on the answers above, the site "is not likely to be"/ "is likely to be"/ "will be" vulnerable to climate change: *	Not Likely	Is Likely	Will Be

\*LSP to pick applicable conclusion; add summary discussion to CSM and other applicable sections in MCP deliverable. If site is likely to be or will be vulnerable, describe any adjustments to the remedy that have been made to address the potential impacts.

# Thank you! Questions?

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