New Hampshire DOT
Department of Transportation

TSMO BUREAU

TRANSPORTATION SYSTEMS MANAGEMENT AND OPERATIONS STRATEGIC PLAN

2023 – 2032

APRIL 2023

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CONTENTS

INTRODUCTION

The New Hampshire Department of Transportation (NHDOT) applies Transportation Systems Management and Operations (TSMO) to provide travelers a safe, reliable, and efficient transportation experience. For several decades, NHDOT has used informal and formal Intelligent Transportation Systems (ITS) and operational strategies to improve the performance of existing roadways. Formal strategic planning around a program to manage these activities extends back to 2015, not long after the official formation of the NHDOT TSMO Bureau. This TSMO Strategic Plan guides TSMO planning, program implementation, and project identification over a 10-year timeframe (2023-2032). This plan is presented in three parts:

STRATEGIC ELEMENT

Laying the groundwork for NHDOT's focus on TSMO, setting an overall vision, and establishing a set of TSMO strategic objectives

PROGRAMMATIC ELEMENT

Advancing the supporting business processes and functions for transportation operations across NHDOT

TACTICAL ELEMENT

Guiding investment planning and implementation of TSMO services, activities, and projects

The three elements of the plan are intended to work together to support NHDOT's overall commitment to TSMO by providing an understanding where TSMO is today, setting the overall direction for how and where it will evolve, suggesting improvements to how TSMO is implemented as a program within the state, and establishing a baseline set of project needs designed to achieve the plan's strategic objectives and system performance goals.

STRATEGIC ELEMENT

The Strategic Element lays the foundation for the overall strategic plan by setting a vision for TSMO in New Hampshire, outlining NHDOT's approach to conducting TSMO, and establishing a set of TSMO strategic objectives that provide targets for the TSMO program and transportation system performance.

A Strategic Vision of TSMO in New Hampshire

TSMO is a set of services, activities, and applications of technology to improve the safety, mobility, and reliability of the multimodal surface transportation system. TSMO, also called transportation operations, includes traffic and transportation management, traveler information, travel demand management, advanced public transportation management, commercial vehicle operations, emergency services management, and more. These strategies target the causes and outcomes of planned and unplanned events that can result in disruption, cause delays, and affect safety.

TSMO goes beyond tangible, day-to-day activities on the transportation network. At its heart, TSMO is about maximizing the efficiency and capacity of the existing (and future) transportation system by tackling transportation network challenges from an operational perspective. This approach to transportation operations applies to a wide range of challenges—severe weather, traffic incidents, special event traffic, work zone impacts, and other sources of recurring and non-recurring congestion. Successful TSMO is a mindset that NHDOT holds when planning, designing, operating, and maintaining its system. This method emphasizes identifying opportunities to restore and sustain transportation system capacity through operational means as a first priority, among all who contribute to a project, regardless of facility, mode, or scale. NHDOT is seeing momentum for TSMO build as it works closely with its partners such as metropolitan planning organizations and regional planning commissions around the state to implement TSMO strategies.

TSMO Strategies Serving Customers

TSMO is all about communicating real-time transportation system information to transportation system users to help improve their experience. NHDOT uses TSMO on a deliberate and proactive basis to meet customer needs for safe and reliable travel. The Department capitalizes on existing and emerging technology, including ITS devices and communication systems, to enable TSMO strategies that rely on transportation system situational awareness, management approaches, and dissemination of traveler information about system conditions and travel options. Operational performance improves and customers benefit when NHDOT implements strategies that mitigate the disruptive impacts of planned and unplanned events. Customers also gain awareness of current transportation system conditions and travel choices that enable better decisions on when, where, and how to travel.

EXAMPLE NHDOT TSMO STRATEGIES

Traffic Management

Real-time Traveler Information

Safety Patrol Management

Traffic Management – The NHDOT Traffic Management Center (TMC) manages regularly occurring congestion on roadways to preserve travelers' safety and increase mobility. The TMC also manages travel or disruption during inclement weather, through work zones, and during special events. ITS equipment such as traffic cameras and motor vehicle detection systems, supplemented with probe data, allow the TMC to remotely monitor traffic conditions, incidents, and roadway activity to help make informed decisions on roadway operations, field personnel dispatch, and traveler information dissemination.

Real-time Traveler Information – Traveler information dissemination is a significant component of an effective traffic management program. Up-to-date roadway condition information allows travelers to make better choices about where, when, and how to travel. The TMC communicates traffic information through the web and the mobile-friendly newengland511.org traveler information system website that is shared with Maine and Vermont, social media feeds, and directly along roadways using dynamic message signs (DMS).

Work Zone Management – ITS equipment is used in smart work zone applications to improve safety and mobility by responding to work zone traffic conditions. For example, queue warning alerts motorists of slowed or stopped traffic in advance of a work zone, and portable trailers alert drivers of excessive speed or unsafe conditions from trucks entering or exiting as they pass through a work zone.

Traffic Incident Management – NHDOT staff contributes to the coordinated, multiagency response to traffic incidents to preserve safe roadway and incident scene conditions and restore regular travel as quickly as possible. TMC operators detect, verify, and respond to incident information by documenting, activating, and updating information in Compass, a software system that manages ITS devices, data, and traveler information. Operators notify emergency response and dispatch personnel, if not already on scene, and provide updates to internal and external stakeholders, including disseminating traveler information, and is well received by the traveling public.

Safety Patrol Management – Safety Patrol Personnel respond to incidents, breakdowns, or road debris on Interstates 93, 95, and the Everett and Spaulding Turnpikes. This service reduces the risk of secondary impacts and enhances customer service.

Special Event Management – NHDOT plans for and manages impacts from special events, such as NASCAR races, by improving traffic flow in the areas to, from, and around the event. TMC operators communicate conditions and routes through DMS, monitor impacts, and post information on social media.

Road Weather Management – NHDOT uses forecasted weather services, road weather information system sensors, and traffic cameras to monitor road and atmospheric weather conditions in advance of and during weather events. These activities inform snow and ice control strategies employed by winter maintenance crews and the posting of reduced advisory speed limits on DMS.

Emergency Operations – TMC operators support the operations of the Emergency Operations Center when disasters occur. The operators work with Department Emergency Support Function staff to keep the flow of information to the public as current as possible.

Commercial Vehicle Operations – NHDOT, through the Highway Maintenance Permitting Office, manages permitting and truck routing for oversize and overweight trucks to safely traverse the state roadway network. NHDOT's Advanced Transportation Management System (Compass) feeds data to the oversize and overweight permitting software (ProMiles) to notify trucks of roadway restrictions impacting their route.

Future TSMO Strategies – NHDOT continuously examines if and when additional TSMO strategies could be smart investments to improve performance and address safety and mobility problems. Examples include:

- *Ramp metering:* using traffic signals on entrance ramps to let vehicles onto highways in a smooth, even manner. By releasing one or two vehicles at a time, ramp metering reduces merge conflicts and mainline congestion.
- *Dynamic shoulder use:* opening the shoulder lane to vehicle travel during congested periods, often using careful monitoring and lane use control systems to maintain safe travel conditions.
- *Curve speed warning:* using various speed detection methods to determine if a driver's speed is unsafe for an upcoming curve and providing a warning using flashing lights, signs, or in-vehicle alerts.
- *Wrong way driving detection systems and countermeasures:* ranging from roadway ramp treatments to ITS-enabled wrong-way driver detection, alert, and monitoring systems to prevent or mitigate wrong-way driving events.

Challenges, Trends, and Responding with TSMO

Meeting the needs of all travelers using all surface transportation modes continues to evolve rapidly, and NHDOT works to anticipate and respond to these challenges as effectively as possible to continue to provide a safe, efficient, and reliable transportation system. Key trends and challenges expected to influence how NHDOT customers travel over the next decade include the following:

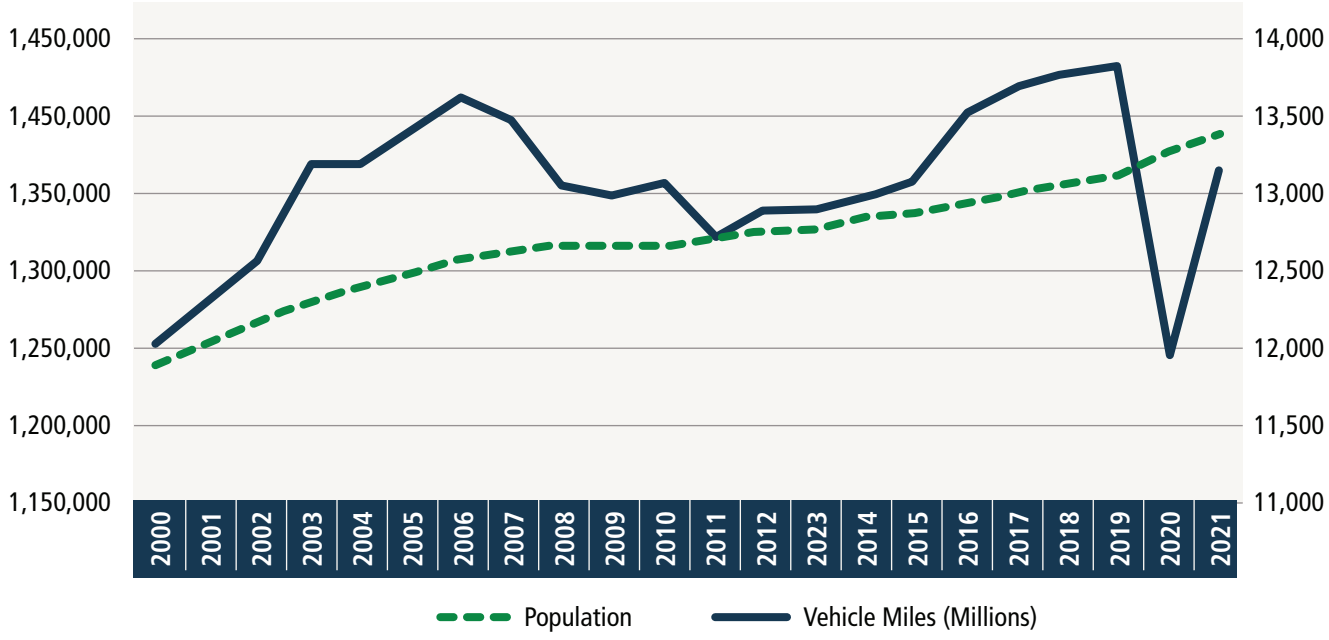
POPULATION AND EQUITY

New Hampshire's population is growing, increasing nearly 5 percent between 2010 and 2020, and this trend is expected to continue. The New Hampshire Office of Planning and Development forecasts all counties in the state, except for Coos, to continue growing through 2040. A growing population translates to more travel, as expressed by vehicle miles traveled (VMT). A greater desire or demand for travel is often linked to a strong and growing economy.

Figure 1 shows the linkage between the state's population growth and VMT since 2000. The significant dip in VMT during the initial period of the COVID-19 pandemic recovered significantly by 2021, and VMT is expected to return to its pre-pandemic level and continue the upward trend. As the state's population continues to grow, as Figure 2, on page 5, indicates, it also continues to age. The share of the state's population 65 and older is expected to increase significantly, as the number of individuals in older age groups is expected to increase by double digit percentages in the coming decades.[1]

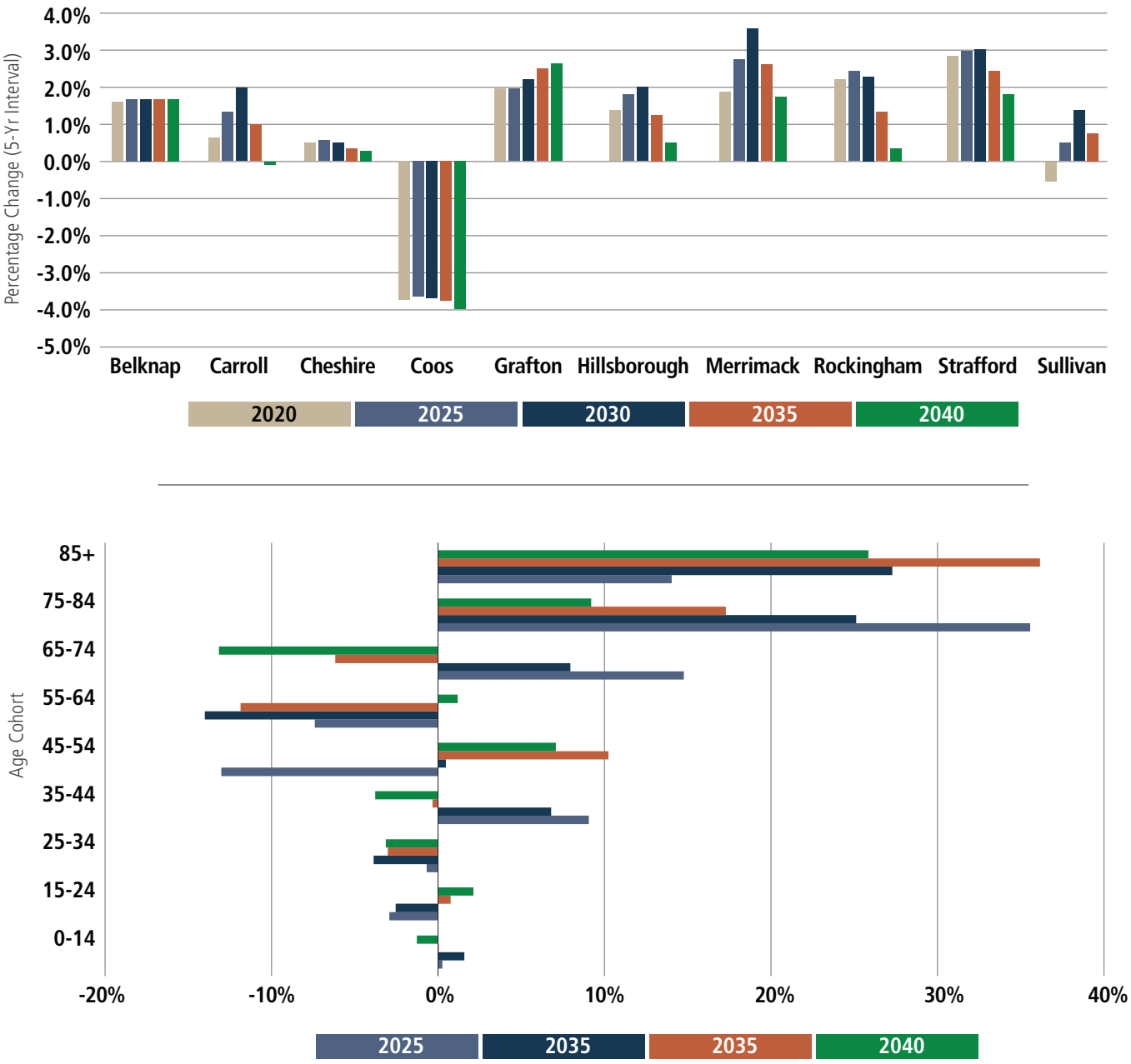
Serving this aging population is a NHDOT priority, as is equitable access to mobility and high levels of system performance and safety across all customer groups.

FIGURE 1. Population and VMT Growth 2000–2021



1 2022–2026 New Hampshire Strategic Highway Safety Plan referencing RLS Demographics and New Hampshire Office of Energy and Planning (now the Office of Planning and Development)

FIGURE 2. Project Population Growth 2020–2040



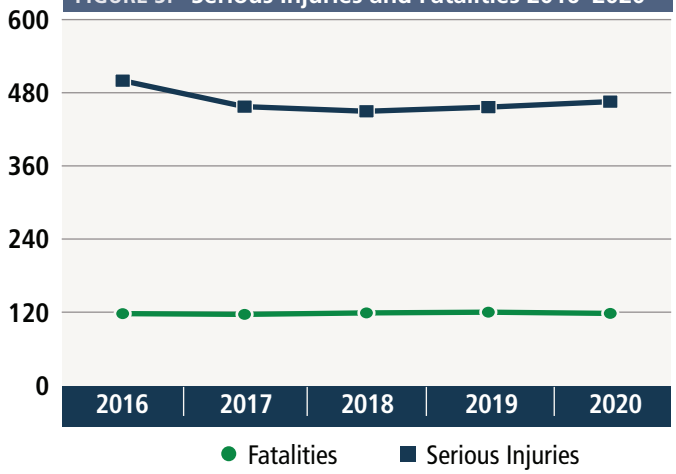
How TSMO helps: *A growing population may increase congestion. As many of the Example NHDOT TSMO Strategies demonstrate, TSMO addresses the causes and impacts of recurring and non-recurring congestion without the time and expense of building new capacity.*

Expanded TSMO strategies could offer alternatives to driving, which may not be viable for some older individuals, by supporting integrated, multimodal mobility solutions that incorporate transit and on-demand transportation. These mobility solutions can help fill gaps in areas of the state or among population groups where access or service may be insufficient, so that all NHDOT customers can be served equitably.

SAFETY

Motor vehicle and non-motorized fatalities and serious injuries remain a persistent challenge. The 2022–2026 New Hampshire Strategic Highway Safety Plan[2] (SHSP) notes: "Although annual traffic fatalities have generally declined since the first SHSP [2008], traffic fatality trends have remained stubbornly flat in recent years" (see Figure 3). From 2015 to 2019, fatalities increased among older drivers (age 65+), those due to speed and aggressive driving, and among vulnerable (non-motorized) road users. New Hampshire maintains a vision of "Zero Deaths" on its roadways, with the specific goal to reduce fatalities and serious injuries by 50 percent by 2035, working toward 0 by 2050.

FIGURE 3. Serious Injuries and Fatalities 2016–2020



How TSMO helps: *By resolving the sources of disruption (crashes, breakdowns, and congestion itself) quickly, TSMO can reduce congestion-related crashes and sources of secondary crashes. Other disruptions, such as work zones, severe weather, and downstream incidents, can also introduce hazardous driving conditions. Providing advanced information to drivers through real-time traveler information, or by using targeted warnings and active TSMO approaches such as queue warning systems and variable speed limits can mitigate these safety concerns.*

MOBILITY

New Hampshire is a mostly rural state, and recurring traffic congestion is below the national average. Even so, there are some occurrences of recurring peak hour congestion on the Everett Turnpike, and as a result of weekend tourist traffic on certain sections of I-93 such as through Franconia Notch and Concord, I-95, and NH Route 16—northbound on Friday afternoons and southbound on Sunday afternoons. Further, both planned and unplanned disruption from maintenance and construction activities contribute to traveler delays and system unreliability. In addition, traffic incidents and weather events are sources of disruption that need to be addressed. Greater VMT (Figure 1 on page 4) can worsen the effects of traffic congestion arising from disruptions, insufficient system capacity, and bottlenecks.

How TSMO helps: *TSMO strategies specifically target the causes of disruption, delay, and unreliability that impact mobility. System conditions and environmental monitoring allow NHDOT staff to make operational decisions and work with state, local, and private sector partners to anticipate, respond, and mitigate the causes and effects of recurring and non-recurring congestion to maintain or restore expected levels of mobility. Information on system conditions and operational decisions is also shared with customers so they can make informed decisions on when, where, and how to travel before or during disruptions. Examples include newengland511.org and third-party applications with which NHDOT shares condition and event data.*

2 https://www.nh.gov/dot/org/projectdevelopment/highwaydesign/hwysafetyimprovements/documents/43246-nh-hsip-08042022.pdf

FREIGHT

NHDOT's 2019 Statewide Freight Plan[3] summarizes the importance of freight in the state:

> *The efficient and reliable movement of goods is a key component to New Hampshire's economic vitality and long-term sustainability. […] Improving freight efficiency and connectivity helps New Hampshire's industries compete in statewide, regional, national, and global markets. In addition, freight and distribution directly create jobs … that are critical to the state's economy.*

Although the plan does not forecast significant changes in highway freight movement metrics (e.g., truck freight tonnage, truck traffic volumes) through 2040, it notes:

> *Freight from [New England and northeastern states] travel mostly on trucks which puts stress on the highways connecting them. New Hampshire should continue investing in the highway system to keep up with growing freight demand. The shipment of high value manufactured goods is expected to increase for both air and marine modes. Infrastructure related improvements … will put the state in a better position to handle the anticipated increases in freight activity.*

How TSMO helps: *Real-time traveler information helps freight carriers, like motorists, make informed decisions on what routes to take to avoid disruption or unsafe driving conditions. This is particularly important for truck drivers who must adhere to hours-of-service regulations, and situations where pickup and delivery windows are often time-critical. Available technology-enabled freight operations strategies also support truck freight movement, including truck parking information systems that provide real-time status on truck parking facilities, weigh-in-motion systems that do not require trucks to stop and incur delay (currently deployed by NHDOT), and electronic bypass systems that similarly eliminate delay and require fewer resources than manual inspection and credentialing.*

3 https://www.nh.gov/dot/org/projectdevelopment/planning/freight-plan/

TECHNOLOGY

The expanding use of technology and connectivity is influencing how NHDOT customers travel and their expectations for the service they experience while traveling. Accurate, up-to-the-minute traveler information on roadway conditions is available from a variety of services. Vehicle connectivity to deliver that information and enable applications that improve safety (along with vehicles' advanced driver assistance systems) and the travel experience are becoming more readily available. Automated trucks are already operating on several interstate corridors in the United States, and their reach is expected to expand. This increased use of technology and connectivity requires a significant investment in cybersecurity measures to protect connected ITS and communications infrastructure, and NHDOT and customer data.

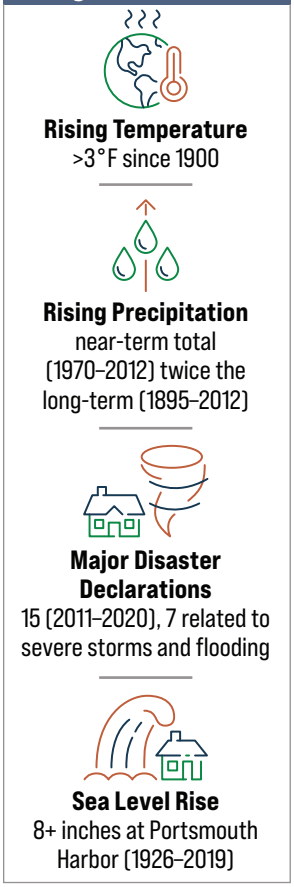
How TSMO helps: *TSMO combines operational management concepts with advanced technology to deliver system performance benefits. Existing TSMO strategies are able to achieve better outcomes by taking advantage of investments in the latest technology. At the same time, advancements in technology enable new TSMO services that expand the options for NHDOT to deploy operational solutions. TSMO leverages advancements in automation, connectivity, and communications to provide the transportation system services that customers expect in a technology-enabled future.*

CLIMATE

The diverse seasonal climate of New Hampshire subjects motorists to wind, rain, and snow events, which can cause dangerous road conditions and lead to significant congestion. A large percentage of the slowdowns on the state's highways are driven by inclement weather, either directly or indirectly due to collisions. The New Hampshire Climate Assessment 2021[4] lays out past and projected increases in extreme weather (see Figure 4), including instances of heavy rain and thaw events in the winter and spring, which pose a danger to both infrastructure and motorists. Increasing land and ocean temperatures represent a higher potential for violent storms—most notably a greater likelihood of impacts from hurricanes in the late summer and early fall. While precipitation volumes remain relatively consistent during the summer tourist season, it is increasingly more likely to come in bursts of 1 inch or more per 24 hours. This concentration of rainfall not only results in flooding, but the intervening periods of drought create greater risks of large wildfires. For tourists and residents alike, being prepared for poor weather and its impacts will become increasingly important.

How TSMO helps: *The TSMO Bureau operates its Storm Desk from the TMC during extreme weather events to collect and disseminate real-time information about road conditions, delays, and closures. Using DMS and traveler information posted to newengland511.org, the TMC can inform drivers of detours, evacuation routes, collisions, and congestion, which can include preplanned scenarios for typical weather patterns or responses developed on the spot. Data-gathering technology like roadside cameras and road weather sensors are instrumental in these efforts, but the TMC can also communicate with emergency services and weather stations to get ahead of inclement conditions or collisions before they result in major system impacts. While the TMC performs congestion-alleviating functions in all types of weather, the Storm Desk focuses the TMC's energy on safety and keeping traffic flowing during the state's worst storms.*

FIGURE 4. Weather Hazards due to Climate Change



Source: NH Department of Health & Human Services

4 https://scholars.unh.edu/cgi/viewcontent.cgi?article=1071&context=sustainability

NHDOT's Policy Commitment to TSMO

NHDOT has been committed to advancing TSMO as a strategic priority while applying an operational mindset and specific strategies to address problems characterized by the highlighted trends and challenges. This TSMO strategic plan recommits NHDOT to this approach and further solidifies TSMO as a program and policy priority within the Department.

At NHDOT TSMO is:

- **Prioritized among programs** – TSMO is a top programmatic priority on par with maintenance and construction.
- **Integrated across the Department** – NHDOT reduces or eliminates barriers that might prohibit integration of Department functions that support the TSMO program.
- **Engrained in the culture** – NHDOT enables and encourages all staff to address system performance challenges by routinely applying an operational mindset.

NHDOT is committed to driving toward zero for its citizens, and TSMO is a critical contributor to reaching this goal. We are also prioritizing TSMO solutions to provide our customers the best possible travel experience in response to planned or unplanned events that potentially cause disruption. This TSMO Strategic Plan lays the foundation to deploy TSMO solutions and strategies in our day-to-day planning, design, construction, maintenance, and operations activities.

—SUSAN KLASEN, PE, ASSISTANT DIRECTOR, DIVISION OF OPERATIONS

At the program level, the following policies and activities demonstrate NHDOT's commitment to TSMO. These examples will continue to be refined and expanded as the TSMO Strategic Plan is carried out.

- All Districts and the TMC strive to apply consistent and uniform procedures related to transportation operations.
- Through the established "mainstreaming" process, a defined 1.5 percent of construction funds for all roadway and bridge infrastructure projects are designated for TSMO elements, if needed to advance the goals of the project and the strategic objectives in this plan.
- An ITS initial request form completed during the Preliminary Plan phase formalizes consideration of ITS elements in the project development process.
- A Smart Work Zone form ensures appropriate temporary ITS and operational strategies are identified during the project development process to actively respond to and mitigate the impacts of work zones on traffic flow and safety.
- The TSMO Bureau delivers an annual executive briefing to update leadership on the past year's accomplishments and plans for the upcoming year.
- Regular updates to the TSMO Strategic Plan promote continuous improvement in TSMO planning, the TSMO program, and application of strategies.

NHDOT recognizes that TSMO is not always the first or only solution. Maintaining and rehabilitating existing roadways and bridges remains a critical activity for the Department. In addition, targeted capacity expansion is a necessary solution to certain capacity and access needs. However, TSMO plays an important role in optimizing existing capacity and minimizing any degradation of new capacity performance as usage grows to ensure that new investments are more cost effective.

TSMO Strategic Objectives

NHDOT maintains a set of four strategic goals that support its overall mission, purpose, and vision. These strategic goals are intended to guide how NHDOT plans, invests, and operates the multimodal transportation system for which it is responsible. These goals can be advanced by establishing objectives specific to TSMO, consistent with the Department's commitment to TSMO. The TSMO strategic objectives guide decision-making at all levels—strategic, program, and decisions on specific TSMO project investments. TSMO project selection and adjustments to the program policies and processes directly support the strategic objectives, and in turn, overall Department goals. Table 1 lists 18 TSMO Strategic Objectives and organizes them by the strategic goals with which they align.

TABLE 1. TSMO Strategic Objectives

NHDOT STRATEGIC GOALS	TSMO STRATEGIC OBJECTIVES
Improve Performance in all business operations including asset conditions, mobility, system safety and security, Department efficiency, and stakeholder engagement.	**1.** Minimize congestion and traveler delay caused by recurring and non-recurring conditions, including planned and unplanned events. **2.** Improve safety by preventing crashes, reducing crash severity, and preventing incident-related secondary crashes. **3.** Support the safe and quick clearance of incidents through proactive TMC operations and by facilitating multiagency responses. **4.** Maintain an awareness of new technology applications that improve transportation system efficiency and access, and identify opportunities for investment. **5.** Maximize ITS device uptime and the useful life of TSMO assets by conducting lifecycle planning and applying asset management principles, including evaluating their condition and performance and performing appropriate maintenance activities. **6.** Assess the criticality of TSMO assets to inform resilience planning, emergency management practices, and the timing and priority of deploying resources to address system disruptions. **7.** Understand the cybersecurity needs and practices applicable to ITS and communication network infrastructure and transportation system data, and apply appropriate measures to protect them. **8.** Understand and develop a comprehensive data-driven performance management program to support transportation operations.
Increase Customer Satisfaction by providing transparent communication and being responsive to the residents of New Hampshire and users of the transportation systems.	**9.** Provide all customers, including freight customers and transit service customers, with accurate, real-time traveler information. **10.** Work with external partners and stakeholders, including other state agencies, State Police, state and local first responders, metropolitan planning organizations, regional planning commissions, and municipalities, to build a common understanding and approach to improving system performance through TSMO. **11.** Elevate public awareness and understanding of the value of TSMO and its impact on system performance.
Implement Employee Development strategies that increase bench strength, optimize employee health and safety, and align employees around the Department's mission.	**12.** Invest in staff development and training to support transportation operations. **13.** Foster a culture that establishes a TSMO mindset among staff and engrains TSMO across the Department.
Improve Resource Management by effectively managing financial resources, protecting and enhancing the environment, and implementing strategic workforce planning.	**14.** Maximize available current and future resources. **15.** Leverage the TSMO strategic planning process to identify cost beneficial operational investments. **16.** Conduct workforce planning to ensure continuity among staff roles and responsibilities that relate to transportation operations. **17.** Apply TSMO strategies to reduce the environmental impacts from delay due to work zones, traffic incidents, and other sources of congestion. **18.** Enhance the understanding of how to mitigate the environmental impacts of field maintenance activities related to transportation operations.

PROGRAMMATIC ELEMENT

The Programmatic Element assesses NHDOT's TSMO program from a business process and organizational perspective and recommends improvements. The assessment examines how effective the TSMO program is at achieving NHDOT's strategic vision of TSMO, meeting its TSMO strategic objectives, and successfully managing the program on a day-to-day basis, including managing current and future TSMO strategies.

The programmatic assessment areas and the recommendations to improve each area were developed through an examination of TSMO program documentation and NHDOT plans, and reflect stakeholder input from TSMO Bureau leadership. The programmatic areas identified are:

- Planning, Prioritizing, and Programming TSMO Projects
- TSMO Program Funding
- ITS Infrastructure Maintenance
- ITS Communications Network
- Organization and Workforce Development
- Emerging Technologies
- Performance Management
- Partner Collaboration
- Outreach and Communication

Table 2 aligns the nine programmatic areas with the TSMO strategic objectives that would be better achieved by implementing the recommendations for each programmatic area. While some programmatic areas align with more than one strategic objective, only the primary alignment is indicated.

TABLE 2. Programmatic Area Aligned with TSMO Strategic Objectives

PROGRAMMATIC AREA	TSMO STRATEGIC OBJECTIVE
Planning, Prioritizing, and Programming TSMO Projects	▪ Leverage the TSMO strategic planning process to identify cost beneficial operational investments. ▪ Apply TSMO strategies to reduce the environmental impacts from delay due to work zones, traffic incidents, and other sources of congestion. ▪ Minimize congestion and traveler delay caused by recurring and non-recurring conditions, including planned and unplanned events. ▪ Improve safety by preventing crashes, reducing crash severity, and preventing incident-related secondary crashes.
TSMO Program Funding	▪ Maximize available current and future resources.
ITS Infrastructure Maintenance	▪ Maximize ITS device uptime and the useful life of TSMO assets by conducting lifecycle planning and applying asset management principles, including evaluating their condition and performance and performing appropriate maintenance activities. ▪ Assess the criticality of TSMO assets to inform resilience planning, emergency management practices, and the timing and priority of deploying resources to address system disruptions.
ITS Communications Network	▪ Understand the cybersecurity needs and practices applicable to ITS and communication network infrastructure and transportation system data, and apply appropriate measures to protect them.

PROGRAMMATIC AREA	TSMO STRATEGIC OBJECTIVE
Organization and Workforce Development	▪ Invest in staff development and training to support transportation operations. ▪ Foster a culture that establishes a TSMO mindset among staff and engrains TSMO across the Department. ▪ Conduct workforce planning to ensure continuity among staff roles and responsibilities that relate to transportation operations. ▪ Enhance the understanding of how to mitigate the environmental impacts of field maintenance activities related to transportation operations.
Emerging Technologies	▪ Maintain an awareness of new technology applications that improve transportation system efficiency and access, and identify opportunities for investment.
Performance Management	▪ Understand and develop a comprehensive data-driven performance management program to support transportation operations.
Partner Collaboration	▪ Work with external partners and stakeholders, including other state agencies, State Police, state and local first responders, metropolitan planning organizations, regional planning commissions, and municipalities, to build a common understanding and approach to improving system performance through TSMO. ▪ Support the safe and quick clearance of incidents through proactive TMC operations and by facilitating multiagency responses.
Outreach and Communication	▪ Elevate public awareness and understanding of the value of TSMO and its impact on system performance. ▪ Provide all customers, including freight customers and transit service customers, with accurate, real-time traveler information.

The programmatic element organizes each area into the following sections:

- *Summary* – what the programmatic area is, why it is important, and what the current status or capability within NHDOT and/or the TSMO Bureau is.
- *Recommendations* – what actions can be taken to improve the current practice described in the summary. Actions can include business process improvements, organizational actions, policy changes, planning exercises, technical process improvements, collaborative activities, leadership initiatives, and others.

Following the sections on each of the nine programmatic areas, Table 3, on page 23, categorizes all programmatic recommendations into three priority groups.

Planning, Prioritizing, and Programming TSMO Projects

SUMMARY

Since the formation of the TSMO Bureau, NHDOT has used a strategic planning process to identify TSMO and ITS projects in a five-year implementation plan. These projects tie back to a strategic vision and set of goals and objectives established in the plan. They include both programmatic initiatives and tactical deployments that support TSMO strategies. Projects have been categorized into:

- ITS Infrastructure and Device Deployment
- Traffic Management Center (TMC) Operations
- ITS Device Maintenance
- ITS System/Communications Network
- Traveler Information Systems
- Traffic Incident Management
- Partnering and Public Outreach
- Performance Measures
- Transit and Bridge Recordings (added 2020)
- Emerging Technologies (added 2020)

During the project development process, projects selected from the Ten Year Plan[5], which includes both Federally supported transportation improvements and projects and programs funded with State transportation funds, go through a conceptual project development phase, followed by a project scoping phase. During the scoping phase, a Project Scope of Work checklist is applied. This checklist addresses, among other considerations, whether ITS should be part of the project's scope. TSMO solutions are not formally considered at the earlier, conceptual stage when project alternatives that are operationally focused could be considered alongside more traditional capacity enhancements.

TSMO or ITS projects are generally implemented in one of two ways:

- *Through the mainstreaming process* – 1.5 percent of the construction funds for roadway and bridge infrastructure projects from the Statewide Transportation Improvement Program are available for the TSMO Bureau's ITS needs. Exceeding this share requires a formal justification memo to the Executive Office for consideration of an exception. The priority of these construction projects dictates where TSMO projects can be considered. Suggestions regarding specific ITS infrastructure to incorporate into the construction project come from the TSMO Strategic Plan; various corridor ITS Master Plans; and consultation with TMC Operations, the Bureau of Turnpikes, and the Districts. The suggestions also consider high crash locations, high levels of traffic congestion, and the availability of fiber optic or microwave communication networks.
- *As a standalone TSMO deployment* – projects are selected from the strategic plan and funded with the TSMO Bureau's share of Federal Programmatic funds. While the project selection process applies safety and mobility criteria, it is often more dependent on immediate needs and not always tied to a longer-range prioritization process.

RECOMMENDATIONS

- **P-1:** Incorporate a checklist item or deliberate decision point at the conceptual project development stage and before project scoping to consider TSMO alternatives and the inclusion of ITS in the project development process.
- **P-2:** Reassess the mainstreaming process for how TSMO projects are selected and incorporated into construction projects and the percentage of construction project budgets allocated to TSMO. Adjustments to this process would allow TSMO initiatives to be incorporated earlier in the project planning process, better align TSMO projects selected through mainstreaming with current needs and priorities, and offer better flexibility in using construction funds allocated for TSMO.
  - » Revisit the ITS Mainstreaming Funding Approval Process memo published in 2015.
  - » Consider a policy change that would convert the fixed 1.5 percent funding share limit to a programmatic share across multiple construction projects so funding can be used on a discretionary basis.
- **P-3:** Develop criteria and/or policies for ITS installation that can be used to inform project identification and selection for mainstreaming and other TSMO projects.
- **P-4:** Work with the NHDOT Safety Section to evaluate and apply operational solutions to safety problems.
- **P-5:** Work with the Office of Highway Safety on providing TSMO inputs into the procurement and application of a new Crash Analysis System.

5 https://www.nh.gov/dot/org/projectdevelopment/planning/typ/index.htm

- **P-6:** Update the Work Zone ITS Toolbox[6] document, which provides guidelines on smart work zone deployment design and operations, to reflect current practices and strategies.

TSMO Program Funding

SUMMARY

The primary funding requirements of the TSMO program are operating and capital expenses.

Operating expenses include ITS device maintenance and replacement, among others. This funding generally comes from State Highway funds and Bureau of Turnpikes funds. The Bureau of Turnpikes' funding share is allocated based on Turnpike ITS needs and is typically a straight percentage based on the number of ITS devices tied to Turnpike facilities. A Memorandum of Agreement between the Bureaus of TSMO and Turnpikes formalizes what ITS infrastructure and associated communication network on the Bureau of Turnpikes owned Piscataqua River and Little Bay Bridges is maintained by the TSMO Bureau and how that maintenance is paid for. The TSMO Bureau also maintains ITS infrastructure (closed circuit television [CCTV] cameras) and associated communication network owned by the Bureau of Rail & Transit on a cost-sharing basis. The TSMO Bureau operating budget has increased in recent fiscal years in response to increased asset needs.

Capital expenditures are generally funded through a share of NHDOT's Federal Programmatic funds and through the mainstreaming process, where up to 1.5 percent of construction funds are available to TSMO from roadway and bridge infrastructure projects. The TSMO Bureau's allocation of Federal Programmatic Funds is $1 million annually as of FY 2023.

Federal Programmatic funds also cover NHDOT's share of operating and maintaining the tristate newengland511.com (Compass), in partnership with Maine and Vermont.

Capital expenditures that support NHDOT itself (e.g., NHDOT buildings and large equipment purchases) are subject to review and funding allocation by the Governor.

RECOMMENDATIONS

- **F-1:** Periodically review the Federal Programmatic funding allocation for TSMO so that it aligns with anticipated TSMO project needs.
- **F-2:** Periodically review the TSMO operating budget so that it aligns with growing levels of ITS equipment.
- **F-3:** Execute a memorandum of agreement with the Bureau of Rail & Transit that formalizes what ITS infrastructure and associated communication network owned by the Bureau of Rail & Transit is maintained by the TSMO Bureau and how that maintenance is paid for.

6 https://www.nh.gov/dot/org/projectdevelopment/highwaydesign/documents/swzman_05102011.pdf

ITS Infrastructure Maintenance

SUMMARY

The TSMO Bureau is responsible for maintaining ITS infrastructure, which includes:

- ITS devices
  - » CCTV cameras
  - » Dynamic message signs (DMS)
  - » Portable changeable message signs (PCMS)
  - » Road weather information systems (RWIS)
  - » Variable speed limit (VSL) systems
  - » Motor vehicle detection systems (MVDS)
  - » Lane use signs (LUS)
  - » Blank-out signs (BOS)
  - » Roadside units (RSU)
  - » Onboard units (OBU)

  The number of ITS devices grows every year. Each device type or system has multiple related ancillary components that also require inspection, testing, and maintenance.
- The ITS network that includes wireless, fiber optic, and cellular communications infrastructure.
- Statewide microwave radio communications infrastructure (radio towers with repeater equipment, base stations, portable and mobile units).

The TSMO Bureau's state-funded biennial operating budget, which includes the contribution from the Bureau of Turnpikes Replacement & Renewal program, funds ITS infrastructure maintenance. As noted above, the Turnpike contribution is directly proportional to the percentage of ITS infrastructure that is located on the Turnpike system.

The TSMO Bureau prepares an annual preventative maintenance program for ITS infrastructure and performs the work through a combination of in-house staff and an on-call maintenance and repair contract. Maintenance and inspection (excluding mounting structures) activities are managed and tracked through a work order ticketing system. The TSMO Bureau's four in-house maintenance personnel plan, inspect, troubleshoot, prioritize, and organize the work performed in-house and by the maintenance contractor. The goal is to inspect all ITS devices annually, and some devices, like RWIS, are inspected consistently, but other devices (e.g., cameras) often undergo inspection only every two years. Some performance-based maintenance is performed on corridors with newly installed equipment, but experience to date has not been fully satisfactory. Overall, maintenance generally tends to be reactive and should be performed on a more proactive basis.

The ITS device service life plan that provides maintenance cycle and replacement recommendations is being updated as of early 2023 with greater levels of detail and accounting for obsolescence and security requirements. However, while the current iteration of the plan is used for maintenance budgeting and directing maintenance personnel activities, maintenance staff are not using it.

TSMO maintenance personnel work out of a building constructed in the early 1980s as an open storage shed with subsequent modifications and additions. The facility does not provide adequate secure space for tools, hardware, or parts inventory. The existing Bureaus of TSMO (maintenance) and Traffic (signals) in a new maintenance facility suffers from similar challenges. Collocating the Bureaus of TSMO and Traffic in a new joint maintenance facility would promote more efficient operations and collaboration.

The statewide radio communications towers are reaching the end of their useful lives and exhibit poor reliability. This system is critical to maintaining field voice communications among the TMC (where the signal is converted to radio over IP), district offices, maintenance sheds, toll booths, and NHDOT vehicles. This network is separate from the ITS communications network and does not receive the same level of support from the Department of IT (DoIT) as the ITS communications network does.

RECOMMENDATIONS

- **M-1:** Expand and enhance the ITS preventive maintenance and inspection program.
  - » Deploy recommendations from the updated ITS service life plan to better optimize maintenance and replacement cycles and move toward more proactive regimes.
    - – *Incorporate guidance from the service life plan into maintenance staff and contractor routines.*
    - – *Incorporate any necessary maintenance staff training into the TSMO Bureau's technical training plan (see the Organization and Workforce Development area).*
  - » Develop a criticality methodology to apply to ITS assets and incorporate the results into maintenance and replacement decisions.
  - » Identify opportunities for collaborative maintenance and inspection (i.e., combining and performing the inspection and maintenance of ITS infrastructure alongside other roadway assets and vice versa).
  - » Develop and implement an ITS inspection component for all ITS mounting structures (poles, trusses, and gantries).
    - – *Associate the ITS device GIS layer with appropriate mounting structures so that the linkage is made to track and manage inspections.*
- **M-2:** Identify priorities and approaches for entering ITS assets into the Department-wide Work Order Fleet Inventory (WOFI) system, ensuring WOFI includes the requirements of the TSMO Bureau ITS preventative maintenance and inspection program.
  - » Identify a mechanism to support work order tickets related to ITS, which are not currently included in WOFI.
- **M-3:** Evaluate the functional needs for replacing the statewide radio communications system, document the network requirements, identify the next-generation systems that can meet the needs and requirements, and plan for procurement.
- **M-4:** Construct a new Joint Signal/ITS Maintenance Building at the Bureau of Traffic facility on Smokey Bear Boulevard in Concord to serve workgroups from the Bureaus of TSMO and Traffic.

ITS Communications Network

SUMMARY

The ITS communications network connects ITS field devices to various systems located at the TMC and the Compass hosting facility. Its reliability and security are critical to meeting the 24/7 operation of the TMC and TSMO. The ITS network is separate from the statewide enterprise communications network for state agencies and departments, and firewalls are in place between the two. The statewide network uses Cisco products and services, but the ITS network does not.

The ITS communications network consists of ITS supporting hardware (e.g., workstations, file servers, switches, video wall hardware), communications equipment (e.g., fiber optic, microwave, and wireless cellular modems), the data archive, and ITS systems standards and specifications. The State owns and operates the ITS fiber optic and microwave networks. The network and its components are situated along a large quantity of NHDOT-owned right-of-way, and the network has excess fiber optic or conduit capacity in certain locations. The ITS network and the devices it connects reside in a multivendor environment because of how the program was built out over time. As a result, it is challenging to support, apply standards, and secure. Network component redundancy is also a concern.

The TSMO Bureau has embedded DoIT staff (roughly 2.5 full time equivalents) devoted to network operations, which includes network monitoring and maintenance, application of standards, and the integration of new equipment and software. However, embedded DoIT staff's job descriptions do not include cybersecurity, and staff has received no training specific to ITS, ITS networks, or ITS cybersecurity. TSMO Bureau maintenance personnel also perform some network maintenance activities.

RECOMMENDATIONS

- **N-1:** Continue to support network operations staff's initiatives to introduce greater degrees of standardization and network security (e.g., exploring the application of Cisco network configuration, management, and security products where feasible).
- **N-2:** Develop a standardized and documented process for adding, changing, or removing a device or component connected to the ITS network.
  - » Consider cybersecurity risks.
  - » Develop appropriate outreach and training guidance to ensure the process is understood and applied routinely.
  - » Revisit and update the process as necessary on a periodic basis.
- **N-3:** Review procurement and contract language for the application of cybersecurity best practices and revise as necessary.
- **N-4:** Incorporate ITS cybersecurity awareness into applicable staff job descriptions, responsibilities, and training, including embedded DoIT staff.
- **N-5:** Clearly define roles and responsibilities for ITS network communications development and support between TSMO Bureau and DoIT staff.

- **N-6:** Explore partnership agreement opportunities for public or private sector entities to lease NHDOT-owned property or right-of-way for the installation and operation of infrastructure (e.g., communications equipment) or to lease excess fiber optic/conduit capacity.
  - » Identify and propose a means to address any impediments to engaging in such partnerships (e.g., adequate staff resources or processes).

Organization and Workforce Development

SUMMARY

The TSMO Bureau staff's responsibilities include but are not limited to:

- TSMO planning and deployment (engineering)
- Data collection, analysis, and performance reporting
- TMC operations
- Compass management
- ITS device inventory management and maintenance
- TSMO communications network management

The TSMO Bureau's staffing is lean. As of early 2023, these responsibilities are handled by approximately 10 core staff, not including TMC operators. In most cases, specialized knowledge is held by a single person, creating the potential for significant historical knowledge loss if someone were to leave and a steep learning curve for replacement staff. TMC operator work instructions are documented, but instructions for other TSMO Bureau staff are not. There is limited documentation of key activities and processes that support staff's roles and responsibilities. A more deliberate and proactive approach to TSMO staff planning and recruitment would be helpful.

A technical training plan for all TSMO Bureau staff to address the needs of current employees as well as the onboarding needs of staff new to the Bureau would also be useful. Important areas to consider are:

- Introductory training for new TSMO employees on the Bureau's function and individual roles and responsibilities.
- TMC operator staff training that goes beyond customer service, essential processes (e.g., dispatching), and knowing how to operate individual devices and systems. An understanding of the purpose and consequence of those actions from a holistic network operations perspective would provide an opportunity to improve real-time TSMO strategy performance. Traffic signal operations training will be needed as a centrally managed statewide traffic signal system is implemented.
- Ongoing technical training needs of other TSMO staff such as cybersecurity, traffic incident management, and emergency response.

An ITS Steering Committee is in place to "set guidelines, establish business requirements and standards in order to ensure consistency, coordination, continuity, and interoperability of the Department's Intelligent Transportation Systems. The committee is responsible to review new transportation technologies and ensure that ITS activities align with the mission of the Department." The 10-member committee is chaired by the Administrator of the TSMO Bureau and includes representation from a wide range of other Bureaus.

RECOMMENDATIONS

- **OW-1:** Formally document all TSMO Bureau staff work instructions (in addition to those already complete for TMC operators) to better understand staff members' activities and the processes that support their roles and responsibilities and maintain continuity as changes to staff may occur.
- **OW-2:** Compile TMC operator standard operator procedures (SOPs) and work instructions into a digital "manual" and periodically review and update them.
- **OW-3:** Explore options for filling TMC operator staffing (e.g., interns or university traffic engineering students) needs during short-term periods of demand (e.g., winter operations season).
- **OW-4:** Develop a TSMO Bureau onboarding process that includes training (detailed below) and a review of work instructions.
- **OW-5:** Create a technical training plan that addresses training needs by staff role, frequency, source, and resource implications. Assess and include the following:
  - An "introduction to TSMO" onboarding training track to familiarize new TSMO Bureau employees with Bureau functions, staff roles and responsibilities, and TSMO concepts as necessary. Include appropriate elements of this training in the engineering training program for new college graduates joining NHDOT.
  - National Incident Management System (NIMS) training needs.
  - National TIM Responder Training needs (e.g., tabletop exercises, train-the-trainer).
  - Network management and cybersecurity training, including for embedded DoIT staff.
  - TMC operator training addressing the application of a systems perspective to TSMO strategies and a broad range of traffic engineering and management concepts to help them understand the impacts their actions have on traffic flow and safety and developing a level of anticipation for the needs of travelers and response partners. Areas of focus include incident response and emergency management, active traffic management concepts, and traffic signal operations. (See Tactic T-8.)
  - TMC operator training for traffic signal management software. (See Tactic T-9.)
  - Other technical training, environmental training, and field safety training.
- **OW-6:** Consider developing cross-training opportunities as an incentive for retention and position growth.
- **OW-7:** Familiarize the NHDOT departmentwide recruiter with all TSMO Bureau functions and staff needs, not just TMC operations.
  - Develop a brief (one-page) brochure/poster that captures the roles, outcomes, and benefits of the TSMO Bureau, similar in nature to the "Where is the IT?" poster.
  - Proactively reach out to technical schools and high schools to build awareness of TSMO.
- **OW-8:** Reexamine the responsibilities, function, and membership of the ITS Steering Committee. Consider the committee's role in supporting the implementation of the TSMO Strategic Plan and members' involvement in specific TSMO initiatives and projects recommended by this plan.

Emerging Technologies

SUMMARY

The transportation industry has entered a transformative period with new and emerging technologies, especially related to electric vehicles (EVs), connected vehicles (CVs), and automated driving systems (ADS) or automated vehicles (AVs). These technologies affect the work of NHDOT and the TSMO Bureau and offer significant opportunity to advance several TSMO strategic objectives.

NHDOT prepared a strategic plan for CVs and AVs in early 2018 that summarized the technology state of the practice, current issues, and guidance, and provided recommendations for future planning and achieving infrastructure readiness. Several recommendations were carried forward as projects into the 2020–2024 TSMO Strategic Plan, but they have not been undertaken and are carried forward in the recommendations below. In addition, one of the responsibilities of the ITS Steering Committee, as noted previously, is to "provide recommendations on new technology to Department management."

NHDOT has also participated in national training and regional workshops about CVs. However, the TSMO Bureau has not worked with academic partners on these topics and could take better advantage of its membership in the CV Pooled Fund Study. The TSMO Bureau has participated in New England Transportation Consortium (NETC) research projects such as Project 20-4[7] *Coordinating State Policies, Laws and Regulations for Automated Driving Systems Across New England.*

RECOMMENDATIONS

- **ET-1:** Understand and document opportunities for CV and other emerging technologies and applications to advance the TSMO strategic objectives, including example deployments or application scenarios.
  - » Review and participate in other states' initiatives that are revealing effective practices.
  - » Continue to actively participate in NETC research and identify NHDOT's role in implementing research results.
- **ET-2:** Look for and prioritize opportunities to increase engagement in the CV Pooled Fund Study.
- **ET-3:** Pursue opportunities to support or partner with academia on emerging technology research that would benefit NHDOT.
- **ET-4:** Regularly review opportunities to use emerging technology and new sources of data to support building the TSMO mindset within NHDOT.
- **ET-5:** Reenergize and support the work of the multi-department CV/AV Committee, especially related to providing information on specific technologies and strategies. In order to appropriately disseminate this information to the Committee and the public, support materials such as primers, one-pagers, and white papers will need to be prepared.
- **ET-6:** Develop a Concept of Operations document that details the current needs and functional requirement for implementing technologies related to CVs and AVs. The document will contain a high-level description of the future system and how it interacts with various stakeholders.
- **ET-7:** Design and deploy new technologies for CVs and AVs through mainstreaming or pilot projects.

7 https://www.newenglandtransportationconsortium.org/projects/netc-20-4/

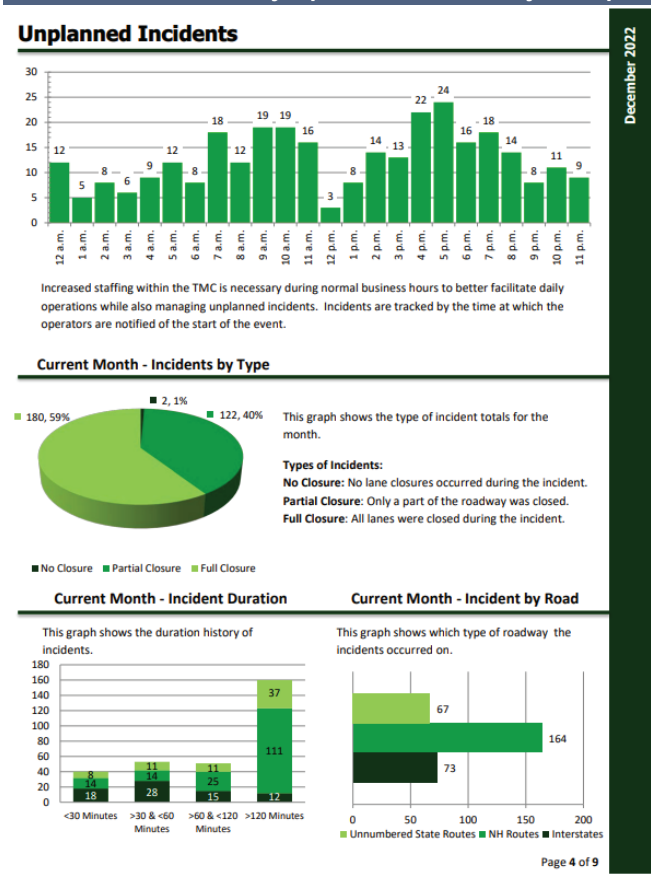
Performance Management

SUMMARY

The full potential of the TSMO program is captured through a performance management reporting program. The TSMO Bureau collects data through MVDS sensors, RWIS sensors, and activities observed by the TMC and tracked in Compass. Third-party data from TomTom and Waze augment these NHDOT sources.

The TSMO Bureau tracks performance measures and publishes the TMC Monthly Operational Summary (Figure 5) and separate set of Safety Patrol performance measures for public consumption. In addition, a Corporate Quarterly Report summarizes core data goals, and costs for internal audiences. However, existing performance measures are largely activity-based, output measures (e.g., number and type of incident, or number and type of call logged by the TMC) reported in a historical basis. The TSMO Bureau lacks performance data and measures that inform operational decision-making in real time. Reporting on outcome measures that reflect what customers experience during their day-to-day use of the system (e.g., travel times, delay, reliability, and safety metrics) is limited.

FIGURE 5. TMC Monthly Operational Summary Excerpt



The TSMO Bureau needs to improve its performance data management and analytics capabilities to better understand the impact TSMO strategies have on strategic objectives and system performance. This advancement will help communicate the benefits of TSMO, understand the return on investments, and identify where new investments in TSMO strategies are warranted.

RECOMMENDATIONS

- **PM-1:** Implement the recommendations of the TSMO Bureau's analysis of performance measurement needs and effective peer practices. Use Missouri DOT's "Tracker: Measures of Departmental Performance" as a benchmark. Recommended performance measures include: ITS device uptime, travel times, volumes/user delay, incident clearance times, response times (condensed) for advanced traffic management system (ATMS)/Twitter/DMS, year-round major event activation (i.e., Storm Desk) activity, social media activity, TSMO project status, and TSMO workforce statistics.
- **PM-2:** Revisit the methodologies for incident clearance time data collection for I-95 and the non-Turnpike southern portion of I-93, as they are not currently the same.
- **PM-3:** Identify a mechanism to better track secondary crashes due to incidents.
- **PM-4:** Identify a method to automate winter performance measures that use data from snowplow automatic vehicle locators (AVLs). Determine how to use data from newly installed AVLs to demonstrate improvements to customer service related to winter maintenance.

Partner Collaboration

SUMMARY

An effective TSMO program and many TSMO strategies depend on collaboration with partners outside the NHDOT. Important collaborative relationships, among others, include:

- *State Police, Homeland Security & Emergency Management (HSEM) within the Department of Safety, local law enforcement agencies, and first responders* – for traffic incident management and emergency response, including after-action reviews.
- *Metropolitan Planning Organizations (MPOs) and Regional Planning Commissions (RPCs)* – for TSMO planning.
- *Municipalities* – to coordinate TSMO strategy between the state system and local roads (e.g., traffic signal operations, smart work zone planning).
- *Neighboring states* – to collaborate on traveler information (Compass) and quarterly meetings on operational issues (Maine and Vermont); coordination on work zones near borders, typically through the mainstreaming process; and shared research interests through NETC.

RECOMMENDATIONS

- **PC-1:** Streamline and improve the State Police computer-aided dispatch (CAD) feed into Compass so that incident-related communications and information are more readily available to TMC operators for incident verification and response. Require that this integration ensures the protection of any sensitive State Police CAD data.
  - » Review what percentage of time State Police is contacting the TMC for all incident types. Determine the accuracy of reporting on damage to NHDOT property.
- **PC-2:** Continue to participate in the annual HSEM Preparedness Conference, New Hampshire Association of Chiefs of Police Tradeshow, and the New Hampshire Emergency Dispatchers Association Training Conference to build relationships among law enforcement agencies and first responders.
- **PC-3:** As a collaborative effort with the Bureau of Highway Maintenance, document the criteria and participants for conducting an after-action review of a major incident or weather event and use that as a baseline to identify potential improvements to the process. Emphasize that the focus of the reviews is to share lessons learned and is not meant to be disciplinary in nature.
- **PC-4:** Include MPOs and RPCs in relevant NHDOT-led training in TSMO.
- **PC-5:** Leverage the development of an updated ITS architecture with participating local agencies to communicate and collaborate on TSMO activities.
- **PC-6:** Develop an understanding of MPO, RPC, and large municipalities' organizational structures and identify their staff members who are engaged in TSMO or applications of ITS on a regular or occasional basis. Use this information as an avenue for improved communication and collaboration between NHDOT and local entities to advance TSMO objectives and strategies. Coordinate with the Bureau of Planning and Community Assistance as necessary.

Outreach and Communication

SUMMARY

Building and maintaining a TSMO mindset depends on awareness and appreciation of the TSMO program, its objectives, activities, and its benefits to NHDOT customers. The Strategic Element section on NHDOT's Policy Commitment to TSMO articulates this expectation. Proactive outreach and communication about the TSMO program are important to strengthening the TSMO mindset internally, and sharing successes builds support among the public, external partners, and other stakeholders, such as state legislators. Outreach to the public is particularly important as investments in new technology should be understandable and justifiable. Communication strategies should use cohesive branding and messaging. This approach can improve the effectiveness of initiatives like recruiting for TSMO.

RECOMMENDATIONS

- **OC-1:** Implement the TSMO performance dashboard, focusing on outcomes that benefit NHDOT customers.
- **OC-2:** Identify an easily implementable set of outreach and communication tools to promote the work of the TSMO Bureau and TSMO generally. Consider developing a "What Is TSMO?" or "Why Is TSMO Important?" video and related brochure/poster.
- **OC-3:** Work with the Public Information Office on a streamlined process to regularly communicate about the TSMO program through social media.

Priority Groups

Table 3 categorizes all programmatic recommendations into three priority groups based on when the recommended activity would start. Priorities are subject change and dependent on staff availability and funds.

TABLE 3. Programmatic Recommendation Priorities

NEAR-TERM (WITHIN 1 YEAR)		MID-TERM (WITHIN 1–2 YEARS)		LONG-TERM (AFTER 2 YEARS)	
P-1	OW-3	P-2	OW-1	P-4	ET-1
P-5	OW-7	P-3	OW-2	N-6	ET-3
F-3	ET-4	P-6	OW-8	OW-4	ET-5
M-2	PM-1	F-1	ET-2	OW-5	PC-3
M-3	PM-2	F-2	ET-6	OW-6	PC-4
N-1	PC-1	M-1	ET-7		PC-6
N-3	PC-2	M-4	PM-3		OC-2
N-4	PC-5	N-2	PM-4		
		N-5	OC-1		
			OC-3		

P = Planning, Prioritizing, and Programming TSMO Projects
F = TSMO Program Funding
M = ITS Infrastructure Maintenance
N = ITS Communications Network
OW = Organization and Workforce Development
ET = Emerging Technologies
PM = Performance Management
PC = Partner Collaboration
OC = Outreach and Communication

TACTICAL ELEMENT

The Tactical Element identifies a set of TSMO strategies, services, activities, master plans, and supporting investments designed to achieve NHDOT goals and TSMO strategic objectives (see Table 1 on page 10). These tactics guide decisions on future deployments and supporting projects that can be prioritized and programmed as needs and funding availability dictate. (The tactics are not presented in any specific order.)

T-1 **Project Specific Mainstreaming:** Deploy ITS devices on the New Hampshire State Highway System through the mainstreaming process. The mainstreaming process allocates up to 1.5 percent of construction funds for roadway and bridge infrastructure projects from the Statewide Transportation Improvement Program to TSMO elements, if needed to advance the goals of the project. The priority of these construction projects dictates where TSMO projects can be considered. Suggestions regarding specific ITS infrastructure to incorporate into the construction project come from the TSMO Strategic Plan; various corridor ITS Master Plans; and consultation with TMC Operations, the Bureau of Turnpikes, and the Districts. The suggestions also consider high crash locations, high levels of traffic congestion, and the availability of fiber optic or microwave communication networks.

T-2 **I-93 North of Concord Master Plan:** Prepare master deployment plan for the 105-mile portion of I-93 between Concord and the Vermont State Line. This deployment includes ITS devices and a communications network. Consider the application of TSMO strategies and enabling ITS devices not currently deployed (see for example Future TSMO Strategies on page 3) as well as other active traffic management and integrated corridor management concepts. Use content from the AASHTO Transportation Operations Manual to increase the understanding within NHDOT of the applicability and benefits of these strategies.

T-3 **Consolidated Turnpike Master Plan:** Prepare master deployment plan combining all existing Turnpike Master Plans and identifying updates and gaps to fill in ITS and ATMS coverage. This deployment includes ITS devices (CCTV, DMS, MVDS, RWIS, VSL), a communications network, and integration into Compass. Consider the application of additional TSMO strategies (and enabling ITS devices), such as queue warning and others not currently deployed (see for example Future TSMO Strategies on page 3) along with other active traffic management and integrated corridor management concepts. Use content from the AASHTO *Transportation Operations Manual* to increase the understanding within NHDOT of the applicability and benefits of these strategies.

T-4 **Existing Master Plans Update:** Reexamine existing Master Plans (not including Turnpike, addressed under T-3) for opportunities to incorporate additional TSMO strategies (and enabling ITS devices), such as queue warning and others not currently deployed (see for example Future TSMO Strategies on page 3) along with other active traffic management and integrated corridor management concepts.

T-5 **Rural ITS Master Plan:** Identify TSMO solutions and ITS device deployments for rural roadways and intersections. Include involvement from Districts and TMC operators. Consider strategies such as traffic incident management, road weather management, curve speed warning, detour routing, and intersection ITS.

T-6 **Enhance Road Weather Program:** Assess the Road Weather Program's use of fixed RWIS infrastructure and mobile RWIS equipment, temperature sensors, and fleet AVL to optimize the use of these tools and align with goals related to traveler information, winter maintenance, and emergency response. This assessment follows the design and construction of RWIS devices at 10 locations along established NHDOT rights-of-way with existing communications infrastructure, which was completed in summer 2022.

T-7 **Transit Master Plan Mainstreaming Development:** Prepare master deployment plan for transit ITS throughout New Hampshire. This plan will include mechanisms for mainstreaming to ensure seamless and cost-effective deployment.

T-8 **TMC Operator Traffic Management Concepts Training:** Provide training to TMC operators on the application of a systems perspective to TSMO strategies and a broad range of traffic engineering and management concepts to help them understand the impacts their actions have on traffic flow and safety and develop a level of anticipation for the needs of travelers and response partners. Areas of focus include incident response and emergency management, active traffic management concepts, and traffic signal operations. (See Programmatic Recommendation OW-5.)

T-9 **TMC Operator Traffic Signal Management Software Training:** In anticipation of operating state network traffic signals enabled with central system connectivity, provide traffic signal management software training to TMC operators. Training will familiarize operators with what actions to take during specified operational scenarios. (See Programmatic Recommendation OW-5.)

T-10 **Freight Parking Analysis:** Conduct an analysis of freight parking needs and operational considerations that includes, at a minimum, identification of potential conflicts between existing parking areas and maintenance operations and the need for and benefit of a Truck Parking Information System.

T-11 **Safety Patrol Expansion and Enhancement:** Review current geographic extent and hours of operation of existing safety patrol service routes and conduct an analysis of the costs and benefits of incremental extensions in service (geography and hours of operation). Examine the implementation of dash cameras.

T-12 **Wrong-way Driving Detection and Countermeasures:** Understand and characterize the extent of wrong-way driving events, causes, and safety impacts on the State Highway System. Become familiar with current research findings and peer effective practices that address wrong-way driving in a cost-effective, systemic manner (e.g., the AASHTO Innovation Initiative Lead States Focus Technologies in 2021[8] and 2017[9], and recently completed NCHRP Project 03-135[10]). As appropriate, identify the deployment of countermeasures, considering a range of options from low-cost (enhanced signage and pavement markings) to technology-based (active detection and alerting).

8 https://aii.transportation.org/Pages/Systemic-Approach-to-Wrong-Way-Driver-Safety.aspx
9 https://aii.transportation.org/Pages/Wrong-Way-Driver-Detection-Systems.aspx
10 https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4548

T-13 **Compass Enhancements:** As required, update and enhance the Compass software and hardware elements, including the ATMS, Data Hub, and Advanced Traveler Information Systems (ATIS) systems, as new devices, communications, and software platforms are added to the system. In the longer-term (in 5+ years), understand the use of traveler information provided through Compass—for example, identify what level of investment in the newengland511.com website makes sense given alternative sources available to travelers.

T-14 **Diversion and Alternate Route Planning:** Provide input to NHDOT Emergency Support Function diversion route planning. Diversion activities include route selection, validation of the diversion route in real time, and closure and diversion instructions to those responsible to divert the traffic, and to the motorists who will be diverted. This must be a coordinated, facilitated effort that involves all responsible parties. Alternate route selection and definition would use a GIS-based application to present information that could be used by diversion practitioners and shared with diversion partners and the public, so that there is a coordinated, cooperative, and informed decision that can be shared with users. Enter diversion and alternate routes (GIS layer) as Compass response plans.

T-15 **Work Zone ITS Deployments:** Support smart work zone deployments as identified in the updated Work Zone ITS Toolbox (see Programmatic Recommendation P-5). Consider piloting technologies that improve work zone safety such as safety vests worn by construction workers connected to a work zone intrusion detection/alarm system, including those triggered by connected vehicle broadcasts.

T-16 **TMC Video Wall Replacement:** Replace TMC video wall hardware and software. The current video wall was installed in 2007 with bulb technology and upgraded to LED modules within the past five years. The existing wall hardware is no longer manufactured, and repairs require the purchase of used parts. Replacement hardware will also require a change in software.

ACRONYM LIST

ADS	Automated Driving System
ATIS	Advanced Traveler Information System
ATMS	Advanced Traffic Management System
AV	Automated Vehicle
AVL	Automatic Vehicle Locator
BOS	Blank-out Sign
CAD	Computer-aided Dispatch
CCTV	Closed Circuit Television (Camera)
DMS	Dynamic Message Sign
DoIT	Department of Information Technology
EV	Electric Vehicle
HSEM	Homeland Security & Emergency Management
ITS	Intelligent Transportation Systems
LUS	Lane Use Sign
MPO	Metropolitan Planning Organization
MVDS	Motor Vehicle Detection System
NETC	New England Transportation Consortium
NHDOT	New Hampshire Department of Transportation
NIMS	National Incident Management System
OBU	Onboard Unit
PCMS	Portable Changeable Message Sign
RPC	Regional Planning Commission
RSU	Roadside Unit
RWIS	Road Weather Information System
SHSP	Strategic Highway Safety Plan
SOP	Standard Operating Procedure
TMC	Traffic Management Center
TSMO	Transportation Systems Management and Operations
VMT	Vehicle Miles Traveled
VSL	Variable Speed Limit
WOFI	Work Order Fleet Inventory