

# **Massachusetts Climate Change Site Vulnerability Mapping and Analysis**

NEWMOA: Annual States/EPA Brownfields Program Meeting  
June 15, 2017

Thomas M. Potter  
MassDEP Bureau of Waste Site Cleanup  
Division of Policy and Program Development  
Clean Energy Development Coordinator



# AGENDA

- **State Drivers and Activities**
  - GWS Act
  - EO 569
- **Boston University – Hazardous Waste Site Vulnerability Assessment**
  - Current Hazards
  - Future Hazards
- **Adaptation Considerations**
  - Buildings
  - Waste Sites



# Massachusetts Mandates

- 2007 established Executive Office of Energy & Environmental Affairs
- **2008 Global Warming Solutions Act**
  - Comprehensive Program -> Climate Change
  - **2020 Goal of 25 % Below 1990 GHG Levels**
  - **2050 Goal of 80% Below 1990 GHG Levels**
  - **No interim limits for 2030 and 2040**
- **2008 Green Communities Act (GCA)**
  - Supports Development of Clean Energy Resources
  - Expands Efforts to Promote Energy Efficiency
  - Increased the Renewable Energy Portfolio Standard (RPS) to 1% per year
  - Goal of 15% “New Sources” by 2020

# 2016 Governor's Executive Order No. 569

<http://www.mass.gov/governor/legislationexecorder/execorders/executive-order-no-569.html>

- **September 16, 2016**
- “Establishing An Integrated Climate Change Strategy For The Commonwealth”
- “Climate Change presents a serious threat to the environment and the Commonwealth’s residents, communities, and economy”
- “Extreme weather events associated with climate change present a serious threat to public safety, and the lives and property of our residents”



CHARLES D. BAKER  
GOVERNOR

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SECRETARY OF STATE  
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2016 SEP 16 PM 12:44

KARYN E. POLITO  
LIEUTENANT GOVERNOR

By His Excellency  
CHARLES D. BAKER  
GOVERNOR

EXECUTIVE ORDER NO. 569

## ESTABLISHING AN INTEGRATED CLIMATE CHANGE STRATEGY FOR THE COMMONWEALTH

WHEREAS, climate change presents a serious threat to the environment and the Commonwealth's residents, communities, and economy;

WHEREAS, extreme weather events associated with climate change present a serious threat to public safety, and the lives and property of our residents;

WHEREAS, the Global Warming Solutions Act (the "GWSA") directs the Secretary of Energy and Environmental Affairs and the Department of Environmental Protection to take certain steps to reduce greenhouse gas emissions and prepare for the impacts of climate change, including setting statewide greenhouse gas emissions limits for 2020, 2030, 2040 and 2050;

WHEREAS, the statewide greenhouse gas emissions limit for 2020 is 25% below the 1990 level of emissions and the corresponding limit for 2050 is 80% below the 1990 level of emissions, but no interim limits have yet been set for 2030 or 2040;

WHEREAS, the Commonwealth can provide leadership by reducing its own emissions from state operations, planning and preparing for impending climate change, and enhancing the resilience of government investments;

WHEREAS, the transportation sector continues to be a significant contributor to greenhouse gas emissions in the Commonwealth, and is the only sector identified through the GWSA with a volumetric increase in greenhouse gas emissions;

WHEREAS, the generation and consumption of energy continues to be a significant contributor to greenhouse gas emissions in the Commonwealth, and there is significant potential

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# EO 569 (cont.)

1. Make new and existing efforts to mitigate and reduce greenhouse gas emissions and build resilience and adapt to the impacts of climate change
2. MassDEP shall promulgate final regulations to meet the 2020 state emissions limit mandated by the GWSA
3. Secretary of Environmental Affairs and secretary of safety **shall coordinate efforts across the Commonwealth to strengthen the resilience of our communities, prepare for the impacts of climate change, and to prepare for and mitigate damage from extreme weather events.**
4. Secretary of each executive office shall designate an existing employee to serve a the secretariat's "Climate Change Coordinator"



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# 2011 Climate Change Adaptation Report

## MA Impacts & Vulnerabilities

- **Sea Level Rise and Flooding**

*(MA = 192 miles coastline & 1,519 miles of tidal shoreline)*

- Coastal inundation and storm surges
- Property damage and loss of natural habitats
- Interruption of key services

- **Extreme Weather Events**

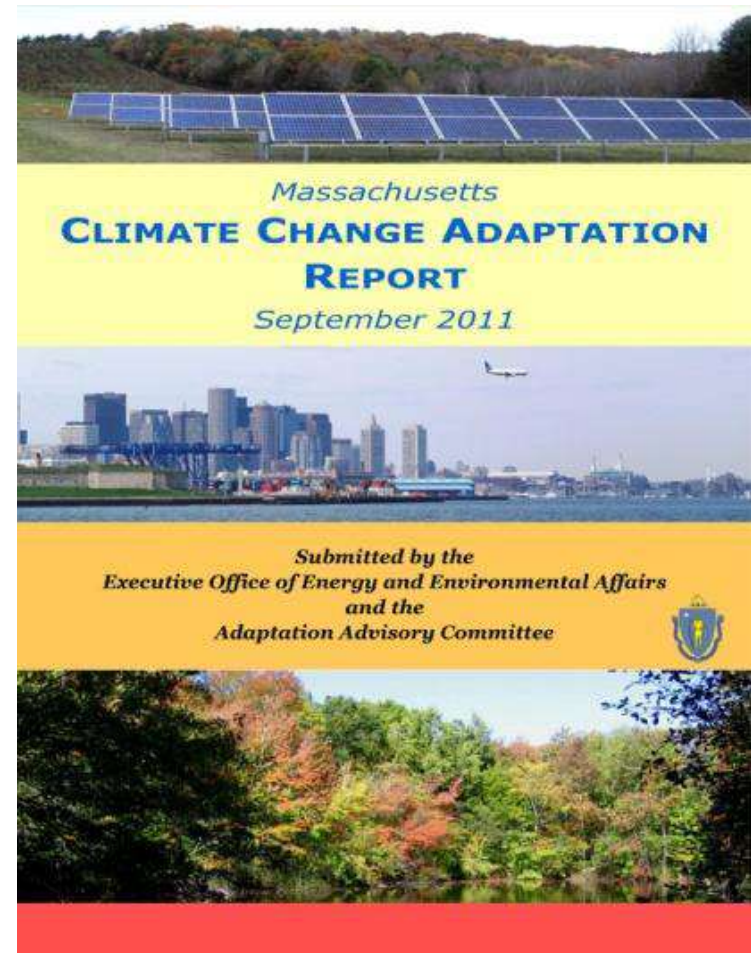
- High winds, hurricanes, storm surges, waves, ice storms, flooding
- Reduced emergency response capacity

- **Precipitation Changes**

- Decreased summer, increased winter precipitation
- Less spring snow melt and earlier peak streamflow
- Current 100-year flood every 2-3 years by 2100
- Extended low-flow periods, decreased summer water supply

- **Temperature Increases**

- Higher temps, more extreme heat



# State Activities Related to Adaptation

- **Executive Office of Energy and Environmental Affairs**
  - Dam/Seawall Loan and Grant Program
  - Draft MA Environmental Policy Act Adaptation Policy
  - National Disaster Resilience Competition
- **Department of Environmental Protection (MassDEP)**
  - “Circuit Rider” for Water & Wastewater Utilities
  - *BWSC’s Emergency Response & Climate Change Preparedness*
  - *BWSC’s Site Assessment & Remediation - Mitigation and Adaptation*
- **Coastal Zone Management**
  - Storm Smart Coasts Program for municipalities
  - Green Infrastructure Grants
  - Coastal Resiliency Grants
- **Department of Energy Resources**
  - \$25M protect against energy service interruptions
  - Regulatory changes to encourage investment in system hardening, new communication, innovative technologies
  - Community Clean Energy Resiliency Initiative

# MassDEP's – Bureau of Water Resources

## *“Circuit Rider” for Water & Wastewater Utilities*

- Many of the Commonwealth's drinking water and wastewater treatment facilities are gravity-fed and therefore located at low elevations, especially along the Commonwealth's 1500-mile coastline.
- Although this reduces the expense of pumping large volumes of water, it also makes such facilities more vulnerable to coastal and inland flooding during extreme storm events
- PROJECT: Climate change adaptation planning for Massachusetts drinking water and wastewater utilities
  - Sponsored by MassDEP through Worcester Polytechnic Institute (WPI), focuses on how MassDEP can provide assistance to water utilities for adapting to climate-change effects such as sea-level rise, an increase in storm intensity, and rising temperatures.





# MassDEP's – Bureau of Waste Site Cleanup

## *Emergency Response - Climate Change Preparedness*

- Extreme weather events typically contribute to spills and other releases of oil and hazardous materials to the environment
- Flooding causes waste and fuel storage tanks to breach
- When our transportation infrastructure is impacted, there is an increased risk of spills from trucks and trains that transport harmful materials
- The Emergency Response Program at MassDEP responds to releases and threats of release of oil and hazardous materials to the environment on a 24/7 basis.



<http://www.mass.gov/eea/agencies/massdep/climate-energy/climate/preparedness/emergency-response-and-climate-change.html>

# MassDEP's – Bureau of Waste Site Cleanup

## *Site Assessment & Remediation - Mitigation and Adaptation*

### **Mitigation** (Implemented)

- Reduce Greenhouse Gas (GHG) through:
  - **Green and Sustainable Remediation practices** for Assessment and remediation of OHM at sites
  - U.S. Green Building Council's **Leadership in Energy and Environmental Design (LEED)** for building construction
    - **Massachusetts #1 – most LEED-certified space per resident**
  - Green Communities Act “Stretch Energy Code” (residential, multi-family)

### **Adaptation** (ongoing)

- Ensure **resilience** in the face of climate change impacts through:
  - **Evaluating our universe of regulated sites and their vulnerability to climate change impacts**
    - “Open” sites
    - Active Remedial Systems
    - Engineered Barriers
    - AUL's

# **Boston University *Independent Study* Climate Change/Global Warming Adaptation Project**

Fall 2016

Rick Reibstein, *Lecturer*,  
Department of Earth and Environment  
Boston University

# Boston University *Independent Study*

1. Research and understanding of available authoritative resources (e.g. MassDEP, USEPA & FEMA) on climate change scenarios/impacts (e.g. Flooding, Inundation, Extreme Storms (surge), Large Snowfall, Wildfires, Drought, Extreme Heat, Landslides (precipitation))



**Plotting Sites near or within 100 & 500 year floodplains** (source: USEPA, 4/1/15)

## Boston University *Independent Study (cont.)*

2. Conduct a statewide assessment of regulated sites and their vulnerability to climate change impacts
  - “Open” sites
  - Active Remedial Systems
3. Evaluate adaptation measures available and applicable to address vulnerabilities and increase remedy resilience including available incentive programs (e.g. DOER’s resiliency program)



**Plotting Sites near or within 100 & 500 year floodplains** (source: USEPA, 4/1/15)



# **“Hazardous Waste Site Vulnerability Assessment”**

Fall 2016

*By Katelyn Tarrio*

*(with help Antonio Chidiac)*

Boston University

# Introduction

- **Current** environmental hazards facing MA

- Flooding
- Hurricanes/storm surges

- **Future** climate change hazards facing MA

- Exacerbation of flooding/hurricanes
  - Increased frequency
  - Increased severity
- Sea level rise

*Imperative to prevent additional waste site contamination spread:*

*→ Identify sites vulnerable to natural hazards*

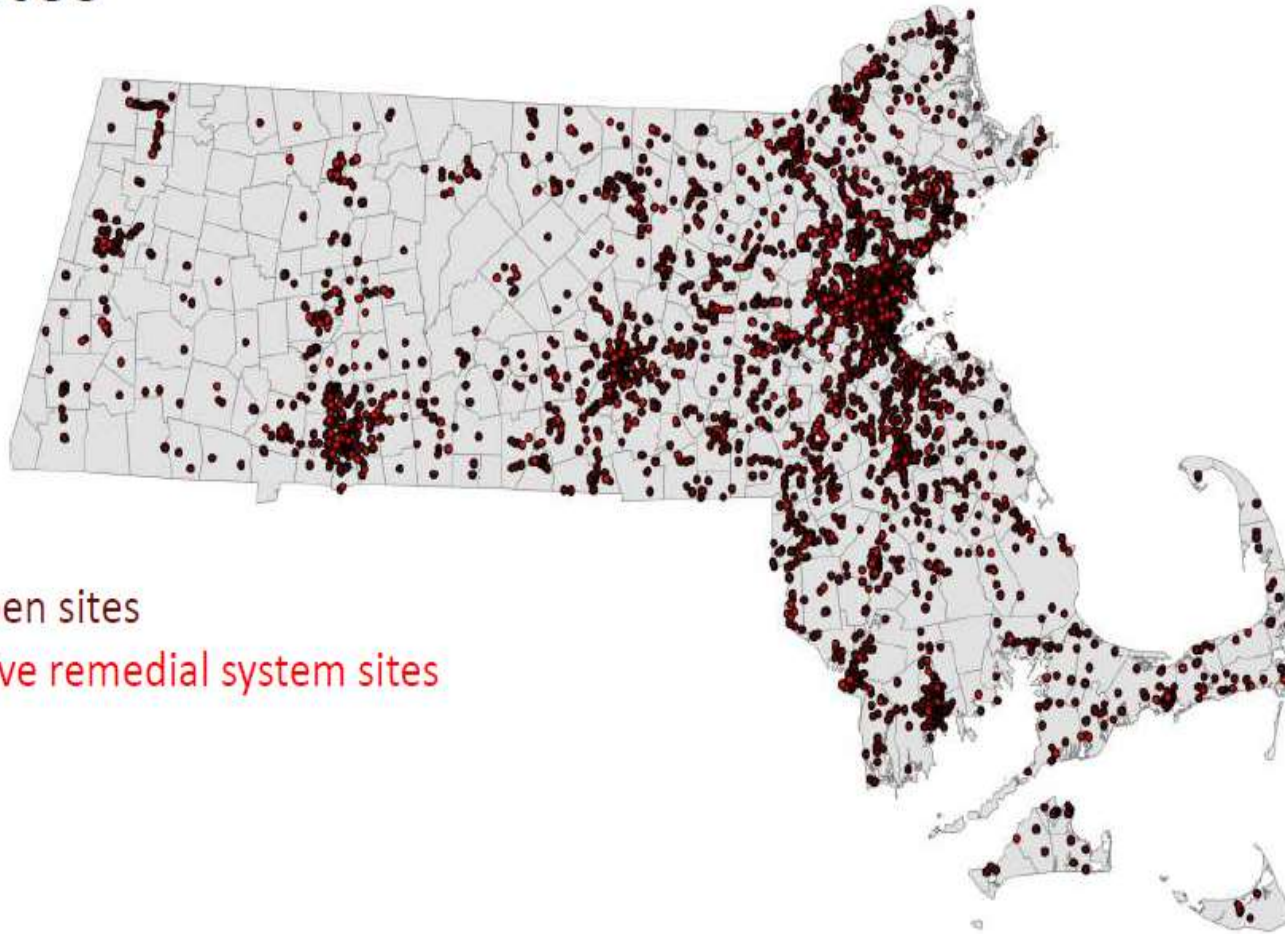


Flooded street in Marshfield, MA, after a winter storm January 27, 2015 (NBC News)

# Methods – Current Vulnerability

1. Graph waste sites
2. Create buffer zones around sites
  - EPA standard: 50 feet
3. Calculate overlap with hazard areas:
  - **Flooding** (*FEMA National Flood Hazard Layer*)
  - **Hurricanes/storm surges** (*Army Corps of Engineers Hurricane Surge Inundation Layer*)
4. Assess vulnerability
  - Identify sites with:
    - High # of environmental risks
    - High # of active remediation systems

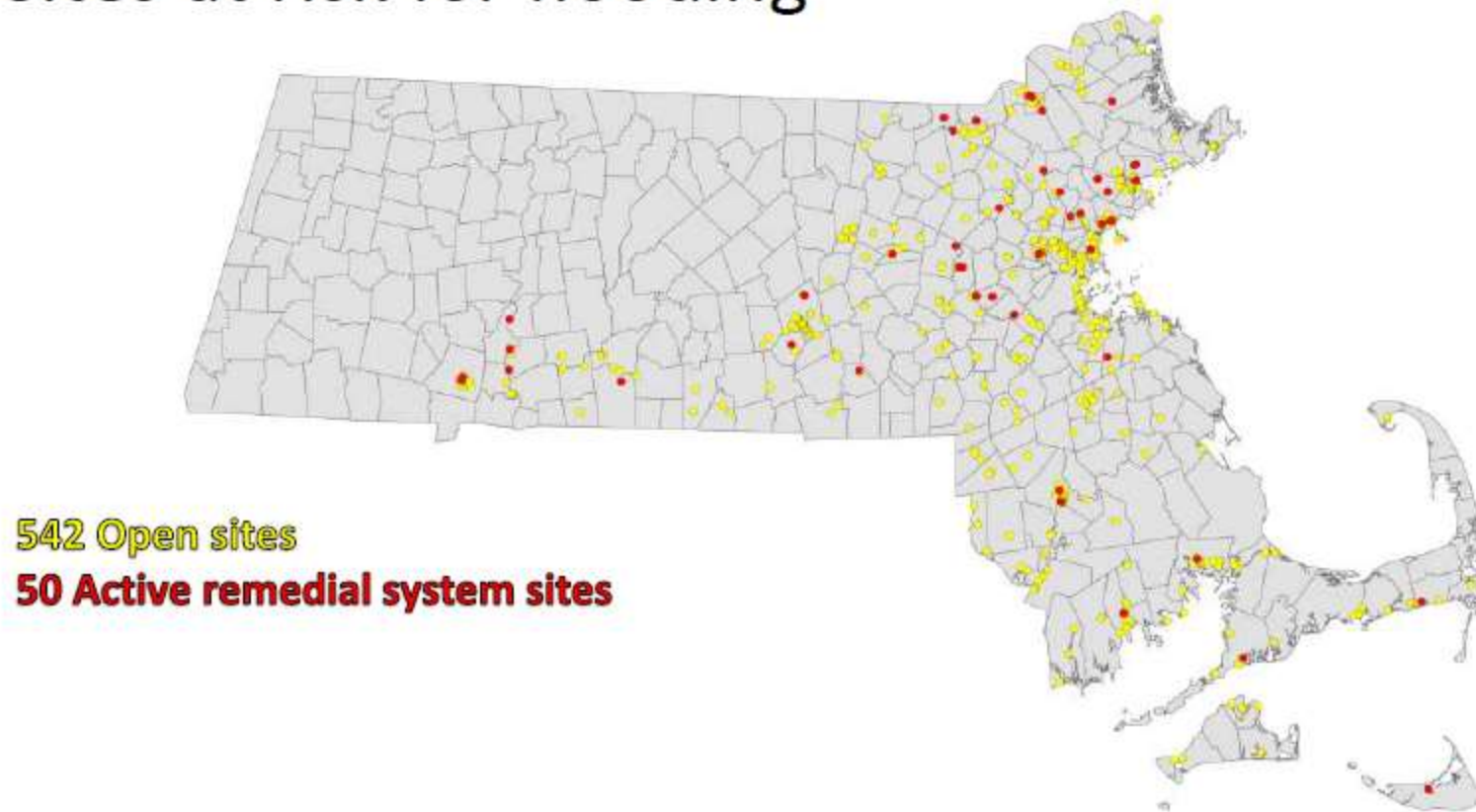
# All sites



3772 Open sites

443 Active remedial system sites

## Sites at risk for flooding

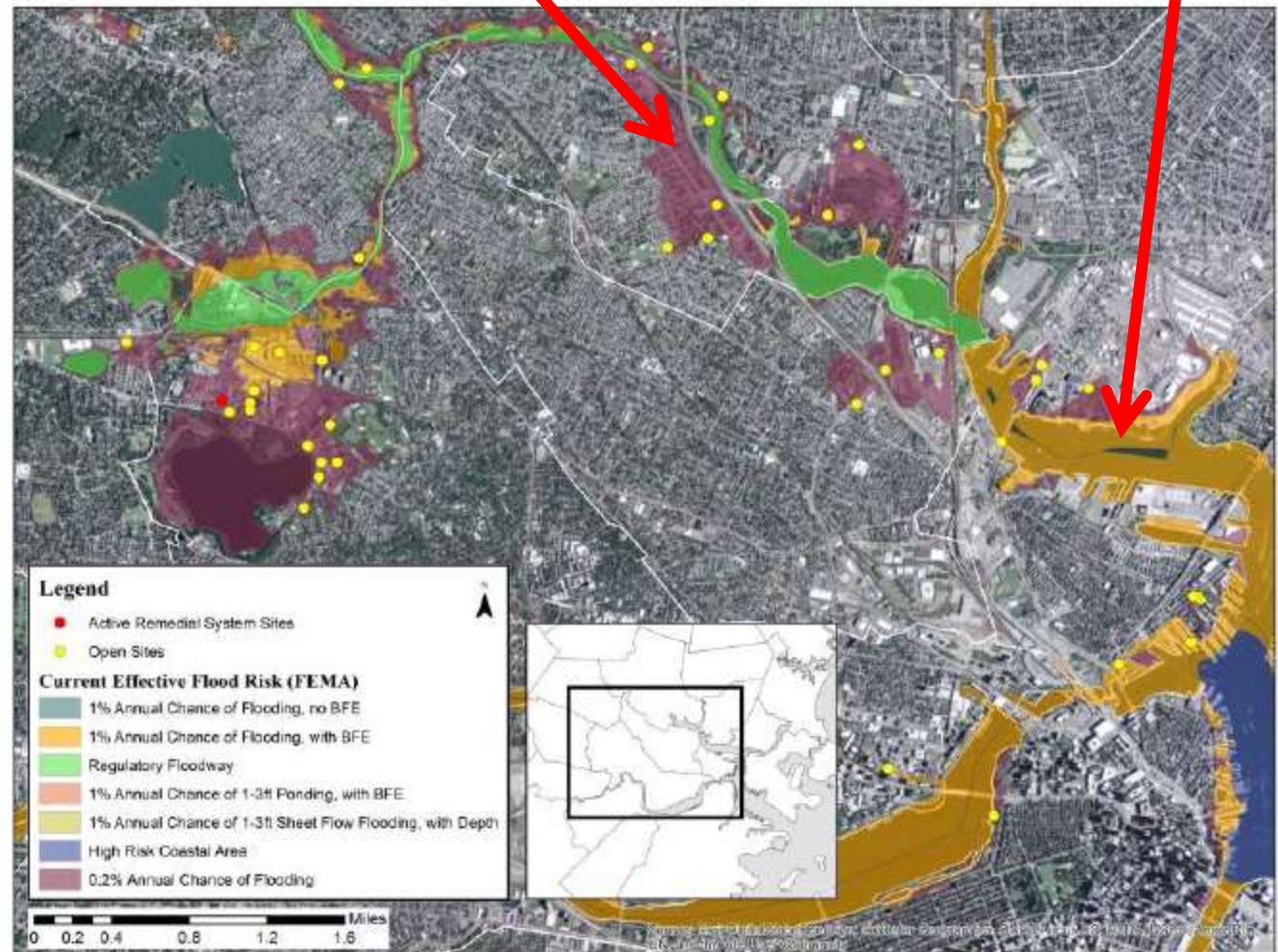




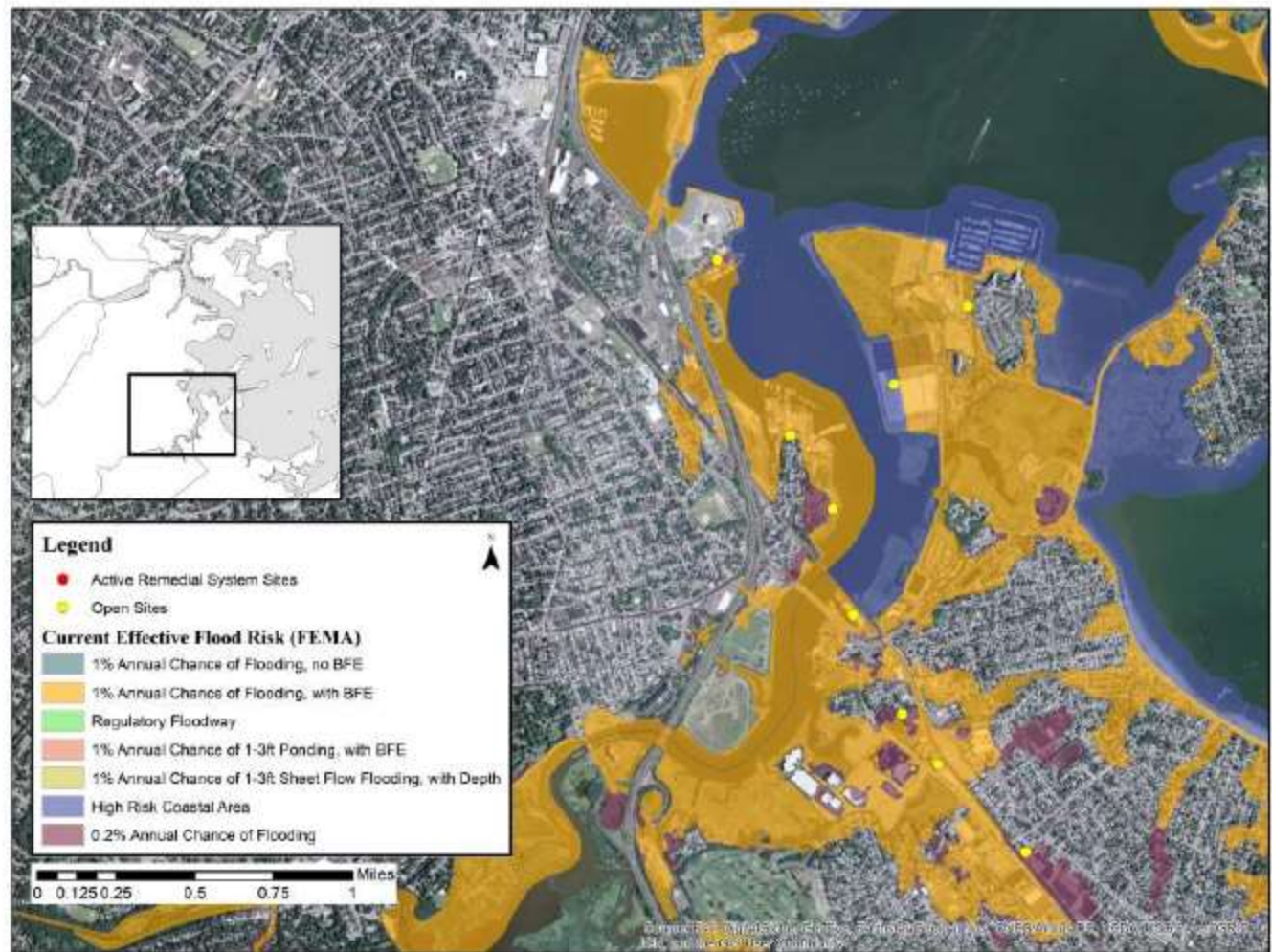
## “500 year flood”

## “100 year flood”

Cambridge,  
MA

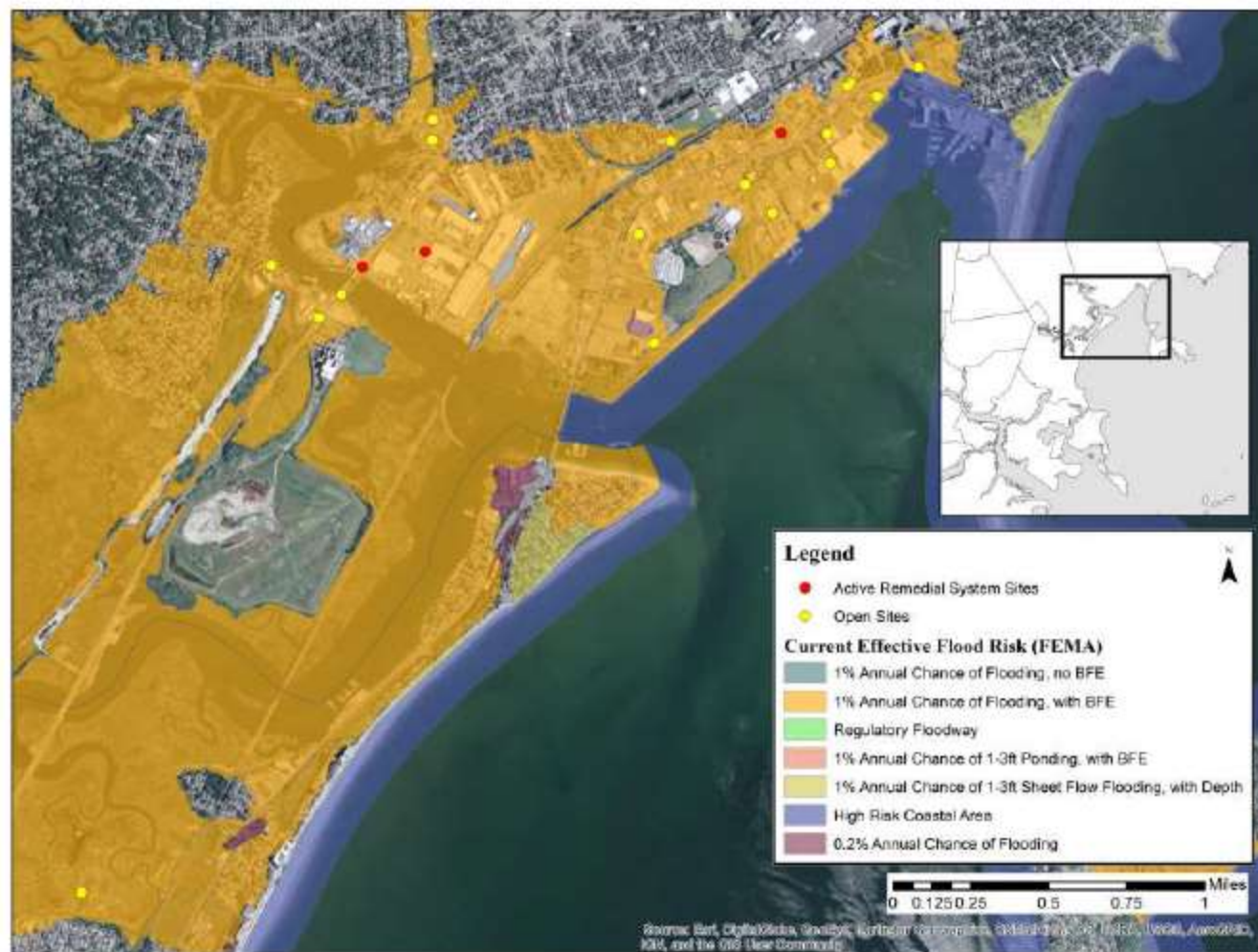


# Marina Bay, Quincy MA

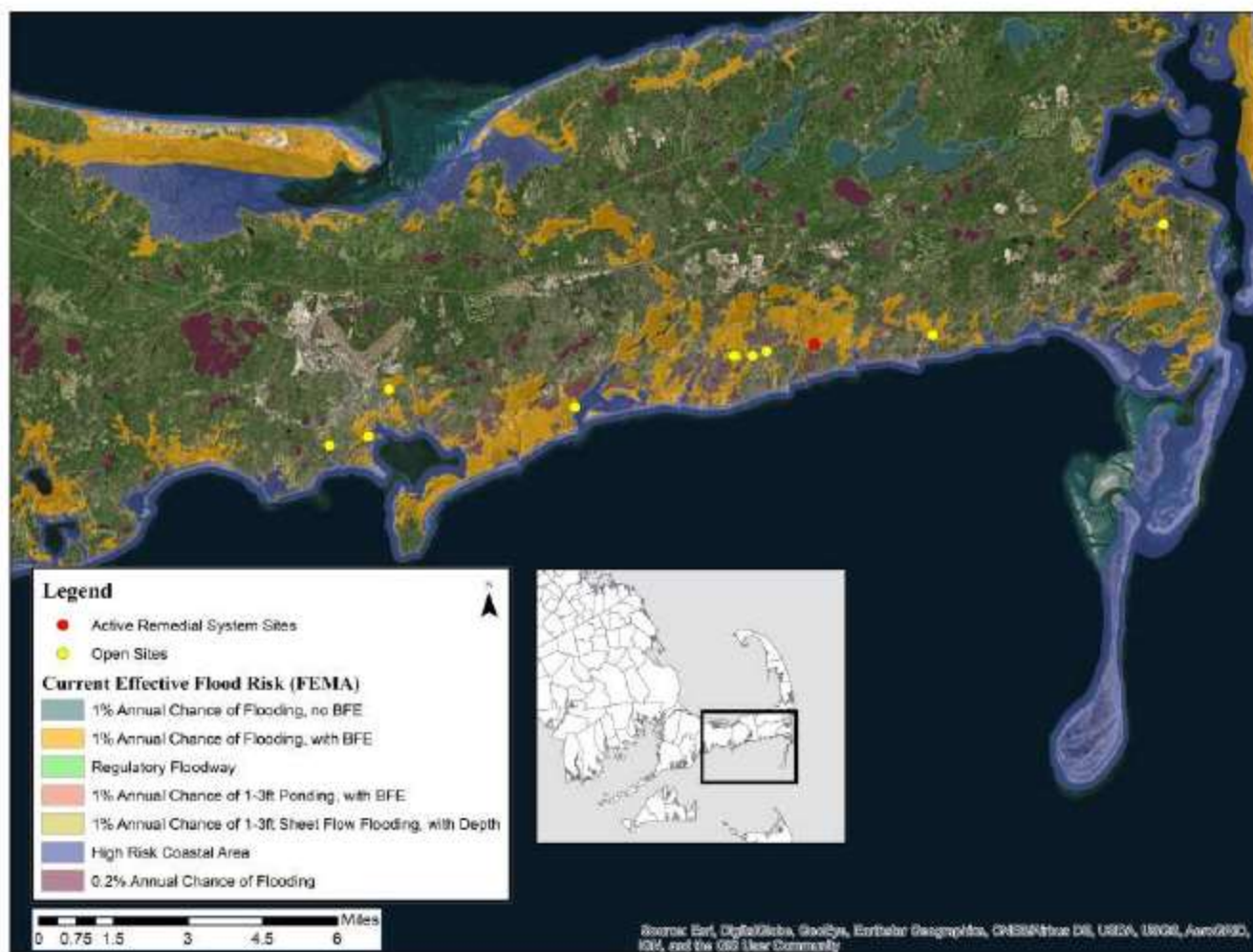




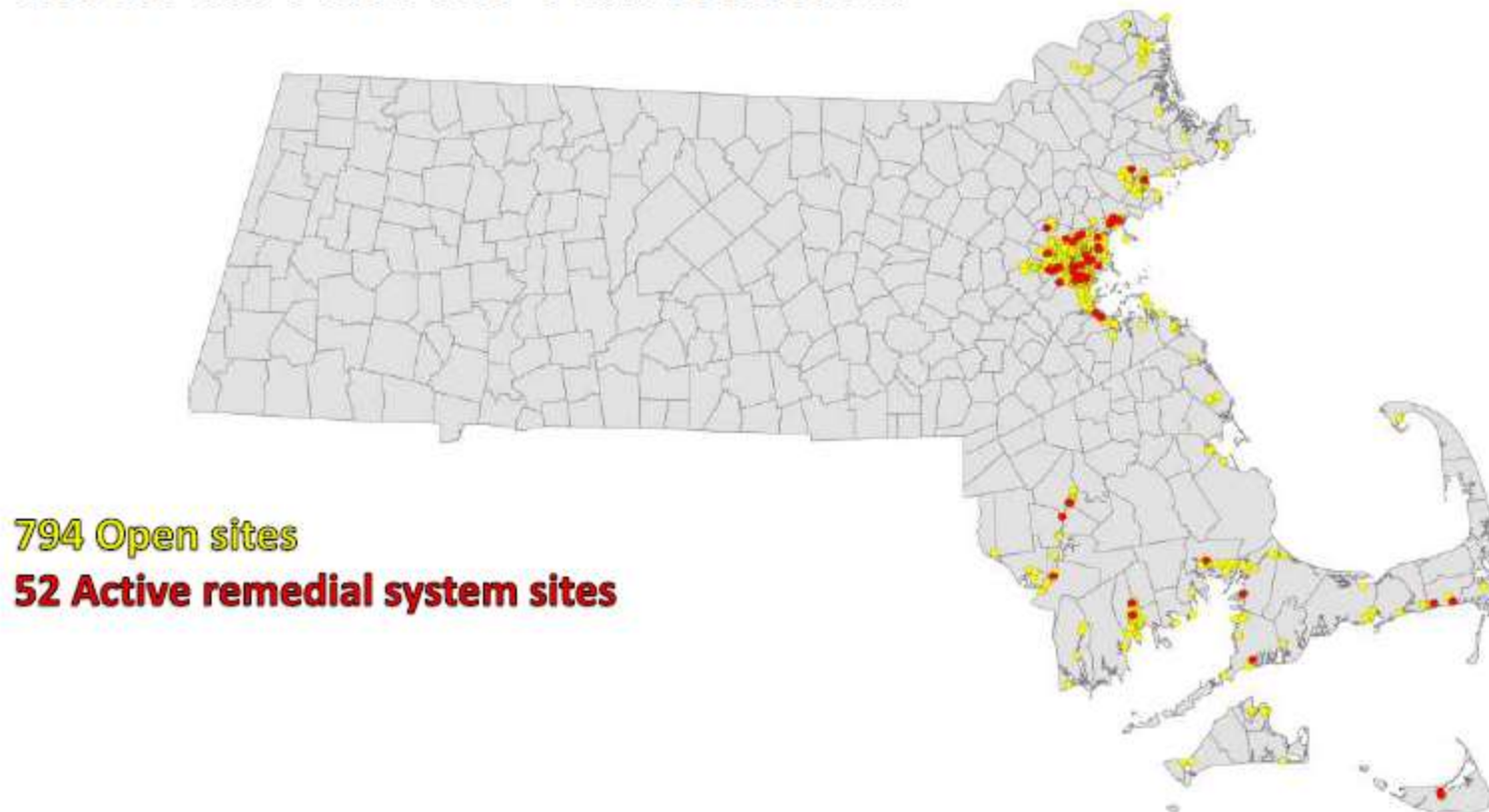
# Revere, MA



# Cape Cod, MA

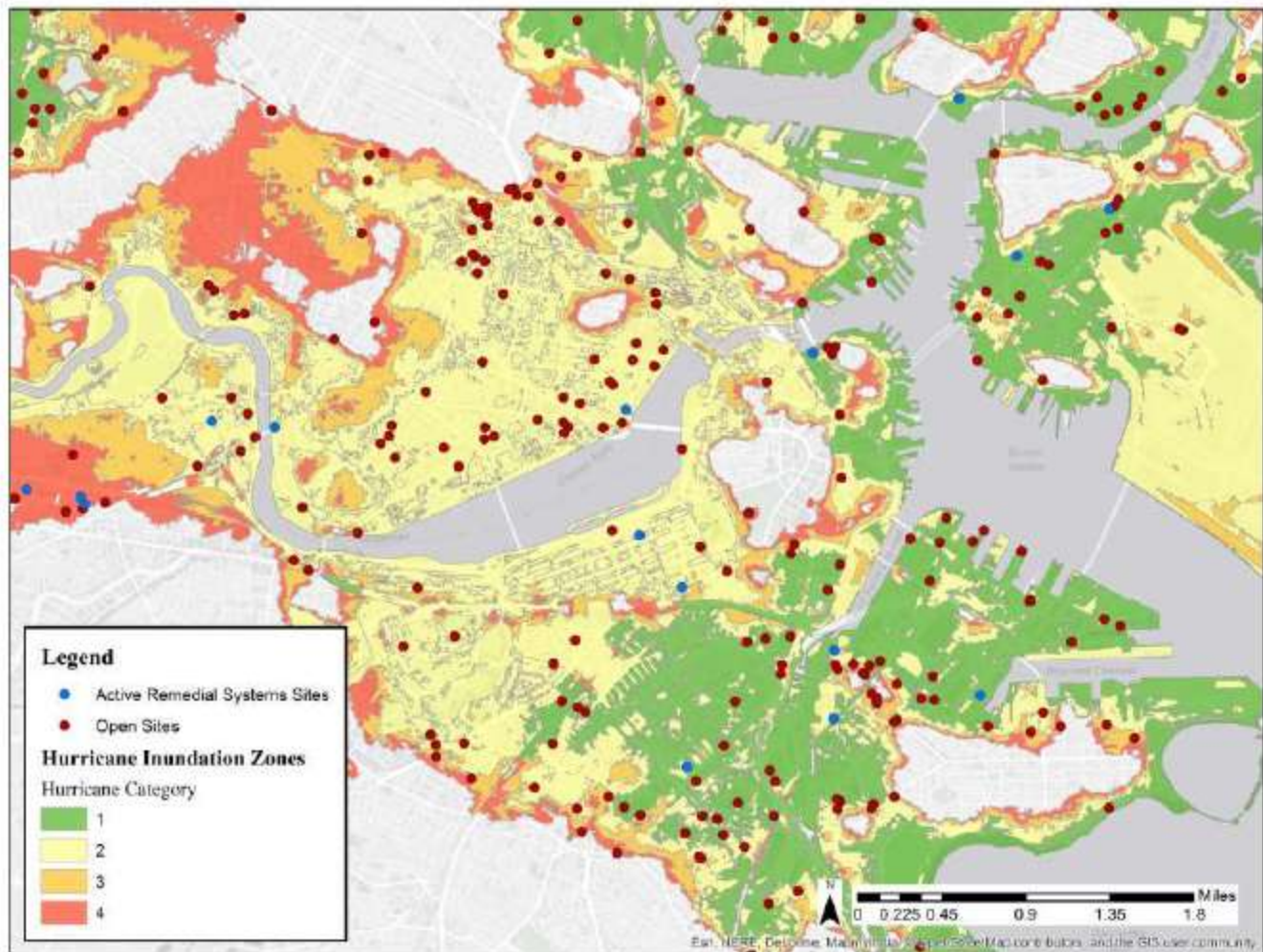


## Sites at risk for hurricanes

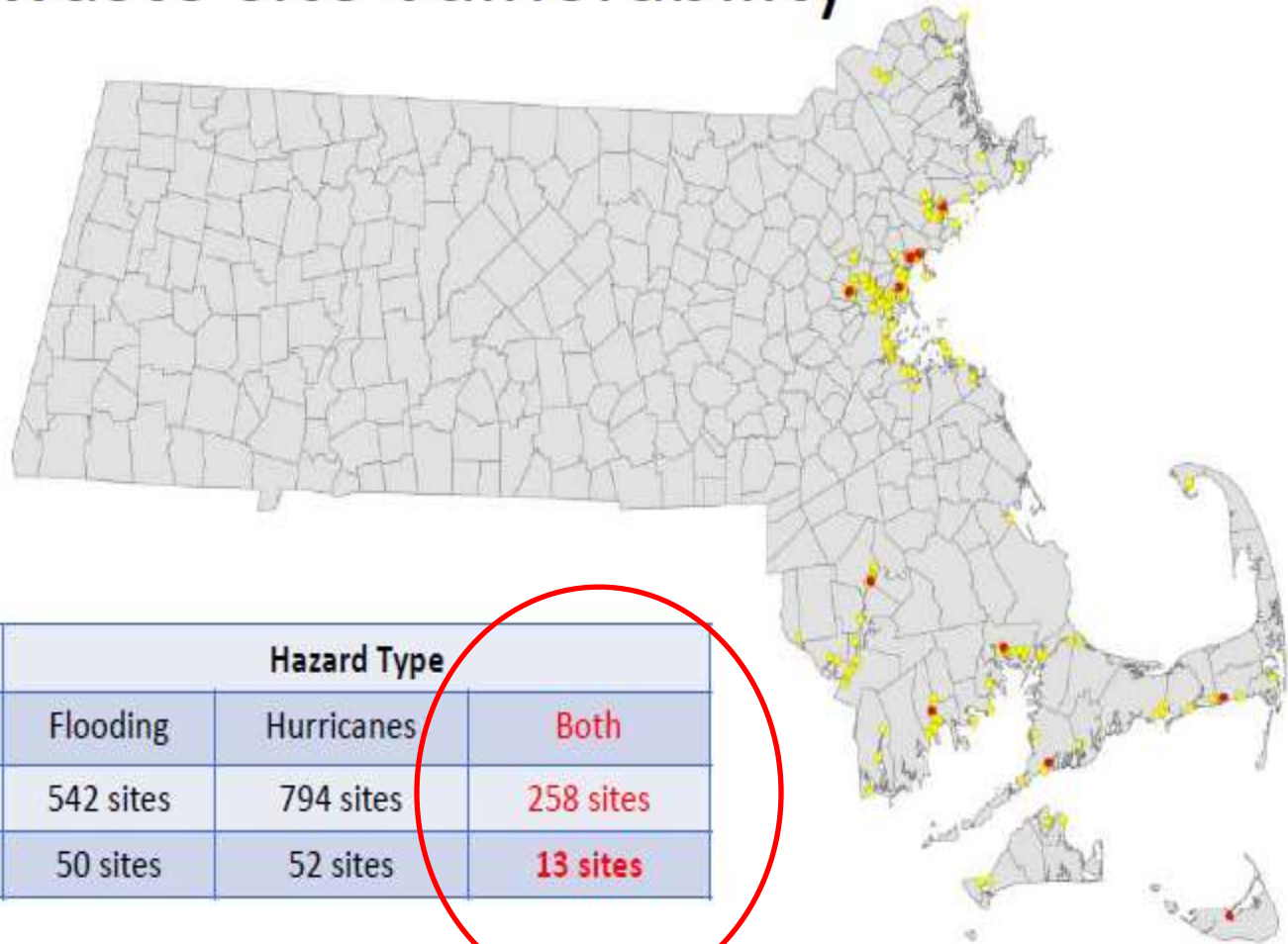




# Boston, MA



# Current waste site vulnerability



Site Type	Hazard Type		
	Flooding	Hurricanes	Both
Open Sites	542 sites	794 sites	258 sites
Active Remedial Sites	50 sites	52 sites	13 sites

# Priority sites: active remedial systems

Site Description	Region	GW Recover	SVE	Sparging	Dual phase	OHM type(s)	# Remedies
Commercial	NERO	0	1	1	0	Hazardous Material	2
Manufacturing	NERO	1	1	0	0	Oil	2
Bus Terminal	NERO	1	0	0	1	Oil	2
Bulk Petroleum Storage	NERO	1	0	0	0	Oil	1
Manufacturing	SERO	1	0	0	0	Oil	1
Fmr Gas Station	SERO	0	1	1	0	Oil	2
Residential Development	NERO	1	0	0	1	Oil and Hazardous Material	2
Gas Station	SERO	1	0	0	0	Oil	1
Fmr Manufacturing	SERO	1	0	0	0	Oil	1
Sewer Main Replacement	SERO	1	0	0	0	Oil	1
Fmr Gas Station/Bulk Fuel Oil	SERO	0	1	0	0	Oil	1
Fmr Manufacturing	NERO	0	1	0	0	Oil and Hazardous Material	1
HWY Drainage System	NERO	1	0	0	1	Oil	2

# Introduction

- **Current** environmental hazards facing MA
  - Flooding
  - Hurricanes/storm surges
- **Future** climate change hazards facing MA
  - Exacerbation of flooding/hurricanes
    - Increased frequency
    - Increased severity
  - Sea level rise

*Imperative to prevent additional waste site contamination spread:*

*→ Identify sites vulnerable to natural hazards*



Flooded street in Marshfield, MA, after a winter storm January 27, 2015 (NBC News)



# Climate change & future vulnerability

- Sea level rise:

	2030	2050	2100
Slow rise scenario	0.4 ft	0.8 ft	1.9 ft
Medium rise scenario	0.6 ft	1.3 ft	4.0 ft
Fast rise scenario	0.8 ft	1.9 ft	6.4 ft

*Localized projections from the 2014 National Climate Assessment*

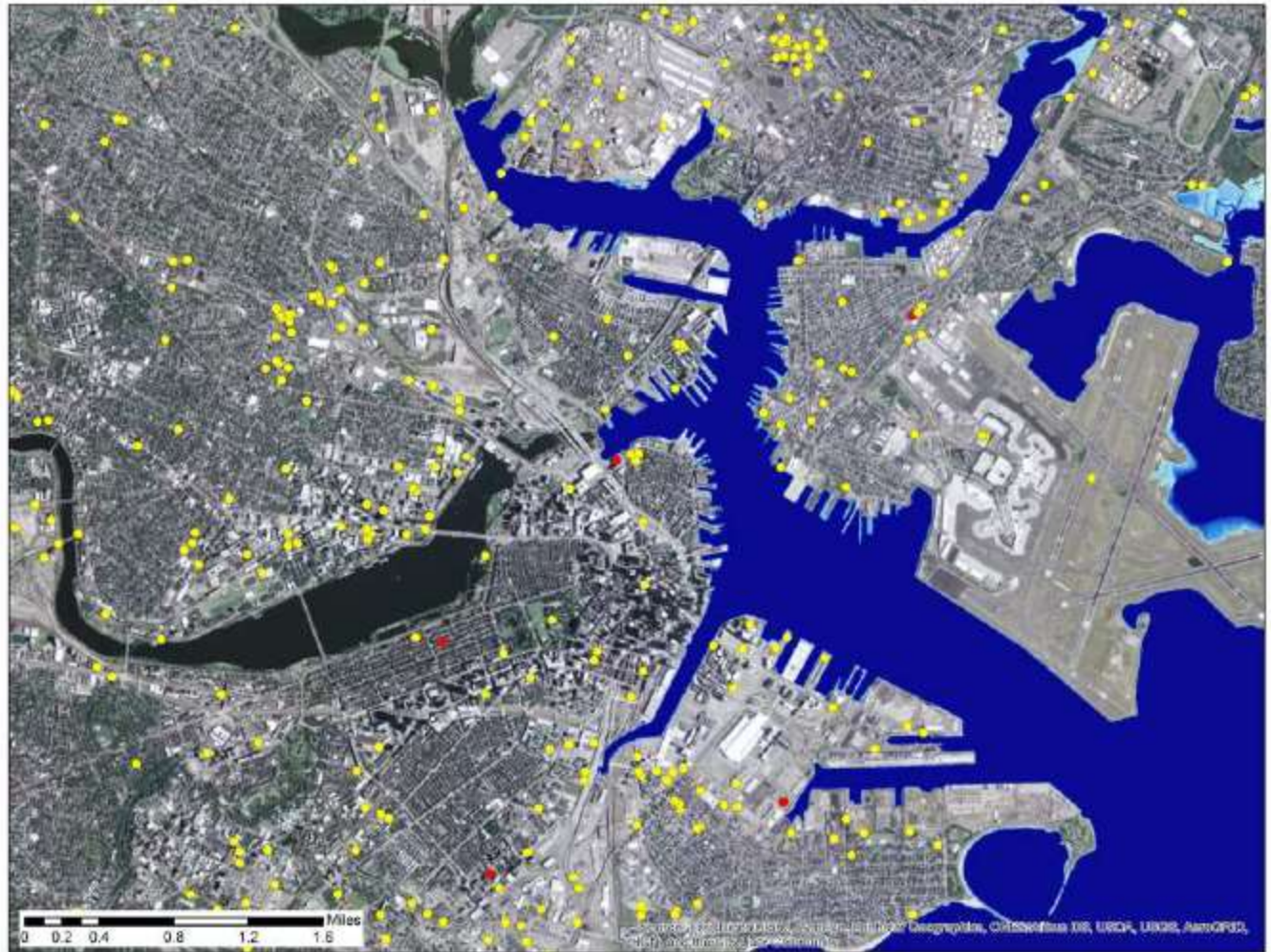
- Exacerbation of flooding/storms:
  - Increased frequency
    - 100 year flood possibly every 35 to 55 years
    - Greater occurrence of ponding
  - Increased intensity
    - Greater inundation extent
      - Floodplain expansion



Boston,  
currently

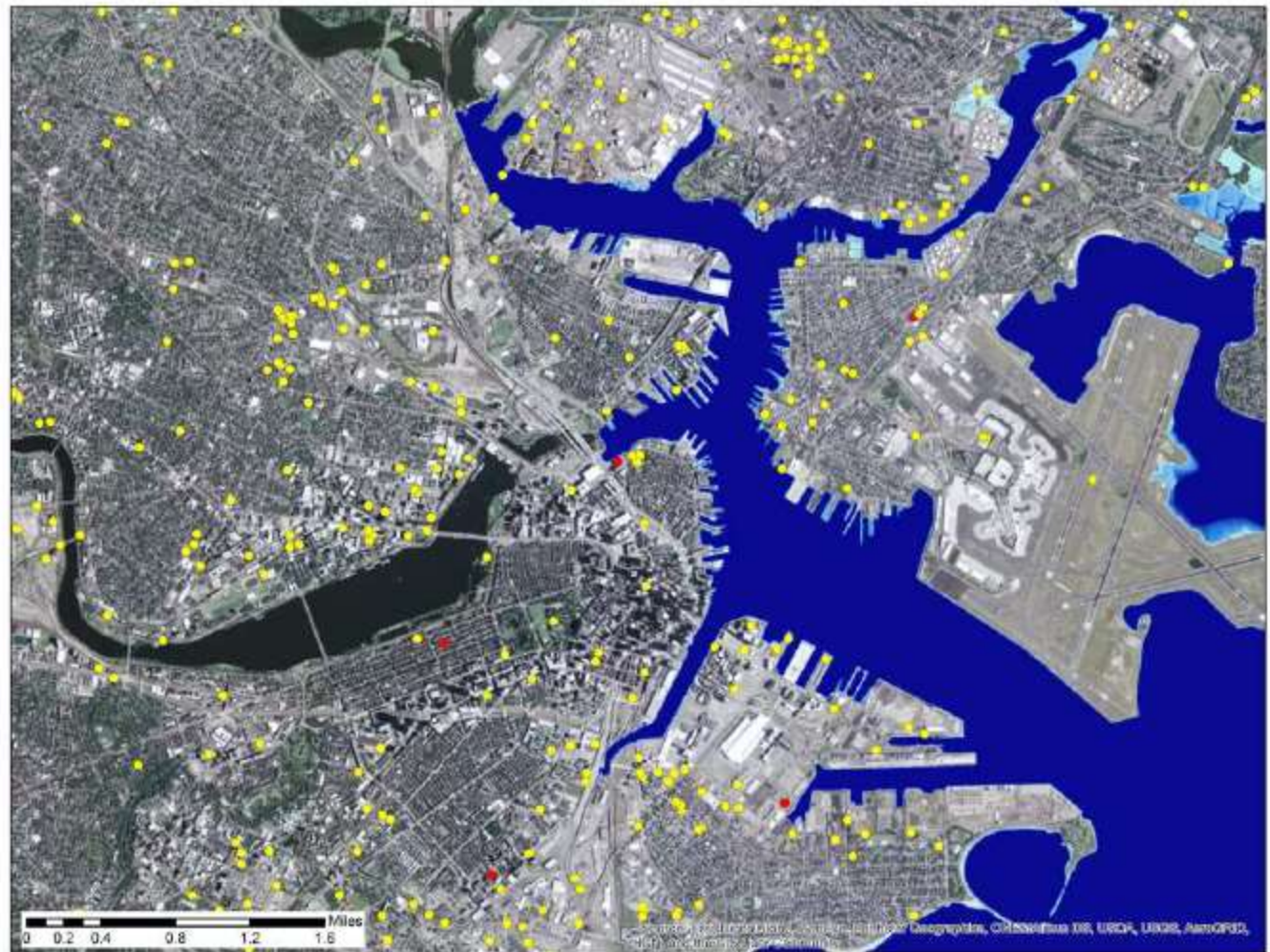


Sea level rise:  
1 foot





Sea level rise:  
2 feet

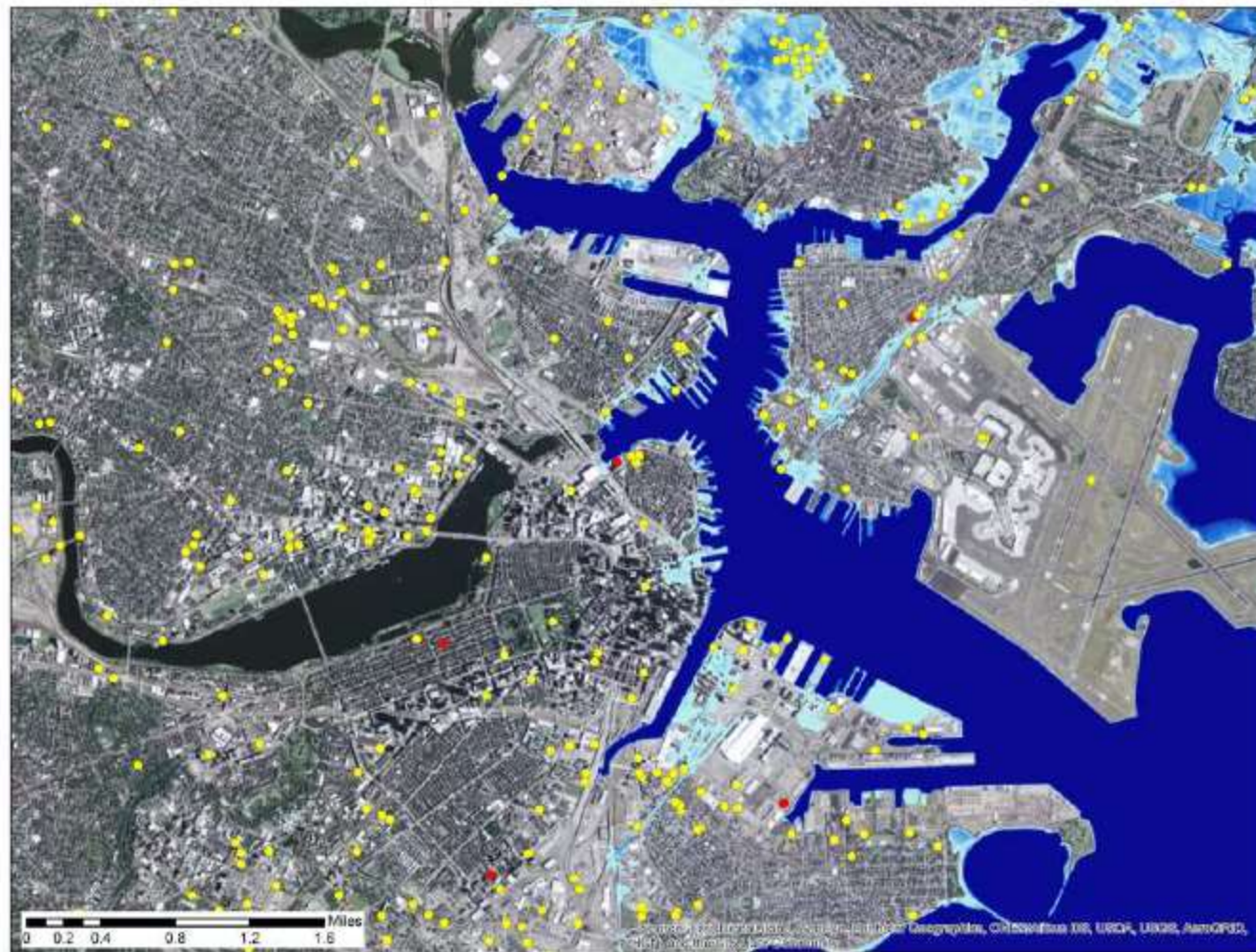


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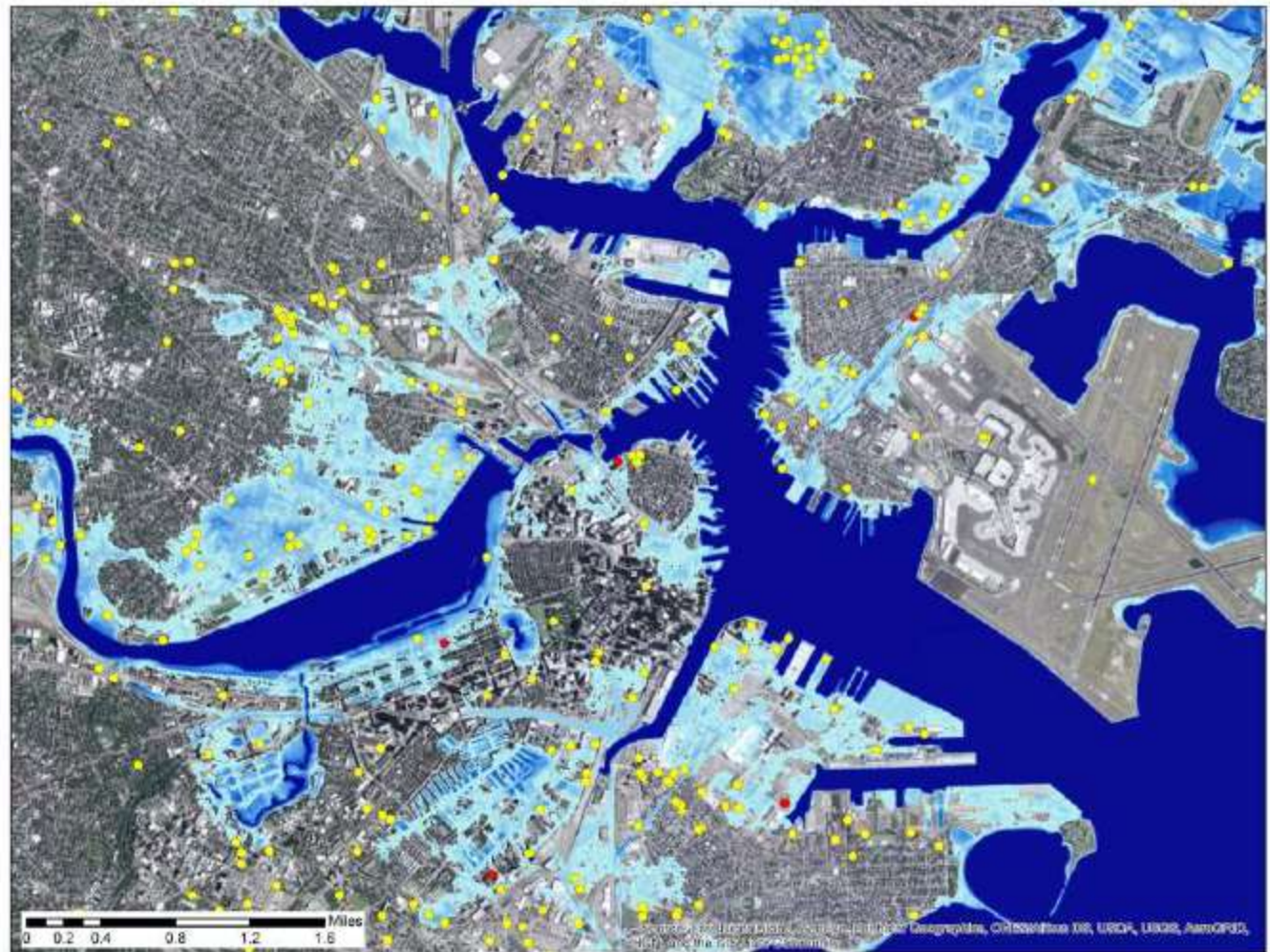


Sea level rise:  
4 feet



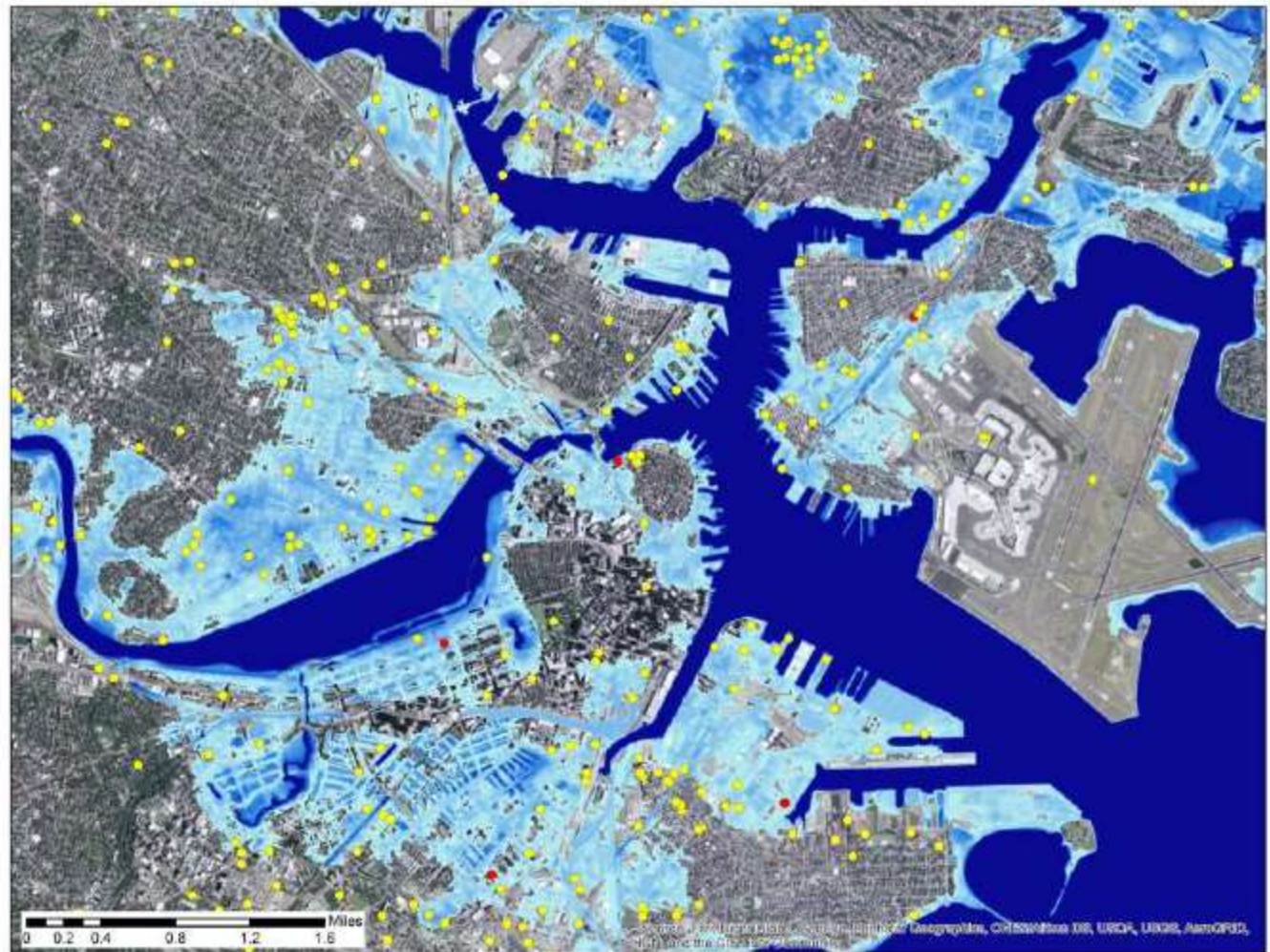


Sea level rise:  
5 feet





Sea level rise:  
6 feet



# ADAPTATION CONSIDERATIONS

- **PRIORITIZATION OF VULNERABILITIES?**
  - Drinking Water Protection
  - Indoor Air (e.g. AEPMM)
- **EVALUATING OPTIONS FOR ADAPTATION AND RESILIENCY MEASURES**
  - Physically Secure the system
    - E.g. Backup power, insulated well heads
  - Provide additional barriers to protect the system
    - E.g. flood controls, barriers
  - Alerts to project personnel of system compromises
    - E.g. alarm systems
- **INCENTIVE PROGRAMS – WHERE'S THE \$\$?**
  - DOER
  - MassCEC

# BUILDINGS: Spaulding Rehabilitation Hospital Charlestown, MA

- Opened April 27, 2013
- 8 stories, 132 beds
- Designed for 2 ft. of sea level rise as new 100-year flood elevation; first floor is 1.35 ft. higher than that
- Patient rooms have key-operable windows and are not on ground or lower floors
- Mechanical and electrical systems on the roof





# WASTE SITES: Potential Adaptation Measures

## Adaptation measures

- Treatment specific
  - Groundwater remediation
  - Landfills/containment
  - Sediment containment
- Site-specific

	Climate Change Impacts					Potential Adaptation Measures for System Components
	Temperature	Precipitation	Wind	Sea Level Rise	Wildfires	
Groundwater Extraction or Containment System		•				<b>Dewatering well system</b> <i>Installing additional boreholes at critical locations and depths to maintain target groundwater levels in the extraction/containment zone and reduce groundwater upwelling while not compromising the remediation system</i>
	•	•	•	•	•	<b>Remote access</b> <i>Integrating electronic devices that enable workers to suspend pumping during extreme weather events, periods of impeded access, or unexpected hydrologic conditions</i>
	•	•	•			<b>Well-head housing</b> <i>Building insulated cover systems made of high density polyethylene or concrete for control devices and sensitive equipment situated aboveground for long periods</i>
Aboveground Components of the Treatment System	•	•	•	•	•	<b>Alarm networks</b> <i>Integrating a series of sensors linked to electronic control devices that trigger shutdown of the system, or linked to audible/visual alarms that alert workers of the need to manually shut down the system, when specified operating or ambient parameters are exceeded</i>
		•	•	•		<b>Coastal hardening</b> <i>Building "soft" seawalls (through techniques such as replenishing sand and/or vegetation), jetties or groins to stabilize and shield a shoreline from erosion; in some cases, "hard" seawalls (such as those made of reinforced concrete) may be warranted</i>
	•	•		•		<b>Concrete pad fortification</b> <i>Repairing concrete cracks, replacing pads of insufficient size or with insufficient anchorage, or integrating retaining walls along the pad perimeter</i>
					•	<b>Fire barriers</b> <i>Creating buffer areas (land free of dried vegetation and other flammable materials) around the treatment system and installing manufactured systems (such as radiant energy shields and raceway fire barriers) around heat-sensitive components</i>
		•		•		<b>Flood controls</b> <i>Building one or more structures to retain or divert floodwater, such as vegetated berms, drainage swales, levees, dams or retention ponds</i>
	•	•	•	•	•	<b>Power from off-grid sources</b> <i>Constructing a permanent system or using portable equipment that provides power generated from onsite renewable resources, as a primary or redundant power supply that can operate independent of the utility grid when needed</i>
		•	•	•		<b>Relocation</b> <i>Moving the system or its critical components to positions more distant or protected from potential hazards; for flooding threats, this may involve elevations higher than specified in the community's flood insurance study</i>

EPA Climate Change Adaptation Factsheet – Groundwater remediation systems

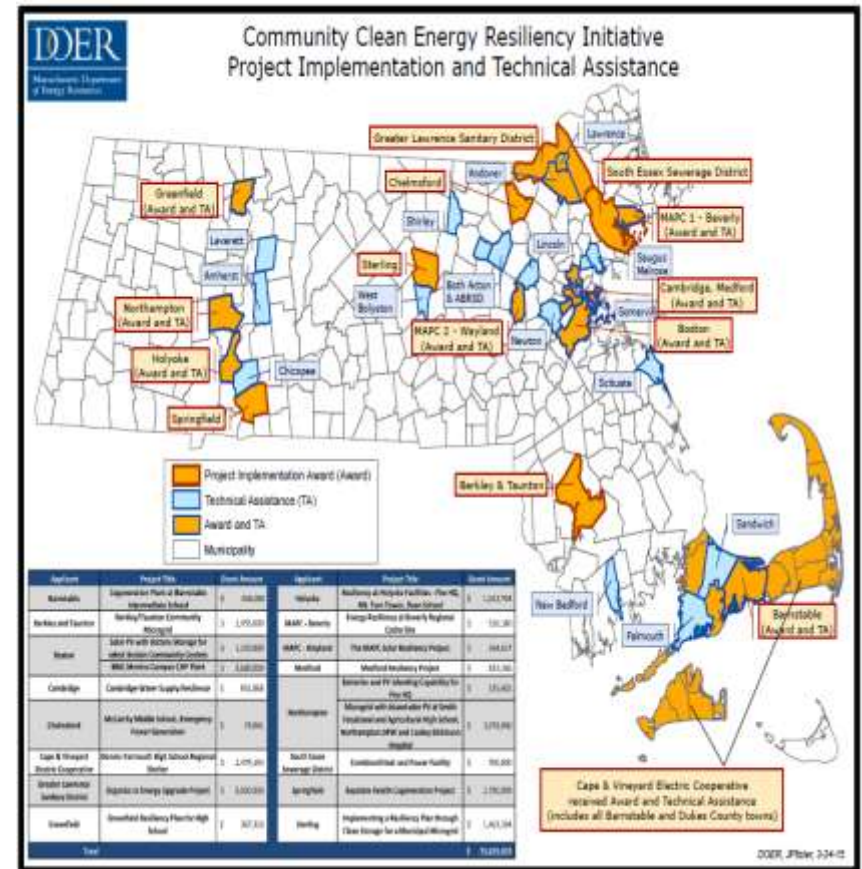
# WASTE SITES: Potential Adaptation Measures

## Groundwater P&T:

- **Power from off-grid sources** - *Constructing a permanent system or using portable equipment that provides power generated from onsite renewable resources, as a primary or redundant power supply that can operate independent of the utility grid when needed*
- **Flood controls** - *Building one or more structures to retain or divert floodwater, such as vegetated berms, drainage swales, levees, dams or retention ponds*
- **Remote access** - *Integrating electronic devices that enable workers to suspend pumping during extreme weather events, periods of impeded access, or unexpected hydrologic conditions*

# DOER's Community Clean Energy Resiliency Initiative

- \$40 million initiative
- Commonwealth's broader climate adaptation and mitigation efforts
- Grant program focused on municipal resilience
- Use of clean energy technology solutions to protect communities from interruptions in energy services due to severe climate events made worse by the effects of climate change.



## Example: Clean Energy Resiliency

Applicant	Project Title	Grant Amount	Applicant	Project Title	Grant Amount
Barnstable	Cogeneration Plant at Barnstable Intermediate School	\$ 406,000	Holyoke	Resiliency at Holyoke Facilities - Fire HQ, Mt. Tom Tower, Dean School	\$ 1,013,794
Berkley and Taunton	Berkley/Taunton Community Microgrid	\$ 1,455,000	MAPC - Beverly	Energy Resiliency at Beverly Regional Cache Site	\$ 526,180
Boston	Solar PV with Battery Storage for select Boston Community Centers	\$ 1,320,000	MAPC - Wayland	The MAPC Solar Resiliency Project	\$ 264,627
	BMC Menino Campus CHP Plant	\$ 3,680,000	Medford	Medford Resiliency Project	\$ 833,366
Cambridge	Cambridge Water Supply Resilience	\$ 851,868	Northampton	Batteries and PV Islanding Capability for Fire HQ	\$ 525,401
Chelmsford	McCarthy Middle School, Emergency Power Generation	\$ 74,941		Microgrid with Island-able PV at Smith Vocational and Agricultural High School, Northampton DPW and Cooley Dickinson Hospital	\$ 3,078,960
Cape & Vineyard Electric Cooperative	Dennis-Yarmouth High School Regional Shelter	\$ 1,479,193	South Essex Sewerage District	Combined Heat and Power Facility	\$ 700,000
Greater Lawrence Sanitary District	Organics to Energy Upgrade Project	\$ 5,000,000	Springfield	Baystate Health Cogeneration Project	\$ 2,790,099
Greenfield	Greenfield Resiliency Plan for High School	\$ 367,310	Sterling	Implementing a Resiliency Plan through Clean Storage for a Municipal Microgrid	\$ 1,463,194
Total					\$ 25,829,933



# MassCEC Resilient Service Stations Challenge

## Seeking “Concept Paper”

- InnovateMass will provide funding (\$250K - \$75/per) for projects that **deploy commercially viable energy resilience technologies** providing measureable energy resilience, risk management, clean energy and/or climate benefits to Massachusetts service stations, enabling these facilities to provide critical goods and services to the communities they **serve during extended electric grid failures**.
- **Consideration for OHM remedial systems at service stations**
- **DUE: 7/14/17 @ 4:00 PM**

## Project Examples

- City of Boston Installed solar plus storage at refueling locations
- British petroleum installed solar PV on canopies over fueling areas.
- Boston Evacuation Routes (e.g. Blue Hill Ave) installed solar panels and battery storage at key intersections to maintain traffic signals

# Massachusetts Climate Change Resources

## Massachusetts Executive Office of Energy and Environmental Affairs – Climate Change Adaptation

- <http://www.mass.gov/eea/waste-mgmt-recycling/air-quality/climate-change-adaptation/>

## Governor's Executive Order No. 569

- <http://www.mass.gov/governor/press-office/press-releases/fy2017/gov-baker-signs-climate-change-strategy-executive-order.html>

## MassDEP Climate & Clean Energy

- <http://www.mass.gov/eea/agencies/massdep/climate-energy/climate/>

## Department of Energy Resources – Climate Resiliency

- <http://www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/resiliency/resiliency-initiative.html>

## Massachusetts Clean Energy Center – Service Station Resiliency

- <http://www.masscec.com/request-proposals-resilient-stations-challenge>

# Thank You!

**Thomas M. Potter**

**Clean Energy Development Coordinator**

MassDEP Bureau of Waste Site Cleanup

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**Climate & Clean Energy Program Website:**

<http://www.mass.gov/eea/agencies/massdep/climate-energy/>