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The Boston Region MPO is
composed of:

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Transportation

Metropolitan Area Planning Council

Massachusetts Bay Transportation
Authority Advisory Board

Massachusetts Bay Transportation
Authority

Massachusetts Port Authority

Regional Transportation Advisory
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Federal Highway Administration
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(nonvoting)

MEMORANDUM

DATE March 15, 2012
TO Boston Region MPO
FROM Seth Asante and Efi Pagitsas
MPO Staff
RE Maintenance Costs for Municipally Controlled
Federal-Aid-Eligible Roadways

BACKGROUND

On December 16, 2010, MPO staff presented to the Boston Region Metropolitan Planning Organization (MPO) a rough estimate of maintenance costs for federal fiscal years (FFYs) 2010–14 and preliminary recommendations on the development of a pavement management system (PMS).¹ Staff determined that a PMS could provide an important input to investment-strategy decisions regarding the maintenance of federal-aid-eligible (FA-eligible) roadways. Staff recommended that the MPO should consider collecting and managing pavement information for the effective maintenance of such a system in order to:

- Estimate accurately the maintenance costs for FA-eligible roads in the region, information originally requested by the Federal Highway Administration (FHWA)²
- Inform the Transportation Improvement Program (TIP) development process about FA-eligible roadway priorities
- Potentially reduce the number of TIP “reconstruction” projects that, having been neglected by municipalities for pavement repairs, typically may include a very costly deep-pavement-reconstruction component

In preparation for a possible PMS for the MPO region, staff sought authorization to begin exploring the potential development of such a system. During the discussion that followed, at the December 16, 2010, MPO meeting, the MPO authorized staff to begin planning for possible development of a PMS by exploring the following questions:

¹ Seth Asante and Efi Pagitsas, Technical Memorandum to the Transportation Planning and Programming Committee, “Federal-Aid-Eligible Boston Region MPO Roads: A Rough Estimate of Maintenance Costs for FFYs 2010–2014 and Recommendations on the Development of a Pavement Management System (PMS),” December 16, 2010.

² FHWA and FTA letter to EOT Secretary James A. Aloisi Jr., October 1, 2009, regarding “Approval of the Massachusetts FY 2010 Unified Planning Work Program.”

- How do the MPO municipalities make pavement management decisions?
- What methods and tools are presently available for a PMS, how effective are they, and which of these do MassDOT, MPO municipalities, and other regional planning agencies in the state use?
- How would a potential Boston Region MPO PMS relate to PMS activities of the MPO municipalities?
- What would the cost of implementing a PMS in the Boston Region MPO be?

OBJECTIVES

The objectives of this study are to be able to answer the questions described above in order to help the MPO decide whether or not to pursue the development of a PMS.

EXECUTIVE SUMMARY

To achieve the objectives of this study, MPO staff designed an online survey instrument addressed to the chief elected officials of the 101 MPO municipalities requesting information about their pavement management programs. In addition, MPO staff conducted a literature review of PMS practices of MassDOT and regional planning agencies (RPAs) in Massachusetts. The following is an executive summary of the findings of the study.

Online Municipal PMS Survey

Thirty-three municipalities responded to the survey. The findings are summarized below.

Preparation of Annual Road Maintenance Programs

- Public works departments (PWDs) prepare a majority (85 percent) of the municipal road-paving programs using in-house resources.
- A majority of the municipalities rely on more than one process in preparing their annual road-paving program. The predominant process is based on pavement condition data, but it is supplemented with other processes, such as relying on the knowledge and experience of managers or using the “fixing the worst first” approach.
- A majority of the municipalities (97 percent) coordinate their road-paving programs with projects of the water and sewerage departments and utility companies.
- Many of the municipalities (55 percent) collect pavement condition data using only in-house staff; 12 percent use both in-house and outsourcing; 21 percent outsource all of their pavement condition data collection to consultants or contractors; and 12 percent do not collect any kind of pavement condition data.

Data-Collection Methods

- The principal criteria for determining whether to outsource the data collection on pavement condition were cost-effectiveness, the capability of in-house resources, and the scope of data requirements. There was no significant factor differentiating municipalities that use in-house staff from those that outsource some or all of their pavement condition data collection.
- A majority of the municipalities (84 percent) collect pavement condition data using the windshield-survey method. A windshield survey is conducted by driving the road at speeds between 25 and 30 mph and noting pavement distress and drainage problems.
- There are differences in the pavement condition index (PCI) scales used to score pavement conditions among municipalities.
- A majority of the municipalities collect pavement condition data for municipally owned arterial and collector roads.

Software and Analysis Tools

- The important criteria that municipalities used to select PMS software were cost, ease of use, capabilities, and level of training (time and knowledge).
- Many of the municipalities (60 percent) use a simple spreadsheet program or no software at all in developing their annual road-paving programs. These municipalities usually have a low number of centerline miles of roadways and few congested roadways, and maintain a simple PMS. Spreadsheet programs, in many cases, do not have automated pavement management functionality for making effective pavement management decisions.
- Forty percent of the municipalities that responded to the survey use software that is commercially available or is developed by a contractor. These municipalities, which are usually urban or suburban, have many congested roadways or a high number of centerline miles of roadways. Commercially available and contractor-developed software are more versatile for network-level PMS analysis.

Funding Sources

- The principal source of funding for municipal road-paving programs is Chapter 90 state funds. All of the municipalities use part or all of their Chapter 90 apportionment for road-paving programs.
- In addition to Chapter 90 funds, 18 municipalities (55 percent) reported that they allocate municipal funds in their budget for road-paving programs.
- For FFY 2011, the 33 municipalities surveyed were expected to have spent 1.5 times their Chapter 90 funds on municipal road-paving programs. The additional funds came from municipal budgets and water and sewerage enterprises.

- Several municipalities reported that funding for road-paving programs is not enough to cover maintenance needs, and suggested increasing Chapter 90 funds. They recommended doubling or tripling the size of the Chapter 90 fund.

PMS Practices of RPAs in Massachusetts

MPO staff reviewed the PMS practices of regional planning agencies (RPAs) in Massachusetts. The following are the findings:

- A total of four RPAs in Eastern Massachusetts have established PMSs:
 1. The Southeast Regional Planning and Economic Development District (SRPEDD)
 2. The Central Massachusetts Regional Planning Commission (CMRPC)
 3. The Old Colony Planning Council (OCPC)
 4. The Montachusett Regional Planning Commission (MRPC)
- The PMS network coverage of RPAs encompasses only the FA-eligible roadways in their jurisdictions, and it takes between two and five years to complete the data collection cycle, depending on the size of the network.
- All of the RPAs use full-fledged PMS software for analyzing pavement condition data and answering “what-if” questions regarding funding or maintenance strategies.
- The RPAs use their PMSs primarily to support their planning processes and develop project priorities in their TIPs and long-range transportation plans (LRTPs). In addition, they support the development and implementation of municipal PMSs by providing technical assistance to municipalities in the form of training, analysis, and other resources.
- RoadManager GPMS and CarteGraph PAVEMENTviewPLUS were the most common commercially available types of PMS software used by municipalities, and RPAs in Eastern Massachusetts. Each program contains the necessary components for a full PMS and either is expected to meet the needs of the Boston Region MPO.

MassDOT’s Pavement Management Systems

MPO staff reviewed the PMS practices of MassDOT. The following are the findings:

- MassDOT uses PMS to monitor pavement conditions, predict future conditions, determine when rehabilitation efforts are needed, and prioritize rehabilitation and reconstruction strategies and funding allocation.
- MassDOT’s PMS is similar to PMSs of the RPAs.
- MassDOT collects and analyzes pavement condition data on FA-eligible roadways using a specialized testing vehicle, the Automatic Road Analyzer, or ARAN, on a biennial cycle. The ARAN measures pavement roughness and indicators of pavement distress such as cracking, rutting, and raveling, and then combines all of the measures into an

overall pavement condition indicator (Pavement Serviceability Index, or PSI) on a 5-point scale, with 0 being impassable and 5 being perfect condition. Based on this scale, MassDOT qualitatively rates roadway pavement conditions as poor, fair, good, or excellent.

- MassDOT uses current pavement conditions and a series of performance algorithms developed from historical data to predict future pavement conditions and determine when rehabilitation efforts are needed. The analysis considers factors such as pavement distress, ride quality, and historical rehabilitation costs.
- For the purpose of pavement management and funding allocation, MassDOT classifies its roadways into two types: Interstates and Non-Interstates. MassDOT's target pavement value is "excellent" for both Interstate and Non-Interstate roads, but the associated PSI targets differ slightly: 4.0 for Interstate roads and 3.5 for Non-Interstate roads.

Cost of Implementing a PMS for the Boston Region MPO

- A PMS for the MPO area is estimated to cost \$359,722 over a five-year period (\$71,945 annually) to prepare, collect, process, analyze, and document the results of a PMS.
- MassDOT has pavement condition data for a sample of 936 (33%) of the 2,804 centerline miles that are owned and maintained by municipalities in the Boston Region MPO area. (Because these segments are between segments of MassDOT-maintained roadways, data on the former are captured during collection of data on the latter by MassDOT pavement management staff for MassDOT's PMS.) MPO staff concluded that the Boston Region MPO could use pavement condition data collected by MassDOT on municipally controlled FA-eligible roadways to supplement its own data in the development of a PMS.
- MPO staff concluded that the Boston Region MPO could not use pavement condition data from the municipalities in the development of a PMS. We suggest that if the MPO decides to implement a PMS, staff collect new pavement condition data for the municipally controlled FA-eligible roads and use a uniform PCI scale to score the pavement data. The reasons behind this suggestion are that:
 - The PCI scales used to score pavement condition data vary significantly from one municipality to another.
 - Several municipalities do not score pavement condition data or collect condition data at all.
 - Several different data collectors using different methods collect pavement condition data for the municipalities. This introduces data errors that might lead to inaccurate decisions.
 - Many of the municipal PMSs were established to support project-level decision-making, where specific data are collected for use in decisions such as the design and selection of the treatments. On the other hand, a PMS for the Boston Region MPO needs to support network-level analysis, which involves collecting data and converting them into indices to assess the overall pavement-network condition and monitor performance, determine maintenance and rehabilitation strategies, and

assess the consequences of various funding levels to provide a sound basis for allocating resources.

Benefits and Impacts of a PMS for the Boston Region MPO

Implementing a PMS for the Boston Region MPO is estimated to cost approximately \$67,000 to \$75,000 annually, excluding an initial start-up cost of approximately \$30,000 for the purchase of software and equipment. This investment will have several benefits for and impacts on MPO activities.

Benefits

- Addressing FHWA concerns about estimating the maintenance costs for FA-eligible roads in the MPO region and enabling the MPO to become more consistent with the FHWA policy of using performance-based planning to assess the effectiveness of plans and programs in meeting regional needs.
- Informing the TIP development process by providing objective data (pavement condition indices) that could be used as criteria for evaluating TIP projects for funding, identifying appropriate maintenance strategies, and developing comprehensive project costs.
- Informing the LRTP development process by determining existing and future pavement conditions, setting a target pavement value (goal) of “good or excellent condition” for the FA-eligible roadways, and determining the funding levels for achieving this target value, and monitoring performance.
- Supporting municipalities in the maintenance of FA-eligible roads. A PMS would provide valuable and consistent information to municipalities to allow them to consider more efficient and cost-effective pavement management strategies to keep FA-eligible roadways in good or excellent conditions and prevent them from deteriorating to fair or poor condition, which would require very costly deep-pavement reconstruction.

In addition, such information could help the MPO in its effort to reduce the number of TIP “reconstruction” projects that often include very costly deep-pavement reconstruction.

- Providing continued, limited technical assistance and support for municipal pavement management programs by making pavement reports and presentation material available to decision makers.

Impacts

Because of the MPO’s level funding, the implementation of a PMS for the Boston Region MPO would have an impact on other planning activities currently being carried out by the MPO through the UPWP at the cost of \$67,000 to \$75,000 annually. This impact would have to be considered when making the decision to implement a PMS.

Recommendations

From the analysis in this study, staff concluded that there are a lot of benefits to be had for a relatively modest cost, and that therefore, the MPO might want to strongly consider adopting a PMS.

HOW DO THE BOSTON REGION MPO MUNICIPALITIES MAKE PMS DECISIONS?

MPO staff developed a Web-based questionnaire for collecting information from the municipalities. A link to the electronic survey was emailed to chief elected officials in all 101 municipalities of the Boston Region MPO. On completion, the survey was automatically saved in a database for analysis. As a follow-up, MPO staff sent out reminder emails a week later. Staff received responses from 33 municipalities. Staff do not have any explanation of why some MPO members did not respond. Figure 1 (all figures are in the appendix) shows the municipalities that responded to the survey. Copies of the survey form, cover letter, and the names of the municipalities that responded to the survey (Table 1) are included in the appendix.

The following sections describe the results of the survey in detail.

Preparation of Municipal Road-Paving Programs

Public Works Departments (PWDs) prepare the majority of the municipal road-paving programs (Figure 2). Of the 33 municipalities that responded to the survey, 85 percent use in-house staff to prepare road-paving programs. Three municipalities reported that they develop their annual road-paving programs through the community development, planning, or engineering departments. Only one municipality reported using consultant services to develop its road-paving programs.

Processes Used in Developing Municipal Road-Paving Programs

Figure 3 shows the processes used by municipalities in the MPO region for developing their annual road-paving programs. The predominant process adopted by many of the municipalities is based on a decision-making process using pavement condition data. Twenty-three municipalities (70 percent) use pavement condition data as input to the decision-making process. Other significant processes used alone or in combination with pavement condition data for developing annual road-paving programs are:

- Relying on the knowledge and experience of managers (52 percent)
- “Fixing the worst first” approach (33 percent)

As Figure 3 shows, the “fighting fires” approach and political pressure do not significantly influence municipal road-paving programs, as only five municipalities reported using them.

Coordination of Municipal Road-Paving Projects

Utility cuts cause structural and functional damage to the pavement, which reduces the level of service of the street and increases maintenance and future-rehabilitation costs. This is a major

concern of citizens and municipalities. As the demand for greater access to the right-of-way increases due to aging infrastructure repair, replacement, and the need to serve new customers, so will the need for better coordination of multiagency schedules to reduce the impacts of utility cuts. Thirty-two municipalities (97 percent) coordinate their road-paving projects with water and sewerage and other utility work. They modify their working list to integrate these needs into their road-paving schedules.

Data Collection Practices

Collecting pavement condition data is one of the key components of pavement management systems; it requires resources such as labor, training, equipment, and software. Of the 33 municipalities that responded to the survey, 18 (55 percent) reported that they collect pavement condition data using only in-house staff. Seven municipalities (21 percent) reported that they outsource all of their pavement data collection to consultants or contractors. Four municipalities (12 percent) collect pavement condition data using both in-house resources and by outsourcing. Another four municipalities do not collect pavement condition data at all.

All of the municipalities that responded to the survey that collect pavement condition data collect the data on municipally owned, non-MassDOT arterial and collector roads, except for two municipalities, which collect data on only municipally owned arterial roads.

Criteria for Outsourcing Data Collection

Figure 4 shows the criteria for outsourcing data collection tasks and the number of municipalities using each particular criterion. A third of the municipalities use a multicriteria approach for determining whether to outsource data collection tasks. There were three important criteria for deciding whether or not to outsource:

- Cost-effectiveness
- Scope of data requirements
- Capability of in-house resources

Methods for Collecting Pavement Condition Data

Network-level data collection involves the collection of large quantities of pavement condition data using windshield and automated-imaging surveys converted to pavement condition indices (PCIs). These surveys are performed at average highway speeds without affecting traffic or posing a hazard to data-collection teams. Project-level data involve detailed data for design and maintenance purposes and often include a higher prevalence of walking surveys (walking on and near the pavement to assess it). Figure 5 shows the data-collection methods and the number of municipalities utilizing each method. Using windshield surveys was the most common method for collecting pavement condition data; 82 percent of the municipalities use this method alone or in combination with other methods.

Scoring Pavement Condition Data

Pavement condition data are converted into indices in order to describe the current condition and rate of deterioration of roadway pavement, and these indices are used to identify and monitor maintenance and rehabilitation needs. PCIs are usually on a scale of 0 to 5, 1 to 10, or 0 to 100%. Which PCI scale is used depends upon a municipality's pavement management objectives. Of the 33 municipalities, 61 percent reported that they use some form of PCI in scoring pavement conditions; however, the methods for calculating the indices and the scale of the PCI varied among municipalities and were not consistent. While some municipalities used a PCI scale of 0 to 100% or 1 to 10, others used a scale of 1 to 5 or 1 to 6. Eleven municipalities (33 percent) reported that they do not score pavement condition data at all.

Software and Analysis Tools

In recent years, advances in technology such as mobile computing, imaging technologies, and spatial (GIS) technologies have enabled the integration of data collection and the other procedures necessary for supporting comprehensive PMS analyses. Because of these developments, several pavement management software programs have been developed to automate pavement management tasks, from inventorying roads and collecting data to analyzing data, budgeting, reporting, and decision making.

Figure 6 shows the types of PMS software and the number of municipalities using each type. The software ranges from commercially available packages (RoadManager GPMS and CarteGraph) to in-house or contractor-developed software and simple spreadsheet programs. According to Figure 6, many municipalities (60 percent) use simple spreadsheets or no software at all in developing their annual road-paving programs. Thirteen municipalities (40 percent) reported using commercially available software or software developed by a contractor or in-house.

Funding Sources

One of the functions of a PMS is to support funding requests and allocations. MPO staff sought information on funding sources and budget sizes, as staff wanted to know how well current funding meets the road maintenance needs of the municipalities. Figure 7 shows the kinds of funding for municipal road-paving programs. According to the survey, the principal source of funding for municipal road-paving programs is Chapter 90 funds. All 33 municipalities use part of or all of their Chapter 90 apportionment for road-paving projects. In addition to Chapter 90 funds, 18 municipalities (55 percent) allocate funds from annual municipal budgets for road-paving programs. Other sources of funding for municipal road-paving programs (although they represent a small percentage of the total funding) include municipal bonds and funds from water and sewerage enterprises.

The total Chapter 90 apportionment for the 33 municipalities that responded to the survey was \$28.9 million (estimate of last two years' annual budgets). For the same 33 municipalities, the total reported spending for road-paving programs was \$43.4 million (about 1.5 times the Chapter 90 apportionment). The additional funding was allocated through municipal budgets, bond bills, and water and sewerage work.

MASSDOT's PMS PRACTICES

MassDOT uses PMS to monitor pavement conditions, evaluate needs, prioritize rehabilitation and reconstruction strategies, and determine funding needs. MassDOT measures the condition of pavement on the Interstate Highway System, the National Highway System (NHS) and all other roads under its jurisdiction. MassDOT collects pavement condition data using a specialized testing vehicle, the Automatic Road Analyzer, or ARAN, on a biennial cycle. The ARAN measures pavement roughness and indicators of pavement distress such as cracking, rutting, and raveling, and then combines all of the measures into an overall pavement condition indicator (Pavement Serviceability Index, or PSI) on a 5-point scale, with 0 being impassable and 5 being perfect condition. Based on this scale, MassDOT qualitatively rates roadway pavement conditions as poor, fair, good, or excellent.

The second component of a PMS consists of a set of tools or models that determine existing and future pavement conditions and funding needs, and are used to help prioritize pavement preservation projects. MassDOT does this through algorithms that are built into models to estimate at what pace the roadway will deteriorate. MassDOT uses the current pavement conditions and a series of performance algorithms developed from historical data to predict future pavement conditions and determine when rehabilitation efforts will be needed. The analysis considers factors such as pavement distress, ride quality, and historical rehabilitation costs. For the purpose of pavement management and funding allocation, MassDOT classifies its roadways into two types, Interstates and Non-Interstates, and has set a target pavement value of “excellent condition” for both categories of roadways. The associated PSI targets differ slightly: 4.0 for Interstate roads and 3.5 for Non-Interstate roads.

A very important question PMS models can analyze is which roads should be maintained at a predefined target level, given the amount of funding available for a sequence of forecast years. To reach a conclusion, the PMS tool allows MassDOT to define and run several “what if” scenarios to determine the optimal scenario. For example, for MassDOT’s FFY 2011–15 Highway Capital Investment Plan (CIP), MassDOT pavement management staff applied associated models for pavement deterioration to estimate the cost of maintaining Interstate and Non-Interstate roads in excellent condition. According to MassDOT’s CIP, it would require \$128 million annually to achieve the targeted PSI for Interstate highways and \$185 million annually to achieve the targeted PSI for Non-Interstate roads.

PMS PRACTICES OF RPAs IN MASSACHUSETTS

On a broader scale, PMSs for the regional needs of RPAs must support network-level analysis that involves collecting pavement condition data and converting them into indices to:

- Assess overall pavement network conditions and monitor performance
- Determine maintenance and rehabilitation strategies
- Test the consequences of various funding levels and provide a sound basis for allocating resources
- Answer “what-if” questions regarding various maintenance programs and funding levels

Staff reviewed the PMS practices of four RPAs in Massachusetts to acquire insight into what PMS data collection methods and analysis tools are available to them, as well as how their PMS feeds into their planning processes and municipal road-paving programs. The four RPAs are:

1. The Southeast Regional Planning and Economic Development District (SRPEDD)
2. The Central Massachusetts Regional Planning Commission (CMRPC)
3. The Old Colony Planning Council (OCPC)
4. The Montachusett Regional Planning Commission (MRPC)

These RPAs use their PMSs primarily to support their planning processes and to develop their TIPs and long-range transportation plans (LRTPs). A secondary objective is for an RPA to assist in the development and implementation of municipal PMSs by providing data collection assistance, training, and other resources to the municipalities. Table 2 shows the type of software, network roadway coverage, data-collection update cycle, annual operating costs, programming of funding, and relationship to the municipal PMS. The PMS network coverage of the RPAs encompasses only the FA-eligible roadways in their jurisdictions. Depending on the size of the network, it takes between two and five years to complete the data collection cycle. All of the RPAs use full-fledged PMS software for analyzing pavement condition data and answering “what-if” questions regarding funding or maintenance strategies. The following are summaries of PMS activities included in UPWPs for FFY 2012.

The Southeast Regional Planning and Economic Development District (SRPEDD)

SRPEDD allocated \$35,000 in its FFY 2012 budget to survey approximately 260 miles of road-distress data —\$135 per roadway mile—using the windshield-survey method. The survey will provide a comprehensive update of the regional FA-eligible roads that are not surveyed by MassDOT and will be used to identify appropriate maintenance strategies and develop comprehensive project costs, and will be used as criteria for evaluating TIP projects. In addition, SRPEDD staff will analyze pavement condition data to provide sufficient information for municipalities to allow them to consider more efficient and cost-effective pavement management strategies. Staff will also create an interactive pavement condition map for use with Google Earth or Google Maps to assist local communities with pavement management efforts and inform the public of pavement conditions in their communities.

The Central Massachusetts Regional Planning Commission (CMRPC)

CMRPC collects pavement distress data on municipally owned, FA-eligible roadways. In recent years, state-maintained FA-eligible roadways and rural, minor collectors were included to provide a more comprehensive pavement-condition picture in the region. For FFY 2012, CMRPC allocated approximately \$45,000 in its UPWP for pavement management systems, which will complete the data collection on approximately 400 miles of road, at a cost of \$113 per roadway mile, using the windshield-survey method, and using CarteGraph software to process and analyze the data. CMRPC will analyze pavement condition data and use it to support the development of the LRTP. In addition, it will provide continued, limited technical assistance and support for community pavement management programs.

The Old Colony Planning Council (OCPC)

OCPC allocated \$50,000 for management systems, which include pavement-, congestion-, land-use-, and safety-management systems. For pavement management, OCPC will collect, update, and analyze pavement condition data using Road Manager GPMS software to inform the MPO of the regional costs associated with pavement conditions and needs, as well as to support the inclusion of pavement projects in the TIP. In addition, OCPC will use the pavement condition data to develop realistic cost estimates for the LRTP. It will also provide technical assistance to member communities interested in pavement management programs by initiating, coordinating, and developing pavement management programs for municipalities.

The Montachusett Regional Planning Commission (MRPC)

MRPC has established a two-year program to inventory and analyze pavement condition data for 640 miles of FA-eligible roads. For FFY 2012, MRPC allocated \$30,000 for PMS activities, at a cost of \$94 per mile, including collecting and analyzing pavement condition data using RSMS software (PWS Road System Management Suite software, described in the next section), updating a PMS database, assisting municipalities with PMS programs as requested, and preparing a regional report outlining the status and needs of the region.

PMS SOFTWARE AND ANALYSIS TOOLS

As Table 2 shows, RPAs use several kinds of commercially available software for PMS analyses. PMS software packages vary in scope, complexity, ease-of-use, and capability. RoadManager GPMS and CarteGraph were the most commonly used, commercially available, PMS software programs used by many municipalities and the RPAs in Eastern Massachusetts. Both programs contain the necessary components for a full PMS and are expected to meet the needs of the Boston Region MPO. The following describes in detail the three software programs used by RPAs, and municipalities in Eastern Massachusetts:

CarteGraph PAVEMENTviewPLUS

CarteGraph software is a set of tools for accurately capturing and maintaining pavement-condition and roadway-inventory information, determining the overall PCI values, planning pavement budgets, analyzing maintenance needs, and creating capital improvement plans (CIPs) and scenarios based on budget and pavement conditions. Public works professionals in many municipalities, counties, state and federal agencies, and private firms currently use CarteGraph software worldwide. It costs \$3,000 to \$4,000 per user per year.

RoadManager GPMS

RoadManager GPMS is powerful PMS software that has database and GIS interface capabilities. Vanasse Hangen Brustlin Inc.'s new RoadManager Geographic Pavement Management System (GPMS) runs from a toolbar inside of ArcGIS Desktop. Features of the software include:

- Pavement inventory with a flexible database that can be defined by the user
- GIS tools to add, edit, split, and merge pavement segments
- Dynamic segmentation to create segments
- PCI calculation based on standard visual distress evaluation
- Maintenance needs and repair history records for every road section
- Customized reports created and saved using the flexible ad hoc reporting system
- Advanced budget analysis capabilities to predict future pavement conditions under various funding scenarios or to determine the budget required to meet various levels of service
- Repair-alternatives selection based on any number of factors, such as roadway classification, surface type, PCI, condition of curb or sidewalk, and deflection data
- User-definable pavement deterioration curves
- Ability to create any number of predefined thematic maps for displays, such as current pavement condition, future pavement condition, planned maintenance and rehabilitation work, and repair history
- Built-in charts to display pavement condition and projected funding scenario results

RoadManager GPMS software is packaged with pavement management services (data collection and/or analysis) performed by the vendor. Because of this complicated license structure, a cost estimate could not be obtained at this preliminary stage.

PWS Road System Management Suite (RSMS)

PWS [Public Works Software] RSMS was built in partnership with public works and transportation professionals. Originally programmed by the University of New Hampshire's New Hampshire Local Technical Assistance Program (NH LTAP), with funding from the Federal Highway Administration, RSMS includes the following features:

- Inventory and condition modules with easy-to-use graphical interfaces
- Data-import wizard to utilize existing roadway shapefiles
- Analysis and multiyear forecasting module
- Tools to manage storm-water assets
- Ability to create asset and report wizards to easily add and track any asset on a map (for example, utilities and historical monuments)
- Signs-management module

The PWS RSMS costs \$799 per user per year for municipalities and \$1,499 per user per year for commercial use. Upgrades, maintenance, and support cost \$499 per year thereafter.

PMS Software Selection Process

To choose the proper PMS software for the Boston Region MPO, the three candidate software packages described above have to be examined in detail before making a decision. The selection process consists of defining the components of the software and determining the needs of the Boston Region MPO with respect to each component. Each component of the candidate software would be rated against the needs of the planning agency and scored according to evaluation criteria on a scale of 1 through 10 (10 being the best). The software with the highest score would be selected. This process is performed after the decision is made to implement a PMS for the Boston region MPO area.

CAN THE BOSTON REGION MPO USE PAVEMENT CONDITION DATA PROVIDED BY MUNICIPALITIES?

Some municipalities have adapted cost-effective ways of implementing PMSs, such as outsourcing data-collection and analysis tasks to contractors. MPO staff believe that the integration of data collection and analysis procedures necessary for supporting PMSs has created challenges for municipalities, as they do not have the necessary in-house resources to collect data and conduct analysis using versatile PMS software programs. We concluded that the Boston Region MPO could not use pavement condition data from the municipalities, were it to implement a PMS. Staff came to this realization because the PCI scales used to score pavement condition data varied significantly, and the data could have inherent measurement errors because of the many different collectors obtaining the data. These issues create challenges for ensuring data consistency and have significant impacts on the quality of data and pavement management decisions resulting from that data. In other words, if the pavement condition data are not reliable, the recommendations made based on those data will also be unreliable. We suggest that if the MPO decides to implement a PMS, it should collect new pavement condition data for the municipally controlled FA-eligible roads and use a uniform PCI scale to score the pavement data.

However, MassDOT collects pavement condition data for a sample of 936 centerline miles of municipally controlled federal-aid-eligible (FA-eligible) roadways in the Boston Region MPO area and would be appropriate for the Boston Region MPO use. Because these municipally controlled FA-eligible roadways are between segments of MassDOT-maintained roadways, data on the municipally controlled roadway segments are captured during collection of data by MassDOT pavement management staff for MassDOT's PMS. MPO staff concluded that the Boston Region MPO could use pavement condition data collected by MassDOT on municipally controlled FA-eligible roadways to supplement the development of a PMS.

HOW WOULD A BOSTON REGION MPO PMS RELATE TO PMS ACTIVITIES OF THE MUNICIPALITIES?

Upon review of the PMS practices of RPAs, staff identified the following types of assistance that they could provide to municipalities interested in developing and implementing an effective PMS or updating a PMS program:

- Training and monitoring municipal personnel in their data collection efforts to ensure that all information is collected accurately.
- Setting up or updating any existing database with the new survey information for the municipalities that are in the Boston Region MPO area. The municipalities receive survey forms with their road-inventory information already present, and they check the road-inventory files for accuracy, provide new condition data, and update the costs for various repairs practiced within the municipality.
- Working directly with the municipalities by providing the analysis and preparing pavement management reports. The Boston Region MPO provides guidance to the municipalities about effective maintenance and rehabilitation strategies for preserving roads. The municipalities survey their entire road network to update the existing database needed for the analysis.
- Providing technical assistance to member municipalities interested in a PMS program. Such assistance includes initiating, coordinating, and developing pavement management programs for municipalities. The municipalities are responsible for all data collection and must make a commitment to participating in the program on an ongoing basis.
- Sharing pavement condition data and other information with the municipalities by making available various kinds of data through the MPO's website. Non-MassDOT FA-eligible roads compose one-third of the total mileage of roads in the MPO region; therefore the MPO could provide a significant amount of pavement condition data and information to the municipalities.

COST OF IMPLEMENTING A PMS IN THE BOSTON REGION MPO AREA

A typical network-level PMS for an MPO comprise six components:

1. Inventory data (roadway and traffic information)
2. Pavement condition data (distress and ride-quality data)
3. Database for storing and preparing the inventory and pavement condition data for analysis
4. Data analysis (most commercially available PMS software contains analytical routines for rehabilitation, prioritization, and funding analyses)
5. System output (PMS software produces several outputs: reports, graphics, and maps)
6. Monitoring and providing feedback

The cost of implementing a PMS is related closely to the six components described above. A work plan outlining the goals and objectives for the Boston Region MPO's PMS and the various tasks and products of the components is the first step. The Boston Region MPO has already acquired some of these components, including roadway inventory and traffic data, database management systems, and GIS software. As a result, the MPO needs to focus resources on the following:

- Acquisition of PMS software and data-collection and processing equipment
- Collection of pavement condition data

- Data analysis (staff time for data processing and analysis)
- Other direct and indirect costs

Table 3 shows the implementation costs for the 2,804 centerline miles of local FA-eligible roadways in the Boston Region MPO area. It is estimated to cost \$359,722 over a five-year period (\$71,945 annually) to prepare, collect, process, analyze, and document the results of a PMS for the FA-eligible roadways in the Boston Region MPO area. This estimate is based on a data collection methodology that maximizes the speed of data collection in the field. The entire data collection effort would be completed using high-definition digital video to capture road surface conditions. The video is both distance-referenced and geo-referenced using GPS technology for ease of post-processing and maximum compatibility with any GIS. The videos are post-processed in the office to produce condition information on each road segment. The entire 2,804-centerline miles of FA-eligible roads would be collected over a period of four years using this methodology and analysis, and documentation of the findings and recommendations would take another year. The whole process would be repeated every five years.

MPO staff have a preference for video over manual pavement surveys because the latter are labor- and time-intensive, and data reliability depends on training and rater performance. A number of studies have shown that manual ratings have high levels of variability with respect to rater repeatability, as well as high rater-to-rater variability.

BENEFITS AND IMPACTS OF A PMS FOR THE BOSTON REGION MPO

Implementing a PMS for the Boston Region MPO is estimated to cost approximately \$67,000 to \$75,000 annually, excluding an initial start-up cost of approximately \$30,000 for the purchase of software and equipment. This investment would have several benefits for and impacts on MPO activities.

Benefits

Addressing FHWA Concerns

- Estimating accurately the maintenance costs for FA-eligible roads in the MPO region, information originally requested by the FHWA. Such information will also inform the MPO of regional needs and shortfalls and the effects of underfunded roadway programs. The MPO could use this information to build support for increased funding.
- Becoming more consistent with the FHWA policy of using performance-based planning to assess the effectiveness of plans and programs in meeting regional needs.

Informing the TIP Development Process

A PMS would provide the MPO with objective data (pavement condition indices) that could be used as criteria for evaluating TIP projects for funding, identifying appropriate maintenance strategies, and developing comprehensive project costs.

Informing the LRTP Development Process

A PMS would allow the MPO to determine existing and future pavement conditions and funding needs to support the development of the LRTP. With a PMS, the MPO can set a target pavement value (goal) of “good or excellent condition” for the FA-eligible roadways, determine the funding levels needed for achieving this target value, prioritize pavement preservation projects in the TIP for that purpose, and monitor performance.

Support Municipalities in the Maintenance of FA-Eligible Roadways

- A PMS would provide valuable and consistent information to municipalities to allow them to consider more efficient and cost-effective pavement management strategies to keep FA-eligible roadways in good or excellent conditions and prevent them from deteriorating to fair or poor condition, which would require very costly deep-pavement reconstruction. Pavement condition data collected on FA-eligible roadways could be analyzed and used to create an interactive pavement condition map to assist municipalities with pavement management efforts and inform the public of pavement conditions in their communities.

In addition, such information could help the MPO in its effort to reduce the number of TIP “reconstruction” projects that often include very costly deep-pavement reconstruction. However, other than using the information to influence TIP project selection, it is understood that the MPO would not have the power to influence the maintenance priorities of municipalities.

- A PMS would also provide continued, limited technical assistance and support for municipal pavement management programs by making pavement reports and presentation material available for decision makers, and initiating, coordinating, and developing pavement management programs for municipalities as requested.

Impacts

Funding may be an impact in implementing a PMS for the Boston Region MPO. With level-funding, a PMS could impact other planning activities currently being carried out by the MPO through the UPWP at the cost of \$67,000 to \$75,000 annually. This potential impact would have to be considered when making the decision to implement a PMS.

Recommendations

From the analysis in this study, staff concluded that there are a lot of benefits to be had for a relatively modest cost, and that therefore, the MPO might want to strongly consider adopting a PMS.

Appendix

Cover Letter to Chief Elected Officials

Survey Questionnaire Form

Tables

Table 1: Survey Respondents: Municipal Pavement Management Systems

Table 2: Status of RPA Pavement Management Systems

Table 3: Estimated Cost of a Pavement Management Systems for the Boston Region MPO

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Figure 1: Municipalities That Responded

Figure 2: Preparation of Annual Road-Paving Budget

Figure 3: Process Used in Developing Annual Road-Paving Program

Figure 4: Criteria for Outsourcing Data Collection

Figure 5: Data Collection Methods

Figure 6: Pavement Management Software

Figure 7: Funding for Road-Paving Projects

Cover Letter to Chief Elected Officials

Subject line of message: Municipal Road-Paving Programs

Dear Chief Elected Official

The Boston Region Metropolitan Planning Organization (MPO) invites you to participate in an online survey regarding road maintenance programs in our region. MPO staff value your thoughts and opinions and thank you in advance for your time. The survey will give the MPO insight into the cost of the maintenance of federal-aid-eligible roadways that is performed by the cities and towns that make up our region. This is important information for updating the region's Long-Range Transportation Plan and Transportation Improvement Program.

The purpose of this study is threefold:

- To determine the maintenance costs for the federal-aid-eligible roads in the MPO region that are maintained by municipalities
- To understand the process that the municipalities use in developing their annual road-paving projects
- To obtain information about the data, software, and funding for municipal pavement management systems

If this survey would be better answered by somebody else within your municipality, such as your municipality's Director of Public Works, please feel free to forward it to that individual. We hope to receive your completed electronic survey by Monday, June 20, 2011. If you have any questions, please contact Seth Asante of my staff at sasante@ctps.org or 617-973-7098.

Please click the following link to begin your survey:

http://www.ctps.org/bostonmpo/paving_program_survey.html

Thank you in advance for your help and cooperation with this study. Upon completion of the study, you will be able to view the results on the MPO's website.

Yours truly,

Efi Pagitsas
Manager, Traffic Analysis and Design
Central Transportation Planning Staff
State Transportation Building
10 Park Plaza, Suite 2150
Boston, MA 02116

epagitsas@ctps.org
Telephone: 617-973-7106
Fax: 617-973-8855

Survey Questionnaire Form

A SURVEY OF MUNICIPAL PAVEMENT MANAGEMENT SYSTEMS BOSTON REGION METROPOLITAN PLANNING ORGANIZATION

Part I: General Information

1. Please select your city or town. (choose one)

(required)

2. Please provide the contact information of the person filling out this survey.

Name:

(required)

Phone:

E-

mail: (required)

3. Who prepares your municipality's annual road paving budget? (choose one)

Public Works Department (in-house)

Public Works Department, along with a pavement-maintenance committee

Public Works Department, along with a consultant

Other (please specify below)

4. What process does your municipality use in developing its annual road-paving budget?

(check all that apply)

Decision-making process using pavement condition data

Last year's funding with arbitrary increase or decrease

Periodic maintenance schedule (such as micro-surfacing every 5 years and overlay every 15 years)

“Fighting-fires” approach (fixing roads that citizens complain about)

Fixing “worst-first” approach

Political pressure

Reliance on recommendation based on experience and knowledge of managers

and employees

Other (please specify below)

5. Does your municipality coordinate its annual road paving with the work of the water and sewerage division and other utility work? (choose one)

Yes

No

Not sure

Additional Comments:

Part II: Data Collection Practices

6. How does your municipality collect pavement-condition data? (check all that apply)

In-house collection

Outsourced to contractor(s)

Not collected

Other (please specify below)

7. What criteria does your municipality use to determine whether or not to outsource pavement-condition data collection? (check all that apply)

Cost-effectiveness

Scope of data-collection requirements

Availability of qualified contractors

Capability of in-house data-collection teams

Experiences of other municipalities that have outsourced data collection

Other (please specify below)

8. What types of pavement data-collection methods are employed? (check all that apply)

Walking survey

Windshield survey

Automated image collection from pavement evaluation vehicles

Other (please specify below)

9. For what types of roadways does your municipality collect pavement-condition data?
(check all that apply)

Arterial roads only (municipally owned)

Arterial roads only (federal-aid eligible)

Arterial and collector roads (municipally owned)

Arterial and collector roads (federal-aid eligible)

Other (please specify below)

10. Does your municipality use an overall-pavement-condition index when analyzing pavement conditions?
(choose one)

Yes

No

Not sure

(If yes, please check the index.)

PSI: Pavement present-serviceability index

PCI: Pavement condition index

IRI: International roughness index

Other (please specify below)

Part III: Software

11. What type of pavement-management software does your municipality or your consultant use?
(choose one)

Road Manager

CartêGraph PAVEMENTview

eRoadInfo Pavement

MicroPaver

Developed by contractor (please specify below)

Developed in-house (please specify below)

Spreadsheets/database (Microsoft Excel, Access, etc.)

Other (please specify below)

12. What decision criteria did your municipality use to select your pavement-management software?
(check all that apply)

Cost

Flexibility and ease of use for pavement management systems

Software's capabilities and functionalities

Ease of use and training

Other (please specify below)

Part IV: Funding

13. What kinds of funding does your municipality use for developing its annual road-paving budget?
(check all that apply)

Chapter 90 funds

City/town budget for roads
City/town bond bill
Funds from water and sewerage enterprises
Other (please specify below)

14. Approximately how much does your municipality spend annually for road-paving projects?
(Please give an average estimate based on funding for the last two years.)

15. Do you have any additional comments or recommendations?

Please send any information you think may be of use for this project to Seth Asante at sasante@ctps.org;
10 Park Plaza, Suite 2150, Boston, MA 02116; telephone: 617-973-7098; or fax: 617-973-8855.

TABLE 1
Survey Respondents: Municipal Pavement Management Systems

Community	Name	Phone	Email	Comments
Acton	Corey York	978-929-6630	Cyork@Acton-ma.gov	None
Ashland	Doug Small	508-881-0120 ext. 14	dsmall@ashlandmass.com	The high cost of bituminous concrete has put a major strain on roadway maintenance. The annual allocation is 1/3 of what the Town actually needs in order to keep up with road deterioration.
Bedford	Richard Warrington	781-275-7605	rwarrington@bedfordma.gov	None
Bellingham	Donald DiMartino		ddimartino@bellinghamma.org	None
Belmont	Glenn R. Clancy	617-993-2650	gclancy@belmont-ma.gov	None
Boston	David Mallen	617-635-4963	David.Mallen@cityofboston.gov	None
Braintree	Robert Campbell	None provided	rcampbell@braintreema.gov	The town gets the greatest efficiency by performing timely repairs to higher-volume streets, because the treatments are relatively inexpensive when performed early enough, and the pavement condition index will stay high for longer.
Burlington	Thomas Hayes	None provided	lmatarazzo@burlmass.org	None
Duxbury	Peter Buttkus	781-934-1100	buttkus@town.duxbury.ma.us	None
Everett	Julius Ofurie	617-394-2251	julius.ofurie@ci.everett.ma.us	None
Framingham	Jeremy Marsette	508-532-6010	jmarsette@framinghamma.gov	The Town's policy now focuses on maintaining and preserving pavement using various techniques, such as crack sealing, micro surfacing, and patching. We have also optimized surface treatment strategies in order to extend pavement life using available funds.
Hamilton	John Tomasz	978-468-5591	jtomasz@hamiltonma.gov	Costs will be much higher this year as we were saving Chapter 90 funding for larger projects.
Hopkinton	Mike Mansir	None provided	mikemansir@hopkinton.org	None
Lexington	John Livsey	781-274-8305	jlivsey@lexingtonma.gov	Please note that our funding is far below what is needed to maintain our roadways at the current PCI and that additional funding is needed. This is common throughout Massachusetts communities.
Manchester	Thomas P, Kehoe	978-526-4381	tkehoe248@aol.com	In FY 11 budgeted at \$125,000 plus Chapter 90 money. In FY 12 budgeted at \$125,000 plus Chapter 90 money.
Marblehead	Rebecca Curran	781-631-0000	curran@marblehead.org	Whatever we receive in Chapter 90 funds.
Medway	Tom Holder	508-321-4936	tholder@townofmedway.org	None
Natick	Mark Coviello	508-647-6551	mcoviello@natickma.org	Approximately \$850,000.00 per year plus any money that is appropriated through our Capital Improvement Plan
Newton	David Turocy	617-796-1000	dturocy@newtonma.gov	None

(Continued)

TABLE 1 (continued)

Norfolk	Robert J McGhee	508-528-4990	mcghee@virtualnorfolk.org	\$30,000 for maintenance and emergencies only.
Norwood	Mark Ryan	781-762-1413	mryan@norwoodma.gov	Increased funding from state and federal programs would help cities and towns keep roads in a more respectable condition.
Peabody	Robert Langley	None provided	Robert.langley@Peabody.ma-gov	None
Revere	Thomas Ambrosino	None provided	tambrosino@revere.org	None
Rockport	Joe Parisi	978-546-3525	jparisi@town.rockport.ma.us	We are holding off on doing more paving projects in order to do other utility work first.
Sharon	Bill Petipas	781-784-1525 ext. 2320	wpetipas@townofsharon.org	Residents and town government have always had proactive approach to paving budgets and schedules. Annual budget is \$1.5–2.5 million, depending on capitol budget and Chapter 90 reimbursement.
Sherborn	Edward Wagner	508-651-7878	ed.wagner@sherbornma.org	None
Sudbury	William Place	978-443-2209 ext. 1390	placeb@sudbury.ma.us	None
Walpole	Michael Boynton	508-660-7289	mboynton@walpole-ma.gov	None
Wenham	Bill Tyack	978-468-5520 ext. 6	btyack@wenhamma.gov	None
Weymouth	Jeffrey Bina	781-337-5100 ext. 309	jbina@weymouth.ma.us	None
Wilmington	Donald Onusseit	978-658-4481	donusseit@townofwilmingtonma.com	\$600,000 per year (all Chapter 90 funds). No Town funds are provided for road resurfacing reconstruction.
Winchester	James Gill	781-721-7106	jgill@winchester.us	None
Wrentham	Irving Priest	508-384-5477	ipriest@wrentham.ma.us	Increase Chapter 90 funding. It was funded at \$150 million 15 years ago and has not kept pace with cost increases.

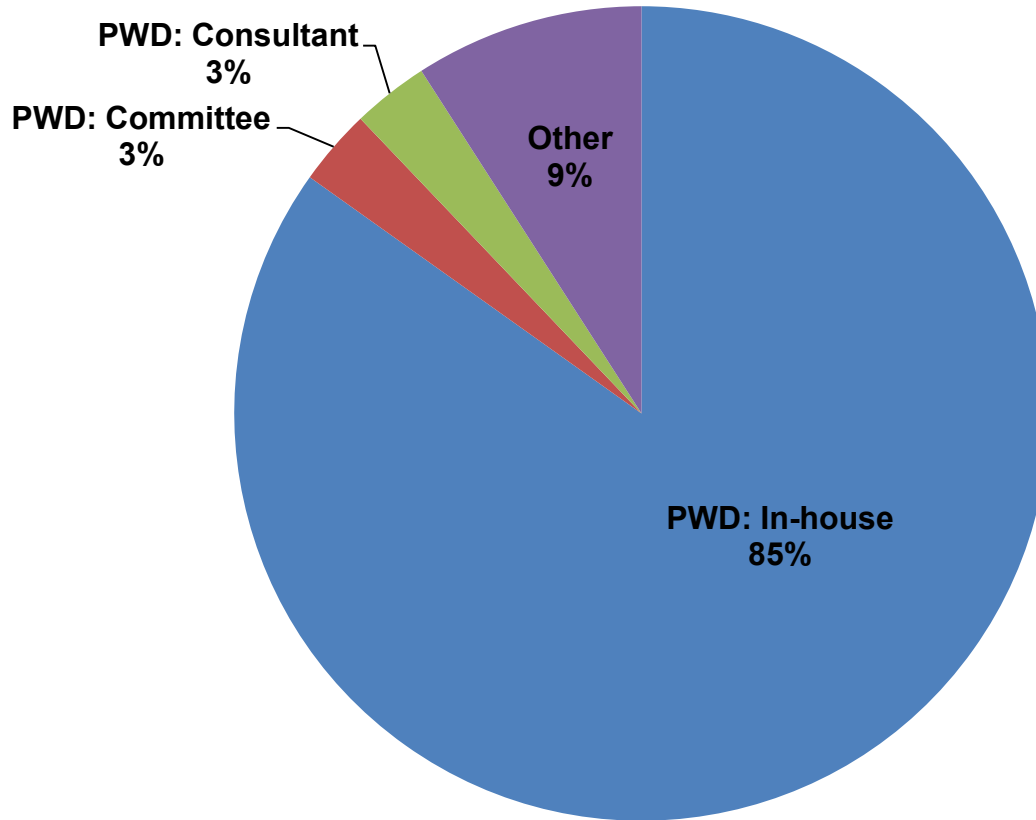
TABLE 2
Status of RPA Pavement Management Systems

	Central Massachusetts Regional Planning Commission	Montachusett Regional Planning Commission	Old Colony Planning Council	Southeastern Regional Planning and Economic District
Software	CarteGraph	RSMS	Road Manager	RSMS
Centerline miles	1,200	600	608	780
Update cycle	4 years	2 years	4 years	3 years
Roadways included	Federal-aid system only	Federal-aid system only	Federal-aid system only for LRTP, Local sections by community requests	Federal-aid system only
Data collection	RPA	RPA	RPA	RPA
Segment identifier	Road inventory file	Road inventory file	Road inventory file	Road inventory file
Annual cost	\$45,000	\$30,000	\$15,000	\$35,000
Funding programming	UPWP	UPWP	UPWP	UPWP
Local jurisdiction PMS	RPA will contract to provide PMS services (1 contract per year for the past 3 years)	1 out of 22 jurisdictions uses the RPA. Others have expressed interest in hiring consultants	RPA provides occasional technical assistance to local jurisdiction	Yes

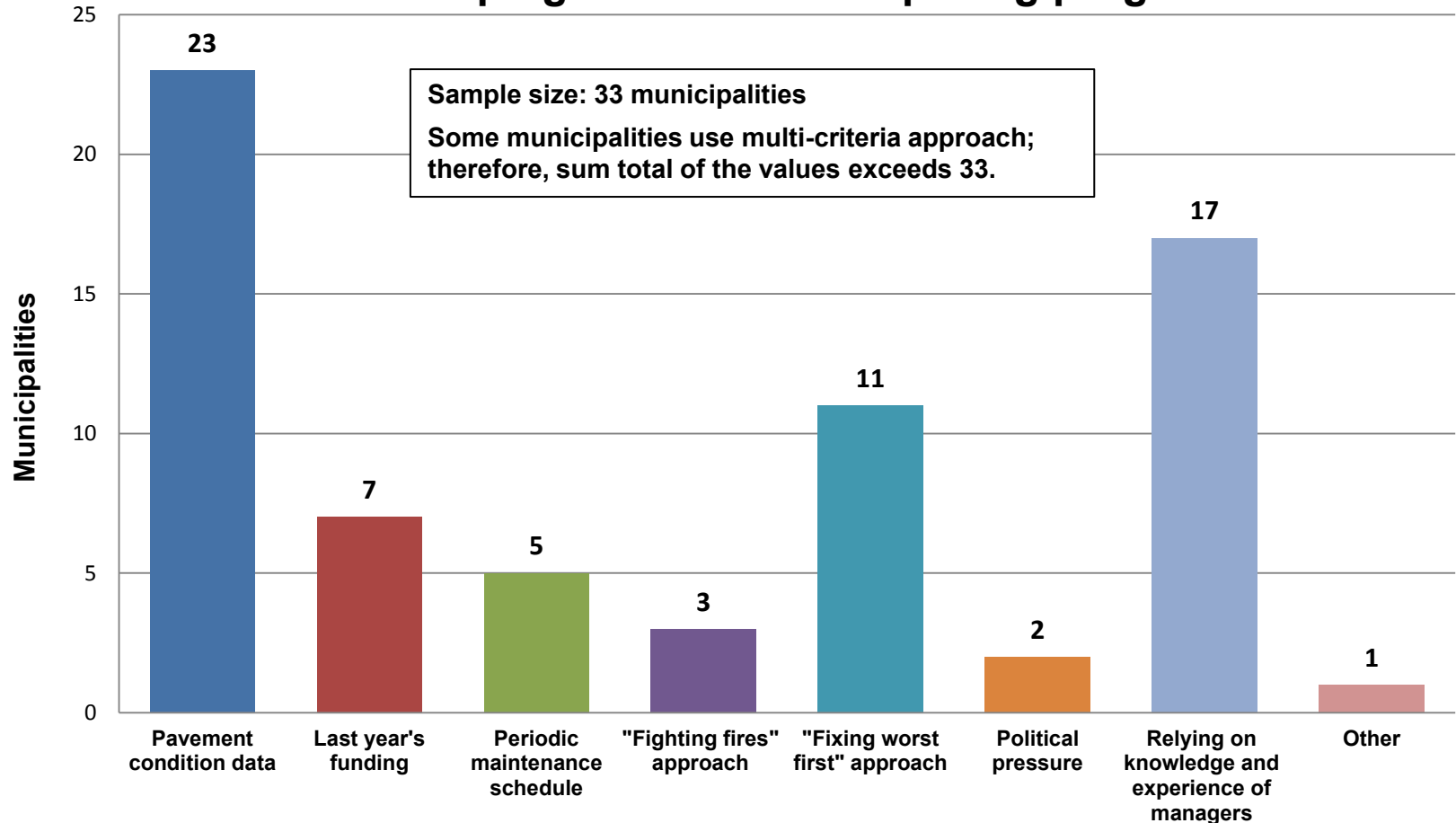
TABLE 3
Estimated Cost of a Pavement Management System for the Boston Region MPO

Direct Salary and Overhead								\$318,722	
Task	Person-Weeks					Direct Salary	Overhead (@ 94.57%)	Total Cost	
	M-1	P-5	P-2	Temp	Total				
1. Preparation and selection of FA roads	2.0	4.0	4.0	0.0	10.0	\$13,462	\$12,731	\$26,192	
2. Data Collection	3.0	4.0	8.0	38.0	53.0	\$37,084	\$35,070	\$72,154	
3. Data Processing	3.0	6.0	8.0	75.0	92.0	\$58,217	\$55,056	\$113,272	
4. Data Analysis	8.0	6.0	8.0	0.0	22.0	\$30,258	\$28,615	\$58,873	
5. Documentation	6.0	8.0	2.0	0.0	16.0	\$24,789	\$23,442	\$48,231	
Total	22.0	28.0	30.0	113.0	193.0	\$163,809	\$154,914	\$318,722	
Other Direct Costs								\$41,000	
Travel (Rentals and Gas)								\$13,000	
Data processing equipment (video-processing software, mobile GPS system, and distance-measuring device)								\$8,000	
PMS software								\$20,000	
TOTAL COST								\$359,722	

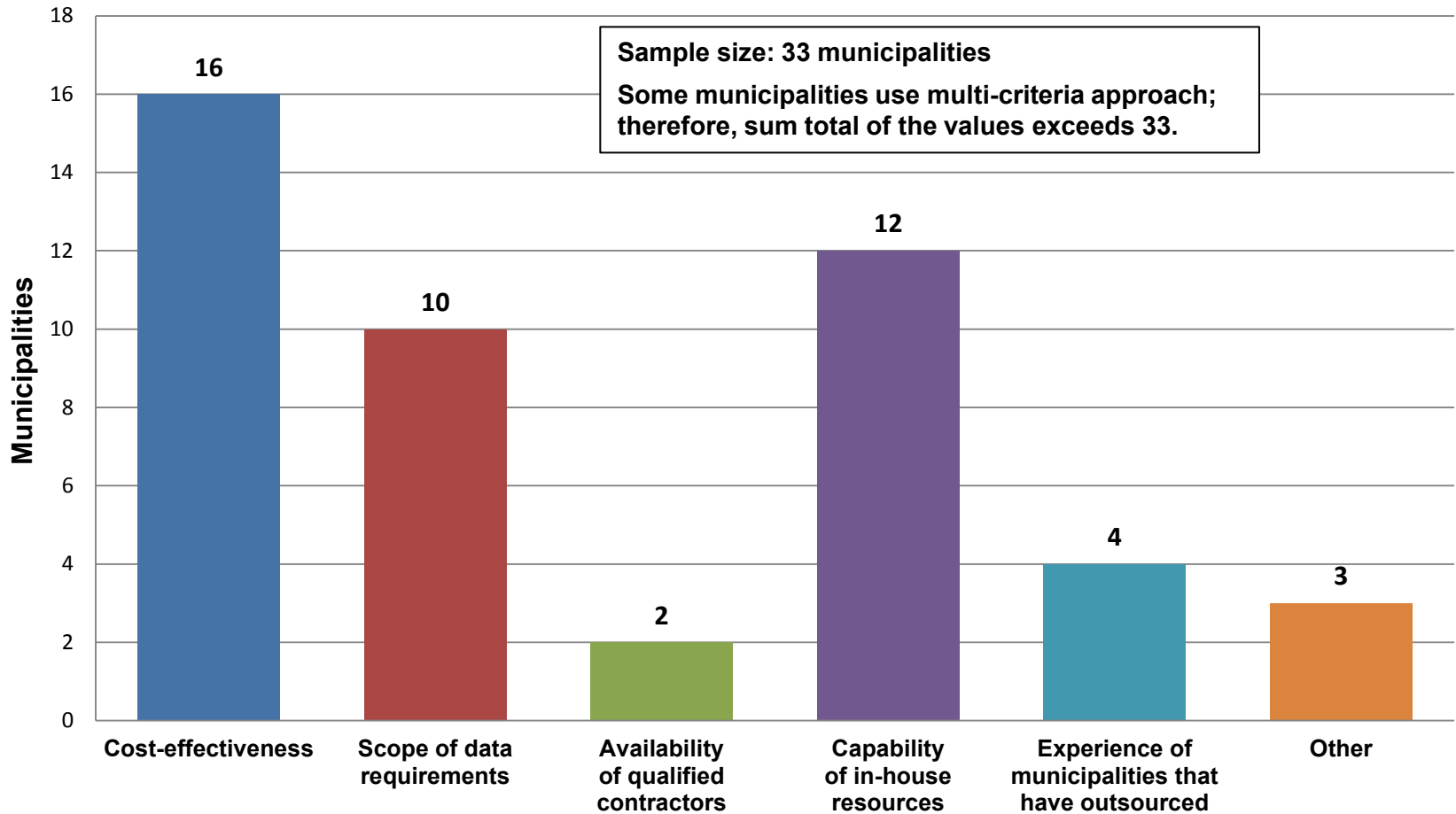
Who prepares your annual municipal road-paving program?



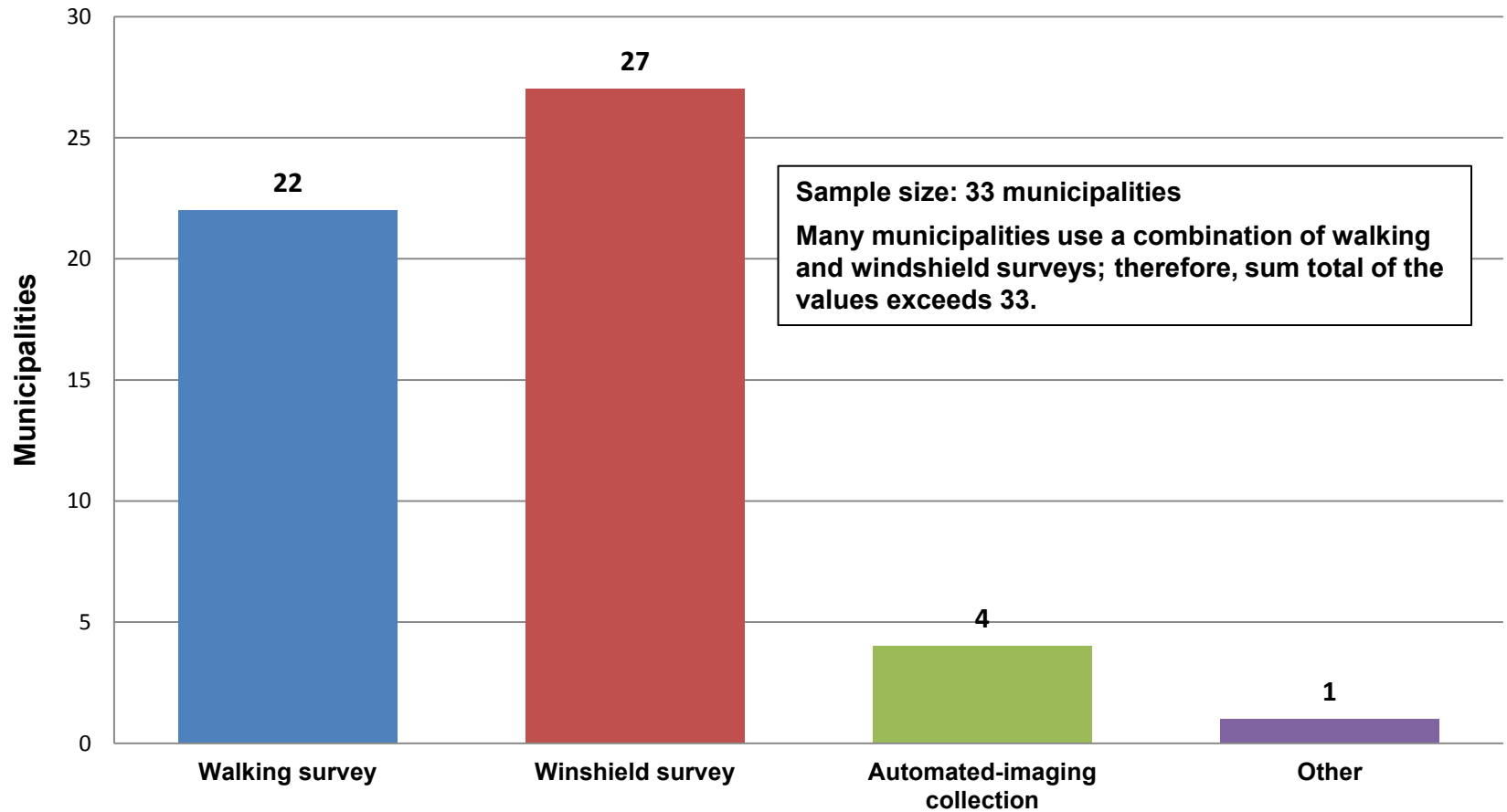
What process does your municipality use in developing its annual road-paving program?



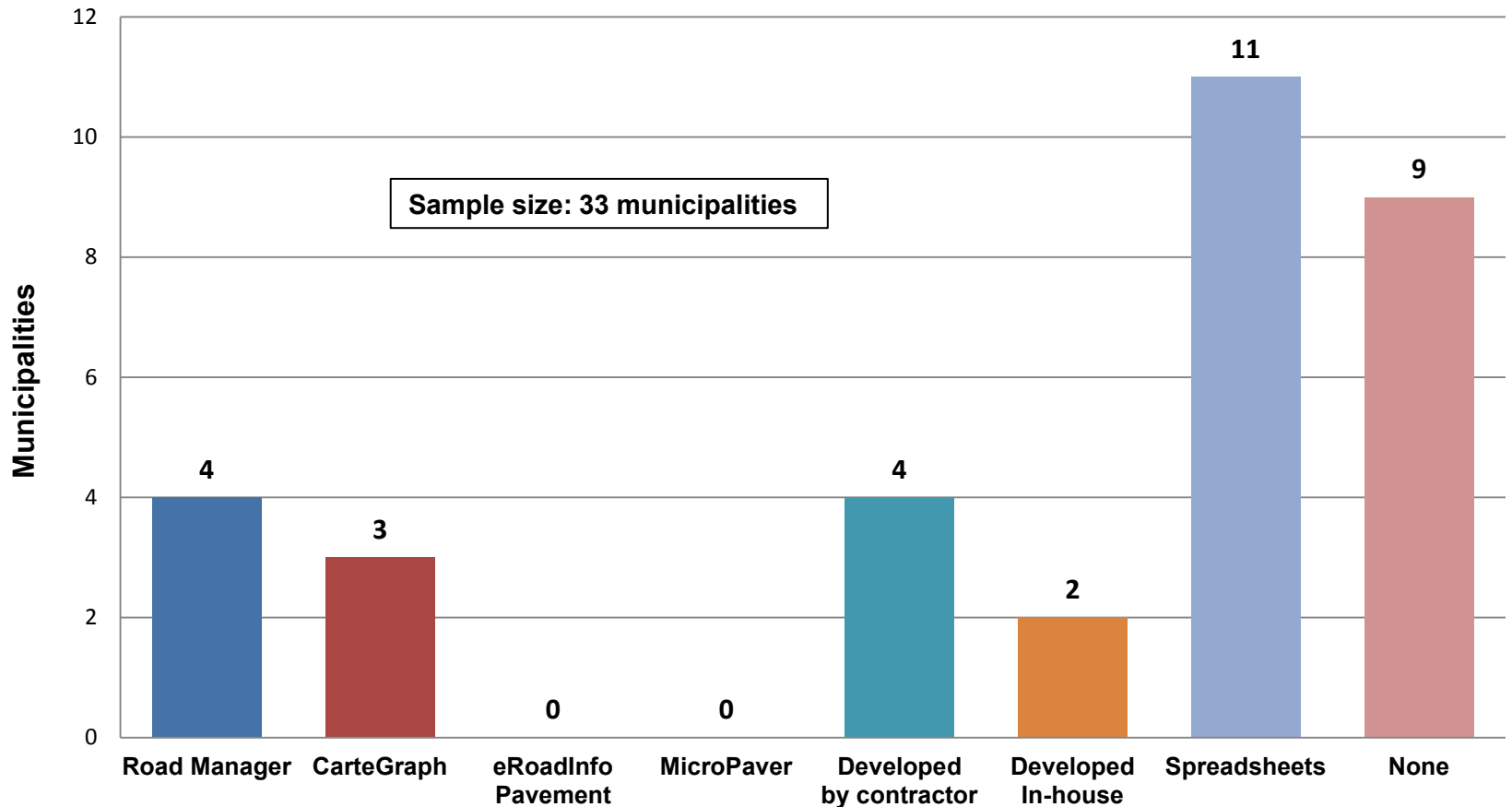
What criteria does your municipality use for determining whether or not to outsource pavement condition data collection?



What types of pavement data collection methods are employed?



What type of pavement management software does your municipality or consultant use?



What kinds of funding does your municipality use in developing its annual road-paving budget?

