



MCP Climate Change Toolkit

Table of Contents

Introduction

1 - Climate Change Evaluation Flowchart

2 - Vulnerability Assessment Checklist (Excel Download)

3 - Case Study 1

- Case Study 1 – Coast LNAPL
- Case Study 1 – Coast LNAPL Screenshots
- Case Study 1 - Vulnerability Assessment Checklist (Excel Download)

3 - Case Study 2

- Case Study 2 - River Flooding
- Case Study 2 – River Flooding Screenshots
- Case Study 2 - Vulnerability Assessment Checklist (Excel Download)

4- MCP Climate Change Glossary of Terms

5 - Climate Change Technical Resources



assess.
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MCP Climate Change Toolkit

January 2024

1 Introduction

This toolkit was developed by the LSP Association (LSPA) Climate Change Subcommittee to assist waste site cleanup practitioners as they consider the potential effects of climate change on site assessment and the selection and implementation of cleanup response actions as required by the 2023 amendments to the Massachusetts Contingency Plan (MCP); 310 CMR 40.0000. The tools in this document are available for use in all phases of the remediation process under the MCP and can be customized to meet the needs of individual sites. The tools are intended to support consideration of climate change with respect to MCP response actions but should not be considered policy and are not a replacement for application of professional judgment on the part of the Licensed Site Professional (LSP)-of-record for an MCP Site. Parties using this toolkit should be aware that there may be other acceptable alternatives for considering and documenting impacts associated with climate change. This toolkit was developed and is maintained by the LSPA, which retains primary authorship. It is meant to work in concert with MassDEP's Q&A document on Climate Change.

The tools are reflective of the framework defined in the 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan (the SHMCAP), as well as the updated September 2023 SHMCAP ([2023 ResilientMass Plan | Mass.gov](#)). The SHMCAP accounts for projected changes in precipitation and temperature, sea level rise, and extreme weather events, and aims to reduce the risks associated with natural hazards and the effects of climate change. The SHMCAP and related resources can be found at the [MA Climate Change Clearinghouse \(mass.gov\)](#).

1.1 MCP Revisions/Regulatory Setting

On September 16, 2016, Governor Charlie Baker issued Executive Order 569, establishing an Integrated Climate Change Strategy for the Commonwealth. The Executive Order included, in part, requirements for development of the SHMCAP and supporting frameworks that state agencies, cities, and towns can use to assess and adapt to climate change. The MCP Amendments incorporate language to apply the goals of Executive Order 569 to the waste site cleanup process. The MCP language directs persons conducting cleanups to identify and assess foreseeable climate impacts that may affect the permanency and protectiveness of the cleanup at vulnerable sites and take reasonable measures to reduce vulnerabilities.

The climate change-related revisions to the MCP are reflected by the **blue** text in the following sections:

- The definition of Conceptual Site Model (CSM) in 310 CMR 40.0006 is revised as follows:
“Conceptual Site Model or CSM means a site-specific description of how contaminants entered the environment, how contaminants have been and may be transported within the environment, and routes of exposure to human and environmental receptors that provides a dynamic framework for assessing **current and foreseeable future** site characteristics and risk, identifying and addressing data gaps and managing uncertainty, eliminating or controlling

MCP Climate Change Toolkit

January 2024

contaminant sources, developing and conducting response action strategies, and evaluating whether those strategies have been effective in achieving desired endpoints. At sites at which NAPL is or may be present, this includes the body of fundamental scientific principles describing the behavior of fluid flow in porous media necessary to assess NAPL in subsurface strata.”

- The Response Action Performance Standard (RAPS) in 310 CMR 40.0191 is revised as follows:
 - “(1) The Response Action Performance Standard (RAPS) is the level of diligence reasonably necessary to obtain the quantity and quality of information adequate to assess a site and evaluate remedial action alternatives, and to design and implement specific remedial actions at a disposal site to achieve a level of No Significant Risk for any foreseeable period of time, **as defined at 310 CMR 40.1005**, and, where feasible, to reduce to the extent possible the level of oil and/or hazardous materials in the environment to background levels.
 - (2) RAPS shall be employed during the performance of all response actions conducted pursuant to 310 CMR 40.0000, and shall include, without limitation, the following:
 - (a) consideration of relevant policies and guidelines issued by the Department, **EOEEA** and EPA;
 - (b) use of accurate and up-to-date methods, **models**, standards and practices, equipment and technologies which are appropriate, available and generally accepted by the professional and trade communities conducting response actions in accordance with M.G.L. c. 21E and 310 CMR 40.0000 under similar circumstances; and
 - (c) investigative practices which are scientifically defensible, and of a level of precision and accuracy commensurate with the intended use of the results of such investigations.
 - (3) The application of RAPS shall be protective of health, safety, public welfare and the environment and shall include, without limitation, in the context of meeting the requirements of this Contingency Plan, consideration of the following:
 - (a) technologies which reuse, recycle, destroy, detoxify or treat oil and/or hazardous materials, where feasible, to minimize the need for long-term management of contamination at or from a disposal site;
 - (b) containment measures as feasible Permanent Solutions only where reuse, recycling, destruction, detoxification and treatment are not feasible;
 - (c) remedial actions to reduce the overall mass and volume of oil and/or hazardous material at a disposal site to the extent feasible, regardless of whether it is feasible to achieve one or more Temporary Solutions and/or Permanent Solutions or whether it is feasible to achieve background for the entire disposal site and not include the dilution of contaminated media with uncontaminated media;
 - (d) response actions to restore groundwater, where feasible, to the applicable standards of quality within a reasonable period of time to protect the existing and potential uses of such resources;
 - (e) eliminating or reducing, to the extent practicable and consistent with response action requirements and objectives, total energy use, air pollutant emissions, greenhouse gases, water use, materials consumption, and ecosystem and water resources impacts, resulting from the performance of response actions through energy efficiency, renewable energy use, materials management, waste reduction, land management, and ecosystem protection; **and**

MCP Climate Change Toolkit

January 2024

(f) response actions that incorporate climate change resilience to the extent practicable and consistent with response action requirements."

- The "Foreseeable Period of Time" for a Permanent Solution at 301 CMR 40.1005 is further defined as follows: "(1) A Permanent Solution shall ensure a level of control of each identified substance of concern at a site or in the surrounding environment such that no such substance of concern shall present a significant risk of harm to health, safety, public welfare or the environment during any foreseeable period of time, **considering existing site conditions and reasonably foreseeable future changes in site conditions, including anticipated impacts associated with climate change.**"

Collectively, the above revisions provide a framework to consider, based on models and resources developed through Executive Office of Energy and Environmental Affairs (EEA) and other government resources, the vulnerability of the release site to climate change and the need for adaptation to address such vulnerability.

1.2 Toolkit Applicability

The tools and references are applicable to MCP cleanup sites regardless of the site setting, location, or type of oil and/or hazardous materials (OHM) released to the environment. The tools can support the development of the CSM and evaluation of response actions at any stage of the MCP process but will be most helpful when applied during development of the CSM and throughout the selection and design of comprehensive response actions. Where short term response actions such as Release Abatement Measures (RAMs) and Immediate Response Actions (IRAs) are typically implemented within a timeframe much less than the timeframes for sustained climate change effects, it is nevertheless applicable in some circumstances to incorporate climate change considerations when the outcome of the RAM or IRA will become all or part of a Permanent Solution.

The climate change toolkit is an on-line resource for waste site cleanup practitioners and is meant to work in concert with the models, data and references available online at [MA Climate Change Clearinghouse \(mass.gov\)](#), which provides the best available resource on expected climate changes in the Commonwealth as identified by EEA and is the primary resource for this work.

Whenever possible, this toolkit includes live links to these resources, which provide a living, regularly updated means to support and inform consideration of climate change. Note that the resources accessible through [MA Climate Change Clearinghouse \(mass.gov\)](#) are not specific to MCP response actions; rather they are utilized by a broad range of stakeholders, including municipalities, cities and towns assessing community vulnerability and state departments and agencies engaged in development and infrastructure projects in the Commonwealth. Consequently, the use of professional judgement on the part of the LSP is needed when developing and applying the [2023 ResilientMass Plan](#) outputs.

MCP Climate Change Toolkit

January 2024

2 Toolkit Components

This toolkit includes the following tools to support the consideration of climate change in the MCP process:

- MassDEP's Climate Change Q&A
- MCP Climate Change Evaluation Flowchart
- Vulnerability Assessment Checklist
- Case Studies
- MCP Climate Change Glossary of Terms and Technical Resources

The following sections provide a summary of each of these tools.

2.1 Climate Change Q&A

MassDEP's Climate Change Q&A, incorporated here by reference, should be considered by LSPs as the primary guideline for approaching climate change at MCP sites. It provides a set of frequently asked questions about climate considerations in the MCP process. The Q&A was compiled by MassDEP Bureau of Waste Site Cleanup (BWSC) from a set of questions submitted by LSPs, waste site cleanup practitioners and other interested parties, and the responses were developed by MassDEP BWSC. The goal of the Q&A is to clarify when and how climate change considerations are to be incorporated into MCP deliverables, the application of reasonably foreseeable future site attributes in the context of climate change, and the potential climate-driven changes to MCP decision making.

2.2 MCP Climate Change Evaluation Flowchart

Attachment 1 is a flow chart for evaluating MCP sites to help determine whether or not a more detailed vulnerability assessment may be necessary. The flowchart illustrates how the site setting, contaminant type, and fate and transport factor into the level of detail required in a vulnerability assessment.

2.3 Vulnerability Assessment Checklist

The vulnerability assessment checklist (**Attachment 2**) provides a series of questions to consider in the process of assessing the vulnerability of an MCP site to climate change. The checklist provides a broad range of considerations structured to prompt the LSP to look at each of the four primary exposure parameters in the SHMCAP (precipitation, sea level rise, extreme weather, and temperature change) for the site, along with the potential effects of climate change on groundwater. Not all sections of the checklist will necessarily apply to each cleanup site. The checklist includes links to predictive model outputs and location-specific databases available through the [ResilientMass Climate Hub \(arcgis.com\)](https://www.arcgis.com) which can inform and support responses to the checklist questions.

The intent is to allow the LSP to consider the information in checklist sections A through E to form an opinion on the potential for climate change to impact the CSM and the resilience of the remedial action to projected climate change impacts. An LSP may choose to complete and incorporate the checklist into one or more MCP deliverables for a given site, envisioned as an appendix or attachment, and then use the checklist findings to prepare and support the climate change discussions in the CSM. The goal of the checklist is to support the LSP's opinion regarding a site's vulnerability. The LSP may consider applying all or part of the checklist or incorporating the checklist into deliverables.

MCP Climate Change Toolkit

January 2024

2.4 Case Studies

Attachment 3 includes case studies that walk the reader through the climate change consideration process using the flowchart and checklist tools as a guide. The case studies are fictitious sites based on a real-world setting, contaminant fate and transport mechanisms, site sensitivity and one or more climate exposure parameters. The case studies illustrate MCP sites in a coastal and inland settings, but the same process can be followed regardless of the site location and setting. The case studies are intended to illustrate use of the toolkit and exercising professional judgement by the LSP.

2.5 MCP Climate Change Glossary of Terms and Technical Resources

Throughout the toolkit, specific climate change terminology is used. Where a climate change term is first included in any of the tools, a live link to the glossary is provided so that the practitioner can readily reference the meaning of that term specifically in the context of MCP sites. The glossary definitions are derived from the SHMCAP as the primary reference, but the glossary also pulls in terms and standards from more widely distributed global, federal, and state references. Each term in the glossary includes a link to the underlying supporting reference(s). However, it should be noted that the glossary definitions have been customized and narrowed to be more directly applicable to the MCP process and the pending climate change revisions to the MCP.

There are many technical resources that may be helpful to LSPs considering climate change during the MCP process. **As noted above, the primary technical resource in considering climate change using this toolkit is the [MA Climate Change Clearinghouse \(mass.gov\)](#) website.** This website and its associated content are reviewed and updated regularly, and it is the primary resource for this work. To assist users of the [2023 ResilientMass Plan and the ResilientMass Climate Hub \(arcgis.com\)](#), a current map tutorial video can be found [here](#) and a data graphing tutorial can be found [here](#). Other technical resources that may also be helpful to LSPs include state resources, federal and United States Environmental Protection Agency (EPA) resources, and resources published by national organizations such as the Interstate Technology and Regulatory Council (ITRC) and the American Society for Testing and Materials (ASTM).

Attachment 4 includes the climate change Glossary of Terms, the glossary references, and links to [MA Climate Change Clearinghouse \(mass.gov\)](#) and other suggested technical resources available as of the date of publication of this toolkit. The references and resources linked in **Attachment 5** are routinely updated as advances are made.

3 Acknowledgements

The Climate Change MCP Toolkit is the result of the considerable efforts of the members of the LSPA Climate Change Subcommittee. It is the Subcommittee's intent that the Climate Change MCP Toolkit be reflective of, and consistent with, MassDEP BWSC policy. However, the LSPA, through the LSPA Climate Change Subcommittee, is the sole author of the Climate Change MCP Toolkit. Gratitude and acknowledgement are extended to the following for their contributions:

- Cathy Rockwell, Woodard & Curran – LSPA Climate Change Subcommittee Co-Chair
- Marilyn Wade, Brown and Caldwell – LSPA Climate Change Subcommittee Co-Chair
- Ken Marra, MassDEP – BWSC Climate Change Team Leader
- Elizabeth Callahan, MassDEP - Acting Assistant Commissioner, Bureau of Waste Site Cleanup
- David Austin, AECOM

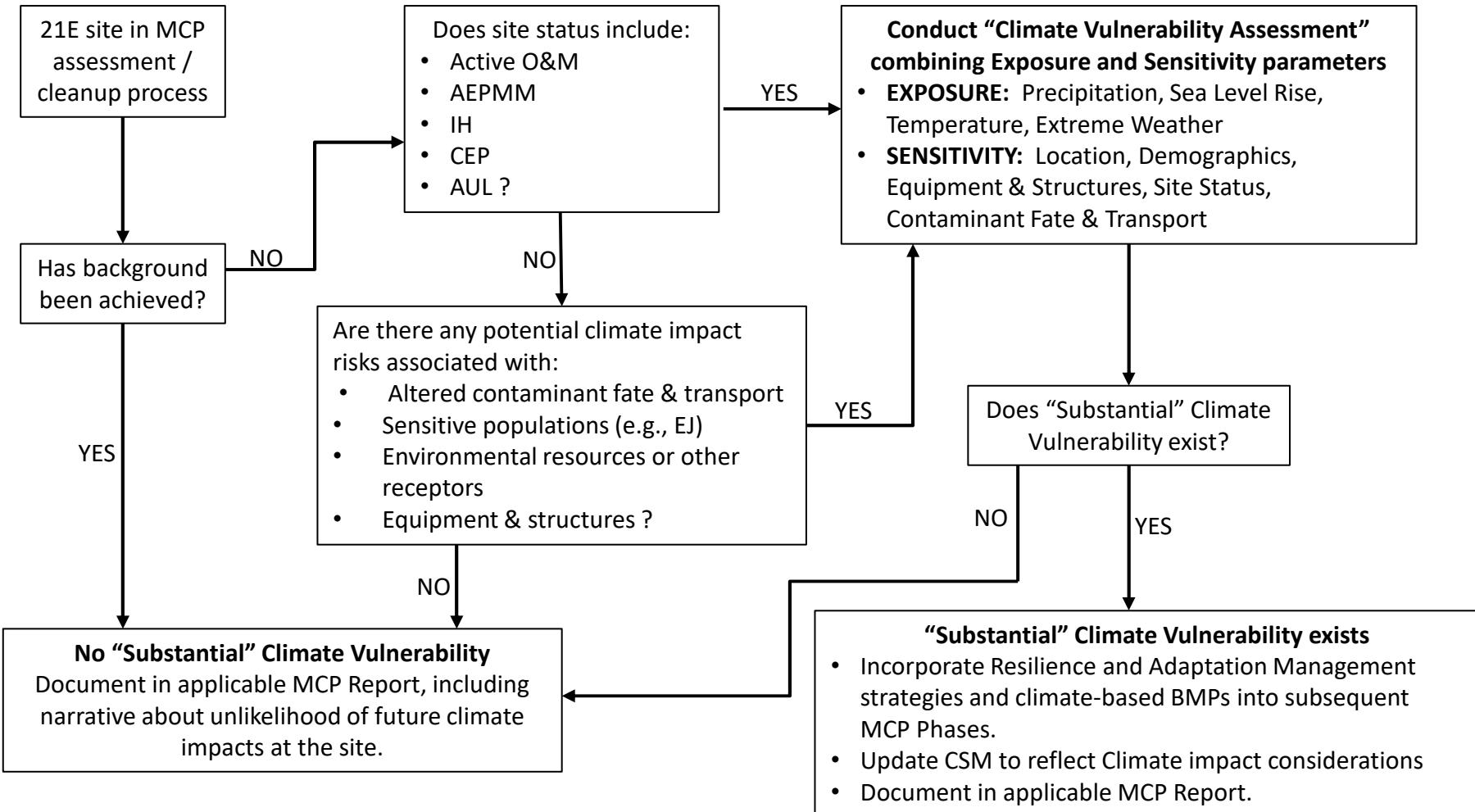
MCP Climate Change Toolkit

January 2024

- David Billo, Sovereign Consulting
- James Bossange, Ascent Environmental
- Susan Chapnick, New Environmental Horizons
- James Doherty, TRC
- Jeanine Grachuk, Beveridge & Diamond
- Molly Greer, GEI
- Jonathan Higgins, Higgins Environmental
- Dorothy McGlincy, Massachusetts Association of Conservation Commissions (MACC)
- Michele Paul, City of New Bedford Department of Environmental Stewardship
- Dianne Phillips, Holland & Knight
- Myron Ritrosky, Ecogenesis
- Amy Roth, Wilcox & Barton
- Wendy Rundle, LSP Association
- Annika Scanlon, Weston & Sampson
- Irwin Silverstein, Science Educator
- Roger Thibault, Beta Group
- Ted Wickwire, Woods Hole Group
- Cole Worthy, Haley & Aldrich

Flow Chart

Conceptual MCP Climate Impact Evaluation





ATTACHMENT 2: CLIMATE CHANGE ASSESSMENT CHECKLIST, January 2024

DATE PREPARED: _____

INSTRUCTIONS/ RESOURCES

The intended use of this Checklist (and the accompanying Glossary and Resources) is as a tool to provide a broad range of considerations when assessing climate vulnerability at 21E sites pursuant to Conceptual Site Model as defined in 310 CMR 40.0006 , RAPS in 310 CMR 40.0191, and consideration of foreseeable future changes in site conditions 310 CMR 40.1005.

Section A contains a summary of the general conditions that are most likely to drive risk at the site. Add any relevant site-specific information if not already provided.

GW Categories are defined in 310 CMR 40.0932.

Area Use is current use; however, keep in mind that future area use may differ substantially depending on the site.

Soil Categories are defined in 310 CMR 40.0933.

Section B is an initial screening step, describing the site now. If all the answers in this section are "no", document the finding in the CSM and current MCP report, and no further vulnerability assessment is necessary.

B.10 For example: stormwater infrastructure, remedial systems that rely on a constant source of power, etc.

B.13 Information can be found at ResilientMA CCSC Map Viewer (resilientma.org), and contacting the Town/City's Engineering Department or Department of Public Works.

<https://msc.fema.gov/portal/home>

GENERAL SITE INFORMATION																						
<p>A.</p> <p>Site Name: _____ Site RTN(s): _____ Site Address: _____</p> <p>Setting: _____</p> <table border="0"> <tr> <td style="vertical-align: top;"> <p>Site Use</p> <p>Residential _____ School _____ Daycare _____ Commercial _____</p> <p>Recreational/ Open Space _____</p> <p>Other _____</p> </td> <td style="vertical-align: top; padding-left: 10px;"> <p>Mark those applicable with an 'X'</p> <p>GW Category</p> <p>GW-1 _____ GW-2 _____ GW-3 _____</p> <p>Depth to Groundwater (ft bgs)</p> <p>Minimum _____ Maximum _____</p> </td> <td style="vertical-align: top; padding-left: 10px;"> <p>OHM Released:</p> <p>Gasoline _____ Oil _____ TCE _____ Chlorinated VOCs _____</p> <p>Metals _____ PCBs _____ PFAS _____</p> </td> <td style="vertical-align: top; padding-left: 10px;"> <p>Media Impacted</p> <p>Soil _____ Groundwater _____ Sediment _____ Soil vapor (VI) _____</p> <p>Indoor Air _____ Surface water _____</p> <p>Drinking Water _____</p> <p>Ecologically Sensitive area _____</p> </td> </tr> <tr> <td colspan="2"></td> <td style="vertical-align: top; padding-left: 10px;"> <p>Other(s) _____</p> </td> <td style="vertical-align: top; padding-left: 10px;"> <p>Current MCP Phase</p> <p>Phase 1 _____ Phase 2 _____ Phase 3 _____ Phase 4 _____ Phase 5 _____ ROS _____</p> </td> </tr> <tr> <td colspan="5"> <p>Area Use</p> <p>Mixed _____ Rural _____ Commercial _____ Urban _____ Residential _____ Suburban _____</p> <p>Vacant/ Future Development</p> <p>Other _____</p> </td> </tr> <tr> <td colspan="5"> <p>Soil Category</p> <p>S-1 _____ S-2 _____ S-3 _____</p> <p>Source(s) of OHM: _____ _____ _____</p> </td> </tr> </table>					<p>Site Use</p> <p>Residential _____ School _____ Daycare _____ Commercial _____</p> <p>Recreational/ Open Space _____</p> <p>Other _____</p>	<p>Mark those applicable with an 'X'</p> <p>GW Category</p> <p>GW-1 _____ GW-2 _____ GW-3 _____</p> <p>Depth to Groundwater (ft bgs)</p> <p>Minimum _____ Maximum _____</p>	<p>OHM Released:</p> <p>Gasoline _____ Oil _____ TCE _____ Chlorinated VOCs _____</p> <p>Metals _____ PCBs _____ PFAS _____</p>	<p>Media Impacted</p> <p>Soil _____ Groundwater _____ Sediment _____ Soil vapor (VI) _____</p> <p>Indoor Air _____ Surface water _____</p> <p>Drinking Water _____</p> <p>Ecologically Sensitive area _____</p>			<p>Other(s) _____</p>	<p>Current MCP Phase</p> <p>Phase 1 _____ Phase 2 _____ Phase 3 _____ Phase 4 _____ Phase 5 _____ ROS _____</p>	<p>Area Use</p> <p>Mixed _____ Rural _____ Commercial _____ Urban _____ Residential _____ Suburban _____</p> <p>Vacant/ Future Development</p> <p>Other _____</p>					<p>Soil Category</p> <p>S-1 _____ S-2 _____ S-3 _____</p> <p>Source(s) of OHM: _____ _____ _____</p>				
<p>Site Use</p> <p>Residential _____ School _____ Daycare _____ Commercial _____</p> <p>Recreational/ Open Space _____</p> <p>Other _____</p>	<p>Mark those applicable with an 'X'</p> <p>GW Category</p> <p>GW-1 _____ GW-2 _____ GW-3 _____</p> <p>Depth to Groundwater (ft bgs)</p> <p>Minimum _____ Maximum _____</p>	<p>OHM Released:</p> <p>Gasoline _____ Oil _____ TCE _____ Chlorinated VOCs _____</p> <p>Metals _____ PCBs _____ PFAS _____</p>	<p>Media Impacted</p> <p>Soil _____ Groundwater _____ Sediment _____ Soil vapor (VI) _____</p> <p>Indoor Air _____ Surface water _____</p> <p>Drinking Water _____</p> <p>Ecologically Sensitive area _____</p>																			
		<p>Other(s) _____</p>	<p>Current MCP Phase</p> <p>Phase 1 _____ Phase 2 _____ Phase 3 _____ Phase 4 _____ Phase 5 _____ ROS _____</p>																			
<p>Area Use</p> <p>Mixed _____ Rural _____ Commercial _____ Urban _____ Residential _____ Suburban _____</p> <p>Vacant/ Future Development</p> <p>Other _____</p>																						
<p>Soil Category</p> <p>S-1 _____ S-2 _____ S-3 _____</p> <p>Source(s) of OHM: _____ _____ _____</p>																						
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?																						

** If any answers to Questions 2 through 15 above are "Yes," proceed to Sections C - E **

** If all answers to Questions 2 through 15 are "No," proceed to Section F to document no anticipated climate change risk **

EXPOSURE CONSIDERATIONS						Comments/ Notes
1 Applied forecast duration [check one]: Based on Resilientma.org		10 years	30 years	50 - 80 years	Other	[discuss rationale on selection]
Likelihood of impacts						
2 SEA LEVEL RISE Impacts (based on resilientma.org climate data)		LOW	MEDIUM	HIGH	N/A	Related Natural Hazards: Coastal Flooding, Coastal Erosion & Storm Surge
a. All/a portion of the site will change from upland to intertidal conditions (tide benchmarks)						See Climate Projections>Sea Level Rise> Layers at https://resilientma.org/map/
b. All/a portion of the site will change from upland to subtidal conditions (tide benchmarks)						
3 EXTREME WEATHER EVENT impacts (based on resilientma.org climate data)		LOW	MEDIUM	HIGH	N/A	Related Natural Hazards: Coastal Flooding, Coastal Erosion & Storm Surge
a. Erosion or slope stability damage.						See Coastal Vulnerability> Layers at https://resilientma.org/map/
b. Ice dams, frozen utilities, snow load damage						
c. Wind hazards/tree uprooting						
4 PRECIPITATION (based on resilientma.org climate data)		LOW	MEDIUM	HIGH	N/A	Related Natural Hazards: Inland Flooding, Drought & Landslides
a. All/a portion of the site will in the foreseeable future be within a 1% flood hazard area						See Climate Projections>Precipitation> Layers at https://resilientma.org/map/
b. Remediation of the site is likely to result in a net increase in impervious area						
c. All/a portion of the project is within 500 feet of a stream/river at risk of increased flooding in the foreseeable future.						
d. Changes in precipitation lead to drought conditions						
5 Other based on resilientma.org climate data		LOW	MEDIUM	HIGH	N/A	Related Natural Hazards: Average/Extreme Temperatures, Wildfires & Invasive Species
a. Changes in exposure from vadose zone seasonal temperature increase						
b. Ecosystem/flora/fauna loss (invasive species)						
c. Increase in potential for wildfires						
d. Impact of remedial action on surrounding community related to heat island effects						
SENSITIVITY CONSIDERATIONS						Comments/ Notes
1 Altered contaminant fate and transport		LOW	MEDIUM	HIGH	N/A	
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)						
2 Moderate to severe equipment/building/infrastructure impacts		LOW	MEDIUM	HIGH	N/A	
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						
3 Moderate to severe human health/demographic impacts		LOW	MEDIUM	HIGH	N/A	
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						
4 Moderate to severe wildlife/ecosystem impacts		LOW	MEDIUM	HIGH	N/A	
a. A climate impact on the remedial solution may result in new risks to sensitive habitat(s).						

[Massachusetts 2020 Environmental Justice Populations \(arcgis.com\)](https://arcgis.com)

Section C begins with the selection of an evaluation timeframe based on the persistence of contaminants of concern pursuant to an applied remedial and/or forecast duration. For example, planning for a remedial action may use a shorter timeframe than would an opinion about a Permanent Solution. Items 2-5 below can be projected using Resilientma.org and evaluated based on the timeline selected.

See Climate Projections>Sea Level Rise> Layers at <https://resilientma.org/map/>

See Coastal Vulnerability> Layers at <https://resilientma.org/map/>

See Climate Projections>Precipitation> Layers at <https://resilientma.org/map/>

Section D is intended to evaluate the increased risk of exposure to contaminants of concern due to climate-related site changes. For example, such changes can alter contaminant fate and transport, impair site remedy effectiveness, and endanger nearby human and environmental receptors.

CONSIDERATIONS FOR CLIMATE CHANGE IMPACTS ON GROUNDWATER					Comments/ Notes
	LOW	MEDIUM	HIGH	N/A	
1 <i>Significant impacts to groundwater elevation</i>					Section E is intended to evaluate the potential for changes in groundwater flow and/or depth as these may impact contaminant transport or remedial solution efficacy. If contaminant impact is limited to soil and there is no risk of impacting groundwater, either currently or for the foreseeable future, then this section can be skipped.
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					
2 <i>Significant impacts to direction of flow</i>	LOW	MEDIUM	HIGH	N/A	
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					
3 <i>Significant impacts to fate and transport of contamination</i>	LOW	MEDIUM	HIGH	N/A	
a. Inundation of previously unsaturated soils					
b. Increased temperatures resulting in enhanced vapor migration					
c. Changes in groundwater chemistry					
4 <i>Likelihood of significant impacts to effectiveness of remedy</i>	LOW	MEDIUM	HIGH	N/A	
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					
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	Consider all of the information in sections A-E to form a conclusion/opinion on the potential for climate change to impact the Conceptual Site Model and the resilience of the remedial action to projected changes. This conclusion/opinion must be consistent with 310 CMR 40.0193.

*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.

ACRONYMS USED IN CHECKLIST:

ACEC	Areas of Critical Environmental Concern
AEPMM	Active Exposure Pathway Mitigation Measures
CEP	Critical Exposure Pathway
COCs	contaminants of concern
FEMA	Federal Emergency Management Agency
GW	groundwater
IH	Imminent Hazard
LNAPL	light non-aqueous phase liquid
LSP	Licensed Site Professional
MCP	Massachusetts Contingency Plan
N/A	not applicable
O&M	operation & maintenance
OHM	oil and/or hazardous material
PCBs	Polychlorinated biphenyls
PFAS	Per- and Polyfluoroalkyl Substances
RAPS	Response Action Performance Standard
ROS	Remedy Operation Status
SRM	Substantial Release Migration
SVE	soil vapor extraction
TCE	trichloroethene/ trichloroethylene
VI	vapor intrusion
VOCs	volatile organic compounds



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Attachment 3

LSPA CLIMATE CHANGE SUBCOMMITTEE

FICTIONAL CASE STUDY #1

COASTAL FLOODING AND LNAPL DISPOSAL SITE

Climate Change Vulnerability Assessment, January 2024

-- Site Exposed, Remedy Likely Vulnerable --

This case study is fictional and created for educational purposes only.

I. Conceptual Site Model (CSM)

Site Characteristics:

The site is the Fan Pier Courthouse at 12 Northern Avenue, Boston, MA 02110. The 4.56-acre site is covered by a ten-story building, masonry walkways, and landscaping. The site building is serviced by natural gas and municipal water and sewer.

Site Area:

The site is in a commercial area and is adjoined by Boston Harbor to the north, multi-story office buildings to the east, Northern Avenue to the south, and Fort Point Channel to the west. The disposal site is within flood zones.

Site History:

The site was originally part of Boston Harbor until the filling of this section of South Boston in the mid-1800s. The site was covered by warehouses and railroad spurs from the late 1800s to approximately 1970. The current courthouse facility was constructed in 2000.

Site Geology:

The site is located on Boston Harbor and is approximately 5 feet above sea level. The site subsurface geology consists of approximately 20 feet of fill, over sand and gravel, over silt and clay, over glacial till, over bedrock. The water table is approximately 5 feet below ground surface within the fill material, and the groundwater flows to the north to Boston Harbor and to the east to the Fort Point Channel.

Site Oil and Hazardous Material Use:

Various hazardous materials and oil have been stored on the site during its extensive industrial use prior to the construction of the courthouse. In 2000, a 10,000-gallon, No. 2 fuel oil underground storage tank (UST) was installed adjacent to the northern extent of the site building and approximately 100 feet from Boston Harbor. The site building was recently converted to natural gas heat, so the UST was removed.

Response Actions:

On January 4, 2018, the UST was removed and appeared to be rusted. Evidence of petroleum contaminants was observed in surrounding soil. Four soil samples were collected from the excavation and screened in the field using a Photo Ionization Detector (PID) and the MassDEP headspace method. Two of the samples showed headspace readings above 100 ppmv. On January 5, 2018, the headspace readings exceeding 100 ppmv were verbally reported to MassDEP, which issued a Notice of Responsibility with a Release Tracking Number (RTN) of 0-00000. The MassDEP also verbally approved Immediate Response Action (IRA) activities that included additional assessment and excavation of up to 100 cubic yards of petroleum impacted soil.

The four samples were subsequently analyzed by a chemical laboratory for extractable petroleum hydrocarbons (EPH) and volatile petroleum hydrocarbons (VPH). EPHs were detected in soil at concentrations below Massachusetts Contingency Plan (MCP) Method 1 S-1/GW-1 standards. Twenty cubic yards of impacted soil was transported to a licensed disposal facility after the completion of the required chemical analyses for the disposal facility.

Additional assessment discovered light non-aqueous phase liquid (LNAPL) in the area of the former UST at a depth of four to six feet. The LNAPL was subsequently determined to be stable, non-mobile, and less than 1/2-inch in thickness. The removal of the LNAPL was determined to be infeasible in accordance with the MassDEP LNAPL Policy simplified method. An MCP Method 3 Risk Characterization concluded that the disposal site had achieved No Significant Risk.

Climate change vulnerability considerations were incorporated throughout the MCP process for this RTN from the development of the CSM to the selection of the type of MCP closure. Additionally, a final climate change vulnerability assessment, as discussed below, was completed when considering if a Permanent Solution Without Conditions is applicable.

II. CLIMATE CHANGE VULNERABILITY

Climate change vulnerabilities will change over time. The current [ResilientMass Climate Hub \(arcgis.com\)](#) map provides two sea level rise map layers - Sea Level Inundation and Sea Level Rise Projections (Attachment 3, Appendix A). The LSP considers the potential impacts of climate change for the “reasonably foreseeable future.” For this case study, the primary planning horizon is 30 years or 2050.

Changes in Precipitation (inland flooding, drought & landslides):

The MCP regulatory closure for this disposal site may be vulnerable to climate change risks posed by increased future precipitation. The [ResilientMass Climate Hub \(arcgis.com\)](#) precipitation layers indicate that the site would be impacted by extreme precipitation (Attachment 3, Appendix B). The MCP regulatory closure is contingent on the determination of the stability of the LNAPL (under current climate, i.e., precipitation and groundwater conditions) as described in the MassDEP LNAPL simplified

method. Increased precipitation could mobilize the LNAPL by elevating it to the ground surface. Therefore, the disposal site **may be vulnerable** to changes in precipitation.

Sea Level Rise (coastal flooding, coastal erosion)

The MCP regulatory closure of this disposal site may be vulnerable to climate change risks posed by future sea level rise. The site is at an elevation of approximately 5 feet above sea level and on the shore of Boston Harbor. The [ResilientMass Climate Hub \(arcgis.com\)](http://ResilientMass.ClimateHub.arcgis.com) "Massachusetts Coastal Flood Risk Model" layers indicates six layers for coastal flooding - a 1% annual exceedance and a 0.1% annual exceedance for 2030, 2050 & 2070. Three map layers are shown in Attachment 3, Appendix C. For boundary considerations when planning Best Management Practices (BMPs) and other mitigation, the LSP notes that the 0.1% annual 2070 Coastal Flooding map layer indicates that the entire site would be covered. The 1% annual 2030 Coastal Flooding map layer indicates that the outer extent of the site may be covered, but not the area of the UST. Because sea level rise projections may lead to future inundation of portions of the site, LNAPL could rise with the water table closer to the ground surface and erosion will be more likely. Therefore, the disposal site **may be vulnerable** to sea level rise.

Rising Temperatures (average/extreme temperatures, wildfires, and invasive species)

The disposal site's MCP regulatory closure does not rely on conditions, such as pavement barriers or a vegetative cover, which could be adversely affected by rising temperatures. Therefore, the site is **not expected to be vulnerable** to increased temperature.

Extreme Weather (hurricanes/tropical storms, severe winter storms/nor'easters, and storm surges)

The MCP regulatory closure for this disposal site may be vulnerable to extreme weather risks (hurricanes/tropical storms, severe winter storms/nor'easters, and storm surges). The [ResilientMass Climate Hub \(arcgis.com\)](http://ResilientMass.ClimateHub.arcgis.com) "hurricane surge inundation zones layer" indicates that the site will be flooded by category 1, 2, 3 and 4 hurricane surge inundation zones (Attachment 3, Appendix D). The MCP regulatory closure is contingent on the determination of the stability of the LNAPL (under current climate, i.e., precipitation and groundwater conditions) as described in the MassDEP LNAPL simplified method. Flooding from hurricane surges could mobilize/elevate the LNAPL to the ground surface and/or erode shallow overlying soil that currently limits exposure to LNAPL. Therefore, the disposal site **may be vulnerable** to flooding from extreme weather.

III. Conclusion

Future climate change vulnerabilities are considered when reviewing proposed MCP regulatory closure options. The uncertainties associated with climate change predictions increase with time. Therefore, more weight in the planning process is given to shorter term projections for a reasonably foreseeable future. However, projections further into the future may be considered as boundary conditions for mitigation planning purposes. MCP climate change impact assessments for disposal sites rely on available climate change and flooding projection sources, which include [ResilientMass Climate Hub \(arcgis.com\)](http://ResilientMass.ClimateHub.arcgis.com) and Federal Emergency Management Agency's (FEMA) National Flood Hazard maps/layers. [MA Climate Change Clearinghouse \(mass.gov\)](http://MA.ClimateChange.Clearinghouse.mass.gov) is a resource clearing house of climate change projections

that has been developed for Massachusetts. It provides Massachusetts climate change tools to support decisions regarding climate resilience for local planners, practitioners, policy makers, and the public. FEMA provides Flood Hazard Maps for most of the United States, including portions of Massachusetts.

In consideration of the foreseeable future conditions, the following recommendations could be considered in the future:

1. Further removal of LNAPL prior to submitting a Permanent Solution Statement.
2. Implement nature-based solutions to minimize the impacts of storm surge (From ITRC SRR).
3. Maintain reactive coir mats, soft caps, armor, and hard caps to stabilize and shield surfaces from erosion, storm surges, and tidal influence (from ITRC SRR).
4. Maintain monitoring wells with longer screens so that possible LNAPL can be observed during large water table fluctuations and possible downgradient monitoring wells to assess possible horizontal migration.

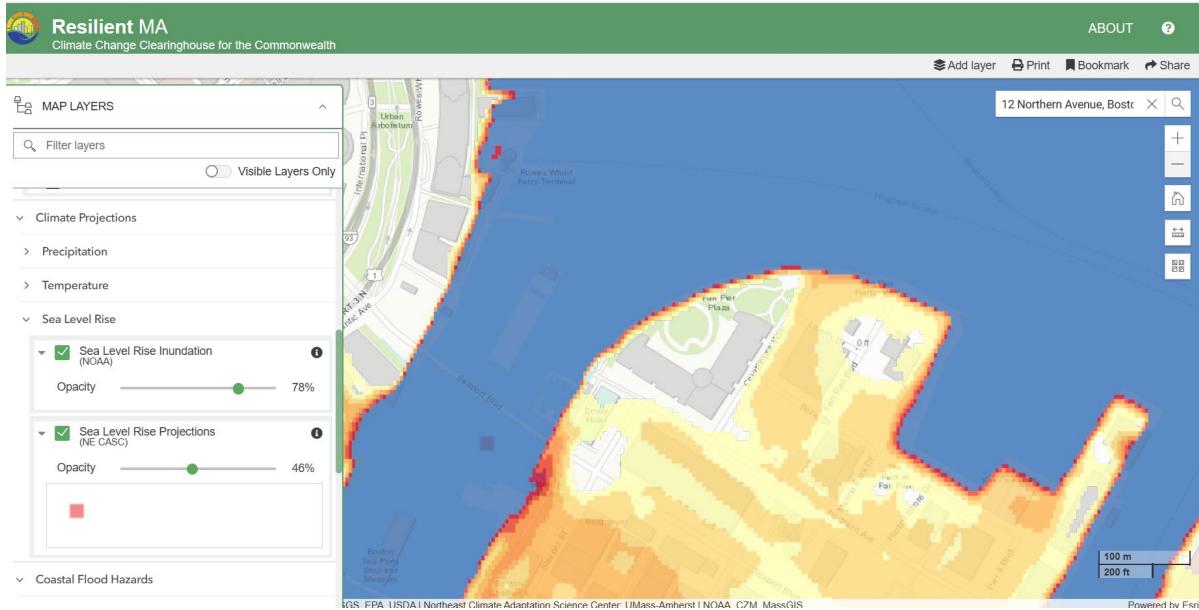
ATTACHMENT 3 APPENDICES: CLIMATE CHANGE VULNERABILITY CASE STUDY, January 2024

[ResilientMass Climate Hub \(arcgis.com\)](#) SCREENSHOTS

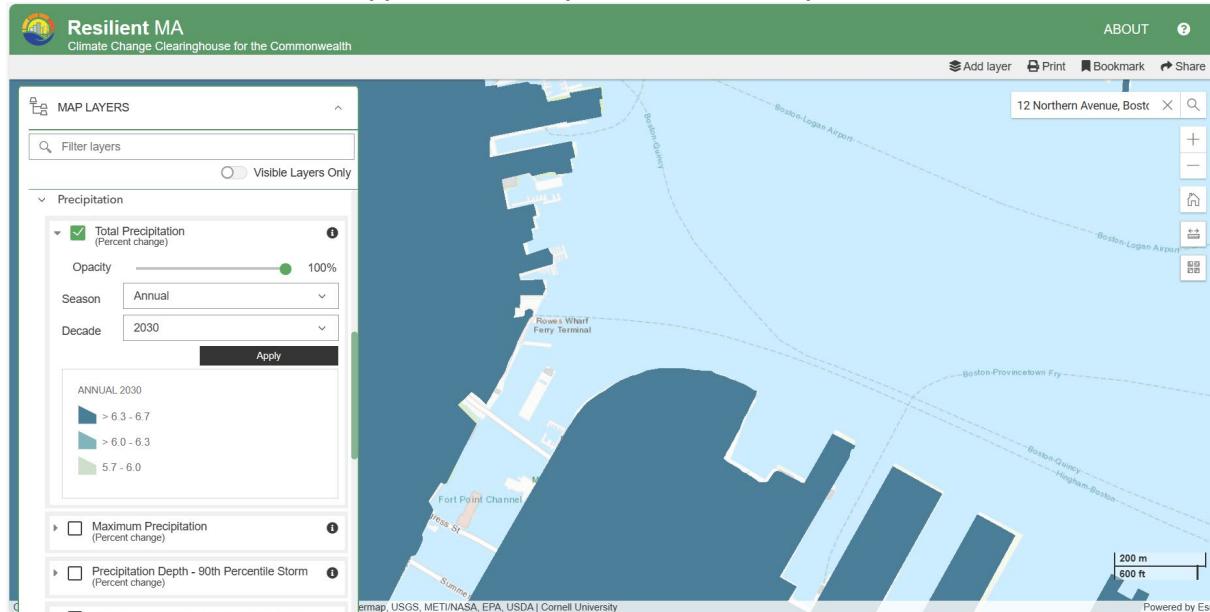
LSPA CLIMATE CHANGE SUBCOMMITTEE

FICTIONAL CASE STUDY #1 - COASTAL FLOODING AND LNAPL DISPOSAL SITE

Appendix A: Sea Level Rise – Both “Sea Level Rise Inundation and Sea Level Rise Projections”

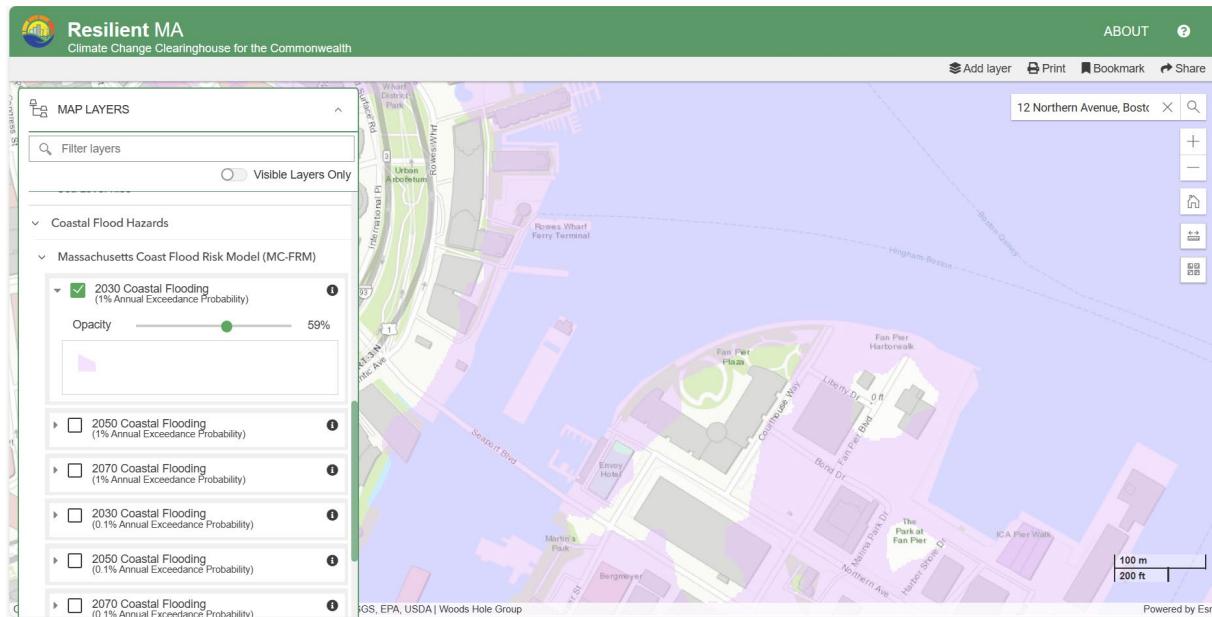


Appendix B: Precipitation; Total Precipitation:

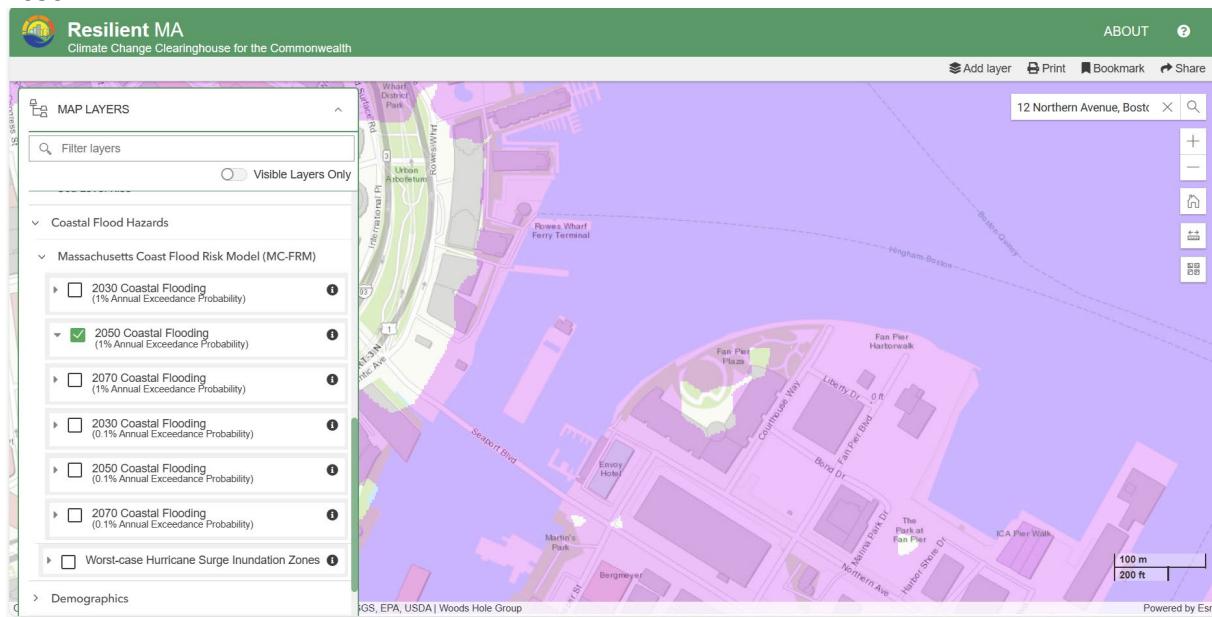


Appendix C: Massachusetts Coast Flood Risk Model (MC-FRM) – 2030, 2050 & 2070, 1% Annual Exceedance Probabilities.

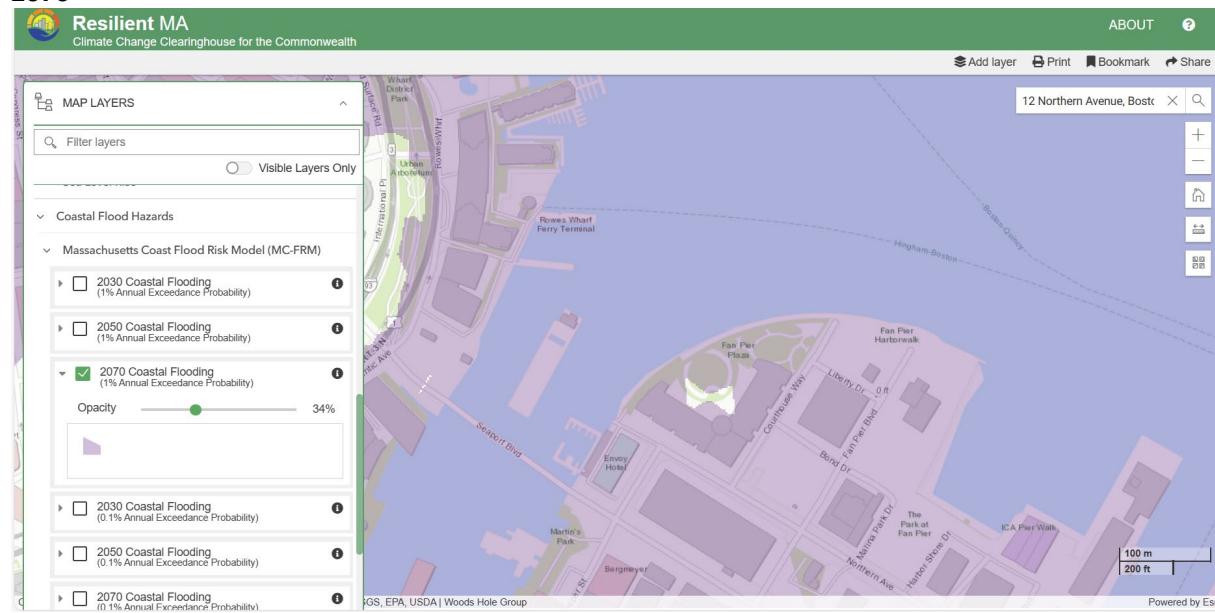
2030



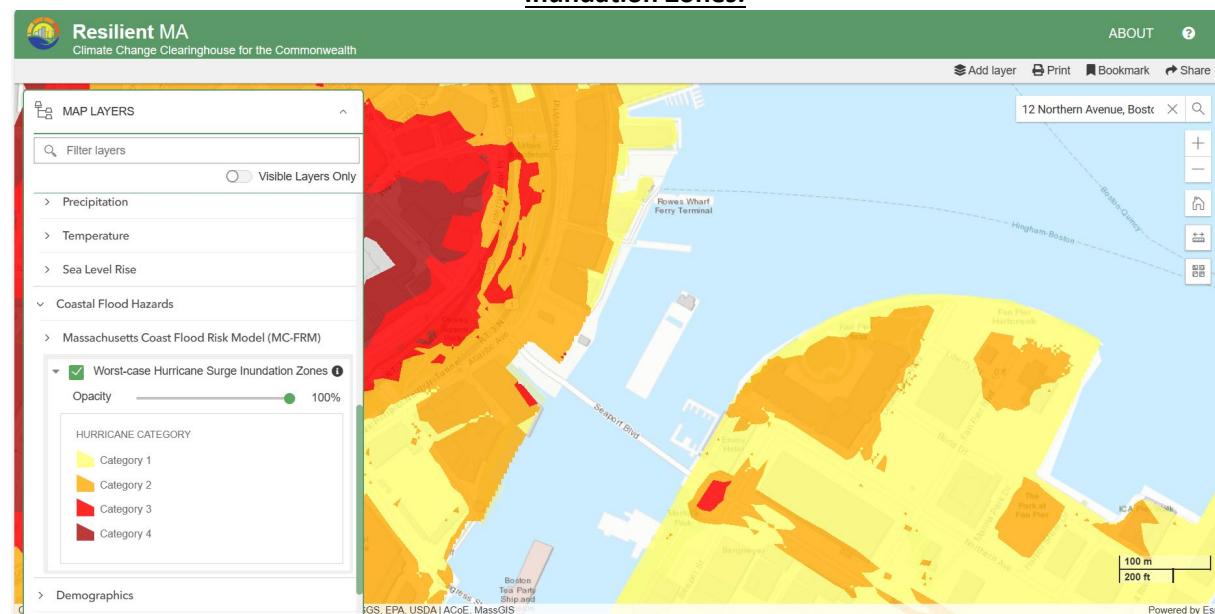
2050



2070



Appendix D: Massachusetts Coast Flood Risk Model (MC-FRM). Worst-case Hurricane Surge Inundation Zones:





INSTRUCTIONS/ RESOURCES

The intended use of this Checklist (and the accompanying Glossary and Resources) is as a tool to provide a broad range of considerations when assessing climate vulnerability at 21E sites pursuant to Conceptual Site Model as defined in 310 CMR 40.0006 , RAPS in 310 CMR 40.0191, and consideration of foreseeable future changes in site conditions 310 CMR 40.1005.

ATTACHMENT 3: CLIMATE CHANGE VULNERABILITY ASSESSMENT CHECKLIST, Applied to Case Study 1

DATE: _____

GENERAL SITE INFORMATION																																																																								
A.	<p>Site Name: Fan Pier Courthouse -This case study is fictional and created for educational purposes only.</p> <p>Site RTN(s): 3-0000000</p> <p>Site Address: 12 Northern Avenue, Boston, MA 02110</p> <p>Setting: Mark those applicable with an 'X'</p> <table> <tr> <td>Site Use</td> <td>GW Category</td> <td>OHM Released:</td> <td>Media Impacted</td> </tr> <tr> <td>Residential _____</td> <td>GW-1 _____</td> <td>Gasoline _____</td> <td>Soil X</td> </tr> <tr> <td>School _____</td> <td>GW-2 X</td> <td>Oil X</td> <td>Groundwater _____</td> </tr> <tr> <td>Daycare _____</td> <td>GW-3 X</td> <td>TCE _____</td> <td>Sediment _____</td> </tr> <tr> <td>Commercial X</td> <td></td> <td>Chlorinated VOCs _____</td> <td>Indoor Air _____</td> </tr> <tr> <td>Recreational/ Open Space _____</td> <td>Depth to Groundwater</td> <td>Metals _____</td> <td>Surface water _____</td> </tr> <tr> <td>Other _____</td> <td>5 ft Minimum</td> <td>PCBs _____</td> <td>Drinking Water _____</td> </tr> <tr> <td></td> <td>5 ft Maximum</td> <td>PFAS _____</td> <td>Ecologically Sensitive area _____</td> </tr> <tr> <td>Area Use</td> <td>Soil Category</td> <td>Source of OHM:</td> <td>Current MCP Phase</td> </tr> <tr> <td>Mixed _____</td> <td>S-1 _____</td> <td>Other LNAPL _____</td> <td>Phase 1 _____</td> </tr> <tr> <td>Rural _____</td> <td>S-2 _____</td> <td>UST _____</td> <td>Phase 2 _____</td> </tr> <tr> <td>Commercial X</td> <td>S-3 X</td> <td></td> <td>Phase 3 X</td> </tr> <tr> <td>Urban _____</td> <td></td> <td></td> <td>Phase 4 _____</td> </tr> <tr> <td>Residential _____</td> <td></td> <td></td> <td>Phase 5 _____</td> </tr> <tr> <td>Suburban _____</td> <td></td> <td></td> <td>ROS _____</td> </tr> <tr> <td>Vacant/ Future Development _____</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Other _____</td> <td></td> <td></td> <td></td> </tr> </table>				Site Use	GW Category	OHM Released:	Media Impacted	Residential _____	GW-1 _____	Gasoline _____	Soil X	School _____	GW-2 X	Oil X	Groundwater _____	Daycare _____	GW-3 X	TCE _____	Sediment _____	Commercial X		Chlorinated VOCs _____	Indoor Air _____	Recreational/ Open Space _____	Depth to Groundwater	Metals _____	Surface water _____	Other _____	5 ft Minimum	PCBs _____	Drinking Water _____		5 ft Maximum	PFAS _____	Ecologically Sensitive area _____	Area Use	Soil Category	Source of OHM:	Current MCP Phase	Mixed _____	S-1 _____	Other LNAPL _____	Phase 1 _____	Rural _____	S-2 _____	UST _____	Phase 2 _____	Commercial X	S-3 X		Phase 3 X	Urban _____			Phase 4 _____	Residential _____			Phase 5 _____	Suburban _____			ROS _____	Vacant/ Future Development _____				Other _____			
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Other _____																																																																								
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)		X																																																																						
2 Is the site in active operation and maintenance (O&M) or ROS?		X																																																																						
3 Does the site have or will the site require an AUL?	X																																																																							
4 Is there a containment cap/barrier or other engineered control?		X																																																																						
5 Does the site have or will the site require an AEPMM?		X																																																																						
6 Is the site characterized by an IH condition, a CEP or an SRM?		X																																																																						
7 Is the site in an environmental justice location or are sensitive populations present?		X																																																																						
8 Is the site in an ACEC and/or sensitive habitat?		X																																																																						
9 Is the site in an inland waterway?		X																																																																						
10 Are there essential infrastructure, equipment, or structures present and at risk?		X																																																																						
11 Would potential climate impacts substantially alter the fate and transport of site contaminants of concern?	X																																																																							
12 Is the anticipated closure a Temporary Solution?		X																																																																						
13 All/a portion of the site has a history of coastal flooding and/or is located within a potential future storm surge area?	X																																																																							
14 All/a portion of the site is within an existing FEMA 1% flood hazard area?	X																																																																							
15 All/a portion of the site has a history of flooding during precipitation events?	X																																																																							
** If any answers to Questions 2 through 15 above are "Yes," proceed to Sections C - E **																																																																								

Section A contains a summary of the general conditions that are most likely to drive risk at the site. Add any relevant site-specific information if not already provided.

GW Categories are defined in 310 CMR 40.0932.

Area Use is current use; however, keep in mind that future area use may differ substantially depending on the site.

Soil Categories are defined in 310 CMR 40.0933.

Section B is an initial screening step, describing the site now. If all the answers in this section are "no", document the finding in the CSM and current MCP report, and no further vulnerability assessment is necessary.

B.10 For example: stormwater infrastructure, remedial systems that rely on a constant source of power, etc.

B.13 Information can be found at ResilientMA CCSC Map Viewer (resilientma.org), and contacting the Town/City's Engineering Department or DPW. Add links

<https://msc.fema.gov/portal/home>

EXPOSURE CONSIDERATIONS						Comments/ Notes
1 Applied forecast duration [check one]: Resilientma.org (or other considered forecasting tools)		30 years	50 years	80 years	Other	
Likelihood of impacts						
2 SEA LEVEL RISE Impacts (based on resilientma.org climate data)		LOW	MEDIUM	HIGH	N/A	Flooding, Coastal Erosion & Storm Surge
a. All/a portion of the site will change from upland to intertidal conditions (tide benchmarks)			X			At the site boundaries - not likely in UST
b. All/a portion of the site will change from upland to subtidal conditions (tide benchmarks)			X			At the site boundaries - not likely in UST
3 EXTREME WEATHER EVENT impacts (based on resilientma.org climate data)		LOW	MEDIUM	HIGH	N/A	Flooding, Coastal Erosion & Storm Surge
a. Erosion or slope stability damage.				X		
b. Ice dams, frozen utilities, snow load damage		X				
c. Wind hazards/tree uprooting				X		
4 PRECIPITATION (based on resilientma.org climate data)		LOW	MEDIUM	HIGH	N/A	Related Natural Hazards: Inland Flooding, Drought & Landslides
a. All/a portion of the site will in the foreseeable future be within a 1% flood hazard area				X		
b. Remediation of the site is likely to result in a net increase in impervious area					X	
c. All/a portion of the project is within 500 feet of a stream/river at risk of increased flooding in the foreseeable future.					X	Coastal only
d. Changes in precipitation lead to drought conditions					X	
5 Other based on resilientma.org climate data		LOW	MEDIUM	HIGH	N/A	Related Natural Hazards: Average/Extreme Temperatures, Wildfires & Invasive Species
a. Changes in exposure from vadose zone seasonal temperature increase					X	
b. Ecosystem/flora/fauna loss (invasive species)					X	
c. Increase in potential for wildfires					X	
d. Impact of remedial action on surrounding community related to heat island effects					X	
SENSITIVITY CONSIDERATIONS						Comments/ Notes
1 Altered contaminant fate and transport		LOW	MEDIUM	HIGH	N/A	
a. Physical characteristics of site contaminants of concern (COCs) support increased transport climate risk			X			LNAPL could be mobilised
b. Chemical characteristics of site COCs support increased transport due to climate change		X				Lower solubility
c. Site specific biological/environmental characteristics increase risk of climate enhanced transport?					X	
d. Climate triggered substantial changes in groundwater elevation may impact fate and transport (including LNAPL)				X		Rising GW could mobilize LNAPL
2 Moderate to severe equipment/building/infrastructure impacts		LOW	MEDIUM	HIGH	N/A	
a. Climate impacts may affect/alter the functioning of remedial components					X	No onsite treatment in place
b. Impacts to utilities and infrastructure at the site or essential to the remedy					X	
c. Site conditions limit ability for adaptive site management to mitigate climate risk					X	
3 Moderate to severe human health/demographic impacts		LOW	MEDIUM	HIGH	N/A	
a. Localized impacts to health and safety of site occupants and abutters as a result of climate-based changes at the site			X			If LNAPL moves to surface
b. Increase in airborne dust exposure due to drought and/or temperature increase					X	
c. Cumulative effects on local environmental justice community as a result of the remedial action					X	
4 Moderate to severe wildlife/ecosystem impacts		LOW	MEDIUM	HIGH	N/A	
a. A climate impact on the remedial solution may result in new risks to sensitive habitat(s).		X				Only if LNAPL migrates to intertidal zone

E. CONSIDERATIONS FOR CLIMATE CHANGE IMPACTS ON GROUNDWATER					Comments/ Notes
	LOW	MEDIUM	HIGH	N/A	
1 <i>Significant impacts to groundwater elevation</i>					
a. Increased or decreased rainfall	X				
b. Increases/decreases in water levels at hydrologic boundaries			X		
c. Impact of future off-site mitigation measures				X	
d. Increased Evapotranspiration/decreasing recharge				X	
e. Episodic elevated groundwater elevation due to high precipitation events		X			
f. Impact on groundwater monitoring wells				X	
g. Saltwater intrusion				X	
h. Potential long term regional changes				X	
2 <i>Significant impacts to direction of flow</i>	LOW	MEDIUM	HIGH	N/A	
a. Increases/decreases in water levels at hydrologic boundaries		X			Sea level rise impacting GW elevation
b. Impact on sources or sinks in area				X	No influence on direction of flow
c. Creation/elimination of preferential pathways	X				Possible movement of LNAPL to coast
d. Impacts of changes in stormwater management	X				If sea level rise results in increased flooding may need to work on stormwater management
3 <i>Significant impacts to fate and transport of contamination</i>	LOW	MEDIUM	HIGH	N/A	
a. Inundation of previously unsaturated soils		X			
b. Increased temperatures resulting in enhanced vapor migration				X	
c. Changes in groundwater chemistry	X				Possible mobilization to GW
4 <i>Likelihood of significant impacts to effectiveness of remedy</i>	LOW	MEDIUM	HIGH	N/A	
a. Impact on capture zone				X	
b. Changes in effectiveness of vadose zone treatment (SVE, bioventing)				X	
c. Impacts on in-situ treatment - groundwater chemistry, saturated thickness, natural attenuation				X	
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	Because of the coastal location combined with limited LNAPL in place, there is a potential climate vulnerability that should be accounted for in the final decision.

*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.

ACRONYMS USED IN CHECKLIST:

ACEC	areas of critical environmental concern
CEP	critical exposure pathway
COCs	contaminants of concern
FEMA	federal emergency management agency
IH	imminent hazard
LNAPL	light non-aqueous phase liquid
MCP	Massachusetts Contingency Plan
O&M	operation & maintenance
OHM	oil and/or hazardous material
ROS	remedy operation status
SRM	substantial release migration
SVE	soil vapor extraction
TCE	trichloroethene/ trichloroethylene
VOCs	volatile organic compounds



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ATTACHMENT 3

LSPA CLIMATE CHANGE SUBCOMMITTEE

FICTIONAL CASE STUDY #2 – DISPOSAL SITE NEAR FLOODING RIVER

Climate Change Vulnerability Assessment, January 2024

-- Site Exposed, Remedy not Vulnerable --

This case study is fictional and created for educational purposes only.

I. Conceptual Site Model (CSM)

Site Characteristics:

The two-acre site located at 220 Reservoir Street in Needham, MA is covered by one commercial building, paved parking areas, and landscaping. The 5,000-square foot, one-story, slab-on-grade building is occupied by ABC Insurance Company (ABC), which uses the building as office space. The site building is serviced by natural gas and municipal water and sewer.

Site Area:

The site is in a commercial area and is adjoined by Main Street to the north and other commercial buildings to the south and west. The Charles River abuts the site to the east. The disposal site is within Federal Emergency Management Agency's (FEMA) National Flood Hazard river flood zones.

Site History:

The site was undeveloped land until 1980 when the current facility was constructed for ABC, which has occupied the site since 1980.

Site Geology:

The site is located approximately 10 miles from the Atlantic Ocean and is approximately 100 feet above sea level. The site's subsurface geology consists of approximately 2 feet of granular fill, over 10 feet of sand and gravel, over glacial till. The water table was measured to be 5 feet below ground surface within the sand and gravel, and the groundwater was measured to flow to the east.

Site Oil and Hazardous Material Use:

Oil and Hazardous Materials have not been stored or used at the site since its development beyond No. 2 fuel oil stored in a former Underground Storage Tank (UST). The tank was approximately five feet from the building foundation until its removal as part of the natural gas conversion.

Response Actions:

The former 550-gallon, steel, single-walled, No. 2 fuel oil UST was removed on January 4, 2018. The UST appeared to be rusted, and evidence of limited oil staining in surrounding soil was noted. Three soil samples were collected from the excavation and analyzed for extractable petroleum hydrocarbons (EPH) and volatile petroleum hydrocarbons (VPH) analyses. EPH were detected in soil above Massachusetts Contingency Plan (MCP) RCS-2 Reportable Concentrations.

In accordance with the MCP, on January 11, 2020, the findings were reported on a Release Notification Form to the MassDEP, which issued a Notice of Responsibility with a Release Tracking Number (RTN) of 0-00000 on January 19, 2021.

A Release Abatement Measure (RAM) Plan was submitted to the MassDEP on January 25, 2021. The RAM Plan proposed:

- Additional assessment by the installation of four groundwater monitoring wells,
- Additional EPH and VPH analysis of soil and groundwater samples,
- The installation and sampling of two sub-slab soil vapor probes, and
- The possible excavation and removal of up to 50 cubic yards of impacted soil.

On February 1, 2021, four monitoring wells were installed:

- In the area of the former UST,
- 15 feet downgradient (south) of the UST,
- 60 feet downgradient of the UST, and
- 50 feet to the east of the UST.

EPH and VPH analyses of the soil and groundwater samples detected EPH in soil and groundwater samples obtained from the boring/monitoring well in the immediate area of the former UST. Collection and analysis of two sub-slab soil gas samples for air-phase petroleum hydrocarbons found Air-Phase Petroleum Hydrocarbon concentrations well below the commercial and residential screening values.

On February 8, 2021, 20 cubic yards of petroleum impacted soil was excavated from the former area of the UST. EPH and VPH analyses of five confirmatory soil samples obtained from the bottom and sides of the excavation did not detect EPH or VPH analytes above the applicable MCP Method 1 standards. The twenty cubic yards of excavated petroleum impacted soil was transported to a nearby licensed recycling facility. Subsequent sampling and analysis of groundwater from disposal site monitoring wells showed decreased concentrations of EPH in the monitoring well in the area of the former UST.

To assess whether additional remedial actions were warranted, an MCP Method 1 Risk Characterization was completed by comparing the final EPH and VPH soil and groundwater concentrations to the applicable Method 1 standards. All contaminants were below the applicable MCP Method 1 standards. Based on the results of the risk characterization, the release has achieved No Significant Risk and will achieve regulatory closure with a Permanent Solution Without Conditions.

Climate change vulnerability considerations were incorporated throughout the MCP process for this RTN from the development of the conceptual site model to the selection of the type of MCP closure.

Additionally, a final climate change vulnerability assessment, as discussed below, was completed when considering if a Permanent Solution Without Conditions is applicable.

II. CLIMATE CHANGE VULNERABILITY

Climate change vulnerabilities will change over time. Current [ResilientMass Climate Hub \(arcgis.com\)](#) map layers provide two sea level rise map layers - Sea Level Inundation and Sea Level Rise Projections (Attachment 3, Appendix A). The LSP considers the potential impacts of climate change for the “reasonably foreseeable future.” For this case study, the LSP has chosen 30 years or 2050.

Changes in Precipitation (inland flooding, drought & landslides):

The MCP regulatory closure of this disposal site is not impacted by future changes in precipitation, associated flooding, or groundwater fluctuations. The [ResilientMass Climate Hub \(arcgis.com\)](#) precipitation map layers indicate that the site would be impacted by extreme precipitation (Attachment 3, Appendix B). However, because the site does not have contaminant concentrations exceeding Method 1 Standards, the predicted increase in precipitation does not impact the Permanent Solution. Also, impacts to groundwater levels are not a concern because there are no residual LNAPLs or potentially mobile residual contaminants in the current unsaturated zone. Based on currently available FEMA flood risk maps (Attachment 3, Appendix B), the disposal site is exposed to the risk of the flooding from the abutting Charles River; however, the MCP Permanent Solution Without Conditions for this disposal site is not vulnerable to the flooding risk since the concentrations of the soil and groundwater Contaminants of Concern are below Method 1 standards and approaching background. The closure does not rely on a vegetative cover, which could die during a drought. Therefore, the closure of this disposal site is not vulnerable to changes in precipitation.

Sea Level Rise (coastal flooding, coastal erosion)

The MCP regulatory closure of this disposal site does not rely on conditions that could be adversely affected by future sea level rise. The site is at an elevation of approximately 100 feet above sea level and not near the coast. The Massachusetts Coastal Flood Risk Model map layers indicate that coastal flooding will not impact the site (Attachment 3, Appendix C). Therefore, the site is not vulnerable to sea level rise.

Rising Temperatures (average/extreme temperatures, wildfires, and invasive species)

As with all Massachusetts properties, [ResilientMass Climate Hub \(arcgis.com\)](#) temperature layers indicates that the site would be impacted by extreme temperature; however, the MCP regulatory closure of this disposal site does not rely on conditions, such as pavement barriers or a vegetative cover, which could be adversely affected by rising temperatures. Therefore, the site is not vulnerable to increased temperature.

Extreme Weather (hurricanes/tropical storms, severe winter storms/nor'easters and storm surges)

The MCP regulatory closure of this disposal site does not rely on conditions that could be adversely affected by extreme weather. As previously noted, based on currently available FEMA flood risk maps, the disposal site is exposed to the risk of extreme weather including river flooding from the abutting Charles River (Attachment 3, Appendix B). However, the closure does not rely on active remedial systems or above grade remedial infrastructure that could be affected by storms, hurricanes, resulting flooding or power outages. [ResilientMass Climate Hub \(arcgis.com\)](https://resilientmassclimatehub.arcgis.com) maps (storm surge) confirm that future storm surge scenarios in the Charles River do not extend to nearby river sections (Attachment 3, Appendix D). Therefore, the site is not vulnerable to extreme weather.

III. Conclusions

Future climate change vulnerabilities are considered when reviewing proposed MCP regulatory closure options. The uncertainties associated with climate change predictions increase with time. Therefore, more weight in the planning process is given to shorter term projections for a reasonably foreseeable future. However, projections further into the future may be considered as boundary conditions for planning purposes. MCP climate change impact assessments for disposal sites rely on available climate change and flooding projection sources, which include [ResilientMass Climate Hub \(arcgis.com\)](https://resilientmassclimatehub.arcgis.com) and Federal Emergency Management Agency's (FEMA) National Flood Hazard maps/layers. [MA Climate Change Clearinghouse \(mass.gov\)](https://www.mass.gov/info-details/ma-climate-change-clearinghouse) is a resource clearing house of climate change projections that has been developed for Massachusetts. It provides Massachusetts climate change tools to support decisions regarding climate resilience for local planners, practitioners, policy makers, and the public. FEMA provides Flood Hazard Maps for most of the United States, including portions of Massachusetts.

The LSP is not recommending any additional Best Management Practices (BMPs), design features or response actions to support the Permanent Solution. Although foreseeable future climate change impacts may impact the site (i.e., river flooding), the Permanent Solution is supported by the limited removal of impacted soil and confirmatory sampling indicating that contamination exceeding Method 1 Standards does not remain on site.

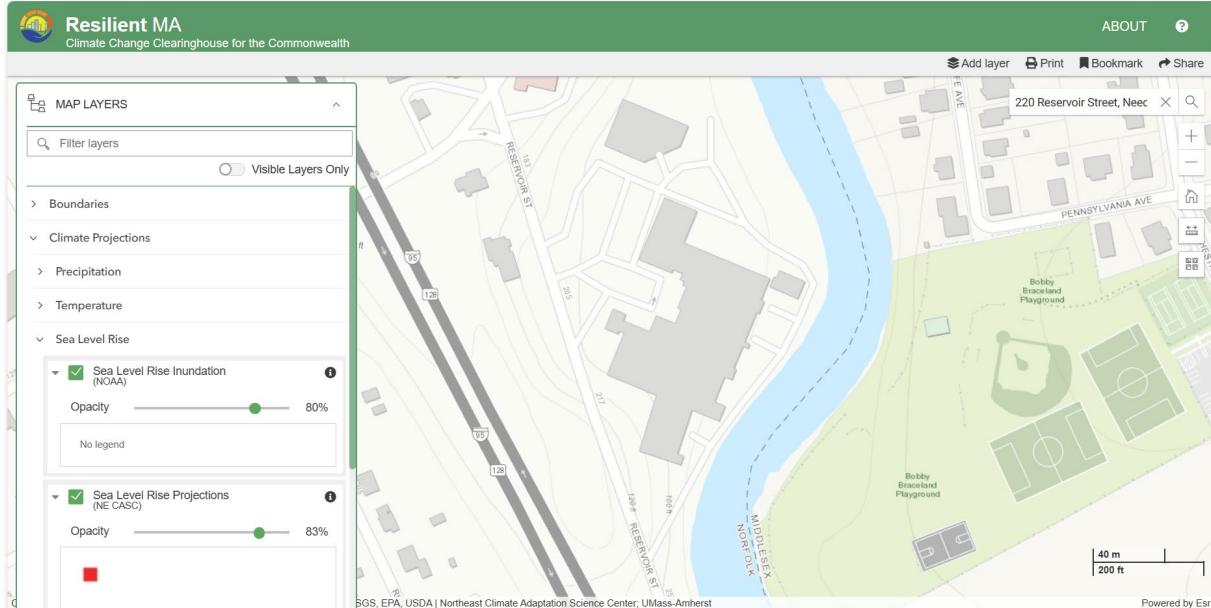
ATTACHMENT 3: CLIMATE CHANGE VULNERABILITY CASE STUDY, January 2024

[ResilientMass Climate Hub \(arcgis.com\)](#) SCREENSHOTS

LSPA CLIMATE CHANGE SUBCOMMITTEE

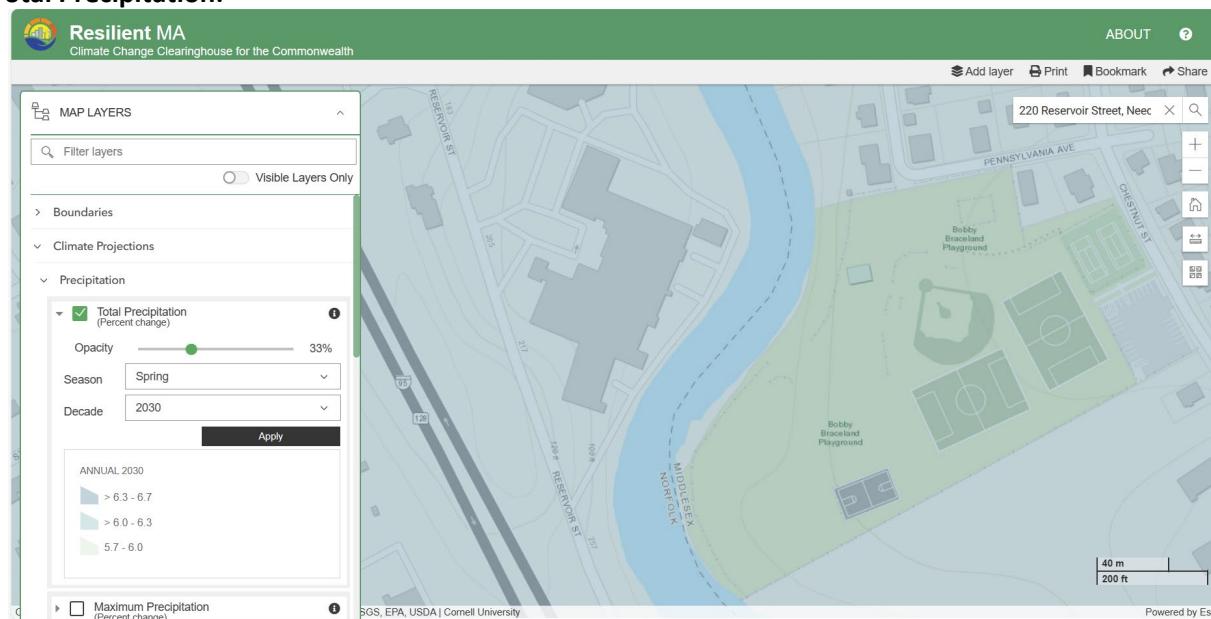
FICTIONAL CASE STUDY #2 - DISPOSAL SITE NEAR FLOODING RIVER

Appendix A: Sea Level Rise – Both “Sea Level Rise Inundation and Sea Level Rise Projections”

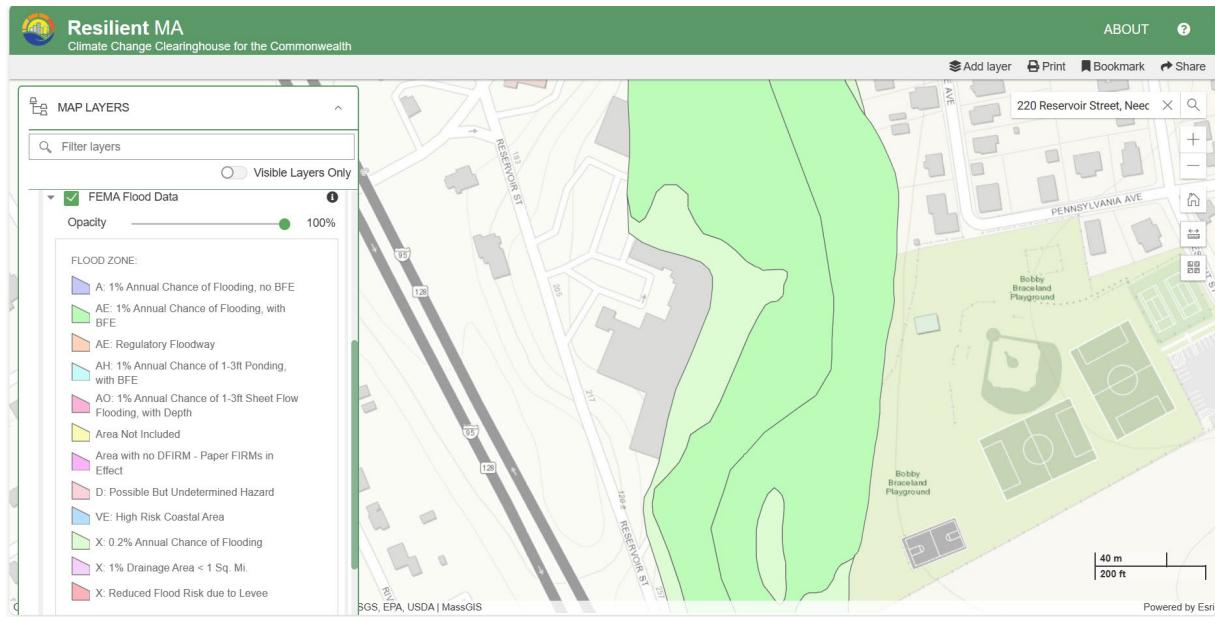


Appendix B: Precipitation.

Total Precipitation:

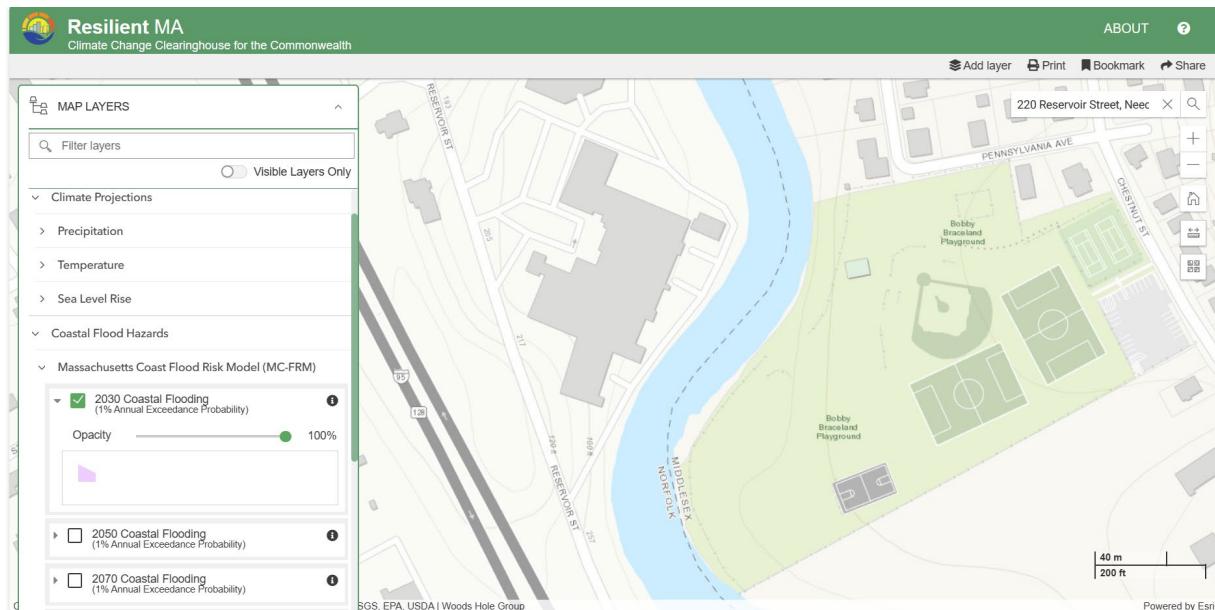


FEMA Flood Zone:

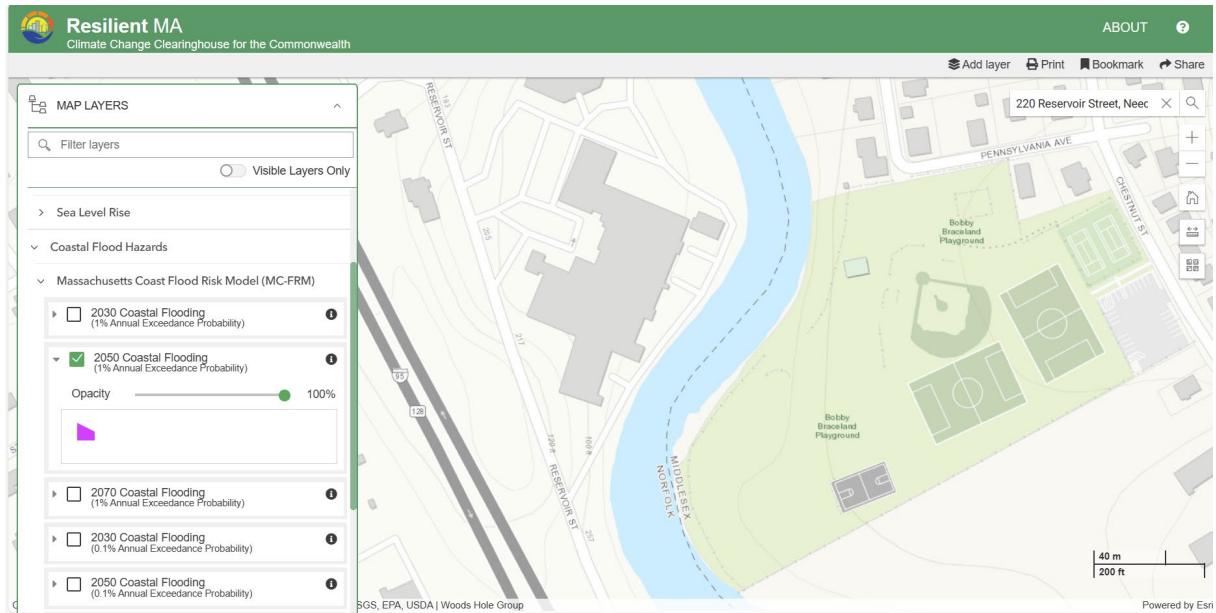


Appendix C: Massachusetts Coast Flood Risk Model (MC-FRM) – 2030, 2050 & 2070, 1% Annual Exceedance Probabilities.

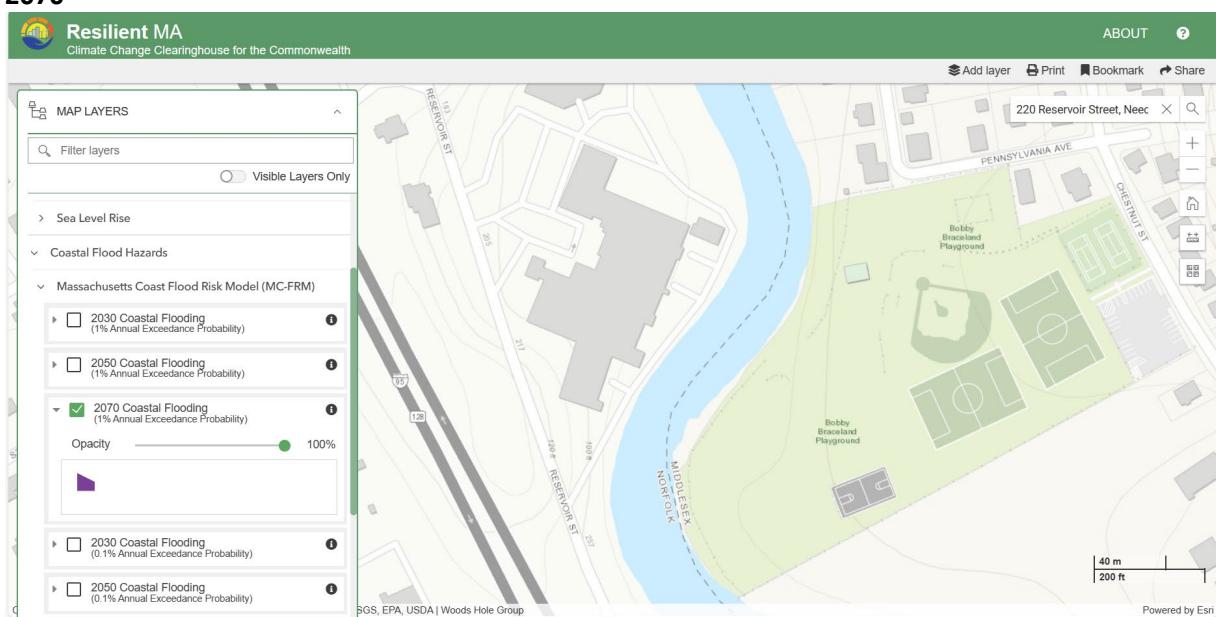
2030



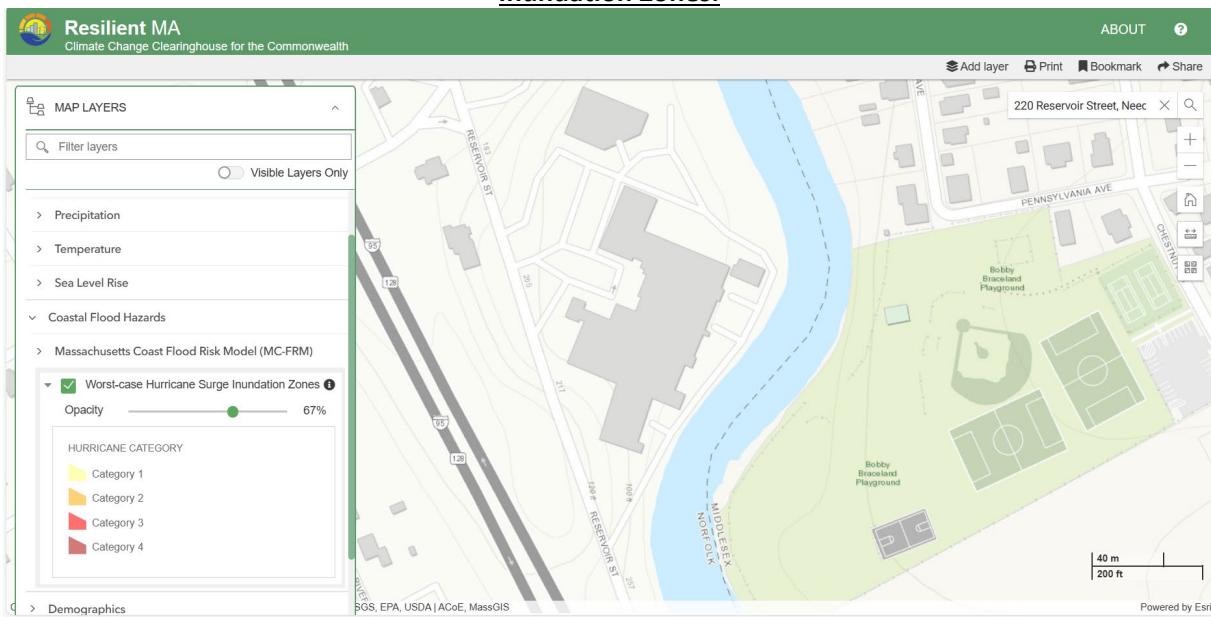
2050



2070



Appendix D: Massachusetts Coast Flood Risk Model (MC-FRM). Worst-case Hurricane Surge Inundation Zones:




ATTACHMENT 3: CLIMATE CHANGE VULNERABILITY ASSESSMENT CHECKLIST, Applied to Case Study 2

DATE PREPARED: _____

A. GENERAL SITE INFORMATION																																																																																			
<p>Site Name: Flooding River Case Study - This case study is fictional and created for educational purposes only.</p> <p>Site RTN(s): 0-00000</p> <p>Site Address: Fictional MCP Site</p>																																																																																			
<p>Setting: Mark those applicable with an "X"</p> <table> <tr> <td>Site Use</td> <td>GW Category</td> <td>OHM Released:</td> <td>Media Impacted</td> </tr> <tr> <td>Residential _____</td> <td>GW-1 _____</td> <td>Gasoline _____</td> <td>Soil <input checked="" type="checkbox"/> X</td> </tr> <tr> <td>School _____</td> <td>GW-2 <input checked="" type="checkbox"/> X</td> <td>Oil <input checked="" type="checkbox"/> X</td> <td>Groundwater <input checked="" type="checkbox"/> X</td> </tr> <tr> <td>Daycare _____</td> <td>GW-3 <input checked="" type="checkbox"/> X</td> <td>TCE _____</td> <td>Sediment _____</td> </tr> <tr> <td>Commercial <input checked="" type="checkbox"/> X</td> <td colspan="3">Chlorinated VOCs _____</td> </tr> <tr> <td>Recreational/ Open Space _____</td> <td>Depth to Groundwater (ft bgs)</td> <td>Metals _____</td> <td>Soil vapor (VI) _____</td> </tr> <tr> <td>Other _____</td> <td>3 7 Minimum Maximum</td> <td>PCBs _____</td> <td>Indoor Air _____</td> </tr> <tr> <td></td> <td></td> <td>PFAS _____</td> <td>Surface water _____</td> </tr> <tr> <td></td> <td></td> <td></td> <td>Drinking Water _____</td> </tr> <tr> <td></td> <td></td> <td></td> <td>Ecologically Sensitive area _____</td> </tr> <tr> <td>Area Use</td> <td>Soil Category</td> <td>Source(s) of OHM:</td> <td>Current MCP Phase</td> </tr> <tr> <td>Mixed _____</td> <td>S-1 _____</td> <td>UST Release _____</td> <td>Phase 1 <input checked="" type="checkbox"/> X</td> </tr> <tr> <td>Rural _____</td> <td>S-2 <input checked="" type="checkbox"/> X</td> <td>_____</td> <td>Phase 2 _____</td> </tr> <tr> <td>Commercial <input checked="" type="checkbox"/> X</td> <td>S-3 <input checked="" type="checkbox"/> X</td> <td>_____</td> <td>Phase 3 _____</td> </tr> <tr> <td>Urban _____</td> <td></td> <td>_____</td> <td>Phase 4 _____</td> </tr> <tr> <td>Residential _____</td> <td></td> <td>_____</td> <td>Phase 5 _____</td> </tr> <tr> <td>Suburban _____</td> <td></td> <td>_____</td> <td>ROS _____</td> </tr> <tr> <td>Vacant/ Future Development</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Other _____</td> <td></td> <td></td> <td></td> </tr> <tr> <td>River _____</td> <td></td> <td></td> <td></td> </tr> </table>				Site Use	GW Category	OHM Released:	Media Impacted	Residential _____	GW-1 _____	Gasoline _____	Soil <input checked="" type="checkbox"/> X	School _____	GW-2 <input checked="" type="checkbox"/> X	Oil <input checked="" type="checkbox"/> X	Groundwater <input checked="" type="checkbox"/> X	Daycare _____	GW-3 <input checked="" type="checkbox"/> X	TCE _____	Sediment _____	Commercial <input checked="" type="checkbox"/> X	Chlorinated VOCs _____			Recreational/ Open Space _____	Depth to Groundwater (ft bgs)	Metals _____	Soil vapor (VI) _____	Other _____	3 7 Minimum Maximum	PCBs _____	Indoor Air _____			PFAS _____	Surface water _____				Drinking Water _____				Ecologically Sensitive area _____	Area Use	Soil Category	Source(s) of OHM:	Current MCP Phase	Mixed _____	S-1 _____	UST Release _____	Phase 1 <input checked="" type="checkbox"/> X	Rural _____	S-2 <input checked="" type="checkbox"/> X	_____	Phase 2 _____	Commercial <input checked="" type="checkbox"/> X	S-3 <input checked="" type="checkbox"/> X	_____	Phase 3 _____	Urban _____		_____	Phase 4 _____	Residential _____		_____	Phase 5 _____	Suburban _____		_____	ROS _____	Vacant/ Future Development				Other _____				River _____			
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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")		X																																																																																	
2 Is the site in active operation and maintenance (O&M) or ROS?		X																																																																																	
3 Does the site have or will the site require an AUL?		X																																																																																	
4 Is there a containment cap/barrier or other engineered control?		X																																																																																	
5 Does the site have or will the site require an AEPMM?		X																																																																																	
6 Is the site characterized by an IH condition, a CEP or an SRM?		X																																																																																	
7 Is the site in an environmental justice location or are sensitive populations present?		X																																																																																	
8 Is the site in an ACEC and/or sensitive habitat?	X																																																																																		
9 Is the site near an inland waterway?	X																																																																																		
10 Are there essential infrastructure, equipment, or structures present and at risk?		X																																																																																	
11 Would potential climate impacts substantially alter the fate and transport of site contaminants of concern?		X																																																																																	
12 Is the anticipated closure a Temporary Solution?		X																																																																																	
13 All/a portion of the site has a history of coastal flooding and/or is located within a potential future storm surge area?		X																																																																																	

INSTRUCTIONS/ RESOURCES

The intended use of this Checklist (and the accompanying Glossary and Resources) is as a tool to provide a broad range of considerations when assessing climate vulnerability at 21E sites pursuant to Conceptual Site Model as defined in 310 CMR 40.0006 , RAPS in 310 CMR 40.0191, and consideration of foreseeable future changes in site conditions 310 CMR 40.1005.

Section A contains a summary of the general conditions that are most likely to drive risk at the site. Add any relevant site-specific information if not already provided.

GW Categories are defined in 310 CMR 40.0932.

Area Use is current use; however, keep in mind that future area use may differ substantially depending on the site.

Soil Categories are defined in 310 CMR 40.0933.

Section B is an initial screening step, describing the site now. If all the answers in this section are "no", document the finding in the CSM and current MCP report, and no further vulnerability assessment is necessary.

B.10 For example: stormwater infrastructure, remedial systems that rely on a constant source of power, etc.

B.13 Information can be found at ResilientMA CCSC Map Viewer (resilientma.org), and contacting the Town/City's Engineering Department or DPW. Add links

14 All/a portion of the site is within an existing FEMA 1% flood hazard area?	X				https://msc.fema.gov/portal/home	
15 All/a portion of the site has a history of flooding during precipitation events?		X				
** If any answers to Questions 2 through 15 above are "Yes," proceed to Sections C - E ** ** If all answers to Questions 2 through 15 are "No," proceed to Section F to document no anticipated climate change risk **						
C. EXPOSURE CONSIDERATIONS						
1 Applied forecast duration [check one]: Based on Resilientma.org	10 years	30 years	x	50 - 80 years	Other	Believed sufficient based on CSM.
Likelihood of impacts						
2 SEA LEVEL RISE Impacts (based on resilientma.org climate data)	LOW	MEDIUM	HIGH	N/A	Flooding, Coastal Erosion & Storm Surge	Section C begins with the selection of an evaluation timeframe based on the persistence of contaminants of concern pursuant to an applied remedial and/or forecast duration. For example, planning for a remedial action may use a shorter timeframe than would an opinion about a Permanent Solution. Items 2-5 below can be projected using Resilientma.org and evaluated based on the timeline selected.
a. All/a portion of the site will change from upland to intertidal conditions (tide benchmarks)				X	Inland site	See Climate Projections>Sea Level Rise> Layers at https://resilientma.org/map/
b. All/a portion of the site will change from upland to subtidal conditions (tide benchmarks)				X	Inland site	
3 EXTREME WEATHER EVENT Impacts (based on resilientma.org climate data)	LOW	MEDIUM	HIGH	N/A	Flooding, Coastal Erosion & Storm Surge	
a. Erosion or slope stability damage.		X				See Coastal Vulnerability> Layers at https://resilientma.org/map/
b. Ice dams, frozen utilities, snow load damage				X	No remedy infrastructure	
c. Wind hazards/tree uprooting		X				
4 PRECIPITATION (based on resilientma.org climate data)	LOW	MEDIUM	HIGH	N/A	Related Natural Hazards: Inland Flooding, Drought & Landslides	See Climate Projections>Precipitation> Layers at https://resilientma.org/map/
a. All/a portion of the site will in the foreseeable future be within a 1% flood hazard area			X			
b. Remediation of the site is likely to result in a net increase in impervious area				X	No increase in paving	
c. All/a portion of the project is within 500 feet of a stream/river at risk of increased flooding in the foreseeable future.			X			
d. Changes in precipitation lead to drought conditions		X				
5 Other based on resilientma.org climate data	LOW	MEDIUM	HIGH	N/A	Related Natural Hazards: Average/Extreme Temperatures, Wildfires & Invasive Species	
a. Changes in exposure from vadose zone seasonal temperature increase	X					
b. Ecosystem/flora/fauna loss (invasive species)	X					
c. Increase in potential for wildfires	X					
d. Impact of remedial action on surrounding community related to heat island effects				X	Remedy has no heat island effect	
D. SENSITIVITY CONSIDERATIONS						Comments/ Notes
1 Altered contaminant fate and transport	LOW	MEDIUM	HIGH	N/A		Section D is intended to evaluate the increased risk of exposure to contaminants of concern due to climate-related site changes. For example, such changes can alter contaminant fate and transport, impair site remedy effectiveness, and endanger nearby human and environmental receptors.
a. Physical characteristics of site contaminants of concern (COCs) support increased risk of transport due to climate change (such as solubility, absorption, etc.)	X				NSR levels unlikely to be affected	
b. Chemical characteristics of site COCs support increased transport due to climate change	X				NSR levels unlikely to be affected	
c. Site specific biological/environmental characteristics increase risk of climate enhanced transport	X				NSR levels unlikely to be affected	
d. Climate triggered substantial changes in groundwater elevation may impact fate and transport (including LNAPL)	X				NSR levels unlikely to be affected	
2 Moderate to severe equipment/building/infrastructure impacts	LOW	MEDIUM	HIGH	N/A		
a. Climate impacts may affect/alter the functioning of remedial components			X		No remedy infrastructure	
b. Impacts to utilities and infrastructure at the site or essential to the remedy			X		No remedy infrastructure	
c. Site conditions limit ability for adaptive site management to mitigate climate risk			X		No remedy infrastructure	
3 Moderate to severe human health/demographic impacts	LOW	MEDIUM	HIGH	N/A		
a. Localized impacts to health and safety of site occupants and abutters as a result of climate-based changes at the site	X				NSR-unlikely to pose new future risk	
b. Increase in airborne dust exposure due to drought and/or temperature increase	X				Subsurface location makes unlikely	
c. Cumulative effects on local environmental justice community as a result of climate change impacts on the remedial action				X	Not in EJ zone	
4 Moderate to severe wildlife/ecosystem impacts	LOW	MEDIUM	HIGH	N/A		
a. A climate impact on the remedial solution may result in new risks to sensitive habitat(s).	X				NSR-unlikely to pose new future risk	Massachusetts 2020 Environmental Justice Populations (arcgis.com)

CONSIDERATIONS FOR CLIMATE CHANGE IMPACTS ON GROUNDWATER					Comments/ Notes
	LOW	MEDIUM	HIGH	N/A	
1 <i>Significant impacts to groundwater elevation</i>		X			
a. Increased or decreased rainfall		X			
b. Increases/decreases in water levels at hydrologic boundaries		X			
c. Impact of future off-site migration measures			X	No off-site migration measures	
d. Increased evapotranspiration/decreasing recharge	X				
e. Episodic elevated groundwater elevation due to high precipitation events		X			
f. Impact on groundwater monitoring wells			X	MWs will be decommissioned	
g. Saltwater intrusion			X	Inland site	
h. Potential long term regional changes		X			
2 <i>Significant impacts to direction of flow</i>	LOW	MEDIUM	HIGH	N/A	
a. Increases/decreases in water levels at hydrologic boundaries		X			
b. Impact on sources or sinks in area	X				
c. Creation/elimination of preferential pathways	X				
d. Impacts of changes in stormwater management		X			
3 <i>Significant impacts to fate and transport of contamination</i>	LOW	MEDIUM	HIGH	N/A	
a. Inundation of previously unsaturated soils			X		
b. Increased temperatures resulting in enhanced vapor migration	X				
c. Changes in groundwater chemistry	X				
4 <i>Likelihood of significant impacts to effectiveness of remedy</i>	LOW	MEDIUM	HIGH	N/A	
a. Impact on capture zone			X	No active systems	
b. Changes in effectiveness of vadose zone treatment (SVE, bioventing)			X	No active systems	
c. Impacts on in-situ treatment - groundwater chemistry, saturated thickness, natural attenuation			X	No active systems	
CONCLUSION					
1 Based on the answers above, the remedy "is not likely to be" / "is likely to be" / "will be" vulnerable to climate change: *	Not Likely	Is Likely	Will Be		Consider all of the information in sections A-E to form a conclusion/opinion on the potential for climate change to impact the Conceptual Site Model and the resilience of the remedial action to projected changes. This conclusion/opinion must be consistent with 310 CMR 40.0193.

*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.

ACRONYMS USED IN CHECKLIST:

ACEC	areas of critical environmental concern
CEP	critical exposure pathway
COCs	contaminants of concern
FEMA	federal emergency management agency
IH	imminent hazard
LNAPL	light non-aqueous phase liquid
MCP	Massachusetts Contingency Plan
O&M	operation & maintenance
OHM	oil and/or hazardous material
ROS	remedy operation status
SRM	substantial release migration
SVE	soil vapor extraction
TCE	trichloroethene/ trichloroethylene
VOCs	volatile organic compounds

CLIMATE RELATED GLOSSARY DEFINITIONS

January 2024



Climate in a narrow sense is usually defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization. The relevant quantities are most often surface variables such as temperature, precipitation, and wind. Climate in a wider sense is the state, including a statistical description, of the climate system.

TERMINOLOGY	DEFINITION - as used in this toolkit and in the framework of the MCP	SOURCE REFERENCE
Adaptation	Process, action, or adjustment (natural or facilitated) to reduce site vulnerability and lessen the negative impacts of climate change.	A, G
Assessment	The practice of identifying options to adapt to climate change and evaluating them in terms of criteria such as availability, benefits, costs, effectiveness, efficiency, and feasibility.	A
Adaptive Capacity	The ability to adjust or modify operations, policies, or other functions to changing natural hazards and climate change impacts.	H
Adaptive Site Management	A process of iteratively planning, implementing, and modifying strategies for protecting/managing sites and resources in the face of impacts from changing climate conditions.	F
Anticipated Useful Life	An estimated number of years a remedial approach will be in use before needing reinvestment to continue performing its normal function(s). Considering the anticipated useful life can help inform decisions about resilience-related remedial alternatives.	G
Best Management Practices (BMPs)	Effective and practical methods or techniques to achieve climate-impact resilient cleanup.	F
Climate	Climate in a narrow sense is usually defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization. The relevant quantities are most often surface variables such as temperature, precipitation, and wind. Climate in a wider sense is the state, including a statistical description, of the climate system.	A

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TERMINOLOGY	DEFINITION - as used in this toolkit and in the framework of the MCP	SOURCE REFERENCE
Climate Change	A change in the state of the climate that can be identified by statistical changes of its properties that persist for an extended period, typically decades or longer, whether due to natural variability or as a result of human activity.	A,G,H
Climate Forecast	Output from climate model as applied to the site.	
Climate Parameters	The primary climate hazards referenced by the State Hazard Mitigation and Climate Adaptation Plan (SHMCAP)/Resilient Massachusetts Action Team (RMAT) standards including changes in precipitation, sea level rise, rising temperatures, and extreme weather.	H
Climate Model	A numerical/mathematical tool to provide a forecast of future climate parameters.	H
Cumulative Risk / Probability	Measure of the total probability that a certain event will happen during a given period of time (e.g., for a 1% annual chance flood event also called the 100-year flood, the cumulative probability over 30-years is 25%).	G
Drought	A period of dry weather long enough to cause a serious hydrological imbalance. Drought is a relative term; therefore, any discussion in terms of precipitation deficit must refer to the particular precipitation-related activity that is under discussion.	A
Environmental Justice	Environmental Justice (EJ) is the equal protection and meaningful involvement of all people with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies and the equitable distribution of environmental benefits.	F
Environmental Justice Populations	Environmental Justice Areas as designated by the Commonwealth. See ResilientMA.org population layer.	I,O
Extreme Heat	Extreme heat for Massachusetts is usually defined as a period of time of 3 or more consecutive days above 90 degrees.	H

CLIMATE RELATED GLOSSARY DEFINITIONS

January 2024



Climate in a narrow sense is usually defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization. The relevant quantities are most often surface variables such as temperature, precipitation, and wind. Climate in a wider sense is the state, including a statistical description, of the climate system.

TERMINOLOGY	DEFINITION - as used in this toolkit and in the framework of the MCP	SOURCE REFERENCE
Extreme Weather Events	Includes hurricanes, tropical storms, severe winter storms, nor'easters, tornadoes, and other severe weather events (including strong wind and extreme precipitation) as defined in SHMCAP.	H
Exposure (to climate impacts)	The extent to which the site is located in an area that could be adversely affected by climate change; specifically precipitation (e.g., inland flooding, drought, landslide), sea level rise (e.g., coastal flooding, coastal erosion, tsunami), rising temperature (e.g., average/extreme temperatures, wildfires, invasive species), and extreme weather (e.g., hurricanes/storms, nor'easters, tornadoes).	A,G
Flood	The accumulation of water over areas that are not normally submerged.	A
Flood Protection	Measures taken to mitigate adverse affects to the remedy, assets, or site due to flooding.	G
Forecast or Climate Forecast (Prediction)	Output of Climate Model or Climate Projections. See <i>Projections</i> definition.	
Foreseeable Future (in terms of MCP cleanup regulations)	See <i>Reasonably Foreseeable Future</i> definition below.	
Green Infrastructure	Ecological systems with the purpose of increasing resilience to climate change, improving environmental sustainability, and/or managing other environmental hazards.	F
Green Remediation	The practice of considering all environmental effects of remedy implementation and incorporating options to minimize the environmental footprint of clean-up actions.	C,F

CLIMATE RELATED GLOSSARY DEFINITIONS

January 2024



Climate in a narrow sense is usually defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization. The relevant quantities are most often surface variables such as temperature, precipitation, and wind. Climate in a wider sense is the state, including a statistical description, of the climate system.

TERMINOLOGY	DEFINITION - as used in this toolkit and in the framework of the MCP	SOURCE REFERENCE
Hazard	A process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation.	B
Impact	Effect on natural and human systems that results from hazards. Evaluating potential impacts is a critical step in assessing vulnerability.	E
Impacts of Climate Change	The effects of the climate parameters (see above) on a remedy.	H
Massachusetts Contingency Plan (MCP)	A set of regulations in 310 CMR 40.0000 to clean up contamination due to a release of oil and/or hazardous material as defined in the MGL 21E statute.	M
Model	See climate model.	
Mitigation	Reduction of potential adverse impacts of climate change through design and implementation of remedies that reduce hazard, exposure, and/or vulnerability.	A,B,F
Nature-based Solutions	An action that uses natural systems, mimic natural processes, or work in tandem with traditional approaches to address climate change impacts like flooding, erosion, drought, and heat islands.	L
NOAA Atlas 14	Precipitation frequency data compiled by NOAA, used in evaluation and planning for flood storage capacity and other extreme precipitation mitigation measures.	K
Projections	Potential future climate conditions calculated by computer-based models of the Earth system. Projections are based on sets of assumptions about the future. See also "Climate Model" and "Climate Forecast" definitions.	H

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TERMINOLOGY	DEFINITION - as used in this toolkit and in the framework of the MCP	SOURCE REFERENCE
Reasonably Foreseeable Future (for climate change MCP cleanup regulations)	A future date to which the response action is designed considering anticipated climate change impacts to the remedy in terms of current time (up to 10 years), mid-term (30 years), longer term (50 to 80 years), such that the remedy remains protective of potential future exposure. Reasonably Foreseeable Future depends on LSP judgement and may vary based on contaminant type, fate and transport (e.g., degradation rates, solubility, adsorption, volatilization, and/or NAPL behavior) and may be limited to model forecast timeframe capabilities.	Committee defined ¹
Resilience (to climate change impacts)	The capacity to prevent, withstand, respond to, adapt to, and/or recover from climate change impacts and to build the capability and ability of an area/site/system to minimize the adverse impacts of climate change.	D,F
Resilient Design	Intentional elements of buildings, landscapes, communities, remedies, etc. in response to vulnerabilities to projected adverse impacts of climate change.	F
Resilient Massachusetts Action Team (RMAT)	An inter-agency team tasked with implementing the State Hazard Mitigation and Climate Adaptation Plan (SHMCAP)	G
Risk (in terms of climate change impacts)	A measure of vulnerability in terms of climate change impacts. See definition of vulnerability as a function of exposure, sensitivity, and adaptive capacity.	A, C, F, G

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<u>TERMINOLOGY</u>	<u>DEFINITION - as used in this toolkit and in the framework of the MCP</u>	<u>SOURCE REFERENCE</u>
Sea Level Rise	The worldwide average rise in mean sea level, which may be due to a number of different causes, such as the thermal expansion of sea water and the addition of water to the oceans from melting glaciers, ice caps, and ice sheets.	G
Sensitivity (to climate impacts)	The degree to which a system, population, resource, or remedy is or might be affected by the projected adverse impacts of climate change. Considerations may include location, demographics, equipment & structures, site status, contaminant fate and transport, environmental resources and receptors.	E, Committee defined ¹
SHMCAP (Massachusetts State Hazard Mitigation and Climate Adaptation Plan)	<p>State-wide plan that integrates a traditional hazard mitigation plan with a climate change adaptation plan. The SHMCAP integrates information and planning elements for 14 natural hazards that could affect the Commonwealth with the following four climate changes: changes in precipitation, sea level rise, rising temperatures, and extreme weather.</p>	H
Storm Damage Prevention	Measures taken to mitigate the severity and consequence of a storm event on the remedy / site / asset due to erosion and sedimentation, damage to vegetation, property, or buildings/infrastructure, damage caused by flooding, waterborne debris, ice, and/or wind.	D,G
Storm Surge	A temporary increase in sea level accompanying an extreme weather event whose height is the difference between the observed level of the sea surface and the level that would have occurred from tidal variation alone.	A,G

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TERMINOLOGY	DEFINITION - as used in this toolkit and in the framework of the MCP	SOURCE REFERENCE
Sustainable Remediation	A cleanup that maximizes the net environmental, societal, and economic benefits by considering factors during remedy selection, design, and implementation that improves the overall environmental performance of a remedy while balancing economic growth, protection of human health and the environment, and social responsibility.	J
Vulnerability (to climate change impacts)	The degree to which a system is susceptible to or predisposed to be adversely affected by climate change impacts as a function of exposure, sensitivity, and adaptive capacity.	A, C, F, G
Vulnerability Assessment	Evaluation of the site characteristics and nature of the remedy to cope with adverse effects of climate change in terms of exposure, sensitivity, and adaptive capacity. Four primary climate changes to consider include: precipitation, sea level rise, rising temperature, and extreme weather.	C,F
21E	Massachusetts General Law Chapter 21E is the Massachusetts Oil & Hazardous Material Release Prevention Act that addresses the assessment and cleanup of contamination due to the release of oil and/or hazardous material. The Act is implemented by the Massachusetts Contingency Plan (MCP) regulations to which these climate change amendments will be incorporated. [Please note that these climate change amendments are not being written to address real estate transaction due diligence studies often referred to as 21E studies.]	N

¹ Original definition by the document authors after consulting a variety of resources.

ACRONYMS USED IN GLOSSARY:

NAPL	non-aqueous phase liquid
MCP	Massachusetts Contingency Plan
LSP	Licensed Site Professional
LSPA	Licensed Site Professional Association
NOAA	National Oceanic and Atmospheric Administration
SHMCAP	State Hazard Mitigation and Climate Adaptation Plan

REFERENCES FOR GLOSSARY DEFINITIONS

Note that these references were utilized to tailor definitions specific to 21E sites.

A	Intergovernmental Panel on Climate Change (IPCC), 2012: Glossary of terms. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 555-564	https://archive.ipcc.ch/pdf/special-reports/srex/SREX-Annex_Glossary.pdf
B	United Nations Office for Disaster Risk Reduction: Terminology. Adopted by the United Nations General Assembly on February 2nd, 2017.	https://www.unrr.org/terminology
C	United States Environmental Protection Agency Superfund Climate Resilience	https://www.epa.gov/superfund/superfund-climate-resilience
D	Town of Arlington Regulations for Wetlands Protection, March 2018	https://www.arlingtonma.gov/home/showdocument?id=41320
E	US Climate Resilience Toolkit	https://toolkit.climate.gov/content/glossary
F	Interstate Technology and Regulatory Council (ITRC), Sustainable Resilient Remediation (SRR)	https://srr-1.itrcweb.org/
G	Resilient MA Action Tool (RMAT) 6/24/2020 Draft Climate Resilience Design Standards	https://www.mass.gov/doc/draft-project-overview/download
H	Massachusetts Integrated State Hazard Mitigation and Climate Adaptation Plan, 2018 [SHMCAP] and 2023 update	https://www.mass.gov/info-details/2023-resilientmass-plan
I	Executive Office of Energy and Environmental Affairs (EEA) 2020 Environmental Justice Communities in Massachusetts	https://www.mass.gov/info-details/environmental-justice-communities-in-massachusetts
J	Massachusetts Department of Environmental Protection (MassDEP): Sustainable Remediation - FAQs	https://www.mass.gov/doc/faq-sustainable-remediation/download
K	NOAA Atlas 14 Point Precipitation Frequency Estimates: Northeastern States; NOAA Atlas 14, Volume 10, Version 3	https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html
L	Municipal Vulnerability Preparedness (MVP) Program	https://www.mass.gov/municipal-vulnerability-preparedness-mvp-program
M	Massachusetts Contingency Plan (MCP)	https://www.mass.gov/regulations/310-CMR-4000-massachusetts-contingency-plan
N	21E: Massachusetts Oil & Hazardous Material Prevention Act	https://malegislature.gov/laws/generallaws/partI/titleII/chapter21e
O	EEA Environmental Justice Population Map	https://www.mass.gov/info-details/environmental-justice-populations-in-massachusetts#interactive-map-



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ATTACHMENT 5

LSPA Climate Change Subcommittee, January 2024

MCP Climate Change Toolkit

Climate Change Technical Resources

1 MA Climate Change Clearinghouse and Resilient MA Action Team

- [MA Climate Change Clearinghouse \(mass.gov\)](#)
 - The ResilientMass site is “committed to including only information with scientific merit from credible sources. Where applicable, the ResilientMass site incorporates data and information that Massachusetts has used for statewide and local climate planning.” Among other things, the site links to:
 - [2023 ResilientMass Plan | Mass.gov \(SHMCAP\)](#)
 - MVP Program
 - Resource Clearinghouse
 - [ResilientMass Climate Hub \(arcgis.com\)](#), Interactive Maps and Data Center
 - Climate Resilience Design Standards Tool

2 Massachusetts Office of Technical Assistance and Technology (OTA)

- [Mapping Toxics in Communities and Assessing Climate Vulnerability | Mass.gov](#)
 - Provides maps with various “sensitivity” layers

3 Sustainable Remediation Forum (SURF)(EcoAdapt, BU, MassDEP)

- [Massachusetts Climate Change and Hazardous Waste Site Screening, 2019](#)
 - “Exposure” models for floods, hurricanes, SLR (FEMA, NOAA)
 - Incorporated environmental, demographic and 21E site-specific “Sensitivity” parameters (e.g., Open, Active, AEPMM, IH, CEP, AUL)

4 Interstate Technology & Regulatory Council (ITRC)

- [Sustainable and Resilient Remediation \(SRR\) Team](#)
- [Final Guidance published 4/21](#)
 - Resilience BMPs

5 USEPA

- [Superfund Climate Resilience webpage](#)
 - Vulnerability Assessment
 - Resilience Measures
 - Adaptive Capacity
- [Climate Smart Brownfields Manual](#) 6/21, EPA 560-F-21-002
- [Climate Adaptation Plan](#) 10/21, EPA 231-R-210-01

6 White House

- [Fact Sheet](#) 10/21, Adaptation and Resilience Plans from Across Federal Government

7 MassDOT, WoodsHole, UMassBoston

- [Summary of Pilot Project Report:](#)
 - Climate Change and Extreme Weather Vulnerability Assessments and Adaptation Options for the Central Artery, 2015
 - Probabilistic Hydrodynamic Modeling (ADCIRC, SWAN)
- [Massachusetts Coast Flood Risk Model \(MC-FRM\):](#)
 - Includes every Massachusetts coastal city and town influenced by future coastal storm surge induced flooding during this century

8 First Street Foundation

- [Defining America's Flood Risk](#)
 - Collaboration of 80 of the world's leading hydrologists, researchers and data scientists
 - Property-by-property flood forecast maps for whole country (LISFLOOD-FP, GeoCLAW, ADCIRC-SWAN)

9 US DHS - FEMA

- [National Risk Index](#)
 - Natural hazard risk metrics for 18 natural hazards
 - County and census tract level

10 MA - CZM

- [Massachusetts Sea Level Affecting Marshes Model \(SLAMM\) Viewer](#)
 - Effects of SLR on marshes

11 ASTM

- [Standard Guide for Remedial Action Resiliency to Climate Impacts](#)
 - ASTM E3249 - 21