Canadian Traffic Signal Report Card

Canadian Institute of Transportation Engineers

Prepared by:
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www.ite.org

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EXECUTIVE SUMMARY

This document intends to focus attention on the operation and maintenance of traffic signal systems—an activity that can produce on of the highest benefit-cost ratios for improvement to the highway transportation system. The purpose of the *2008 Canadian National Traffic Signal Report Card* is to:

- assess the current state of traffic signal management and operation;
- identify deficiencies in traffic signal systems and highlight ways to improve operation;
- improve awareness of the current state of traffic signal systems in Canada;
- create awareness of the congestion-reducing benefits of good traffic signal management and operation; and
- provide a benchmarking tool for jurisdictions to identify opportunities for improvement in traffic signal management and operation.

The Traffic Signal Operations Self Assessment was conducted in 2007 by the Institute of Transportation Engineers for the National Transportation Operations Coalition. Twenty eight agencies in Canada responded to this voluntary survey of traffic signal operations.

The self assessment consisted of 50 questions in the topic areas of management; signal operations at individual intersection and in coordinated systems; signal timing practices; traffic monitoring and data collection; and maintenance. The self assessment provided descriptive information on the activities necessary to achieve a benchmark score of "5" and the opportunity to specify if an activity was not applicable to an agency.

The Canadian Traffic Signal Report Card provides a composite score and letter grade for Canada derived from the 28 agencies' responses to the 2007 Traffic Signal Operations Self Assessment. Questions focused on outcomes of traffic signal operations and their performance measures instead of outputs. The report card uses the aggregate of the responses to determine the average national score for each section and the associated letter grade. Individual results are anonymous.

Findings indicate that, overall, traffic signal operations in Canada score a 69, equivalent to a D+ letter grade, with scores remarkably similar across the country and across jurisdictions. This low grade demonstrates the continued need for attention and additional resources for traffic signal management and operation. Although there may be some high-performing signal systems, on the whole, the vast majority of systems across Canada have the potential for greatly improved performance. A grade of D+ means that government agency programs to support efficient maintenance and operations of traffic signals are not as effective as they could be. Similarly, taxpayers should understand that a modest investment in resources can yield the benefits necessary to improve from a D+ grade to an A grade.

The most noteworthy finding is the poor performance in the management section. One-third of the respondents reported having minimal or no management of traffic signal operations and almost one-half do not have staff or resources committed to monitor or manage traffic signal operations on a regular basis. This is a significant concern because proper management of transportation systems is critical to efficient, well-integrated systems that meet the needs of the traveling public.

Operations at individual intersections scored the highest for all systems except for those with fewer than 50 signals, where maintenance scored the highest. This is representative of agencies with limited resources and staff that are forced to address problems in a reactive manner.

Traffic signal maintenance scored the second-highest of the individual sections. To maintain a well-functioning traffic signal system, it is critical to have adequate maintenance. The results indicate that for safety and liability reasons, agencies must ensure a basic level of traffic signal system operation and maintenance. The signals may not function efficiently for traffic or pedestrians but, technically, the signals are working and that is what people see.

Traffic monitoring and data collection was also a low scoring area, regardless of signal system size or type of agency. Without regular traffic data collection, it is difficult for agencies to assess the need to update plans on a routine basis and to react to fluctuations in traffic due to incidents or events. Traffic monitoring and data collection are essential for uniform measuring and monitoring of overall systems performance and provide valuable input to the resource allocation process.

Overall, traffic signal systems with more than 1,000 signals scored best, which may be an indication of increased staff resources and a balance of resources even with the complexity of their systems. Large signal systems represent considerable investment in traffic signal infrastructure and often have resources available to provide a high concentration of service.

Topic area		Where agencies are	Goal: excellence in operations
Management	D	A philosophy for how the agency operates signals has not been well documented or shared with employees or the public. Meetings with law enforcement and emergency service providers happen on an ad-hoc, informal basis. Annual reviews of major roadways are rarely conducted. Agencies are unlikely to have an established business plan for operations with clearly defined performance measures and goals.	Agencies have a documented management approach for traffic signal operations that is shared with employees and reported to agency leadership and the public on a regular basis. Agencies meet routinely with law enforcement and emergency service providers and conduct annual field measurements of major roadways to track performance. Agencies have a business plan for transportation operations that describes performance measures and goals specific to the traffic signal program.
Signal operation at individual intersections	C +	Information on signals and timing inventories is collected and maintained in a central location; however, timing field changes to reflect related safety or efficiency assessment and changes in traffic or land use patterns are made irregular, non-systematic basis.	Agencies maintain a comprehensive system for monitoring high-priority arterials and locations with high crash rates as well as an inventory of all traffic signals and their timing settings. Signal timing is reviewed for all signals at least every three years.
Signal operation in coordinated systems	D	Traffic signal timing is rarely reviewed, resulting in outdated timing patterns that do not reflect current traffic and pedestrian needs. Inadequately coordinated signals force motorists to stop at multiple adjacent intersections and result in significant travel delays.	A comprehensive review of area-wide or corridor signal timing is conducted every three years or more often if traffic volumes or land uses change. Routine reviews are conducted for high-priority arterials and locations with high crash rates. Agencies use a comprehensive system for monitoring all reviews.
		As travelers cross jurisdictional boundaries, they experience stops and delays due to lack of coordination between systems.	Traffic signals are coordinated across jurisdictional boundaries. Travelers don't know when they have entered another jurisdiction's signal system.
		Signal technicians are not current on the use of modern software or are prevented from using current software due to resource constraints, resulting in signal timings that are not optimized.	Technicians are knowledgeable and consistent in the use of signal optimization software.
		Timing plans are not in place for emergencies and special events.	Signal timing plans exist for emergencies and special events. Timing plans are implemented quickly and effectively.
Signal timing practices	D	Intersection operations are infrequently checked in the field to accommodate changing traffic conditions. As a consequence, significant traffic queuing occurs, resulting in blocked lanes and increased congestion.	The overall effectiveness or outcome of traffic signal improvements is measured and assessed to demonstrate practices that produce efficient results. Agencies typically check signal offsets through field observation and adjust as required.
Traffic monitoring and data collection	D	Real-time traffic data are seldom available to the traveling public for information and route planning. There are few, if any, quality checks for traffic monitoring and collection systems. This leads to inaccurate data for signal operations and the potential for broken equipment in the field. As a result, signals may not operate based on actual traffic conditions, resulting in delays.	Established programs for checking the quality of data gathered by roadway detectors are utilized to check against historical data, field observations, or physical checks to make sure they are operating correctly. Real-time traffic monitoring systems are in place to evaluate traffic flow and allow immediate signal timing adjustments.
Maintenance	C	Agencies lack adequate staff and training resources and, therefore, are forced to address only the most critical issues rather than proactively maintain the signal system.	Maintenance offices are adequately staffed to ensure the continued sound operation of traffic signals.

Introduction

Traffic signals have an impact on the everyday lives of the traveling public, whether traveling to and from work, grocery shopping, or simply walking to lunch. Almost everyone encounters a traffic signal in his or her day-to-day travels. The way traffic signals operate either can help the journey along or can increase the time spent on daily routines.

In addition to driver impacts, signal-related congestion has broader economic, societal and environmental impacts. Congestion not only wastes fuel, time and money, but is also a significant factor in shaping the quality of life for individuals and families. The real impact of congestion is felt in how and where people choose to live, how they commute and how much they pay for things resulting from the additional costs congestion imposes on society. As the consumers of the transportation system, everyday travelers observe these inefficiencies and know that something more can be done. Improving traffic signal operations must be a priority.

Transportation professionals have long recognized the value of effectively operating traffic signal systems to meet changing travel patterns and user characteristics. The *2008 Canadian Traffic Signal Report Card* provides an answer to the question: *How well does the nation manage, operate and maintain its traffic signal systems?* This report card presents the results of the 2007 Traffic Signal Operation Self Assessment and the findings from the consolidated responses of 28 agencies across Canada. The self assessment was a voluntary survey conducted by the National Transportation Operations Coalition.

There are more than 25,000 traffic signals across Canada. Traffic signals are owned, operated and maintained by provincial and local governments. Some agencies have performed well and some have made incremental improvements to their programs. On the whole, however, the vast majority of traffic signal systems across Canada have the potential for greatly improved performance. Small changes can help increase the effectiveness of traffic signal operations and ultimately can reduce delay to travelers. Improved traffic signal operations also can help minimize air pollution by making sure that vehicles are not starting and stopping wastefully and using more fuel than necessary. Studies show that the benefits of investing in traffic signal timing outweigh the cost by as much as 40:1.[1] Because traffic signals are a public investment, jurisdictions have a fiduciary responsibility to maintain and operate them at a high level.

Looking at this from the simplest perspective, traffic signals are infrastructure assets for the control of vehicular and pedestrian traffic. Traffic signals assign the right-of-way to the various traffic and pedestrian movements at an intersection. Public agencies have a responsibility to

manage and operate traffic signal systems in a manner that protects public investment like all other roadway infrastructure. Appropriately designed, located, operated and maintained traffic signals can:

- provide for the smooth flow of traffic along streets and highways at defined speeds, thereby **reducing congestion**;
- increase the traffic-handling capacity of intersections to **improve mobility for transit vehicles, commercial vehicles, private vehicles and bikes** through the use of appropriate layouts and control measures, as well as regular reviews and updates to the operational parameters; and
- reduce the number of stops a vehicle makes, thereby:
    - **lessening the negative impacts to air quality**; and
    - **reducing fuel consumption**.

The purpose of the *2008 Canadian National Traffic Signal Report Card* is to:

- assess the current state of traffic signal management and operation;
- identify deficiencies in traffic signal systems and highlight ways to improve operation;
- bring attention to the current state of traffic signal systems;
- create awareness of the congestion-reducing benefits of good traffic signal management and operation; and
- provide a benchmarking tool for jurisdictions to identify opportunities for improvement in traffic signal management and operation.

Self Assessment and Response

The 2007 Traffic Signal Operation Self Assessment is a survey tool created to collect information and assess traffic signal management and operations practices (see Appendix A). A team of professionals representing the National Transportation Operations Coalition (NTOC) developed the survey. The survey was available to respondents electronically through the Institute of Transportation Engineers Web site and by paper copy. Participating in this NTOC team were experts representing professional associations in the public works, municipal signal, intelligent transportation systems and traffic engineering fields as well as national, provincial and local agencies. Questions focused on outcomes of traffic signal operations and their performance measures instead of outputs. Additional information provided to some of the questions to give respondents more specific information on how to score themselves to promote consistent scoring across respondents.

Respondents are asked to rate themselves (on a scale from 1 to 5) the extent to which a particular policy or practice has been adopted by their agency. Each question is followed by a short description of outstanding practice (a score of 5). Respondents also are given an option of "not applicable" for questions that do not apply to their agency.

The *2008 Canadian Traffic Signal Report Card* uses the aggregate of the responses to determine the average national score for each section and the associated letter grade. Individual results are anonymous. Further, to provide an additional tool for practitioners, the 2007 self assessment provides the respondents with a detailed description of the scoring methodology. The scoring methodology was designed to allow agencies to benchmark their own performance and derive an individualized score prior to submittal.

There was at least one agency response (provincial or municipal) from each province/territory except the Northwest Territories. Table 1 shows the number of responses by traffic signal system size and Table 2 presents the number of responses by jurisdiction population.

The 2007 National Traffic Signal Report Card uses the aggregate of the responses to determine the average national score for each section. Individual results are anonymous.

Table 1: Number of Responses by Signal System Size

Number of Traffic Signals	Number of Responses
Less than 50 signals	1
50 to 150 signals	8
150 to 450 signals	8
450 to 1,000 signals	8
More than 1,000 signals	3
Total	**28**

Table 2: Number of Responses by Jurisdiction Population

Population	Number of Responses
Less than 50,000	1
50, 000 to 250,000	7
250,000 to 500,000	5
500,000 to 1,000,000	8
More than 1,000,000	7
Total	**28**

National Results

The national grade is a composite score derived from the 28 responses to the Traffic Signal Operations Self Assessment for the 2008 report card. The 28 responses were treated equally and were not weighted by system size, agency type, or population. While these criteria are important to characterizing and drawing conclusions about the current state of traffic signal operations, the overall score is presented as an indicator that can be applied on a national scale.

Findings indicate that, overall, traffic signal operations in Canada score a 69, equivalent to a D+ letter grade, with scores remarkably similar across the country and across jurisdictions. This grade demonstrates the continued need for attention and additional resources for traffic signal management and operation. Although there may be some high-performing signal systems, on the whole, the vast majority of systems across Canada have the potential for greatly improved performance. A grade of D+ means that agency programs to support efficient maintenance and operations of traffic signals are not as effective as they could be. Similarly, taxpayers should understand that a modest investment in resources can yield the benefits necessary to improve from a D+ grade to an A grade.

The signal assessment was divided into six topic areas identified as necessary for good signal operations:

- Management
- Signal operations at individual intersections
- Signal operations in coordinated systems
- Signal timing practices
- Traffic monitoring and data collection
- Maintenance

Figure 1 shows the individual results by each of the six topic areas. Figure 2 represents the results by signal system size—the number of traffic signals managed by a responding agency. Figure 3 represents the results by agency type—province/territory, county and city/municipality.

Figure 1: National Score by Topic Area

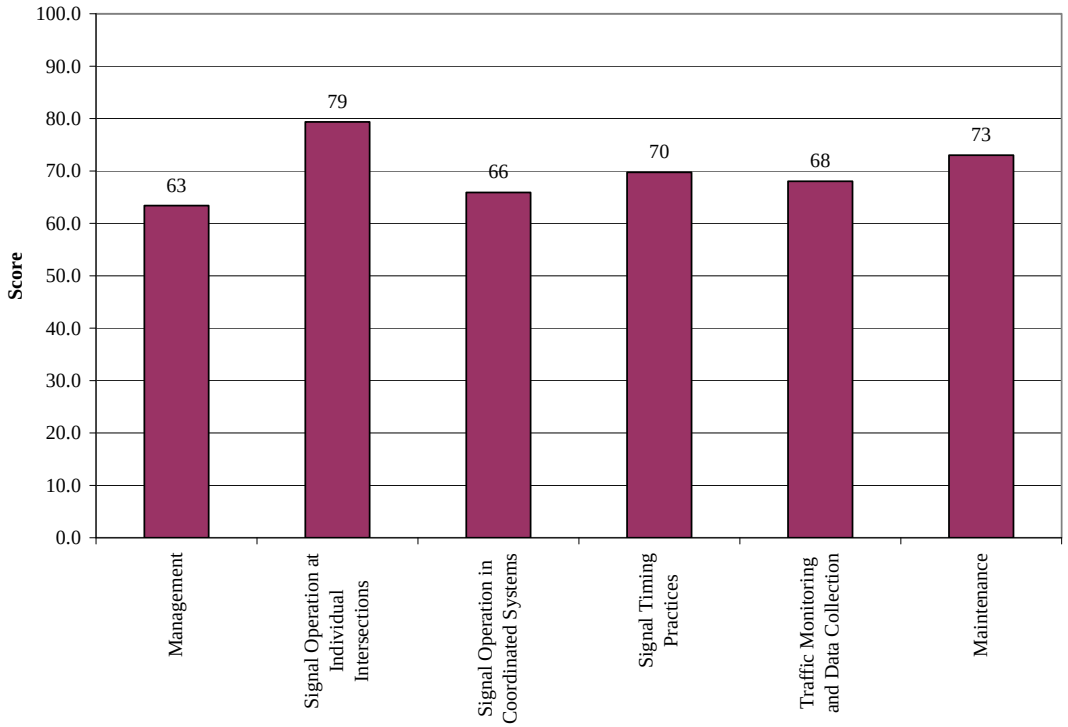


Figure 2: Results by Signal System Size

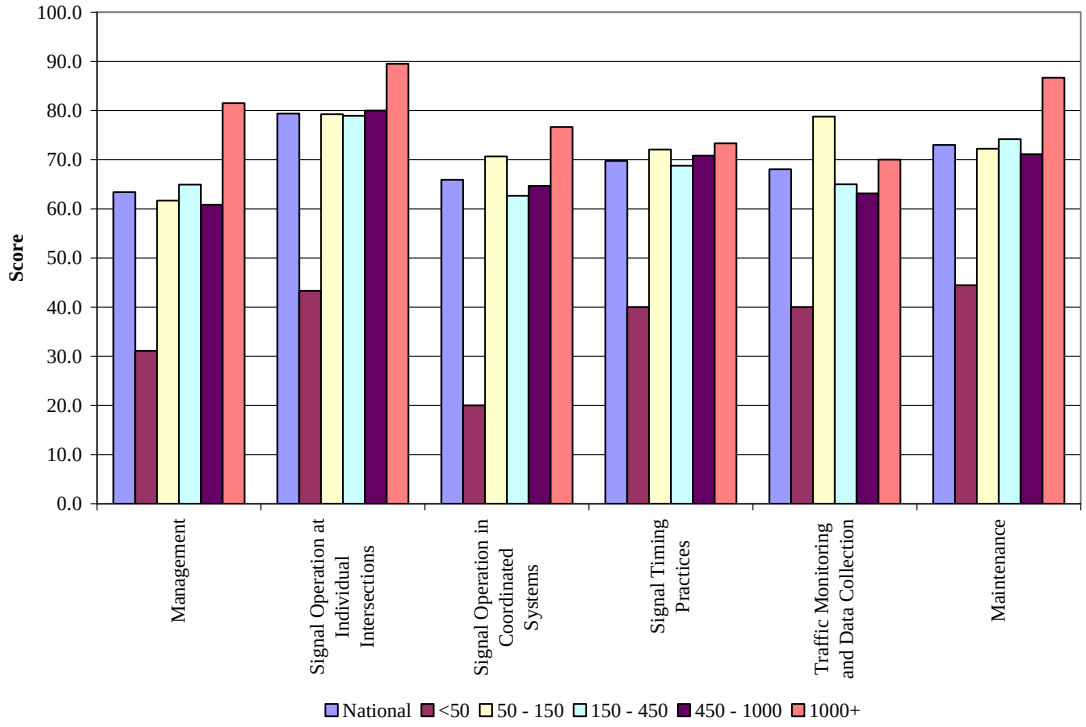
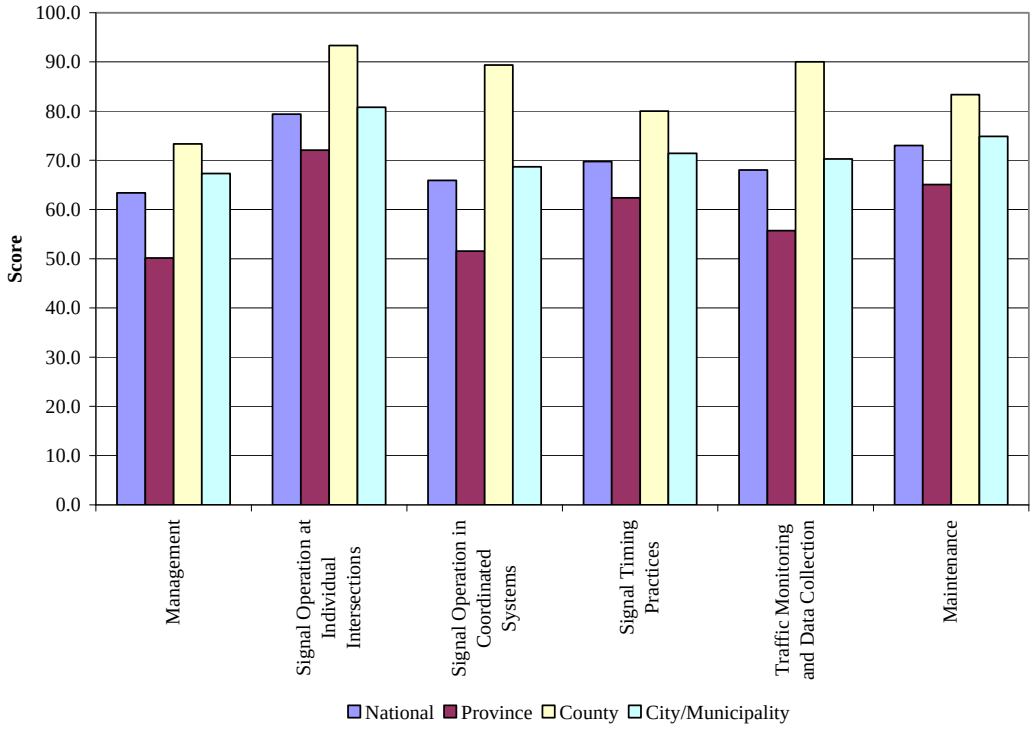


Figure 3: Results by Agency Type



Noteworthy Findings

The most noteworthy finding is the very poor performance in the management section. One-third of the respondents reported having minimal or no management of traffic signal operations and almost one-half do not have staff or resources committed to monitor or manage traffic signal operations on a regular basis. This is a significant concern because proper management of transportation systems is critical to efficient, well-integrated systems that meet the needs of the traveling public.

Operations at individual intersections scored the highest for all systems except for those with fewer than 50 signals, where maintenance scored the highest. This is representative of agencies with limited resources and staff that are forced to address problems in a reactive manner.

Traffic signal maintenance scored the second-highest of the individual sections. To maintain a well-functioning traffic signal system, it is critical to have adequate maintenance. The results indicate that for safety and liability reasons, agencies must ensure a basic level of traffic signal system operation and maintenance. The signals may not function efficiently for traffic or pedestrians but, technically, the signals are working and that is what people see.

Traffic monitoring and data collection was also a low scoring area, regardless of signal system size or type of agency. Without regular traffic data collection, it is difficult for agencies to assess the need to update plans on a routine basis and to react to fluctuations in traffic due to incidents or events. Traffic monitoring and data collection are essential for uniform measuring and monitoring of overall systems performance and provide valuable input to the resource allocation process.

Agencies operating very small signal systems of fewer than 50 signals scored markedly lower than all other agencies. Small cities and towns tend to operate fewer traffic signals than large metropolitan areas. On one hand, the small number of signals means that there are fewer signals to manage and, therefore, they should show better performance; however, many small cities often have no traffic engineering staff and no personnel with specialized knowledge of signal systems operations and maintenance.

Overall, traffic signal systems with more than 1,000 signals scored best, which may be an indication of increased staff resources and a balance of resources even with the complexity of their systems. Large signal systems represent considerable investment in traffic signal infrastructure and often have resources available to provide a high concentration of service.

Results by Section

The following pages describe results for each of the six sections included in the self assessment tool. For each section, a general description, characteristics for high scores and noteworthy findings are described. The text for each question can be found in Appendix A.

SECTION 1—MANAGEMENT
GRADE D

Traffic signal operation is one of the transportation industry's most visible services to the traveling public. Therefore, it is appropriate that executive level senior management and elected leaders be attentive to and supportive of good traffic signal operations. Preparing, documenting and executing a management system for traffic signal operations is essential. Committing the appropriate resources (staff, funding and attention); coordinating activities; communicating with the traveler; and cooperating and integrating with others are all important management activities.

SECTION 2—SIGNAL OPERATION AT INDIVIDUAL INTERSECTIONS
GRADE C+

Regardless of whether an individual signalized intersection is coordinated with other nearby signals or operates totally independent, some issues are critical to how well that intersection operates and serves the public. Reviewing and updating the intersection-specific timing and operational aspects of individual signalized intersections on a regular basis is extremely important, especially where changes in traffic volumes and/or adjacent land uses have occurred since the last review. The issues addressed in this section include review and updating of the phasing sequence, detector operation, displays, timing parameters and other related operational aspects of individual signalized intersections within a jurisdiction.

Figure 4: Management Results by Signal System Size

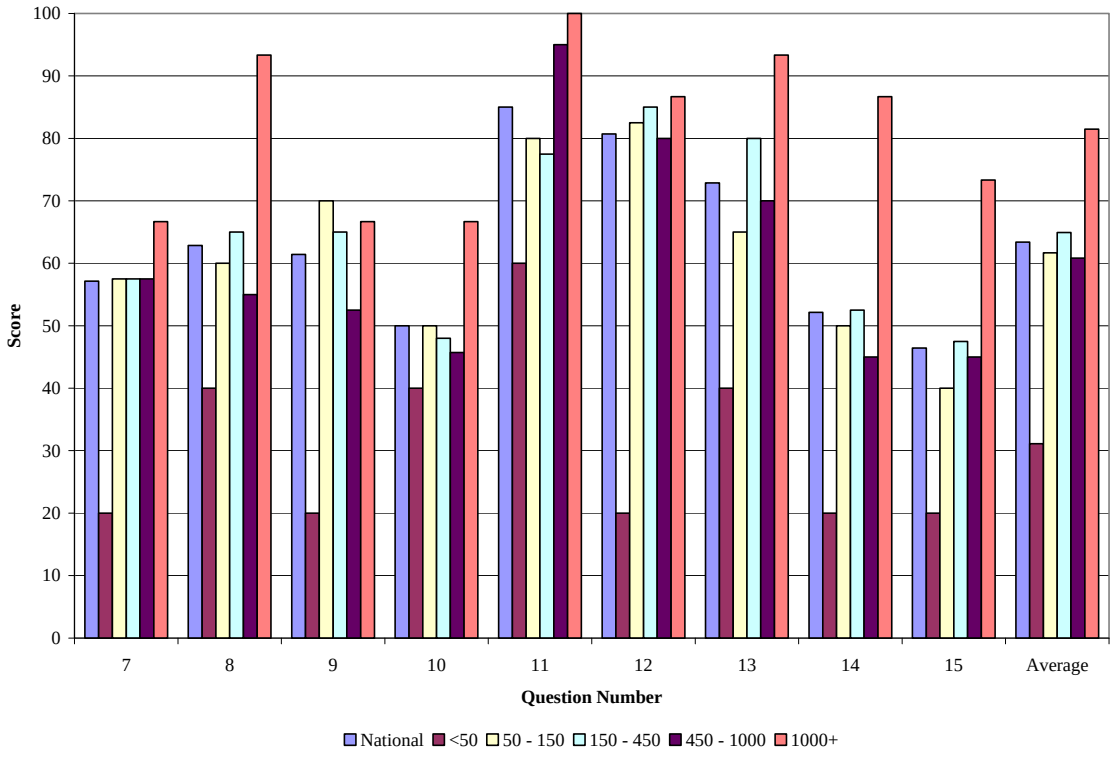


Figure 5: Management Results by Agency Type

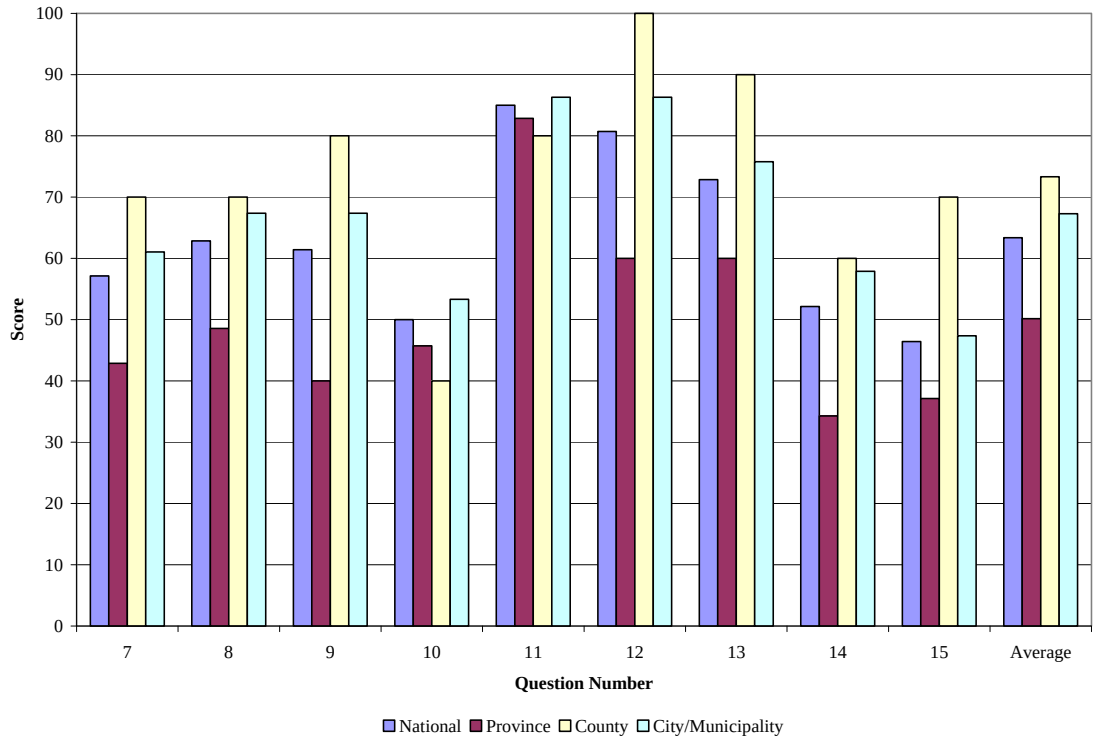


Figure 6: Signal Operation at Individual Intersections Results by Signal System Size

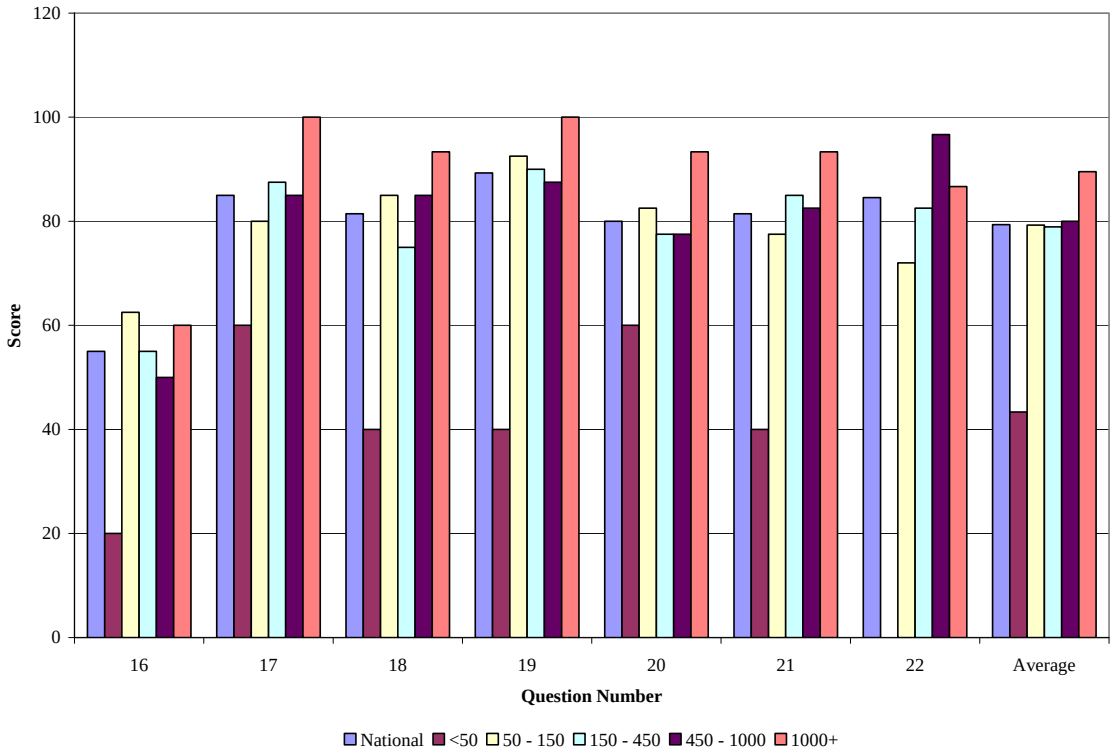
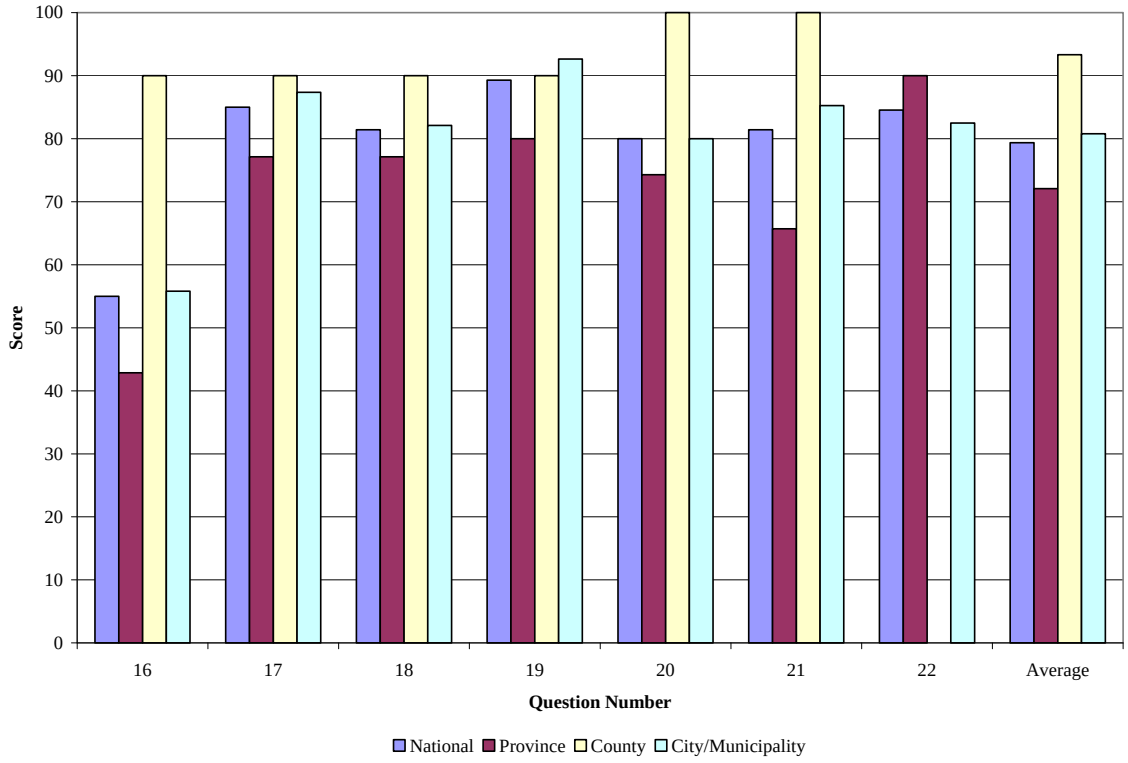


Figure 7: Signal Operation at Individual Intersections
Results by Agency Type



SECTION 3—SIGNAL OPERATION IN COORDINATED SYSTEMS
GRADE D

Traffic signal coordination is one of the most critical aspects of good traffic signal operations. Signal coordination ensures that motorists are able to travel through multiple intersections at a prescribed speed without stopping or with a minimum number of stops. The issues addressed in this section include the timing, interconnection and operation of coordinated signals.

SECTION 4—SIGNAL TIMING PRACTICES
GRADE D+

Understanding the activities agencies perform and the resources they allocate for traffic signal timing is constructive; however, their effectiveness as measured by outcomes achieved also needs to be considered. This section addresses the effectiveness of traffic signal operations through consideration of the degree to which agencies employ traffic signal timing practices that have been shown to produce efficient operation.

Figure 8: Signal Operation in Coordinated Systems
Results by Signal System Size

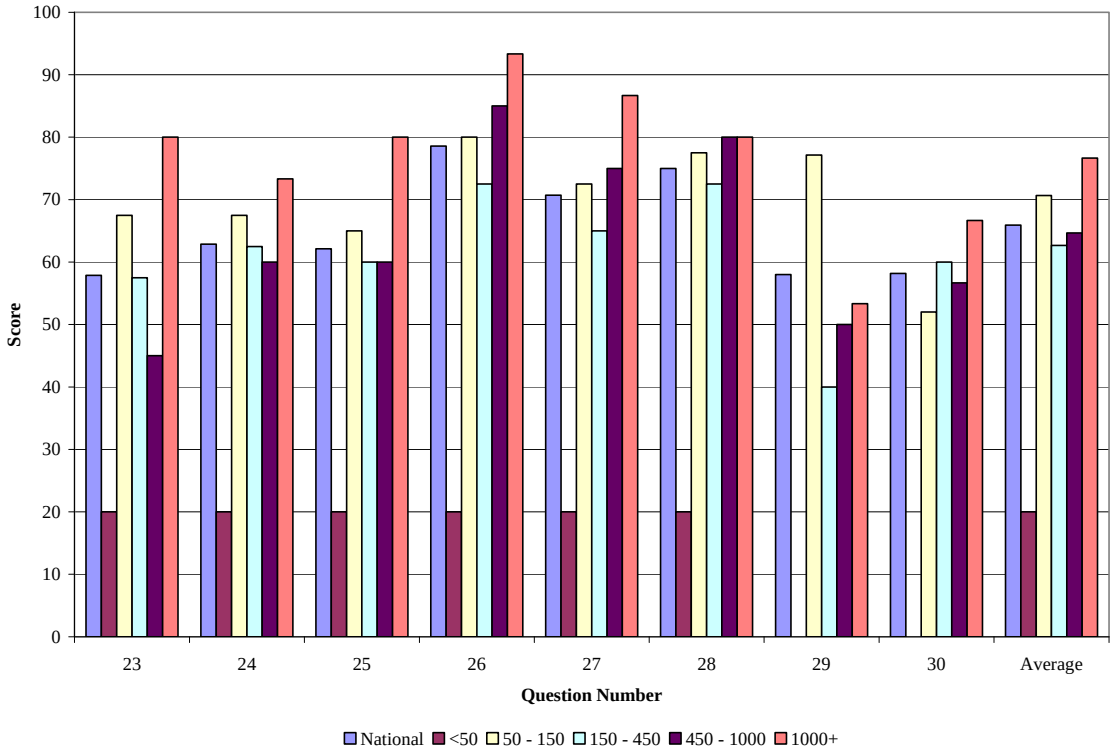


Figure 9: Signal Operation in Coordinated Systems
Results by Agency Type

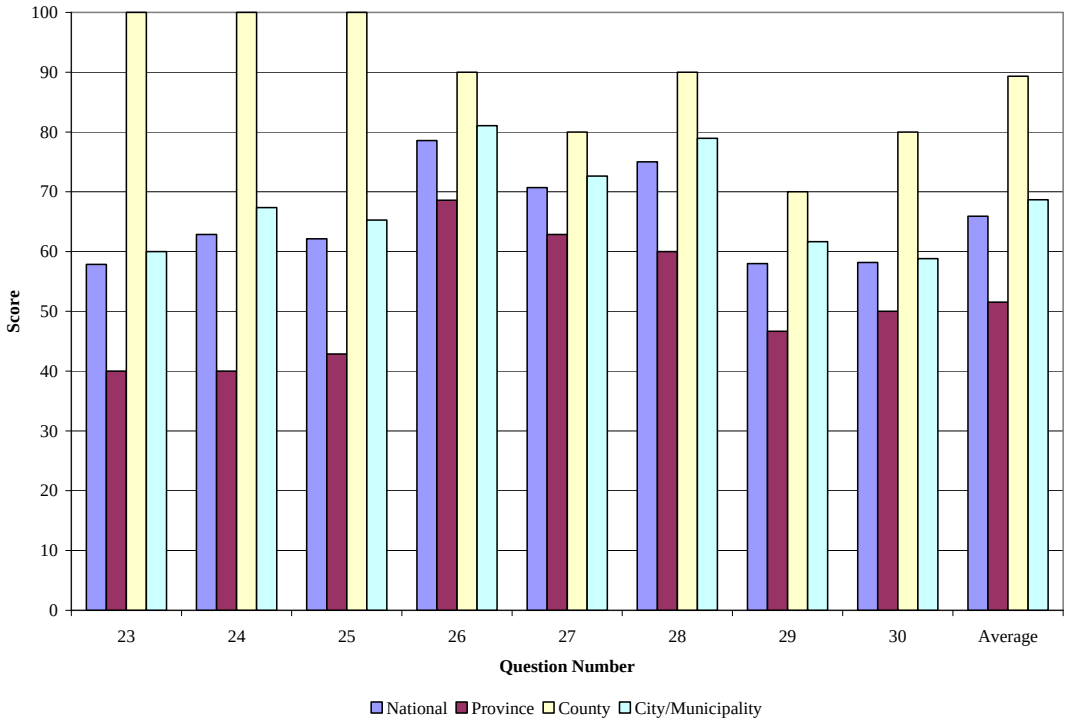


Figure 10: Signal Timing Practices Results by Signal System Size

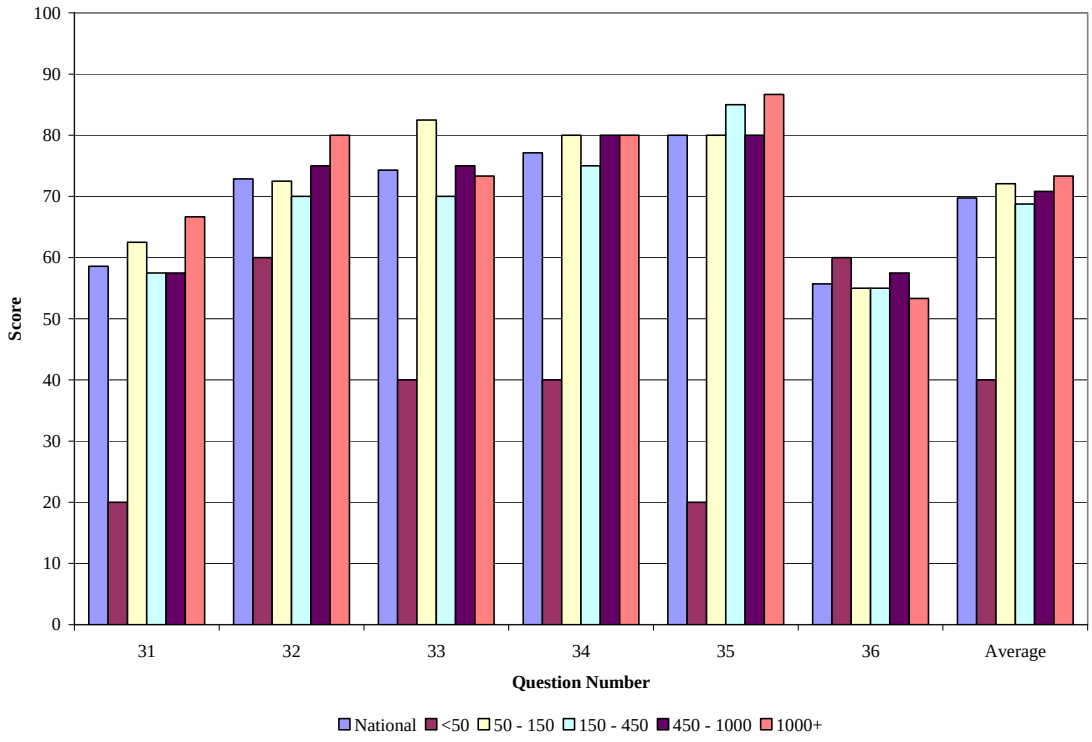
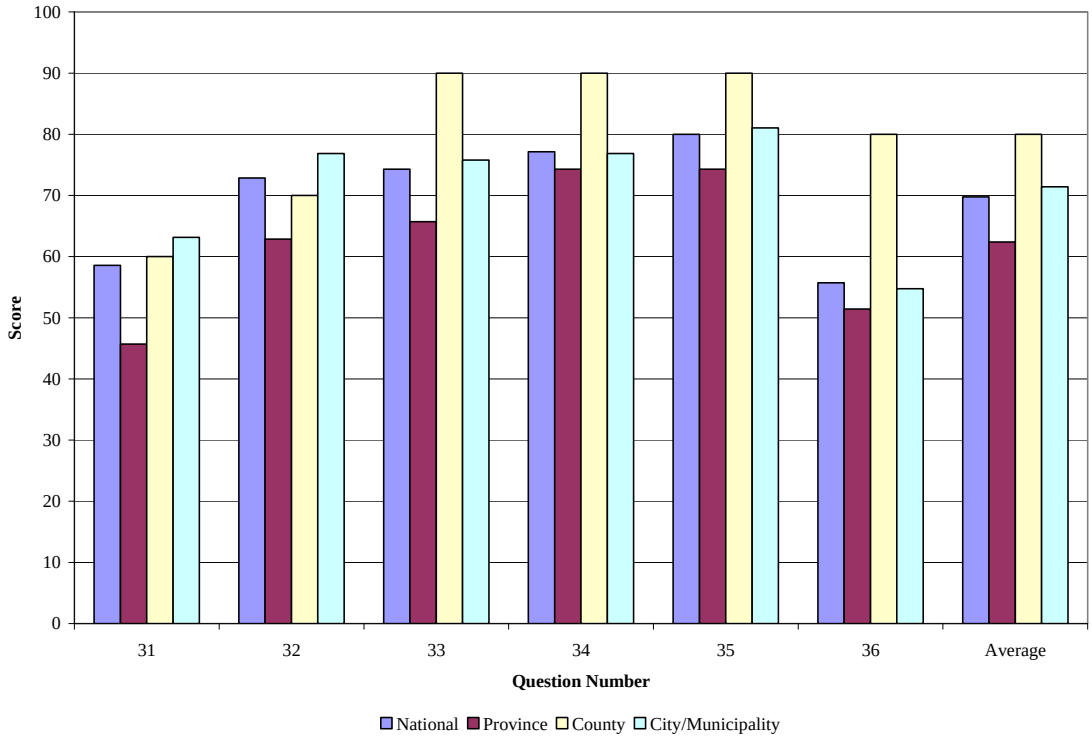


Figure 11: Signal Timing Practices Results by Agency Type



SECTION 5—TRAFFIC MONITORING AND DATA COLLECTION

GRADE D+

Transportation agencies need robust supporting systems to observe and communicate the condition of traffic flow on arterial roadway networks. These systems collect data to provide input for traffic signal control operation; real-time system monitoring; formulation of strategies to effectively manage and control the flow of traffic; monitoring of traffic flows over long periods of time via data archiving; distribution to neighboring jurisdictions and others; and incident management and response. Critical components of traffic monitoring are data collection, assessing the quality of the data and having procedures for archiving the information. Traffic monitoring allows an agency to respond to changes in traffic conditions. Data collection also provides information to determine how well traffic signal systems are performing and to calculate new traffic signal timing plans.

Figure 12: Traffic Monitoring and Data Collection Results by Signal System Size

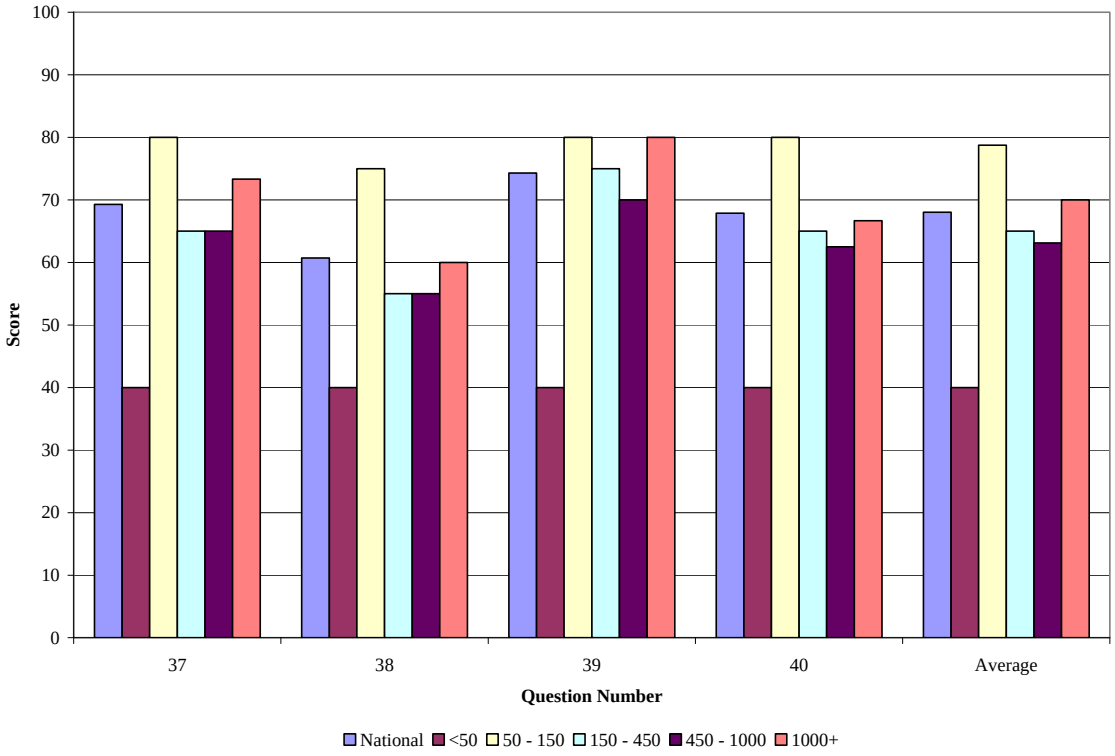
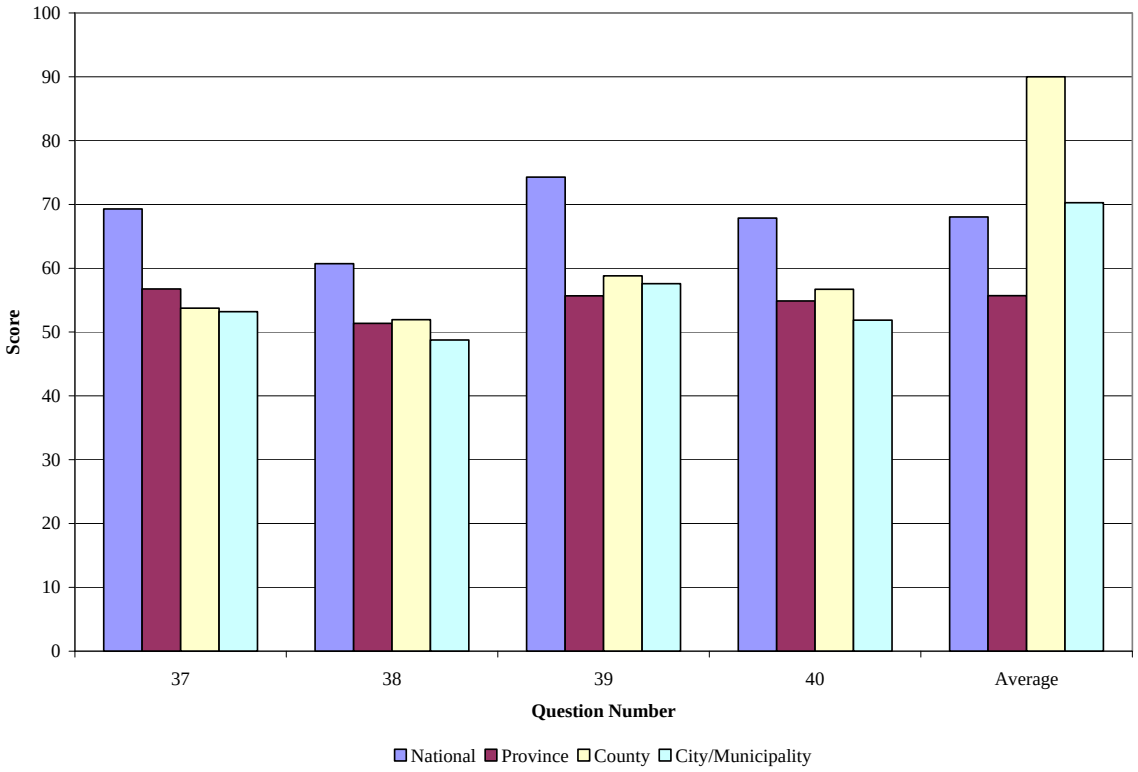


Figure 13: Traffic Monitoring and Data Collection Results by Agency Type



SECTION 6—MAINTENANCE

GRADE C

Good maintenance is one of the keys to effective traffic signal operations. A well-timed traffic signal system must be accompanied by effective maintenance if it is to provide continued high-quality service to the traveling public. This section is intended to assess the effectiveness of the planning, management and execution of maintenance activities. A very basic level of maintenance is not easily ignored; non-functional traffic signals are highly visible and provide an unsafe environment to the traveling public.

Figure 14: Maintenance Results by Signal System Size

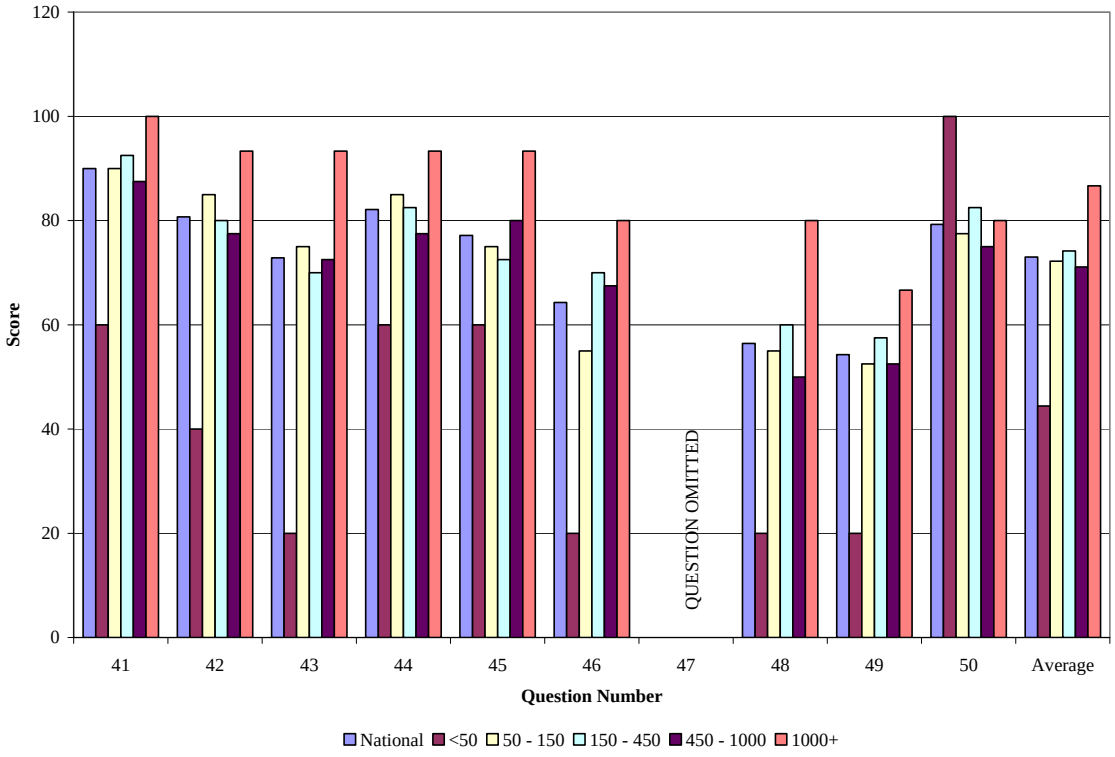
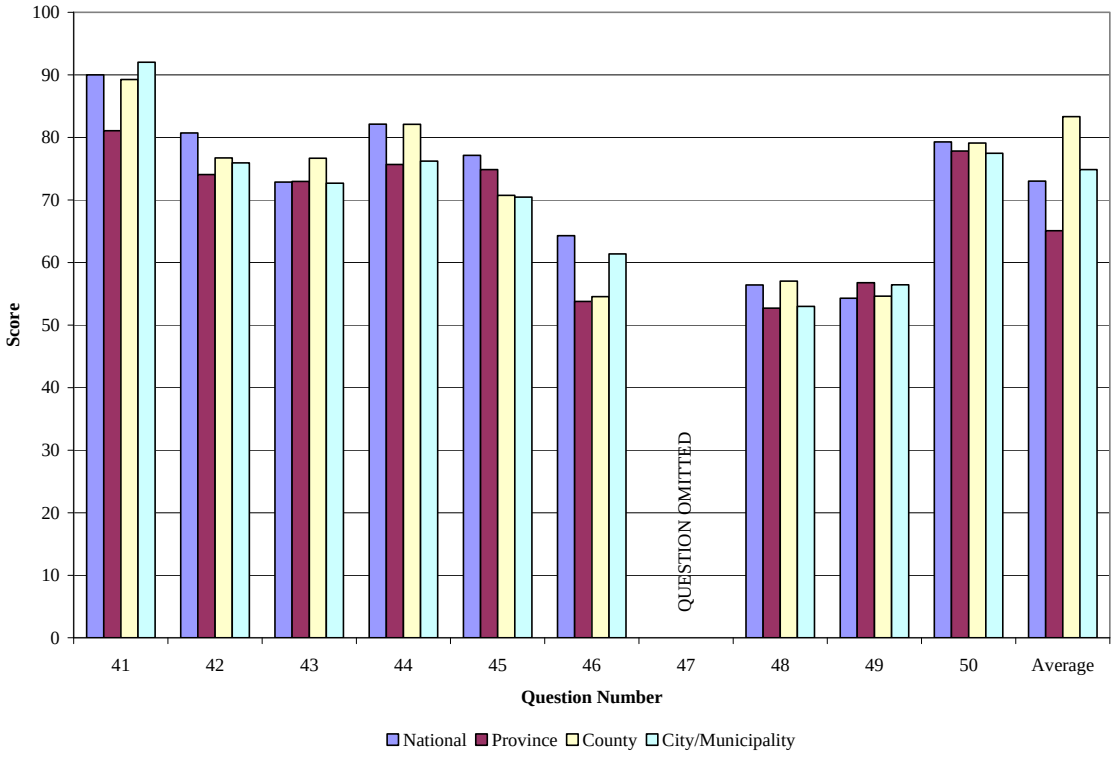


Figure 15: Maintenance Results by Agency Type



Where Do We Go From Here? – Improving the Score

In this time of competing investments and with the recognition that we cannot build our way out of congestion, it is more important than ever to make performance-based decisions on resource allocation. Studies have shown that the benefits of investments in traffic signal systems outweigh the costs by 40:1 or more and have synergies with other transportation department programs.[2]

The results of the *2008 Canadian Traffic Signal Report Card* demonstrate that Canada as a whole is well below a level of excellence with traffic signal performance, even though a number of agencies have achieved a level of success in particular areas. More sustained, stable and consistent resources must be committed to management processes and professionals who design, operate and maintain traffic signal assets to provide significant reductions in congestion, delay, fuel consumption and emissions.

Performance excellence in traffic signal operation involves five core components:

- Program management
- Traffic monitoring and data collection
- Routine signal timing updates
- Sound maintenance practices
- Appropriate traffic signal hardware

Specific attention to any of these components will lead to improvements in an agency's grade, but fundamental change in traffic signal operations can only be fully achieved by an agency's focus on program management.

PROGRAM MANAGEMENT

Leadership in traffic signal program management and associated systems is the foundation of excellence in transportation operations. In general, this approach to traffic signal management establishes clearly defined goals with measurable objectives and specific milestones for achievement.

Performance excellence is based on the following key criteria:[3]

- Leadership
- Strategic planning
- Customer and market focus
- Measurement, analysis and knowledge management
- Workforce development and training
- Process Management
- Outcomes

These key management principles lead to proactive, knowledge-based decision-making that can be applied to traffic signal systems. Application of these principles results in improved operational performance, system reliability, asset life-cycle and resource allocation. The design and implementation of a program management plan for traffic signals and associated systems creates the basis to compare progress in improving the operation of an agency's assets.

Preparing, documenting and executing a management system for traffic signal operations is essential to improving the six technical topic areas assessed in this report. Traffic signal system audits are one tool to verify that people in an organization are doing what they promised or planned to do in accordance with an established management system. By extension, traffic signal system audits can be used as a peer-review method to benchmark an agency's status compared to the nationally accepted state of the practice. The *Traffic Signal Audit Guide* (www.ite.org/reportcard) assists in the continuous improvement of traffic signal systems management by providing general information on the benefits of a well-operated signal system and how to conduct such an audit.

TRAFFIC MONITORING AND DATA COLLECTION

A strong, robust system of monitoring and collecting data provides necessary information on traffic flow conditions on road networks. In addition, it can be leveraged beyond the traffic signal system to provide reporting information on a real-time basis (traveler information systems and traffic reports) or on an archival basis (to support traffic growth trend analyses). The data component of infrastructure is often assigned a low priority when considering the funding needs of transportation infrastructure. However, it is a required tool for the active management of these systems and the basis for performance-based decision-making. Having specific, clear knowledge of conditions allows transportation professionals to be creative in their signal timing solutions because it minimizes unknown variability.

ROUTINE SIGNAL TIMING EVALUATIONS

To keep pace with changing travel patterns, traffic signal timing should be reviewed and updated, if necessary, every three years at a minimum and even sooner depending upon growth and changes in traffic patterns. Recent estimates show that updating signal timing costs less than $3,000 per intersection.[4] To support this level of routine signal timing updates nationally, transportation agencies would need to spend on the order $25M, amount equivalent to about 0.14 percent of the total national expenditure on highway transportation.[5] When the figure is put into context, the cost of improving signal timing is miniscule, compared to annual highway expenditures.

SOUND MAINTENANCE PRACTICES

Well-trained traffic signal technicians are needed to properly maintain traffic signals and preserve the investment in hardware and timing updates. With approximately 25,000 signals across the Canada, response time requirements, current salaries, benefits, vehicles, parts/supplies and other items necessary to run maintenance programs, the annual maintenance investment would be less than 0.37 percent of the total national expenditure on highway transportation.[6]

APPROPRIATE TRAFFIC SIGNAL HARDWARE

Traffic signal hardware consists of many components. The key components are the vehicular and pedestrian signal heads; sensors to detect vehicles and pedestrians; communications; the electric power supply; and the signal controller. The controller is a computer installed at the intersection that controls and adjusts the signal operations for traffic conditions. The controller is similar to a personal computer except that it must function continuously in an outdoor environment through all types of weather conditions. Like a personal computer, signal controller technology becomes outdated over time. To keep from using outdated equipment that limits the operations or increases the maintenance of the traffic signal system, signal controllers should be upgraded at least every 10 years and possibly more frequently in high-growth areas that require more complex control.

Conclusions

Overall, findings from the *2008 Canadian Traffic Signal Report Card* indicate that traffic signal operations in Canada function at a D+ grade level. This does not mean that traffic signals fail to turn green, yellow and red. However, they do not operate as an efficient, well-integrated system that best meets the needs of the traveling public for reliable travel.

Findings from 28 agencies that collectively account for ownership of approximately 48 percent of the nation's 25,000 traffic signals indicate that resource and management constraints limit the effectiveness of traffic signal operations. As noted throughout this report, agencies are forced into difficult choices about how to spend their limited resources. For many agencies, this simply means addressing the most critical issues on a daily basis. A proactive, integrated program management approach that includes the principles of continuous improvement, asset life-cycle costs and resource allocation for traffic signal operations is seldom seen as an option.

Investment in traffic signal operations yields benefit-cost ratios of 40:1 and higher and can effectively address motorists' day-to-day traffic issues. Better traffic signal operations:

- reduces congestion and delays;
- reduces emissions; and
- reduces fuel consumption.

Furthermore, improved signal operations can be completed for lower costs and in shorter time frames than most other capital-intensive transportation improvement options. Focus on the core components of traffic signal operations (program management, traffic monitoring and data collection, routine signal timing updates, sound maintenance practices and appropriate traffic signal hardware) will lead to improvements in an agency's grade.

The nation faces personal and business issues in terms of congestion. This is a significant factor in shaping the lifestyles and costs of doing business in Canada. People feel the real impact in where they choose to live, how they commute and how much things cost at the store, which is a result of the additional costs congestion imposes on society. In urban and many suburban areas, the opportunity to build new streets or widen existing roads is limited or not possible. Projects face significant constraints due to lack of available land, environmental issues and the costs associated with building or widening roads. What remains is to make the best use of the existing transportation network to handle the growing traffic demand, which includes ensuring that traffic signals provide the best operation possible. The environment benefits from reduced fuel consumption and better air quality. Improvements can be made quickly and for the benefit of all.

Each of the agencies that participated can benefit by using their individual results to identify strengths in their signal systems and opportunities for improvement—some already have. In addition, the process of completing the self assessment was educational for agency staff and valuable to the development of additional resources like the *Traffic Signal Audit Guide* (www.ite.org/reportcard).

The agencies managing the traffic signal systems can and want to do better in the daily management of systems, but this will be accomplished only through the support of local public sector leadership. Proactive traffic signal management, operation and maintenance are critical—quality of life and the environment depend on it.

References

1. ITS Benefits, Costs and Lessons Learned Database. U.S. Department of Transportation (U.S. DOT) Intelligent Transportation Systems Joint Program Office. Accessible via www.benefitcost.its.dot. gov; and *Benefits of Retiming Traffic Signals: An ITE Informational Report*. Washington, DC: Institute of Transportation Engineers (ITE), 2005.

2. *Benefits of Retiming Traffic Signals: An ITE Informational Report*. Washington, DC: Institute of Transportation Engineers (ITE), 2005.

3. *2007 Criteria for Performance Excellence*. Gaithersburg, Maryland: U.S. Department of Commerce, National Institute of Standards and Technology, Baldridge National Quality Program, 2007.

4. Tarnoff, Philip J. and Javier Ordonez. *Signal Timing Practices and Procedures: State of the Practice*. Washington, DC: ITE, 2004.

5. Recent estimates show that updating signal timing costs less than $3,000 per intersection. To keep up with changing travel patterns, comprehensive reviews of area-wide or corridor signal timings should be conducted at least every three years and possibly sooner. To support this level of signal timing nationally, an annual investment ranging from $15 million to $25 million would be needed. For a 3-year interval for retiming this represents 0.14 percent of total highway transportation expenditures in fiscal year 2006/07.

   Assumptions:
   - 25,000 signals in Canada
   - Retiming interval every of three years
   - $3,000 to retime each signal
   - $17,454 million in transportation expenditures spent on highways in Canada in fiscal year 2006/07.[6]

   Calculations:
   - 25,000 signals / 1-year retiming interval = 25,000 signals retimed per year
   - 25,000 signals x $3,000 / signal to retime = $75 million per year
   - $75 million per year / $17,454 million = 0.42 percent of total highway expenditures

   - 25,000 signals / 3-year retiming interval = 8,333 signals retimed per year
   - 8,333 signals x $3,000 / signal to retime = $25 million per year
   - $25 million per year / $17,454 million = 0.14 percent of total highway expenditures

   - 25,000 signals/5-year retiming interval = 5,000 signals retimed per year
   - 5,000 signals x $3,000/signal to retime = $15.0 million per year
   - $15 million per year / $17,454 million = 0.08 percent of total highway expenditures

6. Table 3-5: Transport Expenditures/Revenues by Mode and Level of Government, 2002/03 – 2006/07, *Transportation in Canada 2006 Annual Report*. Ottawa, Ontario, Canada: Transport Canada, 2007.

7. Well-trained traffic signal technicians are needed to properly maintain traffic signals in good order and to preserve the investment in hardware and timing updates. It is estimated that one signal technician is needed for every 30 to 40 traffic signals.[8] With approximately 25,000 signals across the Canada and given current labor rates, the annual maintenance personnel investment should be about $63.8 million per year, including salaries, benefits (assumed to be 40 percent of salary), vehicles and other items necessary to support the staff to run the maintenance program. On an annual basis this represents 0.37 percent of total highway transportation expenditures in fiscal year 2006/07.

   Assumptions
   - 25,000 signals in Canada
   - one technician for every 30 traffic signals
   - average cost per technician of $75,000 per year (includes salary, benefits, vehicles, etc.)
   - $17,454 million in transportation expenditures spent on highways in Canada in fiscal year 2006/07.[6]

   Calculations
   - 25,000 signals/30 signals per technician – approx. 850 technicians
   - 850 technicians at $75,000 per technician = $63.8 million
   - $63.8 million per year / $17,454 million = 0.37 percent of total highway expenditures

8. *Traffic Control Systems Operations*. Washington, DC: ITE 2000.

Appendix A

Self Assessment Tool and Scoring Scale

Appendix A: 2007 Self Assessment Tool and Grading Scale

2007 Traffic Signal Operation Self Assessment

Developed by

National Transportation Operations Coalition

NTOC

The 2007 Traffic Signal Operation Self Assessment is part of the 2nd National Traffic Signal Report Card. The self assessment has been updated and improved to reflect comments received on the initial version. The results of the self assessment will provide for some comparison to the results of the previous version, both for individual agencies and at the national level. It is expected that the Traffic Signal Operation Self Assessment and National Traffic Signal Report Card will continue to be released about every two years.

Conducting the Self Assessment

The 2007 Traffic Signal Operation Self Assessment tool is a composite of traffic signal operation best practices by agencies around the United States. The self assessment is not intended to suggest that all practices must or will be used in all cases. It is a tool to identify areas of strength and areas with opportunity for improvement.

The self assessment is designed to use information and knowledge that is readily available. No special studies or data are required. The tool is completely self-scored and should take approximately one hour to complete depending on discussion. **The results and the names of participating agencies are completely confidential.**

The Traffic Signal Operation Self Assessment is best conducted as a small group exercise. Those involved in the assessment should represent the key aspects of the traffic signal operation process. Some suggestions for conducting the self assessment:

- Assemble a small group of participants who are the key players in your traffic signal operation program.
- Provide participants with the self assessment tool in advance so that each may become familiar with the questions, particularly those questions pertaining to his/her role.
- Ask participants to score the designated section(s) and bring their score sheets with them to the assessment exercise.
- Consolidate the consensus scores into a single result and return your results for inclusion in the National Report Card.

All results are anonymous. Please return your results as follows:

We strongly urge you to return results electronically by logging into www.ite.org/selfassessment. Complete the results sheet on the Web site and click "submit."

For **paper copies,** mail the completed results sheet to:

Institute of Transportation Engineers
Attention: Tatyana Jenkins
1099 14th Street, NW, Suite 300 West
Washington, DC 20005-3438

Please return your results by December 29, 2006.

Scoring for the *2007 Traffic Signal Operation Self Assessment*

The 2007 Traffic Signal Operation Self Assessment consists of six sections. Each section contains a number of questions concerning traffic signal operation policies and practices. Respondents are asked to rate the extent to which a particular policy or practice has been adopted and implemented by your agency. Score each question from 1 to 6, based on your program's progress in each area as detailed below. It may prove useful to briefly document the reasons for each question's scoring.

The self assessment is designed to describe the benchmark for traffic signal operation best practices. Each question is followed by a short description that illustrates outstanding practice (a 5 score) or provides guidance on how to score within a range (1 to 6). This provides your agency with a target for improving your own traffic signal operation. **It is not anticipated that any agency will have a perfect score.**

Some questions apply only to agencies that have specialized equipment or applications. In those instances, "not applicable" (N/A) is provided as a scoring option. **Questions scored as "not applicable" will not contribute to the overall score and should not be included on your results sheet.**

Below is general guidance for scoring from 1 to 6:

1. Not currently being done

    - May have been discussed informally but no action has been taken

2. Very little being done

    - Minimal activity
    - Issue has been acknowledged and is being investigated

3. Efforts are moderate. Some good processes exist but they may not be well executed—results are mixed.

    - Has been put into practice on a limited or experimental basis
    - Processes are not consistently applied

4. Efforts are strong and results are promising; however, there is room for improvement.

    - Has become a generally accepted practice but refinements or changes are being discussed or pursued
    - Is done in practice but is not yet integrated as "standard procedure"

5. Efforts are outstanding with good to excellent results.

    - Has become accepted practice and is consistently implemented
    - Policies and procedures are documented and well integrated as "standard procedure"

6. Not applicable: The question does not apply to your agency.

In assigning a rating to an item, first decide which level of effort best fits the overall item response. Overall "best fit" does not require total agreement with each of the questions or the description for that scoring range. Assigning the actual score within the range requires evaluating the level of effort that has been applied within a particular area. If only a minimal effort has been applied, a 2 or 3 should be assigned. If no effort has been applied, a 1 should be assigned. If a comprehensive effort has been applied, the highest rating for a range should be assigned. If the question does not apply to your agency, a 6 should be assigned.

There are six sections in this self assessment:

- Section 1: Management
- Section 2: Signal operation at individual intersections
- Section 3: Signal operation in coordinated systems
- Section 4: Signal timing practices
- Section 5: Traffic monitoring and data collection
- Section 6: Maintenance

All questions have equal weight in the section and overall score.

1. All information and responses to this self assessment will remain confidential.

The information below is requested so that we may contact you with questions regarding the information you have submitted. It also will be used as a mailing address for the material we will send you in response to your completion of the survey and will enable us to correlate survey responses with demographics (organization type, size, etc.).

2. Check one:

- City/municipality
- County
- State/province
- Other, please specify

3. How many traffic signals does your jurisdiction operate and maintain?

- Less than 50
- 50–150 signals
- 150–450 signals
- 450–1,000 signals
- More than 1,000 signals

4. What is your jurisdiction's population?

- Less than 50,000
- 50,000–250,000
- 250,000–500,000
- 500,00–1,000,000
- Greater than 1 million

5. **If your jurisdiction is part of a larger metropolitan area, what is the population of the metropolitan area?**

   - Less than 50,000
   - 50,000–250,000
   - 250,000–500,000
   - 500,00–1,000,000
   - Greater than 1 million

6. **Are you willing to have your response shared with the FHWA Division Office arterial management staff person in your state?** The information is for internal use at the Division Office only and the details of your response will not be shared with anyone else. The intent is to allow the Division Office staff to understand needs and offer to provide appropriate technical assistance and resources.

   - Yes
   - No

Section 1—Management

Traffic signals are one of the transportation industry's most visible points of service to the traveling public. Traffic signals are tools to automate the safe assignment of right of way among conflicting traffic movements to reduce or eliminate the need for full-time manual traffic control at a given location. While a traffic signal can eliminate the need for manual control of the right of way, it does not eliminate human involvement, intervention, or intelligence in service delivery—the customer understands this even though he/she does not know the underlying technologies or engineering involvement. The issues addressed in this section include management actions. Maintenance items will be assessed in Section 6.

7	**Does your agency have a program for managing traffic signal operations?**	**(Score 1–5)**

The following describes the policies, processes and behaviors necessary for a score of 5:

- The high-level concept of operations, or "philosophy," for how your agency operates signals is documented and shared with employees.
- Your staff conducts field measures or floating car studies at least once per year on established "control" or benchmark sections of signalized corridors for tracking performance (e.g., delays/vehicle/intersection, stops/vehicle/intersection, delay/pedestrian/intersection, travel time/section).
- Your staff meets routinely with special event organizers, permits officers, law enforcement and emergency service providers to coordinate upcoming events or closures.
- Your agency has a business plan or other similar document that describes performance measures and goals (e.g. travel time reduction program, percentage of signal systems that are operational, etc.) specific to your traffic signal program.
- Your agency reports to agency leadership and to the public annually on your success at achieving these goals.

8	**Does your agency schedule staff and commit resources to provide traffic monitoring and management activities to accommodate peak traffic periods?**	**(Score 1–5)**

Score using:

1. No staff or resources are committed or available for traffic monitoring or management on a regularly scheduled basis.
2. Staffing and resources are committed and available for traffic monitoring and management activities; however, these activities are not scheduled to occur on a regular basis.
3. Staffing and resources are committed for traffic monitoring and management and occur on a regularly scheduled basis during normal business hours.
4. Staffing and resources are committed for traffic monitoring and management activities, occur on a regularly scheduled basis during normal operating hours and are extended when traffic conditions are abnormal.
5. As a normal operational practice, staffing and resources for traffic monitoring and management are scheduled to accommodate peak traffic periods both during and outside of normal business hours and are extended further when traffic conditions are abnormal.

9	**Does your agency communicate proactively with the road user regarding signal operations?**	**(Score 1–5)**

The following describes the policies, processes and behaviors necessary for a score of 5:

- Provides information on signal outages, excessive delays, crashes, utility or work zone closures, or other conditions affecting travel at or near traffic signals;
- Shares documented response times, frequencies, performance goals and measures with the public through Web sites, brochures, articles, or other media; and
- After investigating signal complaints from the public, follows-up with the road user to provide feedback about the final disposition of the issue.
- A readily accessible and direct mechanism to contact traffic signal staff within the agency specifically regarding traffic signal operations is available to the road user.

10	**Does your agency have a cross-jurisdictional and/or regional agreement (formal or informal) regarding signal coordination and operations?**	**(Score 1–6)**

Score using:

1. No discussions have taken place with other jurisdictions.
2. Cross-jurisdictional coordination occurs on an informal basis with no formal written agreements in place to maintain the practice.
3. Cross-jurisdictional coordination occurs with all relevant adjacent jurisdictions and is documented in a formal written agreement that does not include performance measures, maintenance or coordination standards, or objectives that establish consistent operations from the perspective of the road user.
4. Cross-jurisdictional coordination occurs with all relevant adjacent jurisdictions and is documented in a written agreement that does include performance measures, maintenance and coordination standards, or objectives that establish consistent operations from the perspective of the road user.
5. All items in 4 and cross-jurisdictional operations are supported through an active continuous exchange of data detailing signal coordination and traffic conditions. Stakeholders meet frequently to ensure the optimal operation of the system.
6. N/A: My agency does not border another jurisdiction for which cross-jurisdictional operation would prove beneficial to the road user.

11	**Does your agency have a policy, program, or process to receive, assess and accommodate requests for special pedestrian needs (i.e. visual disabilities or elderly pedestrians) at signalized intersections?**	**(Score 1–5)**

Score using:

1. Your agency does not accommodate special pedestrian needs.
2. Your agency does not have a policy, program, or process but modifies pedestrian timing on an "ad-hoc" basis in response to requests.
3. Your agency does not have a policy, program, or process but modifies pedestrian timing and installs accessible pedestrian devices on an "ad-hoc" basis.

4. Your agency has an undocumented policy, program, or process to receive, assess and accommodate requests for special pedestrian needs; modify pedestrian timing; and install and maintain accessible pedestrian devices.
5. Your agency has a documented policy, program, or process to receive, assess and accommodate requests for special pedestrian needs; modify signal timing; and install and maintain accessible pedestrian devices in accordance with documented procedures.

12	**Do you develop the agency's workforce for signal operations?**	**(Score 1–5)**

For a 5 score:

- You provide resources and encourage continuing technical training programs to include training from equipment suppliers, software suppliers and continuing education courses for technicians, operators and engineers.
- Salaries, benefits, awards, or responsibilities are established to encourage staff to obtain relevant licenses, certificates and degrees.
- You encourage your employees to apply for professional certifications such as the ITE Traffic Signal Operations Specialist (TSOS) certification and/or the IMSA traffic signal certification.

13	**Do the majority of the traffic signals in your agency's traffic signal system have the capability, through either central based or closed loop system operation, to provide active monitoring and management of traffic flow?**	**(Score 1–5)**

Score using:

1. Your agency operates electromechanical or solid-state traffic signal controllers with no capability to actively monitor or manage traffic flows.
2. Your agency operates a traffic signal system that has the capability for providing active monitoring and management of traffic flows on a limited basis; however, no resources have been committed to utilize these functions.
3. Your agency operates a traffic signal system that is capable of providing active monitoring of traffic signal status (i.e. flashing, preemption, operation mode) on a limited basis; no active management of traffic signal timing or monitoring of traffic flow occurs; traffic signals are typically operated in a time-of-day mode.
4. Your agency operates a traffic signal system that is capable of monitoring traffic signal status (i.e. flashing, preemption, operation mode) on a limited basis, with active alarms for critical failures. The traffic signal system is capable of providing information about traffic flow and altering signal timing in response to traffic conditions; however, these features are not actively utilized.
5. Your agency operates a traffic signal system that is capable of real-time monitoring and management of traffic flows. Traffic signal status (i.e. flashing, preemption, operation mode) and information on traffic flow is available in real time and signal timing can be actively monitored and modified to accommodate current traffic conditions. The traffic signal system is capable of operating in a traffic-adaptive or traffic-responsive mode.

14	**Does your agency have the capability and policies in place to adapt its signal systems to planned events, such as to aid in emergency situations requiring evacuations; to allow passage of military convoys; to accommodate traffic diverted from freeways due to crashes or closure; and to handle extraordinary volumes of temporary traffic following planned events such as football games, concerts and other special events?**	**(Score 1–5)**

For a 5 score:

- The agency works closely with local and state agencies to assist with special events.
- Tow trucks are provided or are staged at key points to aid in the removal of disabled vehicles.
- The agency collects advanced information on all major special events so it can plan accordingly.
- It has agreements with local universities, concert venues and other special traffic generators to share in the traffic control requirements.
- It has established communications and agreements with state and neighboring jurisdictions relative to regional emergency situations.

15	**Does your agency have plans or procedures in place for modifying traffic signal timing in response to unplanned events, such as crashes, roadway construction, freeway incidents, inclement weather, or other unexpected occurrences?**	**(Score 1–5)**

For a 5 score:

- Notification procedures exist for contacting signal operations personnel during non-standard business hours.
- Signal operations personnel have the capability to monitor and/or change signal timing remotely, such as with a laptop computer.
- Special timing plans have been developed and are available for use during freeway incidents, roadway construction activities, or other special events.
- Contact lists and procedures for contacting neighboring jurisdictions have been established so that information concerning signal operations can be shared during incidents.

Results for Section 1—Management (Transfer this score to Results Sheet)	**(Max. 45)**

Section 2—Signal Operation at Individual Intersections

Reviewing and updating the timing and operational aspects of individual signalized intersections on a regular basis is extremely important, especially where changes in traffic volumes and/or adjacent land uses have occurred since the last review. This is important for all signalized intersections, regardless of whether they are isolated or coordinated or whether the coordination is provided by a central system or a smaller, more localized system comprising even a few intersections. The issues addressed in this section include review and update of the phasing sequence, detectors, displays, timing parameters (settings) and other related operational aspects of individual signalized intersections within a jurisdiction.

16	**Does your agency have a documented process that triggers timing reviews of individual signalized intersections?**	**(Score 1–5)**

For a 5 score, your process includes:

- Routine reviews in response to land-use changes;
- Routine reviews of traffic volume changes;
- Pre-defined frequent updates with a maximum of 3 years between reviews;
- Routine reviews for high-priority arterials;
- Routine reviews for locations with high crash rates; and
- A comprehensive system for monitoring all of the above.

17	**Does your agency have a documented and managed inventory of approved signal phasing and timing settings for each intersection?**	**(Score 1–5)**

The following describes the policies, processes and behaviors necessary for a score of 5:

- The inventory is centrally accessible;
- Composed of either paper or electronic formats;
- Processes are in place for updating the inventory;
- Changes to phasing and timing settings are approved by a designated authority; and
- Field changes are documented in the central office inventory.

18	**Does the timing review utilize all available information resources to determine timing revisions including data on pedestrian volumes and vehicle volumes and speeds?**	**(Score 1–5)**

For a 5 score, the following are obtained and analyzed:

- Recent turning movement counts and other volume data (such as from system detectors);
- Crash history and previous complaint records;
- Pedestrian volumes; and
- Observations of field conditions are always conducted (on-site or via video cameras) in both peak and off-peak periods.

19	**When doing a timing update, does your agency review individual intersection timing parameters?**	**(Score 1–5)**

For a 5 score, the timing evaluations include:

- Settings that affect each approach's green time (initial green, vehicle extension, maximum green, etc.); and
- Calculation of the required yellow change interval, red clearance interval and pedestrian clearance intervals for all phases, taking into account any physical changes (road widenings, etc.) that may have occurred since the last review.

20	**After a need for changes in timing settings is identified and developed, are mechanisms and resources in place to ensure that the new settings are implemented, evaluated and fine-tuned in the field?**	**(Score 1–5)**

Score using:

1. Procedures and/or lack of resources delay field implementation of timing updates for many weeks or even indefinitely.
2. New timing settings are implemented in a month or two.
3. New timing settings are implemented in a few weeks.
4. New timing settings are implemented within a week.
5. Most timing settings are implemented within two to four working days.

21	**As part of a timing review, does your agency make it a policy or practice to include assessments of other related measures that could make the signalized intersection operate more safely and efficiently?**	**(Score 1–5)**

For a 5 score, these assessments include all of the following:

- Adding coordination with adjacent signals or adjusting offsets;
- Adding or removing the intersection from late-night or off-peak flashing operation in accordance with applicable policies;
- Changing the type of control (pre-timed vs. semi-actuated vs. fully-actuated);
- Confirming that a traffic signal is the most appropriate solution;
- Changing left-turn control modes (permissive only vs. protected-permissive vs. protected only) and left-turn phase sequence (leading vs. lagging vs. "lead-lag" vs. "split-phase") for one or more left-turn movements; and
- Other operational changes, such as adding or eliminating vehicular or pedestrian phases, re-striping to increase the number of lanes, changing the lane-use assignments, improving signing, confirming optimum signal head visibility, etc.

22	**Does your agency have the means to identify, examine and adjust, as needed, those traffic signals in close proximity to railroad-highway grade crossings to prevent vehicles from being trapped on the tracks due to traffic signal operations?**	**(Score 1–6)**

N/A: My agency does not have any railroad-highway grade crossings. (Score 6)

For a 5 score:

- An inventory of all traffic signals within 200 feet of grade crossings exists, including those

signals operated by others within your jurisdiction (i.e., state department of transportation).

- Signal preemptions are installed at those grade crossings with and without active traffic controls in place.
- Increases or decreases in train movements, speeds and that of vehicle traffic are regularly measured.

Results for Section 2—Signal Operation at Individual Intersections (Transfer this score to Results Sheet)	**(Max. 35)**

Section 3—Signal Operation in Coordinated Systems

Traffic signal coordination is one of the most important aspects of traffic signal control. Traffic signal coordination ensures that motorists are able to travel through multiple intersections with minimal stopping. The issues addressed in this section include the timing, interconnection and operation of coordinated systems.

23	**Does your agency conduct a comprehensive review of area-wide or corridor signal timing at least every 3 years or sooner if justified by prevailing traffic conditions?**	**(Score 1–5)**

For a 5 score, a comprehensive signal timing review should include the following:

- Collection of new intersection turning movement count and pedestrian volume data and/or other traffic flow data and comparison to old data to determine if traffic flow patterns have changed;
- Collection of travel time/delay information;
- Review of traffic signal phasing and turn lane designations to determine if changes or adjustments will improve operations;
- Review of pedestrian timing intervals, yellow and all red clearance intervals and other basic timing parameters to determine if they meet adopted guidelines;
- Collection of saturation flow data at critical intersections;
- Review of system master control parameters and algorithms to determine if the system is operating optimally (traffic-responsive or traffic-adaptive parameters); and
- Review of crash data to determine if any safety deficiencies exist that may be addressed through signal timing adjustments.

24	**Does your agency conduct supplemental reviews of area-wide or corridor signal timing? A supplemental review should include but is not limited to the following: review of a.m., p.m. and other peak and off-peak periods to determine if cycle lengths are adequate and are being used during the appropriate time periods; corridor offsets are field-reviewed to determine if arterial progression is adequate; intersection splits are field-reviewed to determine if intersection delays are being minimized; and queuing patterns are observed in the field to determine if any turn-lane blockages or spill-back into adjacent intersections is occurring.**	**(Score 1–5)**

Score using:

1. Supplemental reviews are not conducted.
2. Reviews are conducted in response to citizen complaints only, and only the location identified in the complaint is reviewed.
3. Reviews are conducted in response to citizen complaints only, and the entire area or corridor is reviewed.
4. Supplemental reviews are conducted on all critical areas or corridors that have undergone significant changes, such as new traffic generators, geometric changes, installation or removal of new signals, etc., over the past 12 months.
5. Supplemental reviews are conducted on all area-wide or corridor signal timing plans.

25	**Is new area-wide or corridor timing developed and implemented in a timely manner after the need has been identified?**	**(Score 1–5)**

Score using:

1. New area-wide or corridor timing is not considered.
2. New area-wide or corridor timing is developed and implemented as time permits.
3. New area-wide or corridor timing is developed and implemented within 3 months after the need has been identified.
4. New area-wide or corridor timing is developed and implemented within 2 months after the need has been identified.
5. New area-wide or corridor timing is developed and implemented within 1 month after the need has been identified.

26	**Does the process of developing new area-wide or corridor timing include the use of traffic signal optimization software, simulation of optimized timing, field installation, observation and fine-tuning?**	**(Score 1–5)**

The following describes the policies, processes and behaviors necessary for a score of 5:

- The process of developing the new signal timing should be based on a well-defined process that begins with data collection using turning movement counts and may include data provided by traffic detectors installed in the system.
- The data are used as an input to traffic optimization software, which is used to generate an initial set of signal timing.
- This timing then is evaluated and, ideally, may be tested using traffic simulation.
- The resulting signal timing is installed and observed and additional field fine tuning adjustments are made where needed.

27	**In addition to the normal a.m. peak, off-peak and p.m. peak plans, do the timing plans used in your coordinated systems include timing for weekends, holidays and other planned events?**	**(Score 1–5)**

The following describes the policies, processes and behaviors for a score of 5:

- Traffic patterns have been studied to identify the time periods during which different traffic patterns exist.
- Timing plans exist to address routine traffic changes (more than three plans for weekday operation, weekends) and planned special situations (special events, holidays, weather, emergencies).
- Timing plans are implemented quickly and effectively whenever needed.

28	**Does your criterion for coordinating signals consider traffic flow characteristics, volumes and spatial separations?**	**(Score 1–5)**

For a 5 score:

- Your agency has documented and implemented criterion for interconnecting signals.
- The criterion considers traffic flow, platoon characteristics, volumes, spatial separations and mid-

block friction.
- Your agency uses state-of-the-art techniques for determining when coordination would be beneficial.

29	**Do you coordinate signal timings across jurisdictional boundaries?**	**(Score 1–6)**

N/A: My agency does not border another jurisdiction for which cross-jurisdictional operation would prove beneficial to the road user. (Score 6)

The following describes the policies, processes and behaviors necessary for a score of 5:

- If multiple adjacent jurisdictions operate signal systems, signal timing is coordinated across boundaries, particularly in support of freeways and major corridors (i.e., to efficiently handle freeway diversions, etc.).
- Traffic flow should be continuous along arterials without consideration of the jurisdiction responsible for the operation of the signals.
- At a minimum, coordination is based on a common time base.
- Ideally, coordination includes the use of the same cycle lengths and the calculation of offsets between intersections that will ensure smooth progression as if there was no jurisdictional boundary.
- Agreements are documented in a cooperative agreement between jurisdictions.

30	**Do you make use of either traffic-responsive or adaptive control in areas with routinely unpredictable traffic demand (e.g. in the vicinity of major shopping centers, universities, recreational centers, etc.)?**	**(Score 1–6)**

There are often roadways within a signal system that experience unpredictable changes in traffic flow patterns. Traffic-responsive control (in which timing plans are automatically selected based on measured traffic patterns) or traffic-adaptive control (in which signal timing is calculated online in response to measured traffic patterns) are both well suited to these situations.

N/A: There are no areas in my agency's jurisdiction with unpredictable demand. (Score 6)

For a score of 5, all of the following situations make use of traffic-responsive or adaptive control:

- Incident management corridors (routes that parallel an interstate or freeway);
- Corridors that serve resort areas;
- Corridors that serve cultural, athletic, or other entertainment venues;
- Shopping centers where demand fluctuates;
- Schools and major universities generating unpredictable traffic flows as a result of changing class schedules and school holidays; and
- Other critical corridors or areas with unpredictable traffic flows.

Results for Section 3—Signal Operation in Coordinated Systems (Transfer this score to Results Sheet)	**(Max. 40)**

Section 4—Signal Timing Practices

The majority of questions in this self assessment address "output" issues, such as the frequency with which signal timing is examined and the number of detectors that are operational. While these questions are important, it is equally important to consider the outcomes of these activities; in other words, determining the overall effectiveness of the signal operation that results from all of these activities. This section attempts to evaluate the effectiveness of the signal operation through consideration of the degree to which the agency employs signal timing practices that have been shown to produce efficient operation.

31	**When manually determining offset for signals in a coordinated system, do you take queue discharge time into account?**	**(Score 1–5)**

The following describes the policies, processes and behaviors necessary for a score of 5:

- The agency checks signal offsets produced by signal timing software through time-space diagrams and field observations.
- When manual timing is being developed, offset is calculated as the link travel time minus the time required to discharge standing queues.
- When mid-block sources of traffic (such as major parking structures) are added to the network, offsets are adjusted to reflect the addition of vehicles to standing queues.
- When operational changes are made, such as modified bus stop locations, new turning restrictions, etc., offsets are adjusted to reflect the impact on standing queue length.
- System offsets are reviewed and adjusted in the field so that variations in travel speed, queuing patterns, mid-block friction, or other field conditions can be accounted for.

32	**When timing a system of coordinated signals, do you evaluate and implement the most effective timing based on a comparative analysis of cycle lengths, offsets, phase sequence and other timing parameters?**	**(Score 1–5)**

The following describes the policies, processes and behaviors necessary for a score of 5:

- Signal timing optimization and/or traffic simulation software are used to evaluate a wide range of cycle lengths; the most effective cycle length is implemented after completing a comparative analysis.
- The cycle length at minor intersections with light traffic is minimized by utilizing half-cycle lengths or another sub-multiple to reduce control delay.
- Signal operational modes are selected to accommodate situations such as oversaturated crossing arterials, pedestrian movements and other unique site conditions (for example, alternate max. greens, free running, etc.).
- Modifications to coordinated signal timing parameters are not implemented prior to analysis and understanding of how the changes will impact surrounding intersections.
- An appropriate number of timing plans or signal timing strategies, such as traffic responsive or adaptive control, have been deployed to address traffic demands during all time periods. For example, you consider that multiple a.m., p.m. and off-peak plans may be needed to fully address traffic demands.
- Field observation, fine tuning and calibration of signal timing plans and strategies are completed prior to finalizing timing plans.

33	**When timing a system of coordinated signals, do you evaluate the timing using time-space diagrams and evaluate different phase sequences (for example, leading left turns vs. lagging left turns vs. lead-lag, while recognizing left-turn trap issues) at intersections that appear to be interrupting the progression?**	**(Score 1–5)**

The following describes the processes for a score of 5, recognizing that phasing can have a significant impact on the ability to provide two-way progression along a coordinated arterial:

- When new arterial timing is being developed, the agency produces time-space diagrams that are used to qualitatively evaluate the two-way progression that has been developed.
- Intersections that appear to interrupt the progression are evaluated to determine whether phasing changes will have an impact on the progression.
- New phasing is entered into the signal timing program to evaluate its impact on the program's estimate of performance measures.

34	**When timing actuated controllers, the following factors are considered for a score of 5:**	**(Score 1–5)**

- Cycle length is optimized to utilize the lowest cycle length that will efficiently and effectively serve the traffic demand.
- Volume/density timing is utilized where appropriate.
- Turn lane blockages and spill-back into adjacent intersections are minimized.
- Vehicle delay is equitably balanced across all intersection approaches.
- Vehicle extension times are set based on established practices to provide the safest and most efficient movement of pedestrians and vehicular traffic through the intersection.
- Timing is field-reviewed and adjusted to account for actual field operating conditions.
- During periods of congestion, maximum green times are set to reflect the demand on each phase.

35	**During periods of light traffic flow or at night, do you utilize signal operations that promote smooth and efficient traffic movement along an arterial while minimizing delays to the minor movements?**	**(Score 1–5)**

For a 5 score, your agency uses some or all of the following as appropriate:

- Cycle lengths are optimized along the corridor to utilize the lowest cycle lengths possible while maintaining adequate progression along the arterial.
- Minor intersections are half-cycled where appropriate.
- Intersections are analyzed and grouped according to cycle length needs.
- Intersections are placed into "free" (fully-actuated) mode as appropriate.
- Minor intersections with very low side-street traffic volumes may be placed in flashing operation.

36	**Are there intersection approaches in your system where traffic in left-turn or right -turn bays exceeds the effective green capacity of the corresponding traffic signal phase and blocks through movements during the green period, or are there approaches in your system where queues of thru traffic block access to left and right turn bays?**	**(Score 1–5)**

The following describes the policies, processes and behaviors necessary for a score of 5:

- Intersections are checked annually to ensure that there are no instances of queued traffic in turn lanes blocking through movements.
- When a problem is identified, signal phasing and/or splits are adjusted within 24 hours to reduce or eliminate the problem.
- The system cycle length is re-evaluated to ensure that it is appropriate.
- Specialized signal operation, such as the use of queue detectors, servicing of a left-turn phase twice per cycle, right turn overlap phases, modification of lane assignments during peak traffic flows, or other innovative signal timing techniques, is utilized.
- System offsets are adjusted to reduce queuing of through traffic.

Results for Section 4—Signal Timing Practices (Transfer this score to Results Sheet)	**(Max. 30)**

Section 5—Traffic Monitoring and Data Collection

A robust program and supporting systems are needed to determine the condition of traffic flow on arterial roadway networks. These programs and supporting systems would collect data for:

- Input to traffic signal control operation;
- Real-time systems monitoring;
- Formulating strategies to effectively manage and control the flow of traffic;
- Monitoring flows over long periods of time via data archiving;
- Distribution to others, such as the public, universities and local planning programs; and
- Incident response and management.

37	**Does your agency have a regular, ongoing program for collecting and analyzing traffic data for evaluating and reporting the effectiveness of signal timing?**	**(Score 1–5)**

For a 5 score:

- Turning movement counts are performed for each signal timing effort.
- The data represent traffic conditions for relatively short periods of time, such as every 15 minutes.
- Arterial travel time, average delay, number of stops, or other performance-based data are regularly collected.
- Your agency commits resources to the collection and analysis of the data.
- The data collected are used to determine the need for further study or system changes/modifications.
- Data trends are identified and reported on a regular basis.
- Collected data are analyzed to better manage planned and unplanned events.
- Collected data and resulting analysis are used for regular formal reports to decision-makers.
- The data are combined or cross-tabulated with data that may be collected by others, such as weather data, crash data, construction data, event information, etc.

38	**Do you periodically assess the quality of the data you collect?**	**(Score 1–5)**

For a 5 score:

- You have a formal data quality assessment program.
- You know within practical limits how many of the collection and monitoring systems are working correctly.
- You are able to quickly identify when the systems are not operating correctly.
- You repair systems and devices in a short period of time.
- You have defined metrics and a process upon which to assess data quality. For example, you use other collection methods and systems to verify accuracy of specific technologies at specific locations and use this information to calibrate the systems and devices.
- You prepare a report documenting the quality of the data collected.

39	**Do you have a process to archive the collected data?**	**(Score 1–5)**

For a 5 score:

- There is a formal and well documented archiving system to store the collected data.
- The data are quick and easy to access in a well documented/standardized electronic format.
- The data are easy for all partners' use in analysis.
- The archive system also includes data quality attributes.

40	**Do you actively share collected data?**	**(Score 1–5)**

For a 5 score:

- Your data are shared with regional operating partners.
- Your data are used in regional planning models.
- Your data are used for teaching and research at local colleges and universities, if applicable.
- Your data are readily available to road users and other customers on a Web-based traffic conditions map.
- Your data are available in real time.

Results for Section 5—Traffic Monitoring and Data Collection (Transfer this score to Results Sheet)	**(Max. 20)**

Section 6—Maintenance

Maintenance is one of the keys to effective signal operation. A well-timed system must be accompanied by effective maintenance if it is to provide high quality service to the motoring public. This section can be used to assess the effectiveness of the planning, management and execution of maintenance activities.

41	**Does your agency have established policies and processes and commit resources (in-house or contracted) to provide for timely response after a critical malfunction is reported?**	**(Score 1–5)**

Score using:

1. During regular business hours, a technician is at the intersection by the next business day, and no provisions exist for technician response outside of regular business hours.
2. During regular business hours, a technician is at the intersection within 8 hours and within 16 hours outside of regular business hours.
3. During regular business hours, a technician is at the intersection within 4 hours and within 8 hours outside of regular business hours.
4. During regular business hours, a technician is at the intersection within 2 hours and within 4 hours outside of regular business hours.
5. During regular business hours, a technician is at the intersection within 1 hour and within 2 hours outside of regular business hours.

42	**Does your agency commit maintenance resources and manage maintenance activities to ensure that traffic operations meet safety needs and customer requirement levels?**	**(Score 1–5)**

For a 5 score, your agency:

- Commits specific funding to repair, replace, or upgrade signal equipment, cabinets, controllers, detector cards, etc., based on their specific life cycle;
- Commits specific funding to repair, replace, or upgrade signal infrastructure: poles, junction boxes, conduit, cable and signal heads based on their specific life cycle;
- Scales its maintenance commitment to growth; as equipment, location and technology increase, funding increases proportionally;
- Has a policy for timely replacement of sensors/detectors that are destroyed or disabled by roadway maintenance or permitted utility activities. The replacement of sensors/detectors is included as part of the maintenance project scope or utility work;
- Does not commit funded traffic signal resources to unfunded non-traffic signal activities (ITS, CCTV, DMS, incident management);
- There is an easy way for customers to notify your agency of signal problems.

43	**Does your agency provide regular training programs for traffic signal maintenance personnel?**	**(Score 1–5)**

For a 5 score, your agency:

- Provides funding and encourages maintenance personnel to regularly attend technical training programs to familiarize themselves with the latest equipment and procedures associated with

traffic signal maintenance;

- Training programs include courses offered by manufacturers and suppliers relevant to the specific equipment currently in use as well as courses dealing with the general theory of traffic signal and computer maintenance and operation.
- Certification: For example, the ITE Traffic Signal Operations Specialist (TSOS) certification and/or the IMSA traffic signal certification is required for traffic signal technicians.

44	**Does your agency have a process for performing regular preventative maintenance and operational reviews to assess the condition of the traffic control system?**	**(Score 1–5)**

Score using:

1. Your agency has no process; regular preventative maintenance and operational reviews are not performed.
2. Your agency has no defined processes; performs *limited* preventative maintenance and operational reviews only if time/man-power permit.
3. Your agency has defined processes; performs *limited* preventative maintenance and operational reviews when time/manpower permit, including verification of signal/pedestrian indications.
4. Your agency has defined processes; performs *regular* preventative maintenance and operational reviews at least annually with limited documentation for some or all equipment.
5. Your agency has a defined process for *regular* preventative maintenance and operational reviews, including comprehensive semi-annual maintenance review, quarterly operational reviews and annual conflict monitor/MMU testing; all including formal documentation for some or all equipment.

45	**Does your agency maintain complete configuration management (schematics, interconnection information, software documentation, etc.) and inventories of all traffic signal control equipment?**	**(Score 1–5)**

For a 5 score:

- Complete inventories include all intersection equipment, including traffic signal controllers, ancillary equipment such as flashers, conflict monitors, load switches, actuation sensors and system detectors, including detector locations, the number and types of sensors.
- Complete inventories also include all communications devices and communications facilities.
- Configuration management information includes the interconnection and disposition of all equipment located at field installations, the central system and in the maintenance facility.

46	**Does your system provide continuous malfunction monitoring notification of critical components?**	**(Score 1–5)**

For a score of 5, your agency is provided with continuous malfunction notification of all critical components in less than 5 minutes, and agency personnel are prepared to effectively respond to these malfunctions as needed.

47	**Does your agency have a maintenance management system for evaluating equipment reliability and scheduling maintenance activities?**	**(Score 1–5)**

Score using:

1. There is no maintenance management system.
2. Maintenance management is accomplished through paper recordkeeping.
3. Maintenance management is accomplished through electronic spreadsheets.
4. Maintenance management is accomplished through a fully computerized system.
5. Maintenance management is accomplished through a fully computerized system, and the maintenance management system is actively used for evaluating equipment reliability and scheduling maintenance activities.

48	**Does your agency have battery backup or a plan for power outages, including emergency generators?**	**(Score 1–5)**

Score using:

1. No battery backups or emergency generators are provided.
2. Your agency is developing a plan to provide for operation during power outages.
3. Your agency has a plan to provide for operation during power outages.
4. Your agency is implementing a plan to provide for operation during power outages.
5. Your agency provides battery backups or emergency generators at all critical intersections.

49	**Maintaining the functionality of detection systems is an important component of an effective and efficient signal timing program. What percentage of your agency's detection is operating as designed?**	**(Score 1–5)**

Score using:

1. Less than 80 percent of detection is operational, or your agency does not directly monitor detection failures.
2. Between 80 and 85 percent of detection is operational.
3. Between 85 and 90 percent of detection is operational.
4. Between 90 and 95 percent of detection is operational.
5. 95 percent or more of detection is operational.

Results for Section 6—Maintenance (Transfer this score to Results Sheet)	**(Max. 45)**

Thank you.

We hope the 2007 Traffic Signal Operation Self Assessment has helped your agency evaluate the operation of its traffic signal system operations. We ask that your results be provided for inclusion in the National Report Card. **Individual results and names of participating agencies are completely confidential.**

We strongly urge you to return results electronically by logging into www.ite.org/selfassessment. Complete the results sheet on the Web site and click "submit."

For **paper copies,** mail the completed results sheet to:

Institute of Transportation Engineers
Attention: Tatyana Jenkins
1099 14th Street, NW, Suite 300 West
Washington, DC 20005-3438

Please return your results by December 29, 2006.