Recommendations for

IMPROVING THE EFFICIENCY OF CULVERT AND SMALL BRIDGE REPLACEMENT PROJECTS

Prepared by the Massachusetts Culverts and
Small Bridges Working Group for Senator Hinds
and the Massachusetts Legislature

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Cover Image: Dingle Road, Worthington MA

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ABBREVIATIONS

ConCom	Conservation Commission (municipal board)
CZM	Massachusetts Office of Coastal Zone Management
DCR	Massachusetts Department of Conservation and Recreation
DER	Massachusetts Division of Ecological Restoration
DMF	Massachusetts Division of Marine Fisheries
EEA	Executive Office of Energy and Environmental Affairs
EOHED	Executive Office of Housing and Economic Development
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
MaPIT	MassDOT Project Intake Tool
MassDEP	Massachusetts Department of Environmental Protection
MassDOT	Massachusetts Department of Transportation
MassWildlife	Massachusetts Division of Fisheries and Wildlife
MEMA	Massachusetts Emergency Management Agency
MEPA	Massachusetts Environmental Policy Act
NHESP	Natural Heritage and Endangered Species Program
MHC	Massachusetts Historical Commission
MVP Program	Municipal Vulnerability Preparedness Program
NMFS	National Marine Fisheries Service
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Service

1.0
EXECUTIVE SUMMARY

Culverts and small bridges play an integral role in the Commonwealth's transportation network, ecological health, and climate resiliency. When they are functioning properly, most residents remain largely unaware of these important structures. Massachusetts has more than 25,000 culverts and small bridges in its transportation network. For the purposes of this study, small bridges are generally defined as having spans between 10 and 20 feet in length and culverts are structures less than 10 feet. Many of these structures have reached, or will soon reach the end of their designed service life. To compound the issue, many of these structures are undersized relative to current stream flows.

Massachusetts climate change predictions include increases in both the frequency of severe weather and the amount of precipitation; Massachusetts has already begun to experience these changes, putting many culverts and small bridges at risk. Some communities are still recovering from the impacts of Tropical Storm Irene (2011), which washed out numerous culverts and bridges. As climate change impacts increase, a growing number of culverts and small bridges will be at risk due to increased storm flow. Equally concerning is that undersized culverts have already caused substantial impacts to not only fish and wildlife movement, but also to the survival of organisms and entire wildlife populations. Failing culverts and small bridges pose a direct threat to residents' safety and the Massachusetts economy.

There are 25,000+ culverts and small bridges in Massachusetts.

Many of the state's existing culverts and small bridges were constructed in the 1950s and 1960s using the stream flow data of the time and before modern environmental regulations were in place. Not only are many of the Commonwealth's culverts and small bridges undersized and/or failing, they are not designed to meet the Massachusetts River and Stream Crossing Standards ("Stream Crossing Standards"), which were implemented out of substantial concern over habitat fragmentation and to restore and/or safeguard passage for fish, aquatic organisms, and other wildlife. The incorporation of the Stream Crossing Standards

For the purposes of this study, small bridges are generally defined as having spans between 10 and 20 feet in length and culverts are structures less than 10 feet.

into the Wetlands Protection Act Regulations in 2014 increased the ecological standard for culvert and small bridge replacement projects.

To date, culvert and small bridge projects have been viewed primarily as maintenance activities. Traditionally, maintenance work results in the repair of existing structures or the replacement of the structures with similarly sized structures. More recently, due to the adoption of the Stream Crossing Standards and increased understanding of the role culverts and small bridges play in addressing storm-related water flow and drainage structure management, there has been an increase in the number of proponents seeking to make improvements to culverts and bridges for storm resilience and fish and wildlife passage.

In light of the aforementioned effects of climate change, when culverts and small bridges are in need of replacement, the projects should be treated as opportunities to improve crossings for the conditions of today and the future. It is generally no longer adequate to replace these structures with similar structures designed to criteria of the past.

Through the storms Massachusetts has experienced over the past decade, the importance of repairing and replacing culverts and small bridges with appropriately-sized structures has become apparent. Municipalities have begun to recognize the need to replace failing culverts with larger, more resilient structures, but there are a number of challenges that significantly hinder municipalities and the Massachusetts Department of Transportation (MassDOT) from increasing the size of stream crossings. These include site-specific constraints such as engineering barriers, educational barriers, and regulations. However, cost is the most-reported reason municipalities do not upgrade culverts or small bridges. Environmental and engineering compliance review processes and limitations at state and federal permitting agencies to provide guidance and efficient permit application review are also cited as top reasons that municipalities do not upgrade culverts and small bridges.

The Culverts and Small Bridges Working Group was convened to identify and evaluate the costs and benefits of existing environmental rules and regulations, engineering standards, and permitting processes and their impact on the replacement or repair of deteriorated or substandard culverts and small bridges.

Municipalities throughout the Commonwealth and MassDOT often struggle with the regulatory requirements and high costs associated with completing needed culvert and small bridge replacements. The Working Group has developed a series of recommendations to address these challenges: Advance the Recommendations and Actions of the State Hazard Mitigation & Climate Adaptation Plan (SHMCAP); Expand Technical Assistance and Training Programs; Expand Grant Programs and Provide Additional Financing Options; Research and Innovation; Revise Engineering Standards; Streamline Environmental Permitting; and Continue the Working Group.

Recommendations of the Culverts and Small Bridges Working Group

Advance the Recommendations and Actions of the State Hazard Mitigation & Climate Adaptation Plan (SHMCAP)

The Working Group's mandate can be achieved, in part, through advancing the goals and objectives identified in Executive Order 569 and the September 2018 SHMCAP. Leadership support and cross-agency collaboration is essential to implementing the SHMCAP; periodic interagency symposiums should be convened to share implementation strategies, best practices, and inform other agencies of process or regulatory updates.

Expand Technical Assistance and Training Programs

Expand existing agency technical assistance and training programs to develop an interagency program to provide municipal educational training resources and technical assistance regarding available funding, engineering, and environmental permitting.

Expand Grant Programs and Provide Additional Financing Options

Expand existing grant programs, especially the MassDOT Small Bridge Program, the DER Culvert Replacement Municipal Assistance Grant Program, and the Municipal Vulnerability Preparedness Program (MVP Program), to complete more culvert and small bridge replacement and repair projects across Massachusetts. Additional financing options, such as capital improvement planning, legislative allocations (such as Senate Bill 10), etc., should be explored to help municipalities afford culvert and small bridge replacement projects.

Senate Bill 10: An Act Providing for Climate Change Adaptation Infrastructure Investments in the Commonwealth was filed on January 24, 2019 and proposes a "modest increase in the excise on real estate transfers to fund substantial and sustained investment in climate change adaptation."[1]

Research and Innovation

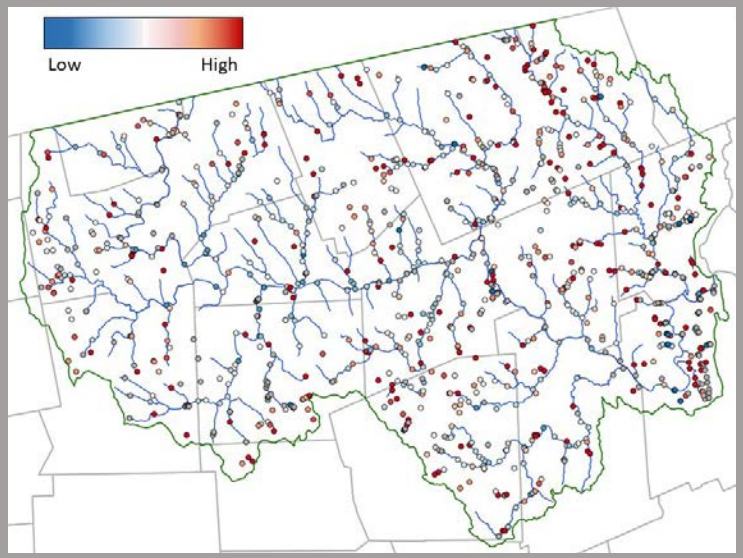
Additional research is needed to comprehensively assess the condition and vulnerability of municipal culverts and small bridges. Massachusetts needs to address these projects in innovative ways, using new tools and modeling to simplify and expedite proper culvert and bridge sizing to improve storm resiliency, wildlife connectivity, and natural river and floodplain processes.

Toward this goal, the Working Group supports MassDEP efforts to develop an easy to use web-based tool and statewide hydraulic model to identify the most appropriate replacement crossing structure size that would maximize ecological benefits without exacerbating downstream flooding, property damage, or other impacts. Further, it would be MassDEP's goal to evaluate implementation of a regulatory change that has the potential to substantially streamline and expedite permitting of culvert and small bridge replacement projects based on the output of this web-based tool. The statewide hydraulic model is included in the Massachusetts Hazard Mitigation and Climate Adaptation Plan to help meet the Commonwealth's resiliency goals.

A PROPOSED METHOD FOR ASSESSING THE VULNERABILITY OF ROAD-STREAM CROSSINGS TO CLIMATE CHANGE: DEERFIELD RIVER WATERSHED PILOT

MassDOT worked in partnership with UMass to develop a credible rapid assessment and prioritization methodology for road-stream crossings in the Deerfield River Watershed. The pilot project reviewed multiple components to assess each crossing. The components reviewed were: risk of failure, climate change and associated impacts, disruption of emergency medical services, ecological disruption, and transportation vulnerability. These factors were used to develop a Transportation Vulnerability and Ecological Disruption score for each crossing to identify an overall prioritization rating.

This methodology could be used statewide to assess and prioritize the replacement of river and stream crossings.



The Deerfield River Watershed Pilot developed a series of maps to help quickly identify where the highest risks and priorities are.

(Source: A Proposed Method for Assessing the Vulnerability of Road-Stream Crossings to Climate Change: Deerfield River Watershed Pilot, UMass Amherst and MassDOT, published December 2018)

Revise Engineering Standards

Develop standard culvert and small bridge design template drawings that reduce design and construction costs and streamline permitting and structural review. Formalize and require early coordination with MassDOT on bridge design, when necessary. Review existing guidelines and standards to be clear, concise, and specifically relevant to culvert and small bridge projects. The Resilient MA Action Team, the State's implementation body for its Hazard Mitigation and Climate Adaptation Plan, is currently launching a process to develop climate resilient standards for use by state agencies that account for future climate changes over the design life of infrastructure projects.

Additionally, the Working Group identified a need to bring the engineering and environmental permitting pathways together to develop a stepwise workflow for communities to follow. This would increase efficiency and reduce the cost of permitting.

Streamline Environmental Permitting

The Working Group has not reached consensus on a comprehensive suite of potential recommendations to streamline the environmental permitting process, but has collaboratively identified several recommendations that warrant further exploration, including:

- mandatory pre-application coordination with permitting agencies;
- requiring the use of consultants who have completed a pre-qualification process;
- consolidating permit applications;

- reducing duplicative reviews and/or permits that ultimately result in the same level of environmental protection; and
- adopting regulatory presumptions and/or providing condensed reviewed for projects achieving certain standards.

Any changes to the permitting process should not compromise either long term infrastructure or environmental integrity.

The Working Group estimates that to implement these recommendations, approximately $53 million in funding would be needed to further enhance existing culvert and small bridge replacement programs. Continued and sustained funding of these programs may be necessary. If enacted, Senate Bill 10 is estimated to generate $1.3 billion over 10 years for the Commonwealth's Global Warming Solutions Trust Fund[2].

The vast majority of the initial funding, $50 million over four years, would increase funding in the state's existing grant programs. Specifically, $20 million would be dedicated to the MassDOT Small Bridge Program and the remaining $30 million would be allocated to the DER Culvert Replacement Municipal Assistance Grant Program and MVP Action Grant Program. Developing the statewide hydrology/hydraulics tool described above in the Research and Innovation section will likely cost between $1 and $3 million. The Working Group recommends that $100,000 be allocated for the first year of expanded training.

Implementing a program to more efficiently reconstruct culverts and small bridges in a resilient and ecologically-friendly manner will help protect resident safety and strengthen the Massachusetts economy in a future of continuing climate uncertainty.

Continue the Working Group

Ongoing collaboration across a subset of the Working Group agencies and organizations will help to advance the group's recommendations and maintain interagency partnerships and cooperation.

Dingle Road, Worthington: before (top) and after (below) a culvert replacement project.

Route 2, Charlemont, Worthington: before (top) and after (below) a small bridge replacement project.

Adamsville Road (unnamed tributary to the North River) Culvert Replacement Project, Colrain

Total Project Cost: **$399,328**

Design, Engineering, Permitting: ***$88,740***

Construction Phase Engineering and Bid Services: ***$25,938***

Construction: ***$284,650***

Grant Funding: ***$238,700***
FY18 and FY19 CRMA Awards

Municipal Funding: ***$160,588***
(Chapter 90)

DER's Culvert Replacement Municipal Assistance Grant (CRMA) Program is for Massachusetts municipalities interested in replacing an undersized, perched, and/or degraded culvert located in an area of high ecological value. The purpose of the funding is to encourage municipalities to replace culverts with better designed crossings that meet the improved structural and environmental design standards and flood resiliency criteria. Only projects that intend to meet the goals of the Massachusetts Stream Crossing Standards are considered for funding.

- The Town of Colrain constructed a 12-ft open-bottom culvert (completed May 2019) on a tributary to the North River. Replacing the existing undersized culvert provides passage for fish and wildlife on coldwater tributary, and improves Colrain's infrastructure by reducing the risk of culvert failure.
- This project received two rounds of funding from the CRMA Grant Program: $88,740 was awarded for design and permitting in FY18 and $150,000 was awarded for construction in FY19.
- The balance of the construction cost was paid through Chapter 90 funding.

After grant awards, the Town was responsible for $160,588 in construction costs - this one crossing cost the town more than half of its total Chapter 90 funding for the year! Colrain was allocated $319,601 in Chapter 90 funding.

Original Culvert (top left)
Construction of New Crossing (bottom left)
Completed Culvert (right)

2.0
INTRODUCTION & PURPOSE

Communities throughout the Commonwealth and the Massachusetts Department of Transportation (MassDOT) often struggle with the site constraints and high costs associated with permitting, planning, and constructing needed repairs and/or replacements of culverts and small bridges. This report documents the work and recommendations of the Culverts and Small Bridges Working Group, convened as directed by Section 102 of the FY 2019 General Appropriations Act.

The purpose of this group was to identify and evaluate the costs and benefits of existing environmental rules and regulations, engineering standards, and permitting processes and their impact on the replacement or repair of deteriorated or substandard culverts and small bridges. For the purpose of this report, small bridges are generally defined as those that span between 10- and 20- feet and culverts are structures that span less than 10-feet.

2.1 Purpose

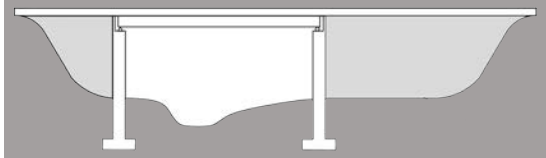
The purpose of this report is to provide actionable recommendations that the Massachusetts Legislature and state agencies can implement to help Massachusetts municipalities and MassDOT replace culverts and small bridges more quickly and cost-efficiently with resilient structures that will be able to withstand more frequent and intense storms while restoring and/or enhancing natural fish and wildlife passage, providing resource and habitat connectivity, and supporting natural river and floodplain processes.

2.2 Problem Statement

There are more than 25,000 culverts and small bridges in the Commonwealth of Massachusetts that provide roadway and rail crossings over rivers and streams. MassDOT specifically has responsibility for 440 small bridges and approximately 6,000 culverts. There are 1,006 small bridges in municipal ownership and an additional 51 small bridges are owned privately or by other agencies. It is assumed that the remaining approximately 17,000 structures are a combination of municipal, private, and other agency ownership. These structures serve an important purpose in the state's transportation network, maintain hydraulic

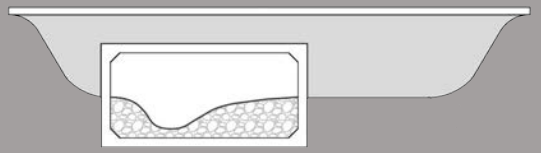
SMALL BRIDGE

A structure that supports a roadway or other access way over a water body by means of a span between 10 and 20 feet wide.



CULVERT

A structure, less than 10 feet wide, that supports a roadway or other access way over a water body.



(Image Source: MassDOT Highway Division Stream Crossing Handbook)

connections within watersheds, and help protect nearby homes, businesses, and other infrastructure from flood damage.

However, many of these structures were constructed 50 or more years ago and now need repair or replacement. A significant percentage of culverts and small bridges are also undersized relative to the size of the stream or river they are crossing. These undersized structures can be flooded or fail during severe precipitation events and may contribute to local flooding of roadways, public buildings, residences, and businesses. Flooding or failure of these structures also disrupts access for emergency services and can cause socio-economic impacts due to transportation disruptions. Access to businesses and schools as well as limited ability to transport goods and services quickly cause economic impacts. Undersized bridges and culverts also negatively impact fish and wildlife by interrupting the continuity of stream systems and present an impediment to aquatic organism passage and movement of wildlife. Habitat connectivity is an important aspect of culvert and small bridge replacement projects.

Exacerbating the risks related to these undersized and aging structures are the larger, more intense storm events that are forecasted to occur more frequently in the coming decades as a consequence of climate change. Not only will the state experience more days with precipitation, the storms will have heavier precipitation, producing a higher volume of rain or snow within a shorter time period. Many communities lack the capacity to carry out a culvert or bridge replacement project that meets the improved design criteria; these communities require assistance from the earliest stages of project development through project construction. Oftentimes, municipalities approach DER's Stream Crossing Specialists and experts at other agencies for help determining what they need to accomplish and how to accomplish the necessary steps. Some communities are unaware of the engineering

TABLE 1: CULVERT AND SMALL BRIDGE CONDITION

	NUMBER OF STRUCTURES	PERCENT STRUCTURALLY DEFICIENT
Municipal Small Bridges	1,006	15%
MassDOT Small Bridges	444	9%
Municipal Culverts	~17,000	n/a*
MassDOT Culverts	~6,000	n/a*

** A statewide, comprehensive engineering assessment of culvert condition has not been conducted.*

An undersized culvert in Becket failed multiple times over a six-year period, costing the town more than $140,000 in repairs. The improved crossing, designed to convey the stream's future water flows and to provide habitat connectivity with adequate fish passage, cost $593,000 to construct. The new structure will likely save the town over $1,000,000 in repairs over its lifetime *(see page 16).*

and environmental reviews necessary and may not know about the impacts of climate change on culvert and small bridge design. While local road managers are extremely knowledgeable about site-specific conditions and community needs, this lack of technical capacity significantly contributes to the number of in-kind replacement structures that are common for municipal projects.

Currently, MassDOT has a comprehensive process to prioritize the repair and replacement of state and municipal bridges less than 20 feet in span length, based upon their condition and other factors. No such process exists for culverts and small bridges, however, MassDOT created the Small Bridge Program to focus on meeting municipality needs for repairing and replacing small bridges. Often with structures owned by small municipalities, repair or replacement work is deferred until the structure's failure has caused a roadway closure, flooding, or other safety hazard. When a culvert or small bridge fails, municipalities and MassDOT undertake "emergency repairs" to replace the structure with a new one that is the same size. Unfortunately, work undertaken on an emergency basis is time-sensitive and does not provide opportunity for municipalities to design and construct culverts that increase capacity or otherwise improve the structure. As a result, communities often end up spending taxpayer dollars to replace undersized culverts with in-kind structures, which are prone to failure during large storm events, and sometimes find that the replacement structure still contributes to flooding and other damage.

MassDOT has begun an evaluation and prioritization process that will identify state-owned structures that are undersized structures and/or most at risk of failure. However, most municipalities do not have the technical expertise or staff capacity to inspect and prioritize each crossing. The Division of Ecological Restoration (DER), which provides financial and technical support to municipalities for culvert and small bridge projects, has estimated that more than half of the Commonwealth's culverts and small bridges are undersized. In addition, through a Federal Highway Administration (FHWA) funded research project, MassDOT has predicted that about 80% of MassDOT culverts are undersized relative to the width of the waterway they cross. Initiating a statewide evaluation and prioritization process for municipal structures would allow the legislature to better understand the scope and cost of replacing vulnerable structures and enable municipalities to identify the most critical projects and begin advancing them through the design and permitting processes.

Some of the major issues affecting the efficient design and replacement of existing culverts and small bridges include:

- Staffing levels and technical expertise (submitting grant applications, permitting, design, etc.) at the municipal level;
- Hydraulic modeling and data analysis;
- Permitting requirements and process;
- Understanding compliance with the Stream Crossing Standards; and
- Replacement cost and amount of available funds.

2.3 Legislation

Led by Senator Hinds of Berkshire, Hampshire, Franklin, and Hampden Counties, the Commonwealth's Fiscal Year 2019 budget called on the Massachusetts Department of Transportation, in conjunction with the Executive Office of Energy and Environmental

Benton Hill Road (Walker Brook) Culvert Replacement, Becket

The pipe culverts on Walker Brook were first surveyed in October 2005, site analysis showed that the crossing, comprised of one 4.5-foot round culvert and one 6.5 by 4-foot elliptical culvert, was undersized and preventing the movement of sediment and material downstream and it was classified as a Minor Barrier to Fish Passage. In the days following the October 2005 survey, Becket experienced 9- to 10-inches of torrential rain as Massachusetts experienced the remnants of Tropical Storm Tammy and Subtropical Depression Twenty-Two. The crossing quickly became overwhelmed and failed. A driver, unaware that the stream crossing had failed, drove into the water and had to be rescued by the local volunteer fire department in the middle of the night. The Town installed steel plates and rebuilt the road, spending between $10,000 and $15,000 on the repair. But, by the fall of 2009, the culverts had deteriorated to the point where they were beginning to fail and the roadway was being undermined again. The crossing was replaced in 2009 with three four-foot round pipe culverts. This repair cost the Town approximately $60,000. The new crossing was found to be undersized, based on bankfull width measurements, was slightly perched, did not contain a natural bottom, and appeared to accumulate sediments and other debris on the upstream end. Due to these findings, the new crossing was classified as a Moderate Barrier to Fish Passage.

Less than two years after the Town of Becket replaced the Walker Brook crossing, Tropical Storm Irene pummeled Massachusetts, dropping another 9- to 10-inches of rain on the Town. The culvert failed catastrophically, washing the road out entirely. The culverts themselves were washed almost 1,000 feet downstream!

Post-Irene, the Town replaced the culverts with two 5-foot round culverts and reports that it spent more than $70,000 on this repair. These replacement culverts had less capacity than the washed-out culverts, were significantly perched, and classified as a Significant Barrier to Fish Passage. The Town spent more than $140,000 over six years repairing just this one crossing.

Using a combination of grant funding and town funds/in-kind services, a new 30-foot clear bridge span was constructed in 2017 at a cost of $593,000. This crossing is designed to meet the Stream Crossing Standards, will be resilient during extreme storm events, and has an anticipated lifespan of 50 - 100 years.

Clockwise from top left:
First replacement crossing (2009); catastrophic culvert failure due to Tropical Storm Irene (2011); "emergency temporary replacement" crossing (2011); replacement bridge (2016).

Affairs, to bring a working group together to study the replacement or repair of culverts and small bridges less than twenty feet wide (An Act Making Appropriations for the Fiscal Year 2019 for the Maintenance of the Departments, Boards, Commissions, Institutions and Certain Activities of the Commonwealth for Interest, Sinking fund and Serial Bond Requirements and for Certain Permanent Improvements (2018)).

Specifically, the working group was charged with identifying and evaluating "the costs and benefits of existing environmental rules and regulations, engineering standards and permitting processes and their impact on the replacement or repair of deteriorated or substandard culverts and small bridges that measure less than 20 feet wide. The working group shall make recommendations to implement cost effective policies and procedures for the replacement or repair of such culverts and small bridges in an expedited manner and to make improvements in storm resiliency and natural resource connectivity that studies the degrees of risk, ecological value, cost and effective permitting."

2.4 Working Group

The Culverts and Small Bridges Working Group is comprised of stakeholders from various backgrounds as representatives from key organizations and agencies. The Working Group members are listed in Table 1 on the next page. Throughout the development of this report, members of the Working Group, supported by their agencies and organizations, spent numerous hours participating in Working Group and Subgroup meetings, reviewing materials, speaking with their constituents, researching the issues, and developing recommendations. This report would not have been possible without their significant effort.

Recognizing the large scope of this project, the Working Group met regularly as a group and broke into three smaller Subgroups that met to address particular topics. The three Subgroups were: Engineering, Permitting, and Stakeholders. Each of these subgroups worked to address specific aspects of the project and advance different priorities. In total, thirteen meetings were held.

The Working Group and Subgroup participants were invited to attend meetings in person or via conference call. The meetings were all open to the public, accessible to participants with disabilities, and posted in compliance with the Massachusetts Open Meeting Law.

This is a statewide problem, culverts and small bridges throughout the Commonwealth are undersized and/or degraded and at risk of failure.

TABLE 2: WORKING GROUP MEMBERS

AGENCY	REPRESENTATIVE	SUBGROUP(S)
MassDOT - Highway (Environmental)	Susan McArthur Working Group Co-Chair	Permitting
EEA/MA Division of Fish and Game	Ron Amidon Working Group Co-Chair	Engineering
American Council of Engineering Companies (Stantec)	Dennis Reip	Engineering
American Council of Engineering Companies (VHB)	Jake San Antonio	Engineering Permitting
CEI	Matt Lundsted	Engineering
EEA/MA Division of Fish and Game Division of Ecological Restoration	Carrie Banks	Engineering Stakeholders
EEA/MA Division of Fish and Game Division of Ecological Restoration	Kristen Ferry	Engineering Permitting
EEA/MA Division of Fish and Game Division of Ecological Restoration	Kristopher Houle	Engineering
EEA/MA Division of Fish and Game Division of Ecological Restoration	Brian Kelder	Permitting
Executive Office of Housing and Economic Development	Bobby Malinn	Stakeholders
Executive Office of Public Safety and Security	Brian Merrick	
MA Association of Conservation Commissions	Dorothy McGlincy	Stakeholders
MA Audubon Society	Heidi Ricci	Stakeholders
MA Department of Environmental Protection	Christopher Ross	Engineering Permitting

Table continues on next page..

Table 2: Working Group Members (continued)

AGENCY	REPRESENTATIVE	SUBGROUP(S)
MA Department of Environmental Protection	Michael Stroman	Permitting
MA Department of Environmental Protection	Stephanie Moura	Stakeholders
MA Department of Revenue	Sean Cronin	Engineering Permitting
MA Emergency Management Agency Hazard Mitigation Unit	Sarah White	
MA Highway Association	Thomas Reynolds	Engineering Permitting
MA Municipal Association	Ariela Lovett	Stakeholders
MA Natural Heritage and Endangered Species Program	David Paulson	Permitting
MA State Police	Michael Miskell	
MA Taxpayers Association	Andrew Bagley	Stakeholders
MassDOT - Highway (Bridge)	Alex Bardow	Engineering
MassDOT - Highway (Environmental)	David White	Permitting
MassDOT - Highway (Environmental)	Tim Dexter	Engineering Permitting
MassDOT - Highway (Structures)	Brian Clang	Engineering
MassDOT - Highway (Hydraulics)	Hanan Fouad	
Rural Policy Advisory Commission	Helena Fruscio Altsman	
Report Preparation and Meeting Support		
Stantec	Michael Paiewonsky	Engineering Permitting Stakeholders
Stantec	Alison LeFlore	Engineering Permitting Stakeholders

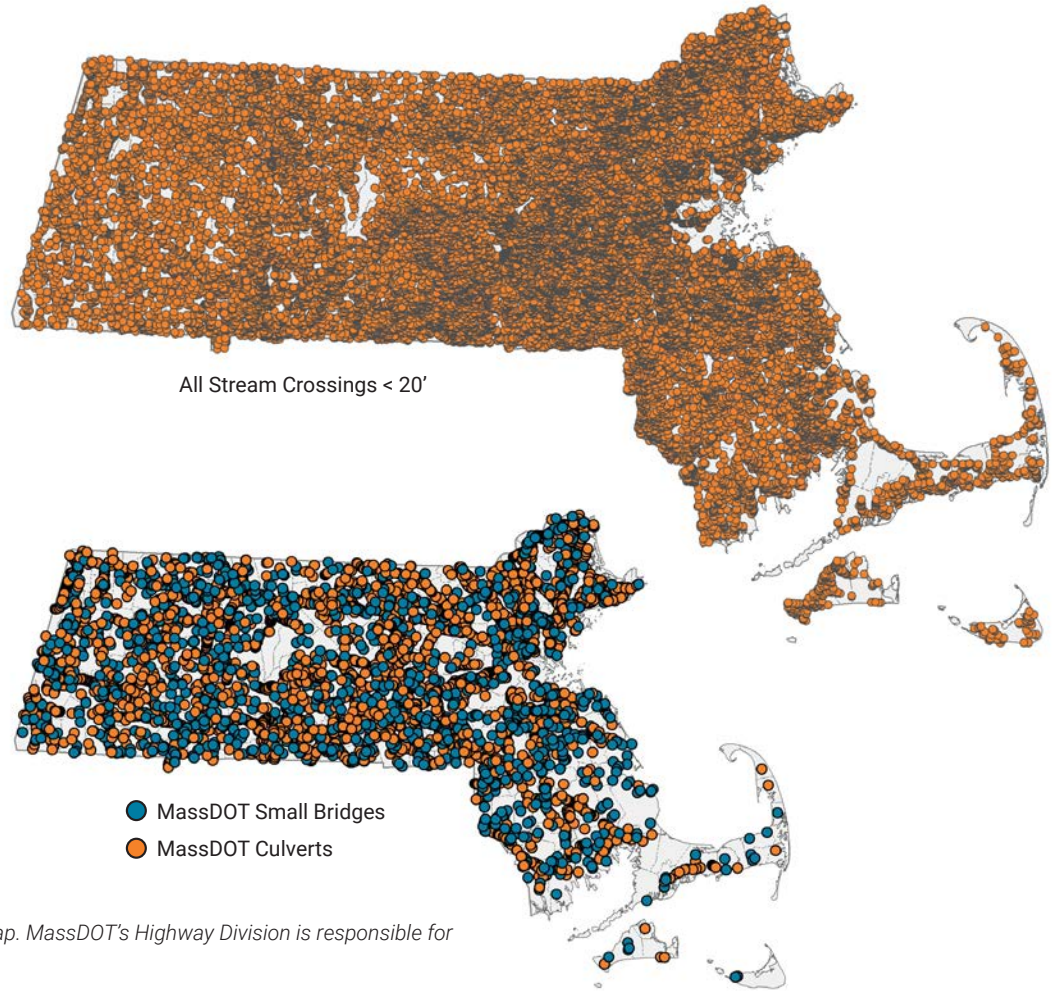
3.0 BACKGROUND

There are more than 25,000 culverts and small bridges in the Commonwealth of Massachusetts. Of these, MassDOT is responsible for 440 small bridges and approximately 6,000 culverts. Massachusetts's 351 cities and towns are responsible for 1,006 small bridges and approximately 17,000 culverts. As described below, maintaining and replacing these structures can be a costly, time consuming, and complicated process.

3.1 Aging Infrastructure

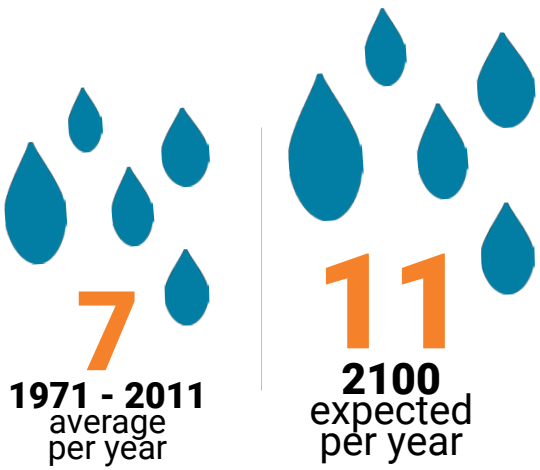
Many of the more than 25,000 small bridges and culverts in Massachusetts were constructed more than 50 years ago and are reaching, or have surpassed, their anticipated useful life. Many of these structures were not designed to current standards and are often undersized and unable to handle the stream's current water flow.

As a result of climate change, Massachusetts is predicted to experience larger, more intense storm events in the coming decades. This will exacerbate the risks related to these undersized and aging structures.



The State's 25,000+ culverts and small bridges are shown in the top map. MassDOT's Highway Division is responsible for 440 small bridges and approximately 6,000 culverts (bottom).

Increases in rainfall intensity in the Northeast are forecast to exceed those in other regions in the United States. Massachusetts will have more storms that produce a larger volume of precipitation over a shorter time period.



3.2 Increased Frequency and Intensity of Storms

As mentioned previously, a majority of culverts and small bridges are predicted to be undersized relative to the size of the waterbody they cross. When appropriately sized and in good repair, culverts and small bridges minimize flood risk to nearby infrastructure and buildings. However, undersized structures can fail during severe precipitation events and can contribute to local flooding causing damage to roadways, public buildings, residences, and businesses. The Commonwealth is already experiencing increased frequency and intensity of storms. These larger storms will result in a greater volume of precipitation in shorter time periods, exacerbating the risks related to culverts and small bridges.

According to the 2018 National Climate Assessment, "More frequent and intense extreme weather and climate-related events are expected to continue to damage infrastructure, ecosystems, and social systems that provide essential benefits to communities. Increases in rainfall intensity in the Northeast are forecast to exceed those in other regions in the United States."[5] In addition, a 2014 USGS study conducted in cooperation with MassDEP concluded that road crossing structures that meet or exceed the Stream Crossing Standards are beneficial because "in addition to improved passage for fish and wildlife, the structures are more resilient to large floods and provide a greater buffer to uncertainties and potential changes in flood flows than the existing stream-crossing structures [not designed in accordance with those standards]."[3]

Additionally, sea-level rise in the Northeast is predicted to be three- to four-times higher than the global average. These higher-than-average rates of sea level rise have already led to a 100%–200% increase in high tide flooding in some places, causing more persistent and frequent flooding impacts over the last few decades. Greater sea-level rise in the Northeast will amplify flood risks caused by large storms such as Nor-easters and hurricanes[4].

During severe precipitation events, the inability of culverts and small bridges to pass high flows can pose a direct threat to the safety of roadway users, the transport of goods and services, emergency services, and the Massachusetts economy. In 2011, Tropical Storm Irene and prior rain events that saturated the soils caused severe property damage in western Massachusetts as a result of widespread flooding of the Connecticut, Westfield, and Deerfield Rivers. This storm resulted in over 525 homes in Massachusetts being destroyed or severely damaged and the closure of a six-mile stretch of Route 2 from Charlemont to Florida for more than 3 months, partially caused by the catastrophic failure of small bridges and culverts. However, some structures that were recently reconstructed to meet the Stream Crossing Standards withstood the storm, such as the DER stream crossing project on Dingle Road in Worthington and all of the U.S. Forest Service stream crossings that had just been upsized in the Green Mountain National Forest in Vermont. These examples suggest that when designing structures to be larger for fish and wildlife passage, increased resiliency to severe

precipitation events can be a dual benefit. Projections suggest Massachusetts can expect to face more storms with the force of Irene in the coming years.

Reconstructing culverts and small bridges to be more resilient also advances the goals of the Massachusetts State Hazard Mitigation and Climate Adaptation Plan (SHMCAP), adopted in September 2018 in fulfillment of Governor Baker's Executive Order 569. The purpose of the SHMCAP is to reduce the statewide loss of life, and protect natural resources, property, infrastructure, public health, and the economy from national hazards and climate change impact through the development of a comprehensive and integrated hazard mitigation and climate adaption program. This plan is the first of its kind to comprehensively integrate climate change impacts and adaptation strategies with hazard mitigation planning that complies with current federal requirements for state hazard mitigation plans.

In addition to more frequent rain events and more intense storms, New England is predicted to experience an overall higher annual rainfall in the future. Total annual precipitation in Massachusetts is expected to increase by one to six inches (2 – 13%) by mid-century[4]. This will result in up to 53 inches of rain per year in Massachusetts; between 1971 and 2011, the average annual precipitation rate was 47 inches. Precipitation during winter and spring is expected to increase, while precipitation during summer and fall will likely decrease. By 2100, the state is predicted to experience up to 11 days per year with storm events dropping more than one inch of precipitation on a single day; between 1971 and 2000, Massachusetts had an average of only seven days per year with more than one inch of precipitation. Across the northeastern states, total average annual precipitation has increased by approximately ten percent over the last 50 years. Increased total rainfall can increase the frequency of minor, but disruptive, flooding events; this is especially common in areas where stormwater infrastructure has not been appropriately sized to accommodate higher levels of precipitation. More intense downpours lead to inland flooding because soils become saturated and are unable to absorb more water, river flows rise, and urban stormwater systems are overwhelmed by the water flow[6].

3.3 Ecological Context

The Commonwealth's rivers and streams play an important role in the integrity of the state's ecosystems and water resources. However, given their linear nature, the ecological system of rivers and streams can become fragmented by poorly designed or undersized culverts and small bridges. Existing undersized bridges and culverts can negatively impact wildlife by interrupting the continuity of stream systems which can impede the movement of fish and other wildlife. This major concern has been the subject of much effort since 2004 when standards to facilitate aquatic organism passage were initially developed by the River and Stream Continuity Partnership in Massachusetts.

Designing culvert and bridge crossings in a manner that considers wildlife habitat, is critical to maintaining and enhancing a healthy ecosystem. Furthermore, designing structures to allow sediment and larger debris restores and maintains natural stream processes, particularly in the face of climate change. State and federal agencies have recognized the importance of sizing stream crossing structures appropriately for these reasons and have adopted regulations and performance standards to address these

Undersized culverts limit water flow and are barriers to passage for fish and other wildlife (top and middle). Replacement structures are often much larger, provide capacity for larger water flows, and allow fish and wildlife to pass safely and freely (bottom).

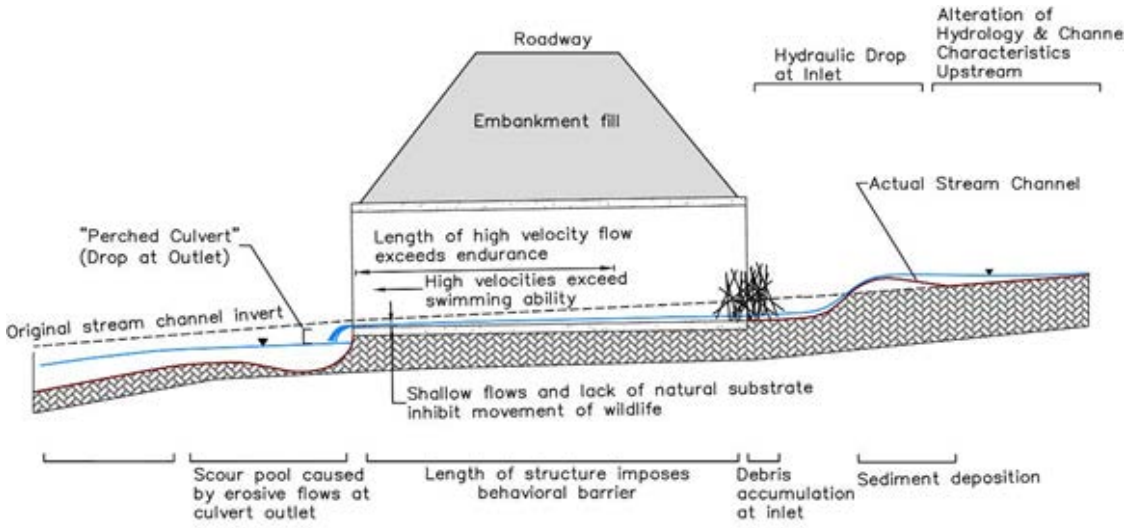
issues for both new and replacement crossings. These regulations are discussed in the next section.

In the past, culvert and bridge designers were only required to consider traffic operations, structural integrity, and typical hydraulic flow when designing river and stream crossings. These older designs have, unintentionally, had a negative impact on fish and other wildlife and on river and stream processes such as sediment and wood transport, and floodplain continuity. Wildlife movement within the river or stream and riparian area, as well as access to upland areas, is essential for organisms to have access to feeding areas, shelter and refuge from predators, cold water habitats, and breeding areas. Additionally, population groups and species require access to new habitats to sustain population growth and/or avoid population decline and allow for interaction with other populations or groups, which is essential for species to maintain genetically healthy populations. Not only does limiting wildlife movement impact individual members of a species, it can have a disastrous effect on larger populations of species, assemblages of species, and the ecosystem as a whole. Requiring culvert and bridge designers to provide unobstructed wildlife movement wherever feasible will help reduce the impacts to wildlife passage and support a healthier ecosystem.

Historically, culverts and small bridges were generally designed without consideration for habitat continuity and wildlife passage. Therefore, replacing these antiquated structures will not only benefit the resiliency of the transportation network, but will also restore ecosystem processes which have been inhibited for decades across the Commonwealth.

Conditions affecting wildlife passage at culverts

(Source: MassDOT Highway Division Stream Crossing Handbook)



3.4 Regulatory Framework

Similar to larger transportation infrastructure projects, culvert and small bridge projects often require a variety of local, state, and federal environmental permits and approvals and engineering review prior to construction. In many instances, the complexity of the review is based on the size of the structure, the potential environmental impact of the project and the sensitivity of the project's location. Table 3 (on pages 29-30) provides a list of typical permits and approvals required for culvert and small bridge projects.

STREAM CROSSING STANDARDS

The Stream crossing standards are based on six important variables. While the specifics of the regulations listed below may change over time, the crossing guidelines presented in the Massachusetts Stream Crossing Handbook remain effective for fish and wildlife.

1. **Type of Crossing**
   - General: Spans (bridges, 3-sided box culverts, open-bottom culverts, or arches) are strongly preferred.
   - Optimum: Use a bridge.

2. **Embedment**
   - All culverts should be embedded (sunk into the stream) at least 2 feet; round pipe culverts at least 25%.
   - If pipe culverts cannot be embedded this deep, then they should not be used.
   - When embedment material includes elements >15 inches in diameter, embedment depths must be deeper.

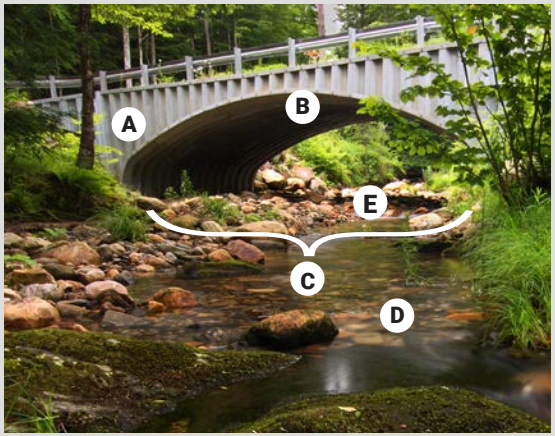
3. **Crossing Span**
   - General: Spans channel width (at least 1.2 times the bankfull width of the stream).
   - Optimum: Spans the streambed and banks (at least 1.2 times the bankfull width) with sufficient headroom to provide dry passage for wildlife.

4. **Openness**
   - General: Openness ratio (cross-sectional area/crossing length) of at least 0.82 feet. The crossing should be wide and high relative to its length.
   - Optimum: Openness ratio of at least 1.64 feet and minimum height of 6 feet. If nearby conditions significantly reduce wildlife passage near a crossing, a higher openness ratio and minimum height are necessary.

5. **Substrate**
   - Natural bottom substrate should be used within the crossing and should match upstream and downstream substrates. The substrate and design should resist displacement during floods and maintain an appropriate bottom during normal flows.

6. **Water Depth and Velocity**
   - Water depths and velocities are comparable to those found in the natural channel at a variety of flows.

A Well-Designed Stream Crossing



A. *Large size suitable for handling high flows*

B. *Open-arch design preserves natural stream channel*

C. *Crossing span helps maintain dry passage for wildlife*

D. *Water depth and velocity are comparable to conditions upstream and downstream*

E. *Natural substrates create good conditions for stream-dwelling animals*

Source: Massachusetts Stream Crossings Handbook

Current Regulations and Limitations

The majority of the environmental permitting processes required for culvert and bridge projects are related to the protection of wetland and water resources. All culvert and small bridges that cross streams are within the jurisdiction of the Massachusetts Wetlands Protection Act and require review by the municipal conservation commission and MassDEP (with the exception of 'bridge exempt' projects advanced by MassDOT, as explained in the next section). More specifically, work subject to Wetlands Protection Act regulations on Banks and Land Under Waterways is subject to the Stream Crossing Standards. To comply with these standards, structures must be 1.2 times the width of the waterbody and be higher than the bank's height. A replacement of existing crossings requires projects to meet these standards to the "maximum extent practicable."[7]

The Stream Crossing Standards were incorporated into the Wetlands Protection Act Regulations in 2014 and are also incorporated into 401 Water Quality Certification. Many communities also have a local bylaw or ordinance that further regulates work in wetland resource areas.

The revised MassDOT Highway Division Stream Crossing Design Guide, currently under review for final adoption, provides guidance for MassDOT projects to address fish and wildlife passage issues in compliance with the Stream Crossing Standards. These MassDOT guidelines have been developed to integrate ecological considerations into the design process for roadway crossings.

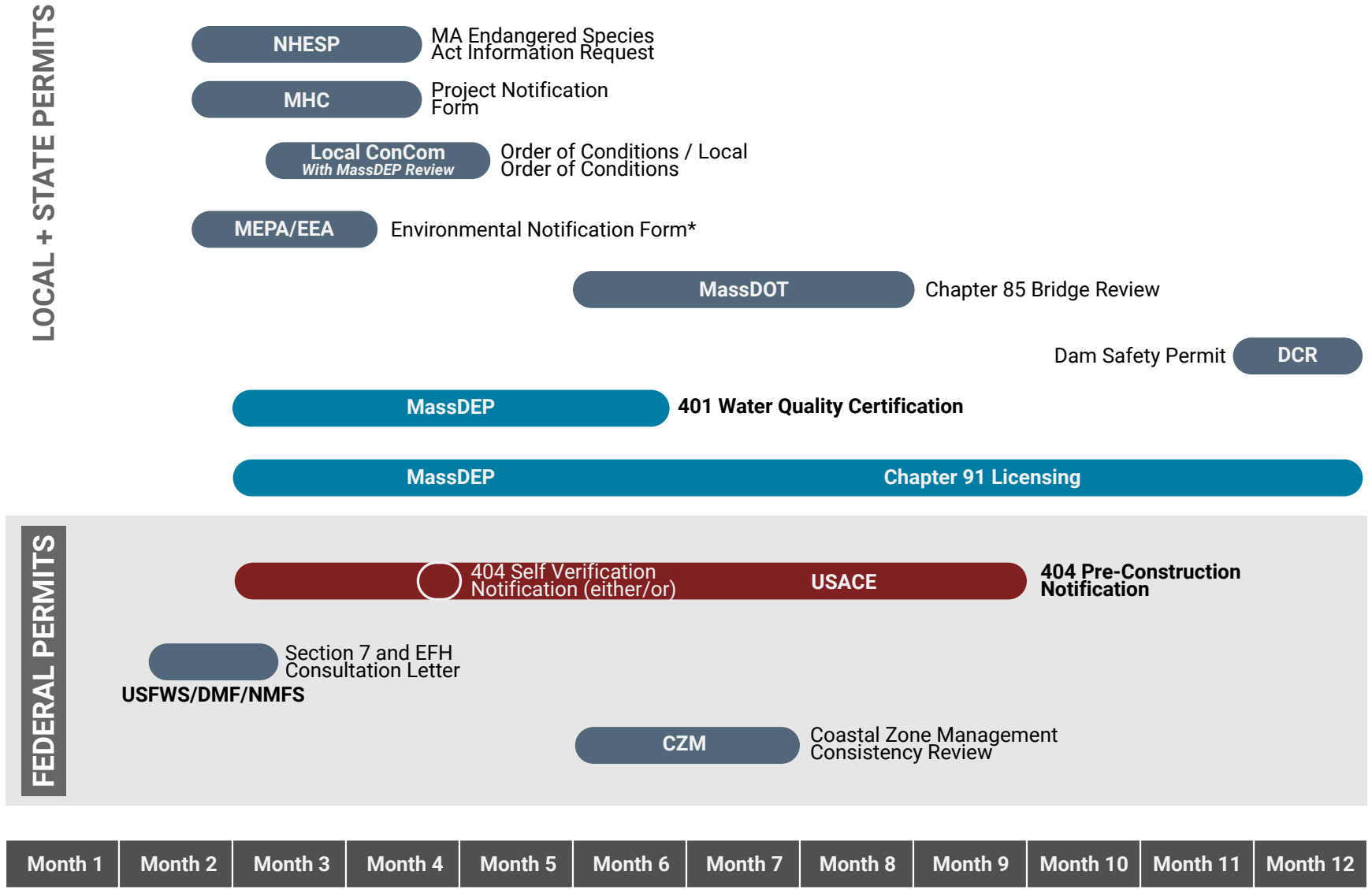
Projects within rare species habitat must file with the Natural Heritage and Endangered Species Program (NHESP) for review and approval. This ensures that the project is in compliance with the Massachusetts Endangered Species Act (MESA). Additionally, the Massachusetts Historic Commission conducts reviews for historic structures and archaeological sites.

More complex environmental permits are generally required when the project exceeds certain impact thresholds. Projects resulting in greater than 5,000 square feet of impact to wetland resources require, in addition to Wetlands Protection Act review, a Section 401 Clean Water Act Water Quality Certificate from MassDEP. An Environmental Notification Form (ENF) must also be filed with the Executive Office of Energy and Environmental Affairs' (EEA's) Massachusetts Environmental Policy Act (MEPA) office when a project impacts more than 5,000 square feet of wetlands or exceeds other impact thresholds. Further, projects which require sediment removal may trigger sediment testing and disposal authorization as part of a 401 Water Quality Certificate review under the Clean Water Act. In addition, a Section 404 Clean Water Act authorization is required by US Army Corps of Engineers (USACE) for any fill placed in waters of the United States. In order to be eligible for "Self Verification" under the USACE Massachusetts General Permits, projects must be designed to meet the Stream Crossing Standards and meet other criteria. However, many designs do not meet these standards and require review by the USACE.

Other permits are required based on a project's location. Projects within designated tidelands, waterways navigable to small vessels (such as paddle boats), and Great Ponds may require MassDEP Waterways Chapter 91 authorization (either a license or a permit). A Coast Guard bridge permit is required for structures across rivers that support interstate commerce

PERMITTING REQUIREMENTS

Culvert and small bridge projects require multiple permits before construction can begin.



** MEPA review must be completed before other State Agencies can issue Permits or Financial Assistance*

(unlikely for culverts and small bridges) or are within the tidal reach of rivers.

A third category of review processes are required to ensure the safety of the structure. MassDOT, under the Chapter 85 Bridge Review program, requires technical review of the design of each bridge structure with a span greater than 10 feet. Similarly, the Department of Conservation and Recreation (DCR) reviews bridges that also serve as a dam, are connected to a dam, or in the vicinity of a dam structure.

Securing all the necessary permits and approvals to replace a culvert or small bridge can be a challenge and drives up project costs. Even small projects may trigger a variety of reviews by different local, state, and federal agencies or boards. These entities may have similar goals (such as the protection of wetlands) but have different permit application or plan requirements. Each permit type has its own application process, forms, review timelines, prerequisites, and requirements. Municipalities need technical support and resources to identify which permits are required. To meet this need, many communities hire qualified consultants to assist with permitting.

MassDOT Environmental Streamlining

To maintain and replace the culverts and small bridges under their jurisdiction, MassDOT has limited regulatory relief in the form of the "Bridge Exemption" within the Transportation Bond Bill, which allows the Department to advance projects that are "functionally equivalent" to the existing structure. The Bridge Exemption provides for environmental permit streamlining by eliminating duplicative reviews under three state environmental laws; however, project impacts to wetland and waterway resources still receive an adequate level of review by both MassDEP and the USACE through the Section 401 / 404 permitting processes, while remaining subject to the public consultation process. Since this exemption is not available to cities and towns, a recommendation of the Working Group is to continue to evaluate options to streamline and reduce duplicative environmental reviews for municipal projects. However, it should be noted that the Working Group did not reach consensus on a mechanism for achieving this goal.

3.5 Funding and Support Challenges

Funding

Funding for the replacement of culvert and small bridge projects is also a substantial challenge. Cities and towns primarily rely on state and federal funding to make transportation infrastructure improvements. Municipalities may use their allotted Chapter 90 funding which are provided by the Legislature each year for capital improvements such as roadway maintenance, preservation, and improvement projects. However, this funding is limited as most municipalities receive less than $1 million per year and is often used for other municipal priorities. The vast majority of Chapter 90 funding is used for road and bridge maintenance and repair.

Many culverts and small bridge projects fall into a funding gap. Unless part of a larger transportation project, federal funding is generally not available to repair or replace culverts or bridges smaller than twenty feet wide.

As described below, there are currently several programs to provide state funding and technical assistance to allow municipalities to replace

TABLE 3:
CULVERT AND SMALL BRIDGE - TYPICAL ENVIRONMENTAL PERMITS/APPROVALS AND APPROXIMATE TIME TO REVIEW

PERMIT/REVIEW	PERMIT PURPOSE	WHEN REVIEW REQUIRED	PERMIT GRANTING AUTHORITY	APPROXIMATE TIME TO ISSUE*
Local Agency/Board				
MA Wetlands Protection Act Order of Conditions	Protection of state wetland resources (may include local wetland bylaw review)	Impact to or located within 100' of state wetlands	Local Conservation Commission *(also reviewed by MassDEP)*	2 months
State Agency/Board				
Project Notification Form (PNF)	Protect historic or archaeological resources	All Projects	Massachusetts Historical Commission	1 month
Massachusetts Endangered Species Act Review	Protection of rare species and their habitats	Projects within Priority Habitats of Rare Species	MA Natural Heritage and Endangered Species Program	1 - 3 months
Section 401 Water Quality Certification	Protection of federal wetland resources	Impact federal wetlands (not required if wetland impact <5,000 sf)	MassDEP	3 - 4 months
Chapter 91 License or permit	Protects the public's interest in Commonwealth tidelands and waterways	In tidelands, non-tidal rivers, or great ponds	MassDEP	4 - 10 months
Environmental Notification Form (ENF)**	Broad public review of project's environmental impacts and development of measures to avoid, minimize, and mitigate environmental impacts	Must exceed certain review thresholds	EEA's MEPA Office	1.5 months
Chapter 85 Bridge Review	Ensure that bridges are designed properly	Only required for bridge spans greater than 10-feet	MassDOT	1 - 3 months

* *Approximate Time to Issue is based on a standard, non-complex project with limited public controversy and does not include the time needed to prepare application materials.*

Table continues on next page..

** *MEPA review is not a permitting process, it is an environmental review process, and must be completed before other State Agencies can issue Permits or Financial Assistance.*

Table 3: Culvert and Small Bridge - Typical Environmental Permits/Approvals and Approximate Time to Review (continued)

PERMIT/REVIEW	PERMIT PURPOSE	WHEN REVIEW REQUIRED	PERMIT GRANTING AUTHORITY	APPROXIMATE TIME TO ISSUE*
Dam Safety Permit	Protect against dam failure	Required when a dam is proposed to be constructed, repaired, manually altered, breached, or removed and/or work will result in a water level change that affects safety conditions	MassDCR	1 month
Federal Review				
Section 404 Self Verification Notification	Protection of federal wetlands	Less than 5,000 sf of wetland impact	USACE	> 1 month
Section 404 Pre-Construction Notification	Protection of federal wetlands	Greater than 5,000 sf of wetland impact but less than 1-acre	USACE	7 months
Section 7 and Essential Fish Habitat Consultation Letter	Protects federal rare species and Essential Fish Habitat (EFH)	Within federal rare species habitat or designated	USFWS / DMF / NMFS	1.5 months
Coastal Zone Management (CZM) Consistency Review (Coastal communities only)	Protection of coastal or marine resources	Concurrent with MEPA ENF review	CZM	1.5 months
Coast Guard Waiver or Permit	Protection of interstate navigation	Applies to rivers with commercial navigation or some tidal waterways	US Coast Guard	1 month (Waiver) 10 - 12 months (Permit)
FEMA Floodplain Letter of Map Revision / Conditional Letter of Map Revision	Updates related floodplain maps	May be required when changing hydraulic opening of bridge	FEMA	> 6 months

* *Approximate Time to Issue is based on a standard, non-complex project with limited public controversy and does not include the time needed to prepare application materials.*

and improve culvert and small bridge crossings. These grant programs have been effective but the higher number of applications than available grants suggests that there is a need to expand these programs.

The Culvert Replacement Municipal Assistance Grant Program, which began in 2017, is administered by the Division of Ecological Restoration (DER). In its first two years, this program awarded $1.65 million in grants to 24 communities. This state funded grant program seeks to encourage municipalities to replace aging culverts with better designed crossings that meet improved structural and environmental design standards and flood resiliency criteria. The Culvert Replacement Municipal Assistance Grant Program is an incentive grant program and does not require local match. Communities that receive awards also receive direct technical assistance from DER staff to help them advance the culvert replacement through the funded phase of work that can be accomplished in one fiscal year. Work supported may include one or more of the following phases: field data collection, engineering and design, permitting, and/or construction. To be eligible for this program, the applying municipality must be replacing an undersized, perched, and/or degraded culvert or small bridge located in an area of high ecological value with an improved structure that meets current structural and environmental design standards (i.e. the Massachusetts River and Stream Crossing Standards) and flood resiliency criteria consistent with the Stream Crossing Standards. The program has been overwhelmed with applications and cannot fund many of the important projects that municipalities need to complete.

In FY 2018, DER received 37 applications requesting a total of $4.1 million. However, the program was only able to award a total of $750,000 to thirteen communities, leaving projects in 24 communities unfunded. This funding gap increased in FY 2019, when 67 communities submitted applications totaling $5.7 million in requests. DER's level funding allowed them to award the $750,000 in FY 2019 grant funding to thirteen communities leaving $5 million in unfunded projects. The funding gap between requested funding and grants available grew by more than $1 million in one fiscal year. DER is currently reviewing the FY 2020 applications; there is a record 78 applications for $6.5 million in requests. These applications represent only a fraction of the need. There are many more communities that need funding for culvert and small bridge projects, but do not have the capacity to complete grant applications.

The state-funded Small Bridge Grant Program, managed by MassDOT, is available for bridges with spans between 10- and 20-feet in length, leaving smaller structures ineligible for this type of funding. Since the program's inception in 2018, it has been both popular and successful. The Small Bridge Grant program is funded for five years, but the matched funding municipalities are eligible for is capped at $500,000 per project, which is often not enough to get a project designed, permitted, and constructed. As of 2019, this program has funded 102 projects in 80 municipalities with a total award amount of $42.6 million.

The Town of Colrain was awarded two grants to assist in the replacement of an undersized culvert, the remaining project cost was funded through the Town's Chapter 90 allocation. Even with two grant awards, Colrain had to spend more than half of its $320k Chapter 90 funding on this one crossing *(see page 12).*

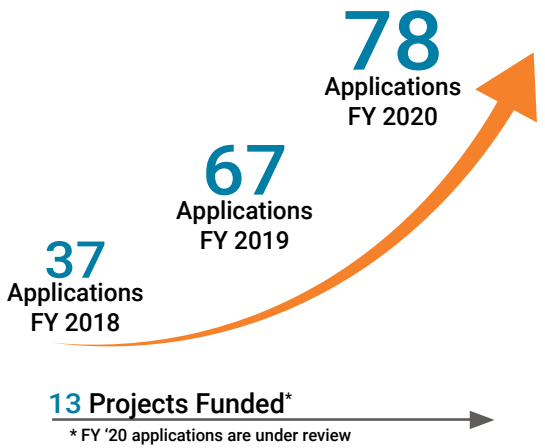
Some municipalities do not necessarily have the funding to implement culvert and small bridge projects to today's environmental and engineering standards. The Working Group found that municipal culvert and small bridge projects often go undone, either until a future grant application is funded or until an emergency repair or replacement is necessary.

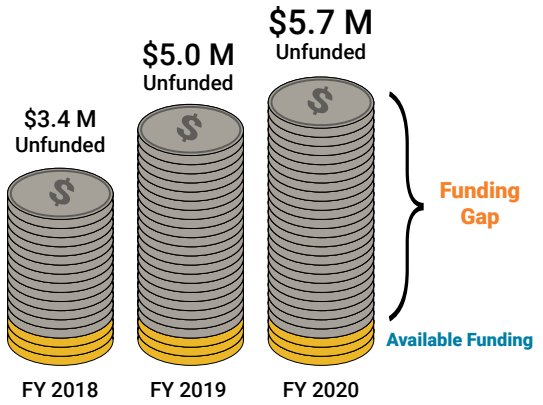
The Massachusetts Emergency Management Agency (MEMA) implements the FEMA Flood Mitigation Assistance Grant Program and Pre-Disaster Mitigation Grant Program. These two programs are typically offered annually and require a local match. Following a federal disaster declaration, MEMA receives funding from the Federal Emergency Management Agency to fund the Hazard Mitigation Grant Program. This funding varies based on the amount of recovery money FEMA spends.

Another source of funding, currently in its first grant cycle, is the Municipal Vulnerability Preparedness (MVP) Program Action Grants. These grants are available to communities that have been designated as MVP Communities by EEA and included the project for which they are seeking funding in their preparedness plan. This money supports a wide variety of resiliency work, so culvert and small bridge replacement projects are competing with other project types in this program. In the first round of MVP Action Grant Funding (FY 18-19), nine projects to address advanced planning and assessment, design, and permitting for municipal culverts were funded. These nine projects were awarded a total of $1.4 million, of the $5 million total Action Grant awards.

In addition to these programs, there may be opportunities for municipalities to receive funding through other organizations and programs. Some of these funding sources are shown in Table 4 on pages 36-39.

Funding for the Culvert Replacement Municipal Assistance Grant Program has remained level, but the number of applications and dollars requested has increased substantially since the program began in FY 2018.





While there are a variety of programs available for culvert and small bridge replacement, the majority of available funding is tied to specific objectives and performance standards. For project proponents unfamiliar with culvert and small bridge projects, these various requirements can be difficult to understand.

Communities must apply separately to each of these programs. Applications for individual grant programs are scored and ranked based on that program's advertised evaluation criteria. When there are a large number of applicants for very limited funds, only those applications that score the highest will receive awards. There is simply not enough funding to address the need.

Understanding that projects cannot be designed, permitted, and constructed within one funding cycle, typically tied to the fiscal year calendar, many grant programs counsel applicants to apply for funding in phases. Unfortunately, this means that municipalities must complete multiple grant applications and wait several years to bring a culvert or small bridge replacement program from identifying the need to completion. Also, there is always a chance that municipalities are able to secure funding for design and/or permitting, but not construction.

Technical Support

There is also technical support available to help communities undertake culvert and small bridge replacement projects. In addition to the Culvert Replacement Municipal Assistance Grant Program, DER provides direct technical assistance to municipalities for new culvert projects, provides learning opportunities through its Culvert Replacement Training Initiative, and provides website resources such as a sample Request for Proposals (RFP) and Scope of Work for culvert replacement site assessment. MassDEP's Circuit Rider Program also provides support to Conservation Commissions on wetlands issues, including culvert and bridge permitting and MassDEP regional technical staff are available to provide technical support to applicants and others.

As successful and well-received as the Small Bridge Grant Program has been, design, permitting, and construction costs often exceed the $500,000 grant amount. Additional technical support could help defer design and permitting costs and could result in more of the grant amount being allocated towards construction.

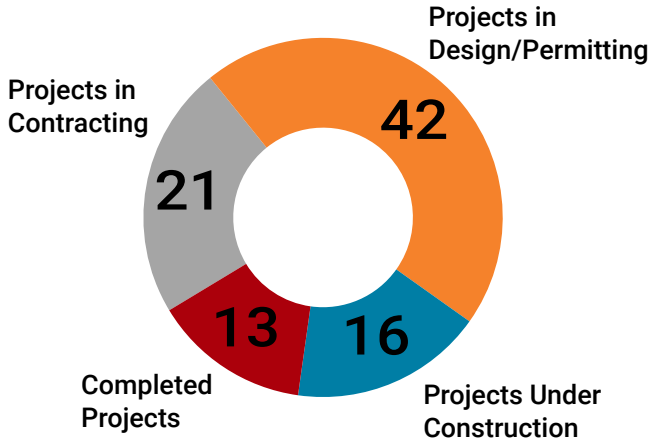
The Small Bridge Program has funded 102 projects in 80 municipalities with a total award amount of $42.6 million.

$30K - $170K
Design/Permitting Cost

$300K - $1.2M
Construction Cost

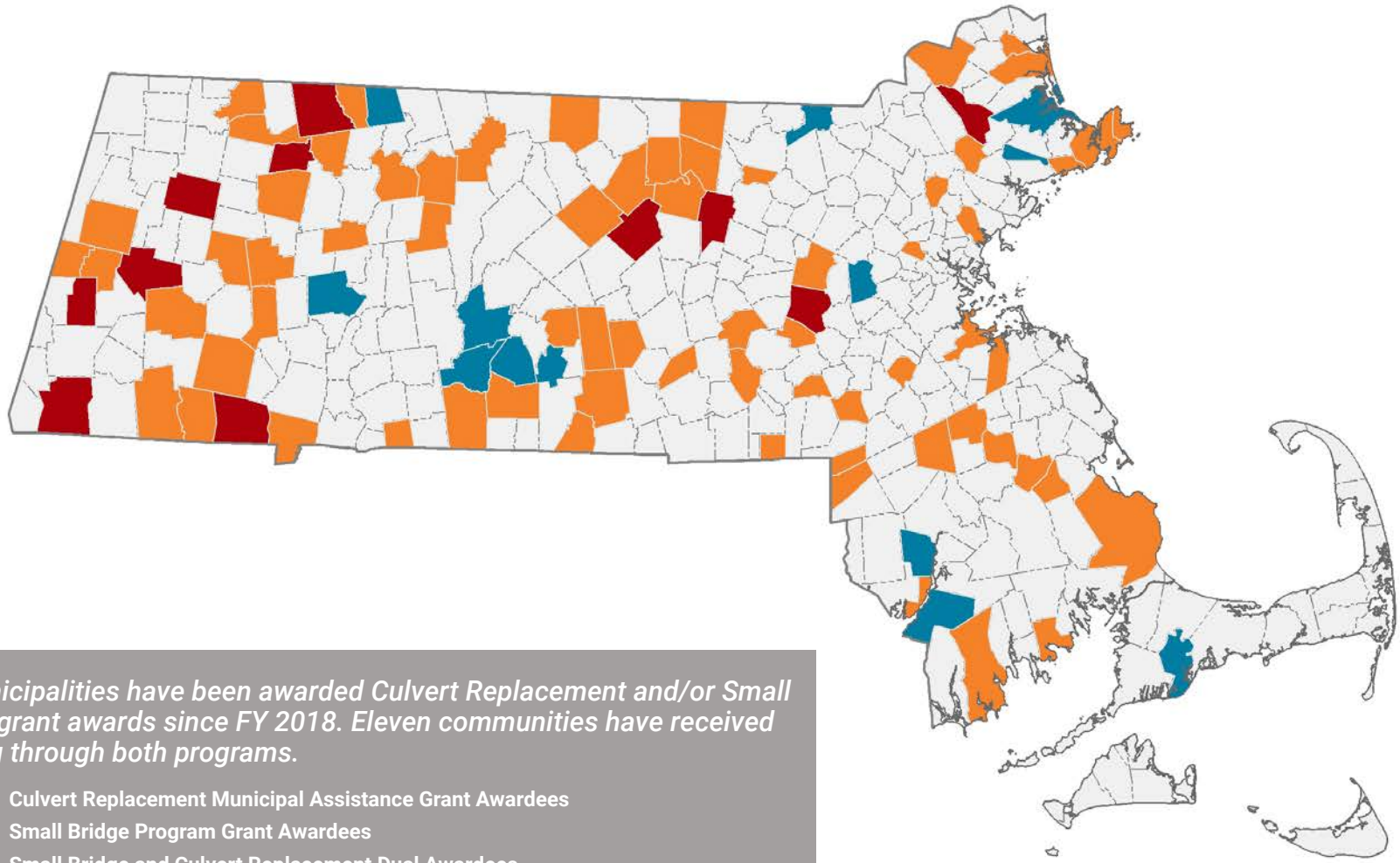
$680,000
Median Construction Cost

$500,000
Maximum Grant Award



Small Bridge Program Statistics (as of May 2019)

Communities must complete multiple grant applications and wait several years to bring a culvert or small bridge replacement project to completion.



95 municipalities have been awarded Culvert Replacement and/or Small Bridge grant awards since FY 2018. Eleven communities have received funding through both programs.

- **Culvert Replacement Municipal Assistance Grant Awardees**
- **Small Bridge Program Grant Awardees**
- **Small Bridge and Culvert Replacement Dual Awardees**

CASE STUDY

Baptist Corner Road (unnamed tributary to Bear River) Culvert Replacement Project, Ashfield

DER's Long-Term Culvert Replacement Training Initiative is designed to build a network of culvert replacement sites across the state that can serve as case studies and provide in-depth training opportunities. It also aims to build a network of road managers with advanced experience implementing culvert replacements that meet the Stream Crossing Standards. Selected sites receive assistance through all phases of the project including field data collection, design and engineering, permitting, and construction. DER offers trainings at each phase of the project to share the process and site-specific lessons with road managers from other towns.

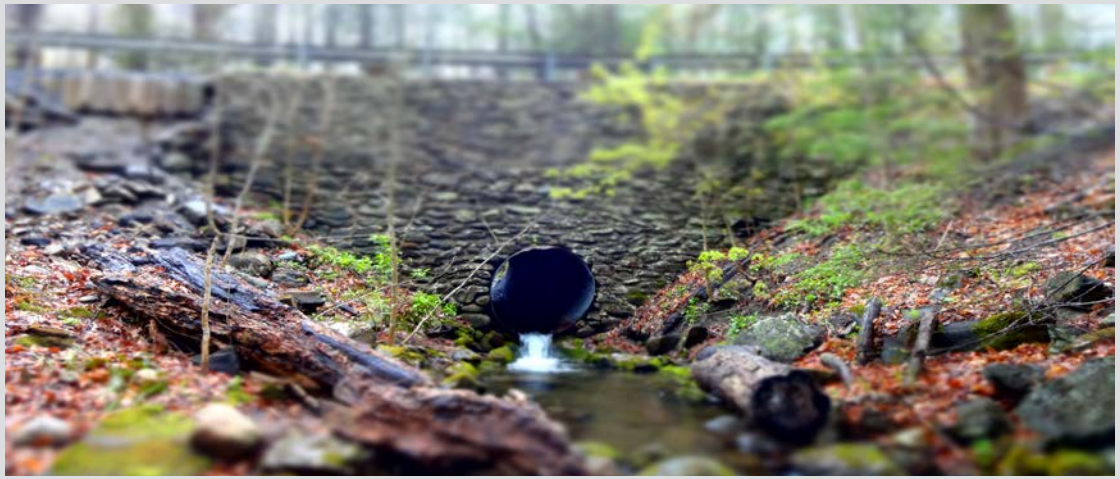
- Ashfield's Baptist Corner Road is one of DER's Long-term Training Site for Municipal DPWs.
- Approximately $125,000 has been spent on design, engineering, and permitting*
- Engineering 30% Design Opinion of Cost for Construction is $260,000 (2017)
- The project is almost construction-ready. Final designs and permits are anticipated to be completed soon.
- Municipality does not have enough Chapter 90 funding for construction and no other funding sources are available at this time.
- Funding through DER's Long-Term Training Initiative and Culvert Replacement Municipal Assistance Grant Program is not enough to support construction.

Expected Total Project Cost: $385,000

Design, Engineering, and Permitting*: ***$125,000***

Estimated Construction Cost: ***$260,000***

** **Note:** Some additional costs beyond typical culvert replacement costs were incurred due to the use of this site for training purposes.*



This perched culvert is an undersized crossing that is at risk of causing flood damage, is further constricted by accumulated debris, and poses a significant barrier to fish and wildlife passage.

TABLE 4:
EXISTING FUNDING OPPORTUNITIES AND RESOURCES

NAME	ORGANIZATION	DESCRIPTION	WEBSITE
Funding Opportunities			
Culvert Replacement Municipal Assistance Grant Program	DER	DER's Culvert Replacement Municipal Assistance Grant Program is for Massachusetts municipalities interested in replacing an undersized, perched, and/or degraded culvert located in an area of high ecological value. This funding is to encourage municipalities to replace aging culverts with better designed crossings that meet improved structural and environmental design standards and flood resiliency criteria. Only projects that intend to meet the goals of the Massachusetts Stream Crossing Standards will be considered for funding. Grant funding helps towns upgrade road-stream crossings to provide fish passage, habitat continuity, and resilience to large storms. Began in 2017; as of 2018 had awarded $1.65M in grants to 24 municipalities.	https://www.mass.gov/how-to/culvert-replacement-municipal-assistance-grant-program
MVP Action Grants	EEA	The MVP Action Grant offers financial resources to municipalities that are seeking to advance priority climate adaptation actions to address climate change impacts resulting from extreme weather, sea level rise, inland and coastal flooding, severe heat, and other climate impacts.	https://www.mass.gov/service-details/mvp-action-grant-eligibility-criteria
Municipal Small Bridge Program	MassDOT	This is a 5 year program to assist cities and towns to replace or preserve bridges with spans between 10' and 20'. Each municipality may qualify for up to $500,000 per year. These small bridges are not eligible for federal aid under existing programs.	https://www.mass.gov/municipal-small-bridge-program

Table continues on next page..

Table 4: Existing Funding Opportunities and Resources (continued)

NAME	ORGANIZATION	DESCRIPTION	WEBSITE
Hazard Mitigation Grant Program (HMGP)	FEMA *(Administered by MEMA)*	The HMGP provides funds to states, territories, tribal governments, and other communities after a disaster, to reduce or eliminate future risk to lives and property from natural hazards. The intent for funding of hazard mitigation plans and projects is to reduce the need for the reliance on taxpayer-funded federal assistance for disaster recovery. Mitigation also minimizes overall risk to lives and property. State and local governments, tribal organizations, and certain private non-profits may be eligible to apply for funding to cover projects including: Stormwater upgrades, drainage and culvert improvements, property acquisition, slope stabilization, infrastructure protection, seismic and wind retrofits, and structure elevations. Funds are available following a major disaster declaration	https://www.mass.gov/service-details/hazard-mitigation-grant-program-hmgp
Pre-Disaster Mitigation Grant Program (PDM)	FEMA *(Administered by MEMA)*	The PDM Grant provides funds to states, territories, tribal governments, communities, and universities for hazard mitigation planning and the implementation of mitigation projects before a disaster. This is typically an annual allocation subject to Congressional appropriation.	https://www.mass.gov/service-details/pdm-fma-grants
Flood Mitigation Assistance Grant Program (FMA)	FEMA *(Administered by MEMA)*	The FMA grant provides funds to assist state agencies and local governments implement measures that reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insured under the National Flood Insurance Program. This is typically an annual allocation subject to Congressional appropriation.	
MassWorks Infrastructure Program	EOHED	The MassWorks Infrastructure Program is a competitive grant program that provides the largest and most flexible funding source of capital funds to municipalities and other public entities for public infrastructure projects that support and accelerate housing production, spur private development, and create jobs throughout the Commonwealth.	https://www.mass.gov/service-details/massworks-infrastructure-grants

Table continues on next page..

Table 4: Existing Funding Opportunities and Resources (continued)

NAME	ORGANIZATION	DESCRIPTION	WEBSITE
Community Compact Best Practices Program	Division of Local Services	The Community Compact is a voluntary, mutual agreement entered into between the Baker-Polito Administration and individual cities and towns of the Commonwealth. In a Community Compact, a community will agree to implement at least one best practice that they select from across a variety of areas. The community's chosen best practice(s) will be reviewed between the Commonwealth and the municipality to ensure that the best practice(s) chosen are unique to the municipality and reflect needed areas of improvement. Once approved, the written agreement will be generated and signed by both the municipality and the Commonwealth. The Compact also articulates the commitments the Commonwealth will make on behalf of all communities.	https://www.mass.gov/how-to/apply-for-the-best-practice-program
NOAA Habitat Restoration Projects	NOAA Fisheries, Habitat Conservation	The Community-based Restoration Program supports restoration projects that use a habitat-based approach to rebuild productive and sustainable fisheries, contribute to the recovery and conservation of protected resources, promote healthy ecosystems, and yield community and economic benefits.	https://www.fisheries.noaa.gov/grant/coastal-and-marine-habitat-restoration-grants
NOAA Coastal Resilience Grants	NOAA Fisheries, Habitat Conservation	The Coastal Resilience Grant Program is intended to build resilience through projects that conserve and restore sustainable ecosystem processes and functions and reduce the vulnerability of coastal communities and infrastructure from the impacts of extreme weather events, climate hazards, and changing ocean conditions.	https://www.fisheries.noaa.gov/grant/noaa-coastal-resilience-grants
National Fish Passage Program	US Fish and Wildlife Service	The National Fish Passage Program is a voluntary program which provides financial and technical assistance to reconnect aquatic habitats through the removal of barriers, conducting projects in partnership with state and federal agencies, non-governmental organizations, universities, and tribes to benefit species and communities.	https://www.fws.gov/fisheries/fish-passage/fish-passage-projects-at-work.html
New England Forest and Rivers Fund	National Fish and Wildlife Foundation	The New England Forests and Rivers Fund is dedicated to restoring and sustaining healthy forests and rivers that provide habitat for diverse native bird and freshwater fish populations in New England.	https://www.nfwf.org/newengland/Pages/home.aspx

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Table 4: Existing Funding Opportunities and Resources (continued)

NAME	ORGANIZATION	DESCRIPTION	WEBSITE
Resources			
General Culvert-Related Resources	DER	DER's website includes general resources that help connect communities with technical assistance, training, technical tools and approaches, and grant programs.	https://www.mass.gov/river-restoration-culvert-replacements
Culvert Replacement Technical Assistance	DER	DER helps municipalities replace undersized and unsafe culverts. Undersized culverts can be barriers for fish and wildlife and pose a risk to the public. Massachusetts has regulatory standards for culverts – the Massachusetts River and Stream Crossing Standards. Culverts that meet the Standards can better protect against floods and are fish and wildlife friendly. DER works with towns to help them replace undersized culverts with ones that meet the Standards.	https://www.mass.gov/service-details/replace-a-culvert
Sample RFP and Scope of Work for Site Assessment for Culvert Replacement	DER	n/a	https://www.mass.gov/doc/sample-request-for-proposal-for-site-assessment-for-culvert-replacement/download https://www.mass.gov/doc/sample-scope-of-work-for-site-assessment-for-culvert-replacement/download
Circuit Rider Program	MassDEP	Provide support to Conservation Commissions on wetland issues, including culvert and bridge permitting.	https://www.mass.gov/guides/massdeps-wetlands-circuit-rider-program
Regional Technical Staff	MassDEP	Provide technical support to applicants and others.	

4.0
CULVERT AND SMALL BRIDGE PROJECT DELIVERY

In addition to potentially complex permitting processes, there are multiple steps municipalities must take to construct a new or improved culvert or small bridge. The following steps outline the process that the Massachusetts Department of Transportation (MassDOT) takes to initiate and complete a project. Municipal projects may proceed through a less formal process but must accomplish the same basic activities. The MassDOT project delivery process is an eight-step process.

1. Need Identification: Define the problem, establish project goals and objectives, and define the scope of planning work necessary for implementation. For large MassDOT projects, planning studies are often required to determine if a project should advance to the design phase or should be dismissed from further consideration.
2. Planning: Define the existing context, confirm the project need, establish goals and objectives, initiate public outreach, define the project, collect data, develop and analyze alternatives, make recommendations, and provide report documentation. The planning work necessary to advance culvert or small bridge projects will likely not be the large-scale planning studies that MassDOT undertakes, but municipalities working on smaller projects should still evaluate the crossing's context, confirm the project need, collect data, and develop and analyze alternatives. Alternatives analysis is required for many environmental permits.
2. Project Initiation: Document the project type and description, summarize the project planning process, identify likely funding and project management responsibility, and define a plan for interagency and public participation.
3. Public Outreach, Environmental Permitting, and Right-of-Way Processes: The result of this multi-part step is a fully designed and permitted project ready for construction.
4. Programming: At this stage, MassDOT identifies funding sources available to advance the project. Given the limitations of municipal budgets, municipalities typically need to complete this step before designing and permitting a project.
5. Advertising & Procurement: Identify the construction company. Most culvert and small bridge replacement projects will need to be advertised for bids through an open request for proposal process.
6. Award & Construction: The selected Contractor works with MassDOT to construct the project.

Project Development Process Overview

(Source: Massachusetts Highway Department Project Development & Design Guide)

PROCESS	OUTCOMES
STEP I Problem/Need/Opportunity Identification	1. Project Need Form (PNF)
STEP II Planning	2. Project Planning Report (If necessary)
STEP III Project Initiation	3. Project Initiation Form (PIF) 3. Identification of Appropriate Funding 3. Definition of Appropriate Next Steps 3. Project Review Committee Action
STEP IV Environmental/Design/ROW Process	4. Plans, Specs and Estimates (PS&E) 4. Environmental Studies and Permits 4. Right-of-Way Plans 4. Permits
STEP V Programming	5. Regional and State TIP 5. Programming of Funds
STEP VI Procurement	6. Construction Bids and Contractor Selection
STEP VII Construction	7. Built Project
STEP VIII Project Assessment	

1. Assessment: MassDOT Highway Division is always seeking to improve the process. The Assessment step provides an opportunity for MassDOT to review constituent comments on the project's development process and design elements.

For smaller projects, the Division of Ecological Restoration (DER) combines MassDOT's eight steps into four categories as follows: Field Data Collection and Structure Selection (MassDOT Steps 1 - 3), Engineering and Design (MassDOT Steps 3 & 5), Permitting and Compliance (MassDOT Step 4), Construction (MassDOT Steps 6 - 7), and Monitoring (MassDOT Step 8).

4.1 Engineering State of Practice

Traditionally, culverts and small bridges have been sized and designed based on hydraulic analysis with minimal consideration given to aquatic organism health, water quality, stream processes, or storm resiliency. Massachusetts is one of few states that have adopted standards to establish acceptable culvert sizing based on aquatic organism passage, river and stream continuity, and wildlife passage. The Massachusetts Stream Crossing Standards are applied when culverts or bridges are newly constructed or replaced. Project proponents must demonstrate that the replacement projects meet the Stream Crossing Standards to the "maximum extent practicable." Crossings in a new location must fully meet the Stream Crossing Standards.

Anticipated flow is one of the primary factors considered in determining the appropriate size of replacement culverts and small bridges. The United States Geological Service (USGS) provides stream data to help estimate and project stream flow. This data has been used

for decades to help engineers and designers to "size" the structure correctly. Similar to other metrics, this data has been developed by looking backwards to previous years' storm events and peak flows. For decades, this analysis used USGS equations based on antiquated data, however, the equations have recently been updated with present day stream flow data.

Simply relying on hydraulic analysis negatively affects the environment by fragmenting habitat, impeding passage of aquatic species, and providing low flood resiliency by limiting passage of some floodwaters, sediment, and woody debris during high flows. Consequently, stream crossings may fail catastrophically during storm events when floodwaters exceed the hydraulic capacity of a culvert and/or sediment and debris block the culvert[10]. Additionally, this method of sizing stream crossings does not take the impacts of climate change and increased frequency and intensity of storms into account. For New England, what was the 1- in 25-year storm event is predicted to become a 1- in 5- year event and what has been the 1- in 250-year event is likely to become a 1- in 25-year storm[11].

As communities begin to experience the effects of climate change, some municipalities have found that their replacement culverts are already too small to handle the increased flow, when the structure is replaced in-kind. The resilience of upgraded culverts has already been experienced in the region. When Hurricane/Tropical Storm Irene hit New England, a series of culverts in Massachusetts and Vermont that had been upsized to handle a 100-year flood with additional clearance for debris transport experienced minimal damage while other structures were overwhelmed by the storm flows and failed. This indicates the flood resiliency of upgraded culvert designs[8]. To help address this issue, the Commonwealth is in the process of developing projections for future rainfall that build in the predicted increase in frequency of storms that produce large quantities of precipitation in a short amount of time.

As communities begin to experience the effects of climate change, some municipalities are finding that their new, in-kind replacement structures are already too small to handle the increased flow.

4.2 Barriers to Larger, More Resilient Structures

Though larger structures are preferred for resiliency and benefit wildlife habitat continuity, there are a number of barriers to the use of upgraded culvert and small bridge design. A recent literature review identified site-specific and financial considerations that limit a municipality's ability to increase culvert size: engineering and technical barriers, education, regulatory requirements, and financial barriers.

Engineering Barriers

Technical barriers include any limitations on structure size due to roadway geometry, right-of-way boundaries, and/or utilities. These challenges also include a review of the culvert or small bridge's place in the larger hydrologic system. As downstream flooding can be exacerbated by enlarging an upstream opening, these impacts must be considered as a factor in the potential removal of an undersized culvert.[9]

Educational Barriers

Educational barriers are primarily related to the public's ongoing misconception that upgraded

culverts and small bridges lack economic or societal benefits beyond natural resource protection[13]. The public, including public officials, may be less accepting of upgraded designs due to their increased implementation costs and a general unfamiliarity with the benefits of improved roadway crossings.[14] These benefits include hazard reduction, climate resiliency, and protecting transportation access for emergency services, deliveries, and other transportation.

Regulatory Barriers

In addition to the required permits discussed in the previous sections, there are additional requirements through the National Flood Insurance Program (NFIP) when projects propose fill to a FEMA designated floodway or if an enlarged crossing will increase the FEMA base flood elevation downstream and adjoining properties are affected. When such work is proposed, the municipality may be required to conduct an extensive and expensive flood study and recreate the flood insurance rate map through a Letter of Map Revision (LOMR) and/or purchase a floodplain easement to compensate any impacted landowners, extending the project timeline and causing significant right-of-way acquisition costs.[15]

These NFIP constraints and other site-specific barriers limit the number of upgraded crossings completed in Massachusetts, but increased project cost is the primary barrier limiting the implementation of upgraded culvert design. Designing a crossing to simulate the stream's natural conditions in an ecologically beneficial and flood resilient manner almost always cost more than a traditional pipe culvert only designed to meet a hydraulic standard[12]. Without subsidies, the upfront installation cost to upgrade stream crossings can be prohibitive to municipalities and MassDOT alike.

In 2015, DER completed a Needs Assessment Study to better understand the barriers that communities face when attempting to replace undersized and degraded culverts with better design structures that meet the Stream Crossing Standards. This short online survey was distributed to municipalities across the state; 138 of the 351 communities responded. The communities reported that the primary obstacles to culvert and small bridge replacement are obtaining funding for construction, engineering, and design. Other important obstacles reported by the communities were regulatory processes and traffic disruption during construction. The ability to close roads to complete work was particularly challenging for rural communities.

Financial Barriers: Cost of Resilient Design

Resilient structures are more expensive to construct and can cost more to permit, but no consistent practices have been developed for municipalities or MassDOT to gauge the full cost-effectiveness of planned upgraded culvert and small bridge replacements.

For this project, MassDOT commissioned a literature review of research on the costs and benefits of improved stream crossings. In summary, this review found that the initial cost of improving culverts and bridges is higher than completing an in-kind replacement, but that cost savings are generally achieved for the improved culverts when longevity benefits and reduced maintenance needs are considered.

A 2015 DER analysis of three culvert replacement projects found that the up-front costs of improved crossings were higher, but the long-term costs were 38% lower for resilient structures than for in-kind replacement projects.

A 2015 DER study found that the average cost savings of three upgraded culvert installations, relative to in-kind replacement over a 30-year period, varied drastically from a $50,000 deficit to a $520,000 savings[16]. Determining the predicted frequency of intense storm events will contribute to how quickly upgraded culverts become economically viable. However, these estimates only consider construction and replacement costs. These costs, while important, are only a portion of an overall community cost-benefit analysis. Culvert damage from storms can result in costs that far exceed the physical repair costs. Travel delays on local roadways, flood damage to businesses and private property are burdens to private citizens. There are also less quantifiable costs, such as erosion damage and deteriorated water quality that cause ecosystem impacts. A model created and tested for the American Association of State Highway and Transportation Officials (AASHTO) Standing Committee on Environment, which incorporated socioeconomic and ecological factors in addition with construction costs, found that the initial higher capital costs of upgraded culverts were offset by benefits over the long run. Based on this model, structures that meet the Stream Crossing Standards have lower lifetime costs (over a 50-year period) than traditionally-designed structures[17].

In a few cases, individual crossings have been reviewed to determine the maintenance costs associated with an undersized culvert versus replacing that same culvert with a larger structure. These instances have shown that a properly sized and designed crossing can provide municipalities with significant savings. For example, an undersized culvert in Becket was replaced multiple times over a six-year period, costing the town more than $140,000 in repairs. A larger structure was estimated to cost approximately $593,000 and provide a 50 – 100 year lifespan. Over the same time period, had repairs been necessary with similar frequency, continuing to replace the existing culvert in-kind would have cost the Town $1.2 to $2.2 million. For more detail, see page 16.

An undersized culvert on Walker Brook (Benton Hill Road) in Becket failed multiple times over a 6-year period. It failed catastrophically during Hurricane/Tropical Storm Irene in 2011. The multiple repairs cost the town more than $140,000 in only a few years (see page 16).

5.0
FINDINGS & RECOMMENDATIONS

5.1 Findings

As described in the previous sections, the Working Group, through conversations with subject matter experts and stakeholder outreach, confirmed that municipalities and MassDOT face challenges in the design, permitting, and funding of culvert and small bridge projects. The recommendations presented in this section reflect the Working Group's findings.

Outreach and Engagement

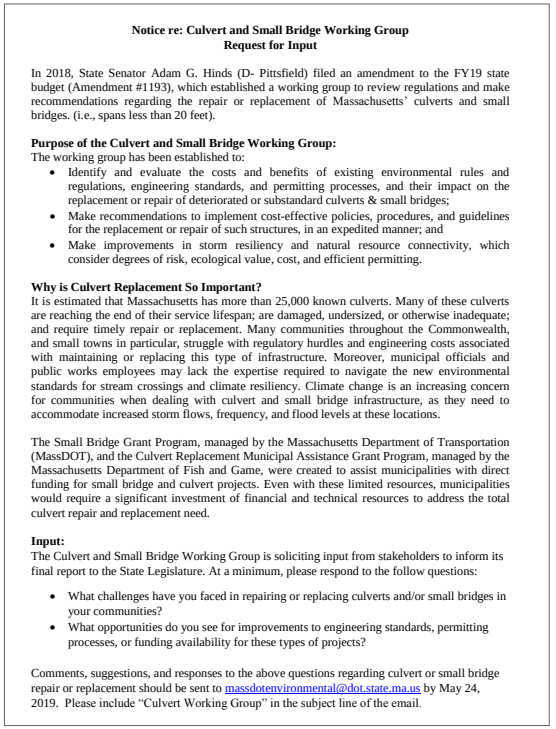
Working Group members conducted significant outreach to other agencies, programs, non-profit organizations, and stakeholders to learn about their experience with culvert and small bridge projects.

In addition to direct outreach and meetings, the Working Group developed a Project Notification and Request for Input which was widely circulated. Individuals, organizations, and municipalities responded to this request and responses were received from throughout the state. In all, more than twenty comments were received.

Responses to the Request for Input identified a lack of funding as the primary challenge facing municipalities. Some respondents indicated a need for multi-year grant funding or other more flexible mechanisms to fund small bridge and culvert replacement projects. The second-highest reported concern was the complexity and rigor of the permitting process. While a handful of responses said explicitly that current regulations should not be changed, many responses asked for more flexibility in the permitting process, a reduction in duplicative reviews, and/or programs that would expedite permitting for projects meeting certain criteria. Several respondents reported a need for more planning, engineering, and funding support. Several responses expressed appreciation for the current funding and technical assistance programs and suggested that these existing programs be expanded.

Additionally, the Working Group met with a variety of agencies, organizations, and program administrators to inform the report and recommendations. Generally, comments and input were consistent with the Working Group's internal conversations and identified many of the same recommendations the Working Group had developed.

The Working Group developed this Request for Input and distributed it to various stakeholder organizations, individuals, and e-newsletters.



Notice re: Culvert and Small Bridge Working Group
Request for Input

In 2018, State Senator Adam G. Hinds (D- Pittsfield) filed an amendment to the FY19 state budget (Amendment #1193), which established a working group to review regulations and make recommendations regarding the repair or replacement of Massachusetts' culverts and small bridges. (i.e., spans less than 20 feet).

Purpose of the Culvert and Small Bridge Working Group:
The working group has been established to:

- Identify and evaluate the costs and benefits of existing environmental rules and regulations, engineering standards, and permitting processes, and their impact on the replacement or repair of deteriorated or substandard culverts & small bridges;
- Make recommendations to implement cost-effective policies, procedures, and guidelines for the replacement or repair of such structures, in an expedited manner; and
- Make improvements in storm resiliency and natural resource connectivity, which consider degrees of risk, ecological value, cost, and efficient permitting.

Why is Culvert Replacement So Important?
It is estimated that Massachusetts has more than 25,000 known culverts. Many of these culverts are reaching the end of their service lifespan; are damaged, undersized, or otherwise inadequate; and require timely repair or replacement. Many communities throughout the Commonwealth, and small towns in particular, struggle with regulatory hurdles and engineering costs associated with maintaining or replacing this type of infrastructure. Moreover, municipal officials and public works employees may lack the expertise required to navigate the new environmental standards for stream crossings and climate resiliency. Climate change is an increasing concern for communities when dealing with culvert and small bridge infrastructure, as they need to accommodate increased storm flows, frequency, and flood levels at these locations.

The Small Bridge Grant Program, managed by the Massachusetts Department of Transportation (MassDOT), and the Culvert Replacement Municipal Assistance Grant Program, managed by the Massachusetts Department of Fish and Game, were created to assist municipalities with direct funding for small bridge and culvert projects. Even with these limited resources, municipalities would require a significant investment of financial and technical resources to address the total culvert repair and replacement need.

Input:
The Culvert and Small Bridge Working Group is soliciting input from stakeholders to inform its final report to the State Legislature. At a minimum, please respond to the follow questions:

- What challenges have you faced in repairing or replacing culverts and/or small bridges in your communities?
- What opportunities do you see for improvements to engineering standards, permitting processes, or funding availability for these types of projects?

Comments, suggestions, and responses to the above questions regarding culvert or small bridge repair or replacement should be sent to massdotenvironmental@dot.state.ma.us by May 24, 2019. Please include "Culvert Working Group" in the subject line of the email.

5.2 Recommendations

The Working Group spent much of its time discussing a variety of approaches to more effectively replace culverts and small bridges. Each approach was carefully reviewed to ensure that it would result in resilient structures that are structurally sound and provide necessary ecological connectivity in a cost- and time-efficient manner without compromising important environmental review. The Working Group's goal was to develop a suite of recommendations that could be advanced either as a package or as individual actions. The first two recommendations, implementation of the State Hazard Mitigation & Climate Adaptation Plan (SHMCAP) and continuing the Working Group, are reflective of the interconnected and complex nature of culvert and small bridge replacement. While the Working Group was able to agree on some important recommendations, consensus could not be reached on all recommendations. Therefore, some implementation details, particularly on mechanisms to streamline environmental permitting, remain to be worked out.

The recommendations fall into seven broad categories:

- Advance the Recommendations and Actions of the State Hazard Mitigation & Climate Adaptation Plan (SHMCAP);
- Expand Technical Assistance and Training Programs;
- Expand Grant Programs and Provide Additional Financing Options;
- Research and Innovation;
- Revise Engineering Standards;
- Streamline Environmental Permitting; and
- Continue the Working Group.

Advance the Recommendations and Actions of the State Hazard Mitigation & Climate Adaptation Plan (SHMCAP)

The Working Group's mandate can be achieved, in part, by advancing the goals, objectives, and actions identified in *Executive Order 569 Establishing an Integrated Climate Change Strategy for the Commonwealth* and included in the September 2018 State Hazard Mitigation & Climate Adaptation Plan (SHMCAP). Plan actions include, but are not limited to, developing new trainings, creating new modeling tools and mapping products, and developing design guidance and standards. Leadership support and cross-agency collaboration is essential to advancing the SHMCAP. To ensure that all agencies are working towards these goals and implementing the specified actions, periodic interagency symposiums should be convened.

This report echoes some of the recommended actions and projects included in the 2018 SHMCAP. There are several SHMCAP items specifically related to culvert and small bridge design, permitting, and funding that were also identified as important recommendations of this report. The development of design and engineering standards based on updated climate change projections and increased storm flows appears in both this report and the SHMCAP. The SHMCAP directs MassDEP and MassDOT, respectively, to update precipitation data used by the wetlands program and to revise design standards to incorporate Massachusetts climate change predictions.

MassDOT has been working towards a comprehensive evaluation and prioritization of culverts and bridges in need of replacement. This work began before the SHMCAP was completed and is specifically mentioned in the

SHMCAP. Two related initiatives outlined in the SHMCAP are the development of a Statewide Transportation Asset Vulnerability Assessment focused on inland flooding and the development of a pilot asset management project focused on the vulnerability of culverts and bridges.

MassDOT has already begun offering a "Rivers & Roads" training that incorporates some climate change adaptation design guidance for staff at state agencies. As specified in the SHMCAP, this training will be extended to municipalities and consultants over the coming years. The Working Group recommends that this training be revised, if necessary, to include information necessary for municipal projects and offered to municipal officials working on culvert and small bridge projects. The Rivers & Roads training could potentially be expanded or rolled into a larger, comprehensive training program recommended later in this report. In addition, MassDOT is working to finalize the Massachusetts Coastal Flood Risk Model (MCFRM). Similar to the Boston Harbor Flood Risk Model, the MCFRM will serve to be a useful planning tool that will help identify vulnerable areas and inform project design. Once complete, the MCFRM can be shared with coastal communities and included in future training sessions.

As described throughout this report and in the SHMCAP, DER is actively working to build municipal capacity to replace undersized, deteriorated culverts, with larger, safer structures that are resilient to extreme storms and that provide passage for fish and wildlife. DER provides direct technical assistance to communities seeking to replace culverts in locations of high ecological value (e.g. cold water habitat impacted by warming temperatures) and is developing numerous tools and trainings to address community needs. DER has also implemented the Culvert Replacement Municipal Assistance Grant Program, described in Section 3.5, as an incentive to communities to replace culverts with better designed structures. In support of EEA's effort to advance the MVP Program through the SHMCAP, DER is developing a pilot approach for partnering with regional organizations to implement habitat restoration projects that provide climate change adaptation and public safety benefits for communities.

Expand Technical Assistance and Training Programs

While many organizations currently offer training programs and some programs have a technical assistance component, potential attendees have to navigate multiple websites and information sources to learn about different aspects of culvert and small bridge project delivery. An interagency program to provide municipal educational training resources and technical assistance regarding available funding, structure engineering and design, hydrology and hydraulics, and environmental permitting should be developed. Building upon existing technical assistance and training programs, this one-stop-shop training would be conducted as live, in-person trainings throughout the state, recordings of which would be available on-demand online for those unable to attend a training in-person. Guidance documents, for municipalities and consultants, covering the aforementioned topics will also be developed.

The Working Group recommends a $100,000 allocation for the first year of an expanded education, training, and outreach program.

While the training program is in development, the Working Group will compile a comprehensive list of technical and professional training programs currently offered and review their curriculum to identify necessary changes and existing gaps in program offerings. The compiled list of programs should be publicly available to help municipal officials and others find current training opportunities. This compiled list can be used to help coordinate existing culvert, permitting, and engineering educational programs among the various stakeholder groups and encourage participation between public and private organizations. The Working Group recommends the development of short, one-page flow charts outlining the project development process for each type of structure (< 10 feet, 10 to 20 feet, and > 20 feet).

Expanding the availability of technical assistance would give communities points-of-contact who could help walk them through the earliest stages of project development. Presently, DER provides technical assistance in several ways, including direct one-on-one technical assistance to municipal road managers for new culvert projects, a formalized Culvert Training Initiative Program, and pre-grant technical assistance. DER offers a six-week Pre-RFR period that gives municipalities the opportunity to discuss specific projects one-on-one with DER staff. These models of technical assistance could be expanded and/or extended to other state-wide programs.

MassDEP's Circuit Rider Program provides technical assistance on permitting issues. The existing Small Bridge Grant Program administered by MassDOT does not include technical assistance; MassDOT, stakeholders, and other Working Group partners identified this as a program need and an opportunity for improvement.

Expand Grant Programs and Provide Additional Financing Options

All agencies, project proponents, and other stakeholders agree that there is simply not enough funding available for culvert and small bridge projects. The Working Group recommends that existing grant programs be expanded to implement more culvert and small bridge replacement and repair projects across Massachusetts. Programs recommended for increased funding include the MassDOT Small Bridge Program, DER's Culvert Replacement Municipal Assistance Grant Program, and EEA's MVP Action Grant Program.

As part of their work to date, the Working Group developed a preliminary list of existing grant programs that can be used to fund culvert and small bridge replacement projects (See Table 4 on pages 36-39), this list should be further refined and more widely reviewed to ensure that it includes all funding opportunities and expanded to include basic eligibility requirements for each funding method and potential barriers or challenges communities may face utilizing these funds. This comprehensive list of funding resources can be used to outline opportunities for municipalities to connect funding across programs and project types as well as to identify funding gaps.

Recognizing the complexity of culvert and small bridge replacement projects, many grant programs encourage applicants to break their projects into phases and then work with municipalities to secure funding for separate pieces of the project since many grants require

that all the funding is used within one fiscal year. Relatively few, if any, culvert and small bridge projects can be completed in this timeframe. The Working Group recommends exploring the opportunity to create new grant programs and/or change existing programs to allow for flexible funding timelines that would allow municipalities to retain funds across fiscal years for long-term projects or multiple phases of a project if they are actively advancing the project through the permitting and/or design phases.

If enacted, Senate Bill 10 would provide funding for "resiliency initiatives including grants and technical assistance to communities for implementing priority actions identified through the MVP Program and addressing climate-related risk in cities and towns throughout the state."[18]

Additionally, the Working Group recommends exploring the use of additional financing options, such as including culvert and small bridge projects in local capital asset planning and/or utilizing stormwater/drainage enterprise funds to complete these projects. There should be broader inclusion of culverts and small bridges in longer term capital asset management, planning, and financing at the local level.

Many communities are unfamiliar with the complexities of designing and permitting culverts and small bridges and stakeholders have found that communities sometimes find that they've pursued the wrong type of structure or have to restart design and permitting for other reasons such as time lapses due to lack of funding or unanticipated review requirements. Providing financial assistance to municipalities to support the earliest stages of engineering and environmental permitting could streamline the design and permitting process and help provide important early coordination between the permitting agencies and project designer. Early coordination helps project proponents avoid additional costs and lost time.

The Working Group recommends that $50 million over a four-year period be allocated to expand the MassDOT Small Bridge, DER Culvert Replacement Municipal Assistance Grant, and EEA MVP Action Grant Programs.

Culvert and Small Bridge Project Funding

The Working Group recommends that at least $50 million over a four-year period be allocated to expand existing culvert and small bridge grant programs. Specifically, $20 million would be dedicated to the MassDOT Small Bridge Program through the Transportation Bond Bill and the remaining $30 million would need to be allocated, from another funding source, to the DER Culvert Replacement Municipal Assistance Grant Program and the EEA MVP Action Grant

Most grant programs require work be completed within one fiscal year; but culvert and small bridge replacement projects are so complex, they cannot be completed in a single year. This means that municipalities have to apply for separate grants for each phase.

Program. While this funding will help expand these programs in the short-term, it is important to note that continued and sustained funding of these programs would likely be necessary. The MassDOT Small Bridge Program could also relax its requirements so that some culverts may be eligible for the program. The Commonwealth has a significant backlog of culvert and small bridge projects and an increasing number of structures will need to be replaced in the coming years.

Research and Innovation

Though the different agencies and organizations that worked together to develop this report have a lot of information about the state of repair of culverts and small bridges throughout the Commonwealth, additional research is needed to comprehensively assess the condition and vulnerability of municipal culverts and small bridges throughout the Commonwealth. The reality is that the scale of the problem remains relatively undefined; there are a lot of crossings in need of replacement - so many that it will be impossible to fund all of the important projects. Municipalities, MassDOT, and other partners would benefit tremendously from a comprehensive assessment of the condition and vulnerability of culverts and small bridges across the Commonwealth.

In 2019, MassDOT and FHWA completed a statewide pilot vulnerability assessment of MassDOT culverts and bridges. The data from these assessments will be used to help prioritize culvert inspections. MassDOT has also developed the Mapping Our Vulnerable Infrastructure Tool (MOVIT), a web-based application that compiles and displays information about infrastructure that has experienced weather-related problems.

If adequately resourced, these programs could be extended to municipally-owned structures. The Working Group recommends that municipalities, either through grants or other support from state agencies, complete a vulnerability assessment to prioritize structures for repair or replacement and that all the available data and assessment tools are compiled to create a comprehensive inventory of culverts and small bridges that identifies structures at risk of failure. Priority areas can be identified at the watershed scale for aquatic health or critical populations; specific crossings with high social significance, such as high-volume traffic roadways or are critical to emergency service access should be prioritized. Ecological climate resiliency should also be evaluated during the site selection process to ensure that selected sites have a high likelihood of maintaining ecological function and supporting the local complexity and biodiversity over time as the climate changes.

Massachusetts has always led on research and innovation and is one of only a few states that has standards in place to establish acceptable culvert sizing based on requirements for aquatic organism passage, river stream continuity, and wildlife passage. Hydraulic assessments are critical challenges when permitting replacement culverts. New or replacement culverts need to be sized and embedded to convey both high stream flows and provide aquatic organism passage without exacerbating flooding either upstream or downstream. At the same time, proper culvert design needs to improve the resilience of crossings to hydraulically convey future expected extreme streamflow.

MassDEP proposes to develop an easy to use web based tool, including a statewide hydraulic model and scenario builder, that will

maximize improvement in resiliency, aquatic organism passage, and habitat connectivity without exacerbating downstream flooding, property damage or other impacts. MassDEP's goal in creating such a tool would be to develop a regulatory presumption that could be implemented based on its use to make permitting of river and stream crossing projects easier. The tool would be developed in three stages, with each subsequent phase based on the results of the previous phase: 1) Feasibility Study, 2) Pilot Watershed Tool, and 3) Statewide Tool. The feasibility analysis will consider linking existing web-based platforms with a web-based scenario builder, where the stream crossing size can be varied to estimate the effect on aquatic passage, flooding, and bed load movement. The development of this regulatory tool, if found feasible, would eliminate the need for applicants to create case-by-case models or obtain a copy of FEMA's model, and streamline permitting.

Projections of future stream flows in Massachusetts using climate forecasting is in the planning stage. The projections are planned to be made available in the web-based United States Geological Survey StreamStats service. Once these projects are available, they will be integrated through StreamStats into hydraulic applications.

The Working Group supports MassDEP's efforts to develop a hydrology and hydraulics-based culvert and small bridge assessment tool. A web-based model should be developed to meet the resiliency goals outlined in the SHMCAP and would give engineers, designers, and regulatory review agencies a tool to simplify and expedite proper culvert sizing to improve storm resiliency and natural resource connectivity to the maximum extent practicable.

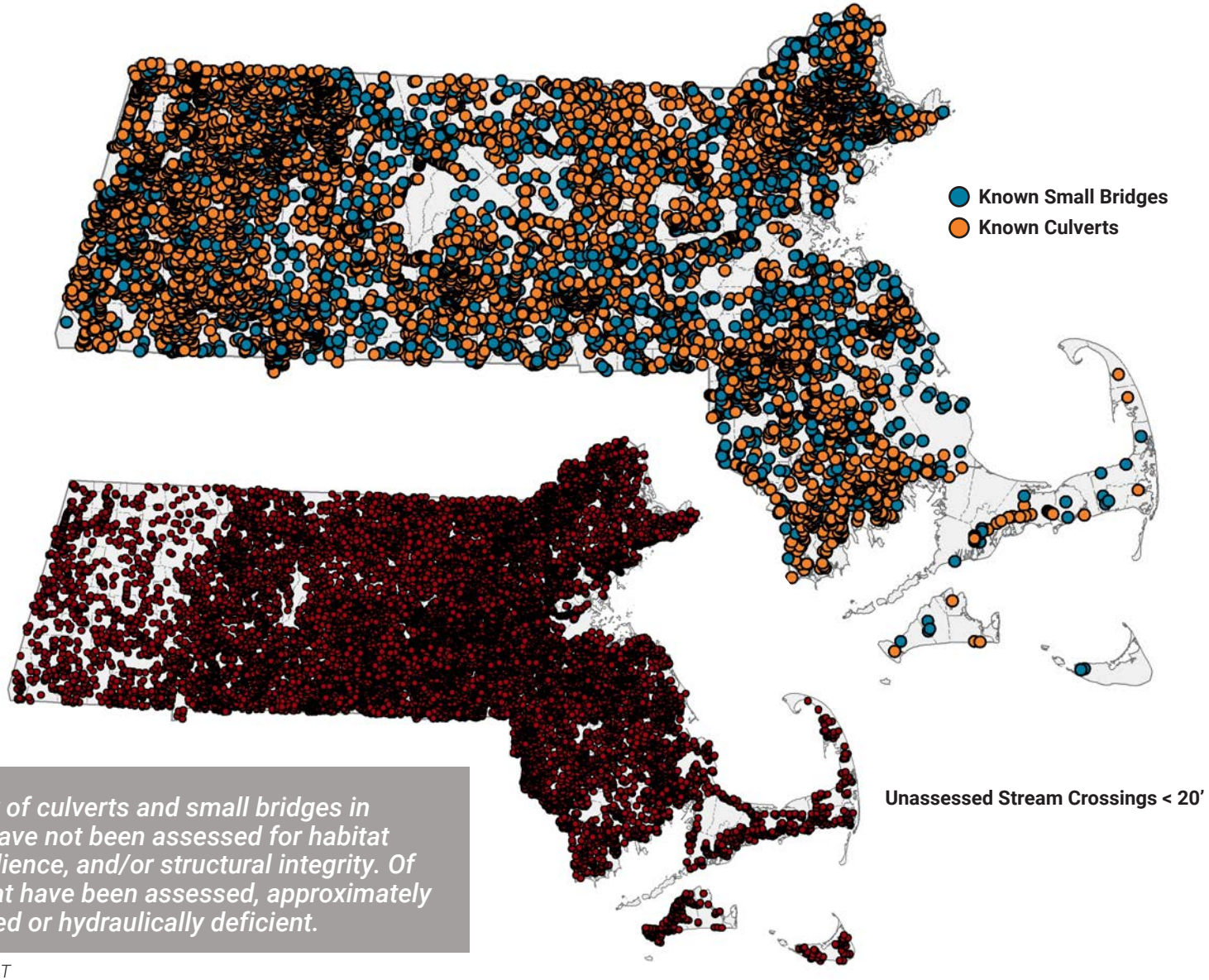
MASSDOT PROJECT INTAKE TOOL (MAPIT)

The MassDOT Project Intake Tool (MaPIT) streamlines project initiation and approval while also screening against multiple databases to identify potential problems early in the project development process. MaPIT uses a map-based interface and accesses the agency's various transportation asset, environmental, and safety datasets to make the path from project initiation to environmental permitting, project priority scoring, and project delivery more seamless and efficient. Projects can be initiated internally by MassDOT or externally by a city, town, or other local authority. The tool automatically screens each project location against multiple geographic information system (GIS) datasets: roadway inventory, highway facility information, roadway condition, bridge database transit routes, rail inventory, crash data, and environmental and social equity concerns. This automatic screening helps bring potential challenges, including permitting issues, to light early on, avoiding problems later in the process.

(Source: American Association of State Highway and Transportation Officials, Better Connections for Communities Case Study: Project Initiation with Mapping Tool Speeds MassDOT Project Delivery)

MAPPED STREAM CROSSINGS*

There are more than 25,000 small stream crossings in Massachusetts.



The vast majority of culverts and small bridges in Massachusetts have not been assessed for habitat connectivity, resilience, and/or structural integrity. Of the structures that have been assessed, approximately half are undersized or hydraulically deficient.

*Source: DER and MassDOT

The Working Group recommends that $1 to $3 million is allocated to develop a web-based culvert and small bridge assessment tool.

The Working Group estimates that MassDEP will need a $1 to $3 million allocation to develop this tool. If enacted, Senate Bill 10 could support its development.

Revise Engineering Standards

A set of standard culvert and small bridge design templates would reduce design and construction costs and streamline the permitting and structural (if required) review processes. These designs should be vetted through MassDOT, MassDEP, and other agencies to ensure that they will help communities meet the required specifications and meet the Stream Crossing Standards to the maximum extent practicable. Although projects developed with these standard drawings would still require the appropriate level of design work and hydraulic analysis, they should improve the cost efficiency of early project development and type selection processes. The Draft MassDOT Highway Division Stream Crossing Design Guide proposes six culvert and small bridge standard drawings; this document is expected to be published in 2020.

In addition to standard drawings, there are a number of actions MassDOT and other agencies can take to streamline the structural review process. The Working Group recommends that MassDOT formalize a mechanism for early coordination about bridge design so communities can make sure their design approach will be acceptable. This early coordination would include a site visit to review bridge type selection and multiple scoping sessions. Additionally, general timeframes for the Chapter 85 review process should be established and shared from the earliest stages of project development so communities are clear on when to submit their bridge plans and 25% design package and know approximately how long this review will take. For projects not subject to Chapter 85 review, municipalities need general guidance.

The Working Group has provided initial revisions to the Bridge Scoping Checklist for MassDOT to review and incorporate into a revised Bridge Scoping Checklist. These revisions add questions and measurements relevant to all culvert and small bridge projects to ensure that project proponents are collecting all the necessary information from the very beginning of a project.

The Resilient MA Action Team, the State's implementation body for its Hazard Mitigation and Climate Adaptation Plan, is currently launching a process to develop climate resilient standards for use by state agencies that account for future climate changes over the design life of infrastructure projects.

Streamline Environmental Permitting

The Working Group agrees that improved efficiencies in the environmental permitting process is central to the legislature's intent in

convening the Working Group. While consensus has not been reached on a comprehensive suite of potential recommendations to achieve this goal, the Working Group has collaboratively identified several actions that warrant further exploration. These actions include:

- Requiring pre-application coordination with permitting agencies;
- Developing a process for consultants to become pre-qualified before they can be hired to complete municipal culvert or small bridge projects;
- Consolidating permit applications and/or allowing certain state reviews to occur concurrently (with the goal of reducing duplicative reviews and/or permits that ultimately result in the same level of environmental protection);
- Developing a quick process by which municipalities and MassDOT can make certain improvements to structures when they have failed;
- Adopting regulatory presumptions and/or compressed reviews for projects achieving certain standards;
- Having dedicated review staff who only handle these project types;
- Considering streamlining the Article 97 authorization process, while ensuring ongoing protection of public lands. This could include the development of a land-swap bank; and
- Evaluating the development of one state level environmental permit application and plan template that is simultaneously submitted to each agency, organization, and department.

MassDOT funds review positions at several agencies, including MassDEP. These reviewers only review MassDOT projects and have provided a consistent point of contact as MassDOT navigates projects through the review process. Having this consistent point of contact has enabled both the project proponents and permit reviewers to develop a shared understanding of project standards, processes, and to address potential stumbling blocks early in the process, saving time and resources.

As the Working Group continues to meet and adds new partners, there will be opportunity to further explore these, and other, ideas. In addition to the ideas that the Working Group has agreed upon, there are other nascent concepts that will require further development before the Working Group can make a recommendation.

Another potential recommendation addresses mitigation requirements. Wetland mitigation requirements are important to ensure that wetlands functions are not lost. However, compliance with current Wetlands Protection Act mitigation requirements can be challenging and there has been uneven success implementing mitigation strategies across the state. MassDEP is evaluating its standards to determine how they can be improved, including affording greater flexibility in mitigation planning. The Working Group supports this effort and recommends that mitigation policies be revised.

One challenge that the Working Group identified but did not solve, is that communities may find themselves in an emergency situation where a structure has failed, but the community is unable to make necessary improvements to the structure because emergency work only allows in-kind replacement. The Working Group discussed whether or not it might be possible to establish a quick process that would allow municipalities to enlarge or otherwise improve culverts and small bridges in an emergency

situation, beyond what is currently allowed through current emergency permitting provisions. The Working Group also discussed opportunities to clarify existing language, especially MGL Chapter 85 to clarify how to measure distance for bridge width, and other state regulations that have made permitting more challenging.

Any changes to the permitting process must not compromise long term infrastructure integrity or environmental stability.

Environmental permitting is inextricably linked to engineering review. The Working Group discussed establishing an early coordination process that includes both the environmental and engineering review staff to help municipalities sequence their applications to environmental agencies and MassDOT. This would facilitate a smoother review process and reduce cost. To accomplish this coordination, the agencies would need to develop the process together.

Finally, as further described in the Research and Innovation Section, MassDEP proposes an examination of the feasibility and estimation of the cost to create an easy to use web-based tool, including a statewide hydraulic model, that could be used to identify the most appropriate crossing structure size that will maximize improvement in aquatic organism passage, habitat connectivity, and resiliency while not exacerbating downstream flooding, property damage, or other related impacts. It would be MassDEP's goal to develop a Wetlands Protection Act regulatory presumption that would streamline permitting based on results from the web-based tool, including the statewide hydraulic model, if it could be built.

CASE STUDY

Route I-90 Culvert Replacement Project (Blandford)

A failed 84-inch corrugated metal culvert under the Massachusetts Turnpike was replaced with a resilient structure that met the Stream Crossing Standards to the maximum extent practicable. The construction cost of this replacement culvert was $5.5 million.

Original Culvert (top)
Replacement Culvert (bottom)

Continue the Working Group

The Working Group found this format to be very useful and these meetings have already sparked additional inter-agency collaboration. Members felt that coming together to talk about culvert and small bridge projects was extremely valuable and quickly decided that the Culvert and Small Bridge Working Group should continue meeting after the report is finalized.

The final report and Working Group meeting notes should be made available on a public website. Following the publication of this report, the Working Group would like to host two to four regional meetings to inform interested stakeholders and the public about the report's findings and recommendations and outline the Working Group's next steps. Ideally, these meetings will be held in conjunction with already-scheduled, related meetings. As part of the outreach for these meetings, the Working Group anticipates developing a list of stakeholder groups and interested individuals, including the organizations and individuals who submitted comments during the stakeholder involvement process. The list may also include individuals who did not submit comments but are known to be interested in culvert and small bridge replacement projects. The Working Group regional meetings will provide an opportunity for additional public input and help publicize available opportunities for technical assistance, training, and existing grant programs.

Continued collaboration across some of the Working Group agencies and organizations is an important strategy for implementing the report's recommendations. These organizations and agencies can reach out to other partners to assist with implementation and program delivery.

Additionally, this Working Group can facilitate ongoing inter-agency and program coordination, by bringing representatives from the various grant and technical assistance programs together to inform each program of deadlines, general eligibility requirements, and offerings to help municipalities choose the correct program(s) and learn about opportunities to utilize multiple programs.

As discussed above, the Working Group has identified a number of potential recommendations to streamline the permitting process while maintaining environmental protections but has not reached consensus. Discussing these potential recommendations would be a primary activity of the Working Group at future meetings.

5.3 Recommendations Summary

Some of the actions recommended by the Working Group may require legislative action, but there are a number of priorities that the agencies can make internally and in partnership

with one another that do not require legislative action. In some cases, the Working Group has already begun implementing these recommendations.

The Working Group has not identified specific recommendations for streamlining environmental permitting. The potential actions are included in "Continue the Working Group" since the Working Group needs to continue discussing potential regulatory changes.

Recommendations Requiring Legislative Action

The table on pages 60-62 outlines the recommended actions that necessitate legislative action for implementation. Some of these actions require funding and others center on legislative fixes to challenges municipalities face designing and permitting culvert and small bridge projects.

Recommendations for Internal Actions Not Requiring Legislative Action

The table on pages 63-64 summarizes recommended actions that the agencies and other partners can implement without legislative action. The Working Group has already begun advancing some of these recommendations.

Funding Proposal Summary

The Working Group has provided rough estimates of funding required to initiate implementation. Without additional funding, municipalities will not be able to complete all the culvert and small bridge replacement projects that are required to keep Massachusetts resilient to increased storm frequency, intensity, and precipitation volumes, which will cause increased flooding and likely property damage as well as render areas of the Commonwealth inaccessible due to a lack of connectivity. It is important to note that this initial investment will need to be followed with ongoing financial commitment for the Commonwealth to make steady progress towards providing improved road-, rail-, and trail-stream crossings that will provide ecological benefit and provide climate change resilience.

The Working Group estimates that an approximately $53 million investment, spread over four years, will enable more municipalities to fund culvert and small bridge projects. This initial allocation includes:

- Municipal Grants: $50 million for the expansion of grant programs (over 4 years):
  - $20 million to the MassDOT Small Bridge Program through the Transportation Bond Bill
  - $30 million (through other funding sources) spread across the DER Culvert Replacement Municipal Assistance Grant Program and EEA MVP Action Grant Program
- Training: $100,000 for the first year of expanded training programs
- Research: Between $1 and $3 million is necessary for MassDEP to develop a statewide hydrology/hydraulics tool.

Senate Bill 10: An Act Provision for Climate Change Adaptation Infrastructure Investments in the Commonwealth could be used to fund these programs, training, and research if enacted. Senate Bill 10 was filed on January 24, 2019 and referred to the Committee on Revenue.

Table 5: Recommendations Requiring Legislative Action

RECOMMENDATION CATEGORY	RECOMMENDED ACTION	LEGISLATIVE REQUEST
Advance the Recommendations and Actions of the SHMCAP	Actively work to advance SHMCAP goals and recommendations.	Funding for Capacity Building
Continue the Working Group	Hold two to four town hall or roundtable meetings to inform stakeholders and the public about this report and recommendations.	
Continue the Working Group	Establish a standing Working Group to address the challenges associated with culvert and small bridge project funding and delivery.	
Continue the Working Group	Identify a Standing Group (comprised of representatives from the various grant and technical assistance programs) that meets regularly to ensure ongoing coordination and help match applicants with the proper program(s). This would help municipalities and others learn about the various programs and opportunities to access different funding sources.	
Expand Technical Assistance and Training Programs	Create a technical assistance working group for MassDOT and municipalities to provide guidance and technical assistance.	Funding for Capacity Building
Expand Technical Assistance and Training Programs	Develop a culvert and small bridge project delivery presentation for use at in-person trainings and with voiceover for online, on-demand viewing.	Funding for Capacity Building
Expand Technical Assistance and Training Programs	Provide additional training opportunities for municipal officials, consultants and others involved with culvert and small bridge projects.	Funding for Capacity Building
Expand Technical Assistance and Training Programs	Develop guidance documents, including workflow processes, to help communities understand the permitting process, work through alternatives evaluation, and inform cost estimates. These guides should: include example projects as case studies, stress the importance of Early Environmental Coordination, provide guidance on managing the process, including designing a budget to match the project's requirements, include a municipal process flow chart.	Funding for Capacity Building

Table continues on next page..

Table 5:
Recommendations Requiring Legislative Action (continued)

RECOMMENDATION CATEGORY	RECOMMENDED ACTION	LEGISLATIVE REQUEST
Expand Technical Assistance and Training Programs	Develop a training process for consultants to become pre-qualified to lead culvert and small bridge projects. Consultants could become pre-qualified by attending a one-day training course and/or being included on MassDOT's list of pre-qualified providers in certain categories.	Funding for Capacity Building
Expand Technical Assistance and Training Programs	Develop a culverts and small bridges training program that brings all the parties together to cover all aspects of project development, including funding opportunities, technical assistance, the permitting process, construction, etc.	Funding for Capacity Building
Expand Grant Programs and Provide Additional Financing Options	Develop methods to target funding specifically for culvert and small bridge types that are falling into a funding gap.	Legislative Change
Expand Grant Programs and Provide Additional Financing Options	Establish flexible funding timelines to allow municipalities to retain funds for long-term projects. This could be accomplished by creating tools that allow municipalities that are actively pursuing projects to retain funding across fiscal years and/or developing a mechanism that would allow municipalities to bundle projects into one, larger grant and permitting process.	Legislative Change Funding for Capacity Building
Expand Grant Programs and Provide Additional Financing Options	Consider additional financing options, such as including culverts and small bridges in local capital asset planning and/or stormwater and drainage enterprise funds.	Legislative Change
Expand Grant Programs and Provide Additional Financing Options	Provide expanded municipal financial and technical assistance for early engineering and environmental permitting services.	Funding for Capacity Building
Expand Grant Programs and Provide Additional Financing Options	Incentivize projects striving to meet or exceed stream crossing standards by reducing review timelines, providing flexibility in time of year restrictions, increasing funding opportunities, and providing a community of practice.	Legislative Change
Expand Grant Programs and Provide Additional Financing Options	Senate Bill 10: An Act Providing for Climate Change Adaptation Infrastructure Investments in the Commonwealth could provide funding to support culvert and small bridge replacements.	Legislative Change

Table continues on next page.

Table 5:
Recommendations Requiring Legislative Action (continued)

RECOMMENDATION CATEGORY	RECOMMENDED ACTION	LEGISLATIVE REQUEST
Research and Innovation	Provide funding for municipalities to complete vulnerability assessments and prioritize structures for repair or replacement.	Funding for Capacity Building
Research and Innovation	Compile all available data and assessment tools to create a comprehensive inventory of culverts and small bridges that identifies structures at risk of failure.	Funding for Capacity Building
Research and Innovation	Support MassDEP efforts to develop an easy to use web-based tool, including a statewide hydrology and hydraulics models incorporating the principles of river and floodplain processes, to streamline assessments for culvert and small bridge projects, expedite permitting, and meet SHMCAP resiliency goals.	Funding for Capacity Building
Research and Innovation	Provide designers, engineers, and regulatory review agencies with a tool that will simplify and expedite proper culvert sizing to improve storm resiliency and natural resource connectivity to the maximum extent practicable.	Funding for Capacity Building

Table 6:
Recommendations for Internal Actions Not Requiring Legislative Action

RECOMMENDATION CATEGORY	RECOMMENDED ACTION	STATUS
Advance the Recommendations and Actions of the SHMCAP	Agencies will continue working on the actions and tasks as assigned in the SHMCAP.	In progress
Continue the Working Group	Continue this Working Group.	
Continue the Working Group	Post the final report and Working Group meeting notes on a public website.	
Continue the Working Group	Develop a list of stakeholder groups and interested individuals.	
Expand Technical Assistance and Training Programs	Provide a comprehensive list of technical and professional training programs currently available, including programs offered by DER, MACC, MassDEP, Baystate Roads, and others.	
Expand Technical Assistance and Training Programs	Identify new training programs and/or materials necessary and the agency(ies) or organization(s) are best suited to deliver these programs and materials. Indicate whether this information could be incorporated into existing programs or requires new programs.	
Expand Technical Assistance and Training Programs	Develop one-page flow charts outlining the project process for culverts, bridges 10' to 20', and bridges > 20'. Include a simple list of tasks at each step of project development, making the charts understandable to everyone involved with the process, including municipal finance staff, residents, and board/committee members.	In Progress *Workflows are included in the MassDOT Highway Department Project Development & Design Guide and can be amended to include municipal projects.*
Expand Grant Programs and Provide Additional Financing Options	Provide a comprehensive list of funding opportunities for culvert and small bridge programs, identifying basic eligibility requirements and potential limitations on funding.	
Expand Grant Programs and Provide Additional Financing Options	Share opportunities for funding projects using a variety of programs and across project types.	
Revise Engineering Standards	Establish general timeframes for the Chapter 85 review process so communities know when to submit their 25% design package and know approximately how long the review will take.	

Table continues on next page..

Table 6:
Recommendations for Internal Actions Not Requiring Legislative Action (continued)

RECOMMENDATION CATEGORY	RECOMMENDED ACTION	STATUS
Revise Engineering Standards	Create and formalize a mechanism for early coordination with MassDOT about bridge design (if required).	
Revise Engineering Standards	Revise the Bridge Scoping Checklist to include questions relevant to culvert and small bridge projects.	In Progress *Working Group has submitted suggested revisions to MassDOT for review.*
Revise Engineering Standards	Provide reference (in the Stream Crossing Handbook) to ways municipalities can identify other prefabricated structures, if necessary.	
Streamline Environmental Permitting	Continue Working Group conversations to develop specific recommendations.	

6.0
SUMMARY & CONCLUSIONS

Culverts and small bridges are an important part of the Commonwealth's transportation system but have typically been overlooked in infrastructure planning and funding. Many of the state's more than 25,000 culverts and small bridges have reached, or will soon reach, the end of their anticipated useful life and are in need of repair and resiliency upgrades. A significant percentage of the State's culverts and small bridges create barriers to habitat connectivity and prevent wildlife passage. Additionally, a significant portion of these structures are undersized for today's stream flows. In the coming years, stream flow is projected to continue increasing as the region experiences more frequent and intense storm events. Replacing culverts and small bridges with similar structures that handle the same water capacity will no longer be a practical or economically feasible practice.

As municipalities and MassDOT work to improve stream crossings to handle increased stream flows and to be more ecologically sound, they have found that the permitting process can be complicated and lengthy. Though the permitting process is often identified as a challenge, the number one concern voiced by municipalities is project cost. While the Culvert Replacement Municipal Assistance Grant Program (administered by DER) and the Small Bridge Program (administered by MassDOT) have provided much-needed financial support to municipalities, the programs receive more applications than available grants, which suggests a need to expand these programs. Each year, DER's Culvert Replacement Municipal Assistance Grant Program has been unable to fund all of the worthy projects; this funding gap grew to more than $5 million for FY 2019. For FY 2020, DER received a record 78 applications for more than $6.5 million; with level funding in the grant program, there will be a $5.8 million funding gap. Municipalities that do not receive grant funding to complete projects primarily leave the projects undone until a grant award is available or until the structure fails and requires emergency repair or replacement.

The design and permitting process can sometimes take upwards of a year and cost an estimated $50,000 to $200,000 before construction. Many municipalities simply do not have the funding to replace their deficient culverts and small bridges. Municipalities also need help navigating the complicated regulatory compliance process and learning how to install replacement structures that meet improved, resilient design criteria. As climate change necessitates more resilient structures, there is not enough grant money or technical assistance available for communities to complete all of the culvert and small bridge upgrades necessary.

Culvert and small bridge replacement projects are expensive and complicated infrastructure projects.

The Working Group reached out to stakeholders and solicited public input to help identify recommendations for cost-effective policies and procedures that facilitate the replacement and/or repair of culverts and small bridges to improve resiliency and natural resource connectivity. The actions recommended by the Working Group fall into seven categories:

- Advance the Recommendations and Actions of the State Hazard Mitigation & Climate Change Adaptation Plan;
- Expand Technical Assistance and Training Programs;
- Expand Grant Programs and Provide Additional Financing Options;
- Research and Innovation;
- Revise Engineering Standards;
- Streamline Environmental Permitting; and
- Continue the Working Group.

The permitting process is complicated and can add significant cost to culvert and small bridge projects. In addition to a complicated process, many municipalities do not understand the permitting process and find it confusing. Missteps or mistakes during the project development phases of a project can result in environmental and/or engineering design flaws that cost time and money to rectify. While the Working Group did not identify specific changes to the permitting process, the group agreed that the process needs to be simplified. Any changes to the permitting process must balance environmental protection with engineering and design. There are multiple state reviews with similar goals that could potentially be changed to maintain environmental benefits while simplifying the process. While there was consensus that simplifying the process is needed, there was not widespread agreement on how the streamlining should occur. This issue will require substantial commitment and state resources to address, but all parties are in agreement on the need to prioritize these discussions to address the common goal - expediting stream crossing replacement projects that improve resiliency and wildlife passage.

Municipalities often do not have the technical capacity or budget to replace undersized and failing structures with improved crossings that are necessary to protect the Commonwealth's transportation system, provide wildlife habitat connectivity, and increase resiliency to the effects of climate change.

The Working Group did not identify details, but there was support amongst many, but not all, members for a pilot program that would streamline projects meeting certain criteria. MassDEP is proposing to develop guidance that would clearly explain how to meet the permitting standards and that would identify categories of projects where permitting review could be reduced, if possible. The reality is that the Commonwealth has thousands of culverts and small bridges in need of repair or replacement; without additional resources and changes to the permitting process, there will be a growing backlog of permit applications, which will increase review times. As the state's rivers and streams need to handle increased precipitation, more undersized culverts and small bridges will fail, presenting a real risk to the Commonwealth's transportation system, environment, and communities as well as personal and commercial property.

Though there is much work to be done to integrate resilient design and ecological connectivity into the state's more than 25,000

culverts and small bridges, the Working Group's partner agencies and organizations have begun addressing some of the barriers to efficient design and review processes. Sharing information across agencies made participants aware of programs and opportunities available from other organizations and facilitated MassDOT reviewing the Bridge Scoping Checklist to better address culverts and small structures. While additional funding is necessary to significantly expand training opportunities, the Working Group has already begun developing comprehensive lists of training and educational programs, outlining the permitting process in layman's terms, and sharing information about available resources and funding opportunities. Continuing to develop these resources and explicitly discussing culvert and small bridge projects in future development guides is the foundation for what can be achieved with additional funding.

A combination of a stable, re-occurring source of funding, standardized culvert and small bridge designs, and a more streamlined permitting process will enable the Commonwealth to make meaningful progress in making the state's culverts and small bridges resilient to the effects of climate change.

Funding Proposal Summary

The Working Group has provided rough estimates of funding required to initiate implementation. Without additional funding, municipalities will not be able to complete all the culvert and small bridge replacement projects that are required to keep Massachusetts resilient to increased storm frequency, intensity, and precipitation volumes, which will cause increased flooding and likely property damage as well as render areas of the Commonwealth inaccessible due to a lack of connectivity. It is important to note that this initial investment will need to be followed with ongoing financial commitment for the Commonwealth to make steady progress towards providing improved road-, rail-, and trail-stream crossings that will provide ecological benefit and provide climate change resilience.

The Working Group estimates that an approximately $53 million investment, spread over four years, will enable more municipalities to fund culvert and small bridge projects. This initial allocation includes:

- Municipal Grants: $50 million for the expansion of grant programs (over 4 years):
  - $20 million to the MassDOT Small Bridge Program through the Transportation Bond Bill
  - $30 million (through other funding sources) spread across the DER Culvert Replacement Municipal Assistance Grant Program and EEA MVP Action Grant Program
- Training: $100,000 for the first year of expanded training programs
- Research: Between $1 and $3 million is necessary for MassDEP to develop a statewide hydrology/hydraulics tool.

Senate Bill 10: An Act Provision for Climate Change Adaptation Infrastructure Investments in the Commonwealth could be used to fund these programs, training, and research if enacted. Senate Bill 10 was filed on January 24, 2019 and referred to the Committee on Revenue.

ENDNOTES

1 An Act Providing for Climate Change Adaptation Infrastructure Investments in the Commonwealth Bill History (https://malegislature.gov/Bills/191/S10) and Baker-Polito Administration Announces Availability of $8 Million in Climate Change Funding for Cities and Towns (https://www.mass.gov/news/baker-polito-administration-announces-availability-of-8-million-in-climate-change-funding-for)

2 Baker-Polito Administration Announces Availability of $8 Million in Climate Change Funding for Cities and Towns (https://www.mass.gov/news/baker-polito-administration-announces-availability-of-8-million-in-climate-change-funding-for)

3 Hydraulic Assessment of Existing and Alternative Stream Crossings Providing Fish and Wildlife Passage at Seven Sites in Massachusetts https://pubs.usgs.gov/sir/2014/5146/pdf/sir2014-5146.pdf

4 National Climate Assessment – Northeast Section

5 Fourth National Climate Assessment, Volume II: Impacts, Risks, and Adaptation in the United States., U.S. Global Change Research Program, 2018, https://nca2018.globalchange.gov/

6 Massachusetts Climate Change Clearinghouse (www.reslientma.org)

7 See 310 CMR 10.00 Wetlands Protection Act Regulations

8 Stack, L. et al., 2010. "The Oyster River Culvert Analysis Project," PREP Reports & Publications. Volume 121. March.

9 AASHTO Standing Committee on Environment, 2017. NHCRP 25-25 Task 93: Long Term Construction and Maintenance Cost Comparison for Road Stream Crossings: Traditional Hydraulic Design vs. Aquatic Organism Passage Design. Prepared by: The Louis Berger Group Inc. March.

10 Gillespie, N. et al., 2014. Flood Effects on Road-Stream Crossing Infrastructure: Economic and Ecological Benefits of Stream Simulation Designs. Volume 39 Number 2. February.

11 Stack, L. et al., 2010. "The Oyster River Culvert Analysis Project," PREP Reports & Publications. Volume 121. March.

12 Levine, J., 2013. "An Economic Analysis of Improved Road-Stream Crossings." The Nature Conservancy, Adirondack Chapter. August.

13 Gillespie, N. et al., 2014. Flood Effects on Road-Stream Crossing Infrastructure: Economic and Ecological Benefits of Stream Simulation Designs. Volume 39 Number 2. February.

14 AASHTO Standing Committee on Environment, 2017. NHCRP 25-25 Task 93: Long Term Construction and Maintenance Cost Comparison for Road Stream Crossings: Traditional Hydraulic Design vs. Aquatic Organism Passage Design. Prepared by: The Louis Berger Group Inc. March.

15 AASHTO Standing Committee on Environment, 2017. NHCRP 25-25 Task 93: Long Term Construction and Maintenance Cost Comparison for Road Stream Crossings: Traditional Hydraulic Design vs. Aquatic Organism Passage Design. Prepared by: The Louis Berger Group Inc. March.

16 Massachusetts Department of Fish & Game, Division of Ecological Restoration, 2015. "Economic & Community Benefits from Stream Barrier Removal Projects in Massachusetts." Prepared by: Industrial Economics, Incorporated. March.

17 AASHTO Standing Committee on Environment, 2017. NHCRP 25-25 Task 93: Long Term Construction and Maintenance Cost Comparison for Road Stream Crossings: Traditional Hydraulic Design vs. Aquatic Organism Passage Design. Prepared by: The Louis Berger Group Inc. March.

18 Baker-Polito Administration Announces Availability of $8 Million in Climate Change Funding for Cities and Towns (https://www.mass.gov/news/baker-polito-administration-announces-availability-of-8-million-in-climate-change-funding-for)

Recommendations for

IMPROVING THE EFFICIENCY OF CULVERT AND SMALL BRIDGE REPLACEMENT PROJECTS