Flood Risk Mapping Resource Assessment and Recommendations

A Report to the Massachusetts Legislature

August 2025

The Executive Office of Energy and Environmental Affairs developed this report to review the existing state flood risk mapping resources, assess the need for and feasibility of creating additional resources, and recommend steps towards developing those resources.

Report

August 2025

Prepared for:

Joint Committee on Environment and Natural Resources

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I. Introduction

Bill S.2967, *An Act Promoting a Clean Energy Grid, Advancing Equity and Protecting Ratepayers* (Climate Bill), signed into law on November 20, 2024, reforms the siting and permitting of clean energy facilities, while responsibly reforming the gas distribution system. It vastly expands the electric vehicle (EV) charging network, incentivizes innovative technologies such as battery storage, fusion energy, advanced metering and meter socket adapters, includes measures to protect residents from high energy costs, and equips state agencies with the mandate to fight climate change.[1]

Section 125 of the Climate Bill requires the Secretary of Energy and Environmental Affairs (EEA) to (1) conduct a review of existing flood risk mapping resources, (2) conduct an assessment of the need for and feasibility of creating additional flood risk mapping resources to identify areas of vulnerability across the Commonwealth, and (3) develop associated recommendations, including any legislation or funding necessary, to be submitted to the legislature by August 18, 2025. Appendix A includes the full text of Section 125.

Section 125 reflects the importance of accurate and comprehensive flood hazard information, including mapping, to support a wide range of activities. These include land use planning, zoning, infrastructure and building siting, strategy for maintenance and retrofits, as well as strategic initiatives to proactively address the evolving flood exposure profile of Massachusetts' existing building stock, infrastructure systems, and natural resources. With comprehensive and accurate flood hazard information, these activities can minimize the impact of flooding on Massachusetts' housing stock, infrastructure resilience, public health, safety, and financial security.

To provide the Massachusetts Legislature with the information required under Section 125, this Report provides an inventory of and details the scope and limitations of existing sources of flood risk mapping resources developed and maintained both within and outside of EEA, summarizes ongoing initiatives to develop and / or effectively deploy additional resources, and outlines a set of recommendations for funding necessary to effectively support these and future efforts.

II. Review of Existing Flood Risk Mapping Resources

A multitude of flood information resources exist and are used within the Commonwealth for various purposes related to planning, design, communication and risk mitigation. These resources address flooding associated with groundwater, rivers and streams, stormwater or pluvial (i.e. urban or stormwater), and coastal, tidal, and storm surges.

[1]Commonwealth of Massachusetts Legislature's Press Room: "Sweeping Climate Bill Passes the Massachusetts Legislature"

This Report identifies data that are used to calibrate and validate flood models and used to map flooding, including data on observed precipitation, streamflow, coastal water level, and documented flood locations. The Report also identifies resources that can be used to drive flood model runs to map flooding for particular events of interest, for example, the 100-year flood. Most importantly, this Report summarizes resources which map past and projected future flood risk.

These resources are produced by federal entities, state entities, local and regional governments, as well as private entities and nonprofit groups such as watershed organizations. These existing resources and products have been summarized below, where they are organized in order of the producer of each resource.

Many of the flood information resources used broadly in Massachusetts are produced or supported by federal sources. These include resources produced by the Federal Emergency Management Agency (FEMA), the United States Army Corps of Engineers (USACE), the United States Geological Survey (USGS), the National Oceanic and Atmospheric Administration (NOAA), and others. Several of these federal flood risk information products and supporting resources are under active development and their future release date is unknown. A number of flood information resources are produced within the Executive Office of Energy and Environmental Affairs and other state agencies, such as the Massachusetts Department of Transportation (MassDOT). Flood risk mapping resources are also produced by local entities, regional government entities, and nonprofit organizations such as watershed groups. These flood information resources reflect the special capabilities, capacity, and resources available to their producer, such as local knowledge or insights, expertise, and federal resources and standards.

A. Federally-Produced Resources

i. NOAA and USGS: Tide Stations

NOAA and USGS maintain tidal monitoring stations at coastal locations nationwide, including several in and near Massachusetts' coast. Data from the tide stations (6 NOAA, 4 USGS) are collected and posted publicly in real time; data may be publicly displayed as "provisional" until they have been reviewed and quality-checked. Tide station data include long-term coastal water level time series. In addition, NOAA provides mean sea level estimates and other information on water level variability and record highs and lows.

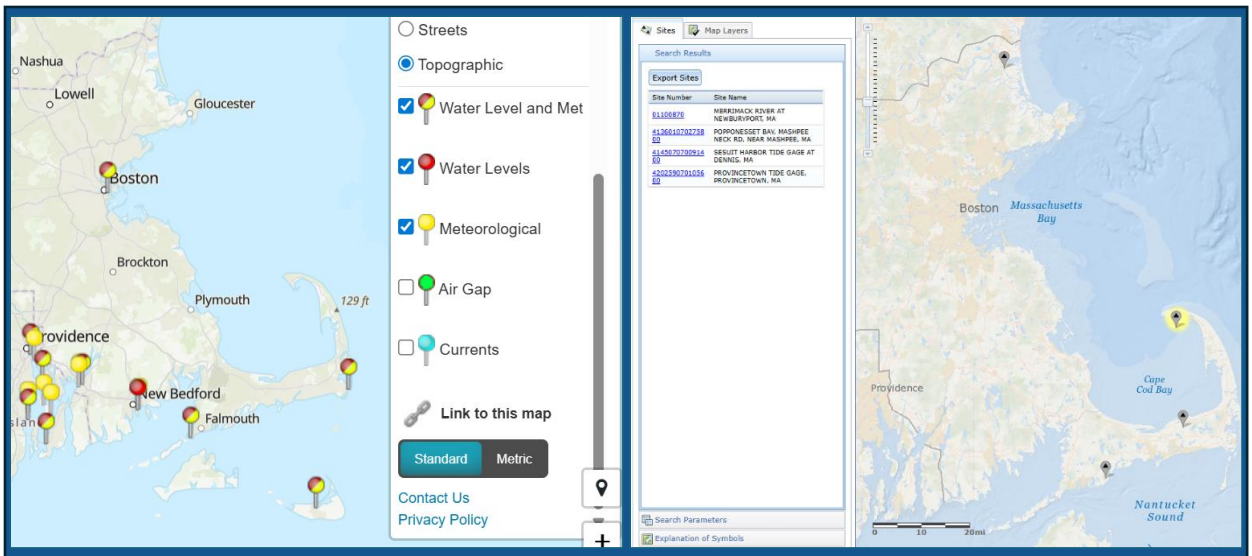

Figure 1: (a) NOAA Tide Gage Locations by Data Monitored; (b) USGS Tide Gage

These data are useful for understanding trends in sea level and tidal variability, understanding how storms affect coastal water levels (surge), and supporting coastal flood model development.

ii. USGS: Hydrologic Monitoring Network, High Water Marks and StreamStats Application

USGS monitors precipitation, streamflow and groundwater at over 200 locations throughout Massachusetts funded cooperatively by EEA and USGS. In addition, as part of the streamflow monitoring program, USGS collects high water marks during and after flood events. Measured data is shown on the website in real time; data may be shown as provisional until they have been

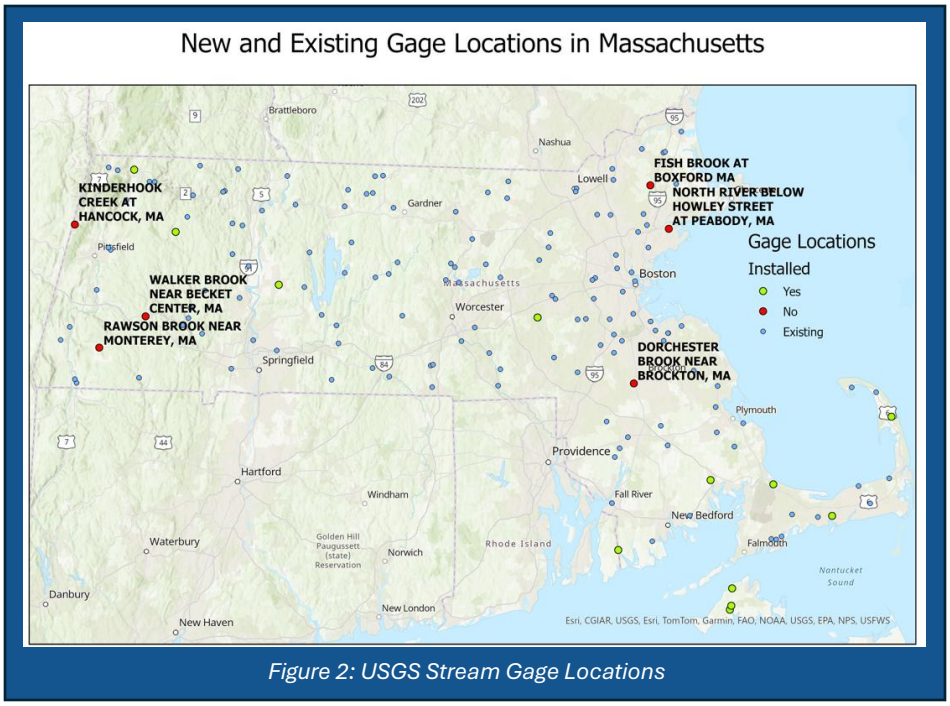

Figure 2: USGS Stream Gage Locations

quality-reviewed, which typically happens within weeks and up to a few months.

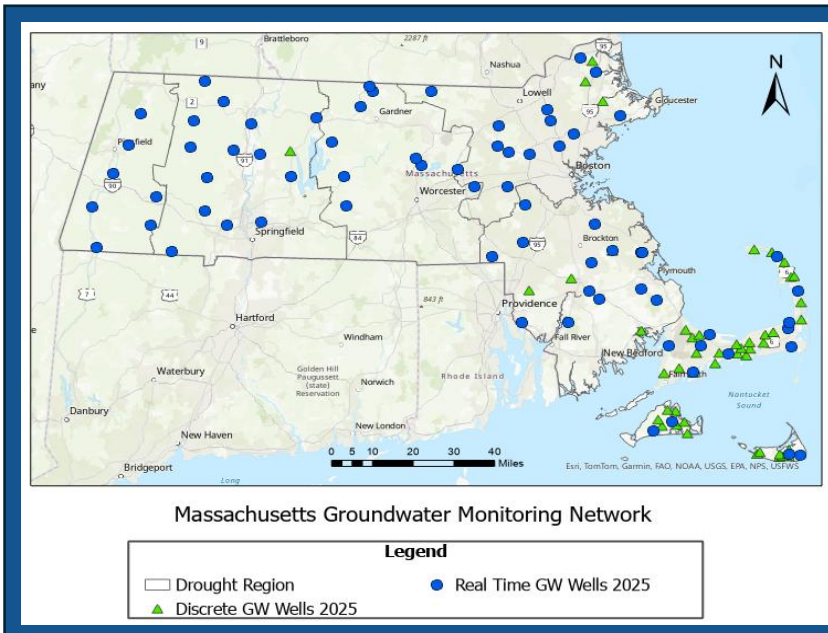

Figure 3: USGS Groundwater Monitoring Locations By Monitoring Type (real-time data collection vs. discrete measurements)

These data are used for critical operational purposes such as weather and flooding forecasting, dam management and drought monitoring. These data are also the basis of numerous special studies, models and tools that serve to understand and adapt to a changing climate including intense and erosive precipitation events, flash flooding, and flash droughts. Other important functions that the state performs and for which data are critical include the determination of Total Maximum Daily Loads (TMDLs) for polluted water bodies; implementation of the Wetlands Protection Act (WPA); implementation of the National Pollutant Discharge Elimination System (NPDES) permitting; water allocation decisions; design of roads, culverts, bridges, and septic systems; design and review of stormwater management systems, among others.

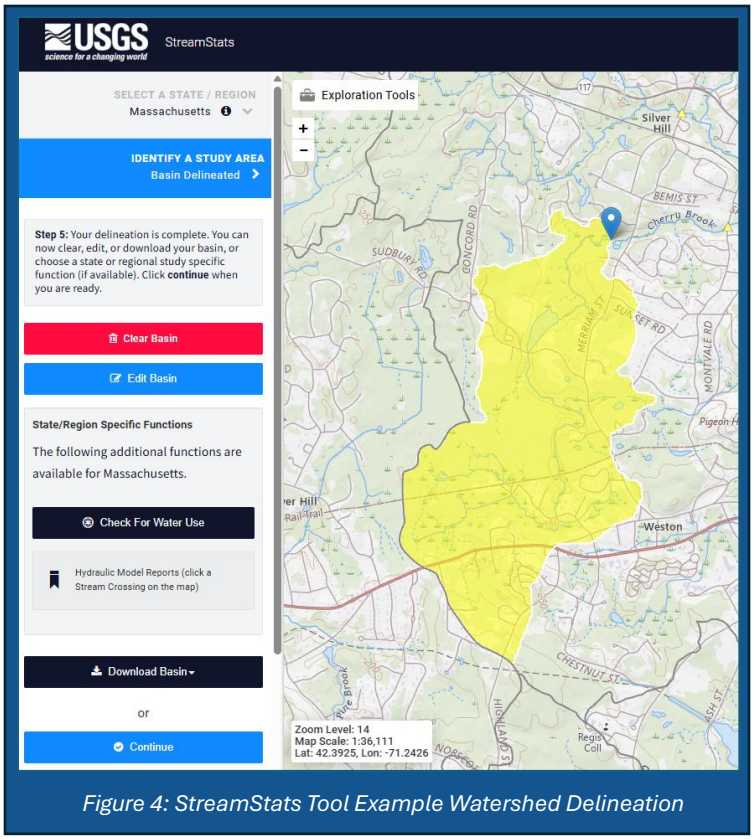

Figure 4: StreamStats Tool Example Watershed Delineation

USGS also maintains a StreamStats tool that allows users to view streamflow statistics, including flood flow statistics, at any location on a river or stream in Massachusetts. These streamflow statistics can be used as inputs to models that generate maps of riverine flooding for particular flood flow return periods (e.g. 100-year flood, 50-year flood). This tool does not currently provide climate-informed streamflow statistics. StreamStats can be used to identify

streamflow statistics which reflect patterns of streamflow, but do not account for trends in streamflow over time or future climate change influence on streamflow.

iii. NOAA: Atlas 14

NOAA publishes a nation-wide atlas of precipitation frequency relationships. NOAA Atlas 14 is the latest federal data source of this variety. The statistical estimates published in NOAA Atlas 14 are based on precipitation gage data collected through the period of record, up until 2012. NOAA Atlas 14 Volume 10, which covers northeastern states including Massachusetts, was published in 2015 and revised in 2019. Precipitation frequency data relate precipitation depths (amount of precipitation, typically in inches) by location, duration, and chance of occurrence. Estimates of the depth of precipitation within a particular duration (e.g. two hours, 24 hours, etc.) that has a particular chance of occurrence or exceedance each year are used in a broad variety of design and risk assessment contexts. The estimates assume the chance of extreme precipitation with a particular depth and duration are static and have not changed over time.

Funded by the Bipartisan Infrastructure Law, NOAA has been developing an Atlas 15 which would (a) account for trends in extreme precipitation during the period for which gages have been collecting precipitation data until present, and (b) develop a methodology for adjusting extreme precipitation frequency relationships to account for future trends and climate change. Precipitation frequency relationship resources can be used to drive flood models and map flooding which would occur under particular precipitation events.

iv. USACE: National Levee Database

USACE maintains a database on all known levees in the United States. The database includes information on levee age and condition, as well as the areas, populations, and assets protected by levees. The data is updated continuously in cooperation with federal, state, tribal, and local agencies.

The database is useful for flood risk management and for configuring hydraulic models that may be used to map flooding.

v. USACE: National Inventory of Dams and Dam Inundation Mapping

USACE maintains a database of dams nationwide, including both federal- and state-regulated dams with either high hazard potential, significant hazard potential, or dams that meet specific height and reservoir size requirements. The majority of dams in the database are state-regulated. The database is continually updated in cooperation with outside entities, primarily state dam regulating entities such as the Massachusetts Office of Dam Safety, to improve its completeness.

The database includes an interactive web tool allowing users to view areas which could be inundated if the dam were to malfunction or fail for some dams in the database. Not all dams (especially smaller dams) are included in the database, and not all dams in the database are associated with inundation maps in the tool.

Dams included in the database may be used to support development of hydrologic and/or hydraulic models which are used to map riverine flooding. The dam inundation mapping in the database, when available, may be used to understand places that could be at risk of flooding in the event of dam failure.

vi. FEMA: Flood Insurance Studies

FEMA Flood Insurance Studies (FIS) are detailed reports on flood studies conducted by FEMA or in compliance with FEMA standards to map FEMA flood zones. The studies, typically conducted by county, contain more detailed information on flood risk than typically provided in FEMA flood maps. FIS can be consulted individually by county through FEMA's Map Service Center. FIS are paper or pdf documents that include some technical engineering maps and cross sections of flood depths at different points along a river or coast. FIS are typically conducted and updated county by county. Once published, FIS remain effective for decades. The currently effective FIS in several western Massachusetts counties were published in the 1980s. Estimates of the 100-year and 500-year flood flow in FIS reports are based on variable periods of record. For example, the FIS for Deerfield, MA uses Deerfield River streamflow records which begin in 1914 at one gage and 1941 at a second gage; the study does not reflect any streamflow data or flood events occurring after 1980, when the study was published. Flood flow estimates in the Essex County FIS, revised 2025, are based on 14-84 year records from several stream gages for which records exit. Streamflow records used in the study begin at points between 1931 through 2001; flood events and stream gage data collected after 2015 were not considered.

These graphics, tables, and charts may be consulted by technical experts to derive forcing scenarios for coastal storm surge and/or riverine flood modeling and mapping. Technical experts may also use the FIS to develop an understanding of coastal or riverine flood risk at a particular point in space.

vii. FEMA: National Flood Hazard Layer

The National Flood Hazard Layer (NFHL) is a geospatial database containing maps of flood hazard areas identified through FEMA FIS and Letters of Map Change (LOMC). The maps delineate areas exposed to a 1% annual chance (100-year flood) and 0.2% annual chance (500-year flood) coastal or river flood, as well as several technical/regulatory zones within these categories. The floods are mapped using estimates of the chance of flooding based on past sea levels and precipitation and streamflow patterns. However, they do not account for sea level rise or trends in precipitation or streamflow and do not account for future climate change influence on sea levels, precipitation, and streamflow. The products do not map

flooding on small streams. The maps also do not represent pluvial (urban or stormwater) flooding that is caused by high rates of precipitation away from streams and rivers.

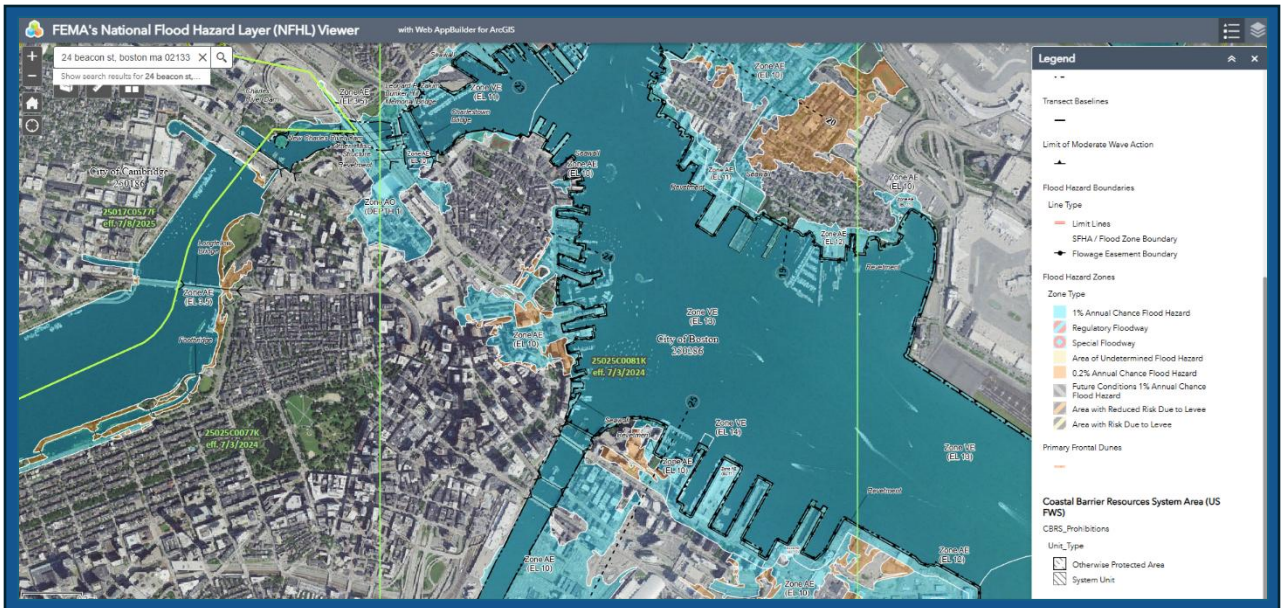

Figure 5: National Flood Hazard Layer detail; Boston Harbor

FEMA updates the NFHL continuously as new FIS studies and updates are completed. A cohesive version of the NFHL for Massachusetts is hosted at MassGIS and updated upon request; typically several years apart.

The FEMA National Flood Hazard Layer is an important digital spatial data resource that maps two levels of riverine or coastal storm surge flood risk in a way that is broadly accessible. While the primary use case for this dataset is flood insurance regulatory information and support, the dataset is also used broadly for understanding areas exposed to river and storm surge flood risk.

viii. FEMA: Non-Regulatory Products

FEMA has initiated an effort to publish additional flood map datasets as non-regulatory products that are not used in insurance determinations. These products include mapped flood depth and flood velocity digital spatial datasets based on modeling. Through the Future of Flood Risk Data Initiative, FEMA may continue to expand these offerings with additional spatial coverage and additional types of mapped flood data and mapped flood scenarios provided as raster and network datasets.

These products include maps of riverine and coastal storm surge flood extent and depth for a variety of forcing scenarios. Some products may also map the chance of flooding over

space. The products are under development, though none have been developed for Massachusetts at this time.

B. State-Produced Resources

i. EEA: MyCoast King Tide and Coastal Storm Reports

In 2009, the Massachusetts Office of Coastal Zone Management (CZM) standardized real-time reporting of moderate to major coastal storm damages with the development of an online form and database for the Massachusetts Rapid Response Coastal Storm Damage Assessment Team. In 2013-2014, the MyCoast platform was launched with mobile applications to more broadly collect photos and document flooding and other impacts from coastal storms and King Tides (or higher than normal tides). The crowd-sourced database includes locations and water levels of impacts. MyCoast data on damages to infrastructure, homes, businesses, and natural resources is used to inform emergency response and recovery, weather warnings and forecasts, scientific studies and modeling (e.g., storm surge and wave overtopping of seawalls), and resilience planning and projects. While MyCoast has over 1,500 registered users along the Massachusetts coast, additional coverage is needed to support and validate mapping of riverine flooding, pluvial (urban or stormwater) flooding, tidal river flooding, and coastal compound flooding. The MyCoast platform does not contain any information on storm and flood impacts outside of the coastal region.

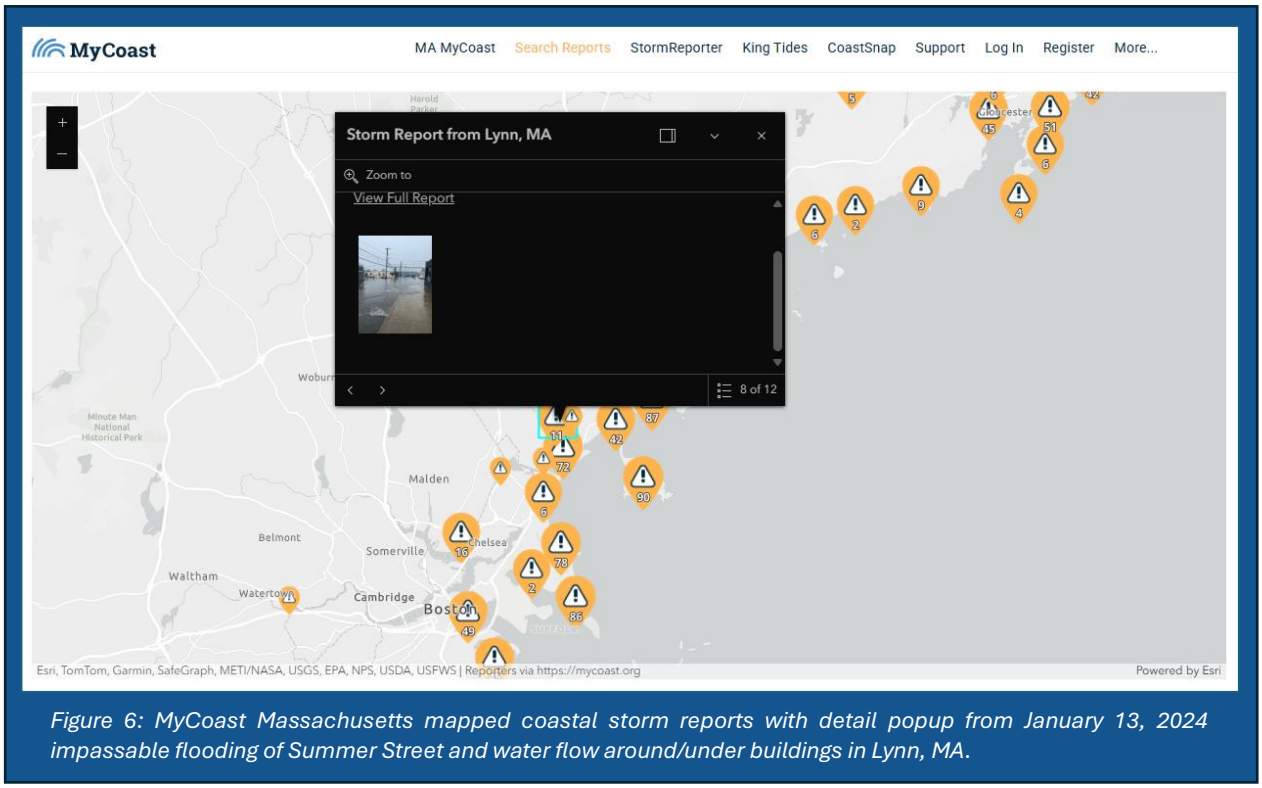

Figure 6: MyCoast Massachusetts mapped coastal storm reports with detail popup from January 13, 2024 impassable flooding of Summer Street and water flow around/under buildings in Lynn, MA.

Reports of flooding in the database may be used to support the development and validation of coastal storm surge flood models which map coastal storm surge flood risk, riverine flood models which map riverine flood risk in coastal areas, and stormwater models which map pluvial flood risk in coastal areas. The flood reports in the database may also be used to support the development and validation of flood models that represent interactions between each type of flooding ("compound flooding") which map compound flood risk in coastal areas.

ii.Statewide Flooding and Environmental Justice Vulnerability Assessment

This project involves collecting existing spatial flood risk information from a variety of sources, including the Massachusetts Coast Flood Risk Model (MC-FRM), FEMA flood maps, and local stormwater modeling studies and knowledge, and engaging with municipalities that contain state-designated Environmental Justice (EJ) neighborhoods to characterize past

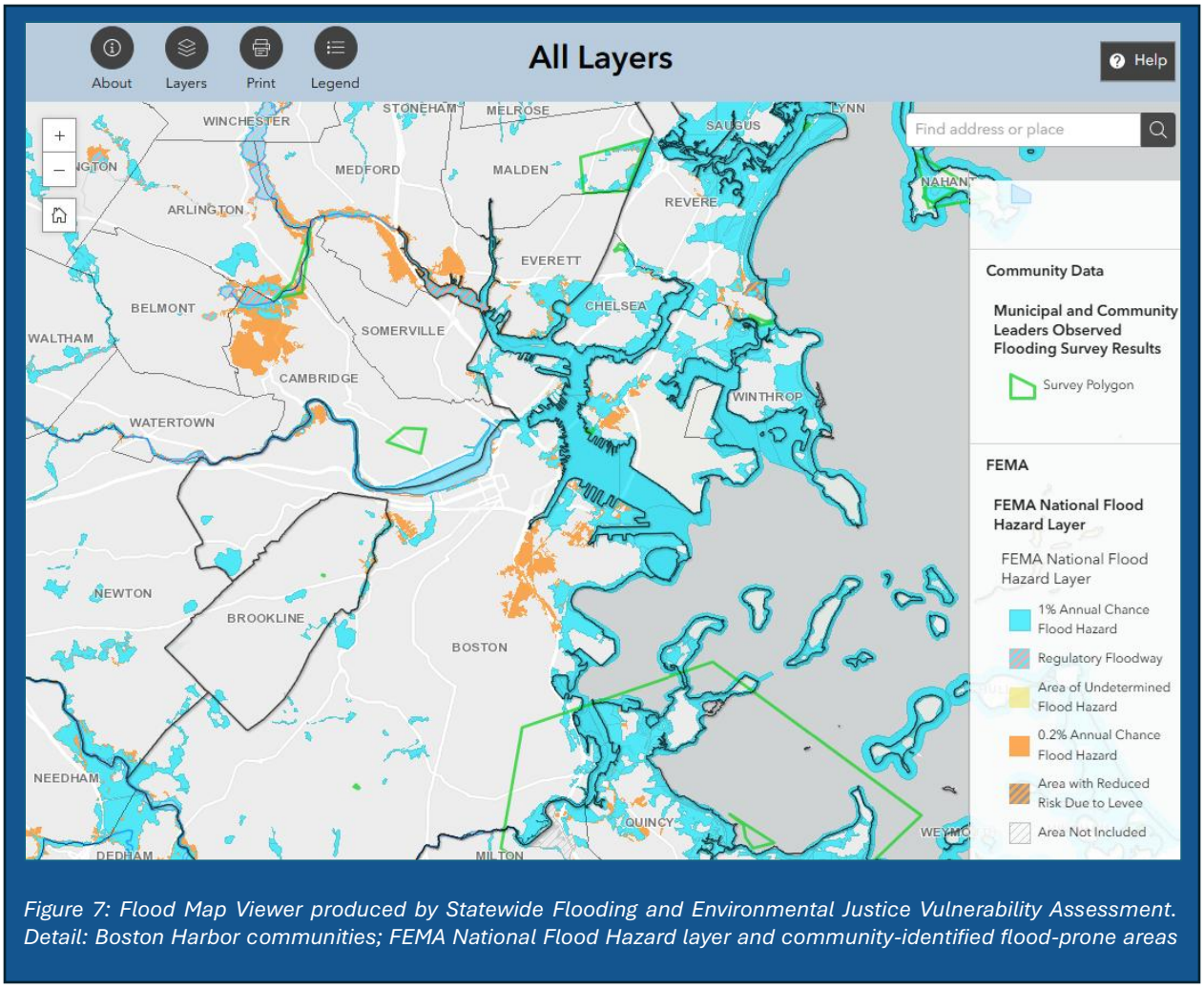

Figure 7: Flood Map Viewer produced by Statewide Flooding and Environmental Justice Vulnerability Assessment. Detail: Boston Harbor communities; FEMA National Flood Hazard layer and community-identified flood-prone areas

flooding, understand flood issues and potential flood mitigation strategies in those communities through a community-driven framework.

This project involved collecting modeled, documented, and crowd-sourced areas prone to flooding into a GIS dataset which is framed in a web map product. The dataset combines existing modeled coastal flooding, riverine flooding, and pluvial flooding extents created through a variety of modeling studies such as FEMA flood maps, MC-FRM products, and local/regional hydrologic and hydraulic model studies. Documented flood-prone areas produced for municipal Hazard Mitigation Plans, compiled by municipal committees that typically include emergency services, public works, and/or city or town engineers are also included. Lastly, the data products include the results of a map-based survey distributed to participating communities to further identify locations known for flooding.

These data products are useful for understanding vulnerabilities to flooding at the local level, where flooding may occur in the future as identified through the localized studies incorporated, and for identifying and prioritizing areas for flood mitigation. The data products are also useful supporting resources for flood modelling projects that seek to expand upon the types of flooding and scenarios depicted in FEMA flood maps (FEMA maps display modeled riverine and coastal flood areas based on historically based static estimates of flood probability). Documented areas of past flooding collected through this project, especially areas of stormwater flooding, can be used to calibrate and validate hydrologic and hydraulic flood models which are used to generate flood maps, especially those mapping future flood conditions and stormwater flooding away from rivers, streams, and coastal water bodies. The mapped flood areas collected through this project will be used in several ongoing state flood modelling projects.

iii.EEA: Temperature and Precipitation Projections

In the Climate and Hydrologic Risk Project, EEA collaborated with researchers at USGS, Tufts University, and Cornell University to develop resources to help EEA better understand evolving hydrologic risks under future climate conditions. Phase 1 of this project developed temperature and precipitation projections at a Massachusetts watershed scale.

The projections are based on Coupled Model Intercomparison Project (CMIP) 5 climate modeling experiments. Projections based on the greenhouse gas Representative Concentration Pathway (RCP) 8.5 are posted publicly; projected statistics for RCP 4.5 are available upon request. They cover four future decades and include temperature and precipitation statistics representing average conditions as well as how both high and low extremes (cold and extreme heat; drought and heavy precipitation) may change in the future. The projected statistics are applicable to a wide variety of climate adaptation applications.

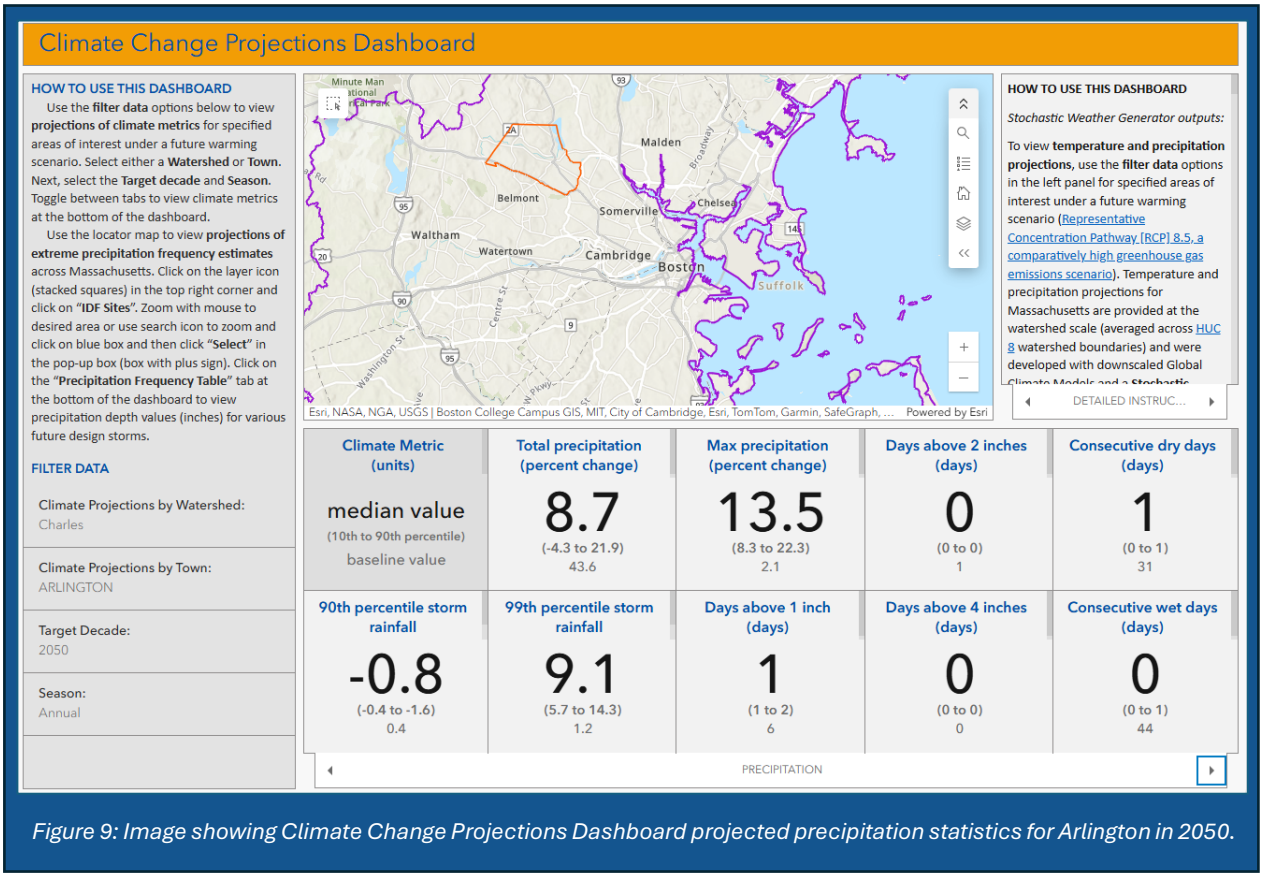

Figure 9: Image showing Climate Change Projections Dashboard projected precipitation statistics for Arlington in 2050.

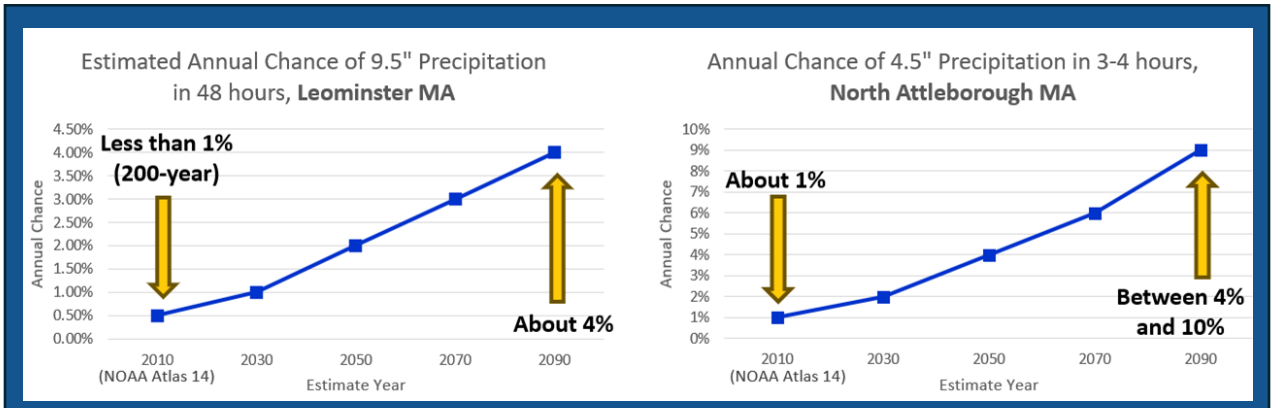

Figure 8: Estimated annual chance of September 11, 2023 Leominster and North Attleborough precipitation amounts based on NOAA Atlas 14 precipitation frequency relationships and Climate-Hydrologic Risk Phase 1 projected precipitation design storms for future decades.

The projected precipitation design storms are a key input to mapping future precipitation-driven flooding, including both riverine and pluvial flooding. These projected values may also be used to map compound riverine/storm surge flood scenarios and/or stormwater/coastal storm surge flood scenarios.

iv.EEA: Dam Inundation Mapping

Massachusetts Dam Safety Regulations, promulgated by the Massachusetts Department of Conservation and Recreation (DCR) Office of Dam Safety, require owners of Significant and High Hazard Dams to prepare Emergency Action Plans (EAPs). The Office of Dam Safety has jurisdiction over dams which are not federally owned. "High Hazard Dams" are dams for which dam failure or mis-operation would likely cause loss of life. "Significant Hazard Dams" are dams for which dam failure or mis-operation would likely not cause loss of life, but could cause economic losses, disrupt lifeline facilities, cause environmental damage, or other important impacts. EAPs must contain dam failure inundation maps, which identify areas downstream that could be impacted by flooding in the event of a dam failure under different scenarios.

The High Hazard Potential Dam (HHPD) EAP is required to provide both a "Sunny Day" and "Wet Weather" Scenario inundation mapping. The term "Sunny Day" scenario represents failure or mis-operation impacts when the dam is storing a normal amount of water ("normal pool") and there is no streamflow at the dam at the time of failure or mis-operation. The term "Wet Weather" scenario refers to conditions in which dam failure or mis-operation occurs during the dam's design peak streamflow with correlating streamflow downstream of the dam. The Significant Hazard Potential Dam (SHPD) EAP inundation mapping is a result of a "Max Pool" Scenario, where the dam is storing the maximum amount of water (filled to the top of the embankment) and allowed to fail, with no streamflow downstream of the dam prior to the dam's failure or mis-operation. These inundation maps are available in the PDF or paper EAP documents and are available to emergency managers and MEMA. They are not posted publicly, though members of the general public can access EAPs via public information request.

The Office of Dam Safety is in the process of digitizing EAP inundation maps into digital spatial datasets.

v.MassDOT: Flood Risk Assessment

MassDOT has an ongoing project (also sometimes referenced as the Climate Adaptation and Vulnerability Assessment (CAVA)) that includes modeling projected riverine flooding to quantify risks to a range of critical transportation assets and support identification and prioritization of capital resiliency investments. The project involves modeling streamflow and flow statistics for all Strahler order 2 + rivers and streams in the state, and modeling the hydraulics (flow dynamics, flood velocity, and flood inundation) at regular intervals along the stream network and in the immediate vicinity of each asset in the project. The modeling uses

climate change inputs recommended by the Federal Highway Administration, that are based on the 50th percentile of the RCP 8.5 ensemble and the 90th percentile of the RCP 4.5 ensemble, to model future riverine flooding outcomes under a range of future decades and design storms. The project is complete for three watersheds comprising approximately 10% of the state and is proceeding for the remainder of the state.

Products from the project include:

- Estimates of future flood flows for all Strahler order 2+ streams for a range of time horizons and return periods
- Maps of riverine flood depth, flood extent, flood elevation, and erosion hazard along Strahler order 2+ streams for a range of time horizons and return periods
- Quantification of transportation asset exposure and risk, and identification of higher-risk assets
- Methodologies for evaluating the cost-effectiveness of resilience solutions and case study applications at a range of assets

vi.MassDOT and EEA: Massachusetts Coast Flood Risk Model Data Products

The MC-FRM was commissioned by MassDOT and developed by the Woods Hole Group (WHG) to understand future coastal flood risks to transportation assets under higher future sea levels and enhanced coastal storm scenarios. CZM subsequently worked with WHG to produce publicly facing data layers, maps, and training materials for broader application and coastal risk management. The model was used to create high-resolution flood maps across the entire Massachusetts coast that demonstrate (a) annual probabilities of coastal storm flooding, and (b) elevations and depths of flooding expected for several specified coastal flood return periods under three future time periods and sea level rise combination scenarios. The model also produced several outputs related to shorelines and wave action for technical users. While focused on sea level rise and storm surge, MC-FRM also incorporates freshwater discharge at major estuarine rivers. The model does not currently include several other important drivers of coastal flooding which interact with sea level rise and storm surge flooding such as stormwater (pluvial) flooding or groundwater changes under future sea level.

Several state web pages and tools feature MC-FRM-based maps which, under several future sea level scenarios, include maps representing coastal storm surge flood probability and depth of flooding for selected flood risk levels.

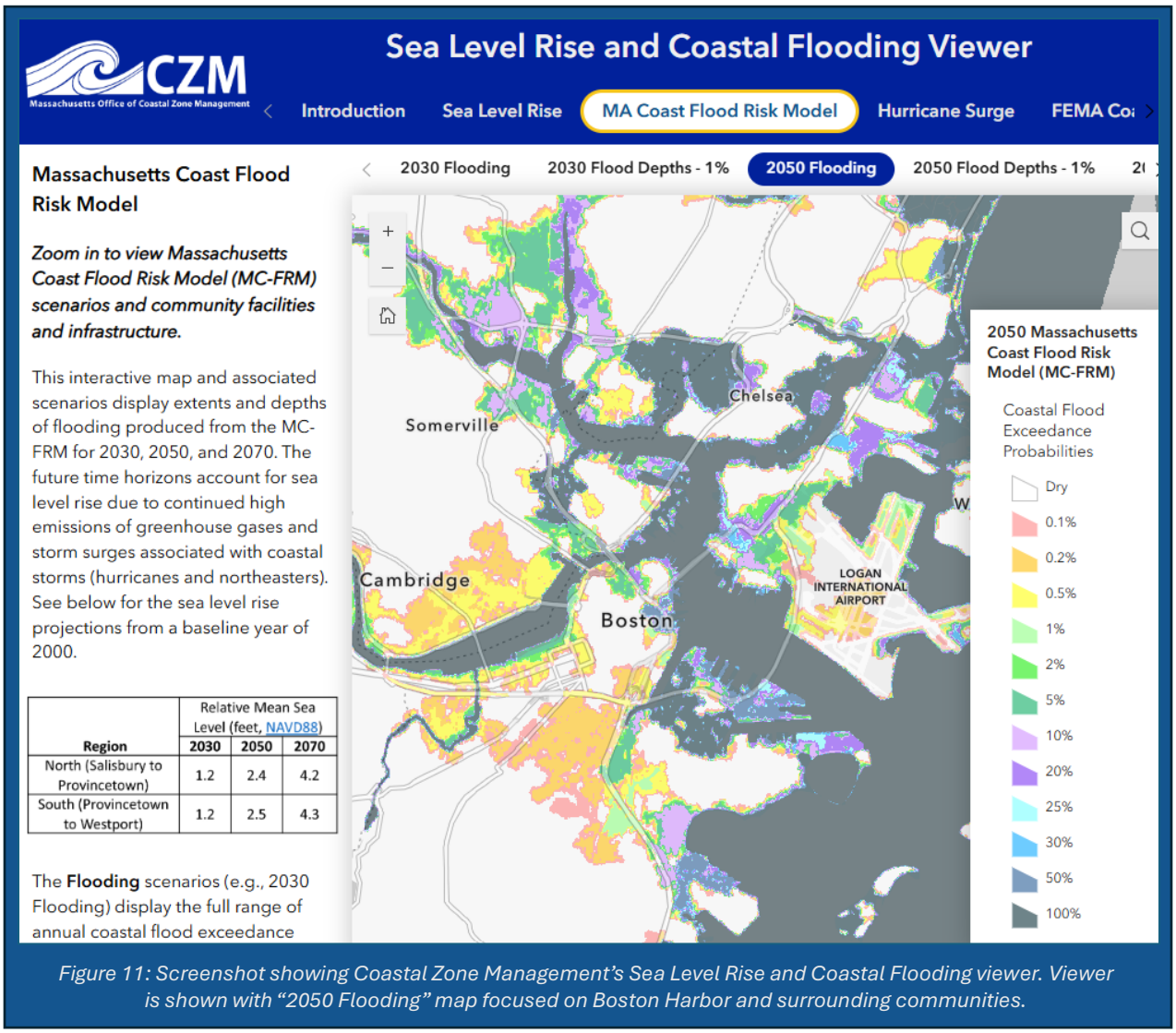

Figure 11: Screenshot showing Coastal Zone Management's Sea Level Rise and Coastal Flooding viewer. Viewer is shown with "2050 Flooding" map focused on Boston Harbor and surrounding communities.

C. Regional and Local Resources

i. Municipal Governments: Locally Identified Flood Areas

Municipalities are required to produce local Hazard Mitigation Plans (HMPs) in order to be eligible for FEMA funding; the HMPs must be updated every five years. The HMPs must include assessments and mapping of a variety of natural hazards that impact or could conceivably impact the municipality and prioritize actions to address these hazards. Part of the process involves documenting areas known to municipal staff to be flood prone. Municipal and community surveys on flood-prone locations are also sometimes issued by watershed organizations and other regional entities.

Maps of flood-prone areas are useful for targeting flood risk management measures; they may also be used in calibration of flood models. These HMPs may be posted on municipal

websites and from the Massachusetts Emergency Management Agency (MEMA) by request. Locally identified flood area maps in HMPs are available in paper report or pdf report format. Spatial data for use in other mapping or analysis applications may be available by request from the HMP producer (typically a private consulting firm, a Regional Planning Agency (RPA), or in some cases municipal staff).

ii. Various Local and Regional Entities: Local and Regional Stormwater Studies

Several municipalities, coalitions of municipalities, and other regional entities such as watershed organizations have been conducting their own flood studies to map river and/or stormwater flooding in their area. The studies are conducted with a range of goals, which include mapping flooding for planning purposes, understanding how to mitigate flooding, and others. The studies use a wide range of modeling methods and model a wide range of scenarios, including scenarios based on projected climate change.

Various geospatial datasets and web maps/tools displaying modeled flooding resulting from these studies are available publicly or by request. Some examples include products developed by the Charles River Watershed Association, Franklin Regional Council of Governments, city of Medford, Mystic River Watershed Association, Neponset River Watershed Association, and the Metropolitan Area Planning Council.

III. Ongoing State Projects and Initiatives

EEA, in coordination with the Resilient Massachusetts Action Team (RMAT), has conducted several initiatives which serve to further assess and characterize the state's existing flood risk mapping resources and the need for additional products. These include the development of the 2022 Massachusetts Climate Change Assessment, the 2023 ResilientMass Plan, and engagement supporting the development of the Climate Resilience Design Standards Tool, which allows users to screen proposed projects for exposure to mapped climate risks including flooding.

In addition, EEA is currently conducting four initiatives that, combined with the completed initiatives mentioned above, provide the inputs to this Report.

A. Streamflow Projections and Temperature and Precipitation Projections Update

Summary

In Phase 2 of the Climate and Hydrologic Risk Project, EEA is updating projected temperature, precipitation, and streamflow statistics for Massachusetts. The project relies

on meteorological and streamflow monitoring data from federal sources, such as the USGS stream gage data. Phase 1 of the project developed the projected temperature and precipitation statistics that were used in the 2022 MA Climate Change Assessment.

Phase 2, currently underway, and a first-in-the-nation effort, will update the projected temperature and precipitation projections and produce streamflow projections for the first time in Massachusetts.

Phase 2 involves several methodological improvements relative to Phase 1:

- Phase 2 projections are based on the latest generation of climate model simulations from CMIP 6. Phase 1 projected temperature and precipitation statistics were based on CMIP 5.
- Inclusion of additional greenhouse gas concentration scenarios (SSP 5-4.5; SSP 3-7.0; SSP 5-8.5)
- Climate model ensemble downscaled to local conditions using improved statistical downscaling technique which better accounts for precipitation extremes relative to statistical downscaling method available in Phase 1
- Improved cutting-edge post-processing technique used to generate projected statistics, which will account for both thermodynamic changes (change in average temperature and impact on extreme precipitation) and dynamic changes to Massachusetts climate (accounting for large-scale shifts in weather regimes affecting Massachusetts derived from climate model simulations)
- Improved spatial resolution in the resulting projections

Relevant Products

This project will produce updated temperature and precipitation statistics to reflect the most recent generation of climate model simulations from CMIP6 and add several new projected meteorological and hydrological statistics to the products. These include:

- Twenty-one new temperature or precipitation statistics
- Peak streamflow statistics, including the discharge of the 2-, 5-, 10-, 25-, 50-, 100-, 200-, and 500-year return period flood flows
- Low flow streamflow statistics, including the 7-day 10-year low flow and the 7-day 2-year low flow

When complete, these projected streamflow statistics (e.g. 2050 100-year flood flow, in cubic feet per second) may be used to model riverine flooding under projected future scenarios. The projected design precipitation values (e.g. 2050 24-hour 100-year precipitation depth) can be used as key inputs to riverine and pluvial (urban or stormwater) modeling and mapping studies, as well as compound flood modeling and mapping studies.

Timeline

The project will conclude mid-2026.

B. MassDOT Highway Division Flooding and Storm Damage Mapper

Summary

MassDOT is developing a GIS-based application for documenting institutional knowledge of Highway Division staff on known areas of flooding and storm damage. The data will be used as an additional tool for screening during project development, and to inform other resiliency efforts within the Division.

Timeline

The application is expected to be completed in December 2025.

C. Groundwater Flooding Risk Assessment and Mapping

Summary

With increasing precipitation and sea level rise, groundwater elevations are rising and are projected to continue to rise under climate change. Groundwater rise impacts include flooding of basements, septic systems, water and wastewater infrastructure, and underground utilities; damage to foundations; destabilization of roads; mobilization of historical subsurface contamination; and drowning of agricultural lands and forests. DCR engaged with the University of Massachusetts at Amherst and developed an initial statewide groundwater model to estimate average annual, historical and future groundwater depths across the state (except the Islands) based on 70 groundwater monitoring points. The Massachusetts projections of future precipitation (derived from the Climate and Hydrologic Risk Phase 1 project) were used to define future increases in recharge. Sea level rise projections were from the same data source as the one used for the MC-FRM.

Relevant Products

The project will produce maps and GIS layers of (a) depth to water categories across the state under historical and potential future recharge and sea level scenarios, and (b) areas where the estimated groundwater levels are likely to cause impacts. Impacts under each scenario are assessed for different land uses such as farmland and forests, basements and subsurface infrastructure based on building footprints, and EJ populations.

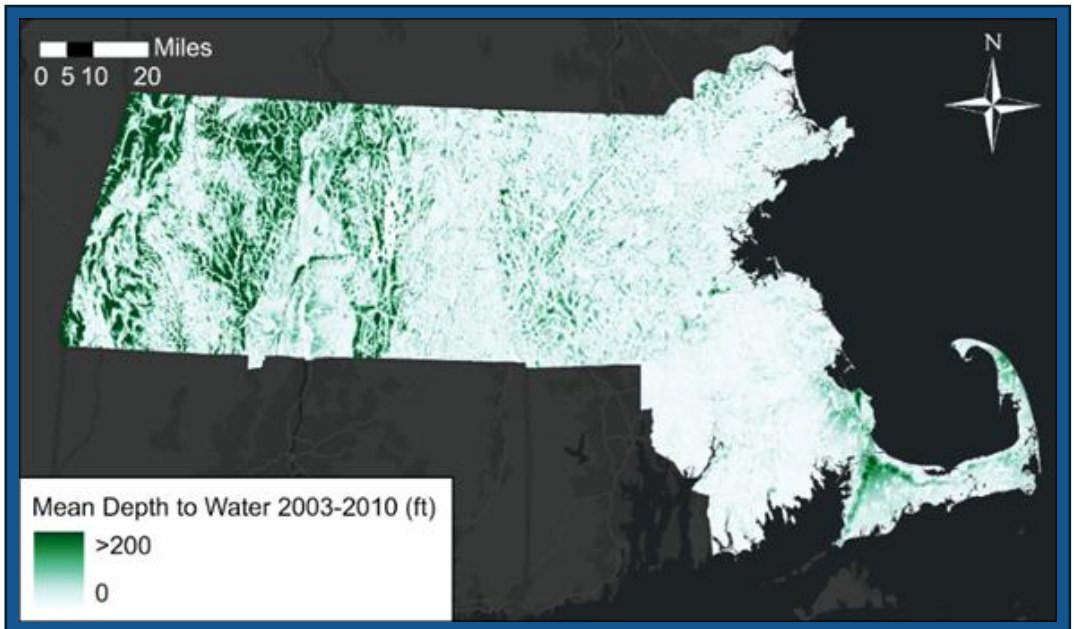

Figure 11: Modeled Mean Depth to Groundwater

The project will produce maps of estimated groundwater depth categories under current and future conditions showing locations of potential flooding. The project's estimated groundwater levels could also serve as key driving inputs to river and pluvial (urban or stormwater) modeling and mapping studies. Future phases may incorporate flood location insights from the Flooding and Environmental Justice project.

Timeline

Products and reports are expected in December 2025.

D. Riverine and Pluvial Flood Modeling and Mapping

Summary

This project is a collaborative effort between EEA and the USGS. The most publicly available flood maps, produced by FEMA for the National Flood Insurance Program (NFIP), represent riverine and coastal flood areas based on static, unchanging estimates of coastal flood risk. Flood maps which reflect trends in flooding, future flooding, and pluvial (urban/stormwater) flooding away from rivers and streams are necessary to support comprehensive flood risk management and climate adaptation in Massachusetts.

This project aims to develop methods and standards for flood risk modeling and mapping to identify areas vulnerable to current and future flooding across the Commonwealth. The project will pilot those methods in several hydrologically diverse locations, refine the methods based on findings from the pilot, and in FY 2027 will deploy the methods in some parts of the Commonwealth, as feasible within project budget and based on findings from the pilot phase.

The project's direction is heavily informed by a User Advisory Group and a Technical Advisory Group. The User Advisory Group is representative of the likely user audience for flood map products, such as representatives from multiple state agencies, nonprofit organizations, regional entities, and private engineering consultants. The Technical Advisory Group is composed of flood modelling and flood mapping experts from diverse backgrounds, including federal agencies such as USGS, FEMA, and the U.S. Army Corps of Engineers (USACE); state agencies, academia, private research and development, and private engineering consultants. The project will incorporate and map flooding caused by the projected peak flow statistics and projections developed through the Climate and Hydrologic Risk Project, Phase 2. Flood location insights from the Flooding and Environmental Justice project and any other documented past flood location mapping will be used to validate modelling conducted in this project.

Relevant Products

A key outcome of this project is insights from engaging with a broad range of flood map users at the local and regional level around needs for projected river and stormwater flood maps and data. The project will produce tiered modeling standards, each tier requiring increasingly detailed levels of data inputs, for riverine and pluvial flooding, guidelines on selecting a modeling standard tier, and riverine and pluvial flood maps across key watersheds in the state.

Timeline

The project launched in June 2024 and will end in mid-2027.

E. Planning and Coordination: Coastal Flooding Strategy

Summary

To facilitate planning and coordination along the coastal zone, the ResilientCoasts Initiative was launched by EEA's Coastal Zone Management Office in November 2023 to develop a comprehensive framework for coastal resilience. This effort is mapping vulnerability and risk across the coast, identifying Coastal Resilience Districts, providing guidance on place-

based coastal resilience measures, and recommendations for coastwide strategies. ResilientCoasts relies on the MC-FRM, which is a dynamic model developed for the Commonwealth to project impacts of coastal flooding accounting for sea level rise this century. Data products used in ResilientCoasts Phase I include the probability of flooding in each year (present day, 2030, 2050, and 2070) and water depths associated with the 1% (100-year), 0.5% (200-year), and 0.1% (1000-year) annual exceedance probability levels.

Relevant Products

The project involves broad engagement, which will identify (1) existing flood risk mapping resources and (2) the need for additional resources. Related work involves development of additional geospatial data on future mean high-water shorelines, which could be used to map future inundation under higher sea levels.

Timeline

The ResilientCoasts Draft Plan was released in May 2025 for public review and comment. The plan will be finalized and released in the Fall of 2025. All final data layers associated with the plan will be made publicly available via an online map viewer. Additional MC-FRM products to support place-based coastal resilience measures including future mean high-water shorelines are being developed and are expected to be available Fall 2025.

F. Planning and Coordination: Floodplain Framework Development

Summary

This interagency coordination initiative led by Massachusetts Water Resources Commission's floodplain management staff brings together staff across state agencies and executive offices who are involved in floodplain planning and development, flood risk management, flood recovery, and flood response for all types of flooding. The project synthesized state entity knowledge, practice, needs, and goals for floodplain management and in the coming years seeks to operationalize an inter-agency framework around floodplain management.

Relevant Products

This effort will generate a report that outlines potential coordination and management strategies and include examination of existing resources, regulations, and policies. Over the next year, the project will also define roles and responsibilities for the numerous actions

required to steward floodplains in general and will include floodplain restoration priorities as well as flood mitigation priorities.

Timeline

The project was launched in 2024. Phase I concluded in FY25; Phase II will begin in 2026.

IV. Assessment of Needs/Feasibility of Developing New Flood Risk Mapping Resources and Recommendations

As outlined above, over the past five years the state has made several investments in studies and projects that have resulted in a better understanding and characterization of precipitation and floods in Massachusetts. The products that have been generated are being used in state-, regional- and municipal-level planning. Several past and ongoing initiatives at EEA have assessed the need for additional flood information resources or are in the process of doing so. However, more of such efforts are needed to fully characterize floods and develop tools and resources at more local scales to help with planning, design, and development of mitigation strategies to deal with floods.

This section provides an overview of possible additional risk assessment, modeling, and mapping resources that could aid in the understanding and mitigation of coastal, riverine, pluvial, and groundwater flooding and their combined effects.

A. Consolidated Database of Past Flood Locations; Development of an Online Reporting Tool for Crowd-Sourcing Real-Time Flood Locations

Needs

Cataloguing location and extent of flooding at the local scale as it occurs and characterizing the extent of impacts and losses helps to inform the state's understanding of flood risk and impacts. Records of past flooding are important resources for calibrating and validating flood models, especially models which map stormwater (pluvial) flooding that occurs away from rivers and streams. Currently, the MyCoast King Tide and Coastal Storm Reporter tool addresses this need in the Commonwealth's coastal areas and the MassDOT App targets flooding which occurs at the agency's infrastructure, but there is no statewide tool for collecting flood impact reports as they occur and no comprehensive statewide database of past flood locations. Flood reports in the tool/database could be used to support disaster assistance requests, identify priorities for flood mitigation and minimization, and support flood modeling studies.

Conversations on this need and potential next steps have begun among EEA staff; however, no funding has yet been identified or project scoped.

Recommendations

1.	Develop a statewide online flood reporting tool
2.	Collect and standardize locally identified flood area digital GIS data from municipal Hazard Mitigation Plans and enhanced by any other local lived experience; post this GIS resource on state web platforms such as MassGIS

B. Statewide Riverine Flood Mapping Products

Needs

Across the Commonwealth there is a need for uniform and complete riverine flood maps statewide. In addition to uniform coverage and quality statewide which is necessary for policy and planning purposes, it is important to many applications of riverine flood mapping that riverine flood maps are up to date, cover rivers and streams of smaller drainage area, and include a wide range of flood return periods and climate change scenarios. These needs have been identified through the development of a MEPA resiliency policy, the ongoing development of guidance for siting clean energy infrastructure and housing, 2022 MA Climate Change Assessment, the 2023 ResilientMass plan, the development and periodic re-assessment of the Climate Resilience Design Standards tool, and through other initiatives. The needs have been further defined and clarified through initial engagement for the Riverine and Pluvial Flood Mapping project.

FEMA flood hazard areas map the 100- and 500-year flood areas based on past estimates of flood risk. The 100-year flood area and FEMA 100-year flood elevations are the basis of many existing regulations, including local floodplain ordinances and elevation requirements in building code. FEMA provides Flood Insurance Rate Maps (FIRMs), available throughout Massachusetts, which can be used to determine whether a site or building is located within a flood hazard area. FEMA also provides a FEMA National Flood Hazard Layer (NFHL), which maps some of the FEMA flood hazard areas in Massachusetts in a digital format suitable for web mapping. Other flood hazard areas can only be identified by consulting location-specific FIRMs in paper or pdf format. Approximate digitizations of these paper flood maps exist in these areas, but these may not include full flood zone designation detail and are not suitable for site-specific determinations. Other areas of the state not yet covered by the NFHL are the subject of recent FEMA flood studies which have not yet been approved by the community. It is important to expand the National Flood Hazard Layer to cover all of Massachusetts so that the impacts of proposed policy based on FEMA flood zone designations may be studied and quantified, for local and community planning purposes, and for individuals' awareness of local flood hazard.

Because FEMA flood hazard areas are the basis of many policies and regulations which seek to protect the Commonwealth from flood damage, but FEMA flood hazard areas are based on past estimates of flood risk, it is also important to develop flood maps which account for future increases in flooding and area in floodplains under climate change. While mapping future 100-year flood elevations is important, it is a time-consuming and expensive endeavor. In the meantime, existing FEMA 500-year flood areas and elevations could serve as a proxy for greater area exposed to the 100-year flood in the future. While the National Flood Hazard Layer does not contain 500-year flood elevations, augmenting existing maps of 500-year flood areas with elevations from FEMA Flood Insurance Studies would be feasible to achieve within a shorter time frame as a temporary proxy and basis of flood adaptation.

Two ongoing projects highlighted above also address part of this need - the ongoing Climate and Hydrologic Risk Project Phase II will develop projected design flood discharge; and the Riverine and Pluvial flood mapping project which will model how projected design flood discharge translates to flood extent (area of floodplains) and depth. However, the project does not have sufficient funding to provide statewide riverine flood mapping coverage. Even with funding available, achieving uniform statewide coverage would be a lengthy process.

Recommendations

1.	Extend the Riverine and Pluvial Flood Mapping project to achieve full statewide coverage
2.	Support FEMA Flood Insurance Study (FIS) updates, particularly in Hampshire, Hampden, Franklin, and Berkshire counties
3.	Sustain, or if possible, expand funding for MassGIS and EOEEA GIS software and personnel to ensure timely updates and functioning web map and data services
4.	Develop publicly available resources for flood elevation of FEMA 500-year flood areas
5,	Continue funding for river and stream gages statewide. Fund the addition of new river and stream gages at key gaps in the monitoring network for better model calibration and validation.

C. Statewide Pluvial (Stormwater) Flood Mapping Products

Needs

Stormwater flood maps exist piecemeal statewide as the result of local and regional modeling projects; however, coverage is very limited spatially and the modeling methods and modeled scenarios vary widely. Pluvial flood data products that map a wide range of storm scenarios and return periods, map climate change scenarios, and which are produced using a standard set of methods are needed. This need for pluvial flooding was identified through the 2022 MA Climate Change Assessment and 2023 ResilientMass plan, the

development and periodic reassessment of the Climate Resilience Design Standards tool (used for screening projects for climate risks and making initial climate-informed design recommendations), in the Floodplain Framework effort, and other initiatives. The needs were further refined and clarified through initial engagement for the Riverine and Pluvial Flood Mapping project.

The ability to provide statewide pluvial flood mapping products is contingent on several ongoing products, including (1) the ongoing Climate and Hydrologic Risk Project Phase II, which will develop projected design precipitation events, and (2) the Riverine and Pluvial Flood Mapping project, which will establish a standard for pluvial flood mapping and develop pluvial flood maps in several locations within the Commonwealth. However, the project does not have sufficient funding to provide statewide pluvial flood mapping coverage, and the lack of detailed digitized stormwater infrastructure information statewide limits the ability to map flood risk accounting for this infrastructure.

Recommendations

1.	Support the development of municipal stormwater infrastructure data through a grant program, potentially as part of an existing related program. These data are key inputs for pluvial flood modeling which require information on stormwater infrastructure location, elevation, shape, and size. Municipalities rarely have these data available (i.e., they mostly only have location data) in an electronic/digitized form.
2.	Extend the Riverine and Pluvial Flood Mapping project to achieve greater statewide coverage of pluvial flooding. We also recommend providing the modeling standards produced through the project as part of state solicitation materials for grants that fund flood studies so that all such flood studies are compatible and can be integrated into statewide flooding platform produced through the Riverine and Pluvial Flood Mapping project

D. Coastal Flood Mapping Products

Needs

The ResilientCoasts Initiative and other statewide initiatives, such as MassDEP's wetlands regulations update process, identified several needs regarding coastal flood mapping resources:

- Additional technical analysis to improve and update MC-FRM with additional data and information
- Incorporation of coastal water conduit and infrastructure in the MC-FRM to better reflect the hydraulics and extent of coastal flooding in future coastal flood maps
- Regularly update MC-FRM so that it may be more suitable as a basis for coastal regulations

- Mapping of compound flood risk that can be incorporated into later phases of ResilientCoasts and used to update municipal and regional flood risk[2]

Recommendations

1.	Conduct additional technical analysis to improve and update the MC-FRM with additional data and information. Update the MC-FRM with additional water infrastructure information and future coastal flooding.

E. Statewide Groundwater Flood Mapping Products

Needs

Initial results from the Statewide Groundwater Flooding Risk Assessment and Mapping project established that modeling at the statewide scale with a static groundwater model that estimates average annual levels yields too much uncertainty to provide design appropriate estimates of current and future groundwater levels. There is a need for statewide, groundwater flood mapping products that are of sufficient temporal and spatial resolution to inform siting, assess impacts, and develop adaptation policy and design given the extensive potential impacts of groundwater rise on subsurface infrastructure (utilities, septic systems, basements, foundations), historical contaminant mobilization potential and loss of arable lands and forests.

Recommendations

1.	Enhance the statewide model from static to transient to allow for the estimation of high groundwater levels rather than only average annual levels. This model and its results will provide a near-term product with statewide coverage that can guide adaptation planning or be downloaded and further refined by local entities to estimate groundwater levels with sufficient accuracy for adaptation design
2.	Conduct high temporal and spatial resolution modeling to determine appropriate regional scale for models that will produce groundwater level estimates of sufficient accuracy to support adaptation design
3.	Build out coverage of the state using high resolution modeling to provide future groundwater level estimates accurate enough for adaptation design.
4.	Publish all groundwater elevation maps and guidance on their use in flood adaptation to the ResilientMass Maps and Data Center in user-friendly web tools. Publish all models as downloadable files for site-specific use.
5.	Continue full funding for groundwater monitoring wells and expand the groundwater monitoring network with sites at current gaps.

[2] Referenced below under "Compound Flooding" needs.

F. Statewide Compound Flood Modeling

Needs

Flood maps representing areas at risk of flooding caused by compound riverine and coastal flood events are needed for flood risk management in coastal areas. This need was identified through the Riverine and Pluvial Flood Mapping Project, which will account for interactions between riverine and pluvial (urban or stormwater) flooding and coastal water levels through a simplified methodology, as well as through the ResilientCoasts initiative modeling.

The need is being partially addressed by the Riverine and Pluvial flood mapping project; however, (1) that project does not have sufficient funding to provide statewide riverine flood mapping coverage, and (2) the project is taking a simplified approach to modeling the interaction between river and stormwater flooding and high coastal water level, and more detailed modelling of compound flood processes may be needed to better support decision-making.

Recommendations

1.	Further clarify the need for compound flood map resources, if any, beyond those to be produced through the Riverine and Pluvial Flood Mapping project through initiatives such as the ResilientCoasts Strategy and ResilientFloodplains initiative.
2.	Ground-truth the compound flood maps developed through the Riverine and Pluvial Flood Mapping project relative to documented past compound flooding through the MyCoast coastal storm impacts database, the Flooding and Environmental Justice project, and any other sources of information on past flooding.
3.	In future phases of the Massachusetts Coast Flood Risk Model (MC-FRM) development, assess opportunities to incorporate more robust representation of compound flooding processes and develop detailed cost estimates for doing so in future model and map updates.

G. Statewide River Corridor Mapping

Needs

Studies and maps depicting areas where rivers could migrate to in the future given existing fluvial geomorphologic trends are needed. This need was identified through the Riverine and Pluvial Flood Mapping project; however, work to address this need is not within the scope of that project. Maps showing where river corridors could shift given natural processes, and increased precipitation causing erosion, sediment transport, etc. are important resources for local and regional land use planning.

Recommendations

1.	Review river corridor mapping methods applied in other New England states and refine methodology for Massachusetts' needs
2.	Develop the maps depicting the migratory path and extent of the changing river corridors over time
3.	Establish a pathway toward incorporating river corridor migration areas in state, regional, and local land use planning

H. Statewide Flooding and Environmental Justice Vulnerability Assessment

Needs

The Statewide Flooding and Environmental Justice Vulnerability Assessment Project, that concluded June 30, 2025, established an approach for engaging with environmental justice communities, built collaborative networks, and began building a statewide crowd-sourced flood map database. The Project identified the following main needs:

(1) Continue community engagement in the three pilot communities that are part of the current study. Add additional pilot communities with high flood vulnerabilities.
(2) Collaborate with local colleges and universities to leverage existing engagement and flood assessment tools, thereby fostering academic partnerships and expanding direct community support.
(3) Expand the approach (that is currently focused in EJ areas, which are primarily urban and suburban areas) to rural communities vulnerable to flooding. Collect existing flood maps and community knowledge of flood-prone areas and develop mitigation designs tailored to the unique challenges and characteristics of rural environments[3].

Recommendations

1.	The project should continue to build upon the successful foundational work over the past two years, emphasizing deeper community engagement, the specific needs of rural communities, project implementation, and knowledge transfer. Future work should include additional pilot communities, characterizing flood vulnerabilities in rural communities, and engaging with local institutions.

[3] Documentation of flood-prone locations in rural areas would support ongoing flood modelling and mapping initiatives including updates to the MC-FRM and riverine and pluvial flood mapping.

I. Vulnerability Assessment of the Agricultural Sector to Flooding

Needs

The agricultural sector has been impacted by precipitation-driven flooding throughout Massachusetts' history and during recent events such as Hurricane Irene and the floods of July 2023. It can be desirable to locate crop lands near rivers, as floodplains such as but not limited to the Connecticut River Valley contain fertile soil and topographically favorable land for farming. However, the vulnerability of farms in these areas to floods increases as the Northeast US faces more frequent and severe intense precipitation.

Recommendations

1.	Engage the agricultural sector in ongoing flood vulnerability assessment and planning efforts as well as flood map resource development projects to ensure that policy, executive actions, and new data products reflect the needs of the agricultural sector to address flooding.
2.	Further clarify the need for flood map resources in the agricultural sector through state planning initiatives,

Conclusions

Over the last 10 years Massachusetts has taken significant steps to understand and characterize floods and strengthen floodplain management in response to changing precipitation patterns and increased flood risks. High-intensity, short-duration storm events are now among the most pressing natural hazards facing the Commonwealth—an issue highlighted in the *ResilientMass Plan*. Recognizing this, state agencies have been prioritizing projects and programs and have been coming together to align flood-related policies, data, and planning efforts.

This report provides a summary of existing and available data, maps and products related to precipitation, streamflow and flooding that are readily available to state agencies and the public. The report also provides a summary of several ongoing studies and projects that are developing cutting-edge and state-of-the-art methods and products as building blocks that showcase existing and future riverine, pluvial (urban), and groundwater flooding. EEA and MassDOT have invested significant resources through dedicated staff time and their capital and operating budgets, along with some federal support to develop these products. We have made noted strides and progress and have developed mapping resources and tools for better planning and management of floods across the Commonwealth.

However, it will take further coordination among state agencies and a combination of funding sources in the future to meet the needs and fully realize our vision for Massachusetts floodplains - to be healthy, resilient and functionally beneficial for the natural environment and all living beings, with no damages to the built environment or the people who are impacted by flooding. As we continue to implement the studies highlighted in Section III and initiate new projects and studies outlined in Section IV we will look to existing authorizations and authorities at EEA. This would include authorization outlined in the Mass Ready Act filed by Governor Healey in June 2025, development and implementation of the Resilient Mass Plan, implementation of ResilientCoasts, and the other broad authority that Massachusetts Water Resources Commission at other programs at EEA currently have related to flood management and flood loss prevention. We would also look to future capital, operating budgets as well as seek opportunities and resources at the federal level to guide floodplain management, and resilience efforts in Massachusetts.

Appendix A – Bill S.2967, An Act Promoting a Clean Energy Grid, Advancing Equity and Protecting Ratepayers – Section 125

SECTION 125. The secretary of energy and environmental affairs shall review existing 2949 flood risk mapping resources and assess the need for and feasibility of creating additional flood 2950 risk mapping resources to identify areas vulnerable to current and future flooding across the 2951 commonwealth. 2952

The secretary shall develop recommendations, including any legislation or funding 2953 necessary, to support any additional required flood risk mapping resources and shall submit its 2954 recommendations to the joint committee on environment and natural resources, the climate chief, 2955 the house and senate committees on ways and means and the clerks of the senate and house of 2956 representatives not later than 6 months after the effective date of this act. The recommendations 2957 shall also be made available to the public on the website of the executive office of energy and 2958 environmental affairs