



Climate Resilience Design Standards Tool
Resilient MA Action Team



One Size Fits All: A Tool for Climate Resilient Design Standards

Indrani Ghosh, PhD

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Climate Resilience**

March 29, 2023



AGENDA



WHY WAS THE TOOL DEVELOPED?



WHAT IS THE TOOL?



WHEN AND WHERE SHOULD THE TOOL BE USED?

Link to the Tool: https://resilientma.mass.gov/rmat_home/designstandards/



Climate Resilience Design Standards Tool

Resilient MA Action Team

Version 1.1 – updated April 25, 2022



2.5-Year History of Iterative Stakeholder Engagement

Resilient MA Action Team (RMAT)

Over 30 climate change coordinators and State Agency representatives



CAPITAL PLANNING WORKING GROUP

20+ State Agency and A&F representatives focused on integrating resilience into capital planning



EEA
MEMA
A&F
HED
DCR



W&S
WHG
BSC

ASSETS WORKING GROUPS & PILOT TESTING BETA TOOL

60+ State Agency representatives organized by buildings/facilities, infrastructure, and natural resources asset working groups



SCIENTIFIC WORKING GROUP

20+ leading climate academics, researchers, and others working on local, regional, and country-wide climate science studies

2020 PUBLIC COMMENT & 2021 BETA TOOL LAUNCH



Beta Tool Used for FY22 MVP and Massworks Grants
256 Responses to Public Feedback Survey and 20 Focus Groups



TECHNICAL ADVISORY GROUP

50+ consultants, academics, municipalities, regional planning organizations, non-profit agencies, and federal agencies

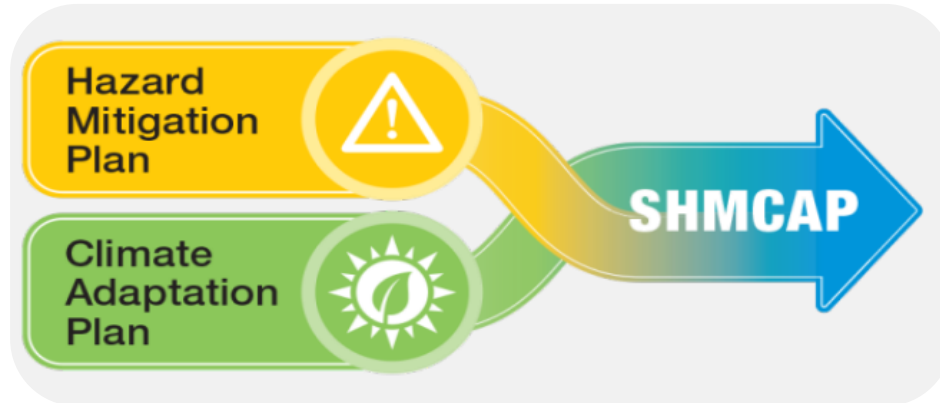


Climate Resilience Design Standards Tool

Resilient MA Action Team



WHY



RMAT's Climate Resilience Design Standards Tool (Tool) advances prioritized global (or cross-agency) actions from the SHMCAP.

The Tool supports efforts by Massachusetts agencies and municipalities to integrate best available statewide climate change projections into conceptual planning and design of projects with physical assets.

Integration of climate resilience into capital planning is a 2018 SHMCAP Priority Action



WHY

GOALS:

- Make preliminary climate resilience analysis **more broadly accessible**
- Provide recommendations based on **consistent use of state's climate data** hosted on **ResilientMa.org**
- Inform **"climate smart" capital planning** and procurement
- Provide a **unified planning and design support tool** that **state agencies and municipalities** can use for grant applications and evaluation of projects

Tool Reporting Workflow





WHAT DO YOU NEED TO USE THE TOOL?



- Access to internet, a computer, and a valid email address
- A project with physical assets that has been identified through Capital Planning, HMP, MVP, or other plans and the following preliminary information:

- Name** of the project
- Project **location** and approximate extent of project limits
- General details**, including estimated capital costs and contact information
- Planned or possible **ecosystem service benefits** through the project, if any
- Past climate exposure**, if any, for example history of flooding
- Asset Information**
 - Infrastructure Assets
 - Buildings/Facilities
 - Natural Resource Assets

The Tool is not recommended for the following types of projects:

- Projects with no physical assets
- Ecological restoration (note: dam removal is a construction type for natural resource assets)
- Demolition projects
- Regular maintenance projects
- Projects without a physical location
- Projects with a location area greater than 3 sq. miles (will need to segment the project and create multiple projects in Tool).



WHAT DO YOU GET FROM THE TOOL?

The Tool is intended to **inform climate resilient planning and design** of infrastructure, buildings, and natural resource assets in Massachusetts.



The Tool's report may be submitted and/or downloaded for inclusion in grant applications and/or project documents.

PRIMARY TOOL OUTPUTS:

- Preliminary Climate **Exposure & Risk** Screening
- Recommended Climate Resilience **Design Standards**

Additional supporting best practices & forms:

- Site Suitability Considerations
- Regional Coordination Considerations
- Flexible Adaptive Pathways Considerations

Recommended to be used in **conjunction with traditional engineering assessments**, feasibility analyses, and cost-benefit analyses to advance planning and design with Project Outputs.



WHAT

Project Outputs: Preliminary Climate Exposure and Risk Screening

OUTPUTS	PURPOSE
Evaluation of whether project within a mapped Environmental Justice population	Preliminary indication of potential impact to climate vulnerable populations , who may have lower adaptive capacity or higher sensitivity to climate hazards like flooding or heat stress due to factors such as access to transportation, income level, disability, racial inequity, health status, or age.
Ecosystem Service Benefits Score	Overall indication of the Ecosystem Service Benefits provided by a project, through protection of natural resources and implementation of nature-based solutions.
Preliminary Climate Exposure Score for Sea Level Rise/Storm Surge, Extreme Precipitation, and Extreme Heat	Provide a preliminary assessment of whether the overall project site and subsequent assets are exposed to impacts of natural hazard events and/or future impacts of climate change . This does not substitute a formal vulnerability assessment.
Preliminary Asset Climate Risk Ratings* for Sea Level Rise/Storm Surge, Extreme Precipitation, and Extreme Heat	Provide an initial screening to identify projects and assets with a “High Risk” designation, which may warrant additional review and/or design considerations. High Risk does not mean risky investment, and this does not substitute a formal risk assessment.



Project Outputs: Ecosystem Service Benefits Score

ECOSYSTEM SERVICES BENEFITS	Provides flood protection through nature-based solutions
	Reduces storm damages
	Recharges groundwater
	Protects public water supply
	Filters stormwater using green infrastructure
	Improves water quality
	Promotes decarbonization
	Enables carbon sequestration
	Provides oxygen production
	Improves air quality
	Prevents pollution
	Remediates existing sources of pollution
	Protects fisheries, wildlife, and plant habitat
	Protects land containing shellfish
	Provides pollinator habitat
Provides recreation	
Provides cultural resources/education	

EJ Impacts and Ecosystem Benefits



WHAT



Overall Project Scores Output

The Ecosystem Service Benefits Score and Preliminary Climate Exposure Ratings presented below are assigned to the overall project, while the Preliminary Climate Risk Ratings and Climate Resilience Design Standards are asset specific. The Scores and Standards are based on the questions previously answered and the location of the overall project. This information can be used to think critically about site suitability, regional resilience efforts, and adaptive site design for long-term climate resilience.

Environmental Justice

In Massachusetts, an Environmental Justice (EJ) neighborhood (census block group) is defined as meeting one or more criteria linked to the size of a census block group's minority populations, median household income, and language isolation. EJ neighborhoods typically include climate vulnerable populations, who may have lower adaptive capacity or higher exposure and sensitivity to



Does this project fall within mapped Environmental Justice neighborhoods?

Yes

Ecosystem Benefits

The purpose of this output is to provide an overall indication of the Ecosystem Service Benefits (ESB) provided by a project, through protection of natural resources and implementation of nature-based solutions. Natural systems and ecosystem services provide great economic value and social benefit, often untapped in non-resilient projects. Nature-based solutions may cost less than



Ecosystem Benefits Scores

Moderate

The Tool provides a preliminary indication of **potential impact to climate vulnerable populations** and of the **Ecosystem Service Benefits** provided by a project, through protection of natural resources and implementation of nature-based solutions.

Preliminary Climate Exposure Rating – Project Scale



WHAT




Overall Project Scores Output


Preliminary Climate Exposure Score

The purpose of the Exposure Score output is to provide a preliminary assessment of whether the overall project site and subsequent assets are exposed to impacts of natural hazard events and/or future impacts of climate change. For each climate parameter, the Tool will calculate one of the following exposure ratings: Not Exposed, Low Exposure, Moderate Exposure, or High Exposure. Click on the question mark to identify why your project location is receiving the exposure rating.

 **Sea Level Rise/Storm Surge** High

 **Extreme Precipitation - Urban Flooding** High

 **Extreme Precipitation - Riverine Flooding** Moderate

 **Extreme Heat** High

The Tool provides a **preliminary assessment** of whether the overall project site and subsequent assets are **exposed to impacts of natural hazard events and/or future impacts of climate change.**

This does not substitute a formal vulnerability assessment.

Preliminary Climate Risk Rating – Asset Scale



WHAT



Preliminary Asset Climate Risk Ratings and Recommended Design Standards Output

Select Asset (3 total)

Corridor Revitalization Infrastructure - Transportation Estimated lifespan: 40	Green Infrastructure Improvements Infrastructure - Green Infrastructure Estimated lifespan: 20	Flood Barrier Infrastructure - Dams and Flood Control Structures Estimated lifespan: 50
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Preliminary Climate Risk Ratings for Corridor Revitalization

The purpose of this output is to provide an initial screening to identify projects and assets with a High Risk designation, which may warrant additional review and/or design considerations. A Preliminary Risk Rating is determined for each applicable climate parameter by considering the asset's Preliminary Exposure Rating and responses to Step 4 questions provided by the user. The project proponent is encouraged to consider ways the Exposure Rating can be reduced through regional

Sea Level Rise/Storm Surge High	Extreme Precipitation - Urban Flooding High
Extreme Precipitation - Riverine Flooding High	Extreme Heat High

The Tool provides an initial screening to identify projects and assets with a “High Risk” designation, which may warrant additional review and/or design considerations.

This does not substitute a formal risk assessment.



Project Outputs: Recommended Climate Resilience Design Standards

The Standards provide a **basis-of-discussion for planning, early design, and evaluation** that is standardized across the Commonwealth based on **asset type, location, criticality, construction type, and useful life** of physical assets.

Each asset receives recommended Design Standards for sea level rise/storm surge, extreme precipitation, and extreme heat. These include recommended


- Intermediate and/or Target **planning horizons**
- **Return period*** or percentile
- Applicable **design criteria** with
 - Definitions
 - Projected values or methodologies for estimating projected values (using planning horizon and return period/percentile)
 - How projected values may inform planning, early design, and project evaluation
 - Limitations

*Note: Natural Resources assets will not receive a recommended return period, but projected values for specified return periods are provided where available to inform planning and early design


Recommended Climate Resilience Design Standards




WHAT



Sea Level Rise/Storm Surge



Extreme Precipitation



Extreme Heat

Target Planning Horizon: 2070 ?

Intermediate Planning Horizon: 2050 ?

Return Period: 500-yr (0.2%) ?

Design Criteria Applicable for Corridor Revitalization

- ✔ Projected Tidal Datums ▼
- ✔ Projected Water Surface Elevation ▲
- Definition** ▼

Projected Water Surface Elevation is the projected elevation for a specific future flood event, considering storm surge, tides, and wave setup.

- Projected Water Surface Elevation Values:** ▼

The projected modeled elevations may vary across large sites due to variations in the site's physical features (e.g., topography), so the elevations are presented as a maximum, minimum, and area weighted average values in the table below. The area weighted average represents the most typical value corresponding to the projected Water Surface Elevation of the project site.

Asset Name	Recommended Planning Horizon	Recommended Return Period	Max	Min	Area Weighted Average
			(ft - NAVD88)		
Corridor Revitalization	2050	0.2% (500-Year)	13.3	13.1	13.2

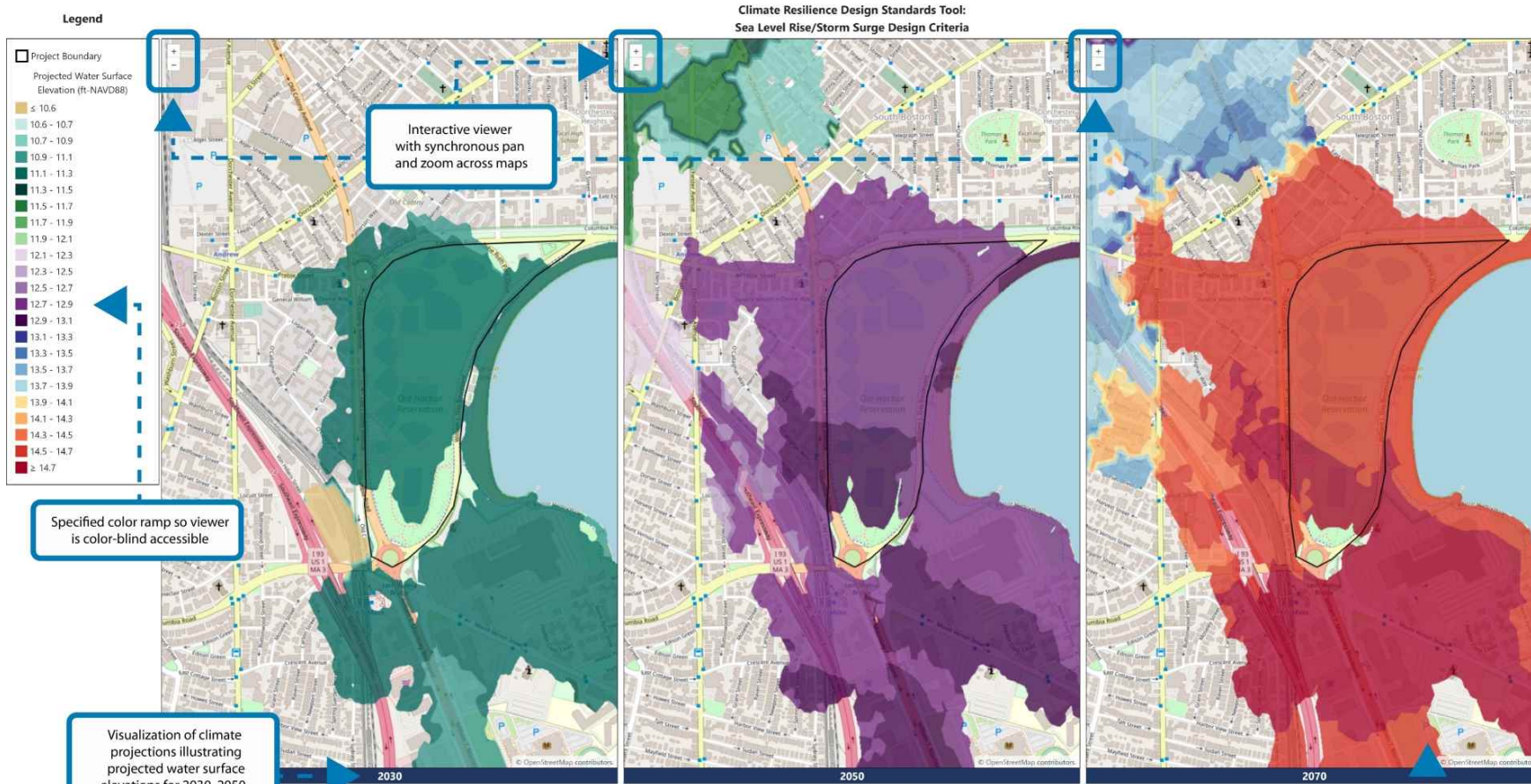
Sea Level Rise/Storm Surge Design Criteria:

- Projected Tidal Datums
- Projected Water Surface Elevation
- Projected Wave Action Water Elevation
- Projected Wave Heights
- Projected Duration of Flooding
- Projected Design Flood Velocity
- Projected Scour & Erosion

Recommended Climate Resilience Design Standards



WHAT



Interactive maps visualizing the projected water surface elevations for different planning horizons within 0.5 miles of the project location

Visualization of climate projections illustrating projected water surface elevations for 2030, 2050, and 2070 planning horizons

Specified color ramp so viewer is color-blind accessible

Interactive viewer with synchronous pan and zoom across maps

Maps and table generated based on asset with the lowest return period (largest design storm) recommendation out of the assets entered

Projected Water Surface Elevation Map: 0.5% (200-yr)
 Project Name: Mosley Park - Updated
 Location (Town): Boston
 Created by: Julie.eaton,W.S
 Date Created: 8/3/2021
 Tool Version: 1.2

Asset Name	Planning Horizon	Return Period	Max (ft-NAVD88)	Min (ft-NAVD88)	Area Weighted Average (ft-NAVD88)
Flood Barrier - South Boston Protection	2030	0.5% (200-yr)	11.3	10.6	11.1
	2050	0.5% (200-yr)	12.9	12.7	12.8
	2070	0.5% (200-yr)	14.7	14.6	14.6

Integrating recommended climate resilience design standards provided through Tool with visualization of projected values

Recommended Climate Resilience Design Standards



WHAT

Sea Level Rise/Storm Surge Extreme Precipitation Extreme Heat

Target Planning Horizon: 2070 ⓘ
Return Period: 100-yr (1%) ⓘ

Design Criteria Applicable for Test Barrier

✓ **Projected Total Precipitation Depth & Peak Intensity for 24-hr Design Storms** ^

Definition v

Total Precipitation Depth for 24-hour Design Storms is the total amount of rain in inches that falls over a period of 24-hours. It can be any 24-hour period, not just a traditional calendar day. This is given for a specific design storm (return period) such as the 100-year or 10-year storm (1% or 10%). Peak Intensity is the maximum rate of rainfall in inches per hour of a 24-hour design storm*.

Projected Total Precipitation Depth and Peak Intensity values can be used to assess potential flooding impacts and inform design of green and grey infrastructure solutions to mitigate flooding and manage stormwater.

Projected Total Precipitation Depth Values and Peak Intensity Methodology v

The Tool uses climate projections developed by Cornell University as part of the EEA's Massachusetts Climate and Hydrologic Risk Project. Assets receive a projected value for the 24-hour Total Precipitation Depth associated with a recommended return period (design storm) and planning horizon.

Asset Name	Recommended Planning Horizon	Recommended Return Period (Design Storm)	Projected 24-hr Total Precipitation Depth (inches)	Step-by-Step Methodology for Peak Intensity
Test Barrier	2070	100-Year (1%)	11	Downloadable Methodology PDF

ATTENTION: This is a Tier 3, Dams & Flood Control Structures project. Due to the criticality and useful life of this project, it is recommended that NCHRP15-61 methodology be used to calculate total precipitation depth for 24-hour design storms, and those results be compared to the provided total storm depth output: [Tier 3 methodology PDF](#).

Extreme Precipitation Design Criteria:

- Projected Total Precipitation Depth & Peak Intensity for 24-hr Design Storms
- Projected Riverine Peak Discharge & Peak Flood Elevation

Recommended Climate Resilience Design Standards



WHAT

Sea Level Rise/Storm Surge Extreme Precipitation Extreme Heat

Target Planning Horizon: 2070

Percentile: 50th Percentile

Design Criteria Applicable for Test O&M

✓ Projected Annual/Summer/Winter Average Temperatures

Definition

Average Temperatures represent the daily average temperature over a period of time: Annual represents January through December, Summer represents June through August, and Winter represents December through February. Annual Temperatures are anticipated to increase with climate change, but the rate of change varies depending upon the season.*

How to Estimate Projected Annual/Summer/Winter Average Temperatures Values

Asset Name	Recommended Planning Horizon	Recommended Percentile	Tiered Methodology	Step-by-Step Methodology
Test O&M	2070	50th	Tier 2	Downloadable Methodology PDF

*Note: Projected Annual/Summer/Winter Average Temperatures are not currently available through this Tool. Users should follow the step-by-step instructions outlined in the downloadable methodology PDF to estimate the projected Annual/Summer/Winter Average Temperatures based on the recommended planning horizon, percentile, and tiered methodology. The three tiers represent various anticipated levels of effort for calculating design criteria values, dependent upon the consequences of failure of an asset as a function of scope, time, and severity and useful life of the asset.

How Annual/Summer/Winter Average Temperatures may inform Planning

How Annual/Summer/Winter Average Temperatures may inform Early Design

How Annual/Summer/Winter Average Temperatures may inform Project Evaluation

Extreme Heat Design Criteria:

- Projected Average Temperatures
- Projected Heat Index
- Projected Days/Year with Max Temp >95, >90, <32F
- Projected Number of Heat Waves & Average Duration
- Projected CDD & HDD
- Projected Growing Degree Days



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WHEN & WHERE

https://resilientma.org/rmat_home/designstandards/

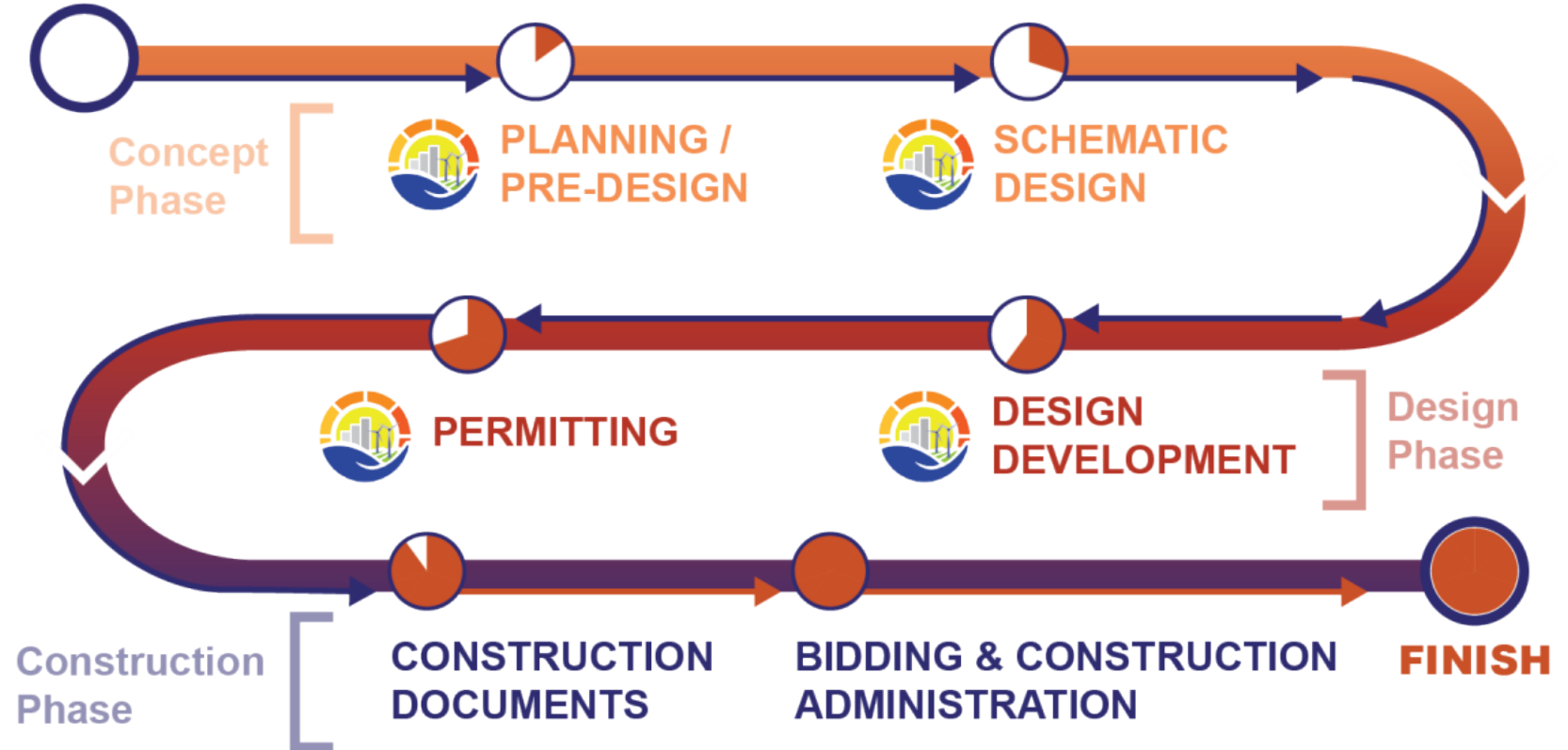


Where the Tool is recommended for benefit to users. Concept Phase is where most beneficial.

NOTE: The Tool can be used or updated any time during the design process. If projects are submitted through the Tool, users can create a clone of a submitted project to update as needed.

START

TYPICAL DESIGN PROCESS





Where the Tool is recommended for benefit to users. Concept Phase is where most beneficial.



Design Process: Concept Phase





START

- Project with physical assets identified through Capital Planning or other means (HMP/MVP)
- Identified need for State Funding

PLANNING/PRE-DESIGN

- General project scope outlined with assets and limit of work (location of project) identified
- Due Diligence for project location
-  Create Project in Tool with preliminary information & review guidance for planning
-  Consider Site Suitability & Regional Coordination forms

SCHEMATIC DESIGN

- Preliminary layout, design considerations and constraints identified
- Opinion of probable cost
-  Create/Update Project in Tool with planned design & review guidance for early design
-  Consider Flexible Adaptive Pathways forms



Design Process: Design Phase



DESIGN DEVELOPMENT

- Engineering analyses and assessments performed
- Design advanced based on concepts identified through schematic and resolving conflicts



Update Project in Tool (as-needed) and review guidance for project evaluation



PERMITTING

- Regulatory compliance documents
- Secured approvals from applicable agencies

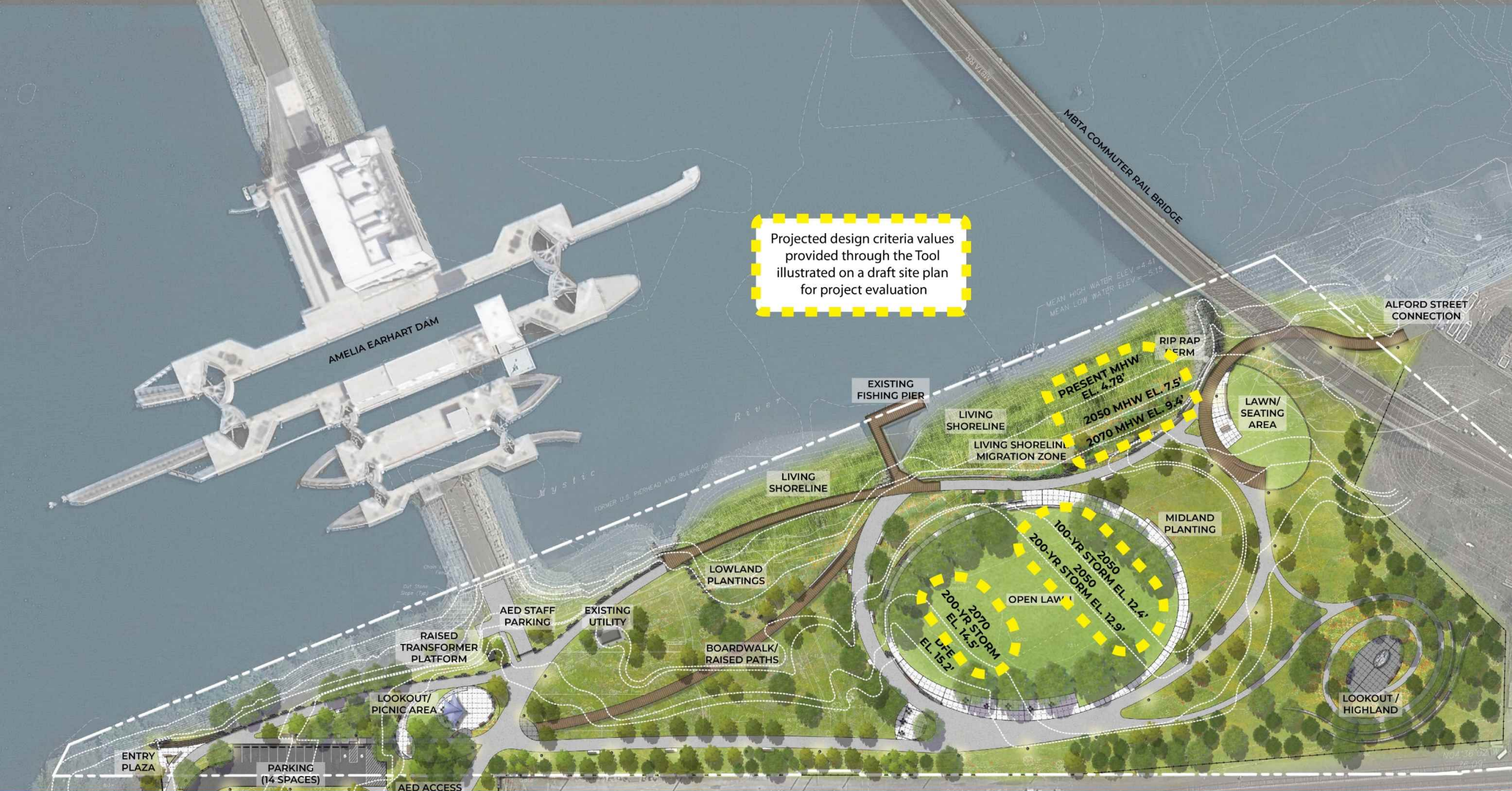


MEPA process requires Tool Report



Piloting and Implementation Examples

- **FY23 A&F Capital Planning**
 - “For any project that receives at least one “High” risk rating for any of the four climate hazards, your FY23-FY27 CIP submission must also include a **detailed description of how the project is proposing to mitigate any “High” risk climate exposures identified in the tool** through project planning and design.”
- **Municipal Infrastructure Grant Programs**
 - MVP
 - **1 point** for utilization and report from the [RMAT Climate Resilience Design Standards Tool](#)
 - Up to **3 points** for the degree to which the most up-to-date climate science and data (including data found on resilientma.org, the [RMAT Climate Resilience Design Standards Tool](#), and/or local-level studies) will be utilized, including specific reference to the climate data utilized.
 - **For Project Type 1:** Planning, Assessments, Capacity Building, and Regulatory Updates—**how will the project utilize the preliminary climate risk rating and recommended design standards** from the [RMAT Climate Resilience Design Standards Tool](#) at this assessment phase of the project?
 - **For Project Type 2:** Design and Permitting – **How will the project utilize the preliminary climate risk rating and recommended design standards from the [RMAT Climate Resilience Design Standards Tool](#) in the design of the project’s physical assets?** What other climate data and standards will be used to inform the design process and how will they be utilized?
 - **For Project Type 3:** Construction and On-the-Ground Implementation – **How does the proposed design meet or fail to meet the recommendations in the [RMAT Climate Resilience Design Standards Tool](#) output report?** (e.g. planning horizon, return periods, design criteria, methodology). If the proposed design does not follow the recommended design standards, please explain how climate science, data, and projections were used to inform the design of the project. Please cite specific data sources. If a different type of implementation project (e.g., land acquisition) describe how climate data informed the project.
 - **Community One Stop for Growth**
 - Does the project’s **Climate Resilience Design Tool report provide a “High”** preliminary exposure score for either Sea Level Rise/Storm Surge, Extreme Precipitation - Urban Flooding, or Extreme Precipitation - Riverine Flooding?
 - If yes, please specify the design storm (return period) that the applicant plans to use in the engineering of the public infrastructure project (e.g., the 25-year storm or 4% storm). Additionally, please describe any design strategies that the public infrastructure project will incorporate, and/or that the applicant plans to investigate as part of the project’s design, to mitigate potential impacts of future flooding.
 - Will the public infrastructure project result in a net increase in impervious area?
 - If yes, please describe any design strategies that the public infrastructure project will incorporate, and/or that the applicant plans to investigate as part of the project’s design, to mitigate a heat island effect.



Projected design criteria values provided through the Tool illustrated on a draft site plan for project evaluation

THANK YOU!

QUESTIONS?

Contact Information:

Indrani Ghosh, PhD
Resiliency Senior Technical Leader
Weston & Sampson
ghosh.indrani@wseinc.com