ANNUAL REPORT

massDOT
Massachusetts Department of Transportation

Research and Technology Transfer

Massachusetts Department of Transportation Office of Transportation Planning

FFY2023

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I. Executive Summary

The Massachusetts Department of Transportation (MassDOT) remains at the forefront of addressing and advancing the Commonwealth's transportation system's multifaceted challenges. In Federal Fiscal Year 2023 (FFY2023), underpinned by the latest legislative advancements, including the Act to Reduce Traffic Fatalities, MassDOT underscored its commitment to roadway safety, with a pronounced focus on protecting Vulnerable Road Users (VRUs). This focus not only informed the strategic agenda but was pivotal in shaping the research and technology transfer efforts, aligned with our overarching goal of creating safer, more inclusive roadways for all.

Leveraging groundbreaking technology is central to our strategy. The increasing use of artificial intelligence, machine learning, mobile and drone-based LiDAR systems revolutionized the approach to assessing and evaluating the Commonwealth's infrastructure conditions. These technologies enabled MassDOT to efficiently gather and analyze data across vast networks, facilitating timely decision-making that enhance the safety and mobility of our transportation assets.

Innovation in best practices for construction and preservation has similarly been a hallmark of MassDOT's efforts. The research spanned critical infrastructure components — from roadways and sidewalks to bridges and innovative materials — yielding insights that directly informed the development of robust guidelines and standards. This work is crucial in ensuring that Massachusetts' transportation infrastructure not only meets today's demands but is also resilient against future challenges.

Asset management, a critical component of the mission, has benefited significantly from our integrated approach to research, technology transfer, and training. By prioritizing the maintenance program of existing assets, the service life is not only extended but this has ensured that they continue to serve the Commonwealth's residents safely and efficiently. The training programs, significantly enhanced by the latest research findings, were instrumental in disseminating best practices and innovative methodologies across the state. This collaborative learning environment fosters continuous improvement and ensures that our workforce is equipped with the state-of-the-practice knowledge and skills to meet the evolving transportation demands.

The year also marked a significant milestone in the commitment to community and professional engagement, with the successful hosting of the Moving Together Conference and the Transportation Innovation Conference, both held in a hybrid format which allowed participants to attend sessions either in-person, virtually, or a combination of the two. These two conferences attracted over 2,800 participants and served as vibrant platforms for discussing current achievements and future directions in transportation policy, research, and innovation.

MassDOT is steadfast in meeting the Commonwealth's transportation needs and demands through a multifaceted approach of research, innovation, implementation, and training initiatives. Through the application of innovative information technology (e.g., cloud-based applications) and methodologies that address unmet needs, MassDOT significantly increased outputs relating to transportation research and technology transfer. Research projects and training encompass a wide range of topics including safety, infrastructure, roadway performance, and environmental sustainability. The ability to incorporate innovative technology into routine practice and operation has allowed for an increase in

efficiency, better decision-making opportunities, enhanced security, and improved customer service in project planning, development, execution and delivery.

During the Federal Fiscal Year 2023 (FFY23), MassDOT provided statewide training opportunities while also focusing on training with partners on the local and regional levels. MassDOT used technology to customize training and conferences by offering options that allowed transportation professionals to participate whether in-person, virtual or blended. The Research Roundtables continued virtually in FFY23 and researchers from both academic and industry shared their areas of expertise. On the training side, both Baystate Roads (BSR) and MassDOT Training Services (MTS) continued to shift back to more face-to-face (F2F) training. Along with the reemergence of F2F training, online and self-paced training options increased this year, with a dramatic increase in classes available and in participation as compared to last year. In FFY23, the number of BSR classes increased by 22 percent and the MTS classes by 25 percent.

A look back at FFY23 highlights many accomplishments:

- Initiating 15 new research projects and completing 11 research projects.
- Presenting the Moving Together Conference and Transportation Innovation Conference in a hybrid format. Combined, the conferences had just over 2,800 participants, including 2,281 who registered to attend in-person and 521 who signed up to attend only remotely.
- Delivering 142 Baystate Roads (LTAP) classes to 2,700 participants, and 104 MassDOT Training Services sessions to 1,867 participants.

This report showcases MassDOT's commitment to implement innovations to manage, process, and communicate information. MassDOT continues to enhance the transportation landscape in Massachusetts and beyond.

Activities documented in this report are predominantly funded with State Planning and Research Funds (SPR) Part II from the Federal Highway Administration (FHWA), as authorized by Title 23, US Code Section 505, and regulated by Title 23, Code of Federal Regulations (CFR), Part 420.

II. Overview

Mission and Vision

MassDOT provides research, training, and technology transfer services to a broad audience of municipal, state, and academic partners to support various transportation needs and initiatives. Research activities address key issues in the areas of policy, management, safety, environment, planning, engineering, construction, operations, and maintenance as those areas relate to the Commonwealth's responsibilities for the state highway, public transportation, and multimodal transportation systems.
Through an Interdepartmental Service Agreement (ISA), MassDOT partners with the University of Massachusetts Transportation Center (UMTC) to provide services in three main areas:

- Massachusetts Cooperative Research Program (MCRP)
- Baystate Roads (the Massachusetts Local Technical Assistance Program otherwise referred to as LTAP)
- MassDOT Training Services (MTS)

MassDOT Research and Technology Transfer Program

MassDOT's Research and Technology Transfer Program (Research Section) is located within the Office of Transportation Planning (OTP). The Research Section organizes its core Research and Technology Transfer (RT&T) activities relating to highway, rail and transit, aeronautics, and intermodal transportation systems in the Commonwealth.

Program Overview

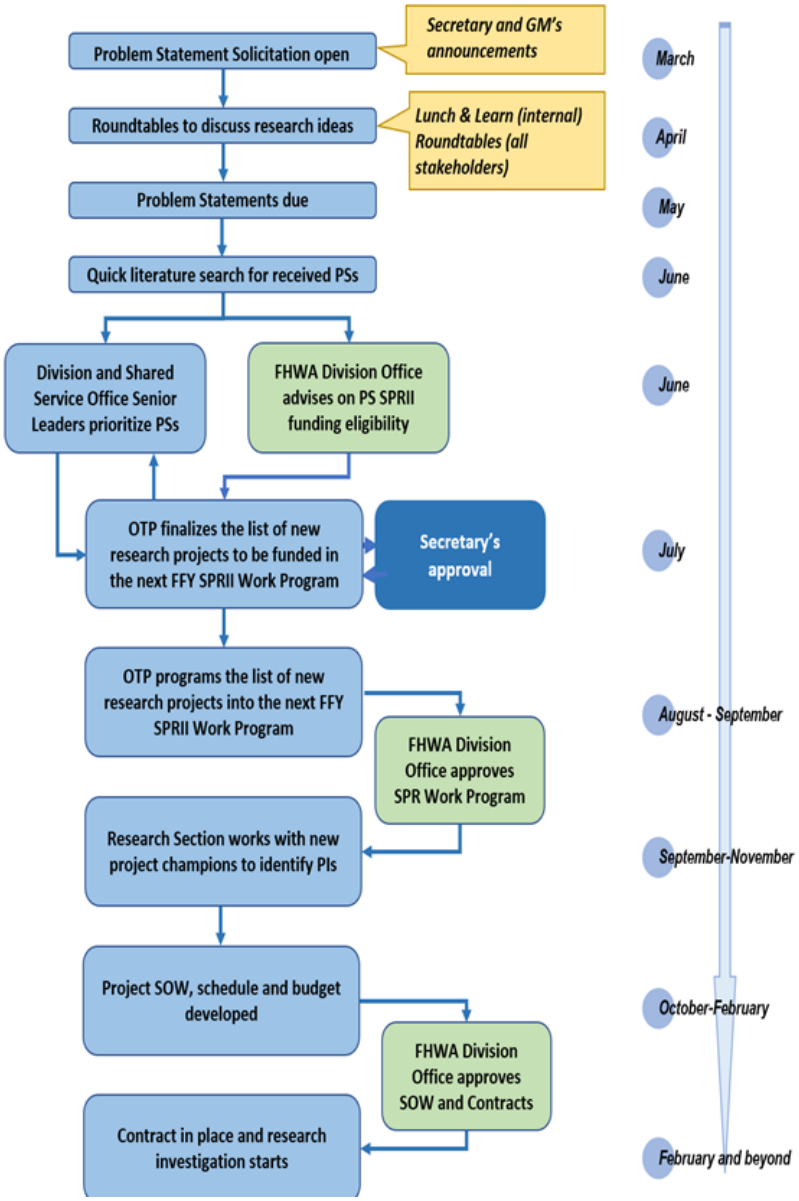
The Research Program is multifaceted, including several key components: Innovative Research, Local Technical Assistance Program, MassDOT Technical Training Services, and regional and national collaboration and engagement.

Research
The purpose of this component is to initiate research projects, conduct internal and external outreach activities, and administer associated contracts. Research activities range from literature searches and state-of-practice synthesis to large-scale multiyear research projects on complex problems. The Research Section carries out its initiatives by soliciting and prioritizing MassDOT's research needs in collaboration with MassDOT Divisions and Shared-Service Offices, managing projects and contracts, and tracking implementation efforts and impacts.

Figure 1 shows the typical process for soliciting and then selecting and beginning SPRII research projects. The process typically takes up to a year. The process starts in the spring with a research problem statement solicitation, and with research roundtables that bring together MassDOT staff and academic researchers together to discuss state transportation priorities and potential topics for problem statements. After the problem statement submission deadline, MassDOT reviews and prioritizes the submitted problem statements. Then, after checking with MassDOT senior administrators, and with FHWA on SPRII funding eligibility for the priority problem statements, OTP finalizes the list of new research projects, identifies Project Champions (PCs), and puts out a call for interest statements from

potential Principal Investigators (PIs) for each project. When the call ends, the interest statements are reviewed and PIs for each project selected. For each project, MassDOT and the PIs then work together to develop the Scope of Work (SOW), schedule and budget, which MassDOT then submits to FHWA for approval. New projects begin once FHWA approval and funding has been obtained.

Figure 1: MassDOT Annual Research Process



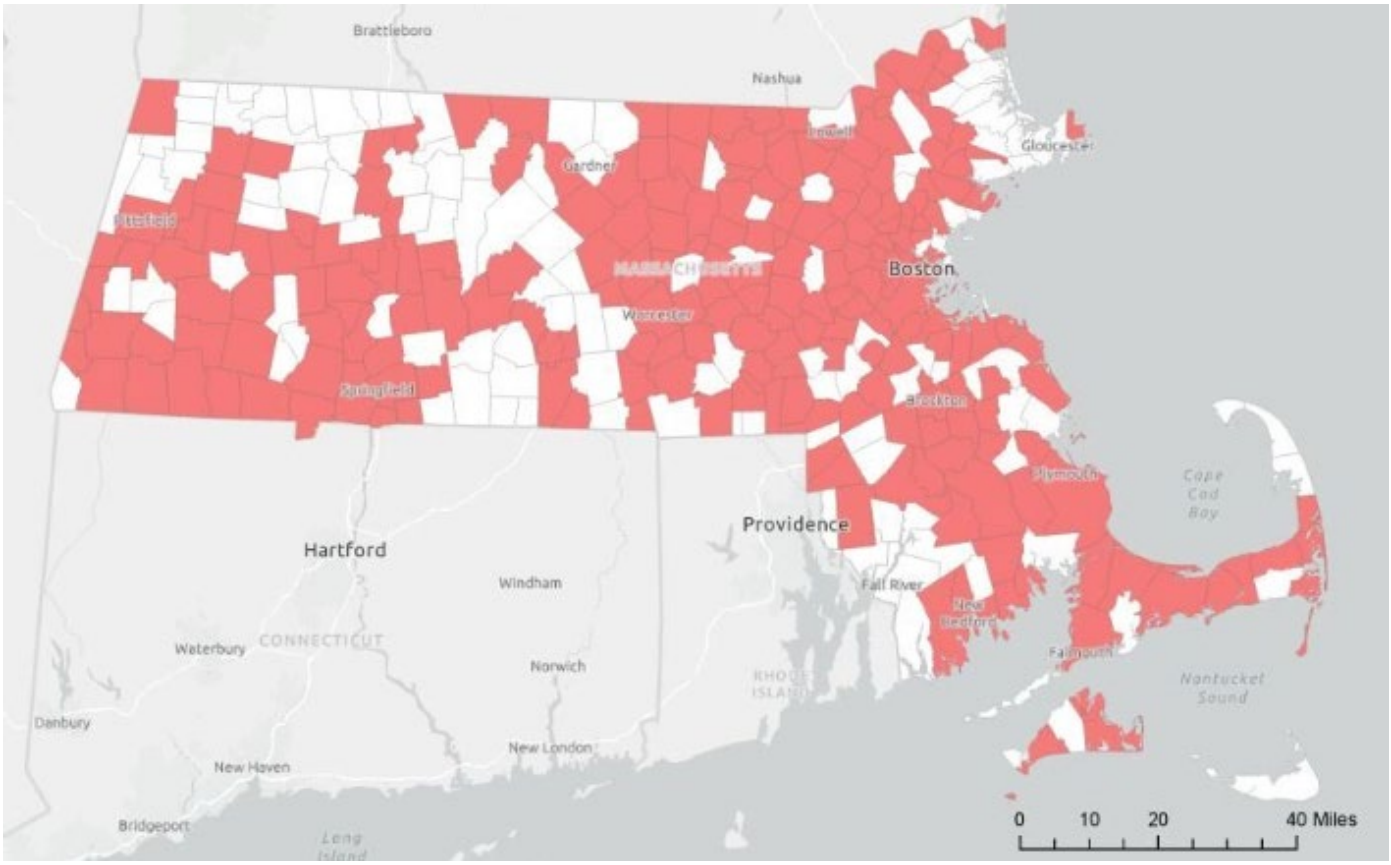
Training

MassDOT works with the UMass Transportation Center (UMTC) to provide training services to both MassDOT and municipal audiences, through Baystate Roads, the Massachusetts LTAP Center, and MassDOT Training Services. These training events serve as conduits for the transfer of new technologies, assist transportation professionals with maintaining mandatory certifications for performing essential work, and share methodologies for operating, maintaining, and managing state and municipal highway

departments throughout the Commonwealth. These programs also serve as communication platforms through which MassDOT shares new initiatives and changes related to policies, programs, and engineering directives.

In FFY23, Baystate Roads (LTAP) training participants represented 224 communities; 64 percent of all Massachusetts cities and towns. The following map highlights (in red) all communities who participated in LTAP training during the year (Figure 2).

Figure 2: Communities with Baystate Roads Training Participants, FFY23



MassDOT Training Services addressed several of the Highway Division personnel training needs. The training topics included: AutoCAD, workforce development, new National Highway Institute engineering topics and a number of safety classes, including Scaffold Use, Fall Protection and Ladders and Welding for Highway Structures.

Collaboration and Engagement

In addition, the Research Section also coordinates and facilitates MassDOT's participation in national and regional research activities, such as the American Association of State Highway and Transportation Officials (AASHTO), Transportation Research Board (TRB), and Transportation Pooled Fund (TPF) studies.

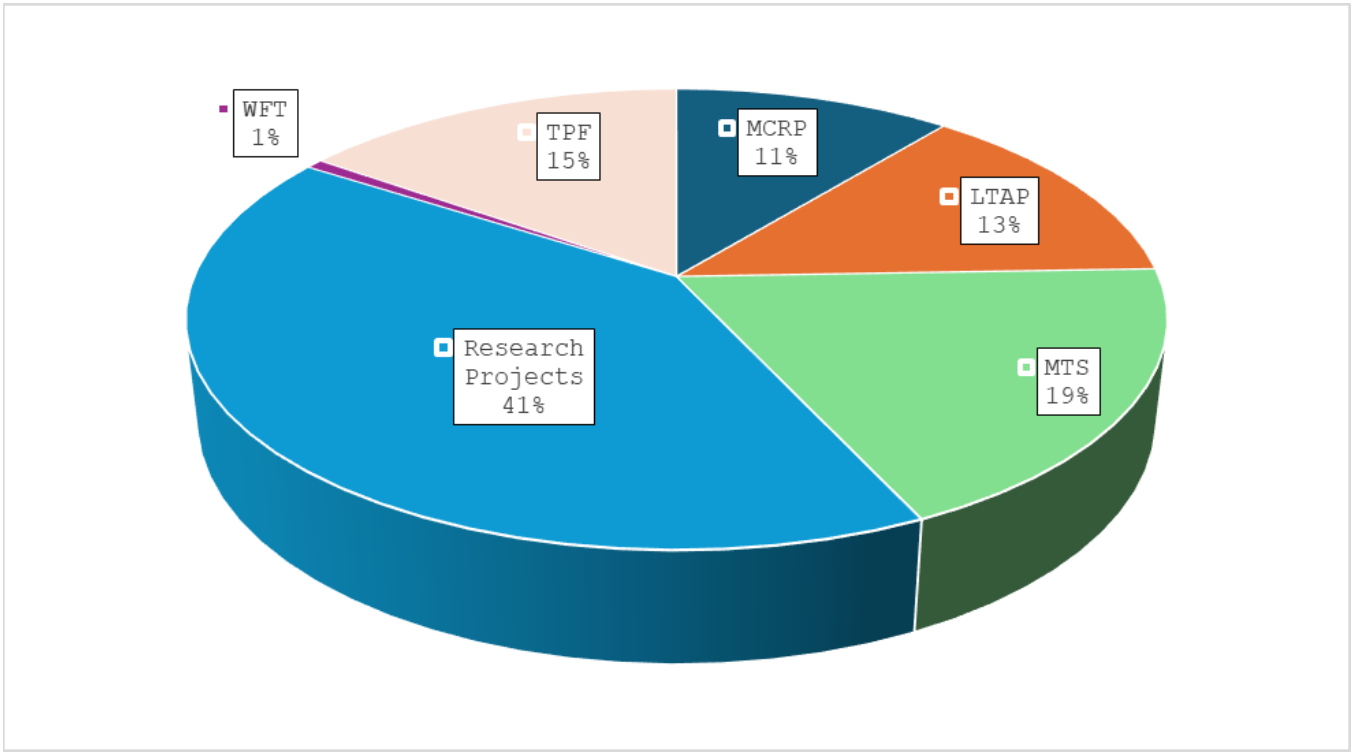
FFY2023 Program Funding

Each year, MassDOT develops its annual SPR Work Program to coordinate planning and research activities funded through the Federal Highway Administration SPR funds as authorized by Title 23, US

Code Section 505, and regulated by Title 23, Code of Federal Regulations (CFR) Part 420. SPRII details how MassDOT will allocate funds to conduct research and technology transfer activities in the next federal fiscal year.

Figure 3 below shows the FFY2023 SPRII funding distribution. Research activities (research projects, Massachusetts Cooperative Research Programs (MCRP) and Transportation Pooled Funds (TPFs)) accounted for 67 percent of SPRII funds, while training activities (MTS, LTAP and MassDOT Workforce Training (WFT)) accounted for about 33 percent of SPRII funds. MassDOT Workforce Training (WFT) distribution supports MassDOT University's activities that provide oversight and administration to the technical training, certification, and professional skills development for MassDOT employees.

Figure 3: SPRII Funding Distribution



III. Research Highlights

Research Solicitation and Selection

MassDOT's typical process of research projects for the coming fiscal year starts with a solicitation of Problem Statements. Each Problem Statement must be submitted or sponsored for consideration by a MassDOT or MBTA personnel who, if the project advances to receive funding, then serves as Project Champion (PC). A project champion is critical in the process to make sure that the research project addresses critical agency needs, produces implementable products, and that there will be a mechanism for MassDOT implementation once the research project is finished.

Starting in 2019, MassDOT began holding Research Roundtables to connect state transportation practitioners with academic researchers, and brainstorm ideas to address research needs. At the Roundtables: MassDOT participants discuss their challenges, needs, and potential ideas for future research projects; and researchers from various Massachusetts universities briefly present on their areas of expertise, their current and past transportation research, and facility capabilities. During the FFY23 solicitation, MassDOT, together with the UMTC, hosted three virtual Research Roundtables on three combined topic areas:

- Roundtable #1: Safety, Roadway Engineering, and Design
- Roundtable #2: Active Transportation, Mobility, Policy, Planning, and Transit
- Roundtable #3: Asset Management, Materials, Maintenance, and Construction

The three Roundtable sessions had 44 attendees, including 22 individual MassDOT and MBTA staff, 19 researchers from academic institutions, and three UMTC personnel. In addition, a Lunch and Learn session was provided for MassDOT and MBTA employees to inform and engage agency staff in the SPRII program as well as other available research resources and services.

Following the Spring 2022 Research Roundtables, 22 problem statements were submitted for FFY23 research funding consideration.

Research Recognition

The MassDOT research study on *Construction and Materials Best Practices for Concrete Sidewalks* was recognized as an American Association of State Highway and Transportation Officials (AASHTO) Sweet Sixteen High-Value Research Project for 2023. This research, which was championed by MassDOT Research Implementation Engineer, Richard Mulcahy, P.E., and conducted by UMTC research affiliates UMass Amherst professors Kara Peterman and Sergio Breña, also received AASHTO's Research Advisory Committee (RAC) 2023 Supplemental Award for Maintenance, Management, and Preservation. The project team presented this project at the 2024 Transportation Research Board Annual Meeting.

Figure 4: UMass professors Sergio Breña, PhD, (left) and Kara Peterman, PhD (right)

IV. Research Projects

In this section, the projects are grouped as follows:

- Projects Completed in FFY23
- New Projects in FFY23
- Projects Started before FFY23 and Continuing in FFY24

As shown in Table 1 below and in the brief project descriptions later in this section, together these projects cover a broad range of transportation topics of interest to MassDOT.

Table 1: Active MassDOT Research Projects, FFY 2023

A. Project Completed in FFY23	***Subject Area(s)***
1. BIM for Transit Infrastructure: A Feasibility and Gap Assessment with Current Practices at the MBTA (*Short-Term Project)*	*Asset Management, Transit*
2. Uncovering the Root Causes for Truck Rollover Crashes on Ramps (*Short-Term Project)*	*Safety; Roadway Engineering, Freight*
3. Using Mycofiltration Treatment for Stormwater Management (*Short-Term Project)*	*Design, Maintenance, Sustainability*
4. Measuring Accessibility to Improve Public Health, Phase I (*Medium-Term Project)*	*Mobility, Policy & Planning, Transit, Active Transportation*
5. Developing Massachusetts Specific Trip Generation Rates for Land Use Projects *(Medium-Term Project)*	*Policy & Planning, Active Transportation*
6. Multisource Data Fusion for Real-Time and Accurate Traffic Incident Detection *(Medium-Term Project)*	*Safety, Mobility, Traffic Operations*
7. Post-Fire Damage Inspection of Concrete Structures in Tunnels, Phase II *(Medium-Term Project)*	*Safety, Materials, Maintenance*
8. Massachusetts Depth to Bedrock Project *(Medium-Term Project)*	*Roadway Engineering*
9. Outdoor Information Panels to Convey Real-Time Travel Information for Ridership Recovery *(Medium-Term Project)*	*Transit, Mobility, Policy & Planning*
10. Construction & Materials Best Practice for Concrete Sidewalks, Phase II *(Medium-Term Project); Cooperative Research Program project*	*Materials, Maintenance, Construction*

11. Evaluating the Safety Impacts of Flashing Yellow Permissive Left-Turn Indications in Massachusetts: Approach Level Analysis, Phase II *(Medium-Term Project); Cooperative Research Program project*	*Safety, Roadway Engineering, Design*
12. Optimization of MassDOT's High Performance Thin Lift Mixtures *(Long-Term Project)*	*Materials, Construction*
B. New Projects in FFY23	*Subject Area(s)*
1. Implementing the AASHTO Mechanistic-Empirical Pavement Design Guide, Phase III *(Short-Term Project)*	*Materials, Construction*
2. Artificial Intelligence Framework for Crosswalk Detection Across Massachusetts *(Short-Term Project) Cooperative Research Program project*	*Asset Management, Active Transportation*
3. Energy-Focused Decision-Making Framework for MBTA Operations and Planning (*Medium-Term Project)*	*Policy & Planning, Transit, Sustainability*
4. Accessible Bus Stop Design in the Presence of Bike Lanes (*Medium-Term Project)*	*Mobility, Transit Active Transportation*
5. Cross-Modal Impact Assessment for Sustainable Transportation Networks (*Medium-Term Project)*	*Policy & Planning, Mobility, Sustainability*
6. Speed Management and Emergency Personnel (*Medium-Term Project)*	*Safety, Roadway Engineering*
7. LIMMS Gap Analysis and Development Plan (*Medium-Term Project)*	*Asset Management*
8. Measuring Fare Payment Compliance on MBTA Buses and Light Rail (*Medium-Term Project)*	*Transit, Policy & Planning*
9. Developing a Visualization, Sharing, and Processing Platforms for Large-Scale Highway Asset Point Cloud Data (*Medium-Term Project)*	*Asset Management*
10. Recycled Ground-Glass Pozzolan (RGGP) for Use in Cement Concrete (*Long-Term Project)*	*Materials, Sustainability*
11. Evaluating the Effectiveness of Driver Education Modules on Safety (*Long-Term Project)*	*Safety, Policy & Planning Driver Education*

12. Measuring Accessibility to Improve Public Health, Phase II (*Long-Term Project)*	*Mobility, Policy & Planning, Transit, Active Transportation*
13. 3D-Printed Lattice-Based Structures for Next Generation Bridge Bearings (*Long-Term Project)*	*Maintenance, Materials, Construction*
14. Method for Pavement Marking Inventory and Retroreflectivity Condition Assessment Using Mobile LiDAR, Phase II (*Long-Term Project)*	*Asset Management, Active Transportation*
15. Effect of Asphalt Binder Source in Asphalt Mixture Performance (*Long-Term Project)*	*Materials*
C. Projects Started before FFY23 and Continuing in FFY24	*Subject Area(s)*
1. Methods to Identify Problematic Carriers and Prevent Infrastructure Damage *(Short-Term Project)*	*Safety, Policy & Planning, Freight*
2. Feasibility Study of 3D Printing Applications for Bridge Elements *(Short-Term Project)*	*Materials, Maintenance, Construction*
3. Data-Driven Approaches for Transit Capital Planning *(Short-Term Project)*	*Asset Management, Transit*
4. Using Traffic Signals to Limit Speeding Opportunities on Arterial Roads *(Short-Term Project)*	*Safety, Roadway Engineering, Traffic Operations*
5. Developing a Salt Spreader Control Program Using Machine-Sensed Roadway Weather Parameters *(Medium-Term Project)*	*Materials, Maintenance*
6. Smart Work Zone Control and Performance Evaluation Based on Trajectory Data *(Medium-Term Project)*	*Safety, Roadway Engineering, Design*
7. Post-Fire Damage Inspection of Concrete Structures in Tunnels, Phase III *(Medium-Term Project)*	*Safety, Materials, Maintenance*
8. Effectiveness of Two-Stage Turn Queue Boxes in Massachusetts: A Comparison with Bike Boxes *(Medium-Term Project)*	*Safety, Design, Active Transportation*
9. Ultra-High Performance Concrete Reinforced with Multi-Scale Hybrid Fibers and its Durability-Related Properties (*Long-Term Project)*	*Materials, Construction*

10. Complete Streets and Urban Trees (*Long-Term Project)*	*Policy & Planning, Design, Sustainability*
11. Revised Load Rating Procedures for Deteriorated Prestressed Concrete Beams (*Long-Term Project)*	*Asset Management, Safety, Policy & Planning*
12. Field Study to Determine Salt Usage Efficiency on Two Pavement Types (*Long-Term Project)*	*Maintenance, Sustainability*
13. Development of Improved Inspection Techniques using LiDAR for Deteriorated Steel Beam Ends (*Long-Term Project)*	*Maintenance, Asset Management*

Projects Completed in FFY23

1. BIM for Transit Infrastructure: A Feasibility and Gap Assessment with Current Practices at the MBTA

Principal Investigators: Dr. Simos Gerasimidis and Dr. Scott Civjan, UMass Amherst
MassDOT Project Champion: Loay Abdelkarim

- **Project Overview:** Managing new and ongoing projects at the MBTA is a critical component to efficiency and cost savings. It is important that the MBTA establish a data governance system in place to integrate these projects. The management of ongoing operations can be improved by implementing the Building Information Modeling (BIM) delivery methodology in the Capital Delivery department. BIM integrates many different concepts and models into a single platform, including the coordination of information between trades, contractors, and designers during the design and constriction processes.

- **Key Findings:**

- It is expected that the implementation of BIM will enable projects to coordinate the construction sequencing of building elements, such that designs can be optimized and issues resolved prior to the commencement of construction, saving time and costs.
- A chief benefit of BIM is its ability to display building and asset data in a visual format that can be easily understood by stakeholders.
- A challenge with BIM is that its use requires shifts in project practices that have been in place for many years in the industry.
- Recommendations for implementing BIM at the MTBA include upskilling MBTA personnel to comprehend BIM processes and uses of software, and creating a BIM task force to guide the implementation process.

Web link to the Research Final Report: https://www.mass.gov/doc/bim-for-transit-infrastructure-a-feasibility-and-gap-assessment-with-current-practices-and-systems-at-the-mbta-0/download

2. Uncovering the Root Causes for Truck Rollover Crashes on Ramps

Principal Investigators: Dr. Yuanchang Xie and Dr. Benyuan Liu, UMass Lowell and Dr. Chengbo Ai, UMass Amherst
MassDOT Project Champions: Bonnie Polin and Dr. Jeffrey DeCarlo

❖ **Project Overview:** The sharp horizontal curves of highway ramps make them hotspots of truck rollover crashes. Such crashes can block an entire ramp and cause severe traffic congestion. Understanding the major causes of ramp truck rollover crashes is important for developing effective crash risk mitigation strategies and improving highway safety and traffic operational reliability.

❖ **Key Findings:**

- The findings suggest that the majority of heavy truck rollovers on ramps occur at the beginning or end of a ramp.
- The primary cause of the ramp truck rollovers is speeding, and reducing drivers' speeding can decrease the incidence of rollovers.
- Pavement markings and dynamic warning signs are two widely used methods for reducing vehicle speeds on ramps and improving ramp horizontal curve safety.
- Artificial Intelligence (AI) can be very useful for identifying key crash contributing factors that are not readily available in crash reports, such as vehicle trajectories, and helping to develop specific safety improvement strategies.

Web link to the Research Summary: https://www.mass.gov/doc/uncovering-the-root-causes-to-truck-rollover-crashes-on-ramps-research-summary-0/download
Web link to the Research Final Report: https://www.mass.gov/doc/uncovering-the-root-causes-to-truck-rollover-crashes-on-ramps-final-report/download

3. Using Mycofiltration Treatment for Stormwater Management

Principal Investigator: Kate Kennen, Offshoots, Inc
MassDOT Project Champions: Robbin Bergfors and Hung Pham

❖ **Project Overview:** Mycofiltration is a nascent stormwater management technology that uses mycelium or fungal webs as biological filters to mitigate stormwater containing nitrogen, phosphorus, and biological pollutants. This low-cost and low-tech solution could be a beneficial addition to MassDOT's typical Best Management Practices (BMPs) for stormwater management, and improve water quality within transportation projects through measures such as sediment control barriers, bioswales, tree trenches, and compost slope blankets. Research is needed to define mycofiltration treatment design and operating parameters and to ensure that mycofiltration systems can meet the needs of MassDOT project types and personnel.

❖ **Key Findings:**

- A review of existing literature and case studies on mycofiltration, as well as interviews with subject matter experts, reviewed encouraging results in support of mycofiltration's ability to treat stormwater and reduce contaminants of concern.
- However, there is not yet sufficient scientific peer-reviewed literature to support currently deploying mycofiltration as an addition to MassDOT Stormwater Control Measures (SCMs).

- MassDOT should undertake further research to define mycofiltration treatment design and operating parameters that will best meet the needs of transportation projects, particularly for Massachusetts-specific climate conditions.

Web link to the Research Summary: https://www.mass.gov/doc/using-mycofiltration-treatment-for-stormwater-management-final-report/download
Web link to the Research Final Report: https://www.mass.gov/doc/using-mycofiltration-treatment-for-stormwater-management-final-report-1/download

4. Measuring Accessibility to Improve Public Health, Phase I

Principal Investigators: Dr. Eleni Christofa and Dr. Eric Gonzales, UMass Amherst
Project Champion: Derek Krevat

❖ **Project Overview:** Inequitable access to healthy and affordable food has been shown to be a significant contributor to health disparities. Data from a variety of sources can be used to identify gaps in accessibility, but there remains a need to systematically identify these gaps and the actions that can be taken by public officials to address them. This project aimed first to develop a methodology to identify and classify gaps in accessibility across time and locations which impact the public health of the populations affected. This methodology could support MassDOT's existing accessibility data dashboard to continuously monitor accessibility gaps and inequities that affect public health.

❖ **Key Findings:**

- Food access gaps exist in urban, suburban, and rural parts of Massachusetts.
- Square footage of supermarkets that can be reached within a travel time threshold better represents food access than number of stores.
- Food access is significantly lower and less equitably distributed in Massachusetts for people who do not have access to a car and use other modes (transit, walking, biking) for their primary transportation. Therefore, efforts should be made to make food more accessible for these populations. The report includes a number of specific recommendations for doing so.

Web link to the Research Summary: https://www.mass.gov/doc/measuring-food-access-to-improve-public-health/download
Web link to the Research Final Report: https://www.mass.gov/doc/measuring-food-access-to-improve-public-health-0/download

5. Developing Massachusetts Specific Trip Generation Rates for Land Use Projects

Principal Investigators: Dr. Danjue Chen, Dr. Yuanchang Xie, and Dr. Benyuan Liu, UMass Lowell
MassDOT Project Champion: J. Lionel Lucien

❖ **Project Overview:** Vehicle trip generation is used to identify potential transportation impacts associated with new development projects, to help plan for and address these impacts. This project focused on creating accurate trip generation rates for high-priority land uses and development projects in Massachusetts. Rates from the oft-used Institute of Transportation Engineers (ITE)'s Trip Generation Manual have been found to overestimate trips for sites that benefit from their proximity to public transportation and accessibility by walking and bicycling, and to not accurately reflect the current trip generation trends for in the state. This project explored the feasibility of using location-based services (LBS) data to develop Massachusetts-specific trip generation rates.

❖ **Key Findings:**

- This project demonstrated that LBS data and data from other nontraditional data sources can be used to quickly develop state-specific trip generation models and to frequently update them.
- This project created a computer vision and Artificial Intelligence tool that can extract data from traffic videos on vehicle counts from traffic videos. These data can be used to directly develop trip generation models or to validate the performance of the models.

Web link to the Research Summary: https://www.mass.gov/doc/developing-massachusetts-specific-trip-generation-models-for-land-use-projects-research-summary/download
Web link to the Research Final Report: https://www.mass.gov/doc/developing-massachusetts-specific-trip-generation-models-for-land-use-projects-final-report/download

6. Multisource Data Fusion for Real-Time and Accurate Traffic Incident Detection

Principal Investigators: Dr. Chronis Stamatiadis, Dr. Yuanchang Xie, and Dr. Nathan H. Gartner, UMass Lowell
MassDOT Project Champion: Chester Osborne

❖ **Project Overview:** This research investigated how data from the various traffic data sources that MassDOT owns or has access to can be merged for accurate, real-time traffic incident detection, which can lead to faster incident responses and ultimately improved travel time reliability. The study assessed MassDOT's current traffic incident detection methods, and developed new tools for improved traffic incident detection based on available traffic data. It addressed the fusion of information from multiple sources of different temporal and spatial scales, such as data collected from loop detectors, information from the MassDOT Real Time Traffic Management system, and information available through third-party vendors (e.g., Waze, Google, INRIX). The fusion of data from these sources was accomplished through evaluating the reliability of the data sources and deploying advanced data analytical methods such as deep neural networks.

❖ **Key Findings:**

- The AI and empirical rule-based models developed through the study successfully identified degraded conditions on the roadway compared to what is normally expected at those times and locations.
- When tested, the AI model developed through the study had a detection rate of 91.7% and a false alarm rate of 0.007%.
- The empirical rule-based model detected some traffic events captured by Waze reports and the Regional Integrated Transportation Information System (RITIS) congestion scans that were not recorded in the MassDOT Highway Operation Center database.

Web link to the Research Summary: https://www.mass.gov/doc/multisource-data-fusion-for-real-time-and-accurate-traffic-incident-detection-via-predictive-analytics-research-summary/download
Web link to the Research Final Report: https://www.mass.gov/doc/multisource-data-fusion-for-real-time-and-accurate-traffic-incident-detection-via-predictive-analytics-final-report/download

7. Post-Fire Damage Inspection of Concrete Structures in Tunnels Phase II

Principal Investigators: Dr. Simos Gerasimidis and Dr. Scott Civjan, UMass Amherst
MassDOT Project Champion: John Czach

❖ **Project Overview:** Tunnels are generally designed with an abundance of safety regarding structural integrity. However, there can be uncertainty related to structural performance after a fire event, and an inspection is needed. Phase I of this research included a literature review, and the development of a draft inspection protocol checklist, and of a heat system for physical testing. Phase II focused on physical testing of critical components of tunnels after being exposed to high combustion temperature. Key activities during Phase II included identification of critical tunnel components for testing, testing of the components in a structural testing facility for their post-fire residual capacity, evaluating the nondestructive test devices and methods identified in the Phase I, and adding updates resulting from lab testing to the inspection protocol checklist developed in Phase I to assist field inspections which will be undertaken in Phase III..

❖ **Key Findings:**

- Lab-based testing found that in general, unique visual changes of materials and components can be associated with specific temperatures, and the duration of heat exposure can cause variances in visual appearances depending on material properties. Specific temperatures correlated with visual changes including melting, charring, discoloration, and other physical changes.
- Structural reinforced concrete slab members were tested mechanically to investigate their residual capacity when exposed to various heating levels (from 300 to 500 degrees C) for three hours. The influence of heat on a structure was found to be minimal for the heating regimens and loading procedures applied.

Web link to the Research Final Report: https://www.mass.gov/doc/post-fire-damage-inspection-of-concrete-structures-phase-ii-final-report/download

8. Massachusetts Depth to Bedrock Project

Principal Investigators: Dr. Stephen Mabee and Dr. Bill Clement, UMass Amherst
MassDOT Project Champion: Jennifer Rauch

- **Project Overview:** Fundamental to any transportation planning and engineering activity is having a reasonable estimate of the thickness of the overburden. Knowing the overburden thickness not only influences cost but may also affect selection of the appropriate foundation system for a particular structure and selection of a suitable subsurface investigation method. An overall goal of this project was to develop statewide GIS data layers of the depth to bedrock and bedrock altitude to help reduce the uncertainty in highway projects planning and design. Maps showing the level of confidence in the bedrock altitude and depth were also developed.

- **Key Findings:**

- Depth to bedrock in Massachusetts ranges from 0 meters at bedrock outcrops, predominantly located at higher elevations, to a maximum of 531 meters on Nantucket.
- Bedrock altitudes range from a 1,059 meters at Mount Greylock to a low of −512 meters on Nantucket.
- The most effective way to use the depth to bedrock and bedrock altitude maps is to use them in conjunction with the error maps, well data, and bedrock outcrops and shallow to bedrock data points.

Web link to the Research Summary: https://www.mass.gov/doc/massachusetts-depth-to-bedrock-project-0/download
Web link to the Research Final Report: https://www.mass.gov/doc/massachusetts-depth-to-bedrock-final-report/download

9. Outdoor Information Panels to Convey Real-Time Travel Information for Ridership Recovery

Principal Investigators: Dr. Song Gao and Dr. Eleni Christofa, UMass Amherst
MassDOT Project Champion: Elizabeth Winters Ronaldson

- **Project Overview:** The MBTA launched an Outdoor Information Panels (OIP) program to update legacy outdoor advertising locations or add other outdoor advertising locations near major roadways through digitization. As all locations eligible for digital upgrade will be near decision-making points for people in vehicles, optimizing MBTA set-aside time with Real Time Travel Information (RTTI) (e.g., train departures, parking availability) will be critical information delivery to users of transit and to nonusers to "nudge" them toward behavior change at that point or in the future. This research aims to provide a better understanding of which RTTI meets the needs of current ridership connecting to transit by vehicle, how RTTI can be used to incentivize off-peak travel, and how RTTI may lead to mode-shifting based on the value propositions of information presented.

- **Key Findings:** Based on the online interview and household survey, the following recommendations were developed for OIP and RTTI:

- Display Info for inbound trips at locations at or beyond Route 128 to allow for enough decision time.

- For both non-major event trips and major event trips: among the top recommended items are transit travel time, parking availability at the start station, next two train arrivals, and transit cost.
- Display RTTI for 10 seconds in every 40 seconds.

Web link to the Research Summary: https://www.mass.gov/doc/outdoor-information-panels-to-convey-real-time-travel-information-for-ridership-recovery-0/download

10. Construction & Materials Best Practice for Concrete Sidewalks Phase II

Principal Investigators: Dr. Sergio Breña and Dr. Kara Peterman, UMass Amherst
MassDOT Project Champion: Richard Mulcahy

❖ **Project Overview:** Massachusetts experiences extreme weather conditions which contribute to scaling of concrete sidewalks, and to significant maintenance and reconstruction costs. MassDOT is seeking to improve the quality and durability of concrete sidewalks and reduce these costs. Phase I of this project investigated various aspects affecting concrete scaling when concrete was placed in cold weather conditions. Phase II investigated the performance of concrete placed in warm weather conditions while continuing to monitor the concrete panels placed in Phase I. This project represents a collaboration between industry, contractors, and research agencies to provide resolution to this complex problem.

❖ **Key Findings:**

- To achieve durability in concrete sidewalks, materials, construction, and maintenance practices should all be carefully monitored. Quality assurance (QA) and Quality control (QC) are both important throughout the process of placement and maintenance of the concrete sidewalks to achieve durable sidewalks.
- The placement and construction practices along with the mix design influence the air void system, w/cm ratio and strength of top layer of concrete. An adequate air void system, low w/cm ratio, necessary strength is required in the top surface to resist the exposure to freeze-thaw cycles and deicing agents.
- For the sidewalks placed in the summer, the concrete (most of the sidewalks) matured and gained enough strength to resist the effect of freeze-thaw cycles and application of deicing agents. It is recommended that the concrete gains a minimum of 4,500 psi strength before freezing, thawing, or deicing cycles begin.
- The concrete placement and finishing must be done following Sections 5.3.2 and 5.3.4 of ACI 301-16 and also National Ready Mix Concrete Association (NRMCA) Flatwork Best Practices. Concrete curing must be done following Sections 5.3.6 of ACI 301-16 and ACI 305R-20.

Web link to the Research Summary: https://www.mass.gov/doc/construction-and-materials-best-practices-for-concrete-sidewalks-phase-ii-long-term-performance-and-hot-weather-placement-effects/download
Web link to the Research Final Report: https://www.mass.gov/doc/construction-and-materials-best-practices-for-concrete-sidewalks-phase-ii-long-term-performance-and-hot-weather-placement-effects-final-report/download

11. Evaluating the Safety Impacts of Flashing Yellow Permissive Left-Turn Indications in Massachusetts: Approach Level Analysis, Phase II

Principal Investigators: Dr. Francis Tainter and Dr. Cole Fitzpatrick, UMass Amherst
MassDOT Project Champion: James Danila, P.E.

- **Project Overview:** Building upon a recent MassDOT study that used high-level crash data to investigate the crash reduction effects and benefit-cost ratio of the Flashing Yellow Arrow (FYA) traffic control device, this follow-up study provides insights into FYA safety impacts from an approach-level perspective. Approach-level analyses remain the most appropriate method to assess the true impact of the permissive indication as well as infrastructure elements. This study evaluated the before and after crashes at 200 FYA intersections statewide from an approach level and using four strategies: naïve before/after analysis including EPDO (Equivalent Property Damage Only) rating, benefit-to-cost analysis, crash modification factor (CMF) using comparison groups, and infrastructure and operational safety impacts.

- **Key Findings:**
  (LT-related: crashes involving a vehicle turning left at the intersection;
  LTOT-related: crashes involving a vehicle turning left and vehicles traveling straight from the opposite direction).
- The naïve before/after analysis showed significant reductions in crashes for both 3-way and 4-way FYA intersections, primarily focused on the LTOT-related crash sample
- At the FYA intersections, for LT- and LTOT-related crashes, there was a reduction in severe crash types (head-on, angle, sideswipe) and a reduction in crashes reducing in injury and property damage.

Web link to the Research Summary: https://www.mass.gov/doc/evaluating-the-safety-impacts-of-flashing-yellow-permissive-left-turn-indications-in-massachusetts-approach-level-analysis/download
Web link to the Research Final Report: https://www.mass.gov/doc/evaluating-the-safety-impacts-of-flashing-yellow-permissive-left-turn-indications-in-massachusetts-approach-level-analysis-final-report/download

12. Optimization of MassDOT's High-Performance Thin Lift Mixtures

Principal Investigator: Dr. Walaa Mogawer, UMass Dartmouth
MassDOT Project Champions: Edmund Naras and Mark Brum

- **Project Overview:** One way to improve pavement resiliency and longevity is by using high-performance thin asphalt overlays (HPOL). Mixtures used in HPOL are generally required to meet enhanced performance characteristics compared to traditional dense-graded hot mix asphalt. MassDOT has been exploring the possibility of allowing contractors to choose between placing HPOLs either as an Asphalt Rubber Gap-Graded (ARGG) mixture, a Superpave High Performance (HP) surface course mixture, or a stone matric asphalt (SMA) mixture. This project will investigate the performance and life-cycle costs/benefits of a HP or SMA mixture compared to the ARGG mixtures with which MassDOT has more experience.

❖ **Main Research Objectives:**

- Evaluate current MassDOT ARGG and HP HPOL mixtures.
- Design and evaluate the performance of ARGG, HP, and SMA mixtures for use as a HPOL.
- Attempt to optimize materials or design parameters to improve on the current specifications for ARGG, HP, and SMA HPOL mixtures.
- Compare the performance characteristics (with respect to long-term aging) and life-cycle costs/benefits of the optimized mixtures.
- Develop recommendations on which HPOL mixture will be best for MassDOT.

Web link to the Research Summary: https://www.mass.gov/doc/optimizing-of-massdots-high-performance-asphalt-overlay-hpol-mixtures-research-summary/download
Web link to Final Research Report: https://www.mass.gov/doc/high-performance-asphalt-overlay-hpol-mixtures/download
Timeframe: Completed in September 2023

New Projects in FFY23

1. Implementing the AASHTO Mechanistic-Empirical Pavement Design Guide, Phase III
Principal Investigator: Dr. Walaa Mogawer, UMass Dartmouth
MassDOT Project Champion: Edmund Naras

❖ **Project Overview:** AASHTO's new Mechanistic-Empirical Pavement Design (PMED) method can be a significant improvement in pavement design but the models must be calibrated using local date to accurately predict design performance. This project involves four phases, each building on the last. Phase I included a literature review and assessment of state of the practice, Phase II consisted of the development of an AASHTOWare Pavement M-E User Manual, and local experimental plan and sampling template. This phase, Phase III, involves evaluating the sample size for distress prediction models, and collecting/obtaining the relevant field data that will be needed for the local calibration of the ASSHTO Level 1 PEMD prediction models.

❖ **Main Research Objectives:**

- Select roadway segments and plant produced mixtures for testing in Phase III, using the local experimental plan and sampling template developed during Phase II. The selected mixtures will represent the spectrum of mixtures produced in Massachusetts.
- Continue laboratory testing of mixtures to obtain data for Level 1 PMED implementation.
- Establish a calibration database in Excel.
- Evaluate the estimated sample size for bias and precision for each of the distress prediction models.

Web link to the Research Cut Sheet: https://www.mass.gov/doc/implementing-the-aashto-mechanistic-empirical-pavement-design-guide-phase-iii/download
Timeframe: Expected Completion in May 2024

2. Artificial Intelligence Framework for Crosswalk Detection Across Massachusetts

Principal Investigators: Dr. Jimi Oke and Dr. Chengbo Ai, UMass Amherst; and
Dr. Yuanchang Xie, UMass Lowell
MassDOT Project Champion: Bonnie Polin

- **Project Overview:** Knowing the locations of crosswalks is important for prioritizing systematic measures to enhance pedestrian safety. MassDOT had previously developed risk models for pedestrian safety but did not have a complete list of crosswalk locations. This project provided such a list through the use of AI (Artificial Intelligence) algorithms that were able to detect crosswalks from satellite images. Compared to manual identification of crosswalks from satellite images or Google Street Views, an AI tool will be more efficient and more adaptable. An AI tool will allow MassDOT to update the crosswalk inventory frequently when new satellite images are available. Given new satellite images, this tool can be used to conduct change detection over time and identify crosswalks that need maintenance.

- **Key Findings:**

- Based on the study's methodology, 88,440 crosswalks were detected in Massachusetts as of 2021, and there were 83,380 crosswalks in the state in 2019.
- Of these crosswalks, 89 percent were intersection crosswalks and 8 percent were midblock crosswalks (the remaining 3% were driveways). These percentages were similar for both 2019 and 2021.
- In terms of crosswalk type by marking, zebra crosswalks accounted to 62–64 percent, standard/parallel lines accounted for 36–38 percent, and solid/painted crosswalks comprised the remainder (< 1%).

Web link to the Research Summary: https://www.mass.gov/doc/artificial-intelligence-framework-for-crosswalk-detection-across-massachusetts-research-summary/download
Web link to the Final Report: https://www.mass.gov/doc/artificial-intelligence-framework-for-crosswalk-detection-across-massachusetts-final-report/download
Timeframe: Completed in February 2024.

3. Energy-Focused Decision-Making Framework for MBTA Operations and Planning

Principal Investigators: Dr. Jimi Oke, Dr. Eleni Christofa, and Dr. Eric Gonzales, UMass Amherst
Project Champion: Sean Donaghy, MBTA

- **Project Overview:** This project aims to develop an enhanced system-wide energy model for MBTA urban rail transit, and a decision support tool to provide system-wide energy and cost predictions for given input operational strategies, to help meet performance targets. This project builds on earlier MBTA/MassDOT research that created a model to accurately predict system-wide electricity consumption.

❖ **Main Research Objectives:**

- Enumerate and analyze high-level operational planning metrics to assist with planning for future energy needs.
- Develop a generative model with mapping between high-level planning metrics and low-level train movement and operational variables (speed, acceleration, etc.)
- Develop an energy forecasting model based on train movement, ridership, and weather, to predict system-wide energy usage.
- Integrate the energy forecasting and generative models into a robust decision-making framework (the MBTA Train Energy Planner) that can provide an assessment of planning strategies.

Web link to the Research Cut Sheet: https://www.mass.gov/doc/implementing-the-aashto-mechanistic-empirical-pavement-design-guide-phase-iii/download
Timeframe: Expected Completion in September 2024

4. Accessible Bus Stop Design in the Presence of Bike Lanes

Principal Investigators: Dr. Eleni Christofa and Dr. Chengbo Ai, UMass Amherst; and
Dr. Peter Furth, Northeastern University
MassDOT Project Champion: Martha Koch

❖ **Project Overview:** This project will investigate how to meet accessibility needs and provide a high-quality experience for transit riders at bus stops, while simultaneously providing space for safe bicycling along bus corridors.

❖ **Main Research Objectives:**

- Conduct a review of the literature and best practices for reducing conflicts between bus riders and bicyclists near bus stops.
- Through field observations and data collection, investigate bus rider and bicyclist behaviors and interactions when bicycle roadway infrastructure is adjacent to floating and constrained bus stops.
- Propose design improvements for bus stop and bicycling infrastructure to mitigate conflicts and achieve better safety and accessibility for both bicyclists and bus riders.

Web link to the Research Cut Sheet: https://www.mass.gov/doc/accessible-bus-stop-design-in-the-presense-of-bike-lanes/download
Timeframe: Expected Completion in August 2024

5. Cross-Modal Impact Assessment for Sustainable Transportation Networks

Principal Investigators: Dr. Jessica Boakye and Dr. Egemen Okte, UMass Amherst
MassDOT Project Champion: Martha Koch

❖ **Project Overview:** Large investments into the transportation system should be environmentally friendly, equitable, and cost-effective, the three pillars for sustainable development. When investing in a multimode transportation system, the following considerations are crucial for defining the sustainability of the system: what is the best way to quantify complex impacts across multiple domains (social, economic, environmental); how can the impact of taking different transportation modes be quantified; and how can policy decisions about mode choice be evaluated through an equity lens. This research examines such questions and then creates metrics and a decision-making framework to promote sustainable transportation networks.

❖ **Main Research Objectives:**

- Conduct an extensive literature review to identify best practices and gaps.
- Based on the lit review and on data availability, identify possible indicators for each sustainability pillar, and then prioritize them based on feedback from stakeholders.
- Develop a cost-metric to estimate the total government of transportation projects as a function of economic, environmental, and social costs.
- Create an aggregate metric and document the repeatable methodology for assessing cross-modal sustainability.

Web link to the Research Cut Sheet: https://www.mass.gov/doc/cross-modal-impact-assessment-for-sustainable-transportation-networks/download
Timeframe: Expected Completion in September 2024

6. Speed Management and Emergency Response – A Synthesis Study

Principal Investigators: Dr. Francis Tainter, Dr. Cole Fitzpatrick. and Dr. Michael Knodler Jr., UMass Amherst; and Dr. Peter Furth and Dr. Daniel Dulaski, Northeastern University
MassDOT Project Champions: Jackie DeWolfe and Chris Falco

❖ **Project Overview:** Reducing vehicular speeding is essential for meeting state transportation safety goals. There are numerous known and effective strategies for speed management, but so far, they have not been implemented on a large scale in Massachusetts. This project aims to first enhance the understanding of the impact of speed management strategies on vehicular speeds, and the understanding of municipal emergency and public safety personnels' concerns regarding speed management. The project will then develop recommendations of preferred speed management strategies that reduce speeding, follow design standards, and address municipal personnel concerns.

❖ **Main Research Objectives:**

- Conduct a survey of current speed management techniques, their effectiveness, and municipal implementation challenges.
- Strategize and host regional speed management forums to engage with local stakeholders.
- Create an inventory of regional speed management case studies and municipal partnerships.
- Develop recommendations for strategies and roadway treatments to reduce speeding.

Web link to Research Cut Sheet: https://www.mass.gov/doc/speed-management-and-emergency-response-a-synthesis-study/download
Timeline: Expected Completion in September 2024

7. LIMMS Gap Analysis and Development Plan

Principal Investigators: Dr. Russ Tessier, Dr. Jeremy Gummeson, and Dr. Chengbo Ai, UMass Amherst
MassDOT Project Champion: Alana Geary

- **Project Overview:** The Laboratory Information Materials Management System (LIMSS) was designed as a secure platform to streamline and centralize materials data collection and provide tools to analyze patterns and trends statewide. The current design of LIMMS limits the expected benefits of the system. This project will include a gap analysis looking at the needs of LIMMS users and an investigation into alternative software that can meet or exceed MassDOT's technical and design requirements. The results will be used to help MassDOT select a next generation material management product.

- **Main Research Objectives:**

- Hold meetings and workshops with MassDOT staff who use LIMMS to gather information on the current scope of LIMM usage and limitations, including regarding security.
- Contact other DOTS to document common use cases for alternative products.
- Conduct a gap analysis based on the feedback from MassDOT staff, other DOTS, and info obtained through a lit review. The analysis will take into consideration the multiple platforms that MassDOT presently uses for materials and contract management.
- The gap analysis findings will be used to develop a Request for Information (RFI) with a detailed and accurate scope of work for a sustainable and efficient LIMMS system.

Web link to Research Cut Sheet: https://www.mass.gov/doc/limms-development-planning/download
Timeline: Expected Completion in July 2024

8. Measuring Fare Payment Compliance on MBTA Buses and Light Rail

Principal Investigators: Dr. Eric Gonzales and Dr. Song Gao, UMass Amherst
Project Champion: Sefira Bell-Masterson, MBTA

- **Project Overview:** Fare evasion reduces needed revenues to the MBTA. There is a need for methods to track fare payment compliance over time and identify where and when manual checks are most valuable. This project coincides with the Fare Transportation project that will change how passengers pay fares.

❖ **Main Research Objectives:**

- Use existing data sources to estimate the rates of fare payment compliance on MBTA buses and light rail services. Such data include records from automated passenger counters on transit vehicles, automated fare collection, and infrequent manual observations.
- Develop a method to identify when and where manual spot checks of fare payment/evasion behaviors will be most valuable.

Web link to Research Cut Sheet: https://www.mass.gov/doc/fare-payment-compliance-on-mbta-buses-and-light-rail-0/download
Timeline: Expected Completion in October 2024

9. Developing a Visualization, Sharing, and Processing Platforms for Large-Scale Highway Asset Point Cloud Data

Principal Investigators: Dr. Chengbo Ai and Dr. Simos Gerasimidis, UMass Amherst
MassDOT Project Champion: Neil Boudreau

❖ **Project Overview:** There is a great need for a convenient software platform that can maximize the utilization of valuable point cloud data through easy visualization, sharing, processing and management. This project will develop such a software platform, and which has to potential to significantly improve the utilization of various LiDAR point cloud data that MassDOT is continuously invested in.

❖ **Main Research Objectives:**

- Develop a convenient data platform with the functionalities of visualization, sharing, and processing for large-scale point cloud data
- Integrate the platform with the typical data sources, including existing relevant spatial databases, and analysis tools generally utilized at MassDOT
- Develop case studies to demonstrate the feasibility and efficiency of the platform for specific MassDOT critical highway applications, such as for asset management, safety analysis, bridge management, etc.

Web link to Research Cut Sheet: https://www.mass.gov/doc/development-of-a-visualization-sharing-and-processing-platform-for-large-scale-highway-point-cloud-data/download
Timeline: Expected Completion in October 2024

10. Recycled Ground-Glass Pozzolan (RGGP) for Use in Cement Concrete

Principal Investigators: Dr. Kara Peterman and Dr. Sergio Breña, UMass Amherst; and Dr. Jianquing Wei, UMass Lowell
MassDOT Project Champion: Richard Mulcahy

- **Project Overview:** Hydraulic cement, the key ingredient of cement concrete, produces an immense amount of heat and carbon dioxide during the manufacturing process. According to the International Energy Agency (IEA), manufacturing hydraulic cement accounts for 7 percent of human-made carbon dioxide emissions. Additionally, other hydraulic cement replacement materials used in today's cement concrete, such as fly ash and slag, are the byproducts of coal-fired power stations and steel manufacturing, respectively, which also increases our carbon footprint. Recycled ground-glass pozzolan (RGGP) is a potential hydraulic cement replacement material, manufactured from recycled glass products, with the potential to greatly reduce the amount of hydraulic cement in cement concrete. The goal of this research project is to validate the efficacy of RGGP to decrease our carbon footprint and increase the quality and long-term durability of cement concrete used in MassDOT projects.

- **Main Research Objectives:**

- Conduct a comprehensive literature and state of knowledge review on the use of RGGP in concrete.
- Develop RGGP cement concrete mix design formulations.
- Evaluate the structural performance of RGGP-based concrete through mock-up tests conducted at the Brack and Boyle Laboratories at UMass Amherst.
- Develop recommendations re: specifications and applications of RGGP and RGGP cement concrete for MassDOT implementation.

Web link to Research Cut Sheet: https://www.mass.gov/doc/recycled-ground-glass-pozzolan-rggp-for-use-in-cement-concrete/download
Timeline: Expected Completion in May 2025

11. Evaluating the Effectiveness of Driver Education Modules on Safety

Principal Investigators: Dr. Shannon Roberts and Dr. Anuj Pradhan, UMass Amherst
MassDOT Project Champions: Sara Lavoie and Martha Koch

- **Project Overview:** There is currently mixed evidence on the effectiveness of driver education courses. This project will assess the effectiveness of the driver education courses and curriculum in Massachusetts. Building on previous MassDOT research regarding vehicle advanced driver assistance systems (ADAS) which automate some aspects of driving and warn drivers of potential roadway dangers, this project will also specifically consider the question of whether driver education courses can be used to train drivers on how to effectively use ADAS.

- **Main Research Objectives:**

- Conduct interviews and/or focus groups with stakeholders – including driving instructors, car dealers, and police officers –to develop an informed perspective on current driver education and training courses in Massachusetts.

- Examine how differences in drivers' education program delivery affects novice drivers' behaviors, and their crashes and citations for infractions in their first 12 months of licensure.
- Investigate how differences in novice drivers' pre-license behaviors affect their crashes and citations in their first 12 months of license.
- Consider how driver education and training programs can help improve novice drivers' use and understanding of ADAS.

Web link to Research Cut Sheet: https://www.mass.gov/doc/evaluating-the-effectiveness-of-drivers-education-modules-on-safety/download
Timeline: Expected Completion in Sept 2025

12. Measuring Accessibility to Improve Public Health, Phase II

Principal Investigators: Dr. Eric Gonzales and Dr. Eleni Christofa, UMass Amherst
MassDOT Project Champion: Derek Krevat

❖ **Project Overview:** Efforts have been made to quantify the access that communities across Massachusetts have to food, jobs, health care, education and other essential destinations. Phase I of this study evaluated access to food providers for different modes but did not consider the built environment and transportation infrastructure's impact on accessibility. This phase of the research expands on the Phase I results, focusing on the data needed and metrics for adequately assessing transportation access to essential destinations via modes such as microtransit, walking, biking, and ridesource/ridesharing services.

❖ **Main Research Objectives:**

- Develop measures of accessibility for alternative modes that account for relevant characteristics of transportation infrastructure, built environment, and areas and hours of service.
- Identify gaps and inequities in transportation access, including for vulnerable or disadvantaged populations, and options for addressing those gaps and inequities.
- Recommend metrics and analyses that can be reproduced with available data and incorporated into a data dashboard or tool that supports ongoing transportation planning and investment decisions.

Web link to Research Cut Sheet: https://www.mass.gov/doc/measuring-food-access-to-improve-public-health-phase-ii/download
Timeline: Expected Completion in August 2025

13. 3D-Printed Lattice-Based Structures for Next Generation Bridge Bearings, Phase III

Principal Investigators: Dr. Simos Gerasimidis, and Dr. Wen Chen, UMass Amherst; and Dr. John Hart, Massachusetts Institute of Technology
MassDOT Project Champion: Catherine Hong

- **Project Overview:** Bridge bearings are installed between the bridge substructure and the superstructure to transfer loads and allow controlled translations to reduce stresses in the structure. In deteriorated and aging bridges, the old bearing system commonly needs to be replaced, and these replacements are currently very costly. Recent progress in 3D printing applications through the MassDOT research program examined promising, customizable design for typical bridge bearings and isolation bearings. This project will develop a prototype architected bearing system, and manufacture and test the 3D-printed bearing systems. The project will involve the design of architected lattices which will serve as the reinforcement of the rubber elastomer interested to replace the undesirable lead core in the traditional isolation bearings.

- **Main Research Objectives:**

- Develop a new architected material bridge bearing product and test it for vertical, transverse, and other load conditions.
- Prepare recommendations regarding the technoeconomic decision-making process (including cost models) informing how to apply the new prototype. Identify the technical capabilities to achieve a cost0-effective solution that can be implemented in the field.

Web link to Research Cut Sheet: https://www.mass.gov/doc/3d-printed-lattice-based-structures-for-next-generation-bridge-bearings-and-bridge-isolation-bearings-phase-iii/download
Timeline: Expected Completion in August 2025

14. Method for Pavement Marking Inventory and Retroreflectivity Condition Assessment Using Mobile LiDAR, Phase II

Principal Investigator: Dr. Chengbo Ai, UMass Amherst
MassDOT Project Champion: Neil Boudreau

- **Project Overview:** There is a pressing need for MassDOT to develop and implement an effective and efficient inventory method and a reliable retroreflectivity condition assessment approach for pavement marking. MassDOT recently completed Phase I of this research with promising results from LiDAR-based methods, including automated pavement marking extraction and retroreflectivity algorithms. The goal of Phase II is to leverage the outcomes from Phase I and expand the knowledge for pavement marking in a few key aspects: in-service markings, newly installed markings, and MUTCD compliance.

- **Main Research Objectives:**

- Collect additional mobile LiDAR, point cloud data in selected roadway test sections with different pavement marking materials and properties.
- For new marking installations, develop procedures to evaluate the retroreflectivity conditions and other critical properties within the first six months of installation.

- Develop a standard operating procedure (SOP) and supporting database for in-service marking retroreflectivity measurement to meet MUTCD requirements.

Web link to Research Cut Sheet: https://www.mass.gov/doc/a-pavement-marking-inventory-and-retroreflectivity-condition-assessment-method-using-mobile-lidar-phase-2/download
Timeline: Expected Completion in February 2025

15. Effect of Asphalt Binder Source in Asphalt Mixture Performance

Principal Investigator: Dr. Walaa Mogawer, UMass Dartmouth
MassDOT Project Champion: Mark Brum

❖ **Project Overview:** Recent research has shown that transportation agencies are increasingly experiencing premature failures of some of their asphalt mixtures that did not fail previously. Some reasons that might attribute to these failures include: variability in the source of the base binder used to produce the mixture, switching to a different binder supplier during production as compared to the mixture design phase, and suppliers using different modifiers and/or additives with a base binder to meet the target Performance Grade. The main goal of this research is to assess the implications of changes in asphalt binder formulation and source during mix design and production, on asphalt mix performance.

❖ **Main Research Objectives:**

- Determine which binder properties display significant variations between different production lots and sources.
- Determine which changes in binder properties alter a mixture's laboratory performance.
- Perform life-cycle cost analysis.
- Establish specifications for allowable binder property tolerances.
- Provide guidance for MassDOT to update their asphalt pavement specifications to incorporate new binder testing protocols for both mix design approval and construction.

Web link to Research Cut Sheet: https://www.mass.gov/doc/effect-of-asphalt-binder-source-on-asphalt-mixture-performance/download
Timeline: Expected Completion in September 2025

Projects Started before FFY23 and Continuing in FFY24

1. Methods to Identify Problematic Carriers and Prevent Infrastructure Damage

Principal Investigator: Robin Riessman, UMass Amherst
MassDOT Project Champion: Makaela Niles

❖ **Project Overview:** This project aims to establish the current use and availability of datasets, methods of access, and integration nuances related to oversize/overweight trucking operations in Massachusetts, as well as violation types and rates for these vehicles.

❖ **Main Research Objectives:**

- Compile a comprehensive classification of relevant existing data sources, fields, and their framework of interoperability from state agencies and departments including but not limited to MassDOT Registry of Motor Vehicles (RMV) division citation, licensed drivers, registered vehicles, and crash data, and Massachusetts State Police (MSP) SafetyNet Commercial Motor Vehicle (CMV) crash and inspection data. Examine and consider inclusion of MassDOT datasets such as for overweight/size permits, freight restrictions, roadway inventory, and toll records.
- Develop recommendations and procedures for the preferred use of shared datasets from multiple departments and agencies to enable MassDOT to identify and analyze height- and/or weight-restricted Massachusetts transportation infrastructure, and to prevent damage from problematic use by commercial carriers.

Web link to the Research Cut Sheet: https://www.mass.gov/doc/methods-to-identify-problematic-carriers-and-prevent-infrastructure-damage-0/download
Timeframe: Expected Completion in March 2024

2. Feasibility Study of 3D Printing Applications for Bridge Elements

Principal Investigators: Dr. Simos Gerasimidis and Dr. Wen Chen, UMass Amherst; and Dr. John Hart, Massachusetts Institute of Technology
MassDOT Project Champions: Paul Tykodi and Catherine H. Chen

❖ **Project Overview:** A previous MassDOT study explored the feasibility of using AM in the framework of MassDOT and concluded that there AM could play a significant role in improving construction and maintenance of transportation infrastructure. This study builds on that earlier research, exploring more AM innovations and capabilities, and focusing on methods for improving repair techniques of deteriorated transportation infrastructure elements, including deteriorated steel bridge ends, and for using 3D printing technologies to repair them.

❖ **Main Research Objectives:**

- Explore the feasibility of additive repair technologies for real corroded steel beam ends. Examine different additive manufacturing solutions and repair technologies in the lab and on-site. Test repaired beams for strength, fatigue, and corrosion resistance.
- Research the key factors related to the different repair technologies and equipment that can impact the success of repairs.

- Develop a list of suggested options for equipment and facilities that seem well suited for handling 3D printing applications, and the associated qualifications testing of 3D-printed repaired steel bridge beams.

Web link to the Research Cut Sheet: https://www.mass.gov/doc/feasibility-of-3d-printing-applications-for-highway-infrastructure-construction-and-maintenance-phase-ii-research-need/download
Timeframe: Expected Completion in August 2024

3. Data-Driven Approaches for Transit Capital Planning

Principal Investigators: Dr. Eric Gonzales, UMass Amherst, and Price Armstrong, Cambridge Systematics
MBTA Project Champion: Elizabeth McCarthy

❖ **Project Overview:** This research aims to develop new approaches and identify best practices for compiling, aggregating, and understanding data that enable better decision-making for transit capital planning. Transparent, repeatable, and uniform processes for data aggregation and analysis will allow MassDOT to make capital planning decisions that are driven by data and consistent with needs and priorities across the Commonwealth. This research will include coordination with the 15 Regional Transit Authorities (RTAs) in Massachusetts.

❖ **Main Research Objectives:**

- To identify and prioritize the data requirements, aggregation methods, and analysis techniques to forecast needs for transit capital investment decisions that align with the Commonwealth's priorities over a five-year planning horizon.
- To identify software tools and workflows that make data aggregation and analysis processes more transparent, consistent, and repeatable for prioritizing capital investments.
- To create an implementation plan so that proposed processes are adopted consistently across RTAs and are repeatable over time.

Web link to the Research Cut Sheet: https://www.mass.gov/doc/data-driven-approaches-for-transit-capital-planning/download
Timeframe: Expected Completion in July 2024.

4. Using Traffic Signals to Limit Speeding Opportunities on Arterial Roads

Principal Investigator: Dr. Peter Furth, Northeastern University
MassDOT Project Champion: James Danila, P.E.

❖ **Project Overview:** Preventing speeding on multilane arterials is critical to safety. This project investigates the use of traffic signal timing as a way to reduce speeding on arterials by removing opportunities to drive at high speeds through multiple intersections, while still providing good traffic flow. Preliminary studies suggest that, compared to conventional arterial signal timing, traffic signal timing can reduce "speeding opportunities" (the number of cars arriving at an intersection on a stale green and with no vehicle ahead of them) by up to 50% with little to no change in average traffic delay.

❖ **Main Research Objectives:**

- Conduct field tests to confirm the performance of traffic signal timing in terms of vehicle speeds, speeding opportunities, traffic delays, and stops.
- Develop a software tool to estimate the number of speeding opportunities that different traffic signal timing plans will produce. This tool will allow traffic engineers to develop and choose timing plans that improve safety without increasing traffic delays.
- Produce a guidebook on timing traffic signals to reduce speeding opportunities.

Web link to Research Summary: https://www.mass.gov/doc/using-traffic-signals-to-reduce-speeding-and-speeding-opportunities-on-arterial-roads-research-summary/download
Web link to Research Final Report: https://www.mass.gov/doc/using-traffic-signals-to-reduce-speeding-and-speeding-opportunities-on-arterial-roads-final-report-0/download
Timeframe: Completed in February 2024

5. Development of a Salt Spreader Controller Program Using Machine-Sensed Roadway Weather Parameters

Principal Investigators: Dr. Chengbo Ai and Dr. Russell Tessier, UMass Amherst
MassDOT Project Champion: Mark Goldstein

❖ **Project Overview:** Massachusetts treats more than 15,000 lane miles during winter. It is critical that the distribution of deicing and anti-icing materials onto roadways is done efficiently and effectively so that transportation agencies can maintain desirable levels of roadway operations and safety while reducing potential environmental impacts of these materials.

❖ **Main Research Objectives:**

- Develop and validate an automated system that can automatically adjust the spreader controller based on acquired mobile Road Weather Information System (RWIS) sensor data, such as road temperature, grip level, and surface state.
- Develop a hardware/software program that enables automated roadway treatment with minimal supervisor and plow driver intervention. The program will consist of essential hardware, RWIS data acquisition software, and the spreader controlling algorithm.
- Via tutorials and presentations, provide recommendations for utilizing the created program.

Web link to the Research Cut Sheet: https://www.mass.gov/doc/development-of-a-salt-spreader-controller-program-using-machine-sensed-roadway-weather-parameters/download
Timeframe: Expected Completion in July 2024.

6. Smart Work Zone Control and Performance Evaluation Based on Trajectory Data

Principal Investigators: Dr. Yuanchang Xie, Dr. Danjue Chen, and Dr. Benyuan Liu, UMass Lowell
MassDOT Project Champion: Carrie McInerney

❖ **Project Overview:** This study seeks to reduce work zone crashes and fatalities by analyzing the trajectories of vehicles approaching work zones, identifying safety hazards, and then developing work zone safety strategies. The study will use computer vision technologies to extract vehicle trajectory data.

❖ **Main Research Objectives:**

- Conduct a review of relevant literature.
- Develop a plan and methods to collect vehicle trajectory data in the field and extract that data for analysis.
- Utilize the extracted trajectory data to analyze driver behavior, particularly lane-changing behavior, under different traffic conditions.
- Utilize the trajectory data to quantify the effects of various merging taper lengths and rumble strip configurations on vehicle speed and lane-changing behavior.
- Based on this analysis, identify safety hazards in work zones, and develop recommendations to improve work zone safety and operations.

Web link to the Research Cut Sheet: https://www.mass.gov/doc/smart-work-zone-control-and-performance-evaluation-based-on-trajectory-data/download
Timeframe: Expected Completion in May 2024.

7. Post-Fire Damage Inspection of Concrete Structures in Tunnels, Phase III

Principal Investigators: Dr. Simos Gerasimidis and Dr. Scott Civjan, UMass Amherst
MassDOT Project Champion: John Czach, P.E.

❖ **Project Overview:** Phase I of this research included a literature review, development of a draft inspection protocol checklist, and an evaluation of a heat system for physical testing. Phase II provided results from lab-based heating of concrete structures and strength testing afterward. Phase III extends the testing from Phase II with in-situ heating and field verification. This will allow for field tests that include in-situ moisture content and thermal conductivity to verify results from the laboratory tests. Testing will be conducted on tunnel and bridge elements that are scheduled for removal or demolition.

❖ **Main Research Objectives:**

- Pilot the heating system setup from the lab in the field.
- Verify the lab results through in-situ heating and field testing.
- Test new fireproofing materials recommended for use in new MassDOT tunnel construction.
- Evaluate concrete/mortar patch repair performance under heat.

Web link to the Research Cut Sheet: https://www.mass.gov/doc/post-fire-damage-inspection-of-concrete-structures-phase-iii-in-situ-experimental-phase-research-need/download
Timeframe: Expected Completion in December 2024.

8. Effectiveness of Two-Stage Turn Queue Boxes in Massachusetts: A Comparison with Bike Boxes

Principal Investigators: Dr. Eleni Christofa, Dr. Chengbo Ai, and Dr. Francis Tainter, UMass Amherst
MassDOT Project Champion: Andrew Wilkins

❖ **Project Overview:** Previous MassDOT research investigated motorist and bicyclist behavior at single-stage bike boxes and assessed the bike boxes' effectiveness in improving safety. This study will assess the effectiveness of two-stage turn queue boxes, and compare the findings with those from the earlier study to develop design and implementation guidelines for the two treatments.

❖ **Main Research Objectives:**

- Create an inventory of two-stage turn queue boxes and update the existing bike box inventory for Massachusetts.
- Characterize bicyclist and motorist behaviors at intersections with two-stage queue turn boxes and compare them with those at bike boxes.
- Develop guidelines on the design and implementation of two-stage turn queue boxes and bike boxes to promote safety.

Web link to the Research Cut Sheet: https://www.mass.gov/doc/effectiveness-of-two-stage-turn-queue-boxes-in-massachusetts-a-comparison-with-bike-boxes/download
Timeframe: Completed in August 2024

9. Ultra-High Performance Concrete Reinforced with Multi-Scale Hybrid Fibers and its Durability-Related Properties

Principal Investigators: Dr. Jianqiang Wei, UMass Lowell, and Dr. Sergio Breña, UMass Amherst
MassDOT Project Champion: Richard Mulcahy

❖ **Project Overview:** Ultra-high-performance concrete (UHPC) is a cementitious composite material composed of an optimized gradation of granular constituents, a low water-to-cementitious materials ratio, and a high percentage of discontinuous internal fiber reinforcement. Due to its excellent mechanical properties, ease of placement, and volume stability, UHPC is often used in transportation infrastructures including roads, underground structures, and bridges. The goal of this study is to develop a novel UHPC reinforced with Multi-Scale Hybrid Fibers (MSHF) and nano-scale additives with enhancements in both early-age properties and long-term performance such as high early-age strength, low volume change, low permeability, and extended service life in the presence of environmental stresses in Massachusetts. The project will also develop a comprehensive understanding of the roles of MSHF, additives, and cement chemistry in improving durability-related properties of UHPC.

❖ **Main Research Objectives:**

- Develop novel nonproprietary Fiber Reinforced Concrete (FRC) and UHPC mixtures.
- Identify and maximize the roles of fibers and additives in enhancing mechanical and durability-related properties in UHPC.
- Promote the widespread use of FRC and UHPC in transportation infrastructure.

Web link to Research Summary: https://www.mass.gov/doc/ultra-high-performance-concrete-reinforced-with-multi-scale-hybrid-fibers-and-its-durability-related-properties-research-summary/download

Web link to Research Final Report: https://www.mass.gov/doc/ultra-high-performance-concrete-reinforced-with-multi-scale-hybrid-fibers-and-its-durability-related-properties-final-report/download
Timeline: Completed in December 2023

10. Complete Streets and Urban Trees

Principal Investigator: Dr. Brian Kane and Delia Mahoney, UMass Amherst
MassDOT Project Champions: George Batchelor and Andrew Schlenker

- **Project Overview:** This research project focuses on the preservation of large trees in high-density areas during infrastructure projects. Trees contribute to the quality of life in communities, as do infrastructure improvement projects to promote walking and cycling. However, infrastructure projects that do not adequately accommodate trees' natural needs can harm trees' health and their value to communities. Preventing harm to trees before and during construction, and restoring habitat conditions as needed post-construction, can be beneficial both to trees and communities.

- **Main Research Objectives:**

- Complete a state-of-practice synthesis including a literature review for preserving trees and improving trees' growth rates following construction.
- Conduct an online survey of practicing professionals responsible for the health of urban forests at select DOTs and cities.
- Gather feedback and facilitate consensus-building from a multidisciplinary panel of experts.
- Develop documentation for preliminary corridor tree-health evaluation and general impact analysis.

Web link to the Research Cut Sheet: https://www.mass.gov/doc/tree-preservation-and-planting-for-complete-streets-development/download
Timeframe: Expected Completion in August 2024

11. Revised Load Rating Procedures for Deteriorated Prestressed Concrete Beams

Principal Investigators: Dr. Sergio Breña, Dr. Simos Gerasimidis, Dr. Scott Civjan, and Dr. Jessica Boakye, UMass Amherst
MassDOT Project Champion: Matthew Weidele

❖ **Project Overview:** MassDOT has a substantial inventory of deteriorating precast, prestressed concrete structures. This project will develop an approach to realistically and reliably determine a safe working capacity for precast, prestressed concrete bridges that exhibit deterioration to avoid unnecessary bridge closures while also keeping the public safe. This project is being carried out through a combination of computer model simulations and full-scale laboratory testing of actual deteriorated beams. The findings from this study will be used to propose updates to the MassDOT Bridge Manual's load rating procedures.

❖ **Main Research Objectives:**

- Categorize the severity of deterioration of precast, prestressed concrete bridges as it relates to safety.
- Develop engineering procedures to estimate the remaining capacity of deteriorated precast, prestressed concrete beams based on severity of the deterioration encountered.
- Develop a reliable rating methodology that results in safe predictions of working capacity applicable to the range of deterioration encountered in existing precast, prestressed concrete bridges in Massachusetts.

Web link to the Research Summary: https://www.mass.gov/doc/revised-load-rating-procedures-for-deteriorated-prestressed-concrete-beams-research-summary/download
Web link to the Research Final Report: https://www.mass.gov/doc/revised-load-rating-procedures-for-deteriorated-prestressed-concrete-beams-final-report/download
Timeframe: Completed in November 2023

12. Field Study to Determine Salt Usage Efficiency on Two Pavement Types

Principal Investigators: Dr. Walaa Mogawer, P.E., UMass Dartmouth, and Kirk Smith, USGS New England Water Science Center
MassDOT Project Champions: Mark Goldstein, Edmund Naras, John Gendall, and Henry Barbaro

❖ **Project Overview:** MassDOT has concerns that certain pavement surface types, specifically Open-Graded Friction Course (OGFC) and dense-graded (DG) surfaces, may be getting overtreated during winter road maintenance. The purpose of this study is to collect and analyze field data to understand if the current treatment applications and frequencies are correct, deficient, or excessive. The study will also investigate both safety and environmental aspects of the current salt treatment rates.

❖ **Main Research Objectives:**

- Compare OGFC and DG pavement response to identical winter maintenance (salt) applications in terms of reflected physical parameters.
- Investigate the safety and environmental implications related to winter maintenance activities for both OGFC and DG pavement types.

- Evaluate whether either pavement type requires a greater or lower application rate to achieve desired results.

Web link to the Research Cut Sheet: https://www.mass.gov/doc/field-study-to-determine-salt-usage-efficiency-and-transport-to-the-surrounding-environment-on-two-pavement-types/download
Timeframe: Expected Completion in September 2025.

13. Development of Improved Inspection Techniques Using LiDAR for Deteriorated Steel Beam Ends

Principal Investigators: Dr. Simos Gerasimidis, Dr. Chengbo Ai, and Dr. Sergio Breña, UMass Amherst
MassDOT Project Champion: Jean Markowski

❖ **Project Overview:** Through recently completed research, MassDOT has developed improved procedures to accurately assess the remaining load carrying capacity of deteriorated steel beams, and in a lab setting, has tested LiDAR scanning technology for acquiring crucial data for load ratings. This project will test this same technology out in the field to verify the methodology.

❖ **Main Research Objectives:**

- Develop and validate automated or semi-automated point cloud processing methods.
- Develop practical, effective on-site procedures for collecting critical data from in-service steel beam ends using LiDAR.
- Evaluate the accuracy and repeatability of LiDAR in quantifying key parameters for evaluating the residual capacity of a bridge with deteriorated steel beams.
- Propose updates to the MassDOT Bridge Design Manual for the estimation of the remaining capacity of steel beams, based on the research results.

Web link to the Research Cut Sheet: https://www.mass.gov/doc/development-of-improved-inspection-techniques-using-lidar-for-deteriorated-steel-beam-ends/download
Timeframe: Expected Completion in August 2024.

V. Research Impacts and Outcomes

Using Research Findings at MassDOT (Project Champion Survey Results)

MassDOT is committed to tracking the implementation and impacts of research. To help with this goal, the MassDOT Research Section sent a Project Completion Survey to the MassDOT Project Champions (PCs) and Principal Investigators (PI), and Project Managers (PM) for research projects completed during FFY23, and a follow-up survey to the PCs and PIs for research projects completed in FFY22.

These surveys collect important information on how research study findings are used by MassDOT and help to inform revisions to agency procedures and policies to improve efficiency and outcomes. The survey results also show how research findings are disseminated through journal publications, conferences, and otherwise, aiding knowledge transfer and future workforce development by sharing the state of research and best practices. In FFY23, MassDOT research projects were featured in a number of peer-reviewed journals. A paper on the *Impact of Advanced Driver Assistance Systems (ADAS) on Road Safety and Implications for Education, Licensing, Registration, and Enforcement* appeared in *Traffic Safety Research* (Web link: https://doi.org/10.55329/udqk4583). Findings from the *Effectiveness of Bike Boxes in Massachusetts* project were featured in the *Transportation Research Record* (Web link: https://doi.org/10.1177/03611981231179473). Results from the *Detecting Subsurface Voids in Roadways Using UAS with Infrared Thermal Imaging* project were published in *Automation in Construction* (Link: https://doi.org/10.1016/j.autcon.2023.104784).

Survey responses from MassDOT Project Champions (PCs) demonstrate a range of potential implementation efforts. In the most successful cases, research findings and results are being, or have already been, incorporated into the agency's Standard Operating Procedures (SOPs) and technical specifications, and/or have facilitated a phased approach to long-term implementation. For example, it is anticipated that the results from the *Construction and Materials Best Practices for Concrete Sidewalks project* (Phase I and II) will inform MassDOT's Standard Specifications for sidewalks and will guide the construction of future sidewalks on roadways within MassDOT's jurisdiction and other roadways constructed in the Commonwealth as well. Similarly, with bridge maintenance and safety, the results from earlier studies such as *Improved Load Rating Procedures for Deteriorated Steel Beam Ends* (2021) and *Development of Load Rating Procedures for Deteriorated Steel Beam Ends* (2019) have led to changes in the MassDOT Bridge Manual. The results from the FFY23 project *Revised Load Rating Procedures for Deteriorated Prestressed Concrete Beams* may lead to further updates to the MassDOT Bridge Manual.

One common theme in PC responses to the survey questions on technology transfer and implementation was that the research results had been shared with other MassDOT personnel who may play a crucial role in MassDOT using the findings and implementing recommendations. Another common theme in the PC responses was that further study was needed before implementation. Of the eleven research projects that finished in FFY23, MassDOT is now funding additional phases for two of them. Additionally, at least thirteen other research projects in FFY23 are themselves building on earlier MassDOT studies.

Training the Next Generation of Transportation Professionals (Principal Investigator Survey Results)

All MassDOT-sponsored research projects that are performed by universities involve graduate students, the next generation of transportation professionals. Through hands-on activities such as data gathering, literature reviews, lab testing, field research, data analysis, and the development and calibration of computational models, these students develop competencies in designing research, choosing study methodologies, conducting research investigations, drawing conclusions, and presenting results effectively. With these hands-on experiences and with having some project Principal Investigators (PIs) incorporating their research project objectives, data, and key findings into academic course curricula, the groundwork continues to be laid for developing qualified new transportation professionals. In their responses to the PI Project Completion Survey, the PIs for six projects completed in FFY23 or FFY22 indicated that they have incorporated aspects of the research projects into their teaching curricula. Here are a few examples:

- The LiDAR point cloud data processing techniques developed for the *Pavement Marking Inventory and Retroreflectivity Condition Assessment* project were incorporated into the PI's class (graduate & undergraduate) on Intelligent Transportation Systems.
- The horizontal curve scenario from the *Automated Guardrail Inventory and Condition Evaluation* project was included in a Highway Design class, as guardrail damages are often correlated with sharp curves and inadequate superelevation and/or surface friction.
- The findings from the *Effectiveness of Bike Boxes in Massachusetts* project are now included in the PI's courses on *Pedestrians and Bicycles* (graduate & undergraduate) and *Transportation Sustainability* (graduate).
- Models and sparse-principal component thermography from the *Detecting Subsurface Voids in Roadways Using UAS with Infrared Thermal Imaging* project has been incorporated into the PI's course (graduate) on sensors and signal processing for structural health monitoring of engineering systems.

Disseminating Research Results

All final MassDOT research reports are publicly accessible online along with their compliancy with accessibility requirements. MassDOT, Federal Highway (FHWA), and UMTC work together to finalize each report, including making the report Section 508-compliant for accessibility. Once a report is 508-compliant, the report is published on the MassDOT Research and Technology Transfer web page alongside the Project Summary cut sheet. Final Reports are also submitted to the following: the FHWA Research Library (Link: https://highways.dot.gov/research/resources/research-library/federal-highway-administration-research-library); the FHWA Office of Corporate Research, Technology, and Innovation Management (Link: https://highways.dot.gov/research/turner-fairbank-highway-research-center/offices/office-corporate-research-technology-innovation-management); the National Transportation Library (Link: https://ntl.bts.gov/ntl); and the Transportation Research Board Library (Link: https://www.trb.org/InformationServices/TRBLibrary1.aspx) for their records and collection.

Sharing Research Internationally, Nationally, and In-State

During FFY23, MassDOT research projects and findings were shared at international, national, and in-state conference settings. Studies and their key findings and data were presented at the 2023

Transportation Board Annual Meeting, the 2023 MassDOT Transportation Innovation Conference, and the MassDOT 2022 Moving Together Conference.

2023 TRB Annual Meeting

The 2023 Transportation Research Board (TRB) Annual Meeting was held in person in Washington, DC, with more than 12,000 transportation professionals from around the world in attendance. MassDOT was well represented at lectern and poster sessions. Presented MassDOT-funded research covered a wide range of projects, including but not limited to:

- Timing Traffic Signals to Reduce Speeding Opportunities on Coordinated Arterials
- Evaluating the Safety Impacts of Flashing Yellow Permissive Left Turn Indications in Massachusetts
- Municipal-Level Analysis of Behavioral Crashes in Massachusetts
- Using Imagery and Data Science to Find Guard Rails
- An Automated Guardrail Face Dentation Identification Method Using Mobile LiDAR Data
- Line-Specific Energy Modeling Framework for Urban Rail Transit Systems: Boston Case Study
- Measuring Access to Food: Application in Massachusetts
- The Use of Mycofiltration with Stormwater Best Management Practices
- Investigating the Feasibility of Black Locust Lumber of Multimodal Projects
- Developing a Methodology to Identify Non-Normative Key Destinations for Transportation Planning
- The Use of High-Resolution Signal Controller Data to Measure Transit Signal Priority Performance: Boston Case Study

MassDOT staff also presided over poster sessions on Analytical Frameworks for Employing Scenario Planning Practices, and on Landscape and Environmental Design Topics and Innovations.

The Innovation Webinar Series

The Innovation Webinar Series started in 2020 as a way to share information on important innovative transportation initiatives, technologies, and projects with state and national audiences. Starting in FFY22 and continuing in FFY23, the Innovation Webinar series focused primarily on presenting and sharing MassDOT-funded research projects and findings. Nine webinars on different projects were held during FFY23 with the research Principal Investigator(s) from academia and the MassDOT Project Champion or their designee presenting at each:

- Detecting Subsurface Voids in Roadways using UAS with Infrared Thermal Imaging
- Impact of Advanced Driver Assistance Systems (ADAS) on Road Safety and Implications for Education, Licensing, Registration and Enforcement
- Pavement Marking Inventory and Retroreflectivity Condition Assessment Method Using Mobile LiDAR
- Understanding Asset Management Systems Utilized in Municipalities in Massachusetts
- Uncovering the Root Causes of Truck Rollover Crashes on Ramps
- Effectiveness of Bike Boxes in Massachusetts
- Post-Fire Damage Inspection of Concrete Structures
- Using Mycrofiltration Treatment for Stormwater Management
- Measuring Food Access to Improve Public Health

These nine webinars combined had a total attendance of 1,116, with 42 percent of attendees being from MassDOT. Attendees also came from FHWA, municipalities, regional agencies, the private sector, academia, and at least 34 other state DOTs.

At the end of each webinar, attendees were invited to provide feedback through a short online survey. The feedback they gave was generally very favorable and included comments such as these:

> *"Very excited to see this technology. I think it will be a vital tool for any highway department."* (Detecting Subsurface Voids in Roadways)
>
> *"The webinar was very interesting. I am very interested in seeing the final report and how we could implement the findings towards preventing truck rollovers."* (Causes of Truck Rollover Crashes on Ramps)
>
> *"I work in bridge inspection and will be sharing this webinar with my colleagues."* (Post-Fire Damage Inspection of Concrete Structures)
>
> *"This was so useful, thank you! I am sharing this with my City staff and fellow cycling/traffic safety advocates."* (Effectiveness of Bike Boxes)
>
> *"The presenter was very clear and concise and explained complicated concepts well"; "This webinar is relevant to my job. which makes me eager to share some of the information I gained."* (Measuring Food Access to Improve Public Health)

The webinar recordings are publicly available through the UMTC's Innovation Webinar Series web page (Link: https://www.umasstransportationcenter.org/umtc/MassDOT-Innovation-Series.asp)

MassDOT Transportation Innovation and Moving Together Conferences

Each year, the MassDOT Transportation Innovation and Moving Together Conferences include sessions and presentations highlighting MassDOT research projects, and how the recommendations and tools developed through the projects are being, or could be, implemented at MassDOT. For example, MassDOT research featured at the 2023 Innovation Conference included studies on: improving the longevity of concrete in sidewalk and bridge construction projects; using scanning technologies to conduct inspections of cables on suspension bridges and steel beams; and best practices to reduce suspension bridge cable deterioration.

More details on the Innovation and Moving Together Conferences are provided under MassDOT Conferences, which is Section VII of this report.

VI. Technology Transfer and Training Services

The Research Section delivers training activities through both the Massachusetts Local Technical Assistance Program (LTAP, branded as Baystate Roads) and MassDOT Training Services (MTS).

FFY23 brought the Technology Transfer and Training Services more in-line with pre-Covid-19 training, but with an approach that continued to provide a variety of training formats and support materials, including virtual classroom, blended learning, online training, and webinars. These remote training formats can be defined as:

- *Virtual classroom:* Live training via an online platform (e.g., Zoom). Classes may be condensed or broken into several presentation dates to complete.
- *Online:* Self-paced modules completed independently online.
- *Blended learning:* A combination of approaches such as completion of online modules followed by a classroom or virtual class.
- *Webinar:* A one-hour presentation conducted on a virtual platform (e.g., Zoom).

Continuing to incorporate a variety of learning options, after Covid-19 restrictions were removed, provides opportunities for a variety of learning preferences and schedules. Face-to-face training works best for some people; others prefer the convenience of a live, virtual class. A self-paced approach provides the most flexibility, whether working through a structured online course, reading materials, watching videos, or listening to related podcasts.

Overview

During FFY23, Baystate Roads (BSR) provided 142 training sessions, covering 62 unique topics, to cities and towns across the Commonwealth. Overall, the number of BSR classes increased this year by 22 percent from the FFY22 total of 116. The technical training needs of MassDOT Highway Division personnel were addressed through MassDOT Training Services (MTS). The number of MTS classes increased from FFY22 to FY23, growing 25 percent to a total of 104, with 21 additional classes offered.

Baystate Roads and LTAP

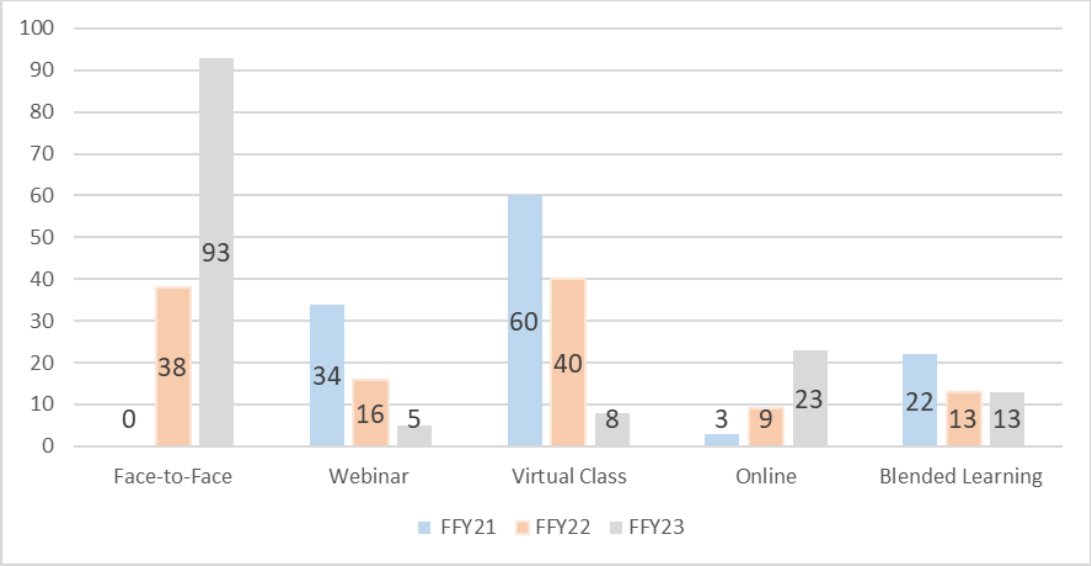
The Massachusetts Local Technical Assistance Program (LTAP) provides training and technical resources to the 351 municipalities across the Commonwealth. Through the development and implementation of annual and quarterly training plans, classes are offered to municipal personnel and contractors based on local needs and MassDOT priorities. Statewide training and specific training for individual municipal groups is provided by a technical training specialist and a variety of additional professional instructors. While the addition of face-to-face (F2F) training was a gradual late FFY22 roll-out, FFY23 saw a 145 percent increase in this format; from 38 classes to 93, and a 228 percent increase in participants from 497 to 1,631. Face-to-face class sizes also grew in FFY23, from an average of 13 participants per class in FFY22, to 18 per class in FFY23. Table 2 on the next page compares training format and participant number changes from FFY22 to FFY23.

Table 2: Baystate Roads (LTAP) Training Sessions and Participants, FFY22–23

Training Format	# Sessions FFY23 (FFY22)	# Participants FFY23 (FFY22)	Session % Change FFY22 to FFY23	% Change Participants FFY22 to FFY23
Face to Face	93 (38)	1,631 (497)	145%	228%
Webinar	5 (16)	206 (678)	−69%	−70%
Virtual Classroom	8 (40)	336 (915)	−80%	−63%
Online	23 (9)	373 (247)	156%	51%
Blended Learning	13 (13)	157 (154)	0%	2%
TOTALS	**142** (116)	**2,700** (2,491)	**22%**	**9%**

Figure 5 more fully shows the transformation of LTAP training formats over the past three years: starting in FFY21 with no F2F due to COVID-19 restrictions, the pivot to various virtual options from FFY21–22, and the FFY22–23 reemergence of F2F training. While some virtual training options, such as webinars and virtual classes, decreased in FFY23, online training products increased. Online training requires more labor to develop initially, but the automated registration and self-guided approach is less expensive to maintain and continue after the training development. F2F training took the place of many prior virtual sessions this year, with a virtual component often included in a larger F2F series.

Figure 5: LTAP Training Format Changes over Time, FFY21–FFY23
Number of classes offered



During FFY23, 62 unique training topics were presented via 142 sessions. The fewer number of topics this year compared with 279 in FFY22, can be explained by the FFY23 focus on F2F training, which requires scheduling more sections of the same class to provide statewide promotion. Of this year's training topics, 8 (6 percent) were new topics or subtopics addressing local roadway safety, construction, design, maintenance and operations, and workforce development. A complete list of

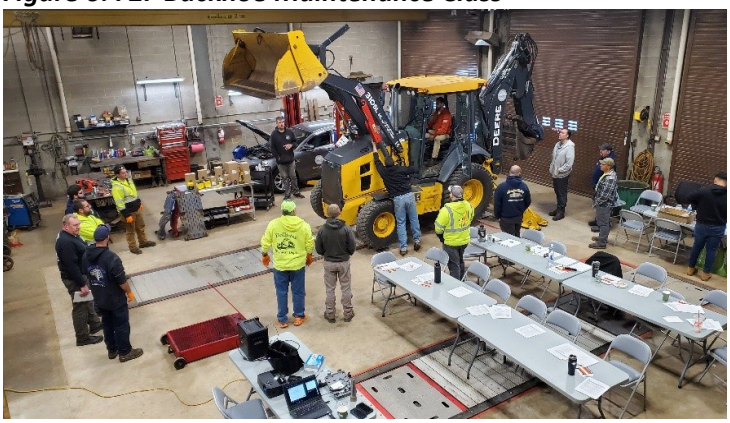
training subjects and formats is available on the UMTC web site (Link: : https://www.umasstransportationcenter.org/umtc/FFY23-LTAP-Training-Topics-Provided.asp)

Face-to-Face (F2F) Training Highlights

Improved Covid-19 conditions in FFY23, combined with an audience preference for non-virtual interaction, increased the number of face-to-face trainings in FFY23. Ninety-three F2F classes were provided during the year and attended by 1,631 people. The FFY23 average class attendance increased from 13.0 to 17.5 participants per class, a 227 percent increase, while the number of training sessions provided increased by 145 percent.

F2F class highlights this year included more hands-on *Backhoe Maintenance* and new workforce development training, including *Tools, Tactics, and Insights: Elevating Your Communication Skills in the Workplace* for employee development, and *Essential Supervisory Skills* for managers.

Figure 6: F2F Backhoe Maintenance Class



The new Management and Employee Supervisory and Communication Skills classes were well-received, with 123 people in total attending. One participant gave this feedback: *"I felt that the curriculum was hands-on in a meaningful way to keep people engaged, while not being overly exhausting or contrived. The format was thoughtfully laid out and allowed us to come to our own conclusions and build off the ideas of others, beyond just simple rote learning."*

Online Highlights

Online training options increased by 156 percent in FFY23, with participation levels rising as well, by 50 percent. Online training expanded to include additional resources provided by AASHTO TC3, including the *AASHTO TC3 Strategies for Accommodating Pedestrians, Bicyclists, and Motorcyclists in Work Zones*. The UMTC-developed *FAA Remote Pilot Exam Prep* class underwent a complete revision in FFY23, updating FAA regulations, course videos, and testing, and materials. Thirty-one people participated in the new version.

Virtual Classroom Highlights

Although virtual classroom options were reduced in FFY23, several training efforts utilized that approach, including the continuing MassDOT *Complete Streets* training initiative, and development of a new class, *Using the 460 Specification to Help Bid Your Next Paving Contract*.

Complete Streets

The *Complete Streets* training series included both F2F and virtual sessions: two F2F of the required *201: Designing Your Streets for People* class, as well as two virtual sessions of the 300-level classes: *302: Safety Countermeasures* and *303: Bicycle/Pedestrian Network Planning*. These classes were attended by 74 virtual and 62 F2F participants. While geared toward municipal staff, local officials and private consultants working closely with Complete Streets also find these courses helpful. Of the 136 participants in FFY23, 68 percent were from the public sector, 29 percent from the private sector, and 3 percent were MassDOT personnel.

Using the 460 Specification to Help Bid Your Next Paving Contract

The new *Using the 460 Specification to Help Bid Your Next Paving Contract* virtual class developed in FFY23 addressed a growing municipal need for project planning and material specification questions. Attended by 65 participants, feedback included:

- *"Very helpful for answering questions regarding the Superpave design and installation, and for updating our towns pavement spec to the Superpave/MassDOT standard."*
- *"I found the presentation very useful and the way it was presented was effective. The 460 Specification is new material for our municipality, so this will be a point of discussion for us moving forward."*

Blended Learning Highlights

Blended learning can take various forms, combining F2F, virtual, and online formats. The FFY23 options differ in their format combinations. The *Flagger/First Aid Certification* course used a virtual approach for the instructor-led portion, followed with an online computer-based certification test. *Grader Operator Training* employing online modules, a virtual class meeting, and a final hands-on F2F class. Both topics were originally available as F2F classroom training, and then redesigned in response during Covid-19 pandemic. Blended learning classes and participation rates remained constant in FFY23, with 13 sessions and 157 participants, a 2% increase in participation over FFY22.

Webinar Highlights

Stump the Instructor

During FFY23, Baystate Roads presented 5 *Stump the Instructor* (STI) episodes, attended by 206 participants. Kicking off shortly after the pandemic started, the series provides local public works staff a means to connect with Baystate Roads personnel, subject matter experts, MassDOT representatives, and each other. FFY23 scheduling has continued to reduce this year with the return to more F2F training expanded. We anticipate the series will continue on a quarterly basis, as an outreach and quick-hit training tool. Topics presented in FFY23 included:

- *New Year New Stump & Anything Winter Operations Related*
- *The Power of GIS in the DPW*
- *Chainsaw Maintenance*
- *Understanding Asset Management Systems Utilized by Municipalities in Massachusetts*
- *All Things Hoisting*

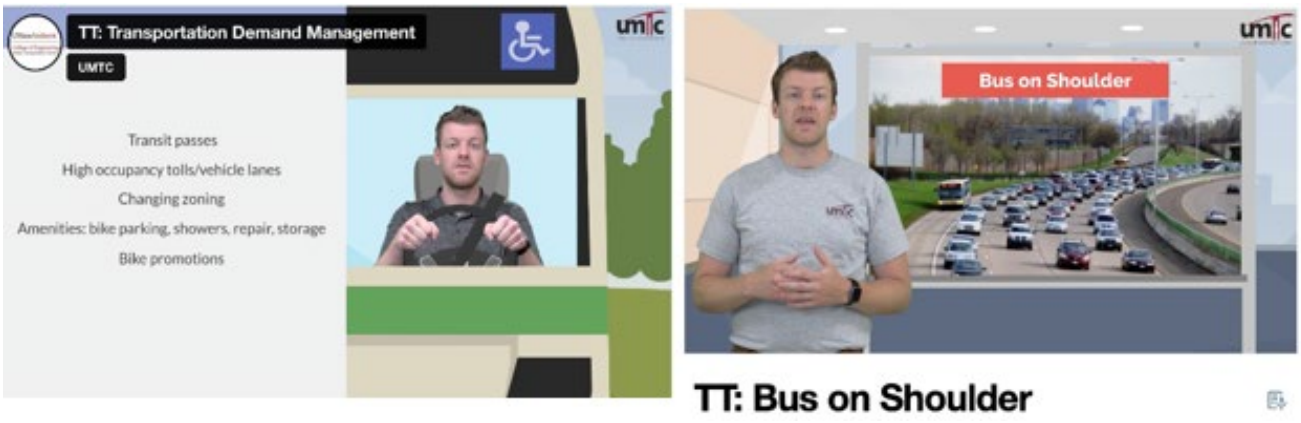
Additional Resources

The development of additional resources continued this year, providing other methods to address both audience needs and learning preferences, support current training efforts, and increase the Baystate Roads training toolbox.

OnDemand Videos

The *Transportation Terminology* series continued with the production of three animated short videos. This series explains new transportation terms and concepts in the news. FFY23 topics included: *Intelligent Transportation Systems (ITS), Transportation Demand Management (TDM)*, and *Bus on Shoulder (BoS).*

Figure 7: Screen Shots of Transportation Terminology Training Videos Transportation Demand Management (left) and Bus on the Shoulder (right)



Job Aids

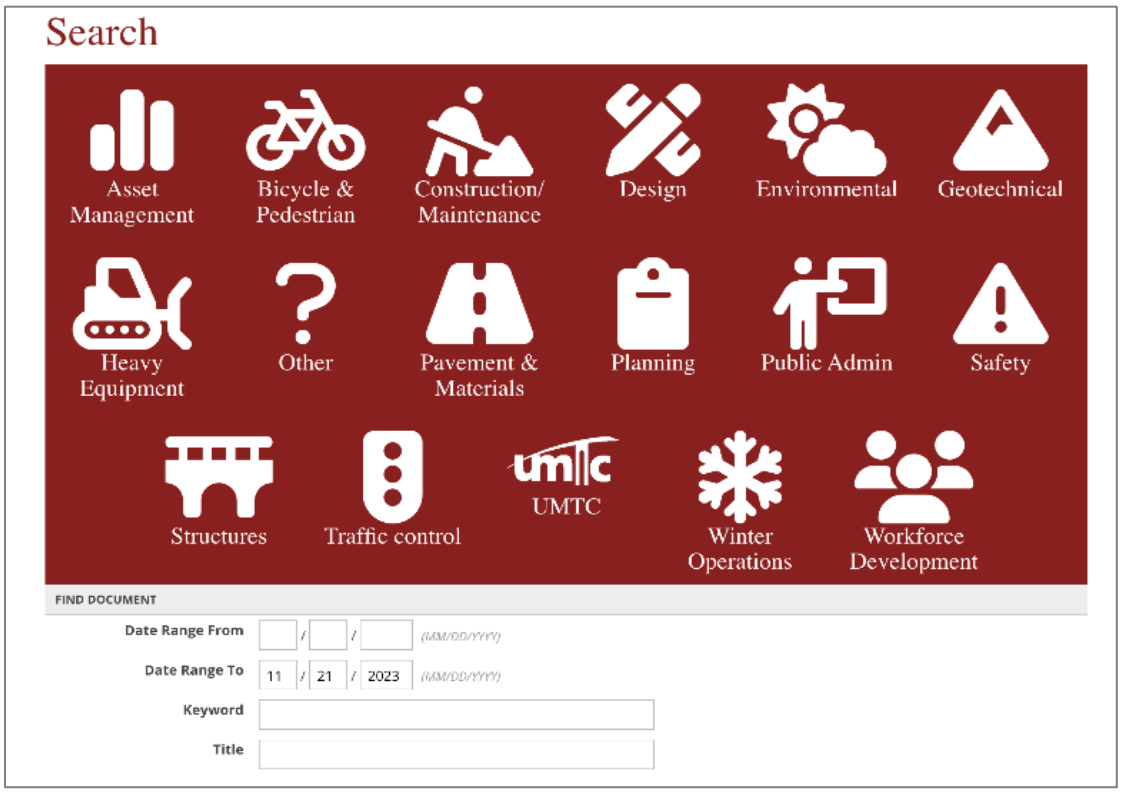
Job Aids provide participants with an easy way to review and reinforce key procedures and steps learned during training. New job aids this year included a laminated *Backhoe Maintenance Essentials* training take away, provided during this new class and available to download in the new *Resource Library.*

Figure 8: Example of a Laminated Job Aid from the Backhoe Maintenance Essentials training

Resource Library

To better access and search the wide variety of videos, newsletters, training materials, and documents available on the UMTC web site, a new *Resource Library* was created and launched in FFY23. Within the Library, materials are categorized into 17 easy-to-identify focus areas: Asset Management, Bicycle & Pedestrian, Construction/Maintenance, Design, Environmental, Geotechnical, Heavy Equipment, Pavement & Materials, Planning, Public Administration, Safety, Structures, Traffic Control, UMTC, Winter Operations, Workforce Development, and Other.

Figure 9: Screenshot of the Resource Library Search Feature



MassDOT Training Services (MTS)

MassDOT Highway Division personnel training needs were addressed by the MassDOT Training Services (MTS) in FFY23. A total of 104 classes were conducted, representing a 25 percent increase over FFY22. Participant numbers in FFY23 decreased by 2 percent to 1,867.

In addition to regularly coordinated MTS courses referenced above, administrative payment oversight continued for several Special Contracts certification and safety training efforts, scheduled and conducted independently by MassDOT District coordinators. Tracking these participant data began in FFY23, and more information is included in the MTS Highlights section.

MTS continued to offer a variety of training approaches in FFY23, including virtual classroom, online courses, and a return to more face-to-face (F2F) training. The number of both blended classes and virtual classes decreased in FFY23 as more MTS resources were focused on F2F trainings.

MTS: New Topics, Formats, and Resources

During FFY23, MTS presented 47 unique training topics. Fourteen (30%) of these were new topics, including on AutoCAD, new National Highway Institute engineering topics, workforce development and a variety of safety classes. A complete list of training subjects is available on the UMTC web page: https://www.umasstransportationcenter.org/umtc/FFY-2023-MTS-Training-Topics-Provided.asp

Table 3 identifies FFY23 session and participant numbers for each training format coordinated, FFY22 data (in parentheses), and the annual percentage changes.

As Covid-19 restrictions eased, MTS F2F classes increased in FFY23. Blended training classes fell to zero, as these subjects were again provided in their original F2F mode. Face-to-face training constituted nearly 80 percent of MTS classes and 77 percent of MTS course participants for FFY23. The average class size virtually (28) outpaced the average class size F2F training (17) by 65 percent, which is indicative of the greater flexibility virtual training affords. While remote blended and virtual training decreased, the total available online training options grew by 25 percent in FFY23, due to the development and availability of NHI and TCCC programs.

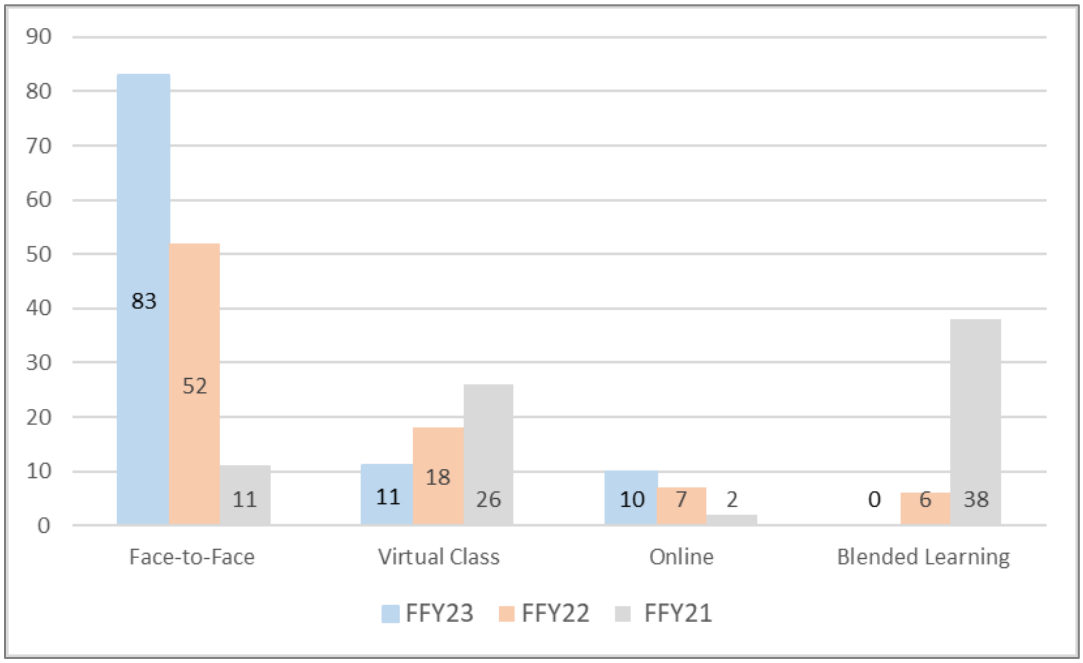
Table 3: MTS Training Sessions and Participants, FFY22–23

Training Format	# Sessions FFY23 (FFY22)	# Participants FFY23 (FFY22)*	Session % Change FFY22 to FFY23	% Change Participants FFY22 to FFY23*
Face-to-Face	83 (52)	1,444 (1,019)	60%	42%
Virtual Classroom	11 (18)	312 (623)	−40%	−50%
Online	10 (6)	111 (146)	43%	−24%
Blended	0 (7)	0 (118)	−100%	−100%
TOTALS	**104** (83)	**1,867** (1,906)	**25%**	**−2%**

**Participant numbers do not include Special Contracts certifications and RR safety training; information included in the FFY23 MTS Highlights section below.*

Figure 10 shows the changes in the number of MTS classes offered in different training formats over the past three years.

Figure 10: MTS Training Format Changes over Time, FFY21–FFY23
Number of classes offered



FFY23 MTS Highlights
Highlights this year included new *AutoCAD* training (both virtual and F2F), *MA Hoisting License Exam Prep* classes for personnel needing 2A/1C and 4G licenses, and a robust Special Contracts effort, providing administrative oversight for multiple technical certifications and Railroad Right-of-Way safety training.

AutoCAD
Several new AutoCAD classes were presented this year, including a virtual *AutoCAD Essentials* class and virtual and F2F versions of the *Civil 3D Essentials* training. Sixty-two MassDOT personnel participated in these new efforts. Post-training evaluations were very favorable, with 94 percent reporting that they will be able to apply new knowledge and skills to their job.

MA Hoisting License Exam Prep 2A/1C, 4G
Returning to F2F training enabled MTS to assist with a backlog of new employee safety training. Among these were licensing exam preparation for 2A/1C and 4G hoisting exams. Three classes were provided statewide in FFY23, with 73 MassDOT employees participating. Of this group, 77 percent have now passed the exam(s) and become licensed. This effort will continue with additional exam preparation training offered in the next year.

Special Contracts
In addition to the MTS training data presented above, separate invoicing oversight continued for several substantial certification and safety training efforts. Participant numbers were tracked in FFY23,

including participation in:

- A variety of virtual and F2F New England Transportation Training Certification (NETTP) classes, with 632 participants.
- A variety of virtual and F2F Northern New England Concrete Association/American Concrete Institute certification classes, with 499 participants.
- Several online railroad right-of-way access safety classes provided by Keolis, Amtrak, and Mass Coastal, with a total of 315 participants.

These special contracting efforts represented 44 percent of MTS spending in FFY2023 and 1,452 additional MTS training participants. Including these classes with other MTS coordinated efforts increases the total annual number of MassDOT staff trained in FFY23 to 3,319.

Gauging the Impact of Training

Annual LTAP Needs Survey
To identify general training participation and application rates, the Baystate Roads Annual Needs Survey includes questions about participation and knowledge transfer. Of the 103 survey respondents, 70 percent said they had participated in training or received other resources provided by the LTAP Center. Of those responses, 90 percent reported that they had applied the information and/or skills they learned through that training or the resources they received.

LTAP Pavement Preservation Training
It is important to delve into the evaluation of specific new trainings and new training formats to identify whether learning objectives are met, and whether training modifications are needed. In FFY23, a survey was distributed to the 103 participants of *Pavement Preservation* classes that had been presented during the past 2 years. Due to Covid-19 conditions, information for this class was provided in various formats, including virtual classroom, blended learning and more recent face-to-face training. The survey obtained a 32 percent response rate. The responses represented each of the four training formats provided (30% virtual classroom, 30% F2F, 21% online, and 18% blended training participants) with no significant differences in responses among the groups.

This evaluation focused on identifying whether learning objectives had been met. When asked to assess their ability to identify pavement preservation options for a given roadway, 94 percent reported that their abilities had improved.

Public Outreach: Providing Assistance and Identifying Needs

LTAP Center assistance is provided not only through training classes, but a variety of outreach mechanisms. The Baystate Roads team's ongoing involvement with municipal peers and organizations allow opportunities for public input and training needs identification. In FFY23, several avenues provided these opportunities including participation at local and regional events such as the New England Public Works Exposition, New England APWA Snowplow Roadeo, MassHighway Association Driver Skills & Backhoe Competition, and local county association meetings. At these events, information on upcoming classes and resources is shared, LTAP marketing materials distributed, and new industry trends and municipal challenges are identified. More formal needs identification approaches include the

information and feedback gathered through Advisory Committee meetings, class evaluations, and the Annual Needs Survey.

In FFY23, Baystate Roads responded to or facilitated over 125 requests for information. Requests are made via email, phone and the Baystate Roads listserv. Remaining the primary communication method, the listserv allows quick feedback from administrators, team members and peers. FFY23 listserv posts covered a wide range of topics, including employment postings, grant opportunities, human resources and contracting questions, material specs and applications, and learning opportunities and resources.

Continued participation in National Local Technical Assistance Program Association (NLTAPA) and industry training events allows sharing of products, services, and new instructor identification. NLTAPA events attended during FFY23 included the winter business meeting (conducted online) and in-person regional meeting in Newport, Rhode Island, and annual conference in Columbus, Ohio.

VII. MassDOT Conferences

In FFY23, MassDOT hosted its two annual transportation conferences, Moving Together and the Transportation Innovation Conference. Both conferences were held in-person with a virtual (remote) attendee option. The remote attendee option, started during the Covid-19 pandemic, was continued during FFY23 to promote equity and inclusion by making the conference accessible to people for whom attending in-person would be a challenge for logistical or health reasons. After each conference, the recordings of the keynote and the hybrid (in-person/virtual) presentation sessions, and the slide decks from presentation sessions, were shared initially with conference attendees, and then later were made publicly available.

Moving Together (MT22), November 1, 2022

The 22nd Annual Moving Together Conference was held in Boston, Massachusetts on November 1, 2022. Moving Together highlights current walking, bicycling, public transportation, and related safety, healthy, and accessibility topics and projects.

A total of 1,358 people registered for the conference, including 1,028 people for in-person attendance and 330 for virtual (remote) attendance. Hybrid (in-person and remote) attendance options were offered for the morning and lunchtime keynote sessions and each of the 17 panel sessions. The conference included two site visit sessions to nearby bicycle and pedestrian infrastructure projects, and 42 in-person sponsors/ exhibitors.

As has been the tradition at past Moving Together Conferences, the Massachusetts Secretary of Transportation, Jamey Tesler, provided the main keynote address at lunchtime and then presented the awards for the best entries in the annual Safe Streets Smart Trips High School Video Contest. Besides Massachusetts Secretary of Transportation, other keynote speakers included Ken McLeod, Policy Director for the League of American Bicyclists, and Jonathan Gulliver, MassDOT Highway Administrator. In the post-conference survey, 93 percent of respondents indicated that they were “Very Satisfied” or “Satisfied” with the conference.

Transportation Innovation Conference (IC23), May 2 and 3, 2023

The Transportation Innovation Conference took place on May 2–3, 2023 at the DCU Center in Worcester, Massachusetts. The annual Innovation Conference provides a forum for sharing knowledge and ideas on innovative transportation initiatives, technologies, and systems.

There were 1,444 people who registered for the conference, with 1,253 signing up to attend in-person, and 191 registering to attend only virtually. The remote attendees had access to the keynote speeches, and one predetermined panel session in each of the concurrent session timeslots.

The conference had 30 podium sessions, a poster session and 80 sponsors/exhibitors. Two highlights of the conference were the plenary talks by Victoria Sheehan, Executive Director of the Transportation Research Board of the National Academies of Sciences, Engineering, and Medicine, and then Massachusetts Secretary of Transportation Gina Fiandaca. Following the lunchtime keynote talks,

awards were given out to the winners of the MassDOT's Municipal Innovation Award and of MassDOT's Digital Billboard Design Contest for college students to promote work zone safety.

In the post-conference survey, 73 percent of respondents indicated that they attended both days, and 90 percent said that overall, they had a favorable—either "Good" or "Excellent"—experience at the conference. From the survey comments, it was clear both that many attendees were happy that the conference was offered in-person, and that other attendees were grateful that a virtual attendance option was offered as well. A number of the virtual attendees noted that it would not have been possible for them to have attended in person.

Moving Together and Innovation Registrations by Organization Type and US State

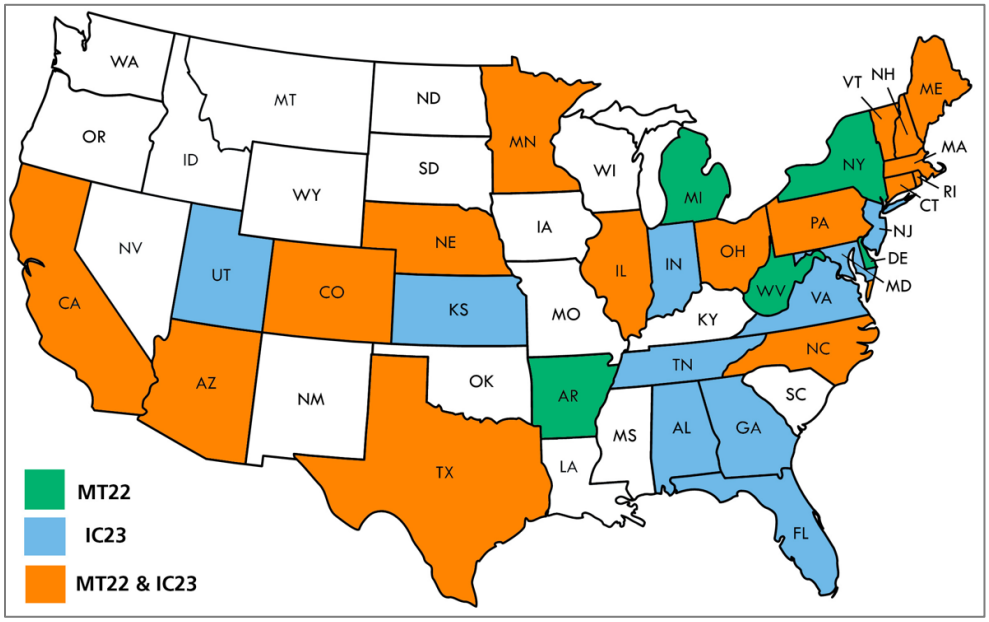
Table 4: Conference Registrations by Organization Type

	MT 22	IC23
Private Sector	32.1%	46.2%
MassDOT/MBTA	31.9%	30.7%
Local /Regional Govt (inc. MPOs)	13.1%	7.8%
Other State DOT	5.8%	3.2%
Regional Transit Agencies	3.5%	1.7%
Other Public	2.2%	1.9%
Nonprofit	4.6%	1.0%
Academia	2.1%	3.2%
HS Students	3.2%	2.9%
Conference Staff (inc. UMTC)	1.5%	2.4%

As indicated in Table 4, for both the 2022 Moving Together Conference (MT22) and 2023 Innovation Conference (IC23), just over 30 percent of the conference registrations were for MassDOT or MBTA employees. At Moving Together compared to the Innovation Conference, there was greater representation from local and regional governments, other state DOTs, and regional transit agencies. In contrast, at Innovation, almost half of the participants (46%) were from the private sector compared to just under one-third of participants (32%) at Moving Together.

Figure 11 shows which US states were represented among the people who registered for MT22 and IC23. All of the northeastern states and most of the southeastern states are included among the participants for one or both conferences. The conferences both attracted participants from other parts of the country as well. For MT22, participants came from 21 states plus the District of Columbia. For IC23, there were participants from 26 states plus DC. There were 15 states with participants at both MT22 and IC23.

Figure 11: Moving Together and Innovation Conference Participation by US State



VI. VIII. National and Regional Collaboration and Engagement

Transportation Research Board Annual Meeting and TRB Committees

MassDOT staff members participate on several Transportation Research Board (TRB) committees to share knowledge of best practices across many transportation platforms. MassDOT employees also serve on TRB-administered research project technical panels, such as National Cooperative Highway Research Program (NCHRP) projects. These panels are made up of experienced practitioners and research specialists from across the country, providing technical guidance on transportation research projects selected annually by the American Association State Highway and Transportation Officials (AASHTO) Research & Innovation (R&I) committee. The following two tables summarize the TRB committees (Table 5) and NCHRP project panels (Table 6) on which MassDOT employees currently participate as members. In FFY23, there were 19 MassDOT employees serving on TRB standing committees and 21 serving on NCHRP project panels.

Table 5: TRB Standing Committees with MassDOT Members

Standing Committee on Data for Decision Making
Standing Committee on Economic Development and Land Use
Standing Committee on Landscape and Environmental Design
Standing Committee on Performance Effects of Geometric Design
Standing Committee on Performance Management
Standing Committee on Safety Performance and Analysis
Standing Committee on Seismic Design and Performance of Bridges
Standing Committee on Strategic Management
Standing Committee on Transportation and Public Health
Standing Committee on Transportation Safety Management Systems
Standing Committee on Workforce Development and Organizational Excellence

Table 6: NCHRP Project Panels with MassDOT Representation

Practitioner's Application Guide to the Highway Safety Manual
Sensitivity Evaluation of Balanced Mix Design Performance Tests to Binder Properties and Mix Design Variables
Development of MASH Test Procedures for Motorcycles
Induced Demand: A Guide to Assessment Frameworks
Roadside Vegetation Management Guidelines for Prevention and Management of Wildfire
Load Rating and Posting of Long-Span Bridges
Incorporating the Safe System Approach into Road Safety Audits
Identifying and Evaluating Divided, Overburdened, and Underrepresented Communities
Incorporation of the Human Factors Guide into Transportation Agency Practices
Performance Measures for Community-Centered Transportation Outcomes: A Guide
Guide for Effectively Linking Performance Measures, Risk Management, and Process Improvement

Transportation Pooled Fund Projects (TPFs)

The Transportation Pooled Fund (TPF) Program is a popular means for the State Department of Transportation (DOT) and Federal Highway Administration (FHWA) program offices to combine resources and achieve common research goals. Pooling resources reduces marginal costs and provides efficient use of taxpayer dollars. It also provides greater benefits to participating interests as compared to individual entities conducting or contracting for research on their own. MassDOT continues to collaborate and contribute with FHWA and other state DOTs to a certain number of transportation studies pertinent to the Commonwealth now and in years to come.

FFY2023 TPF Projects MassDOT Participated In

(*click on the project titles to access the project descriptions at pooledfund.org)*

Project Number	**Title**	**Lead Agency**
TPF-5(370)	Fostering Innovation in Pedestrian and Bicycle Transportation Pooled Fund Study	FHWA
TPF 5(398)	Moving Forward with the Next Generation Travel Behavior Data Collection	FHWA
TPF-5(422)	National Cooperative Highway Research Program	FHWA
TPF-5(431)	Application of Enterprise GIS for Transportation, Guidance for a National Transportation Framework (AEGIST)	FHWA
TPF-5(437)	Technology Transfer Concrete Consortium	Iowa DOT
TPF-5(447)	Traffic Control Device (TCD) Consortium	FHWA
TPF-5(455)	National Accessibility Evaluation Phase II	Minnesota DOT
TPF-5(456)	Econworks	Arkansas DOT
TPF-5(464)	H&H Software Updates	FHWA
TPF-5(479)	Clear Roads Phase III	Minnesota DOT
TPF-5(481)	In-Service Performance Evaluation (ISPE) of Roadway Safety Features	Arizona DOT
TPF-5(482)	Development and Evaluation of Roadside Safety Systems for Motorcyclists	Texas DOT
TPF-5(501)	Roadside Safety Research for MASH Implementation Phase III	Washington State DOT
TPF-5(511)	TRB Core Program Services for a Highway RD&T Program FFY2023	FHWA
TPF=5(TBD)	Additional requests during FFY23	

Over the years, one of the consistent project highlights of the TPF has been the continued involvement and success of the New England Transportation Consortium (NETC). NETC is a cooperative research effort that includes the state DOTs from Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont. The NETC is a valuable regional partnership for the identification and dissemination of shared transportation research initiatives.

NETC Advisory Committee

The NETC Advisory Committee includes representatives from the state DOTs, FHWA, and New England state universities (including the University of Massachusetts, represented by the UMTC). MassDOT's involvement in NETC includes an annual financial contribution for research projects, collaboration on annual project solicitation and prioritization, and participation on project technical committees and at monthly meetings and annual events.

Active NETC research projects in FFY2023 included:
(*click on the project titles to access the project descriptions on the NETC web site)*

- 19-1: Curved Integral Abutment Bridge Design
- 19-3: Experimental Validation of New Improved Load Rating Procedures for Deteriorated Unstiffened Steel Beam Ends
- 20-2: Current Status of Transportation Data Analytics and a Pilot Case Study Using Artificial Intelligence (AI)
- 20-3: Investigating Thermal Imaging Technologies and Unmanned Aerial Vehicles to Improve Bridge Inspections
- 21-1: Quality Review and Assessment of Pavement Condition Survey Vehicle Data Across New England
- 21-3: Initiating Seed Production for Effective Establishment of Native Plants on Roadsides in New England

New England University Transportation Center (NEUTC)

In a significant advancement for transportation research and innovation, the University of Massachusetts Amherst (UMass), a key partner of the Massachusetts Department of Transportation (MassDOT), has been awarded a prestigious US DOT grant, establishing UMass as the New England University Transportation Center. This notable achievement enables UMass to significantly expand its research footprint, leveraging matching dollars to amplify the impact and scope of its initiatives.

This collaboration underscores the shared commitment between the MassDOT Research Program and UMass to pioneer transportation solutions that enhance safety, efficiency, and sustainability across the Commonwealth and beyond.

The USDOT grant not only recognizes UMass's leadership in transportation research but also strengthens MassDOT's capacity to implement cutting-edge solutions through enhanced access to research, technology transfer, and workforce development opportunities. This partnership is poised to deliver transformative outcomes for the transportation sector, setting new benchmarks for innovation and excellence in the New England region and on a national stage.