MaineDOT

Mobility Report

November, 2018

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Executive Summary

MaineDOT established The Traffic Mobility Report Team in 2016 to examine existing mobility issues and to produce a report recommending solutions. The team included MaineDOT employees, municipal officials, the traffic consultant community and traffic contractors.

The Report Team concluded that we can and must do better in three critical areas:

1. Traffic signal performance;
2. Use of Intelligent Transportation Systems (ITS) to better utilize existing capacity; and
3. Promotion and expansion of incident management solutions.

Traffic Signal Performance Recommendations

- MaineDOT should partner with all communities across Maine - sometimes assuming complete responsibility and other times offering a stipend - to maintain traffic signal controllers and traffic signal detection systems. Those MPOs and member municipalities with a demonstrated technical capacity to maintain the equipment will be offered an opt-out option for MaineDOT services, and provided with a yearly stipend to support proper maintenance. This comprehensive collaboration will assure the integrity of traffic signal performance state-wide, and protect our capital investment.
- 40 traffic signals should be replaced annually through an aggressive capital replacement program, at an annual cost of $8 million. This would ensure that ancillary structures are replaced on a proper cycle, that communications to traffic signals are kept current and that adaptive signal technologies are implemented where needed.

Intelligent Transportation System Recommendations

Congestion, "incidents," and road/weather conditions are key situations that can impede mobility. Aggressively expanding our ITS systems can mitigate the resulting mobility problems caused by these situations.

There are two key components to an ITS system:

1. The Transportation Management Center (TMC), and
2. The ITS devices deployed on the roadways.

Improvements are needed in both areas, since one can't be successful without the other. However, before initiating these improvements, MaineDOT must identify mobility issues on specific corridors and then explore what ITS solutions have worked in other states. This will allow the department to craft a comprehensive plan to best utilize ITS to address mobility on our most critical corridors.

Traffic Incident Management Recommendations

The quick clearance of crashes, particularly on the interstate, is critical to reducing congestion and shortening delays. Traffic Incident Management (TIM) is a planned, coordinated and multidisciplinary process to detect, respond to, and clear traffic incidents in order to quickly and safely restore traffic flow. Applied effectively, TIM minimizes the duration and impact of traffic incidents, and enhances the safety of motorists, crash victims and emergency responders.

MaineDOT should initiate and train new TIM groups, starting with the most critical areas and ultimately expanding statewide.

The team recommends that MaineDOT provides patrol coverage on I-295 from Scarborough to Topsham during the high traffic hours of 11 am to 7 pm, May through October. During peak tourist season, those hours would be expanded.

The Traffic Mobility Team also recommends non-law enforcement patrol coverage on I-295 from Scarborough to Topsham during peak traffic times of 11 am to 7 pm, May through October with additional hours during the tourist season. These patrols can quickly clear potential problems by providing fuel to stranded motorists, offering jump starts, clearing debris from the road, etc. When incidents do occur, the patrol is often first on the scene and has the capability to get vehicles out of the travel lane much sooner than if a tow truck was called. Patrols also quickly provide critical information to the Traffic Management Center.

Safety Patrols can be contracted through the private sector. For example, AutoBase is a private company that provides safety patrols for the Maine Turnpike Authority. The relationship between AutoBase and MTA includes funding from State Farm and Travelers Marketing. MaineDOT should pursue a similar model for privatized safety patrols.

Conclusion

It is time for MaineDOT to make strategic investments and assume certain responsibilities that will mitigate mobility issues on our transportation network. Today's traffic and incident management technologies and practices can offer much more cost-effective solutions rather than adding travel lanes or building new highways. Building new capacity is costly, complicated and takes several years of development. However, implementing the recommendations in this report, regarding traffic signal performance, Intelligent Transportation Systems and incident management, will result in timely, significant and lasting mobility improvements for Maine's transportation customers.

Introduction: Improving Mobility

In late 2016, MaineDOT established The Traffic Mobility Report Team to research and prepare a report regarding:

- The operation and maintenance of traffic control and management systems;
- The current policies and practices related to maintenance responsibilities and cost sharing;
- Management strategies to optimize traffic mobility;
- Project selection and prioritization processes; and
- The availability and capacity of public and private resources to maintain traffic control systems in Maine.

The Committee included employees from MaineDOT, municipal officials, the traffic consultant community, and traffic contractors. Per Garder, a professor from the University of Maine, and representatives of companies that provide traffic services and products, also participated in several meetings. The group concluded that we can and must do better in three critical areas:

1. Traffic signal performance;
2. Use of intelligent transportation systems to better utilize existing capacity; and
3. Promotion and expansion of proper incident management.

These three areas were examined with an eye towards MaineDOT's Mission and Goals:

MaineDOT's Mission is to responsibly provide our customers the safest and most reliable transportation system possible, given available resources.

MaineDOT's Goals are to:

- Effectively manage Maine's existing transportation system for safety and effectiveness;
- Support economic opportunity and;
- Build trust through demonstrating our core values of integrity, competence, and service.

It will be important to keep MaineDOT's Mission and Goals in mind as you read through the recommendations.

Traffic Signals

Currently, MaineDOT maintains 51 traffic signals statewide and municipalities maintain the remaining 750. This worked when the sole function of a traffic signal was to randomly turn from red to green to yellow, and back to red again. Signals were installed to get vehicles safely in and out of intersections.

Today's traffic signals are highly complex and interconnected in order to provide efficient traffic flow on our increasingly congested highways. If any part of a traffic signal does not work properly, congestion will result, along with wasted time and fuel. Many municipalities don't have experience or expertise with signal detection and programming modern traffic signals to optimize traffic movements. Consequently, many signal systems are not properly configured, adjusted or maintained to realize the potential operational benefits. Many municipalities are challenged by tight budgets and competing needs that affect their ability to invest in traffic signal monitoring and adjustment. Regardless of who owns or maintains traffic signals, the traveling public has come to expect a high standard for traffic signal operations. Unfortunately, that standard is not being met in many areas of the state.

The problems with traffic signals aren't just related to signal electronics and technology. MaineDOT's Ancillary Structure Inspection Program has documented the pressing need to address the poles and foundations supporting the traffic signals. After inspecting approximately 349 signalized intersections in 2017, the inspection program found that 159 intersections had support structures with foundations or steel poles in poor condition. If this ratio is applied across the state, it means that 46% of signalized intersections have support structures in poor condition. Two such structures in Old Town actually collapsed and several others had to be taken down on an emergency basis during the October 2017 windstorm in order to protect the traveling public.

It is estimated that 369 of the 801 traffic signals will need complete top-to-bottom replacement soon. The current inspection program will determine how projects are selected and prioritized.

Maine needs a new strategy, along with additional funding, to effectively manage the existing statewide signal system infrastructure.

Properly working signals increase mobility, reduce congestion, save time, money and fuel, and enhance economic opportunity.

Signal retiming is a proven cost-effective method to improve traffic operation. It can produce benefit-to-cost ratios for the travelling public as high as $40 saved for every dollar spent (See Appendix A, Cost/Benefit of Signal Projects).

Most important are the safety implications related to traffic signals. MaineDOT uses the American Association of State Highway and Transportation Officials (AASHTO) Highway Safety Manual to determine the benefit-to-cost ratio for all safety projects. The manual also indicates that properly timed and maintained signals can reduce crashes by up to 30%. This has been verified in Maine when comparing before and after crashes on several corridors (See Appendix B, Crashes Before and After Signal Projects).

Traffic mobility and safety are predicated on a realistic signal timing plan and functioning signal detection. Given what is at stake, is it realistic or even fair, to expect communities across Maine to maintain these new and highly complex intelligent traffic control systems? Traffic signal controllers and vehicle detection systems are complex, critical to proper operation, expensive to fix, and unfortunately, the most neglected.

Therefore, the Mobility Team recommends that MaineDOT should partner with all communities across Maine - sometimes assuming complete responsibility and other times offering a stipend - to maintain traffic signal controllers and traffic signal detection systems.

It is estimated that maintaining all 801 traffic signals would cost approximately $2 million annually (Detailed estimates are outlined in Appendix C.).

In addition, the poor condition of the ancillary structures supporting these traffic signals demonstrates the urgent need for a planned replacement schedule on a 20-year cycle.

The Mobility Team recommends replacements initially be done at a rate of 40 traffic signals per year at an anticipated cost of $8 million annually.

Intelligent Transportation Systems (ITS)

ITS can help improve mobility and reduce congestion, and is now a cost-effective or more acceptable alternative to adding lanes or building new highways. In this era of limited funds and daunting regulations, ITS, including traffic signal performance and incident management, are the least invasive, most efficient, and most cost-effective tools available. MaineDOT needs a centralized focus on ITS planning and deployment, rather than having ITS responsibilities spread throughout its different bureaus and offices.

Three types of events can impede mobility: congestion, incidents, and road/weather conditions. Aggressively expanding our ITS systems can mitigate the resulting mobility problems caused by these situations. ITS can quickly notify motorists about these events and their duration, and recommend actions and alternatives to avoid or minimize delays.

There are two key components to an ITS System:

1. the Transportation Management Center, and
2. the ITS devices deployed on the roadways.

Improvements are needed in both areas, since one can't be successful without the other.

Until fully automated Intelligent Transportation Systems are in place, MaineDOT's Transportation Management Center (TMC) needs to gather real-time information and provide that information to the travelling public.

MaineDOT deployed Changeable Message Signs (CMS) at every interchange on I-295 In 2017, and in 2018, we are implementing CMS coverage on all of I-95. CMS are used to provide relevant and timely information, including safety messaging.

Traffic Management Center (TMCs) in other New England states, offer excellent models for us to emulate. They monitor State Police frequencies, Waze, broadcastify.com and Google Maps Traffic on large, wall-mounted screens, and quickly relay traffic information to the public.
In the short term, MaineDOT staff needs increased training with programs such as WAZE, Google Maps Traffic and Roadway Weather Information Systems (RWIS), to gather real-time traffic and road condition information. Combined with interagency communication and clear procedures regarding Transportation Incident Management (TIM), our employees would be better equipped to notify the travelling public of events and their duration, and make recommendations to avoid or minimize delays.

Going forward, MaineDOT needs to review and update job descriptions and outline relevant training or education requirements.

In the longer term, the department should pursue fully automated systems that integrate road sensors, probe data, phone data, and RWIS in order to automate the process of providing real-time, reliable information to the public. By doing this, we can automatically push travel information through websites, texts and social media as well as through changeable message signs on the highways. Travel time signs, variable speed limits, Roadway Weather Information Systems integration and ramp metering are other possible tools to reduce congestion.

Traffic Incident Management

The quick clearance of crashes, particularly on the interstate, is critical to reducing congestion and shortening delays. Traffic Incident Management (TIM) is a planned, coordinated and multidisciplinary process to detect, respond to and clear traffic incidents in order to quickly and safely restore traffic flow. Applied effectively, TIM minimizes the duration and impact of traffic incidents, and enhances the safety of motorists, crash victims and emergency responders.

Traffic Incident Management Committees are key to successful incident management implementation and MaineDOT is working to expand their coverage statewide. Currently, there are two active committees in southern Maine (in the Kittery Compact Area and the Portland Compact Area), one in central Maine and one in the Bangor area.

Current TIM Committees have opened lines of communications among local fire departments, local law enforcement, state police, the towing industry and MaineDOT. However, more needs to be done.

Currently, we have trained approximately 16% of all first responders statewide. All first responders need to be trained, including members of the towing industry. The towing industry has met with MaineDOT twice and will hopefully intensify their participation in TIM groups and after-incident action plans.

More Train the Trainer classes should be offered to increase the size of our training workforce. MaineDOT and state police need to reach out to Maine Fire Chiefs, Police Chiefs, and the Maine Sheriffs Association as well as the Maine Towing Association to reinforce the importance of TIM training. The first responder groups require the feedback generated through the after-incident meetings in order to grow and improve.

MaineDOT should take the lead in training and forming new TIM groups, initially focusing on the most critical areas and eventually expanding throughout the state. MaineDOT received a State Transportation Innovation Council (STIC) Incentive Program grant to pay trainers and there have been several Train the Trainer classes in the state. These additional trainers should help keep up with the demand.

MaineDOT must take the lead to develop additional TIM committees on corridors outside of I-95 and I-295, with the Route 3 corridor from Ellsworth to Bar Harbor being the top priority. MaineDOT will monitor other corridors and make additional recommendations for future committees.

Private Patrol Service

AutoBase is a private company that patrols the Maine Turnpike at no cost since they are funded by State Farm Insurance. AutoBase works to quickly clear potential problems by providing fuel and jump starts to stranded motorists, clearing debris from the road, etc. When incidents do occur, they are often first on the scene and can get vehicles out of the travel lanes much sooner than waiting for a tow truck to arrive.

The Mobility Team recommends that MaineDOT pursue a similar agreement to provide patrol services.

The team recommends that MaineDOT provides patrol coverage on I-295 from Scarborough to Topsham during the high traffic hours of 11 am to 7 pm, May through October. During peak tourist season, those hours would be expanded.

Traffic Incident Management Strategies and Implementation

Strategies

- Continue to work with traffic incident management groups in southern Maine, Portland, central Maine, and the Bangor area.
- Continue Train the Trainer courses and Strategic Highway Research Program TIM training.
- Develop non-interstate corridor TIM groups starting with the Route 3 corridor between Ellsworth and Bar Harbor.
- Work with Maine Fire Chiefs, Maine Police Chiefs, the Maine Sheriffs' Association as well as the Maine Towing Association to further training and get buy-in to the TIM process statewide.

Implementation

- Implement a safety patrol service along I-295 between Scarborough and Topsham.
- Work to procure funding for incident management tools such as road flares and privacy screens to help first responders deal with roadway incidents.
- Work with the towing industry to help them develop a more educated workforce regarding TIM and towing.

Signal Design and Operations

Overview

Statewide, traffic signal maintenance has been inconsistent and often insufficient. Consequently, a significant number of MaineDOT capital intersection improvements have failed to realize their operational benefit potential. The traffic mobility team was charged with identifying potential solutions and estimating the associated costs.

Traffic mobility is predicated on using realistic timing plans and a functioning signal/system detection. MaineDOT should partner with all communities across Maine - sometimes assuming complete responsibility and other times offering a stipend - to maintain traffic signal controllers and traffic signal detection systems. We estimate the cost of this initiative to be $2 million annually.

Timing plans and signal/system detection are relatively costly for municipalities to maintain properly. There is also a lack of expertise available to correctly maintain modern signal systems. As a result, these investments are often neglected and the value of our capital expenditures are minimized.

MaineDOT's Traffic Division must determine the ages of traffic signals and develop a capital improvement program for signal replacement. MaineDOT may adopt a 20-year life cycle for traffic signals. However, the longer the life cycle, the higher the maintenance costs.

Traffic Controllers and Signal Detection

Traffic signals are run by traffic signal controllers which are basically computers. Traffic signal controllers need to be replaced more frequently (every seven to ten years) than the traffic signal itself. Signal detection also has a shorter lifespan than the traffic signal and would need to be replaced approximately every 10 years.

The group proposes that controllers and signal detection should be replaced as part of a proactive maintenance plan funded in MaineDOT's Work Plan.

MaineDOT will start a preventive maintenance plan to cover the costs of cleaning cabinets, planned controller replacement, retiming the signals as needed, and performing routine activities. This too will be included in the Work Plan as a yearly line item with an average maintenance cost per traffic signal. This could be wrapped into the ancillary structure program if we can ensure the ancillary consultants can provide the services needed.

Once MaineDOT establishes communication with our traffic signals, and is assured that we are receiving messages of malfunctions, we can consider running signals along certain corridors on “flash” during overnight hours. However, some corridor signals would remain in full operation depending on the traffic volume. Either way, with properly operating equipment, traffic signals could “rest in green” on major corridors, thereby minimizing the delays on side roads.

Traffic Signal Design and Education

MaineDOT’s Traffic Engineering staff will work with other staff, design consultants and contractors to ensure that our Policies and Procedures on Traffic Signal Design and Operation (see Appendix D) protocols are followed during traffic signal design and operation. Additional training is needed to ensure that the approved policies and procedures are implemented. MaineDOT proposes higher pre-qualification standards for consultants who intend to design traffic signals. These new pre-qualification standards will be part of the package for the next round of General Consultant Agreements.   The proposal requires that consultants obtain four levels of International Municipal Signal Association (IMSA) training before designing and performing construction oversight of our projects.   The four levels of IMSA training was offered between November 2017 and February 2018.

Until recently, the Electric Light Company of Cape Neddick provided three days of training for the traffic engineering community, to help maintain proficiency and relevancy regarding signals. However, they have discontinued this training. MaineDOT will fill that void and offer customized training to order to further our program.   The first round of MaineDOT training began in December 2017 and will continue annually starting in 2019. MaineDOT wants to partner with the New Hampshire Department of Transportation for signal training workshops. The departments’ plan is to coordinate workshops, twice a year, for staffs of the state government, municipalities, consultants and contractors.

Performance Measures

General Mobility Performance Measures

Three basic measures of transportation mobility, described in the Highway Capacity Manual (HCM), are volume, speed, and travel time.

- Traffic volume, usually expressed in vehicles per day or vehicles per hour, measures the quantity of travel at a given location.
- The overall quantity of travel in a corridor can be measured in vehicle miles.
- The overall speed of traffic moving along a corridor, in relation to the posted speed, helps define the level of service (LOS) provided by that corridor.
- Travel time, which is defined by speed and distance, is a building block for measuring the benefits of mobility improvements.
- Mobility benefits can be expressed as savings in travel time, such as reduction in vehicle hours or person hours traveled due to reduced congestion, and as improvements in travel time reliability.

Reductions in vehicle hours and person hours traveled translates into increased productivity in the movement of goods and people. Improved travel time reliability means more predictable and dependable travel times and the ability of people to schedule travel more efficiently. The performance measures of speed and travel time can be applied to a wide range of transportation corridors, from rural two-lane and interstate highways, to signalized urban arterials. These performance measures are used for both planning and operational purposes.

For planning purposes, volume, speed, travel time, and travel time reliability can be used to:

- Identify corridors that need improvement in performance;
- Identify locations where poor performance originates, and
- Evaluate the impacts of proposed improvement alternatives on corridor performance.

For operational purposes, these performance measures can be used to:

- Monitor the operation of a corridor in real time; and
- Alert the transportation agency and the traveling public to current operating conditions.

Real-time performance information allows the transportation agency to respond in a timely manner, to resolve immediate issues and to inform travelers so they can make informed choices on the route and time of their travel plans. Performance measurement at the planning and operational levels helps to keep transportation corridors operating at their best, both in the short term and the long term.

To measure volume, overall speed, travel time, and travel time reliability, the corridors of interest should be subdivided into appropriate segments. For the Interstate System, the segments could be the lengths of highway between interchanges. For rural two-lane highways, segments may be defined by the intersections of major routes or by village and town centers. For an urban arterial corridor, the segments may be defined by major intersections, signalized or un-signalized.

Currently, MaineDOT measures volumes on most corridors on a three-year cycle. However, other mobility performance measures have not been collected on a regular basis. The probe-sourced travel time and speed data has recently become available from the National Performance Management Research Data Set (NPMRDS) produced by the Federal Highway Administration. Unfortunately, NPMRDS data is available only for arterials on the National Highway System, which is approximately 1,300 miles out of MaineDOT's 8,300 miles of arterial and collector roads.

Traffic Signal Operations Performance Measures

In urban arterial corridors, volume, overall speed, travel time, and travel time reliability can be measured for both planning and operational purposes. When monitored, and tracked over time, changes in performance can be detected, unless the lengths of segments are as short as the distance between adjacent traffic signals. In those cases, the source of the performance problem may not be identified. Performance measures at the intersection level are needed.

Examples of intersection-level performance measures for traffic signals include split time utilization and arrival on green (AoG). Split time utilization, for each approach or lane group, measures the efficiency with which green time is allocated among the signal phases. This can identify opportunities to improve signal timing at the intersection. AoG measures how effectively approaching traffic passes through the intersection without needing to stop. A high AoG indicates that platoons from an adjacent signalized intersection are arriving in a manner that allows them to progress along the corridor with minimal stopping. AoG can help with timing coordination between signalized intersections to improve traffic progression.

Traffic Signal Programming Performance Measures

A signal timing plan is a crucial component for successfully moving traffic through intersections. Intersection traffic counts vary by the time of day, the day of the week, and the time of the year. It is not a one-size-fits-all scenario. MaineDOT hasn't been diligent about signal timing and has allowed projects to be designed and built using one timing plan. We are currently implementing a guideline for designers to consider the time of day, the day of the week, and the week of year when establishing appropriate signal timing. This will require MaineDOT to conduct traffic counts over longer periods, including weekends and off-season. MaineDOT realizes that signal plans become outdated, which leads to optimization losses.

We propose that signal timing be reviewed every three years in urban areas and every five years in rural areas. This data may be extracted from existing field equipment or purchased from private firms such as INRIX, or other data sources. MaineDOT will strive to collect more data using our field devices rather than rely on costly outside data sources.

Two signal system performance measures that provide valuable information are:

1. Travel Time - reflects the time a vehicle spends in the "area of influence" i.e. in and around a signal or signal system.
2. Arrival on Green - measures how efficiently the system processed the vehicles.

Signal systems will be reviewed for coordination of offsets, cycle lengths, cycle splits and phase green time. We will review existing data and adjust the signal to provide green time to those legs that would benefit.

The move towards performance measures will require more training for department, municipal, contractor and consultant employees. MaineDOT received a State Transportation Innovation Council (STIC) grant that was used for the International Municipal Signal Association (IMSA) signal training. This was the first step to address the needed training.

An Adaptive Traffic Control System (ATCS) manages traffic by changing traffic signal timing based on actual traffic demand. Currently, MaineDOT has an adaptive signal installation in Wells, which we monitor. To help alleviate congestion, the department is considering adaptive technologies installations in Augusta along Western Avenue and Civic Center Drive, in Waterville along Kennedy Memorial Drive and upper Main Street, and in Manchester on Route 202.

Data Collection

Data collection is the responsibility of MaineDOT, but MPOs, regional planning commissions, municipalities and consultants can also contribute to its collection. Signal equipment can gather that information but, to be reliable, the equipment must be kept in proper working order. Maintenance of the detection and traffic controllers is paramount for sustainable automated signal counts. INRIX and other data sources are needed to supplement the traffic counts. This information is costly, but in many areas, we may be able to get data already being used for ITS activities.

Traffic Signal Performance Monitoring

Most of our traffic signals are maintained "reactively." This means that we initiate a review of the signal hardware and/or signal programming only when problems are reported by the public. Following the complaint, the decision to repair or replace the signal equipment is based on the age of the equipment. The signal programming generally gets changed following a complaint. Otherwise, the signal programming is examined only if there is a project to upgrade the signal equipment, or if there is a nearby development that requires changes as the result of findings in a traffic movement permit.

On occasion, a traffic signal study is conducted which first determines the existing conditions. This could involve collecting data, such as turning movement counts during peak hours, observed vehicle speeds and delays, as well as recording the existing signal programming and phasing. This data is uploaded into a simulation model to determine existing conditions and what improvements, if any, can be made by adjusting the signal phasing and/or the signal timings. In recent years, Bluetooth technology has been used to collect vehicle data to determine estimated travel times along a corridor, which allows for a real-world before/after study to determine the effects of the retiming.

In general, the current state of traffic signal study can be labor intensive and costly. Approximate costs are $1,000 to $2,000 for an isolated signal and $2,000 to $3,000 per intersection along a corridor. The data collected and the analysis only include a small statistical sample since traffic volumes can be heavily influenced by season, construction and weather. Furthermore, for a coordinated system, traffic volumes may need to be collected over a longer time to determine a more refined time-of-day schedule, since factors such as overall cycle lengths, offsets and direction of coordination change by the time of day as well as the day of the week. Once the revised signal timing is implemented, there is no way to check the performance without conducting another study.

Given these challenges, the department could more effectively operate and maintain the traffic signal system if it had a 24/7/365 performance monitoring system in place. Just as the department's pavement management system assists with monitoring and managing our pavement assets, a traffic signal monitoring system would have beneficial impacts on our signal assets.

According to the FHWA Every Day Counts initiative, "Automated Traffic Signal Performance Measures (ATSPM) modernize traffic signal management by providing high-resolution data to support objectives and performance-based maintenance and operations strategies that improve safety and efficiency while cutting congestion and cost." Managing our traffic signals in this way provides data-driven decisions on which signals to upgrade or alter, rather than decisions driven by public complaints.

The ATSPM includes high resolution signal controllers, communications between the controllers and a central server, and specific software to help analyze data. This can be viewed in real time and can be stored for analysis at a later date. These systems provide continuous performance monitoring and measuring, which promotes identification and correction of deficiencies. User-friendly modeling tools have been developed by Purdue University and are being used by many state DOTs. Many of the traffic signals in Maine do not have the high-resolution controllers or communications backbone that is required for ATSPM. An asset inventory is currently underway that will better define the associated hardware needs and costs. The analytical tools have been developed by our partner states and are available at minimal or no cost.

Another way to proactively measure traffic signal performance is the use of probe data from vendors such as INRIX, HERE Technologies, Waze, Google Maps and TOM TOM. The I-95 Corridor Coalition has established a program that takes advantage of economies of scale to get the best data for its members. Pricing ranges from around $100/centerline mile to $350/centerline mile annually. This probe data can be used to conduct traffic signal type studies along signalized corridors. The chart below shows that, for Highway Corridor Priorities 1 and 2, there are 184 miles with AADT greater than 10,000. These miles would include approximately 600 of Maine's 800 traffic signals. The probe data costs to cover these traffic signals range from $18,000 to $64,000 per year. However, the analytical tools are still under development. PennDOT, along with other states, is developing tools to use this probe data. To date, these tools have shown successful results on corridors with more than 20,000 AADT.

Another option, to integrate this probe data, is through the Tri-State Advanced Traffic Management System, COMPASS. COMPASS includes a module for posting speed and delay information on dynamic message signs using the probe data. There's opportunity to integrate traffic signal performance monitoring into this model.

Miles of Highway with AADT and Probe Costs

Urban Non-Intertate Miles			
	HCP 1	**HCP 2**	**Total**
AADT 20,000+	25	9	**34**
AADT 10,000-20,000	97	53	**150**
Total	**122**	**62**	**184**

Cost at $100/Centerline Mile			
	HCP 1	**HCP 2**	**Total**
AADT 20,000+	$2,500	$900	**$3,400**
AADT 10,000-20,000	$9,700	$5,300	**$15,000**
Total	**$12,200**	**$6,200**	**$18,400**

Cost at $350/Centerline Mile			
	HCP 1	**HCP 2**	**Total**
AADT 20,000+	$8,750	$3,150	**$11,900**
AADT 10,000-20,000	$33,950	$18,550	**$52,500**
Total	**$42,700**	**$21,700**	**$64,400**

Another option is vendor-supplied, like that offered by StreetLight. This company provides a turnkey, web-based system using the probe data, which can be accessed by a number of users within the department. They use the probe data, and their own modeling tools, to provide data analysis as defined by the customer. Initial pricing, based on the state of Maine population, is $234,000 for the first year and $350,000 annually for years two and three. Though their product demonstrations have been impressive, there is a data lag of about one month so real-time analysis and reporting is not available.

MaineDOT should consider partnering with academia regarding signal performance measuring and monitoring. Students could perform tasks such as validating the monitoring system initially and periodically. Also, places of higher learning could be a training and education resource both for their students and for those professionals who are involved with traffic signal operations and maintenance.

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Glossary

Adaptive Signal Technology is a traffic management strategy in which traffic signal timing changes, or adapts, based on actual traffic demand, using an adaptive traffic control system consisting of both hardware and software.

Arc Flash is the explosion (heat and light) caused as a result of an electrical fault.

ATPMS – Automated Traffic Signal Performance Measures is a method used to show real-time and historical functionality at signalized intersections. Measures vehicles arrival on green and corridor delay.

ITS – An Intelligent Transportation System is an advanced application which, without embodying intelligence as such, aims to provide innovative services relating to different modes of transport and traffic management and enable various users to be better informed and make safer, more coordinated, and "smarter" use of transport networks.

Pre-emption is a traffic signal add on that allows the normal operation of traffic lights to be altered by emergency vehicles or sometimes, public transit vehicles to facilitate their flow along the corridor. Nearby railroad traffic can also alter traffic signal operations.

Signal Timing Plan is a table that gives the time (in seconds) for various parameters in a traffic signal controller (minimum green, yellow clearance, all red, maximum green, etc.).

TIM – Traffic incident Management is a term describing the activities of MaineDOT and first responders to identify, analyze, and correct hazards to prevent a future reoccurrence or minimize their future impacts were they to recur.

Traffic Signal Controller is a specialized computer that receives input from detectors (vehicle or pedestrian), then determines which phases (traffic/pedestrian movements) to service and for how long. The controller is usually housed in a metal cabinet at the side of the intersection.

Traffic Signal Detection is the method by which vehicles and pedestrians send requests for service to the traffic signal controller. Vehicle detectors may be under the pavement (wire loops) or overhead (video cameras); pedestrian detectors are usually push buttons near a pedestrian crosswalk.

WAZE is a traffic navigation application used by drivers to determine congestion and crashes along the roadway system.

Appendix A

Cost/Benefit of Signal Projects

Sebago Technics recently performed a retiming project on two corridors for the city of Dover, NH:

Glenwood System (3 Coordinated Signals, 18,000 AADT)

- Money Saved in **Fuel Consumption: $10,584/year.** There are additional savings outside of the peak 6 hours that have not been quantified.
- Time Saved by the Public: Average **22% reduction in travel time**. PM Peak reduced from 83 to 57 seconds, Midday Peak reduced from 54 to 48 seconds, and AM Peak reduced from 52 to 40 seconds.

Weeks Crossing System (4 Coordinated Signals, 30,000 AADT):

- Money Saved in **Fuel Consumption: $20,506/year**. There are additional savings outside of the peak 6 hours that have not been quantified.
- Time Saved by the Public: Average **46% reduction in travel time**. PM Peak reduced from 76 to 16 seconds, Midday Peak reduced from 33 to 27 seconds, and AM Peak reduced from 74 to 52 seconds.

Other National Examples

Cited by ***SRINIVASA SUNKARI, P.E. in the ITE Journal, April 2004.***

- Since summer 2002, the Maryland DOT has retimed about 215 signals in the Washington, DC, USA, suburbs and an additional 30 signals on the Route 650 (New Hampshire Avenue) corridor between Montgomery County, MD, USA and the District of Columbia. An analysis has shown that **delays on these roads shrunk by about 13 percent** and vehicles made 10 percent fewer stops at red lights. Fuel consumption also dropped by about 2 percent.
- Adjusting signal timing in Lexington, KY, USA, by responding to real-time traffic data **reduced stop- and-go traffic delays by about 40 percent and accidents by 31 percent**.
- According to the Institute of Transportation Engineers (ITE), traffic signal improvements **reduce travel time by 8 to 25 percent**. The reduction in travel time also reduces fuel consumption and emissions.
- **The Fuel-Efficient Traffic Signal Management Program** in California demonstrated a **benefit to cost ratio of 58:1**. The program retimed 3,172 signals, resulting in 15-percent savings in delays, 8.6-percent savings in fuel consumption, 16-percent savings in stops and 7.2-percent savings in travel time (1988).
- The Traffic Light Synchronization (TLS) Program in Texas showed a **benefit to cost ratio of 62:1**. By retiming traffic signals with the TLS program, Abilene, TX, experienced

reductions of 14 percent in travel time and 37 per- cent in delays. Overall, the program resulted in a 24.6-percent reduction in delays, a 9.1-percent reduction in fuel consumption and a 14.2-percent reduction in stops (1992).

- In Kitchener-Waterloo, Canada, 89 intersections that included arterials in commuter and commercial routes and central business district areas were retimed. The project demonstrated **savings of 10 percent in travel time, 27 percent in delays** and 20 percent in stops (1996).
- In another project in Burlington, Canada, which contained 62 inter- sections, 7-percent savings in travel time, 11-percent savings in stops and 6 percent savings in fuel consumption were observed. The project demonstrated an **annual savings of $1.06 million for delays and fuel consumption alone. Based on total savings, the payback period for this project was just 13 days (2001)**.
- On U.S. 1 in St. Augustine, FL, USA, retiming traffic signals at a 11- intersection arterial reduced average arterial delay by 36 percent, arterial stops by 49 percent and arterial travel time by 10 percent, resulting in estimated annual fuel savings of 26,000 gallons and **overall annual cost savings of $1.1 million (2001)**.
- On RS 26 in Gainesville, FL, retiming traffic signals at an eight-intersection arterial **reduced average arterial delay by 94 percent and arterial stops by 77 percent**, resulting in estimated annual fuel savings of 3,300 gallons and overall annual cost savings of $93,000 (2001).
- On San Jose Boulevard in Jacksonville, FL, retiming traffic signals at a 25-intersection section reduced average arterial delay by 35 percent, arterial stops by 39 percent and arterial travel time by 7 percent, resulting in estimated annual fuel savings of 65,000 gallons and **overall annual cost savings of $2.5 million (2001)**.
- Signal retiming is a cost-effective method to improve traffic operation. It can produce **benefit to cost ratios as high as 40:1**.

Appendix B

Crashes Before and After Traffic Signal Coordination Projects

Municipality	Before		After		Reduction Nodes %	Reduction %	Total Corridor Crash %
	Nodes	Elements	Nodes	Elements			
Augusta	330	127	319	88	3.33%	30.71%	10.94%
Portland	440	215	379	219	13.86%	-1.86%	8.70%
Waterville	181	107	107	30	40.88%	71.96%	52.43%
Presque Isle	155	110	118	113	23.87%	-2.73%	12.83%

Appendix C

Cost of Signal Improvement Recommendations

The Traffic Mobility Group looked at many options for determining which traffic signals should be maintained by the state. It was determined that it made the most sense to group signals by Highway Corridor Priority (HCP), and then look at available funding as we worked our way from HCP 1 traffic signals down through to HCP 4. The table below reflects costs by HCP, with those costs separated into two areas: maintenance, and timing. Maintenance is the average yearly cost to keep traffic signal controllers and traffic signal detection in working order. Timing is the yearly cost to retime a traffic signal, every 3 years for urban signals or every 5 years for rural signals in order to be current with existing volumes.

Maintenance and Timing Optimization

The average costs for maintaining and timing a signal are as follows:

- Preventive maintenance and repair cost annually: $2,000
- Retiming controller cost annually:
  - » Rural $300 (based on $1500 once every 5 years)
  - » Urban $700 (based on $2100 once every 3 years)

MaineDOT Anticipated Yearly Maintenance and Operations Costs

Highway Corridor Priority	Number of Rural Signals	Number of Urban Signals	Annual Maintenance Cost	Annual Retiming Cost	Total Annual Cost	Running Total of Annual Costs
1	47	279	$652,000	$177,035	$829,035	**$829,035**
2	31	315	$692,000	$195,355	$877,355	**$1,706,390**
3	16	67	$166,000	$43,480	$209,480	**$1,915,870**
4	0	33	$66,000	$19,800	$85,800	**$2,001,670**

Capital Replacement

MaineDOT is responsible for capital replacement of virtually all traffic signals in the state, so replacement options are not broken down by HCP because MaineDOT must do all of these replacements regardless of HCP. The cost of a new installation or complete replacement of a signal is $150,000 and there are 801 traffic signals in the state.

Annual Capital cost depends on assumed design life. Annual Capital Costs are shown below based on various assumed Design Life.

- 20-Year Design life – 40 replacements annually - **$6,300,000**

Note: Maintenance costs in the table above are based on a 20-year design life. Increasing the design life beyond 20 years will increase maintenance costs.

Appendix D

Policies and Procedures on Traffic Signal Design and Operation

A. Warrants

MaineDOT uses the Manual on Uniform Traffic Control Devices (MUTCD) signal warrants to decide whether an intersection merits a signal being installed.

- Chapter 4C of the MUTCD describes the warrants for traffic signals.
- Meeting one or more warrants does not mandate a signal installation.
- Peak hour warrant should only be used sparingly for places where there is a true peak hour discrepancy in the side road/entrance traffic.
- Add new intersections to existing systems.

B. Design

There are several ways to design a traffic signal. Each of the below has its merits depending on location.

- Pre-timed – Design where signal cycle follows a fixed sequence with fixed length time interval. No new designs or modifications will be allowed.
- Semi-Actuated – Design where one or two approaches have detection, normally the side road. Once side road demand has been serviced, the signal returns to green on the mainline. Semi-actuation will not be allowed in new designs or modifications to existing design.
- Fully-Actuated – Design where all signal phases are actuated by vehicle detectors, this is the only design now allowed for new or modified signals.
- Coordinated – All new signals shall be coordinated with adjacent signals if within 1200 feet +/-.
  - » Time of Day – coordination in which the time of day determines the cycle length for the coordination program. This is the type of coordination most often used.
  - » Traffic Responsive – coordination in which the volume of traffic determines the cycle length for the coordination program. This type of coordination should be used in areas where there may be event type traffic.
  - » Adaptive – splits and cycle length are continuously adjusted based on effective use of green time.
- Interconnection – required on all new signal installations or retrofit of existing situations. At a minimum, the intersection should be interconnected to adjacent signals if within 1200 feet +/-, and will be considered if within 2600 feet (Department's discretion). Use interconnect options below to ensure that proper communications are installed between traffic signals.

  - Hardwire
    - Fiber Optic – can carry a lot of information at high speed; expensive, specialized equipment needed to repair.
    - Copper – effective for many signal systems; limitations on volume of data, issues with lightning when system is not properly grounded.
  - Time Based – only used on corridors where there is no interconnection, some business districts or with closely spaced signals. The Department will determine if time based coordination will be acceptable on new signals and signal upgrades. If work is being done on a signal, it shall at a minimum be interconnected to the signal or signals adjacent to the intersection and coordinated as appropriate.
  - Wireless – Radio (time-based) – need line of sight. Communications can suffer from interference from outside entities.
- Phasing -
  - No new protected left turns from a shared lane. This is very inefficient and does little to increase capacity or safety. Existing locations may remain.
  - No protected/permitted left turns across two through lanes. History has shown that this type of movement develops into a high crash location over time.
- Timings
  - Consultants shall incorporate an appropriate number of signal plans to ensure that unique traffic patterns generally found throughout the day are attended to. Consultants shall also consider weekend traffic and create plans accordingly.
  - Use dual ring whenever possible (with split phases).
  - Consultant is responsible for coordination timing.
  - Consultant should be kept on for at least six months to adjust timing and/or develop additional coordination plans.
- Battery Back-up – If a municipality outside of the MPOs requests battery back-up for a new or retrofitted traffic signal, the municipality shall pay for the cost of the battery back-up.
- Pre-emption
  - Railroad – used when railroad tracks are within 200 feet or the maximum queue length (whichever is greater) or if tracks are in a position that allowing certain phases will cause vehicular back-up into the intersection. Battery backup required in controller cabinet.
  - Emergency Vehicle – If municipality does not have existing pre-emption, the Department will only install emergency pre-emption if the municipality furnishes and installs emitters in the emergency vehicles. Approaches with pre-emption must be prioritized.
  - Bus Route Priority – The Department will only install in areas where there are fixed bus routes and only if the municipality or transit line furnishes and installs emitter on their buses. Not meant for school buses.

- Dilemma Zone – on high speed roadways, dilemma zones develop when the signal maxes out or the call is dropped and a vehicle has yet to pass the advance detection. The driver needs to determine whether to stop or proceed. Advance detection can allow the vehicle to navigate safely through the intersection by holding the all-red until the vehicle is through.
- Advance detectors shall be used on high speed (speed limit greater than 30 mph) approaches.
- Clearance Intervals (yellow and red)
  - » Use ITE equation to standardize clearance intervals.
  - » Yellow clearance time - Y = t +(1.47v/2[a+Gg] where Y= length of yellow interval, sec, T = perception reaction time, (Use 1 sec), v = speed of approaching vehicles, in mph, A = deceleration rate in response to the onset of a yellow indication. (Use 10 ft/sec2)
  - » g = acceleration due to gravity. (Use 32.2 ft/sec2), G= grade, with uphill positive and downhill negative. (percent grade /100)
  - » Red Clearance Time – R = (W+L)/1.47 v where R = length of all Red interval, sec. W = total traversed width, from the approach stop bar to the far side of no-conflict point. L= Length of vehicle (Use 20 ft.), v = speed of approaching vehicles, in mph.
- Pedestrian Phase – (See Section D below for additional information) in new designs, pedestrian crossing devices shall be investigated and replaced to meet current standards. If there is an existing crosswalk at the intersection, a pedestrian phase and pedestrian signal indications shall be installed. All new and retrofitted Ped signals shall be of the LED countdown type. Care should be taken not to put the pedestrian crossings in locations that may run across heavy turn volumes if another alternative is available.
  - » Exclusive – not used as a standard. Impacts on congestion should be weighed against potential safety. “No Turn on Red” dynamic blank-out signs shall be used on all proposed exclusive phases and installed on existing exclusive pedestrian phases when a traffic signal is modified in any manner. Stops all traffic to cross roadway.
  - » Concurrent – pedestrian phase runs parallel with vehicles that have the green. This is the preferred method for crossing. Where heavy pedestrian traffic is present, the designer should consider the use of the “Right Turn, Yield to Pedestrian” blank-out signs.
  - » Delay start of green. (Leading Pedestrian Interval) -the theory for using delay start of green is to give a pedestrian a headstart to enter the crosswalk before the concurrent leg gets a green. The pedestrian in the crosswalk should be much more visible to turning vehicles.
  - » Clearance Times
    - ◊ FDW is calculated by the following formula - curb to curb distance in feet x 3.5 ft/sec
    - ◊ WALK = 4 to 7 seconds
    - ◊ For longer crossings, it may be necessary to calculate WALK time = curb to curb distance @ 3 ft/sec minus calculated FDW
    - ◊ May use yellow and red clearance times as part of the pedestrian clearance.

C. Equipment

In general care shall be taken in the placement of poles and controller cabinets so that they do not impede sight distance for turning vehicles and do not block sight distance of a pedestrian crossing at the crosswalk. The distance from signal face to stop bar shall be between 40 and 130 feet and the angle between the signal heads as measured from the driver's eye at the stop bar shall not exceed 40 degrees, unless additional near/far side heads are installed.

- Controllers – all new controllers shall be of the TS 2 Type 1 or TS 2 Type 2. Each signal shall have a separate controller unless the Department determines that use of a single controller would provide mobility benefits.
- Cabinets – on all new installations or modifications to existing signals, controller cabinets shall be ground-mounted unless the Department deems that a ground mounted installation is not feasible. Cabinets shall be aluminum and unpainted. Painted cabinets will be allowed on a case by case basis, additional costs to be borne by those requesting that type of cabinet.
- Span Wires and Poles – the most common installation of signals is on wood poles and most commonly on a diagonal span (box spans are preferred). Care should be taken that the minimum 40-foot setback to the stop bar is attained and that signal heads from one direction do not block a signal indication from another direction.
- Mast Arms – unless determined otherwise by the Department, the municipality shall pay for mast arms.
- Strain Poles – can be used where right of way is tight and guying poles would cause right of way issues.
- Detection
  - » Loops – In the past, this was the most commonly used form of detection in signal installations. Many municipalities would like to move away from this type of installation. In general, because of poor pavement conditions and difficulty in detecting bicycles and motorcycles, all loops shall be of the quadrupole type.
  - » Video – Over the years there have been many forms of video detection installed on Maine's roadways. MaineDOT has decided that thermal cameras will be the detection of choice for all new signal installations (for stop bar detection) and signal modifications. Placement of video is crucial as wrong placement could lead to occlusion and problems with detecting due to the brightness of the horizon. Video detection has been shown to be problematic in inclement weather (rain, snow, fog). Camera occlusion will force the signal into recall.
  - » Microwave – issues with detecting slow-moving vehicles entering the detection zone. Not to be used on any new signal or modification of an existing signal.
  - » Radar (Wavetronix, FLIR, smartmicro, etc.) – MaineDOT is requiring these detectors for advance detection on traffic signals on roadways with a speed limit 35MPH or greater. Newer models have secondary stop bar detection, which is beneficial for signals with dedicated left turn lanes on the high-speed legs. Design should take into account dilemma zone protection, so that the all red is held for errant vehicles.

  - System Detectors – used for detection in traffic responsive signal systems. This type of detection basically counts traffic and indicates to the controller when to change plans based on the volume, occupancy, etc. Most types of detectors can serve as system detectors.
- Signal Heads – all signal heads shall be 12 inch LED
  - Use doghouse configuration for new 5-section heads with backplates and yellow retroreflective tape along all borders.
  - May use bi-model section in retrofits, provided there is proper clearance.
  - May use new flashing yellow arrow for permissive left turns.
  - Pedestrian Heads – LED countdown heads must be used in new installations or upgrades.
- Conduit
  - Metallic conduit used for power supply to controller.
  - PVC used for field wiring and interconnect.
- Junction Boxes – Placed behind sidewalk or seven feet from the travel way and the cover shall be labeled "traffic signal."
- Taper Lengths – When two through lanes cross through a signalized intersection, the two lanes shall be carried beyond the intersection for a minimum of 12 times the maximum green time and then the taper back into 1 lane at a rate of WS2/60 (for 40 mph and under) and WS for 45 mph and greater (where W is the width being tapered from and S is the posted speed).
- Use of overhead lane use signs is encouraged.
- Designers should try to incorporate an alternating merge where possible to ensure proper lane utilization at the signal. When using an alternate merge, the taper length shall be doubled.

D. ADA Consideration

Any new or modified signal project shall be checked to determine which ADA issues need to be addressed.

- Audible Indications – anytime a new signal is installed or modifications to a signal are proposed, pedestrian signals shall be fitted with audible indications, as per MUTCD:
  - ◊ Percussive tones to be used when buttons are at least 10' apart.
  - ◊ Speech message to be used when buttons are less than 10' apart.
- Truncated Domes – on all new signal installations, ADA accessible ramps shall be installed and truncated domes shall be placed on the ramps.
- Crosswalks shall have ADA-accessible wheelchair ramps that meet current MaineDOT standards, which includes proper slopes, landing areas, tip downs, etc.
- Crosswalk Location – crosswalk locations should be installed in areas of least pedestrian/vehicle conflict when possible, unless there are crossings across all four legs.

E. Notes

- Eliminate redundant notes (such as information already called out in MaineDOT standard specs or MUTCD) on plans.
- Remember, the signal contractor and their employees are not traffic engineers and should not be tasked with determining timing or design changes.

F. Plan Layout

- Position 5-section (or 4-section) left turn head along lane line (cannot place green ball in exclusive left turn lane).
- Show lane markings on the signal plan sheet.

G. FAQ

- Driveways within the intersection must be signalized.
- Flash Operation - Not recommended. Permit only if detection is not working. Return to 24/7 after repairs. Also, may allow if pre-timed or semi-actuated controller.
- Any and all timing or phasing changes must be approved by a MaineDOT Traffic Engineer before implementation.

Appendix E

Charter of the Traffic Mobility Report Team

Sponsor

- David Bernhardt, P.E., Commissioner
- Joyce Taylor, P.E., Chief Engineer

Executive Guidance

- Joyce Taylor, P.E., Chief Engineer
- Dale Doughty, Director of Maintenance and Operations

Mission

The Traffic Mobility Report Team is established to research and prepare a report for the Department which will:

- Examine existing issues in Maine as they relate to the operation and maintenance of traffic control and management systems;
- Look at current best practices across the country;
- Look at the current policies and practices related to maintenance responsibilities cost sharing ;
- Develop management strategies that will optimize traffic mobility;
- Review project selection and prioritization processes;
- Review availability and capacity of public and private resources available to maintain traffic control systems in Maine.

Report Guiding Principles

1. The Traffic Mobility Report shall include recommendations to improve traffic mobility regardless of who maintains the system.
2. Safety of the traveling public is a priority.
3. Other states and/or municipalities may provide best practices we can model.
4. The Report shall address current contracting and cost-share practices.

Appendix F

Signal Design and Operations Recommendations

Asset Management Plan

- Continue to collect data on traffic signals statewide – expand collection procedures to collect information which will include types and ages of controllers and MMUs.
- Determine whether signal is part of a traffic signal system.
- Determine types of detections.
- Collect pictures of all internal parts.

Life Cycle

- Develop a 20-year life cycle replacement plan for traffic signals.
- Develop and use a preventative maintenance plan and a maintenance plan to change traffic controllers and detection on a 7- to 10-year cycle.

Signal Design

- Revise and fully implement MaineDOT's Policy and Procedure on Traffic Signal Design and Operation
- Develop and provide training to MaineDOT, municipal and consultant staff on signal design expectations.
- Develop a list of signals that should be designed as part of a coordinated signal system and implement through the Work Plan process
- Monitor the use of adaptive signal technologies and ATC hardware, and implement accordingly.
- Develop and document a plan for signal removal when not warranted
- Develop a standard for signal communication and feedback of information back to Traffic Management Center (i.e. alarms for signal malfunctions, etc.)
- Develop strategies for implementing DSRC radios in traffic signal cabinets to ensure we move towards a solution compatible with connected and automated vehicles.

Periodic review and re-timing of traffic signals

- Develop a protocol to recount intersections and recalibrate coordinated signal systems on the following cycle: 3 year urban areas and 5 year rural areas.
- Develop a protocol to revisit uncoordinated signals every 10 years.
- Develop plan for recalibration of adaptive signals.

Timing Plans

- Develop a specification to purchase probe data for timing adjustments.
- Develop an action plan to collect vehicle counts for mid-week and weekend as well as off-season.
- Use data collected to develop multiple timing plans for different times of day/ year.

Signal Add-ons

- Develop protocol for use of and participation in battery back-up along priority corridor – develop cost per signal for add-on features.
- Develop a cost for signal communications (ie. hardwired fiber, Miovision, etc.).
- Develop a protocol for signal phasing and timing (SPAT) challenge for vehicle to vehicle and vehicle to infrastructure improvements.

Arc Flash

- Develop a plan to engineer out arc flash issues – 48V or 2070 cabinets (double door).
- Develop training for Department, municipal and contracting staff on arc flash.

Maintenance

- Develop preventative maintenance plan to extend the life of traffic signals – cleaning, replacing filters, checking wire connections and documenting findings within the cabinet on a 4-year revolving cycle.
- Develop maintenance agreements with the municipalities regarding maintenance responsibilities – MaineDOT (detection and timing), municipalities (wiring, bulbs and signal infrastructure damage).
- Develop strategies to encourage signal contractors to provide maintenance services for MaineDOT.
- Develop training for signal contractors in order for them to provide the services we are requesting.
- Develop purchasing agreements for the Traffic Engineering staff to procure controllers and detection without having to go out to bid every time an improvement is needed. Some purchases may be proprietary, depending on the type of signal system being worked on. MaineDOT may use this inventory to supply hardware to small contractors.

Appendix G

Management and Administration of Statewide Traffic Signal Recommendations

Annual Budgeting and Planning

- MaineDOT has been collecting traffic signal asset data for many years. The asset inventory is going to have to be more in-depth than what has recently been collected. Once Traffic Engineering has the information, it can use that information to develop a long-term capital improvement program, as well as a near term maintenance program, both for routine maintenance and preventative maintenance. The program will include identifying resources to carry out the program.

Traffic Signal Performance Measures

- Develop a strategy for reporting of data collected via protocols defined by our performance measures. The data shall be used to plan future capital projects, planned maintenance and future operations of the signal.
- Work with FHWA to set up peer exchange and training on performance measures (ATSPM).
- Adopt ATSPM measures – work with the University of Maine on studying performance measures

Develop a Training Plan for MaineDOT Staff, Municipal Staff and Contractors

- Training will be provided to the above individuals in order to have a work force with the proper skills, knowledge and ability to perform the work needed to keep statewide signals operating and at a proper level of service.
- MaineDOT will require certain test level certifications through IMSA, that need to be obtained during the first two years of employment. Other training opportunities will be developed throughout the course of the year with a goal of providing 24 hours of training a year. Training can be accomplished through webinars, vendor-sponsored training, internally sponsored training or training through an established certification process. Opportunities for shared training with NHDOT should be explored further.

Personnel Strategies

- Develop a strategy to maintain our in-house staff. State wages aren't competitive with private sector wages. Develop opportunities for state staff so they want to stay, i.e., give them the opportunity to perform signal work.
- Develop strategies to encourage contractors and municipalities to become part of and take part in MaineDOT's maintenance matrix.

- Develop contracting procedures with vendors to have the ability and flexibility to purchase signal maintenance equipment on the fly.
- Work with existing vendors and consultants to implement maintenance as part of their services.
- Work to engineer out arc flash issues, so that non-electricians could work on signals (i.e., training for Transportation Workers, techs and or engineers who may have the expertise to perform the tasks.)

Performance-based Approach to Traffic Management

- Develop goals, strategies and protocols to promote the performance-based approach of maintaining traffic signals. Work with internal and external stakeholders to establish and maintain support of the traffic signal operations and maintenance program.

Jurisdictional Support of Traffic Signals

- Develop an opt in system with performance measures so responsible municipalities can still maintain their signals.
- Develop a protocol for responsibility of maintaining the signals, whether through a Memorandum of Understanding with an individual community, through a contract with an electrical contractor or via boundaries established for in-house staff. Having areas that are consistently maintained by the same entity can help establish a consistency in the maintenance of the signals in the area.
- Develop a stipend process where those communities who maintain signals get paid for it (e.g., an additional URIP type payment)

MaineDOT

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