Improved Traffic Signal Maintenance and Management

Study SD2003-01
Final Report and Executive Summary

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February 2004
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ACKNOWLEDGEMENTS

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The work was performed in cooperation with the United States Department of Transportation Federal Highway Administration.

The research team acknowledges the City of Colorado Springs as the source of the cover photo.
In recent years, some cities in South Dakota have experienced an increased frequency of legal inquiries involving accidents at signalized intersections. Currently, the South Dakota Department of Transportation (SDDOT) does not have a qualitative means to systematically track work that occurs on traffic signal systems or a reliable means to retain records of such work. SDDOT recognized the need to develop a reliable means to verify, track, review, and record an inventory of traffic signal maintenance along state routes, and to produce a set of improved signal maintenance and management procedures. SDDOT through its Office of Research initiated a research study to formulate new policies, agreements, and procedural standards for effective management and maintenance of state highway traffic signals. The research project involved a workshop to provide local and national insight; a review of SDDOT’s existing policies, agreements, and procedures; and surveys of maintenance and management practices, as well as computer system needs at other state departments of transportation with similar operational needs to South Dakota. Using the information compiled in the research effort, the study team identified fourteen issues and formulated seven specific recommendations that include development of a maintenance inspection checklist, a final acceptance punchlist, revised maintenance agreements, a comprehensive policy and procedures for traffic signals on state highways, a traffic signal inventory and maintenance database, and updates to the existing standard specifications. The study team also defined the system requirements, opinions of costs and system benefits, and implementation for a Traffic Signal Management and Maintenance System.
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EXECUTIVE SUMMARY

Problem Description
Like many other states, traffic signals on South Dakota’s State Highway System are normally maintained by local government entities. Brief, simple agreements between the South Dakota Department of Transportation (SDDOT) and local entities are the primary documents stipulating how modifications to signal phasing and timing are to be developed. As SDDOT indicates in its Request for Proposal (RFP), “currently, the SDDOT does not have any reliable means to verify, track, review, and record an inventory of traffic signal maintenance along state routes. Compounding the problem is the lack of any qualitative means to systematically track work that occurs on traffic signal systems, nor are there currently any reliable means to retain records of such work. In addition, there is no formal inspection program in place concerning the structural integrity of traffic signal poles and mast arms. Finally, access to traffic signal control boxes is currently provided through a single "one size fits all" key and there is no certification or licensing requirements for those accessing the control boxes to perform maintenance work.”

In recent years, the City of Sioux Falls Traffic Engineering Office (TEO) has experienced an increase in instances where traffic signal operations played a part in legal reviews. In 2002, the TEO has either been subpoenaed, provided depositions, or provided traffic signal timing data to attorneys for court cases at least a dozen times. Since the State retains ownership of state route signals, the State has inherent liability for accidents. Thus, SDDOT has determined the need to develop a traffic signal management and maintenance system to address all of the deficiencies that currently exist. The SDDOT through its Office of Research has initiated a research study with the purpose to formulate new policies, agreements, and procedural standards for the effective management and maintenance of state highway traffic signals.

1.1 Research Objectives
The research study was designed to address the following three key objectives:

1. Review, and redefine as necessary, policies, agreements, and procedures regarding the management and maintenance of existing traffic signals on state routes in South Dakota.

2. Formulate the new policies, agreements, and procedures so that they are defined and drafted from all necessary practicable, legal, and operational standpoints, and so that they can be instilled effectively within the SDDOT organizational structure.

3. Define the requirements of a Traffic Signal Management and Maintenance System that includes an inventory database, and provides the needed technical and organizational capabilities to vastly improve current operations and procedures.
1.2 Research Approach

Eleven specific tasks were performed to satisfy the above research objectives.

1. **Review, and become familiar with material furnished by the Project Technical Panel related to the performance of traffic signal maintenance in South Dakota, including: agreements, policies, procedures, and other corresponding documentation.**

   The research team reviewed the current policies and procedures, including non-standard practices. The review also included standards for the design, installation, operations and maintenance of traffic signals. The review identified the shortcomings in current maintenance and management practices. Moreover, it provided guidance for the surveys and workshop in Tasks 3 to 5, as well as the framework for the new guidelines.

2. **Meet with the project's technical panel to review the project scope and work plan.**

   The consultant project manager and the lead researcher met with the Technical Panel during a kick-off meeting on August 20, 2003. The kick-off meeting enabled the research team and the Technical Panel to identify their priorities and objectives for the project. The meeting provided the opportunity to discuss issues such as the non-standard or so-called “undocumented” practices.

3. **Review traffic signal management and maintenance processes at other state departments of transportation (DOTs) where operational needs are similar to South Dakota, summarize the findings, and also provide details for any state(s) where their procedures and supporting guidelines are deemed distinctly practicable.**

   The research team surveyed 11 state DOTs. Results from the review provided insights into the current state of practice in South Dakota. The information gathered provided a benchmark for SDDOT in its desire to improve and support better traffic signal management and maintenance for South Dakota’s State Highway System.

4. **Contact other state departments of transportation exhibiting similarities to South Dakota in regard to traffic signal management and maintenance computer system needs, summarize the findings, and also provide details for any existing state system(s) that might correlate well to the needs of this project.**

   The research team sent questionnaires to ten state departments of transportation exhibiting similarities to South Dakota concerning traffic signal management and maintenance computer system needs. Of the ten DOTs, only seven responded. The lower than expected number of respondents, however, did not affect the study findings.

5. **Through a facilitated workshop involving management and staff from the SDDOT, local government entities, and others with interests directly tied to the subject, assess the current procedures, supporting guidelines, perceived needs, and ongoing operations that affect traffic signal management and maintenance.**
The consultant facilitated a workshop on November 13, 2003. There were 26 participants, 13 of them from cities around the state while the other 13 were from the Technical Panel. Participants were divided into three groups; BWR staff facilitated each group. Each group tackled six topics relating to the maintenance agreement, access to signal cabinets, maintenance records, traffic signal inventory system, punchlist for signal final acceptance, and maintenance personnel training and certification requirements.

6. Propose and present, for review and approval of the technical panel, recommendations for new policies, agreements, and procedural definitions that are based on well-founded criteria to specifically address South Dakota’s traffic signal management and maintenance activities and gain the desired levels of improvement.

Based on the review of SDDOT documents, survey of other state departments of transportation on their traffic management and maintenance practices and computer system needs, as well as the outcome from the one-day workshop, the research team formulated the new policies, agreements, and procedural guidelines for improved South Dakota traffic signal maintenance and management. The proposed guidelines take into consideration some of the practical constraints within SDDOT and among local government entities.

7. Upon final approval by the technical panel, prepare final drafts of the new policies, agreements, and procedural definitions, as well as recommendations on the best way to incorporate them at the Department, and then assist the panel in their preparations for ultimate presentation to the SDDOT Executive Team.

A decision was made to defer the Technical Panel’s review of the recommended draft new policies, agreements, and procedural guidelines. This is due to timing constraint resulting from delayed survey returns in Task 4. Until the first week of January 2004, the research team only received five of the ten questionnaires. It was decided the Technical Panel review the final report.

8. Based on feedback and concurrence of the SDDOT Executive Team on the new policies, agreements, and procedural definitions, develop a system requirements document for a traffic signal management and maintenance system for review and approval by the project’s technical panel. The documentation shall include database requirements for maintaining an inventory of signal systems equipment, programming of signal timing/phasing, capital improvements, inspection frequency/history, control box access security, and maintenance costs.

The purpose of this task was to specify the requirements for the new South Dakota Traffic Signal Management and Maintenance System (TSMMS). Following the recommendations in Chapter 7, the system requirements outlined the hardware and software requirements for the inventory and maintenance database, as well as the capital improvements needed to implement the three basic categories that define the TSMMS.
9. **Upon review and approval of the system requirements document by the technical panel, develop estimates for system costs, levels of development effort, system integration needs, and any impacts to Departmental operations.**

The purpose of this task was to develop cost estimates to implement the new guidelines. The research team prepared opinion of costs for development and operation of the signal databases. The costs include hardware, software, and personnel. Other cost components, such as capital improvements, staffing requirements, and increased cost to implement the new maintenance program were also determined.

10. **Prepare a final report and executive summary of the workshop, reviews of other state processes and systems, research methodology, findings, conclusions, & recommendations.**

The purpose of this task was to prepare a complete documentation of the processes involved in developing the TSMMS. The research team put together the outcomes from the workshop, surveys of practices and computing needs in other state DOTs, research methodology, findings, conclusions, and recommendations into a final report and an executive summary report.

11. **Make an executive presentation to the SDDOT Research Review Board at the conclusion of the project.**

At the conclusion of the research project, the research team presented the research findings and recommendations to the SDDOT Research Review Board. Comments and suggestions during the presentation were incorporated into the final report.

1.3 **General Findings**

Findings and lessons learned from the synthesis of the review of policies, agreements, and procedures, lessons gleaned from the surveys of state DOTs, and the outcomes from the workshop discussions provided vital information in formulating new policies, agreements, and procedural standards for a SDDOT Traffic Signal Management and Maintenance System. The synthesis identifies issues in three categories that define an effective SDDOT TSMMS: (1) Maintenance agreements, (2) A comprehensive statewide policy and procedures, and (3) A statewide traffic signal inventory and maintenance database.

**Maintenance Agreements**

**ISSUE 1: WHAT SHOULD “MAINTENANCE” ALL INCLUDE?** Maintenance can be divided into three basic types—preventive, response, and modification. Preventive maintenance actions are performed on a regularly scheduled basis to preserve an intended working condition. Response maintenance actions are performed on an as-needed basis. Modification actions correct a recurring problem. Maintaining agencies perform all three types of maintenance for efficient and safe operation of the traffic signal controls. Maintenance practices at Kansas Department of Transportation (KDOT), Missouri Department of Transportation (MoDOT), Nebraska
Department of Roads (NDOR), New Mexico Department of Transportation (NMDOT), and Wyoming Department of Transportation (WYDOT) indicate a formal statewide maintenance program in place. KDOT, MoDOT, and WYDOT use a maintenance checklist. KDOT requires that maintaining agencies carry out a semi-annual maintenance of the items listed in the maintenance checklist that must be submitted back to KDOT. WYDOT uses a checklist for its annual maintenance inspection.

The current SDDOT maintenance agreement does not specify what “maintenance” should include. During the workshop, participants agreed on the need to develop a uniform maintenance checklist that maintaining agencies submit annually to SDDOT.

**ISSUE 2: DOCUMENTATION AND RECORD KEEPING.** One of the most important but often neglected requirements of system maintenance is relevant and up-to-date documentation. Records needed for effective maintenance fall into three basic categories—maintenance service records, signal timing charts, and maintenance manuals and as-built plans. Practices at MoDOT, Montana Department of Transportation (MDT), North Dakota Department of Transportation (NDDOT), and WYDOT require that maintenance logs be kept in the signal controller cabinets. ITD (Idaho Transportation Department), MoDOT, MDT, and NMDOT document maintenance electronically. Other state DOTs adopt both paper and electronic record, while others only keep paper copies. Workshop participants suggested that SDDOT should develop a maintenance log in a checklist format, which should be kept either at the signal cabinets or at the maintaining agencies’ maintenance shop. Further, SDDOT should develop a maintenance checklist that maintaining agencies submit annually. In addition to the maintenance log and checklist, SDDOT should develop a standard form of the timing change log that maintaining agencies need to keep inside the signal cabinets.

The current SDDOT maintenance agreement does not specify documentation and record keeping, including how and when maintenance records are to be communicated back to SDDOT.

**ISSUE 3: WHO SHOULD BE ALLOWED TO MAKE CHANGES TO SIGNAL TIMINGS?** Practices at other state DOTs reveal a mix of agencies authorized to change signal timings. While some DOTs allow Cities, Counties, and Local Government Agencies to make changes to the signal timings, any changes made generally requires concurrence from the State. KDOT delegates authority to make changes to the signal timings to the maintaining agencies. KDOT, however, requires permission if changing phases on yellow or all red.

The current SDDOT maintenance agreement does not allow maintaining agencies to make changes to the signal timing plans without prior SDDOT approval. The exception is the City of Sioux Falls where the City is permitted to make adjustment to signal splits and offsets to accommodate changes in traffic conditions.

**ISSUE 4: WHO SHOULD BE ALLOWED ACCESS TO THE SIGNAL CONTROLLER CABINETS?** One of the issues identified in this research study is the current SDDOT practice allowing unlimited access to traffic signal controller cabinets through a single “one size fits all” key with no
certification or licensing requirements for those accessing the signal control cabinets to perform maintenance work. SDDOT recognizes this problem and desires to restrict access only to authorized and qualified personnel. Limiting such access will improve the quality of maintenance; at the same time, it will reduce the potential for inadequate, if not incorrect maintenance work.

Practices at other state DOTs indicate some state DOTs use special measures to limit access to the signal controller cabinets. These measures include special keys, padlocks, supervisor access codes, and “police panel” for police access. Workshop participants suggested restricting access to allow access only to authorized personnel from the State, maintaining agencies, and contractors, as well as access to police through a “police panel.”

**ISSUE 5: HOW CAN SDDOT BE SURE SIGNALS ARE BEING MAINTAINED?** Workshop participants suggested the use of a maintenance checklist that maintaining agencies shall submit annually. Some state DOTs impose some form of penalty or sanction against non-performance of maintenance. Sanctions include the State invoicing the maintaining agency, withholding state reimbursements, voiding the maintenance agreement, or removing the signal. It is important to note that the few that indicated some form of sanctions, cost-sharing arrangements do exist with the maintaining agencies.

The current SDDOT maintenance agreement does not specify sanctions against the maintaining municipality in the event of failure to perform its maintenance obligations.

**Policy and Procedures for Traffic Signals on State Highways**

**ISSUE 6: CURRENT POLICY AND PROCEDURES DOCUMENT.** The current policy and procedures for traffic signals on state highways (see Appendix B) is not comprehensive. It only includes policies for installation and procedures for initiation and removal of traffic signals. It does not cover policies and procedures for management and maintenance.

**ISSUE 7: NON-STANDARD PRACTICES.** The lack of comprehensive policy and procedural guidelines for state highway traffic signals has resulted in non-standard practices.

**ISSUE 8: PRECONSTRUCTION CONFERENCE.** A preconstruction conference with the contractor and other interested parties is normally conducted on all construction projects, including traffic signal installations. Many agencies have formal, written policies for the conduct and content of the preconstruction meeting. The primary goal of such a conference is to establish a sound working relationship and a clear understanding of the work to be accomplished, procedures to be followed, and respective obligations and expectations among all parties affected. As suggested during the workshop, the final acceptance punchlist could be discussed during this preconstruction meeting where inspectors would be provided with the list. Further, it was suggested that representatives from maintaining agencies be present during this preconstruction meeting to coordinate their involvement in inspection during certain phases of construction.
The current SDDOT procedures for traffic signal installations do not specify a preconstruction conference.

**ISSUE 9: TRAFFIC SIGNAL FINAL ACCEPTANCE PUNCHLIST.** Maintenance problems often can be traced to inadequate inspection during installation or inadequate design. Undetected installation errors include violations of the National Electrical Code and/or other applicable codes, improper installation of hardware, and incorrect operation of the equipment. A major factor contributing to design and installation problems is often the lack of comprehensive inspection guidelines, including a final acceptance punchlist to ensure a thorough, systematic inspection by the field inspector. Careful adherence to the listed suggestions will not only avoid unnecessary and costly repairs or reconstruction, but will also help minimize exposure to liability. Arkansas State Highway and Transportation Department (AHTD), NMDOT, WYDOT, and the City of Sioux Falls have adopted punchlists in their final acceptance inspection.

SDDOT does not have a uniform final acceptance punchlist. The Mitchell Region has established a punchlist; however, this needs to be more comprehensive. During the workshop, participants agreed that SDDOT should use a uniform punchlist for final acceptance, and that SDDOT should develop such a uniform punchlist. In addition, workshop participants suggested that Cities should be more involved in the final acceptance process.

**ISSUE 10: PERIODIC INSPECTION AND REVIEWS.** Routine periodic inspection of all traffic control devices is the cornerstone of an effective risk management program. Workshop participants suggested that SDDOT Regional offices should conduct an annual random inspection to ascertain that maintenance work meets the minimum level of maintenance standards.

**ISSUE 11: MAINTENANCE RECORDS.** Adequate maintenance records are essential. Maintenance records can help in providing efficient service, detecting and correcting recurrent problems, and developing maintenance schedules and strategies. They are also essential to an adequate defense in the event of a lawsuit. A wide variety of record keeping approaches and forms are currently in use. Generally, however, the records needed for effective maintenance fall into three basic categories: (1) maintenance service records, (2) signal timing charts, and (3) maintenance manuals and as-built plans. Maintenance service history records are most commonly kept for each individual system component, using a variety of forms and ledgers consistent with the preventive, response, and modification maintenance practices. Controller time settings as prepared by the traffic engineer are recorded on signal timing charts. Copies of these charts should be kept inside the controller cabinet for use by signal mechanics or other maintenance personnel to verify and adjust the signal timings if necessary. The third category of maintenance records includes manuals provided by the manufacturer, special controller programs, component layout sheets, wiring schematics, and as-built construction drawings.

In the case of SDDOT, maintenance records will not necessarily include details of each maintenance category. For example, SDDOT does not need a record of all service calls or details of how often each traffic signal is relamped. This is because SDDOT does not perform the
maintenance, rather Local Government Agencies do. SDDOT, however, needs a reliable means to verify, track, and retain records of work that occurs on state route traffic signals. Reliable means of documentation and record keeping is lacking in current SDDOT practice.

**ISSUE 12: TRAINING AND CERTIFICATION REQUIREMENTS.** Maintenance personnel should be thoroughly trained in the proper actions to take in the case of traffic control system malfunction or loss of control. Maintenance work should be carried out only by qualified personnel. One of the problems identified in this research study is the general lack of training and certification requirements for maintenance personnel. Practices at MDT and NMDOT require certification or training for maintenance personnel. MDT typically requires IMSA (International Municipal Signal Association) Level I/Level II certification. MoDOT is not currently requiring certification, but is providing IMSA training for signal crews. MoDOT is considering incorporating the required training into the job specification. Furthermore, MoDOT is also considering requiring contractors to have IMSA training before being able to install or wire any signal. WYDOT has all technicians IMSA Level I certified or higher. Participants during the workshop generally agreed that training is essential for effective maintenance of signal systems. Participants also suggested that SDDOT play an active role in providing training and that SDDOT and maintaining agencies should discuss concerns of mutual interest.

**Traffic Signal Maintenance Database**

**ISSUE 13: MANAGEMENT OF MAINTENANCE RECORDS.** A successful maintenance management plan requires efficient and systematic storage and retrieval of maintenance records. A statewide maintenance management database that is accessible by region personnel is essential. Such a maintenance management database should be capable of tracking maintenance works and programming of the signal timing/phasing, as well as being integrated with the signal inventory system. Although most respondent DOTs do not include maintenance in their current inventory system, a few include timing plans and phasing. SDDOT has timing and phasing in its current, but not yet operational, inventory system.

**Other Issue**

**ISSUE 14: UPDATES TO THE STANDARD SPECIFICATIONS.** The Mitchell Region Traffic Engineer has identified changes and/or updates to the traffic signal standard specifications. The list of proposed specification updates is included as Appendix I.
1.4 Recommendations

The research study undertaken for SDDOT Research Project SD2003-01 identified a number of specific recommendations that the SDDOT should strongly consider. Recommendations were formulated based on findings that define an improved traffic signal management and maintenance system for SDDOT.

Seven specific actions are recommended to improve the management of traffic signal maintenance. Six of the seven specific actions define the Traffic Signal Management and Maintenance System categories that include: (1) Maintenance agreements, (2) A comprehensive statewide policy and procedures, and (3) A statewide traffic signal inventory and maintenance database. In addition, two specific actions are aimed at improving the existing standard specifications and design guidelines for traffic signals. Each recommendation has reference to the identified issues.

**R1. DEVELOP A MAINTENANCE CHECKLIST.** The research team has compiled a checklist from the survey based on practices at other state departments of transportation and from the preventive maintenance guidelines set by the IMSA. The checklist is presented in Table 7-1 of the final report. *(Issue 1)*

**R2. DEVELOP A FINAL ACCEPTANCE PUNCHLIST.** The research team has compiled a punchlist that includes references to the current SDDOT Standard Specifications for Roads and Bridges: Division II-Construction Materials and SDDOT Road Design Standard Plates – Section 635 Traffic Signals and Roadway Lighting, as well as references to the punchlist develop by the Mitchell Region and by other agencies including the City of Sioux Falls, AHTD, NMDOT, WYDOT, and IMSA. The punchlist is presented in Table 7-2 of the final report. *(Issue 8)*

**R3. REVISE THE MAINTENANCE AGREEMENTS.** To achieve the objectives of improving the management of traffic signal maintenance on state highways, five sub-provisions are recommended to be added to Provision 2 of the current maintenance (SDDOT maintenance agreements with municipalities) agreements. These additional sub-provisions would enable the SDDOT to verify and track maintenance work, keep better records of maintenance, restrict access to signal cabinets, and ensure that municipalities perform their maintenance responsibilities to avoid sanctions for non-performance. These additional provisions relate to maintaining traffic signal maintenance and timing change logs, keeping the logs inside the controller cabinets, submitting an annual maintenance report using the SDDOT uniform maintenance checklist, limiting access to the signal cabinets, and defining sanctions for non-performance of maintenance. *(Issues 1 to 5)*

**R4. REVISE THE EXISTING POLICY AND PROCEDURES.** The research team recommends that SDDOT revise its existing policy and procedures for the management and maintenance of traffic signals on state highways. The revised policy and procedures are designed to be more...
comprehensive to include the following specific recommendations that should form part of the comprehensive policy and procedure. (Issue 6)

A. **DEFINE OPERATION AND MAINTENANCE RESPONSIBILITIES.** The comprehensive policy and procedures need to specify operation and maintenance responsibilities for traffic signals outside the jurisdictions of Cities. These include traffic signals located on tribal lands, county roads, towns with population below 2,500 and those with populations above 2,500. Operation and maintenance responsibilities are described in Section D of the comprehensive policy and procedures. (Issue 7)

B. **PRECONSTRUCTION CONFERENCE.** It is recommended that the final acceptance punchlist be discussed during the traffic signal installation preconstruction conference. This recommendation is added as Item 7 in Section F (Procedure for the Initiation of a Traffic Signal Project) of the comprehensive policy and procedures document. (Issue 8)

C. **TRAFFIC SIGNAL FINAL ACCEPTANCE PUNCHLIST.** SDDOT should include the final acceptance punchlist as requisite in the Procedure for the Initiation of a Traffic Signal Project. This recommendation is added in Items 7 and 8 of the comprehensive policy and procedures. (Issue 9)

D. **TRAFFIC SIGNAL REMOVAL.** The current procedure for the removal of an existing traffic signal should be replaced with a more detailed procedure. As described in Section 2.2.1, the current procedure, while adequate, could be expanded to outline a public information process and interim intersection control approach. In addition, the comprehensive policy and procedures specifically define the responsibility to SDDOT for the removal cost of unwarranted traffic signals. This detailed procedure is included as Section G of the comprehensive policy and procedures.

E. **TRAFFIC SIGNAL TIMING.** The comprehensive policy and procedures should identify the agency responsible for making traffic signal timing changes. Likewise, it should describe how and when maintaining agencies should report the changes made to the signal timings. Traffic signal timing is included as Section H in the revised policy and procedures. (Issues 3 and 11)

F. **DEFINITIONS OF MAINTENANCE.** The comprehensive policy and procedures should include definitions of maintenance. This recommendation is included as Item 1 in Section I. (Issue 1)

G. **TYPES OF MAINTENANCE.** The comprehensive policy and procedures should specify the types of maintenance that maintaining agencies should carry out. This recommendation is included as Item 2 in Section I. (Issue 1)

H. **MAINTENANCE CHECKLIST.** The comprehensive policy and procedures should specify the use of a maintenance checklist as a minimum maintenance guide. This recommendation is included as Item 3 in Section I. (Issue 1)

I. **PERFORMANCE OF MAINTENANCE.** The comprehensive policy and procedures should specify the form of penalty or sanction against non-performance of maintenance. This recommendation is included as Item 3 in Section I. (Issue 5)

J. **MAINTENANCE RECORDS.** The comprehensive policy and procedures should specify the maintenance records maintaining agencies need to keep and submit to SDDOT. Likewise, it should also describe when maintenance records need to be submitted to SDDOT. This recommendation is included as Item 4 in Section I. (Issues 2 and 11)
K. Scheduling and Tracking of Maintenance. The comprehensive policy and procedures should describe how SDDOT keeps track of maintenance. This recommendation is included as Item 5 in Section I. (Issue 11)

L. Periodic Inspection and Reviews. The comprehensive policy and procedures should include an annual maintenance inspection to be conducted at regional offices. This recommendation is included as Item 6 in Section I. (Issue 10)

M. Access to Signal Cabinets. The comprehensive policy and procedures should specify the personnel authorized to access the signal cabinets, including measures to restrict access. This recommendation is included as Item 7 in Section I. (Issue 4)

N. Maintenance Personnel Certification and Training. The comprehensive policy and procedures should specify certification requirements for maintenance personnel. It should also establish training opportunities for maintenance personnel, both for SDDOT and maintaining agencies’ staff. These recommendations are included as Item 8 in Section I. (Issue 12)

R5. Maintenance Database. SDDOT should develop a database that stores and retrieves records of maintenance activities. (Issue 13)

R6. Update the Existing Standard Specifications for Traffic Signals. SDDOT should update its standard specifications to incorporate the suggested updates by the Mitchell Region Traffic Engineer, Scott Jansen. These changes are listed in Appendix I. Likewise, additional standard details should be developed. In addition, items in the punchlist that are not currently referenced should be included in Section 635 of the standard specifications. (Issue 14)


1.5 Opinions of System Benefits and Costs

Benefits

Implementation of an improved management and maintenance system for state route signals will undoubtedly create some benefits, both tangible and intangible. For South Dakota, the benefits of improved management and maintenance are largely intangible benefits, (i.e., the potential reduction from liability risk). A good analogy of such intangible benefits is the case with life insurance where benefits are realized only when needed. Another intangible benefit could be an improvement in public perception by the way SDDOT and Cities better protect public interest.

On the other hand, the tangible benefits could come from the savings in travel delays at intersections. Much of the delay experienced by motorists occurs at signalized intersections, as
they wait for the light to turn green. Delays can be reduced, however, by optimizing the timing of the signals. According to a FHWA study, “traffic signal improvements rank as one of the most cost-effective energy conservation strategies in urban areas” (ITE, 1995). The FHWA estimates that the benefit-to-cost ratio of traffic signal timing optimization projects approaches 40 to 1. Furthermore, basic traffic signal improvements can result in a 12 percent improvement in vehicle speed or travel time. Likewise, retimed traffic signals, with no changes in hardware, can generally save 12 percent in travel time.

Costs

Implementing the Traffic Signal Management and Maintenance System involves costs both to SDDOT and to maintaining agencies. Estimate of system costs to SDDOT is given in the table below. Costs to maintaining agencies are not determined as this is out of the scope of the study.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Work Effort (Days)</th>
<th>Opinions of Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost Estimate During First Year of Implementation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Inventory and Maintenance Database</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Software</td>
<td>15</td>
<td>$7,050</td>
</tr>
<tr>
<td>Database Development &amp; Maintenance</td>
<td>20</td>
<td>$9,400</td>
</tr>
<tr>
<td>Training</td>
<td>3</td>
<td>$1,410</td>
</tr>
<tr>
<td>Data Update</td>
<td>20</td>
<td>$9,400</td>
</tr>
<tr>
<td>2. Maintenance Management</td>
<td>40</td>
<td>$18,800</td>
</tr>
<tr>
<td>3. Periodic Inspection and Reviews</td>
<td>130</td>
<td>$82,600</td>
</tr>
<tr>
<td>4. Certification and Training</td>
<td>37</td>
<td>$23,290</td>
</tr>
<tr>
<td>5. Implementation</td>
<td>60</td>
<td>$28,200</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td></td>
<td><strong>$170,750</strong></td>
</tr>
<tr>
<td><strong>Cost Estimate After Subsequent Years</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Inventory and Maintenance Database</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Database Maintenance</td>
<td>5</td>
<td>$2,350</td>
</tr>
<tr>
<td>Data Update</td>
<td>20</td>
<td>$9,400</td>
</tr>
<tr>
<td>2. Maintenance Management</td>
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<td>$18,800</td>
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<tr>
<td>3. Periodic Inspection and Reviews</td>
<td>130</td>
<td>$82,600</td>
</tr>
<tr>
<td>4. Certification and Training</td>
<td>22</td>
<td>$10,340</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td></td>
<td><strong>$123,490</strong></td>
</tr>
</tbody>
</table>

a Assuming MS Access database. There is no separate cost as this program is part of MS Office Suite.
b Assuming a SIGNALview standard license. Price includes 3 days of onsite hands-on training, installation and implementation.
c SDDOT/BIT time
d Cost includes lodging, per diem, and vehicle mileage.
e Assumes 5 SDDOT staff attending IMSA certification. Estimate includes air fare and accommodations plus registration costs.
f Cost also includes a two-day annual training and workshop that SDDOT will conduct to train maintaining agencies’ personnel.

1.6 Conclusions
The review of current maintenance and management practices at SDDOT indicate the need to update the current maintenance agreements, define new policies and procedural guidelines, and develop a maintenance and management database that is accessible by all regions of the state.

The survey of eleven, mainly Midwestern, state departments of transportation indicate that SDDOT’s maintenance and management practices for state route signals in South Dakota, in many respects, fall in line with mainstream practices. Likewise, the results of the computing system needs survey provided insight as to what other DOTs are doing and how they are approaching the maintenance and management of signals in their jurisdictions. DOTs that are largely performing their maintenance have more comprehensive computerized inventory systems. In contrast, DOTs that are not involved in the maintenance have very basic inventory systems, and usually do not include records of maintenance activities.

Lessons gleaned from the review of current SDDOT practices and from these surveys were useful information during the workshop discussions. Workshop participants generally agreed to the need to address current shortcomings in the way maintenance of state highway signals are managed. Participants felt that, while practices at SDDOT fall in line with mainstream practices, there are benefits to improving the current practices.

The research team has identified fourteen issues and has recommended seven specific actions. Six of the seven specific actions define the Traffic Signal Management and Maintenance System categories that include: (1) Maintenance agreements, (2) A comprehensive statewide policy and procedures, and (3) A statewide traffic signal inventory and maintenance database. Five additional sub-provisions to the maintenance agreements are proposed. Comprehensive policy and procedures are drafted, and system requirements for a traffic signal inventory and maintenance database is outlined. Moreover, a maintenance checklist and a final acceptance punchlist are compiled. In addition, certification and training requirements are outlined.

The research team described the system requirements for the TSMMS, together with the levels of development effort and the estimate of system costs. An order of magnitude estimate indicates that implementation of the TSMMS would cost the Department between $171,000 to $181,000 during the first year of implementation and about $124,000 after subsequent years. Implementation of the TSMMS would also cost maintaining agencies; however, determination of such costs is out of the scope of this study. The study also outlines both the tangible and intangible benefits from implementation of such an improved management and maintenance.
1.0 INTRODUCTION

1.1 Problem Description

Traffic signals are valuable devices for the control of vehicles and pedestrians and assigning the right-of-way to the various traffic movements. The use of traffic signals throughout the United States and the technology available for traffic signal equipment has continued to change and provide more tools for traffic engineers to better meet the needs of the traveling public. More sophisticated traffic control equipment, the use of computers and data gathering techniques have continued to evolve the role that traffic signals can play in managing the safe and efficient use of the traffic system.

Essential to the successful performance of any traffic signal or control system, whether computerized or not, is an effective maintenance management program consisting of both preventive and remedial maintenance of traffic signal hardware and software. A poorly maintained signal system can compromise travel efficiency and safety. Moreover, as is the case with most equipment, signal systems that are neglected are likely to perform inefficiently and experience premature failure. The consequence of poor maintenance practices are a reduction in safety to road users and an unnecessarily large exposure to liability claims.

The operation and maintenance of traffic signals on the State Highway System (SHS) varies among State Departments of Transportation (DOTs). Some DOTs operate and maintain the state route signals while others delegate some or all of the maintenance work to local government entities. State DOTs stipulate the maintenance agreements with local government agencies. The maintaining agencies may or may not receive compensation for the maintenance work. The level of compensation varies among DOTs, which may be determined based on the number of signals maintained, as well as on the level of ownership of the signals. If the traffic signal only partly belongs to the state highway system, then the state DOT pays only the partial amount to the maintaining agency.

Like many other states, traffic signals on South Dakota’s State Highway System are normally maintained by local government entities. Brief, simple agreements between the South Dakota Department of Transportation (SDDOT) and local entities are the primary documents stipulating how modifications to signal phasing and timing are to be developed. As SDDOT indicates in its Request for Proposal (RFP), “currently, the SDDOT does not have any reliable means to verify, track, review, and record an inventory of traffic signal maintenance along state routes. Compounding the problem is the lack of any qualitative means to systematically track work that occurs on traffic signal systems, nor are there currently any reliable means to retain records of such work. In addition, there is no formal inspection program in place concerning the structural integrity of traffic signal poles and mast arms. Finally, access to traffic signal control boxes is
currently provided through a single "one size fits all" key and there is no certification or licensing requirements for those accessing the control boxes to perform maintenance work."

In recent years, the City of Sioux Falls Traffic Engineering Office (TEO) has experienced an increase in instances where traffic signal operations played a part in legal reviews. In 2002, the TEO has been subpoenaed, provided depositions, or provided traffic signal timing data to attorneys for court cases at least a dozen times. Since the State retains ownership of state route signals, the State is liable for any traffic accidents. Thus, SDDOT has determined the need to develop a traffic signal management and maintenance system to address all of the deficiencies that currently exist. The SDDOT through its Office of Research has initiated a research study with the purpose to formulate new policies, agreements, and procedural standards for an effective management and maintenance of state highway traffic signals.

1.2 Research Objectives

The study to improve South Dakota Department of Transportation’s maintenance and management of traffic signals on the State Highway System has three objectives. Subsequent paragraphs describe each of these objectives.

Objective 1. Review, and redefine as necessary, policies, agreements, and procedures regarding the management and maintenance of existing traffic signals on state routes in South Dakota.

The first step in defining new policies, agreements, and procedures for an effective traffic maintenance and management system for South Dakota was to undertake a thorough review of the existing state of practice at SDDOT. The review on existing policies, agreements, and procedures provided greater understanding on the shortcomings, as well as strengths, in the current practice. The review identified the changes in the current policy and procedures and the maintenance agreements. Furthermore, the review provided a good background for the workshop and surveys of maintenance and management practices, as well as computer system needs at other state departments of transportation.

Objective 2. Formulate the new policies, agreements, and procedures so that they are defined and drafted from all necessary practicable, legal, and operational standpoints, and so that they can be instilled effectively within the SDDOT organizational structure.

The purpose of the research study was to formulate new policies, agreements, and procedures that collectively represent the guidelines to develop the system requirements for a SDDOT traffic signal maintenance and management system. The in-depth review of current policies, agreements, and procedures, including review of standards for the design, installation, operations and maintenance of traffic signals served as the cornerstone in drafting the new guidelines.

It is not possible to formulate effective new guidelines for South Dakota without the participation of local government entities that are partly responsible for traffic signals within their
jurisdictions. It is paramount that mutual understanding exists between the state and the local entities. To achieve such mutual understanding, a proper forum for stakeholder consultation was pursued through a one-day workshop aimed at bringing out issues, concerns, constraints, and barriers while at the same time attempting to resolve these issues and concerns. Furthermore, knowledge of current practices at other state departments of transportation whose operational characteristics are similar to South Dakota proved invaluable in drafting the new guidelines.

**Objective 3. Define the requirements of a Traffic Signal Management and Maintenance System that includes an inventory database, and also provides the needed technical and organizational capabilities to vastly improve current operations and procedures.**

With the new guidelines, the next logical step was to define an implementation plan. The implementation plan described the requirements of a Traffic Signal Management and Maintenance System (TSMMS). Three basic categories defined the TSMMS: (1) Maintenance agreements, (2) A comprehensive statewide policy and procedures, and (3) A statewide traffic signal inventory and maintenance database. Based on these three elements, estimate of system costs, level of development effort, system integration needs, and impacts to Departmental operations were defined.

**1.3 Research Plan**

To accomplish the above three objectives, eleven research tasks were defined. Below describes the tasks specified in the original request for proposals, together with the steps taken to perform them.

**Task 1. Review, and become familiar with material furnished by the Project Technical Panel related to the performance of traffic signal maintenance in South Dakota, including: agreements, policies, procedures, and other corresponding documentation.**

The research team reviewed the current policies and procedures, including non-standard practices. The review also included standards for the design, installation, operations and maintenance of traffic signals. The review identified the shortcomings in current maintenance and management practices. Moreover, it provided guidance for the surveys and workshop in Tasks 3 to 5, as well as the framework for the new guidelines described in Chapter 7.

**Task 2. Meet with the project's technical panel to review the project scope and work plan.**

The consultant project manager and the lead researcher met with the Technical Panel during a kick-off meeting on August 20, 2003. The kick-off meeting enabled the research team and the Technical Panel to identify their priorities and objectives for the project. The meeting provided the opportunity to discuss issues such as the non-standard or so-called “undocumented” practices.
Task 3. **Review traffic signal management and maintenance processes at other state departments of transportation where operational needs are similar to South Dakota, summarize the findings, and also provide details for any state(s) where their procedures and supporting guidelines are deemed distinctly practicable.**

The purpose of this review was to gain an understanding of how other state departments of transportation manage and maintain traffic signals on the state highway system. The research team surveyed 11 state departments of transportation. Results from the review provided insights into the current state of practice in South Dakota. The information gathered provided a benchmark for SDDOT in its desire to improve and support better traffic signal management and maintenance for South Dakota’s State Highway System.

Task 4. **Contact other state departments of transportation exhibiting similarities to South Dakota in regard to traffic signal management and maintenance computer system needs, summarize the findings, and also provide details for any existing state system(s) that might correlate well to the needs of this project.**

The research team sent questionnaires to ten state departments of transportation exhibiting similarities to South Dakota concerning traffic signal management and maintenance computer system needs. Of the ten DOTs, only seven responded. The lower than expected number of respondents, however, did not affect the study findings.

Task 5. **Through a facilitated workshop involving management and staff from the SDDOT, local government entities, and others with interests directly tied to the subject, assess the current procedures, supporting guidelines, perceived needs, and ongoing operations that affect traffic signal management and maintenance.**

The consultant facilitated a workshop on November 13, 2003. There were 26 participants, 13 of them from cities around the state while the other 13 were from the Technical Panel. Participants were divided into three groups; BWR staff facilitated each group. Each group tackled six topics relating to the maintenance agreement, access to signal cabinets, maintenance records, traffic signal inventory system, punchlist for signal acceptance, and maintenance personnel training and certification requirements.

Task 6. **Propose and present, for review and approval of the technical panel, recommendations for new policies, agreements, and procedural definitions that are based on well-founded criteria to specifically address South Dakota’s traffic signal management and maintenance activities and gain the desired levels of improvement.**

Based on the review of SDDOT documents, survey of other state departments of transportation on their traffic management and maintenance practices and computer system needs, as well as the outcome from the one-day workshop, the research team formulated the new policies, agreements, and procedural guidelines for improved South Dakota traffic signal maintenance and management. The proposed guidelines take into consideration some of the practical constraints within SDDOT and among local government entities.
Task 7. Upon final approval by the technical panel, prepare final drafts of the new policies, agreements, and procedural definitions, as well as recommendations on the best way to incorporate them at the Department, and then assist the panel in their preparations for ultimate presentation to the SDDOT Executive Team.

A decision was made to defer the Technical Panel’s review of the recommended draft new policies, agreements, and procedural guidelines. This is due to timing constraint resulting from delayed survey returns in Task 4. Until the first week of January 2004, the research team only received five of the ten questionnaires. It was decided the Technical Panel review the final report.

Task 8. Based on feedback and concurrence of the SDDOT Executive Team on the new policies, agreements, and procedural definitions, develop a system requirements document for a traffic signal management and maintenance system for review and approval by the project’s technical panel. The documentation shall include database requirements for maintaining an inventory of signal systems equipment, programming of signal timing/phasing, capital improvements, inspection frequency/history, control box access security, and maintenance costs.

The purpose of this task was to specify the requirements for the new South Dakota Traffic Signal Management and Maintenance System (TSMMS). Following the recommendations in Chapter 7, the system requirements outlined the hardware and software requirements for the inventory and maintenance database, as well as the capital improvements needed to implement the three basic categories that define the TSMMS.

Task 9. Upon review and approval of the system requirements document by the technical panel, develop estimates for system costs, levels of development effort, system integration needs, and any impacts to Departmental operations.

The purpose of this task was to develop cost estimates to implement the new guidelines. The research team prepared costs for development and operation of the signals databases. The costs include hardware, software, and personnel. Other cost components, such as capital improvements, staffing requirements, and increased cost to implement the new maintenance program were also determined.

Task 10. Prepare a final report and executive summary of the workshop, reviews of other state processes and systems, research methodology, findings, conclusions, and recommendations.

The purpose of this task was to prepare a complete documentation of the processes involved in developing South Dakota’s Traffic Signal Management and Maintenance System. The research team put together the outcomes from the workshop, surveys of practices and computing needs in other state DOTs, research methodology, findings, conclusions, and recommendations into a final report and a separate executive summary report.

Task 11. Make an executive presentation to the SDDOT Research Review Board at the conclusion of the project.
At the conclusion of the research project, the research team presented the research findings and recommendations to the SDDOT Research Review Board. Comments and suggestions during the presentation were incorporated into the final report.
2.0 MANAGEMENT AND MAINTENANCE PRACTICES AT SDDOT

Task 1. Review, and become familiar with material furnished by the Project Technical Panel related to the performance of traffic signal maintenance in South Dakota, including: agreements, policies, procedures, and other corresponding documentation.

2.1 Introduction

This chapter of the report reviews and documents the existing policies, agreements, and procedures for the installation and maintenance of traffic signals on the South Dakota State Highway System. The review includes both documented and “undocumented” procedures. Documented procedures were obtained from the policies and procedures described in Section 2.2 while the “undocumented” procedures were based on discussions with the Technical Panel during the kickoff meeting in August 20, 2003. These “undocumented” procedures include regional practices that are non-statewide standard practices. Subsequent sections describe SDDOT management and maintenance practices.

2.1.1 South Dakota Department of Transportation Organization

The South Dakota Department of Transportation organizes its functions into a Central office located in Pierre and four regions, namely: Aberdeen Region, Mitchell Region, Pierre Region, and Rapid City Region. Further, each region organizes its functions thru its Area offices. Area Offices are mainly involved in construction and road maintenance. The final inspection of a traffic signal project has been the responsibility of the SDDOT Area Offices that administered the contract. Experience in the Mitchell Region, however, indicates no records of how these inspections were/are conducted or the results of those inspections.

Cities responsible for maintaining the state route signals coordinate with Region Traffic Engineers. For new signal installations, the Road Design section under the Division of Planning and Engineering at SDDOT Central Office is responsible for warrant studies and design.

2.1.2 Traffic Signals and the State Highway System

The South Dakota Department of Transportation maintains approximately 7,855 miles of State Highway System (SHS). Table 2-1 presents the number of traffic signals on state highways by region, together with the total mileage. Also included in the table is the total regional population.
Table 2-1  Population, Traffic Signals, and Miles of State Highway System in South Dakota

<table>
<thead>
<tr>
<th>Region</th>
<th>Population</th>
<th>Miles of State Highway System</th>
<th>Number of Signals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aberdeen</td>
<td>178,358</td>
<td>2,075.388</td>
<td>62</td>
</tr>
<tr>
<td>Mitchell</td>
<td>324,651</td>
<td>1,968.781</td>
<td>115</td>
</tr>
<tr>
<td>Pierre</td>
<td>76,653</td>
<td>2,225.123</td>
<td>19</td>
</tr>
<tr>
<td>Rapid City</td>
<td>175,182</td>
<td>1,586.326</td>
<td>70</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>754,844</strong></td>
<td><strong>7,855.618</strong></td>
<td><strong>266</strong></td>
</tr>
</tbody>
</table>

The SDDOT is responsible for installation of traffic control signals on the State Highway System. For operation and maintenance of these signals, the SDDOT enters into agreements with Local Government Agencies (LGA). Section 2.4 discusses the existing Maintenance Agreements.

### 2.2 Current SDDOT Policies and Procedures

The South Dakota Office of Research furnished the research team with documents describing policies and procedures, as well as documents on maintenance agreements with Local Government Agencies. Subsequent sections describe these documents and the information relevant to the maintenance and management of traffic signals on state highways. Full copies of these documents are included in Appendix B.

#### 2.2.1 Policy & Procedure for Traffic Signals on State Highways

This document — *SDDOT Policy Statement RD-2002-01 – "Policy & Procedure for Traffic Signals on State Highways"* — describes the policy and procedures that SDDOT staff must adhere to for work that involves traffic signals on the South Dakota State Highway System (SHS). This policy document was approved on October 1, 2002, and was last reviewed on December 1, 2002.

The purpose of the policy and procedure document is to provide guidance for traffic signal installations on state highways. The document addresses three areas: (1) policies for traffic signal installation, (2) procedure for the initiation of a traffic signal project, and (3) procedure for removal of an existing traffic signal. The full copy of the *SDDOT Policy Statement RD-2002-01* is in Appendix B.
Findings

1. This policy document mainly defines the course of actions in response to requests for the installation of a new traffic signal. Moreover, the policy only specifies the responsibility of maintaining agencies with respect to maintenance and operational parameters, but does not define how SDDOT manages and verifies the maintenance activities.

2. Item 7 of the procedure for initiating a traffic signal project does not require the use of a final acceptance “punchlist.” Maintenance problems often can be traced to inadequate inspection during installation or inadequate design. A final acceptance punchlist ensures a thorough, systematic inspection by the field inspector. Moreover, the punchlist provides a standard for statewide use.

3. The procedure for removal of an existing traffic signal, while adequate, could be expanded to outline a public information process and interim intersection control approach.

2.2.2 Guidelines for Maintenance on Primary and Secondary System

This policy document — SDDOT Policy Statement S-1970-01 – "Guidelines for Maintenance on Primary and Secondary System (Within Corporate Limits)" — approved on May 25, 1970 and last reviewed on May 1, 2001, provides standard maintenance procedures on the State Highway System within corporate limits. It outlines the general maintenance (snow and ice removal, surface maintenance, mowing and right-of-way cleanup, traffic control pavement marking, etc) for towns under 2,500 and over 2,500 in population. It also defines the responsibilities of the State and the Municipalities.

Findings

The policy document defines the following signal maintenance responsibilities:

1. For towns with a population below 2,500, (under Section A, Item 4) the responsibility of the State concerning the maintenance of traffic signals is rather vague. The policy specifies that the State will be responsible for the following: “all the traffic control pavement marking (excluding marking for parking), signing, and other traffic control work.” The policy is not specific about responsibility for traffic signal maintenance.

2. For towns with a population above 2,500, Section B, Item 4 of the agreement stipulates responsibility of all traffic signal maintenance to the City.
2.2.3 Warranty for Newly Installed Traffic Signals and Roadway Lighting

As per Subsection 635.3 (the SDDOT Standard Specifications For Roads & Bridges, 1998 Edition, for Traffic Signals and Roadway Lighting) contractors installing new traffic signal systems are required to provide a warrant and guarantee for the satisfactory in service operation of all electrical and mechanical equipment and related components for a period of one (1) year following final acceptance of the signals and/or the lighting installation.

This warranty requirement has been in practice throughout the SDDOT for many years. The warranty has been applied for every new and upgraded signal. The Area office keeps a copy of the letter for the warranty period. After the warranty period is over and the project is closed out, all of the files for the project are then forwarded to SDDOT central office and are combined into one file that is stored on microfilm. Most Area offices, however, retain a copy of the files after sending the original copies to the central office.

2.3 Non-Standard Procedures and Practices

This section of the report describes maintenance and management procedures and practices adopted at each of the four regional offices that are not statewide standards. It also describes how maintenance of traffic signals on Tribal Lands and on county roads is accomplished.

2.3.1 Traffic Signal Maintenance on Tribal Lands

Traffic signals located on Tribal Lands are being maintained by cities. The City of Mission and the City of Pine Ridge are representative examples.

2.3.2 Traffic Signal Maintenance on County Roads

For traffic signals located on county roads, the SDDOT generally tries to enter into agreements with the counties for signal maintenance, and only in rare instances where this is nearly impossible to accomplish will the SDDOT need to take over maintenance activities.

Findings

1. These non-standard or non-statewide practices should be defined in a comprehensive statewide traffic signal policy and procedures document.

2.4 Maintenance Agreements

There are two versions of the maintenance agreement (MA) in current use. One is the general MA that the State enters into agreement with maintaining agencies other than the City of Sioux Falls. The State has a variant agreement with the City of Sioux Falls, which allows some degree
of flexibility in signal timing operation. Copies of these maintenance agreements are included in Appendix C.

2.4.1 Maintenance Agreement between a Municipality and the State

This document — Maintenance Agreement Between a Municipality and the State [of South Dakota] for Federal-Aid Highway Improvement Traffic Signals — stipulates a maintenance agreement between the State (acted through the South Dakota Transportation Commission) and a Municipality. The maintenance agreement spells out procedures regarding parking, signal and/or roadway lighting systems, and plastic pavement marking. It also stipulates the responsibilities that a Municipality agrees to abide.

The current maintenance agreement contains six provisions. **Provision 2** below relates the Municipality’s maintenance responsibilities:

2. That when the signal and/or roadway lighting system is installed on this street it will provide electric power necessary to operate the signal and/or roadway lighting system and all necessary maintenance and replacements, in kind, of all parts and apparatus of said system, including lamps so as to insure the continuing operation of said signals and/or roadway lighting systems until such time as the parties to this agreement shall agree to discontinue the operation of the said system.

That if the signal is coordinated through the use of leased telephone lines; it will pay the required hookup fee and monthly rental fees.

It further agrees that on the State Trunk System, prior to changing the signal timing from that originally set by the South Dakota Department of Transportation, the Municipality will submit the necessary data and proposed timing to the South Dakota Department of Transportation for approval.

2.4.2 Maintenance Agreement Between the City of Sioux Falls and the State

The “Maintenance Agreement between the City of Sioux and the State for Federal-Aid Highway Improvement Traffic Signals,” has additional conditions allowing the City flexibility to adjust signal splits and offsets to accommodate changes in traffic conditions. It also allows the City to make adjustment in traffic signal operation during short term projects, detours, and special events. Below is **Provision 2** of the City of Sioux Falls’ maintenance responsibilities:

2. That when the signal and/or roadway lighting system is installed on this street it will provide electric power necessary to operate the signal and/or roadway lighting system and all necessary maintenance and replacements, in kind, of all parts and apparatus of said system, including lamps so as to insure the continuing operation of said signals and/or roadway lighting systems until such time as the parties to this agreement shall agree to discontinue the operation of the said system.
That if the signal is coordinated through the use of leased telephone lines; it will pay the required hookup fee and monthly rental fees.

That, the City may adjust signal splits and offsets to accommodate changes in traffic conditions (volumes and speed) to retain efficient traffic flow on the State highway arterial. The City will advise the State (Region Traffic Engineer) of the adjustments in a timely manner.

In the event that the adjustments are required to signal phasing, cycle length or type of control the City will obtain DOT review, concurrence and approval prior to the adjustments being made.

Findings

The current Maintenance Agreement falls short of provisions that enables for effective management of traffic signal maintenance. The following are specific issues that should be addressed in the revised Maintenance Agreement.

1. A definition of what “maintenance” should include.
2. Documentation and record keeping.
3. Authority to make changes to the signal timing plans.
4. Authorized personnel to access the signal controller cabinets.
5. SDDOT’s means of verifying that signals are being maintained.

2.5 Existing Forms of Documentation

This section describes the existing documentation or record keeping practices at SDDOT.

2.5.1 Aberdeen Region

Aberdeen Region has a relational database in Ms Access™ that contains information on signal controller on state route traffic signals. The database contains the following information: date, contact person, highway intersection, the city where the signal is located, brand of controller, model of controller, date controller installed, controller type, description of controller, and size of controller cabinet.

Region Traffic Engineer, Alan Petrich, is maintaining the MS Access™ relational database. This database has been in use since the fall of 1999.
2.5.2 Mitchell Region

The Mitchell Region Traffic Engineer has provided the research team with information on traffic signal maintenance form and traffic signal inspection checklist that have been in use recently in Mitchell Region.

Traffic Signal Record of Maintenance or Modification

The Mitchell Region has kept files and records for traffic signals. The Region has also developed a checklist or form for traffic signal record of maintenance or modification. The form includes the following information: date maintenance or modification completed, location of signal, traffic signal information (brand and model number of the controller and the identified problem), cause of maintenance problem, and other action (modified controller programming/traffic signal timing and modified traffic signal display). Information on “problem identified” includes controller failure, conflict monitor failure, detector failure, detector loop failure, blown fuse, wiring failure, wet wiring, wire splice loose, bulb replacement, replacement of signal head or lens, and repair of mast arm or vertical support. Information on “cause” includes equipment failure, water in junction box, water in conduit, lightning strike, pavement cracking or heaving, vandalism, vehicle accident damage, undetermined cause, and others. A copy of the form is included in Appendix D.

The Mitchell Region presented the form to the City of Sioux Falls and the City of Mitchell to determine if they would be interested in completing the form on a trial basis to see if the form would be beneficial. The City of Sioux Falls advised that they had their own method of tracking signal maintenance. On the other hand, the City of Mitchell used the form for a period of time and have since reverted to a shortened type of memo that they send copies to the Region. Other towns were not asked to submit maintenance information using the form.

Traffic Signal Project Inspection Checklist

The project inspection checklist currently adopted in the Mitchell Region is included in Appendix D. As of the writing of this report (September 2003), additional concerns are identified that SDDOT needs to consider for traffic signal standard specifications updates. These include standard specifications for labeling of conductors and cables; storing of extra fiber optic cable; standards specifications for space between the concrete footing and the traffic signal pole; standard specifications for conduit sealing; standards on where conduits should enter the junction boxes; standard specifications for conductors including communications cables; standard specifications for securing the conductor cable at the joint; and the method for grounding junction boxes. The full list of concerns is included in Appendix D.

Since the beginning of 2003, the final inspection of a traffic signal project has been the responsibility of the SDDOT Area Engineer and his staff that administered the contract.
Experience in the Mitchell Region, however, indicates no record of how these inspections were/are conducted or the results of those inspections.

2.5.3 Pierre Region

Currently, there is no formal record keeping in the Pierre Region for traffic signal systems as the region has less than twenty signals operating. According to the Region Traffic Engineer, Darren Griese, the regional office is upgrading three signals in Mobridge this year. These are the first signals in the region in the past 6 years.

2.5.4 Rapid City Region

According to the Rapid City Region Traffic Engineer, Daniel Staton, the Rapid City Region has kept a traffic signal controller inventory in paper format. The inventory includes the following information: date, name, title and phone number of person completing the inventory, city, location of controller, brand of controller and software, model number of controller, date controller was installed, type of control, description or photo of the controller, and dimensions of controller cabinet.

2.5.5 Central Office

Dan Martell of Road Design spearheaded the development of a traffic signal inventory system. The purpose of this application is to allow the SDDOT to keep an inventory of existing traffic signals. This inventory keeps track of signal locations, controllers, detectors, signal placement, pole information, timing, cycle lengths, and images. The inventory is designed to retain records when cycle lengths and timings are changed. The old data is retained to provide a history of the signal settings used at an intersection. The current database application is intended to support only signal inventory functionality. It does not address maintenance tracking or scheduling.

SDDOT intends to explore the possibilities of sharing this application with cities (via internet). The goal is to encourage the cities to note when they have changed something about the signals at an intersection. Currently, that information is not always shared and the signals may be quite different from ones shown on the original plans.

The inventory system is stored in an MS Access™ relational database. Design of the database has been completed; however, the data has not been populated yet. Thus, this inventory system has not been operational.
Findings

1. There is no uniform record keeping of maintenance at the regional offices.

2. Most of what regional offices document is changes to the signal timings. These changes are either kept in paper or in electronic form, but not as part of a database system.

3. The current practice does not require maintaining agencies to submit a record of annual maintenance. Therefore, regional offices generally have no records of signal maintenance work. The Mitchell Region does receive a memo of traffic signal maintenance from the City of Mitchell.

4. The electronic databases maintained at the regional offices mainly include an inventory of the signal controller.

5. The traffic signal inventory developed at the Central Office is a more comprehensive one than the regional databases. This inventory, however, does not include tracking of maintenance activities.

6. There is no standard punchlist for traffic signal final acceptance. The Mitchell Region has developed its punchlist; however, this is not comprehensive.

7. Since the beginning of 2003, the final inspection of a traffic signal project has been the responsibility of the SDDOT Area Engineer and the staff administering the contract.

2.6 Other South Dakota Relevant Documents Reviewed

2.6.1 South Dakota Rural ITS Architecture Study

In 2002, the South Dakota Department of Transportation commissioned a study entitled “South Dakota Rural ITS Architecture” aimed at developing a regional ITS architecture that includes South Dakota and the Metropolitan Planning Organizations that include Sioux Falls, Rapid City and Sioux City.

The ITS (Intelligent Transportation Systems) architecture inventory identified 45 stakeholders and 101 elements making up the Statewide ITS Architecture. Two planned elements are relevant to traffic signals. These are the SDDOT Statewide Signal Maintenance Archive and SDDOT Statewide Signal Maintenance Archive Users. The interfaces or information exchanges with these planned ITS elements are defined in Table 2-2.
Table 2-2  Planned Statewide Signal Maintenance Archive in ITS Elements

<table>
<thead>
<tr>
<th>Element</th>
<th>Interfaces With</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDDOT Statewide Signal Maintenance Archive</td>
<td>SDDOT Office of Data Inventory</td>
</tr>
<tr>
<td>SDDOT Statewide Signal Maintenance Archive</td>
<td>SDDOT Roadway Design Office</td>
</tr>
<tr>
<td>SDDOT Statewide Signal Maintenance Archive</td>
<td>SDDOT Statewide Signal Maintenance Archive Users</td>
</tr>
<tr>
<td>SDDOT Statewide Signal Maintenance Archive</td>
<td>SDDOT Statewide Signal Maintenance Archive</td>
</tr>
</tbody>
</table>

The SDDOT Statewide ITS Architecture is a statewide road map for transportation information systems integration over the next 15 years.

### 2.6.2  SDDOT’s Geographic Information Systems Plan

In 2002, the South Dakota Department of Transportation commissioned a study to prepare SDDOT’s Geographic Information Systems Plan. The GIS Plan includes ten recommended actions plus twenty-five applications. One of the identified 25 potential applications is a Signal Management System (A11). The Signal Management System is envisioned as a one-stop-shop for signal information. Functionality of the system includes storing existing CADD data files, Mylar maps and paper documents dating back to 1974, as well as signal maintenance tracking and planning.

The SDDOT GIS Plan includes prioritization of the identified potential applications; the Signal Management System application ranked 11th in the prioritized list. The SDDOT GIS Plan also recommends a 5-year application program that includes ten applications. The Signal Management System application is not part of the 5-year recommended as it is ranked 11th in the application priority list.

**Findings**

1. The current relational database design in MS Access™ of the traffic signal inventory can be readily integrated with a GIS Signal Management System application.

### 2.7  City Traffic Signal Maintenance Practices

Although the focus of this study is the maintenance and management practices at South Dakota Department of Transportation, the study team felt it was relevant to include how cities carry out their traffic signal maintenance activities. At the outset, it was decided to only survey the maintenance practices of the state’s two largest cities. The rationale being that these two cities, the City of Sioux Falls and the City of Rapid City, would readily provide sufficient information.
2.7.1 City of Sioux Falls

The City Traffic Engineer, Mr. Dallas Hofer, of the City of Sioux Falls provided the study team with information on the City’s traffic signal maintenance program. The City’s maintenance program involves the following tasks being carried out once every year for the 204 traffic signals that the City currently maintains:

- Checking the conflict monitor by running it through a conflict monitor test.
- Changing the air filter in the controller cabinet.
- Checking the critical power points in the cabinet for loose connections.

The City has developed a GIS-based traffic signal inventory system. The City just completed an inventory of all traffic signals within the city and the data was incorporated into the GIS system. The inventory included all the following data:

- Location and size of all traffic junction boxes
- Location of all traffic signal pole bases by type, and length of mast arms if applicable
- Location of all traffic signal cabinets by type of mount (base, side of pole, etc.)
- Location and type of all traffic signal heads (pedestrian included)
- Location of all pedestrian push buttons
- Location of all vehicle detectors by type (loops and video)
- Location of all underground conduits (size of conduit and electrical cables in conduit is not yet collected)

However, this current GIS-based traffic signal inventory does not include information on maintenance activities.

In addition to the GIS-based records, the following information is maintained on MS Excel spreadsheet files:

- Type of signal controller
- Location and type of emergency vehicle pre-emption equipment
- Type of conflict monitors ( # of channels)
- Air filter size for each cabinet

The City has also employed a traffic signal punch list for final acceptance inspection. A copy of the punch list is included in Appendix D.
2.7.2 City of Rapid City

For the City of Rapid City, City Senior Signal Technician, Ted Rufledt, provided the study team with the information. The City adopts a similar maintenance practice as that of Sioux Falls. Unlike Sioux Falls, however, Rapid City does not carry out routine maintenance once every year for all the intersections. Every year the City carries out routine maintenance starting from the oldest to the newest installed traffic signal system. This is due to limited staffing. The City has only two engineers to look after all the traffic signals. The following maintenance is carried out once every year for some intersections:

- Relamping and repainting.
- Checking the conflict monitor.
- Washing the lenses.
- The City also maintains the optics and ensures it is clean and in good condition.

The City has adopted an inspection checklist for traffic signal final acceptance, which is included in Appendix D.

With respect to record keeping, the City keeps a record of its current signal timing plan. Superceded plans are not being kept.

Findings

1. Both Sioux Falls and Rapid City have preventive maintenance programs. They, however, did not indicate the procedures for responsive maintenance (e.g., response time for knockdown, power outages, etc.)

2. The City of Sioux Falls has a GIS-based traffic signal inventory system. The current design of this inventory, however, does not include information on maintenance activities.

3. The City of Rapid City only keeps a record of the current signal timing plan. Old timing plans are not kept.

4. Both Sioux Falls and Rapid City adopted a signal inspection punchlist.


3.0 MANAGEMENT AND MAINTENANCE PRACTICES AT OTHER STATE DOTs

Task 3. Review traffic signal management and maintenance processes at other state departments of transportation where operational needs are similar to South Dakota, summarize the findings, and also provide details for any state(s) where their procedures and supporting guidelines are deemed distinctly practicable.

3.1 Introduction

This chapter presents a summary of the results of the Task 3 survey designed to review the traffic signal management and maintenance practices at other state departments of transportation where operational needs are similar to South Dakota. The following sections provide detailed information about the survey and the survey results.

3.2 Survey Respondents

The scope indicated a survey of ten state DOTs. Survey respondents were selected roughly based on the state population, miles of state highway system, ownership and maintenance of traffic signals. Obviously, states with lower population and high state highway mileage are good candidates as these profiles match closer with that of South Dakota. Likewise, nearby states are good candidates as they exhibit some similarity in regional characteristics.

The research team, in consultation with the Technical Panel, settled on the eleven state DOTs listed in Table 3-1. State DOT representatives who filled in the questionnaire are detailed in Table 3-2.

3.3 Survey Questionnaire

The Task 3 survey questionnaire has 23 questions that cover traffic signal management and maintenance practices, including standards for the installation, operations and maintenance of traffic signals, as well as signal inventory systems. In particular, the survey solicited information about the state DOT’s maintenance agreements and certification requirements. The Technical Panel reviewed the questionnaire. The final survey questionnaire is included in Appendix E.
Table 3-1  Profile of Task 3 Respondent DOTs

<table>
<thead>
<tr>
<th>State</th>
<th>Abbrev.</th>
<th>State Population</th>
<th>Population of Major Cities</th>
<th>DOT Districts</th>
<th>Miles of State Highway System</th>
<th>Miles of State Highway System per 1000 Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARKANSAS*</td>
<td>AR</td>
<td>2,673,400</td>
<td>183,133 - LITTLE ROCK 80, 268 - FORT SMITH 60, 433 - NORTH LITTLE ROCK 58, 047 - FAYETTEVILLE 55, 515 - JONESBORO 55, 085 - PINE BLUFF</td>
<td>10 Districts</td>
<td>16,369</td>
<td>6</td>
</tr>
<tr>
<td>IDAHO*</td>
<td>ID</td>
<td>1,293,953</td>
<td>185, 787 - BOISE CITY 51, 867 - NAMPA 51, 466 - POCATELLO 50, 730 - IDAHO FALLS</td>
<td>6 Districts</td>
<td>&lt;5,000</td>
<td>~4</td>
</tr>
<tr>
<td>KANSAS</td>
<td>KS</td>
<td>2,688,418</td>
<td>344, 284 - WICHITA 149,080 - OVERLAND PARK 146, 866 - KANSAS CITY 122, 377 - TOPEKA 92, 962 - OLATHE 80, 098 - LAWRENCE</td>
<td>6 Districts</td>
<td>9,564</td>
<td>4</td>
</tr>
<tr>
<td>MISSOURI*</td>
<td>MO</td>
<td>5,595,211</td>
<td>441, 545 - KANSAS CITY 348, 189 - ST. LOUIS 151, 580 - SPRINGFIELD 113, 298 - INDEPENDENCE 84, 531 - COLUMBIA 73, 990 - ST. JOSEPH 70, 700 - LEE'S SUMMIT 60, 321 - ST. CHARLES 51, 381 - ST. PETERS 50, 497 - FLORISSANT</td>
<td>10 Districts</td>
<td>&gt;32,000</td>
<td>~6</td>
</tr>
<tr>
<td>MONTANA*</td>
<td>MT</td>
<td>902,195</td>
<td>89, 847 - BILLINGS 57, 053 - MISSOULA 56, 690 - GREAT FALLS</td>
<td>5 Districts</td>
<td>&gt;10,900</td>
<td>~12</td>
</tr>
<tr>
<td>NEBRASKA*</td>
<td>NE</td>
<td>1,711,263</td>
<td>390, 507 - OMAHA 225, 581 - LINCOLN</td>
<td>8 Districts</td>
<td>~10,000</td>
<td>~6</td>
</tr>
<tr>
<td>NEW MEXICO*</td>
<td>NM</td>
<td>1,819,046</td>
<td>448, 607 - ALBUQUERQUE 74, 267 - LAS CRUCES 62, 203 - SANTA FE 51, 765 - RIO RANCHO</td>
<td>6 Districts</td>
<td>11,400</td>
<td>6</td>
</tr>
<tr>
<td>NORTH DAKOTA</td>
<td>ND</td>
<td>642,200</td>
<td>90, 599 - FARGO 55, 532 - BISMARCK 49, 321 - GRAND FORKS</td>
<td>8 Districts</td>
<td>7,378</td>
<td>11</td>
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<tr>
<td>OKLAHOMA</td>
<td>OK</td>
<td>3,450,654</td>
<td>506, 132 - OKLAHOMA CITY 393, 549 - TULSA 95, 624 - NORMAN 92, 757 - LAWTON 74, 859 - BROKEN ARROW 68, 315 - EDMOND 54, 088 - MIDWEST CITY</td>
<td>8 Field Divisions</td>
<td>12,266</td>
<td>4</td>
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<tr>
<td>WYOMING*</td>
<td>WY</td>
<td>493,782</td>
<td>53, 011 - CHEYENNE 49, 644 - CASPER</td>
<td>5 Districts</td>
<td>6,760</td>
<td>14</td>
</tr>
</tbody>
</table>

* State DOT is also a respondent in the Computing System Needs survey in Task 4

SOUTH DAKOTA         | SD      | 754,844          | 123, 975 - SIOUX FALLS 59, 607 - RAPID CITY | 4 Regions     | 7,855                         | 10                                            |
Table 3-2  Maintenance & Management Practices (Task 3) Survey Respondents

<table>
<thead>
<tr>
<th>Acronym</th>
<th>State DOT Name</th>
<th>Representative</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHTD</td>
<td>Arkansas State Highway and Transportation</td>
<td>Mark Lyons</td>
<td>Senior Traffic Engineer</td>
</tr>
<tr>
<td></td>
<td>Department</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ITD</td>
<td>Idaho Transportation Department</td>
<td>Lance Johnson</td>
<td>State Traffic Engineer</td>
</tr>
<tr>
<td>Iowa DOT</td>
<td>Iowa Department of Transportation</td>
<td>Tim Crouch</td>
<td>State Traffic Engineer</td>
</tr>
<tr>
<td>KDOT</td>
<td>Kansas Department of Transportation</td>
<td>Linda Voss</td>
<td>State Traffic Engineer</td>
</tr>
<tr>
<td>MoDOT</td>
<td>Missouri Department of Transportation</td>
<td>Steve McDonald</td>
<td>State Traffic Engineer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Matthew Killion</td>
<td>Senior Traffic Studies</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Engineer</td>
</tr>
<tr>
<td>MDT</td>
<td>Montana Department of Transportation</td>
<td>Steve Keller</td>
<td>Assistant State Traffic</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Engineer</td>
</tr>
<tr>
<td>NDDOT</td>
<td>North Dakota Department of Transportation</td>
<td>Blaine Johanneson</td>
<td>Transportation Engineer III</td>
</tr>
<tr>
<td>NDOR</td>
<td>Nebraska Department of Roads</td>
<td>Kent Wohlers</td>
<td>Signal Design Engineer</td>
</tr>
<tr>
<td>NMDOT</td>
<td>New Mexico Department of Transportation</td>
<td>Richard Allison</td>
<td>Assistant Traffic Engineer</td>
</tr>
<tr>
<td>ODOT</td>
<td>Oklahoma Department of Transportation</td>
<td>James G. Rose</td>
<td>Project Manager</td>
</tr>
<tr>
<td>WYDOT</td>
<td>Wyoming Department of Transportation</td>
<td>Lee Roadifer</td>
<td>Studies Engineer</td>
</tr>
</tbody>
</table>

3.4  Survey Results

3.4.1  Ownership and Number of Traffic Signals on the State Highway System

Q₁ Who owns the traffic signals on the State Highway System?

Question #1 asked respondent DOTs to indicate ownership of traffic signals on the State Highway System. Figure 3-1 shows half of the DOTs retain full ownership of state route signals. On the other hand, four DOTs share ownership with Cities. Only the Iowa DOT shares ownership with Cities and Counties: with most of the state route signals owned by the Cities. Moreover, only the state of Arkansas does not own the signals. Instead, Cities and Counties own the traffic signals. KDOT only owns about 28 signals although there may be more than 500 signals statewide. KDOT adopts a policy whereby inside city limits, ownership of state route signals belongs to the City.

For South Dakota, SDDOT owns all the traffic signals on the State Highway System.
Q2 How many traffic signals are on the State Highway System?

Question #2 asked respondent DOTs to provide an estimate of the number of traffic signals on state routes. Figure 3-2 shows seven DOTs have between 250-500 signals installed along state routes while three have at least 750 traffic signals.

SDDOT has about 266 signals, which is within the range of most state DOTs surveyed.

3.4.2 Maintenance and Management Practices

Questions 3 to 15 relate to maintenance and management practices. The following describes the responses to each of the thirteen questions.

Q3 Who is responsible for maintaining the hardware?

Figure 3-3 indicates that of the eleven respondent DOTs, only MoDOT and WYDOT take full responsibility for hardware maintenance. Four DOTs share responsibility with Cities while Iowa DOT shares with both Cities and Counties. NMDOT shares with Cities, Counties, and Contractors. On the other hand, three DOTs delegate hardware maintenance responsibility to Cities and Counties. KDOT pays either the nearby City or County to maintain or have a private
contractor carry out hardware maintenance. NMDOT adopts a similar practice of hiring private contractors in some areas.

![Pie chart showing agency responsible for maintaining the hardware.]

**Figure 3-3 Agency Responsible for Maintaining the Hardware**

SDDOT delegates hardware maintenance to Cities. In some instances, however, SDDOT carries out the maintenance in the event that smaller communities lack the resources to carry out the maintenance work.

**Q4 Is there a written agreement binding some entity to maintain the signals if it is not the state?**

On the question whether an agreement exists binding some entities to maintain the signals if the state does not do its own maintenance, as Figure 3-4 indicates, MoDOT is the only DOT that does not have a maintenance agreement with local government entities. MoDOT does sole maintenance of all state route signals.

SDDOT is in the same situation as the ten respondent DOTs, which have agreements with local government entities.

![Pie chart showing maintenance agreement with local government entities.]

**Figure 3-4 Maintenance Agreement with Local Government Entities**
Q5 Does the state DOT reimburse local government entities for signal maintenance?
Respondents were asked if they reimburse local government agencies for maintaining the traffic signals on state routes. As Figure 3-5 indicates, five DOTs pay local entities for maintenance. The Iowa DOT pays the City for state-owned signals. Similarly, KDOT pays for maintenance outside the city limits.

![Reimbursement for Signal Maintenance](image)

**Figure 3-5  State DOTs Reimbursing Local Government Entities for Signal Maintenance**

SDDOT does not reimburse local government agencies for maintaining the state route signals.

Q6 Who performs the maintenance?
Respondents were asked to indicate the agencies responsible for maintenance of state route signals. Of the eleven respondent DOTs, MoDOT signal maintenance crews are the ones performing the maintenance. The majority of the respondent DOTs share maintenance with City crews as Figure 3-6 indicates. Three respondent DOTs delegate maintenance to the cities and counties or engage contractors. The Iowa DOT delegates all maintenance work to City crews.

For SDDOT, City Staff or Contractor hired by the City performs the signal maintenance.
Q7 If the state owns, operates, and maintains the signals, does the state DOT have a formal maintenance program?

Respondents were asked if they have a formal maintenance program. Ten DOTs responded to this question. As Figure 3-7 shows, five DOTs have adopted scheduled maintenance programs. Some of them have adopted a maintenance checklist. KDOT, for example, has a semi-annual traffic signal maintenance inspection checklist that covers the following items: cabinet, controller and hardware, signal heads, signal poles, junction/service boxes, detector loops and cameras, and other miscellaneous items. The maintenance checklist has to be signed by the Technician, and copies have to be forwarded to the District Engineer, the Area Engineer, and the Bureau of Traffic Engineering. For SDDOT, there is no statewide formal maintenance program.
Q8 Is there a formal inspection program for signal pole structural integrity? If yes, please specify who performs the inspection and how often.

As Figure 3-8 shows, three respondent DOTs have a formal inspection program for signal pole structural integrity. ITD just implemented their inspection program. KDOT hires a structural company every 4-5 years to inspect signals, towers, and sign supports while MoDOT signal crews perform annual visual inspections.

Like the majority of the respondent DOTs, SDDOT has no formal inspection program ascertaining the structural integrity of signal poles.

![Signal Pole Inspection Program](image)

Figure 3-8 State DOTs with Formal Inspection Program for Signal Poles

Q9 If signals are not state-maintained, what sanctions are in place for failure to maintain the signals?

NMDOT did not respond to this question. As Table 3-3 indicates, five DOTs impose some form of sanction. The Iowa DOT indicated removal of the signal as a sanction for maintenance failure. The ITD invoices the maintaining agency while the WYDOT imposes the following sanctions: withholding of state reimbursements, voiding the maintenance agreement, and invoicing the maintaining agency.

<table>
<thead>
<tr>
<th>State DOT</th>
<th>Withholding state reimbursements</th>
<th>Voiding the maintenance agreement</th>
<th>Removal of the signal</th>
<th>State invoicing the maintaining agency</th>
<th>None</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHTD</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Iowa DOT</td>
<td>✅</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ITD</td>
<td></td>
<td>✅</td>
<td>✅</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KDOT</td>
<td></td>
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<tr>
<td>MoDOT</td>
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<td></td>
</tr>
<tr>
<td>MDT</td>
<td>✅</td>
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<td>NDDOT</td>
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<tr>
<td>NDOR</td>
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<tr>
<td>NMDOT</td>
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<tr>
<td>ODOT</td>
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<td></td>
</tr>
<tr>
<td>WYDOT</td>
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<td>✅</td>
<td>✅</td>
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<td></td>
</tr>
<tr>
<td>SDDOT</td>
<td>✅</td>
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</tr>
</tbody>
</table>
Of the few that indicated some form of sanctions, they have cost sharing arrangement with the maintaining agencies.

Like half of the respondent DOTs, SDDOT does not impose sanctions to Cities for such maintenance failures.

Q10 How are maintenance activities documented?

Iowa DOT did not respond to the question regarding documentation of maintenance activities. Documentation practices differ widely among these DOTs. Table 3-4 summarizes the multiple responses. Four DOTs require paperwork to be submitted, documents in cabinet, and maintenance records in electronic form. KDOT keeps documents in paper format only. ITD requires both paperwork and electronic records while WYDOT requires both paperwork and documents in cabinet. Both MoDOT and MDT require documents in cabinet and in electronic form while NDDOT only requires documents in cabinet. NMDOT only requires electronic records.

For SDDOT, maintenance activities have been kept in paper format.

<table>
<thead>
<tr>
<th>State DOT</th>
<th>Paperwork submitted</th>
<th>State inspector</th>
<th>Documents in cabinet</th>
<th>Electronic record</th>
<th>No documentation</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHTD</td>
<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Iowa DOT</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>ITD</td>
<td>✓</td>
<td>✓</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
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<td>✓</td>
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<tr>
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<td></td>
<td>✓</td>
<td>✓</td>
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<tr>
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<tr>
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<td></td>
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<td>NMDOT</td>
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<tr>
<td>ODOT</td>
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<tr>
<td>WYDOT</td>
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<td>✓</td>
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</tr>
<tr>
<td>SDDOT</td>
<td>✓</td>
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</tr>
</tbody>
</table>

Q11 Who is authorized to make signal timing changes?

As Table 3-5 indicates, four DOTs allow only state personnel to make signal timing changes. WYDOT exempted the City of Cheyenne, so that it can make changes, however with state approval. MoDOT has partnerships with some of the state's larger cities where they work together to monitor traffic flow. However, changes to the system are not permitted without MoDOT’s approval. Three DOTs delegate cities, counties, or local agencies to make signal timing changes. KDOT needs permission only if changing phasing on yellow or all red. NDDOT is the only agency that allows contractors to make changes, but only when under construction contract. NDOR allows cities with population > 40,000 to make changes to the signal timings.
At SDDOT, the current policy allows only the City of Sioux Falls to make adjustments to signal splits and offsets to accommodate changes in traffic conditions. Moreover, the City of Sioux Falls is also granted permission to adjust traffic signal operations during short-term projects, detours, special events, etc. For adjustments involving signal phasing, cycle length, or type of control, DOT approval is required.

### Table 3-5 Agency Authorized to Change Signal Timing

<table>
<thead>
<tr>
<th>State DOT</th>
<th>Cities</th>
<th>Counties</th>
<th>State</th>
<th>Contractor</th>
<th>Local Agency with permission from the State</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHTD</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iowa DOT</td>
<td>✔</td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>ITD</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KDOT</td>
<td>✔</td>
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<td></td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>MoDOT</td>
<td>✔</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>MDT</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>✔</td>
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<td>✔</td>
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<td></td>
</tr>
<tr>
<td>ODOT</td>
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<td>✔</td>
<td>✔</td>
<td>✔</td>
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<td></td>
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<tr>
<td>WYDOT</td>
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<td></td>
</tr>
<tr>
<td>SDDOT</td>
<td>✔</td>
<td></td>
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<td></td>
<td></td>
<td>✔</td>
</tr>
</tbody>
</table>

Q12 How are the signal timings backed up?

As Table 3-6 shows, KDOT and ODOT do not have any form of signal timing back up. Of the eight DOTs that backed up their signal timings, WYDOT has only electronic backup. Seven DOTs adopt both electronic and paper copy.

At SDDOT, the current practice is using paper copy.

### Table 3-6 Backing Up Signal Timings

<table>
<thead>
<tr>
<th>State DOT</th>
<th>Electronic</th>
<th>Paper Copy</th>
<th>Not At All</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHTD</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Iowa DOT</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>ITD</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>KDOT</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>MoDOT</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>MDT</td>
<td>✔</td>
<td>✔</td>
<td></td>
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<tr>
<td>NDDOT</td>
<td>✔</td>
<td>✔</td>
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</tr>
<tr>
<td>NDOR</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
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<td>✔</td>
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<td>ODOT</td>
<td>✔</td>
<td>✔</td>
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</tr>
<tr>
<td>WYDOT</td>
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<td>✔</td>
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</tr>
<tr>
<td>SDDOT</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
</tbody>
</table>
Q13 Is any certification or training required for those performing maintenance?

As Figure 3-9 shows, both MDT and NMDOT require certification or training for maintenance personnel. MDT typically requires IMSA Level I/Level II certification. At WYDOT, all technicians are IMSA Level 1 certified or higher. MoDOT is not currently requiring certification, but they are providing IMSA training for signal crews. They are considering incorporating this into the job specification. They are also considering requiring contractors to have IMSA training before being able to install or wire any signal. ODOT may consider providing training.

Like the majority of respondent DOTs, SDDOT does not require certification or training for maintenance personnel.

Q14 Who has access to the signal cabinets?

Table 3-7 depicts the agencies permitted access to the signal cabinets. As shown, only MoDOT prohibits access by other agencies other than the police. Although police only have access to a "police panel", which enables them to place the signal either on flash or to manually change the duration of the green indication. Six DOTs allow County staff access while five DOTs allow contractor access. Four DOTs give police access. Like MoDOT, police access to signal cabinets for New Mexico state signals is thru a “police panel”. NDDOT gives contractor access when under construction contract or when a contractor is hired by the city or the state. ODOT, on the other hand, allows contractor access especially in smaller towns. In the case of WYDOT, access to City staff is only allowed in the City of Cheyenne. Currently at SDDOT, staff from all agencies in Table 3-7 can access the signal cabinets.
Table 3-7  Agency Authorized to Access the Traffic Signal Cabinets

<table>
<thead>
<tr>
<th>State DOT</th>
<th>City Staff</th>
<th>County Staff</th>
<th>State Staff</th>
<th>Contractor</th>
<th>Police</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHTD</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iowa DOT</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>ITD</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
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<td></td>
<td></td>
<td>✓</td>
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<tr>
<td>MoDOT</td>
<td>✓</td>
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<td>✓</td>
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</tr>
<tr>
<td>MDT</td>
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<td></td>
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</tr>
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<td>WYDOT</td>
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<td></td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

Q15 Please list any special measures to limit access to the signal cabinets.

Five DOTs indicated some measures to limit access to the signal cabinets. AHTD does not require special measures, but noted that several cities in Arkansas require a special key. MoDOT typically does not require special measures; however, padlocks have been installed in locations where MoDOT has problems. Padlocks have also been used in some cities in North Dakota. The NMDOT uses a certain key, as well as supervisor access codes.

At SDDOT, there are no current restrictions on maintaining agencies’ crews, state crews, or the police to access the signal cabinets.

3.4.3 Traffic Signal Inventory System

Questions 16 through 18 relate to traffic signal inventory systems. The following describes the responses to each of the three questions.

Q16 Is there a traffic signal inventory system for the state owned signals? If yes, please check all the information that are contained in the inventory system.

Table 3-8 summarizes the multiple responses to this question. The only two DOTs that do not have a traffic signal inventory system are Iowa DOT and ODOT. The ten DOTs that keep an inventory have at least inventoried the “Location” of signals. KDOT only keeps an inventory of the signal location. MoDOT and WYDOT do not keep hardware information while WYDOT does not keep information on their controllers. AHTD, NDDOT, NMDOT, and WYDOT keep timing plans in the inventory. MoDOT is currently working to include signal pictures in the inventory. It also has plans to include wiring diagrams, as well as information relating to installation dates, controller age, and cabinet age. The NDDOT inventory system also includes pictures and plans.
Table 3-8  Information Stored in the Signal Inventory System

<table>
<thead>
<tr>
<th>State DOT</th>
<th>Location</th>
<th>Hardware</th>
<th>Controller</th>
<th>Timing Plans</th>
<th>Other</th>
<th>None</th>
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</thead>
<tbody>
<tr>
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<td>✓</td>
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</tr>
<tr>
<td>WYDOT</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SDDOT</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

At SDDOT, there is no operational, statewide signal inventory system. As outlined in Section 2.5.5, a traffic signal inventory has been developed at the Central Office. This inventory, however, is not yet operational. Regional offices have kept some form of inventory. For example, the Aberdeen Region has an electronic database of signal controllers.

Q17 If yes, who maintains the inventory?

Ten states responded to this question. Figure 3-10 describes their responses. Only the AHTD and MDT share maintenance of the inventory with the City.

At SDDOT, the Central Office and Regional Offices maintain some form of inventory while Cities keep their own inventory.
Q18 If yes, how is the inventory stored?

Ten DOTs responded to this question. Table 3-9 summarizes their multiple responses. Eight DOTs maintain a database format of the traffic signal inventory system. The AHTD keeps both a database and “Other Electronic” formats. The “Other Electronic” format stores timing plans, which is a vendor provided software system. KDOT keeps an inventory in both electronic forms in MS Word document as well as hard copies. None of the state DOTs surveyed adopts a GIS format for the inventory.

<table>
<thead>
<tr>
<th>State DOT</th>
<th>GIS</th>
<th>Database</th>
<th>Other Electronic</th>
<th>Hard-copy</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHTD</td>
<td>🟢</td>
<td></td>
<td>🟢</td>
<td></td>
</tr>
<tr>
<td>Iowa DOT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ITD</td>
<td>🟢</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KDOT</td>
<td></td>
<td></td>
<td>🟢</td>
<td>🟢</td>
</tr>
<tr>
<td>MoDOT</td>
<td>🟢</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MDT</td>
<td></td>
<td></td>
<td>🟢</td>
<td></td>
</tr>
<tr>
<td>NDDOT</td>
<td></td>
<td></td>
<td></td>
<td>🟢</td>
</tr>
<tr>
<td>NDOR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NMDOT</td>
<td></td>
<td></td>
<td>🟢</td>
<td></td>
</tr>
<tr>
<td>ODOT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WYDOT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SDDOT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

At SDDOT, the inventories held at the Central Office and at the Regional Offices are in hard-copy formats. Aberdeen Region has a database in MS Access™ that keeps records only of signal controllers. The Central Office has also developed a more comprehensive signal inventory database in MS Access™; however, this system is not yet operational.

### 3.4.4 Traffic Signal Installation Policy

Questions 19 through 23 relate to traffic signal installation. The following describes the responses to each of the five questions.

Q19 Does the state DOT have a pre-approved signal product list?

Figure 3-11 depicts whether state DOTs have a pre-approved signal product list or not. Six DOTs have pre-approved signal product lists. For NDOR, the pre-approved list only covers LED lamps, loop sealant, and optically programmed traffic signals. ODOT is currently working on their pre-approved product list. In the meantime, it is using products that have been previously approved. Moreover, products that have gone through the committee review process would become pre-approved.

SDDOT does not have a pre-approved signal product list.
Q20 Is state approval required for signal installation plans on state routes?

All eleven respondent DOTs require approval for signal installation plans on state routes. NDOR implements the approval process thru its highway access permit process. ODOT asks developers to send in plans to see if it meets ODOT standards. WYDOT, on the other hand, handles all the installations.

SDDOT has the same policy as with the respondent DOTs. SDDOT also requires plans approval for signal installations.

Q21 Does the state DOT require certification requirements for signal construction inspection?

MoDOT did not respond to this question. As Figure 3-12 shows, only ITD and NMDOT adopt certification requirements for signal construction inspection. In the case of MDT, inspectors either are provided by the State or are approved by the State to perform signal inspection. Prior to the traffic signal activation, State traffic engineers complete a thorough review of the installation for conformance to the approved plans and specifications.

Like the majority of the respondent DOTs, SDDOT does not have certification requirements for signal construction inspection.
Q22 Does the state DOT require inspection during signal installation, prior to acceptance?
As Figure 3-13 shows, eleven DOTs require inspection during signal installation, prior to acceptance. The AHTD does not require inspection; however, on city projects the state performs the final inspection. MoDOT inspection requirements can be found in the Missouri standard specifications book that is available on the internet. At ODOT, construction inspectors perform the inspection to ensure that the right steel and concrete are used. They are not, however, traffic signal inspectors. SDDOT has a similar practice as the majority of respondent DOTs.

![Requiring Inspection Chart]

Figure 3-13 State DOTs Requiring Inspection During Signal Installation, Prior to Acceptance

Q23 If yes, is there a checklist for signal acceptance?
Ten DOTs responded to this question. As Figure 3-14 shows, four DOTs have a checklist for signal acceptance. NDDOT uses an inspection form, while at MoDOT some district offices have developed a checklist for construction. Although MDT currently has no formal checklist, a DOT traffic engineer reviews the signal installations for conformance to the plans and specifications, prior to acceptance. The DOT traffic engineer has final approval for signal installations and gives acceptance prior to the signal turn on.

In the current practice at SDDOT, there is no statewide checklist for signal acceptance. The Mitchell Region has developed its own checklist as described earlier in Section 2.5.2.

![Using Checklist for Signal Acceptance Chart]

Figure 3-14 State DOTs Using Checklist for Signal Acceptance
3.4.5 Summary

The survey of eleven, mainly Midwestern, state departments of transportation indicate that maintenance and management practices for state route signals in South Dakota fall in line with mainstream practices in many respects.

Highlights of the survey results (“DOTs” refers to survey respondents):

- The majority of states retain either full ownership, or share ownership with cities and counties for traffic signals on the State Highway System.
- As for hardware maintenance, most DOTs either share or delegate responsibility to cities and counties.
- With the exception of MoDOT, DOTs enter into maintenance agreements with local government entities.
- More than half of the DOTs do not reimburse local government agencies for maintenance of state route signals. SDDOT is one of them.
- Most DOTs involved maintenance crews from state and local government, as well as private contractors, in the performance of signal maintenance. Only MoDOT does not allow maintenance crews other than state personnel.
- Half of the DOTs have a formal maintenance program. KDOT has a semi-annual maintenance inspection checklist while WYDOT has an annual maintenance inspection checklist.
- The majority of DOTs do not have a formal inspection program for signal pole structural integrity.
- Most DOTs do not impose sanctions against maintenance failure by local government entities. The few that indicated some form of sanctions have cost sharing arrangements with the maintaining agencies.
- In terms of documenting maintenance activities, documentation practices differ considerably among DOTs. Some adopt paperwork, electronic format, or both, while others store documents in the signal controller cabinets.
- With respect to changing signal timing plans, most DOTs retain the authority to change the timing plans. Local government entities may be allowed to make changes with prior DOT approval.
- The majority of DOTs back up the signal timing plans using either electronic, paper copy format, or both.
- The majority of DOTs do not require certification for maintenance personnel. DOTs that require certification and training include MDT and NMDOT. MDT typically requires IMSA Level I/Level II certification while KDOT requires that all maintenance personnel be certified. At WYDOT, all technicians are IMSA Level 1 certified or higher. In addition, the majority of DOTs do not have a training program for maintenance personnel. MoDOT provides IMSA training for signal crews.
- With respect to access to the signal cabinets, only MoDOT does not allow other agencies access to the cabinets. Police are given access thru a “police panel” only.
In terms of measures to limit access to the signal cabinets, use of padlocks, special keys or supervisor access codes were adopted by some DOTs.

The majority of DOTs have some form of signal inventory system. The information contained in the inventory includes the location, hardware, controller, and timing plans. State DOTs are mainly responsible for maintaining the inventory; and most adopt either a database, hard copy format, or both for their inventory.

Half of the DOTs have a pre-approved signal product list. SDDOT does not have a pre-approved product list for traffic signals.

All DOTs require state approval for signal installation plans on state routes.

Most DOTs require inspection during signal installation and prior to acceptance. AHTD, MoDOT, NMDOT, and WYDOT have traffic signal inspection checklists.
4.0 COMPUTER SYSTEM NEEDS SURVEY RESULTS

Task 4. Contact other state departments of transportation exhibiting similarities to South Dakota in regard to traffic signal management and maintenance computer system needs, summarize the findings, and also provide details for any existing state system(s) that might correlate well to the needs of this project.

4.1 Introduction

This chapter presents the results of the computer system needs survey (Task 4). The Task 4 survey was a review of traffic signal management and maintenance computer system needs at other state departments of transportation exhibiting similar operational needs to South Dakota. Subsequent sections present the survey results.

4.2 Survey Respondents

The task scope indicate a survey of ten state DOTs. Respondents to the Task 3 survey qualified for the Task 4 survey if the respondent DOT currently had an inventory system. Of the eleven respondents in Task 3, IowaDOT, KDOT, NDDOT, and ODOT (Oklahoma DOT) do not have an inventory system. They are therefore excluded in the Task 4 survey. To comply with the ten required respondents, the research team included Mn/DOT, ODOT (Oregon DOT), and WisDOT.

Of the ten DOTs, AHTD, MDT, and NMDOT did not return their questionnaires. In addition, WYDOT did not respond to the questionnaire, as WYDOT does not have a true "computerized signal inventory." All of their signals are 170 type controllers that have dial-up capabilities. WYDOT maintain redundant copies of the Pyramid software that contain all of the Wapiti timing tables for all of the signals across the state. That in effect gives WYDOT an inventory of the location and timings for all signals in the state. The Pyramid program can run on any Windows NT or newer operating system. Table 4-1 presents a summary of the final six respondent DOTs.

<table>
<thead>
<tr>
<th>Acronym</th>
<th>State DOT Name</th>
<th>Representative</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITD</td>
<td>Idaho Transportation Department</td>
<td>Lance Johnson</td>
<td>State Traffic Engineer</td>
</tr>
<tr>
<td>Mn/DOT</td>
<td>Minnesota Department of Transportation</td>
<td>Ray Starr</td>
<td>Traffic Electrical Systems Engineer</td>
</tr>
<tr>
<td>MoDOT</td>
<td>Missouri Department of Transportation</td>
<td>Steve McDonald</td>
<td>State Traffic Engineer</td>
</tr>
<tr>
<td>NDOR</td>
<td>Nebraska Department of Roads</td>
<td>Kent Wohlers</td>
<td>Signal Design Engineer</td>
</tr>
<tr>
<td>ODOT</td>
<td>Oregon Department of Transportation</td>
<td>Mark Rodgers</td>
<td>Traffic Signal Services Manager</td>
</tr>
<tr>
<td>WisDOT</td>
<td>Wisconsin Department of Transportation</td>
<td>Graham Heitz</td>
<td>Traffic Signals &amp; Safety Engineer</td>
</tr>
</tbody>
</table>
4.3 Survey Questionnaire

There are two versions of the Task 4 computer system needs survey questionnaire. Version 1 has 19 questions designed for those state DOTs who responded to the Task 3 survey. Version 2 has 23 questions designed for state DOTs that were not surveyed in Task 3. The extra four questions sought information on the number of traffic signals, ownership, and maintenance agreements. Task 3 survey respondents already answered these questions. The Task 4 survey questionnaire is included in Appendix E.

4.4 Survey Results

Ownership, Number of Traffic Signals, Inventory System for Mn/DOT, ODOT, and WisDOT

Mn/DOT, ODOT, and WisDOT all have over 750 state route traffic signals that are largely state-owned. Mn/DOT and ODOT currently maintain an inventory system while WisDOT will soon be acquiring new software for its inventory system. Details of these inventory systems are described in subsequent sections.

4.4.1 System Requirements for Traffic Signal Inventory System

Questions 1 to 11 relate to system requirements for traffic signal inventory systems.

Q1 What type of system is used?

As Figure 4-1 depicts, ITD and NDOR use MS Excel™ spreadsheets for their traffic signal inventories. WisDOT plans to adopt a commercial database called SIGNALview from CarteGraph. SIGNALview is an asset management tool for the collection, inventory, maintenance and management of all components in a signal system. Mn/DOT, MoDOT, and ODOT have developed customized databases. Mn/DOT’s maintenance and management system was developed by consultants and is being operated and maintained by department personnel. Consultants also developed MoDOT’s Traffic Management System as part of a larger system. Similarly, consultants were involved in developing ODOT’s Traffic Signal Information System (TSIS).

SDDOT has developed a relational database in MS Access™. The South Dakota Bureau of Information and Telecommunications (BIT) designed the relational database. This application, however, is not yet operational.
Q2 If stored as a database, please provide a list of the **Tables** and **Fields** contained in the database. If stored as a GIS, please provide a list of the **Layers** and **Fields**. If stored in another format please provide attributes and fields. If possible, please provide screen shots of the system.

Table 4-2 describes the information contained in each DOTs inventory system.

### Table 4-2 Database Information

<table>
<thead>
<tr>
<th>Database Tables and Fields</th>
<th>ITD</th>
<th>Mn/DOT</th>
<th>MoDOT</th>
<th>NDOR</th>
<th>ODOT</th>
<th>WisDOT*</th>
<th>SDDOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Hardware</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Pole Information</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Controller</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Timing Plans</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Custodian</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Dates</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Indications</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Detection</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Maintenance</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Funding</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Plan Sheets</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Comments</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Other</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

*Record of Maintenance is planned for WisDOT.
Q3 What are the system requirements?

As Table 4-3 indicates, the computer configuration (processor, operating system, RAM, hard-disk space) requirements across states are not much different; the software used for the various inventory systems differs between the agencies. Mn/DOT, MoDOT, and ODOT have customized programs. These three DOTs require more complex inventory and management systems, as they are largely responsible for maintenance; MoDOT performs all the maintenance of its signals. WisDOT intends to purchase commercially available software.

<table>
<thead>
<tr>
<th>DOTs</th>
<th>Computer System Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PROCESSOR</strong></td>
<td></td>
</tr>
<tr>
<td>ITD</td>
<td>Intel x86</td>
</tr>
<tr>
<td>Mn/DOT</td>
<td>Standard Client/Server</td>
</tr>
<tr>
<td>MoDOT</td>
<td>Pentium III</td>
</tr>
<tr>
<td>NDOR</td>
<td>Any PC</td>
</tr>
<tr>
<td><strong>OPERATING SYSTEM</strong></td>
<td></td>
</tr>
<tr>
<td>ITD</td>
<td>Windows 98-NT</td>
</tr>
<tr>
<td>Mn/DOT</td>
<td>Client/Server Windows 2000 but could be other operating system</td>
</tr>
<tr>
<td>MoDOT</td>
<td>Windows 2000</td>
</tr>
<tr>
<td><strong>RAM</strong></td>
<td></td>
</tr>
<tr>
<td>ITD</td>
<td>256 MB</td>
</tr>
<tr>
<td>MoDOT</td>
<td>256 MB</td>
</tr>
<tr>
<td><strong>HARD-DISK SPACE</strong></td>
<td></td>
</tr>
<tr>
<td>ITD</td>
<td>20 MB</td>
</tr>
<tr>
<td><strong>OTHER</strong></td>
<td></td>
</tr>
<tr>
<td>ODOT</td>
<td>Client-Server application. Client runs on standard windows platform.</td>
</tr>
<tr>
<td><strong>SOFTWARE AND VERSION</strong></td>
<td></td>
</tr>
<tr>
<td>ITD</td>
<td>MS Office Suite 2000</td>
</tr>
<tr>
<td>Mn/DOT</td>
<td>Oracle Server and Crystal Reports, Internet Explorer for Client using Oracle Forms</td>
</tr>
<tr>
<td>MoDOT</td>
<td>TMS (Custom System Developed for MoDOT)</td>
</tr>
<tr>
<td>NDOR</td>
<td>MS Excel 2000</td>
</tr>
<tr>
<td>ODOT</td>
<td>ODOT custom application</td>
</tr>
<tr>
<td>WisDOT</td>
<td>CarteGraph Version 6</td>
</tr>
<tr>
<td><strong>IMAGING SOFTWARE</strong></td>
<td></td>
</tr>
<tr>
<td>WisDOT</td>
<td>ArcView Version 8</td>
</tr>
<tr>
<td><strong>OPTIONAL SOFTWARE</strong></td>
<td></td>
</tr>
<tr>
<td>MoDOT</td>
<td>ESRI GIS</td>
</tr>
</tbody>
</table>
Q4 Please provide the approximate cost in 2003 dollars for hardware configuration, optional hardware, required software, and optional software:

Table 4-4 provides indication of computer system costs. Inventory systems that use software other than an Excel spreadsheet would cost considerably more than the cost of hardware. The magnitude of software costs depends largely on the system functionality and whether it is a custom developed application or a commercially available software.

Table 4-4  Approximate Computer System Costs

<table>
<thead>
<tr>
<th>DOTs</th>
<th>HARDWARE CONFIGURATION</th>
<th>Approximate Cost in 2003 Dollars</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITD</td>
<td>Typical server</td>
<td>$1,200</td>
</tr>
<tr>
<td>Mn/DOT</td>
<td>This system was developed by consultants as a separate module of a larger system. Specific costs for the signal inventory portion are not available.</td>
<td></td>
</tr>
<tr>
<td>MoDOT</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DOTs</th>
<th>REQUIRED SOFTWARE</th>
<th>Approximate Cost in 2003 Dollars</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITD</td>
<td>$400</td>
<td></td>
</tr>
<tr>
<td>ODOT</td>
<td>$80,000</td>
<td></td>
</tr>
</tbody>
</table>

Q5 How many people are needed to maintain the system?

ITD, Mn/DOT, and NDOR require only one equivalent full time staff to maintain the system. For Mn/DOT, the full equivalent staff time includes the time of a database administrator plus user support staff. ODOT requires two staff while MoDOT requires at least five staff. Likewise, WisDOT plans to have at least five full time staff to maintain the planned inventory system.

Q6 Who maintains the inventory within your agency?

Table 4-5 describes the personnel responsible for maintaining the DOTs inventory.

Table 4-5  Agency Personnel Responsible for Maintaining the Inventory

<table>
<thead>
<tr>
<th>DOT</th>
<th>Agency Personnel Responsible for Maintaining the Inventory</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITD</td>
<td>Signal Operations Staff (either one of two people)</td>
</tr>
<tr>
<td>Mn/DOT</td>
<td>Districts plus maintenance personnel</td>
</tr>
<tr>
<td>MoDOT</td>
<td>District signal electricians</td>
</tr>
<tr>
<td>NDOR</td>
<td>Traffic Signal Engineer and 2 Signal Designers</td>
</tr>
<tr>
<td>ODOT</td>
<td>Information Services maintains the database application. Field Crews generate the data.</td>
</tr>
<tr>
<td>WisDOT</td>
<td>Typically electrical staff, will also include signal operations personnel</td>
</tr>
</tbody>
</table>
Q7 Does the inventory include a record of maintenance activity?

As Figure 4-2 indicates, Mn/DOT’s and ODOT’s inventory systems store information on maintenance activity. The planned inventory system for WisDOT also includes recording of maintenance activity.

![Record of Maintenance Activity](image)

**Figure 4-2 Record of Maintenance Activity Included in the Inventory**

Q8 If yes, how is the maintenance record communicated back to the inventory system?

Three DOTs responded to this question. For Mn/DOT, the inventory system has built-in functionality that allows communication of maintenance records back to the inventory system. ODOT uses PDA/LAPTOP synchronization through network communications, as well as paperwork submittal.

Q9 Does the system have the ability to communicate with traffic signals to download/upload data?

All DOTs responded that their current systems do not have the ability to communicate with traffic signals to download/upload data.

Q10 How is access to the inventory system granted?

Table 4-6 shows the types of access to the inventory system that each of the five DOTs allowed. Mn/DOT also grants Administrator rights to certain individuals while ITD imposes network domain constraints that control read/write access.
Table 4-6  Granted Access to the Inventory System

<table>
<thead>
<tr>
<th>State DOT</th>
<th>Users with View Only privileges</th>
<th>Users with View and Editing privileges</th>
<th>Password</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITD</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Mn/DOT</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>MoDOT</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>NDOR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ODOT</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

Q11 Is the database accessible by the cities through the internet?

As Figure 4-3 indicates, none of the DOTs has their inventories accessible to the Cities via the internet. WisDOT intends to allow such internet access to its future inventory system.

![Internet Access to the Database](image)

**Figure 4-3  Cities' Access to the Database via the Internet**

4.4.2 System Requirements for Traffic Management Center

Questions 12 to 19 relate to system requirements for a Traffic Management Center (TMC).

Q12 Do you have a Traffic Management Center (TMC)?

As Figure 4-4 shows, ITD, Mn/DOT, MoDOT, and ODOT currently operate a TMC. MoDOT operates more than one TMC; the most recent one is the Kansas City SCOUT traffic management system. The SCOUT is a joint venture between MoDOT and KDOT. This system has been operational since January 12, 2004. The other MoDOT TMC is located in Springfield. This TMC is a joint effort between MoDOT and the City of Springfield. The MoDOT responses to subsequent questions all pertain to the Springfield TMC. Mn/DOT has a Regional TMC (RTMC) in the Twin Cities Metro area, as well as several smaller TMCs in other districts. The Mn/DOT responses to subsequent questions are for the Metro area RTMC.
Q₁₃. Describe the functionality or functions of the TMC?

Table 4-7 summarizes the TMC functions at each state DOT. The MoDOT TMC has the least functionality. Except for the Mn/DOT RMTC, TMC at other state DOTs are employed for coordinating traffic signals. All TMCs in Table 4-7 are employed for disseminating information, for managing traffic during special events, and for roadway surveillance and traffic data collection.

**Table 4-7  Functions of the Traffic Management Center**

<table>
<thead>
<tr>
<th>Traffic Management Center Functions</th>
<th>ITD</th>
<th>Mn/DOT</th>
<th>MoDOT</th>
<th>ODOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corridor management/traffic signal coordination or control</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Incident management (e.g., detection, verification, and monitoring incident status)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Information dissemination (public, private and/or interagency)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>En-route driver information (e.g., dynamic message signs, highway advisory radio, and in-vehicle system)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Environmental monitoring (e.g., air quality, noise and weather)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Special event traffic management</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Disaster management and traffic coordination</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Emergency services traffic control coordination</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Ramp management and control</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Lane management and control (e.g., HOV, reversible lanes)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Network or roadway surveillance and data collection</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Network performance monitoring, evaluation and reporting</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Other (511 Operations Response for ODOT)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Q₁₄. Please enumerate the components of the TMC (e.g., closed circuit television systems, dynamic message signs, ramp meter controllers, etc.)

Table 4-8 summarizes the TMC components at each DOT TMC. The differing components employed at each TMC reflect the type of functions the TMC is designed for. For example, the current MoDOT TMC in the City of Springfield has only two components — CCTV (Closed Circuit Television Video) and traffic signal system control. Thus, as Table 4-7 indicates, the MoDOT TMC has limited functionality compared to the other TMCs.
Table 4-8  Components of the Traffic Management Center

<table>
<thead>
<tr>
<th>DOT</th>
<th>Traffic Management Center Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITD</td>
<td>45- Closed Circuit Television Video (CCTV), 5-Dynamic Message Signs,</td>
</tr>
<tr>
<td></td>
<td>12-Vehicle Detector stations, Fiber Optic and wireless communications,</td>
</tr>
<tr>
<td></td>
<td>Traffic Monitoring Stations</td>
</tr>
<tr>
<td>Mn/DOT</td>
<td>CCTV, Closed Loop Signal System Monitoring, Fiber Optic Communication System,</td>
</tr>
<tr>
<td></td>
<td>Highway Incident Patrol, Lane Control Signals, Radio Traffic Reports, Ramp Meters,</td>
</tr>
<tr>
<td></td>
<td>Real Time Detector Information for Web Sites, State Patrol Dispatch,</td>
</tr>
<tr>
<td></td>
<td>Variable Message Signs (VMS)</td>
</tr>
<tr>
<td>MoDOT</td>
<td>CCTV, Traffic Signal System Control</td>
</tr>
<tr>
<td>ODOT</td>
<td>Bus Route Tracking, CCTV, Incident Monitoring, Light Rail Monitoring</td>
</tr>
<tr>
<td></td>
<td>Traffic Signals, VMS, Weather Data</td>
</tr>
</tbody>
</table>

Q15  What hardware/software is used for the TMC?

As Table 4-9 shows, various hardware configurations and types of software are being adopted. The type of hardware/software to employ is largely dictated by the designed functionality of the TMC. The decision may also be influenced by the DOT standards, or IT standards within a state.

Table 4-9  Traffic Management Center Hardware/Software Used

<table>
<thead>
<tr>
<th>DOT</th>
<th>Hardware/Software for Traffic Management Center</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITD</td>
<td>ATMS Freeway/Arterial Software developed by the IBI Group (Toronto, Ontario),</td>
</tr>
<tr>
<td></td>
<td>hardware that includes a PC network, video switch, codecs,</td>
</tr>
<tr>
<td></td>
<td>fiber network equipment (IFS, Seimens OTN) and Diamond camera controller.</td>
</tr>
<tr>
<td>Mn/DOT</td>
<td>170 controllers, Linux/Java central software written in-house,</td>
</tr>
<tr>
<td></td>
<td>various brands of communication software, VMSs, etc.</td>
</tr>
<tr>
<td>MoDOT</td>
<td>BiTrans/Quicknet for Signal System, Pelco for CCTV.</td>
</tr>
<tr>
<td></td>
<td>The system is operated from Windows based PCs.</td>
</tr>
</tbody>
</table>

Q16  What are the staffing requirements for the TMC?

Both ITD and MoDOT require two full time staff while Mn/DOT and ODOT require at least five personnel for their TMCs.
Q17 What are the costs (each component, hardware/software, staffing) for the TMC?

Table 4-10 provides a summary of costs for each TMC component. As shown, only ITD provided a detailed costing. The ITD TMC invested a large amount for software purchase.

<table>
<thead>
<tr>
<th>DOT</th>
<th>Traffic Management Center Components Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITD</td>
<td>Components:</td>
</tr>
<tr>
<td></td>
<td>$ 45,000 (Video wall + 18-20&quot; monitors &amp; 1-56&quot; Barco)</td>
</tr>
<tr>
<td></td>
<td>$ 8,000 (TMC Operators console – 3 position)</td>
</tr>
<tr>
<td></td>
<td>Hardware:</td>
</tr>
<tr>
<td></td>
<td>$ 25,000 (Diamond Video Switch)</td>
</tr>
<tr>
<td></td>
<td>$ 50,000 (Video codecs for wireless freeway video)</td>
</tr>
<tr>
<td></td>
<td>$ 150,000 (Fiber video drivers + fiber network equipment)</td>
</tr>
<tr>
<td></td>
<td>$ 25,000 (TMC workstations (3 PC’s) + 3 Servers)</td>
</tr>
<tr>
<td></td>
<td>Software:</td>
</tr>
<tr>
<td></td>
<td>$ 600,000 (IBI Group ATMS Software)</td>
</tr>
<tr>
<td></td>
<td>$ 100,000 (Signal System Software- Naztec)</td>
</tr>
<tr>
<td></td>
<td>Staffing:</td>
</tr>
<tr>
<td></td>
<td>$ 90,000 yr (one full-time TMC operator + one PT TMC Operator (25hrs/wk)+</td>
</tr>
<tr>
<td></td>
<td>one full time Signal Operations Engineer (spends 10 hrs/week in TMC)</td>
</tr>
<tr>
<td></td>
<td>and one full-time Electronics Tech (spends 10 hrs/week).</td>
</tr>
<tr>
<td>MoDOT</td>
<td>Overall operating costs are estimated to be about $150,000 per year.</td>
</tr>
</tbody>
</table>

Q18 Who controls operation of the TMC (i.e., which department or is it a separate section of its own)?

As Table 4-11 indicates, control of TMC operation usually involves more than one agency, and DOTs usually do not exercise greater share of control in the TMC operation.

<table>
<thead>
<tr>
<th>DOT</th>
<th>Agency Controlling the Traffic Management Center Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITD</td>
<td>Ada County Highway District</td>
</tr>
<tr>
<td>Mn/DOT</td>
<td>Part of Minnesota Department of Transportation, including the Minnesota State Patrol (Department of Public Safety)</td>
</tr>
<tr>
<td>MoDOT</td>
<td>Jointly controlled by MoDOT District 8 and the City of Springfield.</td>
</tr>
<tr>
<td>ODOT</td>
<td>Self-administering under regional maintenance manager</td>
</tr>
</tbody>
</table>
Q19 How many traffic signals are tied into the TMC?

Mn/DOT has between 1-50 while both MoDOT and ODOT have between 100-250 signals tied to the TMC.

4.5 Summary

The results of the Computing System Needs Survey provide insight as to what other DOTs are doing and how they are approaching the maintenance and management of signals in their jurisdictions. Several DOTs have more comprehensive computerized inventories in order to manage their signal systems including MoDOT, Mn/DOT, ODOT and WisDOT. Three DOTs, namely Mn/DOT, ODOT and WisDOT, use the inventory to document maintenance of their signals. The survey response data provides SDDOT with estimates regarding the cost and staffing requirements for traffic signal inventories and TMCs with differing levels of intensity. Questions regarding TMCs were included in the Computing System Needs Survey in order to provide information to SDDOT in the event that a TMC is constructed in South Dakota. A TMC is directly related to signal management and maintenance when traffic signals are tied to the TMC for the role of arterial management. The component and cost information from the respondent DOTs, including the details regarding the differing functionality of varied inventory systems, can be used to estimate the requirements and costs of an inventory system for SDDOT.

Highlights of the survey results are as follows (“DOTs” refers to survey respondents):

- The majority of the DOTs use a database to store their signal inventory.
- Most DOTs’ inventories include data fields for the signal location, hardware, and controller, while some inventories also include timing plans, detection, and maintenance. Other data fields include pole information, funding and plan sheets.
- Computer system configuration requirements are relatively the same, while software requirements vary between customized inventory programs to simple spreadsheet software.
- Costs for software differ largely between the Excel software to the commercially available or custom-built software and depend largely on the desired functionality.
- Staffing requirements varied from one full-time equivalent employee for ITD, Mn/DOT, and NDOR to five full-time staff for MoDOT and WisDOT. ODOT requires two staff.
- Personnel responsible for maintaining the inventory differ by DOT.
- Three DOTs, namely Mn/DOT, ODOT and WisDOT use the inventory to document maintenance of their signals.
- All three of the DOTs that use their inventory to document maintenance, communicate the maintenance performed back to the inventory electronically. ODOT also updates via paperwork submittal.
None of the inventory systems has the ability to communicate with traffic signals to download/upload data.

Access to the inventory is granted in all but one system to users with view and editing privileges. Some systems also allow access to users with view only privileges or via password. ITD utilizes network domain constraints to control read/write access.

Only one DOT inventory is planned to be accessible to cities through the Internet.

Four of the DOTs have at least one Traffic Management Center (TMC)

All of the TMCs are used for disseminating information, for managing traffic during special events, and for roadway surveillance and traffic data collection. All but one are used for coordinating traffic signals.

TMC components differ based on the desired functions intended for the TMC to fulfill. Components include CCTV, dynamic message signs, detector loops, traffic signal system control, incident monitoring, lane control, and communications.

Software used in TMCs includes different applications either purchased or developed in-house in order to meet the specific needs for the desired functionality of the TMC and the various TMC components.

Two of the DOTs require two full time staff, while the other two DOTs require at least five full time staff for their TMCs.

Control of the TMC operation usually involves more than one agency.

Mn/DOT has between 1-50 signals tied to the TMC while MoDOT and ODOT have between 100-250 signals tied to the TMC.
5.0 WORKSHOP DISCUSSIONS

Task 5. Through a facilitated workshop involving management and staff from the SDDOT, local government entities, and others with interests directly tied to the subject, assess the current procedures, supporting guidelines, perceived needs, and ongoing operations that affect traffic signal management and maintenance.

This chapter presents the issues and ensuing discussions of management and maintenance practices during the one-day workshop held at the South Dakota Department of Transportation in Pierre, South Dakota, on November 13, 2003.

5.1 Purpose

The objectives of the event included involving management and staff from the SDDOT, local government entities, and others with interests directly tied to the maintenance and management of the state route signals to assess the current procedures, supporting guidelines, perceived needs, and ongoing operations that affect traffic signal management and maintenance. The workshop aimed at finding solutions to the current shortcomings in tracking down work that occurs on traffic signal systems. Each participant received a copy of the Workshop Background Paper, which outlined the research project's findings to date.

Section 5.5 provides summaries of the workshop discussions. Subsequent sections provide further details on the workshop agenda, participants, and the workshop topics.

5.2 Agenda

Table 5-1 shows details of the workshop agenda. The workshop was kicked-off at 8:15 a.m. by Dennis Johnson, the research project manager from the SDDOT Office of Research. Charles Schwinger, the consultant project manager, started the morning session by providing an overview of the current maintenance and management practices at South Dakota. He then outlined the problems and issues that the workshop participants would tackle during the workshop discussions. Virginia Sapkota followed Charles’ presentation where she described the results of the survey of maintenance and management practices at other state departments of transportation with similar operational needs to South Dakota.

The workshop participants were assigned to three groups. Each group appointed a spokesperson, who was also tasked to take notes of the workgroup discussions. Each participant was handed a workbook that containing the issues that each group needed to address. Each group was allotted two hours to address all six-workshop discussion topics. The spokesperson for each group took turns presenting the findings or suggested solutions to each of the workshop discussion topics.
Table 5-1  November 13, 2003 Workshop Agenda

<table>
<thead>
<tr>
<th>Time</th>
<th>Agenda Item</th>
<th>Other Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:00 - 8:15 AM</td>
<td>Registration</td>
<td>Coffee and Donuts</td>
</tr>
<tr>
<td>9:15 - 10:00 AM</td>
<td>Review of Practices at Other State DOTs</td>
<td>BWR Consultant Team</td>
</tr>
<tr>
<td>10:00 - 10:15 AM</td>
<td>Break</td>
<td>Refreshments</td>
</tr>
<tr>
<td>10:15 - 12:15 AM</td>
<td>Discovery of Solutions</td>
<td>Group Exercise</td>
</tr>
<tr>
<td>12:15 - 12:45 PM</td>
<td>Lunch</td>
<td>Provided</td>
</tr>
<tr>
<td>12:45 - 1:45 PM</td>
<td>Group Presentations</td>
<td>Facilitated</td>
</tr>
<tr>
<td>1:45 – 2:15 PM</td>
<td>Conclusion</td>
<td>BWR Consultant Team</td>
</tr>
</tbody>
</table>

5.3 Participants

Table 5-2 lists all of the twenty-nine workshop attendees.

Table 5-2  Workshop Attendees

<table>
<thead>
<tr>
<th>#</th>
<th>First</th>
<th>Last</th>
<th>Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>John</td>
<td>Adler</td>
<td>SDDOT - Central Office, Division of Operations</td>
</tr>
<tr>
<td>2</td>
<td>John</td>
<td>Becker</td>
<td>SDDOT - Central Office, Div. of Planning &amp; Engineering, Research Office</td>
</tr>
<tr>
<td>3</td>
<td>Herb</td>
<td>Blomquist</td>
<td>City of Watertown, Public Works Department</td>
</tr>
<tr>
<td>4</td>
<td>Robin</td>
<td>Bobzien</td>
<td>City of Aberdeen, Public Works Department</td>
</tr>
<tr>
<td>5</td>
<td>Todd</td>
<td>Chambers</td>
<td>City of Pierre</td>
</tr>
<tr>
<td>6</td>
<td>Ron</td>
<td>Evenson</td>
<td>City of Aberdeen, Public Works Department</td>
</tr>
<tr>
<td>7</td>
<td>Dick</td>
<td>Figland</td>
<td>City of Mitchell, Traffic Department</td>
</tr>
<tr>
<td>8</td>
<td>Thomas</td>
<td>Fulton</td>
<td>Bucher, Willis &amp; Ratliff Corporation</td>
</tr>
<tr>
<td>9</td>
<td>Tom</td>
<td>Gilsrud</td>
<td>SDDOT - Central Office, Div. of Planning &amp; Engineering, Bridge Program</td>
</tr>
<tr>
<td>10</td>
<td>Darren</td>
<td>Greise</td>
<td>SDDOT - Pierre Region</td>
</tr>
<tr>
<td>11</td>
<td>Larry</td>
<td>Grobanburg</td>
<td>City of Mitchell, Traffic Department</td>
</tr>
<tr>
<td>12</td>
<td>Dallas</td>
<td>Hofer</td>
<td>City of Sioux Falls</td>
</tr>
<tr>
<td>13</td>
<td>Ervin</td>
<td>Huber</td>
<td>City of Sturgis, Public Works Department</td>
</tr>
<tr>
<td>14</td>
<td>Scott</td>
<td>Jansen</td>
<td>SDDOT - Mitchell Region</td>
</tr>
<tr>
<td>15</td>
<td>Dennis</td>
<td>Johnson</td>
<td>SDDOT - Central Office, Div. of Planning &amp; Engineering, Research Office</td>
</tr>
<tr>
<td>16</td>
<td>Sharon</td>
<td>Johnson</td>
<td>FHWA - Pierre District Office</td>
</tr>
<tr>
<td>17</td>
<td>Mark</td>
<td>Koller</td>
<td>City of Vermillion, Light &amp; Power Department</td>
</tr>
<tr>
<td>18</td>
<td>Dan</td>
<td>Martell</td>
<td>SDDOT - Central Office, Div. of Planning &amp; Engineering, Road Design</td>
</tr>
<tr>
<td>19</td>
<td>Mark</td>
<td>McDermaid</td>
<td>City of Huron, Traffic Department</td>
</tr>
<tr>
<td>20</td>
<td>Troy</td>
<td>Merriam</td>
<td>City of Huron, Traffic Department</td>
</tr>
<tr>
<td>21</td>
<td>Randy</td>
<td>Nohava</td>
<td>City of Sturgis, Public Works Department</td>
</tr>
<tr>
<td>22</td>
<td>Alan</td>
<td>Petrich</td>
<td>SDDOT - Aberdeen Region</td>
</tr>
<tr>
<td>23</td>
<td>Cliff</td>
<td>Reuer</td>
<td>SDDOT - Central Office, Div. of Planning &amp; Eng’g., Local Government Assistance</td>
</tr>
<tr>
<td>24</td>
<td>Ted</td>
<td>Rufledt</td>
<td>City of Rapid City, Traffic Operations</td>
</tr>
<tr>
<td>25</td>
<td>Virginia</td>
<td>Sapkota</td>
<td>Bucher, Willis &amp; Ratliff Corporation</td>
</tr>
<tr>
<td>26</td>
<td>Charles</td>
<td>Schwinger</td>
<td>Bucher, Willis &amp; Ratliff Corporation</td>
</tr>
<tr>
<td>27</td>
<td>Daniel</td>
<td>Staton</td>
<td>SDDOT - Rapid City Region</td>
</tr>
<tr>
<td>28</td>
<td>Gary</td>
<td>Stykes</td>
<td>City of Sioux Falls</td>
</tr>
<tr>
<td>29</td>
<td>Larry</td>
<td>Ziebart</td>
<td>City of Watertown, Public Works Department</td>
</tr>
</tbody>
</table>
5.4 Workshop Topics

The workshop was dedicated to group discussions on the six topics listed below. Each topic was assigned to a workgroup with about 8 to 9 participants. Each workgroup selected a spokesperson that was responsible for taking notes of the ensuing discussions. At the end of each workshop discussion, the note takers provided a summary of the deliberations.

1. **Maintenance agreement needs rewording.**
   - What should “maintenance” all include?
   - What should happen if signals are not properly maintained?
   - Who should be allowed to change signal timings and how should they report those changes?
   - How can SDDOT be sure signals are being maintained?

2. **Need to restrict access to cabinets.**
   - Who should have access to cabinets?
   - How should access be restricted?

3. **Need to maintain maintenance records.**
   - Is keeping a maintenance log practical?
   - Should maintenance logs be kept in the cabinet and/or submitted in paper or electronically to SDDOT?
   - Is a timing change log practical?

4. **Need of State signal inventory.**
   - Who should maintain a state signal inventory?
   - How should updates to the signal inventory be submitted?
   - What should be included in the inventory?

5. **Need a uniform punch list for signal acceptance.**
   - What is critical to be included on the list?
   - Who should be present at the inspection?

6. **Maintenance personnel need training and certification.**
   - How much training is adequate for maintenance activities?
5.5 Summary of Workshop Discussions

5.5.1 Topic 1: Maintenance Agreement

The review of the current maintenance agreement between the State and the maintaining agencies indicated the need to change and/or add stipulations to the maintenance agreement. Workshop participants indicated their views in response to the following four questions.

1. What should “maintenance” all include?

Participants presented various definitions of maintenance ranging from preventative and responsive maintenance to specific activities that should be required. A minimum standard needs to be developed, possibly in the form of a checklist. Maintenance items could include critical power points, ventilation, lights, lamps, parabolic reflectors, visors, backplates, connections in base of poles, junction boxes, pedestrian push buttons, and detector inputs. Other maintenance activities might include testing of monitors, verification of timings as per plans, and checking batteries used for data back up.

Preventative maintenance could involve the IMSA checklist items, the list provided in the workshop book, and original and subsequent state programming. Some maintenance items may need to be done annually, at a minimum, while other items should possibly be done monthly.

Responsive maintenance should address emergency repairs, signal pole and cabinet (when impacted), traffic control (until repairs are made), and signal programming. Responsibilities for various items need to be defined, such as who pays for a “fried” controller or who pays for a pole if it gets knocked down.

2. What should happen if signals are not properly maintained?

The general consensus when signals are not properly maintained is to have the work done either by the State or by a hired contractor and then bill the City for the work. In addition, if a signal study reveals that warrants are no longer met, then the signal ought to be removed. It was further suggested that the State should work with the maintaining agency to get the signals properly operating. A few suggested imposing some form of penalty, such as withholding urban system funding for cities with a population of 5,000 or more and withholding community access grants for cities with a population less than 5,000.

3. Who should be allowed to change signal timings and how should they report those changes?

In response to this question, participants suggested the following:

- State and maintaining agencies should work together to develop the original timing plan.
- Both the State and the maintaining agencies should be allowed to change signal timings. If on the State Highway System, maintaining agencies should report the
changes to the Regional Office via email, fax, or paper format. State should approve the changes and the maintaining agencies will program in those changes.

- Maintaining agencies could change the splits, offsets and cycle lengths upon approval by the Region Traffic Engineer.
- Qualified City staff could be allowed to change signal timing plans upon concurrence from the State, specifically from the Region Traffic Engineer. City personnel authorized to make signal timing changes must be properly trained.
- Region Traffic Engineer would undertake signal timing changes only for small towns without qualified personnel.
- Region Traffic Engineer should be IMSA certified.
- Signal timing changes could be reported electronically, by paper submittal, or by telephone conversation. In smaller communities, paper submittal should be sufficient. Documentation should be kept at both ends. Documentation by the City can be done either in the signal controller cabinet or at the City office.

4. **How can SDDOT be sure signals are being maintained?**

In response to this question, participants suggested the following measures:

- SDDOT should develop a standardized checklist that could be used for statewide inspection. It was further suggested to include only key items with higher liability implications. Cities should be involved in developing such a checklist.
- SDDOT and the City should conduct annual inspections.
- Cities should submit a record of maintenance on an annual basis to the Region Traffic Engineer.
- This standardized checklist could be stored and updated annually in the proposed signal inventory.
- SDDOT, in coordination with the City, should develop a schedule that prioritizes the annual traffic signal inspection on the state route signals.

5.5.2 **Topic 2: Access to Signal Cabinets**

The current SDDOT practice allows unlimited access to traffic signal control boxes through a single “one size fits all” key. To address this issue, participants were asked the following two questions.

1. **Who should have access to cabinets?**

   Participants suggested the following agencies be given access to the signal cabinets:
   
   - Maintaining Agency,
   - State or Region Traffic Engineer,
   - Other State traffic or maintenance employees,
   - Contractor during the project construction stage and up to final acceptance, and
   - Police through “police panel” only.
2. **How should access be restricted?**

   Workshop participants had differing perceptions regarding access to the signal cabinets. A few did not perceive a problem with the present practice that allows access to anyone with business to the traffic signals. Those who thought otherwise offered the following alternatives to restrict access to the signal cabinets:
   - Allow access only to State and maintaining agency personnel responsible for signal maintenance.
   - Allow access to authorized personnel, e.g., Contractors hired by the State or the maintaining agency.
   - Restrict as necessary by using an access code in the controllers or by using an electronic key pad on controller doors.
   - Locking the cabinets using padlocks, specifying a different lock-key, and/or adding a separate lock.
   - Police access through a “police panel” only.

### 5.5.3 **Topic 3: Maintenance Records**

The current SDDOT practice provides no reliable means to retain records of work that occurs on state route traffic signals. The following three questions asked participants about their views on the practical means to store maintenance records.

1. **Is keeping a maintenance log practical?**

   Most participants felt that keeping a maintenance log is practical, while a few thought otherwise. The following points were made:
   - A standard form, such as a checklist, needs to be established.
   - This checklist should include the minimum maintenance log, which the state should set as minimum requirements. Several participants argued the impracticality of having cities submit every detail of maintenance activities.
   - An annual log could be made mandatory. Several participants suggested that Cities submit only an annual log to the State. Cities should keep detailed records of their maintenance for budget purposes (such as replacing loops, lights, etc.), but should only submit the minimum maintenance log.
   - Cities should keep copies of their maintenance for DOT review as needed.

2. **Should maintenance logs be kept in the cabinet and/or submitted in paper or electronically to SDDOT?**

   Participants made the following suggestions on keeping the maintenance log:
   - Either keep maintenance logs in the signal cabinets or keep these at Cities’ maintenance shops. Another suggestion was to store the maintenance log in the signal inventory system.
   - Keep a simple maintenance log, such as in checklist format.
Timing changes should be kept in the cabinet.
Consider an electronic submittal for larger cities while a paper format for smaller cities.
Copies of annual inspections submitted to the Region Traffic Engineer should be sufficient.
Maintaining agencies should keep their own monthly maintenance logs, and make this available to SDDOT when needed.

3. *Is a timing change log practical?*

Workshop participants generally agreed that it is practical to keep a log of changes made to the signal timing plan at each intersection. Moreover, participants suggested the following measures:

- SDDOT should develop a standard form or sheet of the timing change log.
- Both SDDOT Region Traffic Engineer and maintaining agencies should keep the original timing plan and the changes being made.
- Changes to the timing should be signed off by the SDDOT Region Traffic Engineer.
- Keep the timing information in the cabinet.
- Another suggestion was to keep the timing information at the City office.
- Both SDDOT and maintaining agencies should keep a record of phone calls and relevant documentation.

5.5.4 **Topic 4: State Signal Inventory**

One of the major issues the research study needs to address is a signal inventory system appropriate for South Dakota. The following three questions asked participants on their opinions on this issue.

1. *Who should maintain a state signal inventory?*

Although most participants felt that the State, specifically the Division of Planning & Engineering, Office of Road Design, should maintain the traffic signal inventory, a few questioned the benefit or need for such an inventory at SDDOT considering that SDDOT turns over to the Cities the operations and maintenance aspects of the state route signals, including replacement of parts.

Differing perceptions aside, it was suggested to keep the inventory as simple as possible, and that the State should keep and maintain the inventory. Further, it was suggested that the Bureau of Information and Telecommunications (BIT) should be responsible for storing the inventory as a data file on a state-owned server while SDDOT should be responsible for maintaining and updating the actual data.
2. **How should updates to the signal inventory be submitted?**

Participants suggested the following means for submitting updates to the signal inventory:

- City to send updates to SDDOT via fax, email, or mail.
- Updates could be sent in both electronic and paper format.
- Submit changes as they occur.
- Update the inventory system as changes occur.
- SDDOT should only maintain the inventory system for those items felt most important.

3. **What should be included in the inventory?**

Several participants stressed the need to keep the inventory as simple as possible. A few raised an important point that motivation to maintain a database system stems from the need to use the information contained in the database. In other words, a well-maintained database system reflects the continuing application and use of information in the database.

Those who opted for a highly simplified inventory system suggested only including the following: age and type of certain hardware, poles, mast arms, heads, controllers, and whether signals use LEDs or not. This simple inventory could also include structural integrity testing.

Other items that could be included in the inventory system are:

- Project name and plan number installation.
- Location (Intersection name and City).
- Hardware items (age of poles, type or brand of poles, length of mast arms, loops, number of heads and number of sections, pedestrian indications, controller brand and type, LED or bulbs).
- Conflict monitor type.
- Software updates in controllers.
- Video detection, if used.
- Timing plans.
- Structural integrity testing.
- An index that references old plans and shop drawings.
- Warrant justification.

It was further suggested to refer to the existing (though not yet operational) SDDOT signal inventory and to make appropriate changes to this inventory as needed.
5.5.5 Topic 5: Signal Acceptance Punch List

One of the shortcomings identified in the current SDDOT practice is the lack of a uniform or standard checklist or punch list for traffic signal project inspection. The following two questions elicited participants’ views on this issue.

1. **What is critical to be included on the list?**

   Participants suggested that existing lists, such as those included in the workshop notebook, could be used to develop an applicable punch list for South Dakota. A few suggested expanding the list to include design aspects. Several items that could be part of a punch list include: conductors to match color coding, enough amount of slack in junction boxes, loop lead ins are twisted in junction box, proper labeling of cables in cabinet, junction boxes level with grade, heads aligned and placed properly, power feed neutrals should be white or labeled as such, as-builts provided, flexible duct sealer in conduits entering the controller cabinet, and presence of the pad sealer around the traffic signal cabinet base. It was further suggested that cities and state should submit items for the punch list to enable the development of a list that both cities and state are happy with. The punch list should be applicable on a statewide basis.

   In addition to developing a uniform punch list, several participants felt that this list should be discussed during preconstruction meetings where inspectors will be provided with the list. One participant stressed the need to have the City at the preconstruction meeting to coordinate their involvement in inspection during certain phases of construction.

2. **Who should be present at the inspection?**

   Participants identified the following agencies to be present at the inspection: the maintaining agency, the State, and the contractor. Specific agency representatives should include project engineer during construction, Region Traffic Engineer, City Traffic Engineer or City representative, controller supplier, project inspector, City maintenance personnel, consulting engineer, and plan designer.

   It was also suggested that SDDOT could consider having approximately two staff to go statewide and carry out inspections. Furthermore, SDDOT could consider paying the five largest cities to do signal inspections across the state.

   It was reiterated that a city representative should be present at the preconstruction meeting and that Cities could become more involved in final acceptance.
5.5.6 Topic 6: Training and Certification

One of the problems identified in the research study was the general lack of training and certification required of maintenance personnel. To address this issue, workshop participants were asked whether training or certification be required to perform signal maintenance. Below summarizes workshop participants’ thoughts on the issue.

1. *How much training is adequate for maintenance activities?*

   Participants agreed that training is essential for effective maintenance of signal systems. Likewise, participants agreed on the need for better inspection at all times. They generally concurred on the need for training not only for traffic signal maintenance personnel, but also for construction personnel inspecting signal installation projects.

   Some of the suggested avenues to acquire training and or certification include:

   - Attendance at manufacturer sponsored seminars.
   - Signal maintenance personnel to meet with SDDOT staff on an annual basis to discuss concerns of mutual interest and make, as necessary, suggestions for changes in procedures and methods. Certification, if adopted, could take place at this meeting.
   - SDDOT could sponsor annual workshops that include supplier and vendor training, user group topic discussions, open discussions, and problem solving.
   - IMSA training and certification.
6.0 FORMULATION OF NEW POLICIES, AGREEMENTS, AND PROCEDURES

Task 6. Propose and present, for review and approval of the technical panel, recommendations for new policies, agreements, and procedural definitions that are based on well-founded criteria to specifically address South Dakota’s traffic signal management and maintenance activities and gain the desired levels of improvement.

6.1 Introduction

This chapter presents a synthesis of the review of policies, agreements, and procedures, lessons gleaned from the surveys of maintenance and management practices, computer system needs at other state DOTs, and the outcomes from the workshop discussions. Findings and lessons learned from these tasks are vital information in formulating new policies, agreements, and procedural standards for an effective Traffic Signal Management and Maintenance System (TSMMS) for SDDOT.

The synthesis identifies issues in three categories that define the SDDOT TSMMS. These categories are (1) Maintenance agreements, (2) A comprehensive statewide policy and procedures, and (3) A statewide traffic signal inventory and maintenance database. Recommendations presented in Chapter 7 are designed to address these three TSMMS categories.

6.2 Maintenance Agreements

Section 2.4 outlines five specific issues in the current maintenance agreements. These are discussed in more detail below.

**ISSUE 1: WHAT SHOULD “MAINTENANCE” ALL INCLUDE?** Maintenance can be divided into three basic types—preventive, response, and modification. Preventive maintenance actions are performed on a regularly scheduled basis to preserve an intended working condition. Response maintenance actions are performed on an as-needed basis. Modification actions correct a recurring problem. Maintaining agencies perform all three types of maintenance for efficient and safe operation of the traffic signal controls. Maintenance practices at KDOT, MoDOT, NDOR, NMDOT, and WYDOT indicate a formal statewide maintenance program in place. KDOT, MoDOT, and WYDOT use a maintenance checklist. KDOT requires that maintaining agencies carry out a semi-annual maintenance of the items listed in the maintenance checklist that must be submitted back to KDOT. WYDOT uses a checklist for its annual maintenance inspection.
The current SDDOT maintenance agreement does not specify what “maintenance” should include. During the workshop, participants agreed the need to develop a uniform maintenance checklist that maintaining agencies will submit annually to SDDOT.

**ISSUE 2: DOCUMENTATION AND RECORD KEEPING.** One of the most important but often neglected requirements of system maintenance is relevant and up-to-date documentation. Records needed for effective maintenance fall into three basic categories—maintenance service records, signal timing charts, and maintenance manuals and as-built plans. Practices at MoDOT, MDT, NDDOT, and WYDOT require that maintenance logs be kept in the signal controller cabinets. ITD, MoDOT, MDT, and NMDOT document maintenance electronically. Other state DOTs adopt both paper and electronic record, while others only keep paper copies. Workshop participants suggested that SDDOT should develop a maintenance log in a checklist format, which should be kept either at the signal cabinets or at the maintaining agencies’ maintenance shop. Further, SDDOT should develop a maintenance checklist that maintaining agencies submit annually. In addition to the maintenance log and checklist, SDDOT should develop a standard form of the timing change log that maintaining agencies need to keep inside the signal cabinets.

The current SDDOT maintenance agreement does not specify documentation and record keeping, including how and when maintenance records are to be communicated back to SDDOT.

**ISSUE 3: WHO SHOULD BE ALLOWED TO MAKE CHANGES TO SIGNAL TIMINGS?** Practices at other state DOTs reveal a mix of agencies authorized to change signal timings. While some DOTs allow Cities, Counties, and Local Government Agencies to make changes to the signal timings, any changes made generally requires concurrence from the State. KDOT delegates authority to make changes to the signal timings to the maintaining agencies. KDOT, however, requires permission if changing phases on yellow or all red.

The current SDDOT maintenance agreement does not allow maintaining agencies to make changes to the signal timing plans without prior SDDOT approval. The exception is the City of Sioux Falls where the City is permitted to make adjustments to signal splits and offsets to accommodate changes in traffic conditions.

**ISSUE 4: WHO SHOULD BE ALLOWED ACCESS TO THE SIGNAL CONTROLLER CABINETS?** One of the issues identified in this research study is the current SDDOT practice allowing unlimited access to traffic signal control cabinets through a single “one size fits all” key with no certification or licensing requirements for those accessing the signal control cabinets to perform maintenance work. SDDOT recognizes this problem and
desires to restrict access only to authorized personnel and qualified personnel. Limiting access to authorized and qualified personnel will improve the quality of maintenance; at the same time, it will reduce the potential for inadequate, if not incorrect maintenance work.

Practices at other state DOTs indicate that DOTs allow access to personnel from State, City, County, Contractor, and Police. MoDOT allows only State personnel and police access while WYDOT allows only State and City staff (only for the City of Cheyenne). Some state DOTs use special measures to limit access to the signal controller cabinets. These measures include special key, padlocks, supervisor access codes, and “police panel” for police access. Workshop participants suggested restricting access to allow access only to authorized personnel from the State, maintaining agencies, and contractors, as well as access to police through a “police panel.” Moreover, restrict access as necessary by using access codes in the controllers or by using an electronic key pad on controller doors.

**ISSUE 5: HOW CAN SDDOT BE SURE SIGNALS ARE BEING MAINTAINED?** Workshop participants suggested the use of a maintenance checklist that maintaining agencies shall submit annually. Some state DOTs impose some form of penalty or sanction against non-performance of maintenance. Sanctions include the State invoicing the maintaining agency, withholding state reimbursements, voiding the maintenance agreement, or removing the signal. It is important to note that the few that indicated some form of sanctions, cost-sharing arrangements do exist with the maintaining agencies.

The current SDDOT maintenance agreement does not specify sanctions against the maintaining municipality in the event of failure to perform its maintenance obligations.

**6.3 Policy and Procedures for Traffic Signals on State Highways**

**ISSUE 6: CURRENT POLICY AND PROCEDURES DOCUMENT.** The current policy and procedures for traffic signals on state highways (see Appendix B) is not comprehensive. It only includes policies for installation and procedures for initiation and removal of traffic signals. It does not cover policies and procedures for management and maintenance.

**ISSUE 7: NON-STANDARD PRACTICES.** The lack of comprehensive policy and procedural guidelines for state highway traffic signals has resulted in non-standard practices.

**ISSUE 8: PRECONSTRUCTION CONFERENCE.** A preconstruction conference with the contractor and other interested parties is normally conducted on all construction projects, including traffic signal installations. Many agencies have formal, written policies for the conduct and content of the preconstruction meeting. The primary goal of such a
conference is to establish a sound working relationship and a clear understanding of the work to be accomplished, procedures to be followed, and respective obligations and expectations among all parties affected. As suggested during the workshop, the final acceptance punchlist could be discussed during this preconstruction meeting where inspectors would be provided with the list. Further, it was suggested that representatives from maintaining agencies be present during this preconstruction meeting to coordinate their involvement in inspection during certain phases of construction.

The current SDDOT procedures for traffic signal installations does not specify a preconstruction conference.

**ISSUE 9: TRAFFIC SIGNAL FINAL ACCEPTANCE PUNCHLIST.** Maintenance problems often can be traced to inadequate inspection during installation or inadequate design. Undetected installation errors include violations of the National Electrical Code and/or other applicable codes, improper installation of hardware, and incorrect operation of the equipment. A major factor contributing to design and installation problems is often the lack of comprehensive inspection guidelines, including a final acceptance punchlist to ensure a thorough, systematic inspection by the field inspector. Careful adherence to the listed suggestions will not only avoid unnecessary and costly repairs or reconstruction, but will also help minimize exposure to liability.

AHTD, NMDOT, and WYDOT have adopted punchlists in their final acceptance inspection. The City of Sioux Falls has also adopted its own punchlist.

SDDOT does not have a uniform final acceptance punchlist. The Mitchell Region has established a punchlist; however, this needs to be more comprehensive. During the workshop, participants agreed that SDDOT should use a uniform punchlist for final acceptance, and that SDDOT should develop this uniform punchlist. In addition, workshop participants suggested that Cities should be more involved in the final acceptance process.

**ISSUE 10: PERIODIC INSPECTION AND REVIEWS.** Routine periodic inspection of all traffic control devices is the cornerstone of an effective risk management program. Workshop participants suggested that SDDOT Regional offices should conduct an annual random inspection to ascertain that maintenance work meets the minimum level of maintenance standards.

**ISSUE 11: MAINTENANCE RECORDS.** Adequate maintenance records are essential. Maintenance records can help in providing efficient service, detecting and correcting recurrent problems, and developing maintenance schedules and strategies. They are also essential to an adequate defense in the event of a lawsuit. A wide variety of record keeping approaches and forms are currently in use. Generally, however, the records
needed for effective maintenance fall into three basic categories: (1) maintenance service records, (2) signal timing charts, and (3) maintenance manuals and as-built plans. Maintenance service history records are most commonly kept for each individual system component, using a variety of forms and ledgers consistent with the preventive, response, and design modification maintenance practices. Controller time settings as prepared by the traffic engineer are recorded on signal timing charts. Copies of these charts should be kept inside the controller cabinet for use by signal mechanics or other maintenance personnel to verify and adjust the signal timings if necessary. The third category of maintenance records includes manuals provided by the manufacturer, special controller programs, component layout sheets, wiring schematics, and as-built construction drawings.

In the case of SDDOT, maintenance records will not necessarily include details of each maintenance category. For example, SDDOT does not need a record of all service calls or details of how often each traffic signal is relamped. This is due to the fact that SDDOT does not perform the maintenance, rather Local Government Agencies do. SDDOT, however, needs a reliable means to verify, track, and retain records of work that occurs on state route traffic signals. Reliable means of documentation and record keeping is lacking in current SDDOT practice.

**ISSUE 12: TRAINING AND CERTIFICATION REQUIREMENTS.** Maintenance personnel should be thoroughly trained in the proper actions to take in the case of traffic control system malfunction or loss of control. Maintenance work should be carried out only by qualified personnel. One of the problems identified in this research study is the general lack of training and certification requirements for maintenance personnel. Practices at MDT and NMDOT require certification or training for maintenance personnel. MDT typically requires IMSA Level I/Level II certification. MoDOT is not currently requiring certification, but is providing IMSA training for signal crews. MoDOT is considering incorporating the required training into the job specification. Furthermore, MoDOT is also considering requiring contractors to have IMSA training before being able to install or wire any signal. WYDOT has all technicians IMSA Level I certified or higher. Participants during the workshop generally agreed that training is essential for effective maintenance of signal systems. Participants also suggested that SDDOT play an active role in providing training and that SDDOT and maintaining agencies should discuss concerns of mutual interest.
6.4 Traffic Signal Maintenance Database

**ISSUE 13: MANAGEMENT OF MAINTENANCE RECORDS.** A successful maintenance management plan requires efficient and systematic storage and retrieval of maintenance records. A statewide maintenance management database that is accessible by region personnel is essential. Such a maintenance management database should be capable of tracking maintenance works and programming of the signal timing/phasing, as well as being integrated with the signal inventory system. Although most respondent DOTs do not include maintenance in their current inventory system, a few include timing plans and phasing. SDDOT has timing and phasing in its current, (not yet operational) inventory system.

6.5 Other Issue

**ISSUE 14: UPDATES TO THE STANDARD SPECIFICATIONS.** Mitchell Region Traffic Engineer, Scott Jansen, has identified changes and/or updates to the traffic signal standard specifications. The list of proposed specification updates is included in Appendix I.
7.0 RECOMMENDED POLICIES, AGREEMENTS, AND PROCEDURES

Task 7. Upon final approval by the technical panel, prepare final drafts of the new policies, agreements, and procedural definitions, as well as recommendations on the best way to incorporate them at the Department, and then assist the panel in their preparations for ultimate presentation to the SDDOT Executive Team.

7.1 Introduction

This chapter presents the recommendations to address the issues identified in Chapter 6. The recommendations are grouped into main headings that include an annual maintenance checklist, signal acceptance punchlist, changes to the maintenance agreements, a comprehensive policy and procedures for traffic signals, a maintenance database, and other recommendations. Section 7-2 provides a summary of recommendations. Each recommendation has a reference to the identified issues in Chapter 6.

7.2 Executive Summary of Recommendations

Based on the review of practices at SDDOT and other state departments of transportation, as well as discussions from the workshop, the research team has come up with the following seven specific recommendations.

R1. DEVELOP A MAINTENANCE CHECKLIST. During the workshop, participants agreed on the need to develop a uniform maintenance checklist that maintaining agencies will submit annually to SDDOT. Based on the survey of practices at other state departments of transportation, and on the preventive maintenance guidelines set by the International Municipal Signal Association (IMSA), the research team has compiled a checklist. (Issue 1)

R2. DEVELOP A FINAL ACCEPTANCE PUNCHLIST. The research team has compiled a punchlist that includes references to the current SDDOT Standard Specifications for Roads and Bridges: Division II-Construction Materials and SDDOT Road Design Standard Plates – Section 635 Traffic Signals and Roadway Lighting, as well as references to the punchlist develop by the Mitchell Region and by other agencies including the City of Sioux Falls, AHTD, NMDOT, WYDOT, and IMSA. Section 7.4 describes in more detail the draft punchlist. (Issue 8)

R3. REVISE THE MAINTENANCE AGREEMENTS. To achieve the objectives of improving the management of traffic signal maintenance on state highways, five sub-provisions are recommended to be added to Provision 2 of the current maintenance (SDDOT
maintenance agreements with municipalities) agreements. These additional provisions would enable the SDDOT to verify and track maintenance work, keep better records of maintenance, restrict access to signal cabinets, and ensure that municipalities perform their maintenance responsibilities to avoid sanctions for non-performance. These additional provisions relate to maintaining traffic signal maintenance and timing change logs, keeping the logs inside the controller cabinets, submitting an annual maintenance report using the SDDOT uniform maintenance checklist, limiting access to the signal cabinets, and defining sanctions for non-performance of maintenance. Section 7.5 presents details of the proposed changes to the maintenance agreements. *(Issues 1 to 5)*

**R4. REVISE THE EXISTING POLICY AND PROCEDURE.** The research team recommends that SDDOT revise its existing policy and procedures for the management and maintenance of traffic signals on state highways. The revised policy and procedures are designed to be more comprehensive to include the following specific recommendations that should form part of the comprehensive policy and procedure. *(Issue 6)*

A. **DEFINE OPERATION AND MAINTENANCE RESPONSIBILITIES.** The comprehensive policy and procedures need to specify operation and maintenance responsibilities for traffic signals outside the jurisdictions of Cities. These include traffic signals located on tribal lands, county roads, towns with population below 2,500 and those with populations above 2,500. Operation and maintenance responsibilities are described in Section D of the comprehensive policy and procedure. *(Issue 7)*

B. **PRECONSTRUCTION CONFERENCE.** It is recommended that the final acceptance punchlist be discussed during the traffic signal installation preconstruction conference. Meeting attendance, agenda, and any major comments or concerns expressed with regard to any of the agenda items should be properly documented. It is further suggested that SDDOT develop a standard format for documenting the preconstruction conference. This recommendation is added as Item 7 in Section F (Procedure for the Initiation of a Traffic Signal Project) of the comprehensive policy and procedures document. *(Issue 8)*

C. **TRAFFIC SIGNAL FINAL ACCEPTANCE PUNCHLIST.** SDDOT should include the final acceptance punchlist as requisite in the Procedure for the Initiation of a Traffic Signal Project. This recommendation is added in Items 7 and 8 of the comprehensive policy and procedures. *(Issue 9)*

D. **TRAFFIC SIGNAL REMOVAL.** The current procedure for the removal of an existing traffic signal should be replaced with a more detailed procedure. As described in Section 2.2.1, the current procedure, while adequate, could be expanded to outline a public information process and interim intersection control approach. In addition, the comprehensive policy and procedures specifically define the responsibility to SDDOT for the removal cost of unwarranted traffic signals. This detailed procedure is included as Section G of the comprehensive policy and procedures.

E. **TRAFFIC SIGNAL TIMING.** The comprehensive policy and procedures should identify the agency responsible for making traffic signal timing changes. Likewise, it should describe how and when maintaining agencies should report the changes made to the
signal timings. Traffic signal timing is included as Section H in the revised policy and procedures. *(Issues 3 and 11)*

**F. DEFINITIONS OF MAINTENANCE.** The comprehensive policy and procedures should include definitions of maintenance. This recommendation is included as Item 1 in Section I. *(Issue 1)*

**G. TYPES OF MAINTENANCE.** The comprehensive policy and procedures should specify the types of maintenance that maintaining agencies should carry out. This recommendation is included as Item 2 in Section I. *(Issue 1)*

**H. MAINTENANCE CHECKLIST.** The comprehensive policy and procedures should specify the use of a maintenance checklist as a minimum maintenance guide. This recommendation is included as Item 3 in Section I. *(Issue 1)*

**I. PERFORMANCE OF MAINTENANCE.** The comprehensive policy and procedures should specify the form of penalty or sanction against non-performance of maintenance. This recommendation is included as Item 3 in Section I. *(Issue 5)*

**J. MAINTENANCE RECORDS.** The comprehensive policy and procedures should specify the maintenance records maintaining agencies need to keep and submit to SDDOT. Likewise, it should also describe when maintenance records need to be submitted to SDDOT. This recommendation is included as Item 4 in Section I. *(Issues 2 and 11)*

**K. SCHEDULING AND TRACKING OF MAINTENANCE.** The comprehensive policy and procedures should describe how SDDOT keeps track of maintenance. This recommendation is included as Item 5 in Section I. *(Issue 11)*

**L. PERIODIC INSPECTION AND REVIEWS.** The comprehensive policy and procedures should include an annual maintenance inspection to be conducted at regional offices. This recommendation is included as Item 6 in Section I. *(Issue 10)*

**M. ACCESS TO SIGNAL CABINETS.** The comprehensive policy and procedures should specify the personnel authorized to access the signal cabinets, including measures to restrict access. This recommendation is included as Item 7 in Section I. *(Issue 4)*

**N. MAINTENANCE PERSONNEL CERTIFICATION AND TRAINING.** The comprehensive policy and procedures should specify certification requirements for maintenance personnel. It should also establish training opportunities for maintenance personnel, both for SDDOT and maintaining agencies’ staff. These recommendations are included as Item 8 in Section I. *(Issue 12)*

**R5. MAINTENANCE DATABASE.** SDDOT should develop a database that stores and retrieves records of maintenance activities. *(Issue 13)*

**R6. UPDATE THE EXISTING STANDARD SPECIFICATIONS FOR TRAFFIC SIGNALS.** SDDOT should update its standard specifications to incorporate the suggested updates by the Mitchell Region Traffic Engineer, Scott Jansen. These changes are listed in Appendix I. Likewise, additional standard details should be developed. In addition, items in the punchlist that are not currently referenced should be included in Section 635 of the standard specifications. *(Issue 14)*
R7. **DEVELOP A TRAFFIC SIGNAL DESIGN MANUAL.** It is recommended that SDDOT should consider developing a traffic signal design manual. The current section of the SDDOT Road Design Manual, Chapter 15 – Traffic, only partly covers specifications for traffic signal design and installation. Other specifications for traffic signal installation are covered under the current *SDDOT Standard Specifications for Roads and Bridges: Division II-Construction Materials and SDDOT Road Design Standard Plates – Section 635 Traffic Signals and Roadway Lighting*. A single Traffic Signal Design Manual that contains standard specifications for design, installation, and inspection would be highly beneficial.

### 7.3 Traffic Signal Annual Maintenance Checklist (R1)

During the workshop, participants agreed on the need to develop a uniform maintenance checklist that maintaining agencies will submit annually to SDDOT. Based on the survey of practices at other state departments of transportation, and on the preventive maintenance guidelines set by the International Municipal Signal Association (IMSA), the research team has compiled a checklist. The checklist presented in Table 7-1 may be used as a minimum guide for preventive maintenance tasks where there are no manufacturer’s maintenance recommendations. Otherwise, specific requirements unique to each manufacturer as provided in the manufacturer’s manuals should be followed.

The maintenance checklist shall be used by maintaining agencies for their annual maintenance inspection report that will be submitted to the Region Traffic Engineer at the end of each calendar year. (*Issue 1*)

SDDOT needs to discuss the proposed maintenance checklist with maintaining agencies to ensure their acceptance of the items included in the list.
### Table 7-1  Annual Maintenance Inspection Checklist

**SOUTH DAKOTA DEPARTMENT OF TRANSPORTATION**  
Traffic Signal Annual Maintenance Inspection Checklist

<table>
<thead>
<tr>
<th>Town/City:</th>
<th>Intersection:</th>
<th>Date:</th>
</tr>
</thead>
</table>

#### CABINET
- Clean (as needed)
- Check lock (lubricate if necessary)
- Check/lubricate hinges
- Check fan
- Check filter
- Check anchor bolts
- Check police door functions
- Check inside/outside of cabinet
- Check for water accumulation
- Check weatherproof gaskets
- Documentation (timing & maintenance log)

#### SIGNAL POLES & MAST ARMS
- Check bolts/welds @ arm/pole connection
- Check wire bushings on arm
- Check anchor bolts
- Check hand hole covers
- Check terminal strips
- Check pedestrian push buttons
- Clean (as needed)
- Repaint (as needed)
- Check alignment of mast arms
- Check horizontal & vertical angles of arms
- Check for rust & cracks at arm/upright location and at base plate

#### CONTROLLER & HARDWARE
- Check switches, relays, BIU’s, flashers, etc.
- Check timings/settings
- Check conflict monitor
- Check detector operation
- Check pushbuttons

#### LIGHTING
- Check photo electric control

#### JUNCTION/SERVICE BOXES
- Check covers
- Check bodies
- Check wire splices
- Check conduit bushings
- Check ground wire
- Check drainage

#### DETECTOR LOOPS/CAMERAS
- Check detector loops
- Check cameras
- Check video detection system

#### MISCELLANEOUS

**COMMENTS:**

Technician(s) Signature: ____________________________

Send a copy of this form to the Region Traffic Engineer.
7.4 Traffic Signal Acceptance Punch List (R2)

Maintenance problems often can be traced to inadequate inspection during installation or inadequate design. Undetected installation errors include violations of the National Electrical Code and/or other applicable codes, improper installation of hardware, and incorrect operation of the equipment. Some common examples of design and installation problems include improper grounding of the cabinet and/or poles, cabinet not properly ventilated, cabinet filters not installed, pole position not in planned position, pole anchor nuts left loose, pole base not grouted, signal brackets loose, messy wiring in controller cabinet, push buttons poorly located, loop detectors not cut deep enough in pavement, incorrect loop sealant, signs, signals, and markings not in conformance with MUTCD, and incorrect location of existing utilities.

A major contributing factor to these problems is often the lack of comprehensive inspection guidelines, including a final acceptance punchlist to ensure a thorough, systematic inspection by the field inspector.

As identified in Issue 8, practices at other agencies involve the use of a final acceptance punchlist (AHTD, NMDOT, WYDOT, and the City of Sioux Falls). Current practice at SDDOT, however, does not require the use of a uniform final acceptance punchlist. The Mitchell Region has established a punchlist; however, this needs to be more comprehensive. During the workshop, participants agreed that SDDOT should use a uniform punchlist for final acceptance, and that SDDOT should develop this uniform punchlist. Moreover, participants further suggested that this punchlist should be discussed during a preconstruction meeting. Maintaining agency representative/s should be present during this preconstruction meeting to coordinate their involvement in inspections during certain phases of construction.

The research team has compiled a punchlist that includes references to the current SDDOT Standard Specifications for Roads and Bridges: Division II-Construction Materials and SDDOT Road Design Standard Plates – Section 635 Traffic Signals and Roadway Lighting. Table 7-2 presents the items included in the punchlist while Appendix F shows the formatted version of the punchlist.

Section F (Procedure for the Initiation of a Traffic Signal Project), Items 7 and 8 of the comprehensive policy and procedures includes a reference to the punchlist.
<table>
<thead>
<tr>
<th>ITEM</th>
<th>SDDOT SPECIFICATION OR DETAIL REFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CONTROLLER CABINET</strong></td>
<td></td>
</tr>
<tr>
<td>Check for sealant between footing &amp; cabinet shell</td>
<td>635.3T</td>
</tr>
<tr>
<td>Check anchor bolt nuts</td>
<td>635.3K</td>
</tr>
<tr>
<td>Check for bushings on all conduits</td>
<td>635.3H7</td>
</tr>
<tr>
<td>Check conduit seal</td>
<td>635.3H6</td>
</tr>
<tr>
<td>Check grounding</td>
<td>635.3G,J</td>
</tr>
<tr>
<td>Check wire terminations</td>
<td>635.3V6, S2</td>
</tr>
<tr>
<td>Check wiring diagrams</td>
<td>635.3S</td>
</tr>
<tr>
<td>Check wire color, number, gauge</td>
<td>635.3L</td>
</tr>
<tr>
<td>Check labeling on signal cables</td>
<td>635.3F</td>
</tr>
<tr>
<td>Check lock end two keys</td>
<td>635.3N</td>
</tr>
<tr>
<td>Check as-built plans in cabinet</td>
<td></td>
</tr>
<tr>
<td>Check excess cable</td>
<td></td>
</tr>
<tr>
<td>Check timing against timing plan</td>
<td></td>
</tr>
<tr>
<td>Check vehicle and pedestrian detection</td>
<td></td>
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<tr>
<td><strong>SIGNAL POLES</strong></td>
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<td>Check anchor bolt nuts</td>
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<tr>
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<td>635.3H7</td>
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<tr>
<td>Check grounding</td>
<td>635.3G,J</td>
</tr>
<tr>
<td>Check wire connections</td>
<td>635.3 O1</td>
</tr>
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<td>Check mounting hardware</td>
<td>635.3 O1</td>
</tr>
<tr>
<td>Check height, aiming, and straightness of signal heads</td>
<td>635.3 O1,W1</td>
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<tr>
<td>Check terminations in signal heads</td>
<td>635.3 O1</td>
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<tr>
<td>Check for caps and access covers</td>
<td>635.3 O1</td>
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<tr>
<td>Check for locking pins</td>
<td></td>
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<tr>
<td>Check backplates for screws and washers</td>
<td>635.3 O1</td>
</tr>
<tr>
<td>Check for signal cable strain relief</td>
<td>635.3L2</td>
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<td>Check labeling of cables</td>
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</tr>
<tr>
<td>Check pole base grouting</td>
<td></td>
</tr>
<tr>
<td>Check pedestrian push buttons</td>
<td></td>
</tr>
<tr>
<td>Check pedestrian heads for proper installation and working</td>
<td></td>
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</table>
JUNCTION BOXES

Check for installation at grade level 635.3I
Check for adequate crushed rock in and below JB 635.65
Check grounding 635.3G
Check for bushings on all conduits 635.3H7
Check conduit height 635.65, 635.3H5
Check loop splices 635.3M, 635.77, 635.3V5
Check condition of cables 635.3L,M
Check labeling of cables and loops 635.3F
Check loop lead-ins 635.3V4
Check loop sealant 635.3V2
Check loop test reports 635.3V7
Check excess cable 635.3V7
Check size of boxes against plan

ELECTRICAL SERVICE

Check weatherhead 635.40
Check service cabinet with lock 635.40
Check grounding 635.40

LUMINAIRES

Check photo electric control 635.3R
Check luminaire orientation 635.Q

MISCELLANEOUS

As-built plans are provided by the contractor
Warranty letters are mailed to the contractor
7.5 **Recommended Changes to the Maintenance Agreements (R3)**

Issues 1 to 5 in Section 6.2 describe the shortcomings of Provision 2 of the current maintenance agreement. To achieve the objectives of improving the management of traffic signal maintenance on state highways, five sub-provisions are recommended to be added to Provision 2 of the current maintenance agreement. These additional sub-provisions would enable the SDDOT to verify and track maintenance work, keep better records of maintenance, restrict access to signal cabinets, and help Municipalities’ perform their maintenance responsibilities to avoid sanctions for non-performance.

### 7.5.1 General Maintenance Agreement

The following are the recommended five additional sub-provisions to the general maintenance agreement. Note that “it” here refers to the Municipality (the maintaining agency).

(i) That it will record the maintenance activities in a traffic signal maintenance log that the Municipality may keep inside the signal cabinets or at its office. Maintenance records shall be kept for a minimum of 3 years.

(ii) That it will submit, either electronically or in paper format, an annual maintenance report using the standard form in **Exhibit A** to the South Dakota Department of Transportation Region Traffic Engineer.

(iii) That it will document timing changes as approved by the South Dakota Department of Transportation (SDDOT) on a timing change log kept inside the signal cabinet or by automated means available. SDDOT will also document the timing changes.

(iv) That it will limit access to the signal cabinets following the measures set forth in the “Policy and Procedures for Traffic Signals on State Highways, Section I.7” document.

(v) That if the Municipality cannot, or does not fulfill its maintenance obligations and the annual maintenance inspection report, the South Dakota Department of Transportation reserves the right to perform, or cause to be performed, the necessary maintenance and invoice the Municipality for the costs.

**Exhibit A** is the annual maintenance checklist describe in Table 7-1 and **Exhibit B** is the final acceptance punchlist in Table 7-2. The full revised version of Provision 2 will be:

2. (a) That when the signal and/or roadway lighting system is installed on this street it will provide electric power necessary to operate the signal and/or roadway lighting system and all necessary maintenance and replacements, in kind, of all parts and apparatus of said system, including lamps so as to ensure the continuing operation of said signals and/or roadway lighting systems until such time as the parties to this agreement shall agree to discontinue the operation of the said system.
(b) That if the signal is coordinated through the use of leased telephone lines; it will pay the required hookup fee and monthly rental fees.

(c) It further agrees that on the State Trunk System, prior to changing the signal timing from that originally set by the South Dakota Department of Transportation, the Municipality will submit in writing the necessary data and proposed timing to the South Dakota Department of Transportation Region Traffic Engineer for approval.

(d) That it will record the maintenance activities in a traffic signal maintenance log that the Municipality may keep inside the signal cabinets or at its office. Maintenance records shall be kept for a minimum of 3 years.

(e) That it will submit, either electronically or in paper format, an annual maintenance report using the standard form in Exhibit A to the South Dakota Department of Transportation Region Traffic Engineer.

(f) That it will document timing changes as approved by the South Dakota Department of Transportation (SDDOT) on a timing change log kept inside the signal cabinet or by automated means available. SDDOT will also document the timing changes.

(g) That the Municipality will limit access to the signal cabinets following the measures set forth in the “Policy and Procedures for Traffic Signals on State Highways, Section I.7” document.

(h) That if the Municipality cannot or does not fulfill its maintenance obligations and the annual maintenance inspection report, the South Dakota Department of Transportation reserves the right to perform, or cause to be performed, the necessary maintenance and invoice the Municipality for the costs.

In addition, minor amendments are recommended to paragraph 3 of Provision 2 to include the words “in writing” after “submit” and “Region Traffic Engineer” after “Transportation.” Thus, the revised paragraph 3 should read as follows:

That on the State Trunk System, prior to changing the signal timing from that originally set by the South Dakota Department of Transportation, the Municipality will submit in writing the necessary data and proposed timing to the South Dakota Department of Transportation Region Traffic Engineer for approval.

Minor changes are also recommended to Provision 4 to add the words “and have been notified of the project acceptance punchlist inspection” after the word “Agreement.” Below is the revised version of Provision 4.

4. That said Municipality does acknowledge that the members of its governing board and/or engineering staff have examined the plans for the Project prepared under the supervision of the South Dakota Department of Transportation referred to in this Agreement, and have been notified of the project acceptance punchlist inspection in Exhibit B.

Appendix G shows the revised version of the general maintenance agreement (“Maintenance Agreement between a Municipality and the State for Federal-Aid Highway Improvement Traffic Signals-Revised 2003”).
7.5.2 Maintenance Agreement for the City of Sioux Falls

As discussed in Section 2.4.2, the maintenance agreement for the City of Sioux Falls has additional conditions allowing the City flexibility to adjust signal splits and offsets to accommodate changes in traffic conditions. It also allows the City to make adjustment in traffic signal operation during short term projects, detours, and special events.

The additional conditions for the City of Sioux Falls are only operational parameters. Therefore, the additional five sub-provisions (i to v) to the general maintenance agreement applies to Provision 2 of the City of Sioux Falls agreement. Likewise, minor changes in paragraph 3 under Provision 2 should include the words “in writing” after “advise” as indicated in the paragraph below.

That, the City may adjust signal splits and offsets to accommodate changes in traffic conditions (volumes and speed) to retain efficient traffic flow on the State highway arterial. The City will advise in writing the State (Region Traffic Engineer) of the adjustments in a timely manner.

Minor changes to Paragraph 4 in the general maintenance agreement also apply.

Appendix H shows the revised version of the maintenance agreement with the City of Sioux Falls (“Maintenance Agreement between the City of Sioux Falls and the State for Federal-Aid Highway Improvement Traffic Signals-Revised 2003”).

7.6 Recommended Comprehensive “Policy and Procedures for Traffic Signals on State Highways” (R4)

The current policy and procedures for traffic signals on state highways is included in Appendix B. As described earlier in Chapter 2, the current policy and procedures are not comprehensive. The policy document mainly defines the course of actions in response to requests for the installation of new traffic signals. Moreover, the policy only specifies the responsibility of maintaining agencies with respect to maintenance and operational parameters but does not define how SDDOT manages and verifies the maintenance activities.

The research team has drafted a revised policy and procedures that includes the recommendations outlined in Section 7.2. This comprehensive policy and procedures document is presented in subsequent pages. Note that Exhibit A referred to in Section F, Item 8, is the final acceptance punchlist given as Table 7-2 in Section 7.4. Likewise, Exhibit B referred to in Section I, Item 2, is the annual maintenance checklist described in Table 7-1 under Section 7.3.

SDDOT may consider adding to Section I, Item 8, a requirement for contractors to have IMSA training before being able to install, or wire any signal. Another policy that could be added is a policy for installation and maintenance of signals for commercial developments.
POLICY AND PROCEDURES FOR TRAFFIC SIGNALS ON STATE HIGHWAYS

A. INTRODUCTION

The purpose of this policy and procedures document is to provide guidance for the installation and management of traffic signal maintenance on state highways. It provides the means for establishing a uniform practice for maintaining information on traffic signals, assisting in inspection and maintenance programs, satisfying legal requirements for the maintenance and monitoring of traffic signals and insuring that SDDOT signal maintenance requirements meet the standards set forth in the Manual on Uniform Traffic Control Devices (MUTCD) and the International Municipal Signal Association (IMSA). Through these means a properly maintained traffic signal and data documentation system shall be developed that should aid in reducing the potential for traffic accidents and the risk of tort liability.

B. INSTALLATION OF STATE HIGHWAY SIGNALS

1. It is the policy of the South Dakota Department of Transportation, hereinafter referred to as “Department”, to provide traffic signals, as are warranted and justified. Warrants and justification will be determined by the Traffic Design Engineer and/or Region Traffic Engineer in accordance with the current Manual on Uniform Traffic Control Devices (MUTCD) and the Highway Capacity Manual (HCM). This policy includes traffic signals in reconstruction projects, replacement of existing deficient traffic signals, placement of new traffic signals and removal of existing signals that are determined to no longer be warranted and justified on the state highway system.

2. Traffic signal projects may be identified by the Department or requested by a Local Government Agency, private business or individual. Requests should be made to the Region Engineer.

3. Potential traffic signal projects will be prioritized by Department staff for review and approval by the Transportation Commission. An effort will be made to determine the need and incorporate the traffic signals into the scope of work as a normal component of programmed construction projects.

4. Traffic signal design and installation practices shall be in accordance with the current Department standards governing traffic signals.
C. **OWNERSHIP OF STATE HIGHWAY SIGNALS**

The Department retains the ownership of all traffic signals installed on the State Highway System.

D. **OPERATION AND MAINTENANCE RESPONSIBILITIES**

1. The Department enters into agreements with Local Government Agencies for the operation and maintenance of state highway signals. Local Government Agencies are responsible for the safe and efficient operation and maintenance of traffic signal controls at no cost to the Department. The maintenance agreement stipulates the maintaining agencies’ maintenance responsibilities that include power cost, hookup fee and monthly bills for leased telephone lines, maintenance and replacements in kind of all parts and apparatus of the signal system so as to insure the continuing operation of signals, documentation and record keeping, and annual maintenance reports.

2. The Department determines the operational parameters including, but not limited to, signal timing, signal phasing and other traffic controller functions that the Local Government Agency will implement. No changes to the signal system operational parameters will be allowed without prior Department approval.

3. Maintenance of traffic signals on tribal lands shall be the responsibility of Cities.

4. For the maintenance of traffic signals on county roads, the Department should enter into agreements with the Counties. If an agreement is not possible, then the Department, through its regional office, shall take over the maintenance activities.

5. For towns with a population below 2,500, the Department [under Section A, Item 4 of the South Dakota Department of Transportation Policy Statement S-1970-01 – "Guidelines for Maintenance on Primary and Secondary System (Within Corporate Limits)"] should enter into agreements with the Cities.

6. For towns with a population above 2,500, Section B, Item 4, of the guidelines [Policy Statement S-1970-01 – "Guidelines for Maintenance on Primary and Secondary System (Within Corporate Limits)"] stipulates the responsibility of all traffic signal maintenance to the City.

E. **STANDARDS**

Standards set by the South Dakota Department of Transportation shall be used.
F. **PROCEDURE FOR THE INITIATION OF A TRAFFIC SIGNAL PROJECT**

1. A Local Government Agency or public person may make an initial request to the Department for a traffic signal project by submitting a letter or resolution to the Region Traffic Engineer.

2. The Traffic Design Engineer and/or Region Traffic Engineer will determine if the traffic signal is warranted and justified prior to Department approval and installation of the traffic signal. To be warranted, a documented analysis shall show that a traffic signal warrant in the MUTCD is met. To be justified, an unsignalized analysis, signalized analysis, and arterial analysis based on the Highway Capacity Manual (HCM) shall document the need for the traffic signal.

3. The Divisions of Planning & Engineering and Operations shall determine if the traffic signal project will proceed. The Division of Planning & Engineering will provide construction cost estimates.

4. When the project has been approved as part of the State Transportation Improvement Program (STIP), the Division of Planning & Engineering will prepare the necessary plans, specifications and estimates documents for the project.

5. The necessary agreements with a Local Government Agency for the maintenance of the facility will be drafted by the SDDOT Project Development Office and submitted to the Local Government Agency for review and signing with copies provided to the Region Engineer, Division of Fiscal and Public Assistance and Office of Road Design.

6. The Road Design Office will contact the Local Government Agency to ensure that plans are reviewed and project coordination is made.

7. The Region Engineer or his designee will conduct a pre-construction meeting with the Contractor/s and Local Government Agency. The traffic signal final acceptance punchlist in Exhibit A should be discussed during this pre-construction meeting.

8. After construction is completed, the Region Traffic Engineer or his designee will make a final inspection with the Local Government Agency before acceptance of the project using the final acceptance punchlist in Exhibit A. The completed punchlist should be submitted to the Region Traffic Engineer.

9. Upon project completion and acceptance, the maintenance of the facility becomes the responsibility of the Local Government Agency in accordance with the signed agreement. However, the maintenance of the facility by the Local Government Agency may have elements of the facility that would not take effect until after the warranty period required by the Contract expires.
G. PROCEDURE FOR TRAFFIC SIGNAL REMOVAL

1. Basis for Removal
   a. Consideration for the removal of an existing traffic signal may be given if MUTCD traffic signal warrants are no longer met.
   b. Consideration for the removal of an existing traffic signal may be given if there is a significant change in geometry or traffic flow pattern at the subject location, which will eliminate the existing warrant.
   c. The Region Traffic Engineer shall approve the removal of any traffic signal on state highways.

2. Standard Practices

The Region Traffic Engineer shall be responsible for the following:
   a. Review traffic signal installation warrants including those warrants based on traffic volumes, pedestrian volumes or accidents. If the traffic signal was originally installed in response to an accident warrant, it should not be removed unless an engineering study indicates a reduction in potential vehicular conflicts.
   b. Contact the agency responsible for maintenance and all other local agencies affected by the removal of the traffic signal.
   c. Conduct a sight distance study if the traffic signal is to be permanently replaced by a stop sign control.
   d. Provide an inventory of current site conditions, which may include any of the following:
      i) A summary of accident experience at the intersection
      ii) Travel speed on major roads
      iii) Traffic volumes including a summary of heavy turning movements if appropriate
      iv) Pedestrian counts
   e. Prior to a decision to remove a traffic signal, contact local business leaders, councilpersons, neighborhood associations and/or the police to determine support for or opposition to the removal. Additional public opinion will be gathered during the public notification process.
3. **Public Notification**

   a. News Release. A news release may be distributed to local newspapers, radio, and television stations.

   b. Letter. A letter may be sent directly to the residents and commercial establishments within the immediate vicinity.

   c. Advance notification sign. A variable message sign may be installed on each approach one to two weeks prior to the traffic signal being placed in interim traffic operation. The sign should be removed upon implementation of the interim traffic operation.

4. **Interim Traffic Operation Control**

   a. Install stop signs and go through time periods of flashing operation concurrent with stop signs for ninety days.

   b. Traffic signal equipment should remain in place with the traffic signal heads covered for a period of ninety days. (This does not apply to relocations of the roadway or the removal of temporary traffic signals used for construction or maintenance activities.) Remove advance notifications signs (see above), if any.

   c. Consideration should be given to the temporary installation of an advance “TRAFFIC CONTROL CHANGE AHEAD” sign during the interim control period.

   d. If conditions warrant, a “SIGNAL AHEAD” sign and a “STOP AHEAD” sign should be installed.

5. **Removal of Traffic Signal Hardware**

   Only signal heads should be removed after the interim intersection control period. Accidents and intersection operations should be monitored for up to one year prior to removing the remaining hardware (e.g., poles, mast arms, controller, cabinets, etc.).


   The Department bears the responsibility for the removal of traffic signals on state highways. The Region Traffic Engineer is responsible for organizing the safe and efficient removal of traffic signals.
H. **TRAFFIC SIGNAL TIMING**

Setting traffic signal timings shall be the Department’s responsibility, unless there is an agreement that specifically allows the maintaining agency to perform that function. The Department shall retain the right of review of the traffic signal timing for signals on state highways, or those which the Department maintains, and shall reserve the right to request adjustments when needed.

The Region Traffic Engineer shall be responsible for approving any signal timing changes. The Region Traffic Engineer will notify the local jurisdiction whenever timing changes that affect the operation of local street connections to the state highway are included.

Signal timing changes could be reported electronically, by paper submittal, or via telephone conversation with the Region Traffic Engineer. Documentation should be kept at both ends. The maintaining agency should document timing changes in the timing change log that is kept in the signal cabinet. The maintaining agency could also keep a copy of the timing change log at the maintaining agency’s office.

I. **MAINTENANCE**

1. Definitions

   **Maintenance:** The National Cooperative Highway Research Program (NCHRP) Synthesis 245 defined maintenance as “the act of preserving a particular state.” With respect to traffic control systems, it is the act of keeping the systems operating as they were intended to operate.

   **Emergency (or response) maintenance.** Refers to actions performed on an as-needed basis. It is required when equipment breaks down or malfunctions, i.e., when the situation seriously impedes the flow of traffic or a potential risk to the public exists. Listed below are some examples, which should be classified as emergency situations. These are high priority responses and are responded to as quickly as circumstances allow. The list shown below is not meant to be all-inclusive, and other situations may arise which could be classified as emergency:

   - Traffic signal knockdown (poles, cabinet, etc.)
   - All signal indications are out (excluding power outages).

   **Preventive maintenance.** Refers to actions performed on a regular basis using a set of procedures to preserve the intended working condition of the system. It includes inspection, record keeping, cleaning, and replacement of equipment components based on the function and rated service life of the equipment. It is intended to ensure reliable mechanical and electrical operation of the signals and the signal control equipment, thereby reducing equipment failures, response maintenance, road user
cost, and liability exposure. The emphasis in preventive maintenance is on checking all equipment for proper operation and taking positive steps to repair or replace defective equipment. Some of the major tasks include:

- Signal group relamping
- Cleaning signals lenses
- Aligning signal heads
- Vacuuming cabinets/changing air filters
- Inspecting signal poles and mast arms
- Tuning detector amplifiers
- Inspecting signal controller operations
- Testing conflict monitors

**Modification maintenance.** Refers to actions invoked to correct a recurring problem, to accommodate changes in prevailing traffic or physical conditions, or to update installations to the current state-of-the-practice.

**Non-Emergency.** Is when the situation has little or no effect on traffic and does not appear to pose a serious problem to the public as determined by the maintaining agency’s Traffic Engineer or Manager. These are regular work priority responses and are responded to, as resources are available. Preventive and modification maintenance are of a non-emergency nature. Listed below are some examples, which should be classified as non-emergency situations. The list shown is not meant to be all-inclusive and other situations may arise which may be classified as non-emergency:

- Damaged signal hardware (intersection still functioning)
- A single indicator of a dual indication movement burned out
- Stuck pedestrian push button
- Malfunctioning vehicle detector
2. Types of Maintenance

The maintaining agencies shall perform all three types of traffic signal maintenance: preventive, emergency, and modification.

The maintaining agencies shall set its own priorities and schedules for all types of maintenance activities. However, maintaining agencies shall comply with the preventive maintenance included in the annual maintenance inspection checklist in Exhibit B.

2. Maintenance Checklist

The preventive maintenance checklist in Exhibit B shall be used as a minimum maintenance guide. The maintaining agency shall submit an annual maintenance inspection report for each intersection using the maintenance checklist. The annual report shall be submitted to the Region Traffic Engineer at the end of each calendar year.

3. Performance of Maintenance

All maintenance performed on traffic signal facilities shall meet the current Department’s maintenance standards. Personnel performing the maintenance shall meet the qualifications as described in the Department’s Policy and Procedures for Traffic Signals on State Highways.

If a maintaining agency cannot or does not fulfill its maintenance obligations, including routine replacement of equipment, the Department reserves the right to perform, or cause to be performed, the necessary maintenance and invoice the maintaining agency for the costs.

4. Maintenance Records

To provide the Department with reliable means to retain records of work that occurs on state highway traffic signals, the Department requires that maintaining agencies shall:

a. Keep maintenance and timing change logs. Maintaining agencies may keep maintenance logs in the signal cabinets, but need only submit an annual log using the annual maintenance inspection checklist in Exhibit B. Maintaining agencies should keep detailed records of their maintenance, e.g., monthly maintenance logs, for budget purposes (such as replacing loops, detectors, etc.). Maintaining agencies should keep copies of their detailed maintenance service records for Department review as requested.
b. Submit copies of annual inspections to the Region Traffic Engineer either in electronic or paper format.

c. Keep a log of requests and approvals of changes made to the signal timing plan at each intersection. The original timing plan shall be kept, as well as the approved changes made. The timing change log shall be kept inside the signal cabinet. Maintaining agencies may also keep the timing information at their office. Both the Department and the maintaining agencies shall keep a record of approved changes in the timings.

d. To the extent practicable, copies of manuals and as-built plans should be kept in each controller cabinet and in the operations office. In addition, Agencies should request that manuals be provided on CD-ROMs by the supplier and that as-built plans be prepared in CADD (i.e., Microstation or AutoCADD) files.

5. **Scheduling and Tracking of Maintenance**

The Department, through its regional offices, should keep track of maintenance performed at each signalized intersection on an annual basis. Copies of the annual maintenance checklist shall be submitted to the Region Traffic Engineer annually for each traffic signal and shall be kept on file or electronically in a database by the Region Traffic Engineer.

6. **Periodic Inspection and Reviews**

To ascertain the quality of maintenance work performed by maintaining agencies, the Region Traffic Engineer or qualified Department Staff shall carry out random inspections. The Region Traffic Engineer or his designee shall carry out the periodic inspection and reviews of maintenance reports from maintaining agencies. Inspection of all traffic signals on the state highway system could be made every two years.

7. **Access to Signal Cabinets**

The Department should limit access to the signal cabinets only to qualified personnel from the following agencies: maintaining agency engineer or maintenance staff, State or Region Traffic Engineer, other State traffic or maintenance staff, contractor during the project construction stage and before final acceptance, and police through “police panel” only.

Moreover, should a problem arise regarding access to the signal cabinets, the following measures may be adopted to restrict access as necessary by using access codes in the controllers or by using an additional lock on cabinet doors.
8. Certification and Training

The Department shall require maintenance personnel to be certified by the Department as having received a minimal level of training to carry out the maintenance activities.

The Department shall provide opportunity to maintaining agency staff to acquire a minimal level of signal maintenance skills. The provision of appropriate training opportunities will assist the maintenance staff in practicing proper maintenance procedures.

The Department may pursue the following options:

a Training may be obtained through equipment/supplier-sponsored schools, on-the-job training, seminars, or training video.

b Signal maintenance personnel may meet with Department staff on an annual basis to discuss topics of mutual interest and make, as necessary, suggestions for changes in procedures and methods. Certification, if adopted, could take place at this meeting.

c The Department could sponsor annual workshops that include supplier and vendor training, user group topic discussions, open discussions, and problem solving.

J. Signal Inventory and Maintenance Database

The Department should maintain the signal inventory and maintenance database. The database should be updated for changes to the signal timings as soon as practicable. Likewise, the database should be updated with the annual maintenance report submitted by the maintaining agencies and the annual maintenance inspection report by SDDOT.

The Region Traffic Engineer would be responsible for up-to-date information of traffic signal maintenance for the region.
7.7 **Recommended Maintenance Database (R5)**

The Department should develop a database system that enables effective management of maintenance activities. The format of such a database system should be consistent with the format adopted in the existing traffic signal inventory. The maintenance and management database should, at the minimum, contain the following information:

- Record of timing changes
- Programming of signal timing and phasing
- Record of maintaining agencies’ annual maintenance checklist completion
- Record of SDDOT maintenance inspection

7.8 **Other Recommendations**

**7.8.1 Update of the Existing Standard Specifications for Traffic Signals (R6)**

SDDOT should update its standard specifications to incorporate the suggested updates by the Mitchell Region Traffic Engineer, Scott Jansen. These changes are listed in Appendix I. Likewise, additional standard details should be developed. In addition, items in the punchlist that are not currently referenced should be included in Section 635 of the standard specifications.

**7.8.2 Develop a Traffic Signal Design Manual (R7)**

It is recommended that SDDOT should consider developing a traffic signal design manual. The current section of the SDDOT Road Design Manual, Chapter 15 – Traffic, only partly covers specifications for signal design and installation. Other specifications for traffic signal installation are covered under the current *SDDOT Standard Specifications for Roads and Bridges: Division II-Construction Materials and SDDOT Road Design Standard Plates – Section 635 Traffic Signals and Roadway Lighting*. A single Traffic Signal Design Manual that contains standard specifications for design, installation, and inspection would be highly beneficial. An outline of such an SDDOT Traffic Signal Design Manual could include:

1. Warrants
2. Timing and Phasing (left turns, clearance, pedestrians, vehicle, emergency and railroad pre-emption)
3. Detection
4. Signal Head Placement
5. Conduit
6. Wiring
7. Lighting

The Manual should have tables, legends, and exhibits for design plan calculations and preparation.
8.0 SYSTEM REQUIREMENTS FOR A TRAFFIC SIGNAL MANAGEMENT AND MAINTENANCE SYSTEM

Task 8. Based on feedback and concurrence of the SDDOT Executive Team on the new policies, agreements, and procedural definitions, develop a system requirements document for a traffic signal management and maintenance system for review and approval by the project's technical panel. The documentation shall include database requirements for maintaining an inventory of signal systems equipment, programming of signal timing/phasing, capital improvements, inspection frequency/history, control box access security, and maintenance costs.

8.1 Introduction

This chapter addresses the above Task 8. It describes the system requirements for a Traffic Signal Management and Maintenance System (TSMMS) based on the recommendations discussed in Chapter 7. Three basic categories defined the TSMMS: (1) Maintenance agreements, (2) A comprehensive statewide policy and procedures, and (3) A statewide traffic signal inventory and maintenance database. Subsequent sections describe the capital improvements needed for implementation of the TSMMS, inspection frequency and history, control box access security, and maintenance costs. Estimate of system costs and levels of development effort are discussed in Chapter 9.

8.2 Requirements for the Traffic Signal Inventory and Maintenance Database

The successful implementation of the SDDOT TSMMS requires development and implementation of a database that includes the following three major components:

1. Inventory of signal systems equipment
2. Programming of signal timing and phasing
3. Inventory of maintenance activities

8.2.1 Inventory of Signal Systems Equipment

SDDOT has already developed a traffic signal inventory system as detailed in Section 2.5.5. The current inventory system is a relational database in MS Access™. The main items contained in the database are similar to that of other DOTs with basic inventory systems as Table 4-2 indicates.
Recommended additional features to the existing signal systems equipment inventory are (1) as-built plans or an index to as-built plans and (2) the traffic signal acceptance punch list.

### 8.2.2 Programming of Signal Timing and Phasing

As described earlier in Chapters 2 and 7, SDDOT is responsible for designing the timing plans for newly installed traffic signals while maintaining agencies are responsible for programming any changes to the original timing plans after SDDOT approval and concurrence of such changes. Since SDDOT is not involved in the operations of the traffic signals, a practical means of tracking changes to the signal timings is to keep a historical record of such changes in the database in a timely manner. The current traffic signal inventory already has the capacity to record timing and phasing information.

### 8.2.3 Inventory of Maintenance Activities

Mn/DOT and ODOT have detailed maintenance activities in their inventory system because these DOTs are largely doing the maintenance work. WisDOT plans to have maintenance in its future inventory system. With the exception of MoDOT, DOTs that are not involved in the maintenance, such as ITD and NDOR, do not have maintenance records in the inventory.

Since SDDOT does not perform the maintenance (except in special circumstances), SDDOT does not need to keep track of every maintenance activity (e.g., each relamping or the number of calls for emergency repair) done on the signals. Rather, only receipt of the annual maintenance report from the maintaining agencies and the SDDOT maintenance inspection report need to be stored and noted in the database. These annual maintenance reports are the information that needs to be added to the existing traffic signal inventory system.

### 8.2.4 Recommended System Structure

The recommended contents of the inventory and maintenance database should include the following tables:

**Signal Systems Equipment Inventory**

- Location
- Controller
- Pole information
- Keywords/Picture
- As-built plans or an index to as-built plans
- Traffic signal final acceptance punch list
Signal Timing and Phasing

- Timing Information
- Phasing

Maintenance Activities

- Annual maintenance inspection report from maintaining agencies
- Annual maintenance inspection report by SDDOT

8.2.5 Recommended Hardware and Software Requirements

Minimum Hardware Requirements

- PC with a Pentium 500 MHz processor
- Windows 98, Me, NT 4, 2000 or XP operating system
- 256 MB RAM
- Video 16 MB
- CD-ROM drive (CD burner for technical support)
- Super VGA or highest resolution monitor
- Optional hardware may include a color scanner, digital camera, and a color printer

Computer configurations indicated by respondent DOTs are very similar. The minimum hardware requirements may vary on factors such as the database type (Access, SQL Server, or Oracle); and whether the computer is being used as the database server, administrative workstation, or client-workstation.

For an MS Access™ relational database, the above minimum hardware configuration is more than sufficient. BIT standards should be referred to for the appropriate hardware configuration.

Software Requirements

DOTs with basic inventory systems use either MS Excel™ or MS Access™ software. The database in MS Excel™ is a flatfile database whereas the ones in MS Access™ are relational databases. Complex inventory and management systems, such as that of Mn/DOT, MoDOT, and ODOT, use custom-built systems.

Relational Database in MS Access™

The current SDDOT traffic signal inventory database is in MS Access™. It would therefore be practical to build on the existing database; it will only require adding tables or fields. A “maintenance records” table and fields can be easily added.
Commercially Available Software

SDDOT could also look at a commercially available traffic signal inventory system that has all the required functionalities. VIMMS’s “Signal Manager” and CarteGraph’s “SIGNALview®” are two examples of commercially available software. One major advantage of either of these is the ability to interface with other asset management modules, such as sign and pavement markings, the pavement management system, etc. SIGNALview® has a direct interface with ESRI GIS. Sample screen shots of both types of software are included in Appendix J. WisDOT intends to purchase SIGNALview®.

Cost, functionality, and integration needs of the planned statewide GIS application at SDDOT might be a consideration in the selection of either of these software packages. VIMMS’s “Signal Manager” costs about $2,500 for a single license plus optional annual technical maintenance support of $500. The cost for a SIGNALview® single seat license is $4000 (for a standard edition with MS Access™) plus $800 for annual technical maintenance support. Considering the cost of software development, these two examples of commercially available products appear to be inexpensive.

8.2.6 Database Location

The inventory and maintenance database should be centrally located, ideally at SDDOT Road Design in Pierre. If this arrangement is not possible due to constraints by the Bureau of Information and Telecommunications (BIT) having control over the servers, then the database will be located on BIT servers.

8.2.7 Database Access

The database should be accessible to regional offices either through the Department’s internal server or via the internet. Each Region Traffic Engineer and his designated staff should be given access. If the database is accessible via the internet, access to authorized maintaining agency personnel could also be permitted as ‘read only’.

8.2.8 Database Maintenance

Database maintenance involves data and system maintenance. Ideally, regional offices should be responsible for maintaining data (i.e., data entry of updated maintenance reports and timing changes). Alternatively, Road Design could take control of the data maintenance. BIT should be responsible for system maintenance.
8.3 Inspection Frequency and History

The comprehensive policy and procedures detailed in Chapter 7 (Section 7.6) includes performance of signal maintenance by maintaining agencies and the annual maintenance inspection to be carried out by SDDOT personnel. Section I.2 specifies the three types of maintenance that maintaining agencies perform. Section I.3 prescribes the use of a maintenance checklist that maintaining agencies need to submit to the Region Traffic Engineer at the end of each calendar year. Section I.4 defines documentation and record keeping pertaining to signal maintenance and timing change logs. Section I.5 defines the role of regional offices in tracking maintenance activities. Section I.6 defines the periodic inspection and reviews that SDDOT personnel, mainly at the regional offices, have to perform on an annual basis. Finally, Section J describes the inventory and maintenance database that will store the annual maintenance reports and history of maintenance.

8.4 Control Box Access Security

Section I.7 of the recommended comprehensive traffic policy and procedures defines who should be allowed access to the signal cabinets. Police access should be limited through a “police panel” only. Further, the policy outlines the measures that maintaining agencies employ should problems arise. These measures include the use of access codes in the controllers or the use of additional locks on cabinet doors.

The revised maintenance agreements include security provisions for access to the signal control box.

8.5 Maintenance Costs

Implementation of the Traffic Signal Management and Maintenance System requires additional staff time to carry out the annual inspections and reviews. Staff time is also required for administration and maintenance of the signal inventory and maintenance database. Chapter 9 provides cost estimates of such maintenance.

8.6 Capital Improvements

Needed capital improvements for implementing the Traffic Signal Management and Maintenance System would include the following:

- Update of MS Access™ version to the most current available version
- Additional purchase of software if SDDOT decides to switch to another software (e.g., GIS-based software or a commercially available one such as the SIGNALView from Cartegraph).
- Training materials that could include development of maintenance training videos or purchase of manuals.
- An option to hire a full time position to carry out the periodic inspection and reviews, and to provide training.

Estimate of costs are discussed in the next chapter.
9.0 OPINION OF COSTS

Task 9. Upon review and approval of the system requirements document by the technical panel, develop estimates for system costs, levels of development effort, system integration needs, and any impacts to Departmental operations.

9.1 Introduction

The estimate for system costs is based on capital improvements and levels of development effort needed to implement and maintain the Traffic Signal Management and Maintenance System (TSMMS). As detailed in Chapter 8, three basic categories defined the TSMMS: (1) Maintenance agreements, (2) A comprehensive statewide policy and procedures, and (3) A statewide traffic signal inventory and maintenance database.

9.2 Levels of Development Effort

This section describes administration, supervision, maintenance, training, and capital improvements required to implement the TSMMS.

9.2.1 Traffic Signal Inventory and Maintenance Database

This requires capital improvements costs, staff time for data entry and updates, and required training. Required staff time and training depends on how the database should be managed. As pointed out in Section 8.2.8, there are two possible scenarios: (1) regional offices take responsibility for data entry and updates of maintenance reports, or (2) Road Design takes responsibility for both equipment inventory and updates of maintenance reports. Under scenario 2, a new full-time position under Road Design could be considered. Part of the duties of this new position will be to manage and update information in the database, which is estimated to take about 30% of the full-time. The remaining 70% will be for periodic inspections and training. Cost estimates for scenario 2 are presented in Section 9.3.

9.2.2 Acceptance of Annual Maintenance Checklist

SDDOT needs to obtain cooperation of, and acceptance by, maintaining agencies for the items included in the maintenance checklist. Having most, if not all, the maintaining agencies agree with the items in the annual maintenance checklist could require increased effort from SDDOT.
9.2.3 Acceptance of Final Acceptance Punchlist

It may require less effort to obtain cooperation and acceptance from maintaining agencies for the items included in the punchlist since this does not involve cost to maintaining agencies.

9.2.4 Acceptance of the Revised Maintenance Agreements

SDDOT needs to obtain cooperation and acceptance from maintaining agencies for the additional conditions stipulated in the maintenance agreement. The annual reporting of maintenance based on the checklist and measures to limit access to signal cabinets would have direct cost implications.

9.2.5 Maintenance Management

This involves administration of, and coordination with maintaining agencies, largely by the Region Traffic Engineer. The Region Traffic Engineer will be responsible for annual reviews of maintaining agencies’ compliance with the new maintenance and management guidelines.

9.2.6 Periodic Inspection and Reviews

Periodic inspections should be performed for all of the 266 signals statewide during a span of two years. This periodic inspection is estimated to require about 60% of a full time staff member’s time. In addition, there will be additional time required for supervision and scheduling.

9.2.7 Certification and Training

This certification and training policy would require SDDOT to have certified traffic signal inspectors and maintenance personnel. Preferably, IMSA certified Levels I and II. It would be ideal to have certified personnel at regional offices. The cost involved for participating in IMSA certification and training courses ranges from $300 to $400. IMSA certification and training sessions usually run for two and a half days. Thus, additional costs to the training registration would include travel and accommodations plus salary costs for days in training.

In addition to the cost involved for SDDOT personnel to obtain certification and training, there will be costs involved to provide training and certification to maintenance personnel from local government agencies. The aim of such training is to assist maintaining agencies to acquire the level of maintenance competency necessary to fulfill the maintenance agreement requirements.

The cost involved for training would largely depend on the type of training or options as described in Chapter 7, Section I.8.
9.2.8 Implementation

In addition to the levels of development effort described in Sections 9.2.1 to 9.2.7, implementation would involve administration time. In addition, SDDOT needs to develop the suggested uniform inspection forms, maintenance logs, and timing change logs. SDDOT needs to identify the staff member who will be responsible for implementing the TSMMS, and overseeing its successful on-going operation.

9.2.9 Staffing Option

One option SDDOT may consider is to hire a full time position who would be responsible for providing training and would coordinate with suppliers to provide training. This position would coordinate training during the winter season and perform the annual maintenance inspection outside of training. In addition, part of the duty of this full time position would be to update the database information. Ideally, this position should be located at the Central Office, perhaps as part of Road Design. Breakdown of duties of this full time position include 60% inspection, 30% database maintenance, and 10% training.

9.3 Opinion of Costs

Table 9-1 presents opinions of cost to SDDOT to implement the traffic signal management and maintenance system. Levels of effort required to obtain cooperation and acceptance from maintaining agencies of the changes in maintenance policy are included as part of the implementation costs. Estimated time (in days) is also included in Table 9-1. The estimates of time and of costs are in order of magnitude only. Order of magnitude of costs to maintaining agencies is not determined as this is out of the scope of the study.

Hardware Cost

It is important to note that maintenance would simply be an additional component to the existing traffic signal inventory database. Thus, it may not be necessary to purchase new hardware.

Software Cost

For software cost, two options are being considered. Option 1 assumes that SDDOT will continue to use MS Access™ for the traffic signal inventory and maintenance database. Option 2 assumes SDDOT will consider commercially available software. Under Option 1, development of the maintenance component of the database would not incur additional software cost since the BIT maintains a site licensing arrangement with Microsoft for all Microsoft software products. For Option 2, the cost estimate of new software is given in Table 9-1.
Table 9-1  Opinions of Costs

<table>
<thead>
<tr>
<th>Activity</th>
<th>Work Effort (Days)</th>
<th>Opinions of Cost</th>
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</thead>
<tbody>
<tr>
<td><strong>Cost Estimate During First Year of Implementation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Inventory and Maintenance Database</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Software</td>
<td>5</td>
<td>$0a</td>
</tr>
<tr>
<td>Database Development &amp; Maintenance</td>
<td>15c</td>
<td>$7,050</td>
</tr>
<tr>
<td>Training</td>
<td>3</td>
<td>$1,410</td>
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<tr>
<td>Data Update</td>
<td>20</td>
<td>$9,400</td>
</tr>
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<td>2. Maintenance Management</td>
<td>40</td>
<td>$18,800</td>
</tr>
<tr>
<td>3. Periodic Inspection and Reviews</td>
<td>130</td>
<td>$82,600d</td>
</tr>
<tr>
<td>4. Certification and Training</td>
<td>37</td>
<td>$23,290d</td>
</tr>
<tr>
<td>5. Implementation</td>
<td>60</td>
<td>$28,200</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td>$170,750</td>
<td>$180,750</td>
</tr>
</tbody>
</table>

| **Cost Estimate After Subsequent Years** |                    |                   |
| 1. Inventory and Maintenance Database   |                    |                   |
| Database Maintenance                    | 5                  | $2,350            |
| Data Update                             | 20                 | $9,400            |
| 2. Maintenance Management               | 40                 | $18,800           |
| 3. Periodic Inspection and Reviews      | 130                | $82,600d          |
| 4. Certification and Training           | 22                 | $10,340f          |
| **TOTALS**                             | $123,490           |                   |

*a Assuming MS Access database. There is no separate cost as this program is part of MS Office Suite.
*b Assuming a SIGNALview standard license. Price includes 3 days of onsite hands-on training, installation and implementation.
*c SDDOT/BIT time
*d Cost includes lodging, per diem, and vehicle mileage.
*e Assumes 5 SDDOT staff attending IMSA certification. Estimate includes airfare and accommodations plus registration costs.
*f Cost also includes a two-day annual training and workshop that SDDOT will conduct to train maintaining agencies’ personnel.
*ff Cost includes only the two-day annual training and workshop that SDDOT will conduct.

9.4  System Benefits

Implementation of an improved management and maintenance system for state route signals will undoubtedly create some benefits, both tangible and intangible. For South Dakota, the benefits of improved management and maintenance are largely intangible benefits (i.e., the potential reduction from liability risk). A good analogy of such intangible benefits is the case with life insurance where benefits are realized only when needed. Another intangible benefit could be an improvement in public perception by the way SDDOT and Cities better protect public interest.

On the other hand, the tangible benefits could come from the savings in travel delays at intersections. Much of the delays experienced by motorists occur at signalized intersections as they wait for the light to turn green. Delays can be reduced, however, by optimizing the timing...
of the signals. According to a FHWA study, “traffic signal improvements rank as one of the most cost-effective energy conservation strategies in urban areas” (ITE, 1995). The FHWA estimates that the benefit-to-cost ratio of traffic signal timing optimization projects approaches 40 to 1. Furthermore, basic traffic signal improvements can result in a 12 percent improvement in vehicle speed or travel time. Likewise, retimed traffic signals, with no changes in hardware, can generally save 12 percent in travel time.

Benefits through reduction in travel delays from signal retiming may not be as high as the FHWA study noted considering the present low levels of congestion experienced on South Dakota state routes. However, future levels of congestion may increase as the state continues to grow.

9.5 System Integration Needs

Operation of the traffic signal inventory and maintenance database requires cooperation with the Bureau of Information and Telecommunications. BIT has control over systems that use the BIT servers.

Future integration of the signal inventory and maintenance database with a statewide GIS system should be one consideration in the database design. One of the applications considered in the SDDOT GIS Plan is the signal management system. The signal inventory and maintenance database should be compatible with a GIS-based application.

Similarly, the signal inventory and maintenance database could be integrated with the planned ITS elements (i.e., the SDDOT statewide signal maintenance archive and users) of the South Dakota Rural ITS Architecture study.

9.6 Potential Impacts to Departmental Operations

As defined in the comprehensive policy and procedures, regional offices are largely responsible for the management of signal maintenance. The Region Traffic Engineer is the main point of contact for maintaining agencies. The level of impact on regional operations would be proportional to the size of the region, as well as current staffing. Mitchell Region can be expected to experience greater impact since it has the highest number of state route signals (115 signals). In contrast, Pierre Region would be the least impacted as it only has 19 signals.
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10.0 CONCLUSIONS

10.1 Conclusions

The review of current maintenance and management practices at SDDOT indicate the need to update the current maintenance agreements, define new policies and procedural guidelines, and develop a maintenance and management database that is accessible by all regions of the state.

The survey of eleven, mainly Midwestern, state departments of transportation indicates that SDDOT’s maintenance and management practices for state route signals in South Dakota, in many aspects, fall in line with mainstream practices. Likewise, the results of the computing system needs survey provided insight as to what other DOTs are doing and how they are approaching the maintenance and management of signals in their jurisdictions. DOTs that are largely performing their maintenance have more comprehensive computerized inventory systems. In contrast, DOTs that are not involved in the maintenance have very basic inventory systems, and usually do not include records of maintenance activities.

Lessons gleaned from the review of current SDDOT practices and from these surveys were useful information during the workshop discussions. Workshop participants generally agreed to the need to address current shortcomings in the way maintenance of state highway signals are managed. Participants felt that, while practices at SDDOT fall in line with mainstream practices, there are benefits to improving the current practices.

The research team has identified fourteen issues and has recommended seven specific actions. Six of the seven specific actions define the Traffic Signal Management and Maintenance System categories that include: (1) Maintenance agreements, (2) A comprehensive statewide policy and procedures, and (3) A statewide traffic signal inventory and maintenance database. Five additional sub-provisions to the maintenance agreements are proposed. Comprehensive policy and procedures are drafted, and system requirements for a traffic signal inventory and maintenance database are outlined. Moreover, a maintenance checklist and a final acceptance punchlist are compiled. In addition, certification and training requirements are outlined.

The research team described the system requirements for the TSMMS, together with the levels of development effort and the estimate of system costs. An order of magnitude estimate indicates that implementation of the TSMMS would cost the Department between $171,000 to $181,000 during the first year of implementation and about $124,000 after subsequent years. Implementation of the TSMMS would also cost maintaining agencies; however, determination of such costs is out of the scope of this study. The study also outlines both the tangible and intangible benefits from implementation of such an improved management and maintenance.
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Bibliography


SDDOT Road Design Manual, Chapter 15-Traffic

SDDOT Road Design Standard Plates – Section 635 Traffic Signals and Roadway Lighting.


Appendices

Appendix A  Acronyms
Appendix B  SDDOT Policies and Procedures Documents
Appendix C  Maintenance Agreements
Appendix D  Maintenance Checklist and Final Acceptance Inspection Punchlist Used in Mitchell Region
Appendix E  Survey Questionnaires
Appendix F  Traffic Signal Final Acceptance Punchlist
Appendix G  Revised General Maintenance Agreement
Appendix H  Revised Maintenance Agreement with the City of Sioux Falls
Appendix I  List of Suggested Specification Updates
Appendix J  Sample of Commercially Available Signal Inventory Software
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## Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>ATMS</td>
<td>Advanced Traffic Management Systems</td>
</tr>
<tr>
<td>BIT</td>
<td>Bureau of Information and Telecommunications</td>
</tr>
<tr>
<td>BWR</td>
<td>Bucher, Willis &amp; Ratliff Corporation</td>
</tr>
<tr>
<td>GIS</td>
<td>Geographic Information Systems</td>
</tr>
<tr>
<td>HCM</td>
<td>Highway Capacity Manual</td>
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<tr>
<td>IMSA</td>
<td>International Municipal Signal Association</td>
</tr>
<tr>
<td>ITE</td>
<td>Institute of Transportation Engineers</td>
</tr>
<tr>
<td>ITS</td>
<td>Intelligent Transportation Systems</td>
</tr>
<tr>
<td>LGA</td>
<td>Local Government Agency</td>
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<tr>
<td>LOS</td>
<td>Level of Service</td>
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<tr>
<td>MPO</td>
<td>Metropolitan Planning Organization</td>
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<tr>
<td>MUTCD</td>
<td>Manual on Uniform Traffic Control Devices</td>
</tr>
<tr>
<td>NCHRP</td>
<td>National Cooperative Highway Research Program</td>
</tr>
<tr>
<td>SDDOT</td>
<td>South Dakota Department of Transportation</td>
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<tr>
<td>SHS</td>
<td>State Highway System</td>
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<tr>
<td>TCC</td>
<td>Traffic Control Center</td>
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<tr>
<td>TMC</td>
<td>Traffic Management Center</td>
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<tr>
<td>TOC</td>
<td>Traffic Operations Center</td>
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<tr>
<td>TRB</td>
<td>Transportation Research Board</td>
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</table>
Appendix B

SDDOT Policy and Procedure for Traffic Signals on State Highways
1. It is the policy of the South Dakota Department of Transportation, hereinafter referred to as “Department”, to provide traffic signals, as are warranted and justified. Warrants and justification will be determined by the Traffic Design Engineer and/or Region Traffic Engineer in accordance with the current Federal Manual on Uniform Traffic Control Devices (MUTCD) and the Highway Capacity Manual (HCM). This policy includes traffic signals for reconstructed projects, replacement of existing deficient traffic signals, placement of new traffic signals and removal of existing signals that are determined to no longer be warranted and justified on the state highway system.

2. Traffic Signal projects may be identified by the Department or requested by a Local Government Agency, private business or individual. Requests should be made to the Region Engineer.

3. Potential traffic signal projects will be prioritized by Department staff for review and approval by the Transportation Commission. An effort will be made to determine the need and incorporate the traffic signals into the scope of work as a normal component of programmed construction projects.
4. Maintenance of the traffic signal system will be the responsibility of the Local Government Agency through formal agreement. Maintenance parameters include providing electric power, maintenance and replacements in kind of all parts and apparatus of the signal system so as to insure the continuing operation of signals. If telephone lines are required the Local Government Agency will pay the hookup fee and monthly billings. Operational parameters including but not limited to, signal timing, signal phasing and other traffic controller functions will be determined by the Department and implemented by the Local Government Agency. No changes to the signal system operational parameters will be allowed without prior Department approval.

5. Traffic signal design and installation practices shall be in accordance with the current Department standards governing traffic signals.

### PROCEDURE FOR THE INITIATION OF A TRAFFIC SIGNAL PROJECT

1. A Local Government Agency or public person may make an initial request to the Department for a traffic signal project by submitting a letter or resolution to the Region Engineer.

2. The Traffic Design Engineer and/or Region Traffic Engineer will determine if the traffic signal is warranted and justified prior to Department approval and installation of the traffic signal. To be warranted, a documented analysis shall show that a traffic signal warrant in the MUTCD is met. To be justified, an unsignalized analysis, signalized analysis and arterial analysis based on the HCM shall document the need for the traffic signal.

3. The Divisions of Planning/Engineering and Operations shall determine if the traffic signal project will proceed. The Division of Planning/Engineering will provide construction cost estimates.

4. When the project has been approved as part of the STIP, the Division of Planning/Engineering will prepare the necessary plans, specifications and estimate documents for the project.

5. The necessary agreements with a Local Government Agency for the maintenance of the facility will be drafted by the Project Development Office and submitted to the Local Government Agency for review and signing with copies to the Region Engineer, Fiscal and Public Assistance and Road Design.

6. The Road Design Office will contact the Local Government Agency to ensure that plans are reviewed and project coordination is made.
7. After construction is completed, the Region Traffic Engineer or his designee will make a final inspection with the Local Government Agency before acceptance of the project.

8. Upon project completion and acceptance, the maintenance of the facility becomes the responsibility of the Local Government Agency in accordance with the signed agreement. However, the maintenance of the facility by the Local Government Agency may have elements of the facility that would not take effect until after the warranty period required by the Contract expires.

| PROCEDURE FOR REMOVAL OF AN EXISTING TRAFFIC SIGNAL |

1. An engineering traffic study should be done if it is felt that due to change in traffic patterns that consideration should be given to removing a traffic signal and replacing it with an appropriate alternative traffic control device.

2. The Traffic Design Engineer and/or Region Traffic Engineer will determine that the traffic signal is no longer warranted and justified prior to Department approval for removal of the traffic signal. Documentation shall be provided showing that there are no signal warrants met from the MUTCD and that the unsignalized analysis, signalized analysis and arterial analysis based on the HCM show the signal is no longer justified.

3. When an existing traffic signal is approved for removal procedures outlined in the MUTCD Part 4 will be followed.

<table>
<thead>
<tr>
<th>Recommended:</th>
<th>Approved:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joel Gengler</td>
<td>Leon Schochenmaier,</td>
</tr>
<tr>
<td>Program Manager</td>
<td>Director of Planning/Engineering</td>
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</tbody>
</table>

Michael J. Durick  
Director of Operations
Appendix C

Maintenance Agreements
MAINTENANCE
AGREEMENT BETWEEN A MUNICIPALITY AND THE STATE
FOR
FEDERAL-AID HIGHWAY IMPROVEMENT
TRAFFIC SIGNALS

WHEREAS, the DEPARTMENT OF TRANSPORTATION acting through the South Dakota Transportation Commission, hereinafter designated as the Commission, concurs in the proposal with the Municipality for the new construction or improvement of a street identified as South Dakota Construction Project No._____________________, ________ County, hereinafter designated as the Project, extending through the City of________, South Dakota, hereinafter referred to as the Municipality, located and further described as follows:

____________________________________________________________
__________________________________________________________.

WHEREAS, the Statutes of the State of South Dakota give assent to the provisions of the Transportation Equity Act for the 21st Century and acts amendatory thereof or supplementary thereto and regulations issued pursuant thereto by the Federal Highway Administration, Department of Transportation, United States of America, which hereinafter collectively will be designated as the Act, and charge of the Commission and the Municipality to do all things necessary fully to carry out the cooperation contemplated and provided for in the Act; and

WHEREAS, the section of the Project within the Municipality will be subject to the provisions of the Act, and is within the legal jurisdiction of the Municipality for traffic regulations and the control of building setbacks, zoning, sidewalks, utilities, etc., and

WHEREAS, the construction of the project is conditioned upon the fulfillment of the obligation of the Municipality in a manner satisfactory to the Commission and the Federal Highway Administrator, or their authorized representatives:

NOW THEREFORE, be it agreed for and in consideration of the undertaking of the Project under the requirements of the Act with the Commission's approval that insofar as its legal jurisdiction over the Project is concerned the Municipality assents to the requirements of the Act and pledges its good faith to the carrying out the purposes stipulated in the Act and to this end, the Municipality hereby agrees:

1. That it will prohibit all parking in the traffic lanes constructed under this project. It further agrees that it
will prohibit double parking and control all parking where and if allowed in a manner satisfactory to the Commission or their authorized representatives.

2. That when the signal and/or roadway lighting system is installed on this street it will provide electric power necessary to operate the signal and/or roadway lighting system and all necessary maintenance and replacements, in kind, of all parts and apparatus of said system, including lamps so as to insure the continuing operation of said signals and/or roadway lighting systems until such time as the parties to this agreement shall agree to discontinue the operation of the said system. That if the signal is coordinated through the use of leased telephone lines, it will pay the required hookup fee and monthly rental fees.

It further agrees that on the State Trunk System, prior to changing the signal timing from that originally set by the South Dakota Department of Transportation, the Municipality will submit the necessary data and proposed timing to the South Dakota Department of Transportation for approval.

3. That, if the Municipality applies plastic pavement marking on this street (i.e. Cross Walk), it will use plastic material approved by the South Dakota Department of Transportation, and will maintain those plastic pavement markings which are the responsibility of the Municipality.

4. That said Municipality does acknowledge that the members of its governing board and/or engineering staff have examined the plans for the Project prepared under the supervision of the South Dakota Department of Transportation referred to in this Agreement.

5. That the Municipality will enact such ordinances as are necessary to properly enforce any of the above provisions.

6. That the Mayor is authorized to enter into a mutual agreement with the Commission providing for the understanding of this project under the considerations described above.
DATED this _______ day of ________________, 2003.

CITY OF

ATTEST:

_____________________________________________________
Mayor

_____________________________________________________
City Auditor/Finance Officer
(S E A L)

SOUTH DAKOTA
DEPARTMENT OF TRANSPORTATION

APPROVED AS TO FORM:

_____________________________________________________
Project Development Engineer

_____________________________________________________
Assistant Attorney General
AGREEMENT BETWEEN THE POLITICAL SUBDIVISION AND THE STATE
FOR
FEDERAL AID HIGHWAY ENCROACHMENTS

EXHIBIT "A"

The following encroachments are permitted to remain by action of the South Dakota Department of Transportation Commission for the period specified:

None
MAINTENANCE
AGREEMENT BETWEEN THE CITY OF SIOUX FALLS
AND THE STATE
FOR
FEDERAL-AID HIGHWAY IMPROVEMENT
TRAFFIC SIGNALS

WHEREAS, the DEPARTMENT OF TRANSPORTATION acting through the South Dakota Transportation Commission, hereinafter designated as the Commission, concurs in the proposal with the City for the new construction or improvement of a street identified as South Dakota, Federal Aid Construction Project No. ______, ______ County, hereinafter designated as the Project, extending through the City of Sioux Falls, South Dakota, hereinafter referred to as the City, located and further described as follows:

WHEREAS, the Statutes of the State of South Dakota give assent to the provisions of the Transportation Equity Act for the 21st Century and acts amendatory thereof or supplementary thereto and regulations issued pursuant thereto by the Federal Highway Administration, Department of Transportation, United States of America, which hereinafter collectively will be designated as the Act, and charge of the Commission and the City to do all things necessary fully to carry out the cooperation contemplated and provided for in the Act; and

WHEREAS, the section of the Project within the City will be subject to the provisions of the Act, and is within the legal jurisdiction of the City for traffic regulations and the control of building setbacks, zoning, sidewalks, utilities, etc., and

WHEREAS, the construction of the project is conditioned upon the fulfillment of the obligation of the City in a manner satisfactory to the Commission and the Federal Highway Administrator, or their authorized representatives:

NOW THEREFORE, be it agreed for and in consideration of the undertaking of the Project under the requirements of the Act with the Commission’s approval that insofar as its legal jurisdiction over the Project is concerned the City assents to the requirements of the Act and pledges its good faith to the carrying out the purposes stipulated in the Act and to this end, the City hereby agrees:

1. That it will prohibit all parking in the traffic lanes constructed under this project. It further agrees that it
will prohibit double parking and control all parking where and if allowed in a manner satisfactory to the Commission or their authorized representatives.

2. That when the signal and/or roadway lighting system is installed on this street it will provide electric power necessary to operate the signal and/or roadway lighting system and all necessary maintenance and replacements, in kind, of all parts and apparatus of said system, including lamps so as to insure the continuing operation of said signals and/or roadway lighting systems until such time as the parties to this agreement shall agree to discontinue the operation of the said system.

That if the signal is coordinated through the use of leased telephone lines, it will pay the required hookup fee and monthly rental fees.

That, the City may adjust signal splits and offsets to accommodate changes in traffic conditions (volumes and speed) to retain efficient traffic flow on the State highway arterial. The City will advise the State (Region Traffic Engineer) of the adjustments in a timely manner.

In the event that the adjustments are required to signal phasing, cycle length or type of control the City will obtain DOT review, concurrence and approval prior to the adjustments being made.

During short term projects, detours, special events, etc., the City may adjust traffic signal operation on State highways to efficiently accommodate traffic for the duration of the project, detour or event. After completion of the special events, project and detours, etc., the City will return the signal operation back to the same operation before the start of the special event etc.

3. That, if the City applies plastic pavement marking on this street (i.e. Cross Walk), it will use plastic material approved by the South Dakota Department of Transportation, and will maintain those plastic pavement markings which are the responsibility of the City.

4. That said City does acknowledge that the members of its governing board and/or engineering staff have examined the plans for the Project prepared under the supervision of the South Dakota Department of Transportation referred to in this Agreement.

5. That the City will enact such ordinances as are necessary to properly enforce any of the above provisions.
6. That the Mayor is authorized to enter into a mutual agreement with the Commission providing for the understanding of this project under the considerations described above.

DATED this _________ day of _________________, 2003.

CITY OF SIOUX FALLS

ATTEST:

___________________________________________
Mayor

___________________________________________
City Auditor/Finance Officer
(S E A L)

SOUTH DAKOTA
DEPARTMENT OF TRANSPORTATION

APPROVED AS TO FORM:

___________________________________________
Project Development Engineer

___________________________________________
Assistant Attorney General
AGREEMENT BETWEEN THE POLITICAL SUBDIVISION AND THE STATE 
FOR 
FEDERAL AID HIGHWAY ENCROACHMENTS 

EXHIBIT "A"

The following encroachments are permitted to remain by 
action of the South Dakota Department of Transportation 
Commission for the period specified:

None
Appendix D

Maintenance Checklist and Final Acceptance Inspection Punchlists
STATE OF SOUTH DAKOTA
TRAFFIC SIGNAL
RECORD OF MAINTENANCE OR MODIFICATION

DATE MAINTENANCE OR MODIFICATION WAS COMPLETED: _________________________

LOCATION:

City (check one):

☐ Sioux Falls    ☐ Yankton    ☐ Vermillion    ☐ Mitchell    ☐ Madison

☐ North Sioux City    ☐ Wagner    ☐ Brandon

State Highway:_______________ at the intersection with ________________________

TRAFFIC SIGNAL INFORMATION:

Brand and Model number of the controller:___________________________

Problem identified:

☐ Controller failure    ☐ Conflict monitor failure    ☐ Detector failure

☐ Detector loop failure    ☐ Blown fuse    ☐ Wiring failure    ☐ Wet wiring

☐ Wire splice loose    ☐ Bulb replacement    ☐ Replace signal head or lense

☐ Repair mast arm or vertical support

☐ Other, Explain: __________________________________________________________

Cause:

☐ Equipment failure    ☐ Water in junction box    ☐ Water in conduit

☐ Lighting strike    ☐ Pavement cracking or heaving    ☐ Vandalism

☐ Vehicle accident damage    ☐ Undetermined cause

☐ Other, Explain: __________________________________________________________

________________________________________________________
OTHER ACTION:

The following items must have prior approval from State Region Traffic Engineer.

Date approval from State Region Traffic Engineer was received: _______________

☐ Modified controller programming / traffic signal timing

Explain how the programming or signal timing was modified:

____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

☐ Modified traffic signal display

Explain how the traffic signal display was modified:

____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

Attach intersection analysis that justified the above programming or display modifications.

SIGNATURE AND TITLE OF PERSON COMPLETING THE WORK:

__________________________________________________________________________

Original to Region Traffic Engineer

Distribute copies to: Maintenance Person Completing Work
City Traffic Engineer (where applicable)
City Engineer (where applicable)
Traffic Design Engineer
1. As built plans are provided by the Contractor,

2. Loops labeled as to which phase they are with a plastic band,

3. Identify where the conductor in the cabinet is coming from,

4. Color coded wire is used as per plans,

5. Wires are neatly bundled,

6. Limit excess cable to 3' or less,

7. Grout bottom of pole bases,

8. Astro brackets are properly tightened,

9. JB minimum size is 18",
10. 18” of crushed rock is placed below JBs to provide proper drainage,

11. Install a metal plate to cover hole around pipe if a section of the JB is cut out,

12. Wire splices must be above ground,

13. Limit height of conduit in bottom of cabinet to 2”

14. Anchor bolts must be tight,

15. Loop conductor between mast arm and pole to make water drip from wire and not run into signal pole,

16. Controller is properly programmed as per project plans,

17. Pedestrian heads are properly installed and properly working,

18. Warranty letters are mailed to the contractor,

19. Pedestrian push buttons are properly installed and working properly.
City of Rapid City Signal Inspection Checklist

The signal inspection checklist adopted by the City of Rapid City includes the following information:

1. Junction Boxes flush with finished grade
2. Gavel in Junction Boxes
3. Fittings and setscrews tight
4. Signal heads level and aligned
5. Correct lamps in everything
6. All cables labeled
7. Loops labeled
8. Correct wire
9. Are signs that were taken down back up [remodels]
10. Galvanized cable hangers every 30” [Span Wire signals]
11. As-builts
12. Pipes not too low or too high in Junction Boxes
City of Sioux Falls
Traffic Signal Punch List

Controller Cabinet
- Check for sealant between footing and cabinet shell
- Check anchor bolt nuts
- Check for bushings on all conduits
- Check grounding
- Check wire terminations
- Check labeling on signal cables

Signal Poles
- Check anchor bolt nuts
- Check for bushings on all conduits
- Check grounding
- Check wire terminations
- Check mounting hardware
- Check height, aiming, and straightness of signal heads
- Check terminations in signal heads
- Check for caps and access covers
- Check for locking pins
- Check backplates for screws and washers
- Check for signal cable strain relief

Junction Boxes
- Check for installation at grade level
- Check for adequate crushed rock in and below JB
- Check for grounding
- Check for bushings on all conduits
- Check conduit height
- Check loop splices
- Check condition of cables
Appendix E

Survey Questionnaires
Direction: Please check all that apply.

1. Who owns the traffic signals on the State Highway System?
   - Cities
   - Counties
   - State
   - Other: ________________________________

2. How many traffic signals are on the State Highway System?
   - 0-250
   - 250-500
   - 500-750
   - >750

3. Who is responsible for maintaining the hardware?
   - Cities
   - Counties
   - State
   - Contractor
   - Other: ________________________________

4. Is there a written agreement binding some entity to maintain the signals if it is not the state?
   - Yes
   - No
   - If yes, please attach example agreement.

5. Does the state DOT reimburse local government entities for signal maintenance?
   - Yes
   - No
   - Please explain ________________________________

6. Who performs the maintenance?
   - State crews
   - City staff
   - County staff
   - Contractors
   - Other: ________________________________
7. If the state owns, operates, and maintains the signals, does the state DOT have a formal maintenance program?
   - Yes, scheduled maintenance
   - No, just reactive maintenance
   If yes, please attach example schedule maintenance checklist.

8. Is there a formal inspection program for signal pole structural integrity? If yes, please specify who performs the inspection and how often.
   - Yes
   - No

9. If signals are not state-maintained, what sanctions are in place for failure to maintain the signals?
   - Withholding state reimbursements
   - Voiding the maintenance agreement
   - Removal of the signal
   - State invoicing the maintenance agency
   - None
   - Other:______________________________________________________

10. How are maintenance activities documented?
    - Paperwork submitted
    - State inspector
    - Documents in cabinet
    - Electronic record
    - No documentation
    - Other:______________________________________________________

11. Who is authorized to make signal timing changes?
    - Cities
    - Counties
    - State
    - Contractor
    - Local agency with permission from the State
    - Other:______________________________________________________

12. How are the signal timings backed up?
    - Electronic
    - Paper copy
    - Not at all
13. Is any certification or training required for those performing maintenance?
   □ Yes
   □ No
   □ Explain:_____________________________________________________

14. Who has access to the signal cabinets?
   □ City staff
   □ County staff
   □ State staff
   □ Contractor
   □ Police
   □ Other:_____________________________________________________

15. Please list any special measures to limit access to the signal cabinets.
   a) ____________________________
   b) ____________________________
   c) ____________________________
   d) ____________________________
   e) ____________________________

16. Is there a traffic signal inventory system for the state owned signals? If yes, please check all the information that are contained in the inventory system
   □ Location
   □ Hardware
   □ Controller
   □ Timing plans
   □ Other:_____________________________________________________
   □ None

17. If yes, who maintains the inventory?
   □ State DOT
   □ City
   □ County
   □ Other:_____________________________________________________

18. If yes, how is the inventory stored?
   □ GIS
   □ Database
   □ Other electronic:___________________________________________
   □ Hard-copy

19. Does the state DOT have a pre-approved signal product list?
   □ Yes
   □ No
20. Is state approval required for signal installation plans on state routes?
   □ Yes
   □ No
   If yes, please provide a copy of the approval process and/or checklist.

21. Does the state DOT require certification requirements for signal construction inspection?
   □ Yes
   □ No
   □ Please Explain:_______________________________________________

22. Does the state DOT require inspection during signal installation, prior to acceptance?
   □ Yes
   □ No

23. If yes, is there a checklist for signal acceptance?
   □ Yes
   □ No
   If yes, please provide a copy of the checklist.
Computing System Needs Survey

A pre-screening survey response indicates that you have a computerized traffic signal inventory system. We would like additional information on your system. Please complete the following questions as they apply to your Traffic Signal Inventory System.

**Direction: Please check all that apply.**

1. Who owns the traffic signals on the State Highway System?
   - [ ] Cities
   - [ ] Counties
   - [ ] State
   - [ ] Other: _______________________________________

2. How many traffic signals are on the State Highway System?
   - [ ] 0-250
   - [ ] 250-500
   - [ ] 500-750
   - [ ] >750

3. Please check all the information that are contained in the inventory system
   - [ ] Location
   - [ ] Hardware
   - [ ] Controller
   - [ ] Timing plans
   - [ ] Other: _______________________________________
   - [ ] None

4. Who maintains the inventory?
   - [ ] State DOT
   - [ ] City
   - [ ] County
   - [ ] Other: _______________________________________

5. How is the inventory stored?
   - [ ] Database
   - [ ] GIS
   - [ ] Other Electronic: _______________________________________

Agency: __________________ Filled In ____________________________
Agency Contact: ______ Filled In ________________________________
Title: __________________ Filled In ______________________________
Survey Contact (if different than above): __________________________
Title: _________________________________________________________
Survey Contact Phone Number: ________________________________
6. If stored as a database, please provide a list of the **Tables** and **Fields** contained in the database. If stored as a GIS, please provide a list of the **Layers** and **Fields**. If stored in another format please provide attributes and fields. If possible, please provide screen shots of the system.

7. What are the system requirements?

**Hardware**
- Processor: ___________________________________________________
- Operating System: ____________________________________________
- Random access memory (RAM): _________________________________
- Hard-disk space: ______________________________________________
- Other: ______________________________________________________

**Optional Hardware** (e.g. scanner, digital camera, color printer)

_________________________________________________________________

**Software**
- Software and version: _________________________________________
- Imaging software: ____________________________________________
- Other: ______________________________________________________

**Optional Software** (e.g. Petra for Windows, SmartDraw for Windows, ESRI GIS)

_________________________________________________________________

8. Please provide the approximate cost in 2003 dollars for the following:

- Hardware configuration: $____________________
- Optional hardware: $________________________
- Required software: $________________________
- Optional software: $________________________

*Please provide additional sheets if details are available.*

9. How many people are needed to maintain the system?

- [ ] One
- [ ] Two
- [ ] Three
- [ ] Four
- [ ] Five or more

10. Who maintains the inventory within your agency?

_________________________________________________________________
11. Does the inventory include a record of maintenance activity?
   - Yes
   - No

12. If yes, how is the maintenance record communicated back to the inventory system?
   - Paperwork submitted
   - Via an internet form
   - Other: _________________________________

13. Does the system have the ability to communicate with traffic signals to download/upload data?
   - Yes. Please explain.
   - No
     _________________________________

14. How is access to the inventory system granted?
   - Users with View Only privileges
   - Users with View and Editing privileges
   - Password
   - Other: _________________________________

15. Is the database accessible by the cities through the internet?
   - Yes
   - No

16. Do you have a Traffic Management Center (TMC)?
   - Yes – *complete questions #13 through #19.*
   - No

17. Describe the functionality or functions of the TMC?
   - Corridor management/traffic signal coordination or control
   - Incident management (e.g., detection, verification, and monitoring incident status)
   - Information dissemination (public, private and/or interagency)
   - En-route driver information (e.g., dynamic message signs, highway advisory radio, and in-vehicle systems)
   - Environmental monitoring (e.g., air quality, noise and weather)
   - Special event traffic management
   - Disaster management and traffic coordination
   - Emergency services traffic control coordination
   - Ramp management and control
   - Lane management and control (e.g., HOV, reversible lanes)
   - Network or roadway surveillance and data collection
   - Network performance monitoring, evaluation and reporting
   - Other: _________________________________
18. Please enumerate the components of the TMC (e.g., closed circuit television systems, dynamic message signs, ramp meter controllers, etc.)

____________________________________________________________
____________________________________________________________
____________________________________________________________
____________________________________________________________
____________________________________________________________

19. What hardware/software is used for the TMC?

____________________________________________________________
____________________________________________________________
____________________________________________________________

20. What are the staffing requirements for the TMC?

☐ One  ☐ Two  ☐ Three  ☐ Four  ☐ Five or more

21. What are the costs (each component, hardware/software, staffing) for the TMC?
Components: $_______________________________________________
____________________________________________________________
____________________________________________________________
Hardware: $________________________________________________
____________________________________________________________
Software: $________________________________________________
____________________________________________________________
Staffing: $__________________________________________________

22. Who controls operation of the TMC (i.e., which department or is it a separate section of its own)?

____________________________________________________________

23. How many traffic signals are tied into the TMC?

☐ 0  ☐ 1-50  ☐ 50-100  ☐ 100-250  ☐ 250-500  ☐ 500-750  ☐ >750
Appendix F

Traffic Signal Final Acceptance Punchlist
<table>
<thead>
<tr>
<th>ITEM</th>
<th>SDDOT SPECIFICATION OR DETAIL REFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller Cabinet</td>
<td></td>
</tr>
<tr>
<td>Check for sealant between footing &amp; cabinet shell</td>
<td>635.3T</td>
</tr>
<tr>
<td>Check anchor bolt nuts</td>
<td>635.3K</td>
</tr>
<tr>
<td>Check for bushings on all conduits</td>
<td>635.3H7</td>
</tr>
<tr>
<td>Check conduit seal</td>
<td>635.3H6</td>
</tr>
<tr>
<td>Check grounding</td>
<td>635.3G,J</td>
</tr>
<tr>
<td>Check wire terminations</td>
<td>635.3V6, S2</td>
</tr>
<tr>
<td>Check wiring diagrams</td>
<td>635.3S</td>
</tr>
<tr>
<td>Check wire color, number, gauge</td>
<td>635.3L</td>
</tr>
<tr>
<td>Check labeling on signal cables</td>
<td>635.3F</td>
</tr>
</tbody>
</table>
CONTROLLER CABINET

— Check lock end two keys

— Check as-built plans in cabinet

— Check excess cable

— Check timing against timing plan

— Check & vehicle and pedestrian detection

SIGNAL POLES

— Check anchor bolt nuts

— Check for bushings on all conduits

— Check grounding

— Check wire connections

— Check mounting hardware

— Check height, aiming, and straightness of signal heads
### SIGNAL POLES

- Check terminations in signal heads  
  635.3 O1

- Check for caps and access covers  
  635.3 O1

- Check for locking pins

- Check backplates for screws and washers  
  635.3 O1

- Check for signal cable strain relief  
  635.3L2

- Check labeling of cables  
  635.3F

- Check pole base grouting

- Check pedestrian push buttons

- Check pedestrian heads for proper installation and working

### JUNCTION BOXES

- Check for installation at grade level  
  635.3I

- Check for adequate crushed rock in and below JB  
  635.65
JUNCTION BOXES

— Check grounding 635.3G

— Check for bushings on all conduits 635.3H7

— Check conduit height 635.65, 635.3H5

— Check loop splices 635.3M, 635.77, 635.3V5

— Check condition of cables 635.3L,M

— Check labeling of cables and loops 635.3F

— Check loop lead-ins 635.3V4

— Check loop sealant 635.3V2

— Check loop test reports 635.3V7

— Check excess cable

— Check size of boxes against plan
ELECTRICAL SERVICE

— Check weatherhead 635.40

— Check service cabinet with lock 635.40

— Check grounding 635.40

LUMINAIRES

— Check photo electric control 635.3R

— Check luminaire orientation 635.Q

MISCELLANEOUS

— As-built plans are provided by the contractor

— Warranty letters are mailed to the contractor

COMMENTS:

Project Engineer(s) Signature:

Inspected by:

SDDOT Region Engineer(s) Signature:

City Engineer(s) Signature:

Send copy of this form to the Region Traffic Engineer.
Appendix G

Revised General Maintenance Agreement
MAINTENANCE AGREEMENT BETWEEN A MUNICIPALITY AND THE STATE FOR FEDERAL-AID HIGHWAY IMPROVEMENT TRAFFIC SIGNALS (Revised 2003)

WHEREAS, the DEPARTMENT OF TRANSPORTATION acting through the South Dakota Transportation Commission, hereinafter designated as the Commission, concurs in the proposal with the Municipality for the new construction or improvement of a street identified as South Dakota Construction Project No.____________________, ________ County, hereinafter designated as the Project, extending through the City of________, South Dakota, hereinafter referred to as the Municipality, located and further described as follows:

__________________________________________________________________________

WHEREAS, the Statutes of the State of South Dakota give assent to the provisions of the Transportation Equity Act for the 21st Century and acts amendatory thereof or supplementary thereto and regulations issued pursuant thereto by the Federal Highway Administration, Department of Transportation, United States of America, which hereinafter collectively will be designated as the Act, and charge of the Commission and the Municipality to do all things necessary fully to carry out the cooperation contemplated and provided for in the Act; and

WHEREAS, the section of the Project within the Municipality will be subject to the provisions of the Act, and is within the legal jurisdiction of the Municipality for traffic regulations and the control of building setbacks, zoning, sidewalks, utilities, etc., and

WHEREAS, the construction of the project is conditioned upon the fulfillment of the obligation of the Municipality in a manner satisfactory to the Commission and the Federal Highway Administrator, or their authorized representatives:

NOW THEREFORE, be it agreed for and in consideration of the undertaking of the Project under the requirements of the Act with the Commission's approval that insofar as its legal jurisdiction over the Project is concerned the Municipality assents to the requirements of the Act and pledges its good faith to the carrying out the purposes stipulated in the Act and to this end, the Municipality hereby agrees:

1. That it will prohibit all parking in the traffic lanes constructed under this project. It further agrees that it will prohibit double parking and control all parking where
and if allowed in a manner satisfactory to the Commission or their authorized representatives.

2. (a) That when the signal and/or roadway lighting system is installed on this street it will provide electric power necessary to operate the signal and/or roadway lighting system and all necessary maintenance and replacements, in kind, of all parts and apparatus of said system, including lamps so as to insure the continuing operation of said signals and/or roadway lighting systems until such time as the parties to this agreement shall agree to discontinue the operation of the said system.

(b) That if the signal is coordinated through the use of leased telephone lines, it will pay the required hookup fee and monthly rental fees.

(c) That on the State Trunk System, prior to changing the signal timing from that originally set by the South Dakota Department of Transportation, the Municipality will submit in writing the necessary data and proposed timing to the South Dakota Department of Transportation Region Traffic Engineer for approval.

(d) That it will record the maintenance activities in a traffic signal maintenance log that the Municipality may keep inside the signal cabinets or at its office. Maintenance records shall be kept for a minimum of 3 years.

(e) That it will submit, either electronically or in paper format, an annual maintenance report using the standard form in Exhibit A to the South Dakota Department of Transportation Region Traffic Engineer.

(f) That it will document timing changes as approved by the South Dakota Department of Transportation (SDDOT) on a timing change log kept inside the signal cabinet or by automated means available. SDDOT will also document the timing changes.

(g) That it will limit access to the signal cabinets following the measures set forth in the "Policy and Procedures for Traffic Signals on State Highways, Section I.7" document.

(h) That if the Municipality cannot or does not fulfill its maintenance obligations and the annual maintenance inspection report, the South Dakota Department of Transportation reserves the right to perform, or cause to be performed, the necessary maintenance and invoice the Municipality for the costs.
3. That, if the Municipality applies plastic pavement marking on this street (i.e. Cross Walk), it will use plastic material approved by the South Dakota Department of Transportation, and will maintain those plastic pavement markings which are the responsibility of the Municipality.

4. That said Municipality does acknowledge that the members of its governing board and/or engineering staff have examined the plans for the Project prepared under the supervision of the South Dakota Department of Transportation referred to in this Agreement, and have been notified of the project acceptance punch list inspection in Exhibit B.

5. That the Municipality will enact such ordinances as are necessary to properly enforce any of the above provisions.

6. That the Mayor is authorized to enter into a mutual agreement with the Commission providing for the understanding of this project under the considerations described above.

DATED this _________ day of _________________, 2003.

CITY OF

ATTEST:

______________________________
Mayor

______________________________
City Auditor/Finance Officer

(S E A L)

SOUTH DAKOTA
DEPARTMENT OF TRANSPORTATION

APPROVED AS TO FORM:

______________________________
Project Development Engineer

______________________________
Assistant Attorney General
AGREEMENT BETWEEN THE POLITICAL SUBDIVISION AND THE STATE FOR
FEDERAL AID HIGHWAY ENCROACHMENTS

EXHIBIT "A" Annual Maintenance Inspection Checklist

EXHIBIT "B" Traffic Signal Final Acceptance Punchlist

The following encroachments are permitted to remain by action of the South Dakota Department of Transportation Commission for the period specified:

None
Appendix H

Revised Maintenance Agreement with the City of Sioux Falls
MAINTENANCE AGREEMENT BETWEEN THE CITY OF SIOUX FALLS AND THE STATE FOR FEDERAL-AID HIGHWAY IMPROVEMENT TRAFFIC SIGNALS

WHEREAS, the DEPARTMENT OF TRANSPORTATION acting through the South Dakota Transportation Commission, hereinafter designated as the Commission, concurs in the proposal with the City for the new construction or improvement of a street identified as South Dakota, Federal Aid Construction Project No. ______, County, hereinafter designated as the Project, extending through the City of Sioux Falls, South Dakota, hereinafter referred to as the City, located and further described as follows:

WHEREAS, the Statutes of the State of South Dakota give assent to the provisions of the Transportation Equity Act for the 21st Century and acts amendatory thereof or supplementary thereto and regulations issued pursuant thereto by the Federal Highway Administration, Department of Transportation, United States of America, which hereinafter collectively will be designated as the Act, and charge of the Commission and the City to do all things necessary fully to carry out the cooperation contemplated and provided for in the Act; and

WHEREAS, the section of the Project within the City will be subject to the provisions of the Act, and is within the legal jurisdiction of the City for traffic regulations and the control of building setbacks, zoning, sidewalks, utilities, etc., and

WHEREAS, the construction of the project is conditioned upon the fulfillment of the obligation of the City in a manner satisfactory to the Commission and the Federal Highway Administrator, or their authorized representatives:

NOW THEREFORE, be it agreed for and in consideration of the undertaking of the Project under the requirements of the Act with the Commission's approval that insofar as its legal jurisdiction over the Project is concerned the City assents to the requirements of the Act and pledges its good faith to the carrying out the purposes stipulated in the Act and to this end, the City hereby agrees:

1. That it will prohibit all parking in the traffic lanes constructed under this project. It further agrees that it
will prohibit double parking and control all parking where
and if allowed in a manner satisfactory to the Commission or
their authorized representatives.

2. (a) That when the signal and/or roadway lighting system is
installed on this street it will provide electric power
necessary to operate the signal and/or roadway lighting
system and all necessary maintenance and replacements, in
kind, of all parts and apparatus of said system, including
lamps so as to insure the continuing operation of said
signals and/or roadway lighting systems until such time as
the parties to this agreement shall agree to discontinue the
operation of the said system.

(b) That if the signal is coordinated through the use of
leased telephone lines; it will pay the required hookup fee
and monthly rental fees.

(c) That, the City may adjust signal splits and offsets to
accommodate changes in traffic conditions (volumes and
speed) to retain efficient traffic flow on the State highway
arterial. The City will advise the State (Region Traffic
Engineer) in writing of the adjustments in a timely manner.

(d) In the event that the adjustments are required to signal
phasing, cycle length or type of control the City will
obtain DOT review, concurrence and approval prior to the
adjustments being made.

(e) During short term projects, detours, special events,
etc., the City may adjust traffic signal operation on State
highways to efficiently accommodate traffic for the duration
of the project, detour or event. After completion of the
special events, project and detours, etc., the City will
return the signal operation back to the same operation
before the start of the special event etc.

(f) That it will record the maintenance activities in a
traffic signal maintenance log that the Municipality may
keep inside the signal cabinets or at its office. Maintenance
records shall be kept for a minimum of 3 years

(g) That it will submit, either electronically or in paper
format, an annual maintenance report using the standard form
in Exhibit A to the South Dakota Department of
Transportation Region Traffic Engineer.

(h) That it will document timing changes as approved by the
South Dakota Department of Transportation (SDDOT) on a
timing change log kept inside the signal cabinet or by
3. That, if the City applies plastic pavement marking on this street (i.e. Cross Walk), it will use plastic material approved by the South Dakota Department of Transportation, and will maintain those plastic pavement markings which are the responsibility of the City.

4. That said City does acknowledge that the members of its governing board and/or engineering staff have examined the plans for the Project prepared under the supervision of the South Dakota Department of Transportation referred to in this Agreement, and have been notified of the project acceptance punch list inspection in Exhibit B.

5. That the City will enact such ordinances as are necessary to properly enforce any of the above provisions.

6. That the Mayor is authorized to enter into a mutual agreement with the Commission providing for the understanding of this project under the considerations described above.
DATED this ________ day of ________________, 2003.

CITY OF SIOUX FALLS

ATTEST:

_____________________________
Mayor

______________________________
City Auditor/Finance Officer
(S E A L)

SOUTH DAKOTA
DEPARTMENT OF TRANSPORTATION

APPROVED AS TO FORM:

______________________________
Project Development Engineer

______________________________
Assistant Attorney General
AGREEMENT BETWEEN THE POLITICAL SUBDIVISION AND THE STATE
FOR
FEDERAL AID HIGHWAY ENCROACHMENTS

EXHIBIT "A" Annual Maintenance Inspection Checklist

EXHIBIT "B" Traffic Signal Final Acceptance Punchlist

The following encroachments are permitted to remain by action of the South Dakota Department of Transportation Commission for the period specified:

None
Appendix I

List of Suggested Specification Updates
List of concerns that SDDOT needs to consider for traffic signal specification updates:

1. The Standard Specifications requires conductors and cables to be labeled as per the field wiring diagram. The final installation of the traffic signal system ends up being a combination of the wiring diagram in the plans, the wiring diagram provided by the supplier of the traffic signal controller, and the wiring done by the contractor in the field. The Standard Specification requirement is unattainable in many cases. Different cities and contractors label the conductors and cables in different ways from project to project.
   
   It is recommended that the Standard Specifications require the contractor to label conductor bundles to identify which quadrant of the intersection the conductors serve. The labeling should identify which traffic signal head and the color of the traffic signal head. Detector loop conductor should be labeled to identify the approach of the intersection and the location of the detector loop on the approach.

2. Extra fiber optic cable is being provided and stored in the controller cabinets. This extra fiber optic cable should be stored in a junction box nearest the controller.

3. The Standard Specifications require that the space between the concrete footing and the traffic signal pole be grouted closed. The traffic signal pole manufacturers are advising contractors not to grout the space shut so that adequate ventilation is provided in the traffic signal pole to mitigate moisture condensation on the inside of the traffic signal pole and mast arm. When the space is not grouted shut, mice enter the traffic signal poles and build nests in the traffic signal heads and chew on the electrical conductors.
   
   It is recommended that the SDDOT specify metal screening be installed on the inside of the base of the signal pole between the concrete footing and the bottom of the signal pole to allow the air circulation and prevent mice from entering the traffic signal pole base.

4. The Standard Specifications require the contractors to install paraffin to seal the ends of the conduit in the base of the traffic signal controller cabinets. This is to keep gases from entering the conduits. The contractors are not typically doing this. The sealing of the conduits with paraffin or other sealants compromise the ability of the City maintenance staff access to the conductors in the conduits when emergency repairs are necessary. The need to seal the conduits in the controller cabinets needs to be reconsidered. If the conduits need to be sealed, other methods need to be found to allow easy removal for access to the conductors in the conduits.

5. SDDOT Standards should specify that conduits should enter junction boxes from the bottom of the junction box only and not the sides.

6. The Standard Specifications should require that all conductors including communication cables be spiced above the ground. Detector loop twisted shielded pair would be the exception to this and be allowed to be properly spliced below ground level.

7. The Standard Specifications require a J hook and cable grip be installed at the joint between the signal pole and the mast arm. Many of the newer pole designs do not allow the installation of the J hook. Instead, groments are provided to secure the conductor cable at the joint. The SDDOT Standards should be changed to allow the use of the newer designs.

8. The method of grounding of junction boxes was discussed. Conflicting electrical code requirements were a concern. It is recommended that the State review the subject and dictate how junction boxes should be grounded.
Appendix J

Sample of Commercially Available Signal Inventory Software
Signal Manager®

To view another Page Tab for the highlighted Signal Record, simply click on one of the desired page tabs across the top of the following graphic display.

When the Signal Manager® Icon is selected from the VIMMS® Main Tool Bar, a list of defined signalized intersections will be displayed. When an Intersection Record is highlighted on this Page Tab, its record details can be viewed by clicking on the other Page Tabs to the right of the List Tab.

A thumbnail image on the bottom left depicts a plan view of the intersection along with many common components including: detector loops, signal heads, mast arms, steel poles and even the controller cabinet. Also, a thumbnail is provided for photos of each leg of the intersection. In addition, Map Manager™ provides a thumbnail image which displays the location of the highlighted signalized intersection.
Signal Manager®

To view another Page Tab for the highlighted Signal Record, simply click on one of the desired page tabs across the top of the following graphic display.

This Page Tab contains information concerning the Controller Type, Cabinet, Operational Features and Preemption. The cost of all items at the intersection is summarized on this Page Tab.

A thumbnail image is provided for the cabinet on the lower right corner. To view an enlargement of this image, simply click on the thumbnail image. Also, a user can examine all historical records associated with this Page Tab by clicking on the History Button.
To view another Page Tab for the highlighted Signal Record, simply click on one of the desired page tabs across the top of the following graphic display.

This Page Tab displays detailed information about each signal head at the selected intersection. The table lists all signal head types at the intersection. By highlighting an item in the table, the unique attributes of each defined head type can be viewed, edited or deleted.

The projected Remaining Lamp Life for each signal head is also displayed on this Page Tab.

An image is available for each signal head type on the list and the image may be enlarged by clicking on the thumbnail image.
To view another Page Tab for the highlighted Signal Record, simply click on one of the desired page tabs across the top of the following graphic display.

This Page Tab contains information about detectors at the selected intersection. A list of all defined detectors is provided along with each detector's attributes. The table lists all detectors in use at the intersection. By highlighting an item in the table, the unique attributes of each defined detector can be viewed, edited or deleted.

Multiple graphic images can be added for each detector type listed and an enlargement can be viewed by clicking the thumbnail image.
Signal Manager®

To view another Page Tab for the highlighted Signal Record, simply click on one of the desired page tabs across the top of the following graphic display.

This Page Tab is provided for recording auxiliary hardware such as conflict monitors, coordination units and preemption equipment. The table lists all auxiliary equipment present at the intersection. By highlighting an item in the table, the unique attributes of each defined component can be viewed, edited or deleted.

Multiple graphic images can be added for each piece of auxiliary equipment listed and an enlargement can be viewed by clicking on the thumbnail image.
Signal Manager

To view another Page Tab for the highlighted Signal Record, simply click on one of the desired page tabs across the top of the following graphic display.

This Page Tab is provided for defining each type of support at an intersection. A list of all defined supports is provided along with each support's attributes. By highlighting an item in the table, the unique attributes of each defined support can be viewed, edited or deleted.

Multiple graphic images can be added for each support type listed. An enlargement of the image can be viewed by clicking on the thumbnail image.
### Signal Manager®

To view another Page Tab for the highlighted Signal Record, simply click on one of the desired page tabs across the top of the following graphic display.

#### Signalized Intersection -- MAIN & BUTLER

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<th>Line #</th>
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<td>01/26/1992</td>
</tr>
</tbody>
</table>

This Page Tab is provides a signal-timing chart for recording the intervals and associated time setting for each operational phase at the intersection. In addition, intersection preemption timing intervals can be recorded in the Timing Chart.

A thumbnail graphic image of the companion intersection phase diagram can be added. In this example, an enlargement of the graphic is displayed.
Signal Manager®

To view another Page Tab for the highlighted Signal Record, simply click on one of the desired page tabs across the top of the following graphic display.

This screen display provides independent maintenance tabs for each major hardware component at a selected intersection.

These include Cabinet Equipment, Signal Heads, Detectors, Auxiliary Equipment and Supports. Maintenance performed on each of these items can be recorded including Date Requested, Date Approved and Date Completed for a particular activity.
The Navigator Bar is a new feature to Version Five and is found in all CartéGraph applications. Navigator allows multiple modules to be open at one time. Navigating between programs is done by clicking in a Page icon from the Navigator Bar allowing for increased connectivity between multiple modules. The Navigator Bar can be turned on and off through the View Menu.

The toolbar in CartéGraph software, like most other software applications, provides icons for the most commonly used tools from the Menus. These icons execute a command in the software which makes using the software quicker and easier to use.

The Status Bar displays several pieces of information that are helpful when navigating through the software. This information includes how many records you have in your database, the record number you are currently on, if a filter or sort is applied and the mode the software is in (such as Add Mode).
SIGNALview Properties

The Properties dialog box can be viewed through the File Menu by selecting Properties. This is a read-only form which provides information about your database.

Forms

Forms Menu

The Forms Menu allows you access to various commands and features. Selecting New Form gives you the ability to completely customize a form of your own through Design Mode.

The Most Recently Used List shows the last ten forms that have been have accessed. When you first open SIGNALview, this list will show the predefined forms that are shipped with the application.

Select More Forms to open a dialog box which will list all of your saved forms. This dialog box is shown below.

The Form Design command has a fly-out menu which lists the various functions available when you are creating a custom form.

Open Form Dialog Box

This dialog is accessed through More Forms, which is located on the Forms Menu. It looks very similar to an Open Form in any Microsoft software. However this dialog box opens CartéGraph forms which have the extension .for.

Each form you have saved will be listed in this dialog box. To open a form, click on the form and select Open.

If you have saved your form somewhere other than the default location, use the drop down arrow to browse to that location.

Notes Window
**Auxiliary Equipment Form**

The Auxiliary Equipment Form identifies auxiliary or accessory parts used on the signal group. This form has its own toolbar, allowing multiple auxiliary pieces such as detectors, modems and surge arrestors to be tracked through. There are several tabs on this form allowing you to identify, locate and describe the auxiliary pieces, as well as track condition and GASB 34 financial information.

**Conflict Monitors Form**

This form allows you to track information related to the conflict monitor that governs the signal group. The code look-up on this form will bring you to the Conflict Monitor Library. From this library you can select the appropriate type of conflict monitor. This selection will pull information, including a typical image of the monitor, associated with that type of conflict monitor on to the form.

Using the toolbar on this Form you can track multiple conflict monitors for the signal group. There are several tabs on this form allowing you to identify, locate and describe the conflict monitors as well as track condition and GASB 34 financial information.

**Controllers Form**

The Controllers Form tracks the controllers associated with the signal group.

The Controllers Library can be accessed through the Controllers Form through the Code look-up field. This Library stores the different types of controllers you use in your organization and will include a picture.

There are several tabs on this form allowing you to identify, locate and describe the controllers as well as track condition and GASB 34 financial information.
**Detectors Form**

The Detectors Form identifies the different detectors used to detect traffic governed by the signal group.

The different detector types used by your organization can be stored in the Detectors Library—which is accessed through the Detectors Form.

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**Head Units Form**

This Form identifies the various head units used on the signal group.

Various types of head units are stored in the Head Units Library, available through the Code look-up field. The head units located in the library also include typical images of the head units, as well as information such as the manufacturer and layout of the head unit. This stored information automatically populates onto the head unit form when a code is selected from the library. The features tab also allows the user to link the head unit to the support it is attached to.

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**Supports Form**

The Supports Form identifies the type of support the signal head unit is attached to. Multiple supports can be entered for each signal group.
Location Form

You can enter data information used to identify the location of the signal group on the Location Form. This information includes very general information including state, county and district, as well as specific X, Y and Z coordinates for the signal group. The Location Form directly links to the Routes Library through the Route look-up field.

The Routes Library allows you to identify the streets located in your jurisdiction. It also tracks nodes, significant points along a route such as intersections, starting and ending points and changes in pavement type. These node points can be located along the route using distance ahead and back from the next intersection, addresses and mile markers. This node information is stored in the Node Library.

The Nodes Library stores information about nodes. Nodes are specific points along a route. These nodes are located along the route using locating information such as mile markers, addresses and distance readings from station markers. The nodes will be used as relevant points to identify locations of your assets.

Signal Overview Form

The Signal Overview Form allows you to see all of the components of the signal group on a single form. This Overview Form will pull the various signal parts from their corresponding forms to the Overview Form for easier viewing. The grid list design allows you to see all pieces of equipment associated with the signal group even when there are multiple pieces of equipment for the same component type. Additional equipment may be added to the signal group through this form for easier data entry.

History Form

Historical events that have occurred to the signal group are stored on the History Form. These events may include bulb changes, repairs or removal of parts of the signal group. In addition to historical activity, the History Form stores information about the event including the date the event occurred, the cost to perform the event, what equipment and personnel finished the work, and other pertinent management data. Activities within the History Form can be created to trigger these fields to be populated with the date the event occurred.

In addition to tracking historical information, the History Form also allows you to schedule events that need to be performed for the signal group. A scheduled event is notated by the lack of a completion check mark in the first column of the form.

An added feature is the ability to schedule events that occur at regular intervals. As this event is completed...
the event is recreated in the History Form to be performed in the future at the next regular time.

**Attachments Form**

The Attachments Form adds files to the record. These files are specific to the record and can include various file types, such as spreadsheets, documents, photos, videos and sound bytes.

![Attachments Form](image)

**Notes Form**

In addition to the information contained on the forms, the Notes Form allows you to keep detailed information on each of your sign records. This information can then be printed.

When you press the Clock icon, a time/date stamp is automatically included.

The Person icon will add a User ID to the note. This ID is pulled from the login screen.

![Notes Form](image)

**Design Mode**

When a form is in Design Mode you have the ability to change, add or delete fields. This can be done to a pre-existing form or a form you have just created.

When you are in Design Mode, a Field Chooser and Toolbox will display. The Field Chooser lists all of the fields you have created in Administrator, or those fields that were shipped with the application.

The Toolbox gives you design and data field options which will help you create a form.

Forms that are created can be saved and used on multiple machines.

![Design Mode](image)

**Run Mode**

When a form is in Run Mode you have the ability to use all of the functions of the form, as well as the software, and information can be populated through the fields located on the form.

A form must be saved before it can be run.

![Run Mode](image)
Script Mode

Script Mode allows additional functionality to be added to a form, which is done using VBScript. A script can be saved and utilized in other areas of the software as well.

Records

Records Menu

Under the Records Menu are all of the tools you will need to manipulate the records in your database. The commands that are found on the Records Menu can be added as icons to your main toolbar. You can do this through the Tools Menu, by selecting My Options.

Every command on the Records Menu, besides Delete Record, can also be performed using various shortcuts on your keyboard. These shortcuts are listed next to the command on the Records Menu.

The Save Record command saves a new record added to the database or any changes made to an existing record.

The New Record command adds new sign records to the database.

The Duplicate Record command makes and exact copy of the record currently displayed. This tool can aid in data entry if multiple signs share many properties.

When you refresh a record, you update the record your are currently viewing. When you refresh a recordset, you are altering every record in the recordset.

Event Log

When you save changes to a record in your database, you will be prompted to complete an entry for the Event Log.

The Event Log allows the user to track maintenance activities that occur for the asset. Additional information is saved as well, including the dates the activity was started and completed.

This feature can be turned on and off through the Tool Menu by selecting My Options and then the Other Tab.

Record Control

Record Control is found on the View Menu. This tool helps view records in a spreadsheet type format. Records can be added, edited or deleted through the Record Control.
Filters

Filters Menu

The Filter Menu contains all of the tools necessary to narrow down your database to a specific set of records.

The Filter Builder allows you to create a custom filter for numerous operations and fields. The Filter Builder also contains the Sort function which allows you to determine how you would like your records ordered.

Filters you create can be saved for the future using the Save Active Filter command.

Combine Active With and Replace Active With will combine or replace an active filter with the filter of your choice. A fly-out menu lets you choose any of the ten most recently used filters, or More Filters which allows you to browse to a saved filter.

Show All Records will remove the filters from the database and allow you to view all of your records.

After placing your cursor in a field, you can select By Value which will filter the database to the records that match the value of the current field.

Excluding Value does the exact opposite of the By Value filter command. It will display all records except for the records equal to where you clicked your cursor.

Prompt for Value filters are simple filters that display by field. Select the field you would like to filter by and then choose a specific value to search for.

Filter Builder

Setting a filter displays a certain grouping of your entire database. This is also referred to as a query.

The Filter Builder allows you to create new filters and sorts for your database.

The Filter Tab is where you define any criteria you want to filter your database with. Enter the field you wish to filter in the Field/Filter column. The Operation column supplies a description of what information to find. The Value column is populated with the value the search is looking for.

These filters can be saved for future use.

To create more advanced filters, use the Expression Builder, which can be accessed using the Expression Builder icon, located on the Filter Builder toolbar.

Notes Window
Actions

Actions Menu

Actions will help you simplify many of the tasks that are used most often in SIGNALview.

The Go to Signal ID Action allows you to filter to one signal group in the data set. When using this action the database is queried by the Signal Group ID.

The Recalculate Estimated Conditions Action lets you recalculate information pertaining to the condition of the signal group. This recalculation compares the data entered for the signal group to the condition parameters established for specific signal group types and estimates the condition and life expectancy of the signal group.

The recalculate warning device will determine if a warning device is needed. It scans all the head units in the database, reads the populated Visibility and Speed Limit fields, and determines if a warning device is needed to warn of the upcoming signal.

The Recalculate Route Data Action will help you locate signal groups based on the location of the related nodes and their existing X and Y coordinates. You can actually estimate the X and Y value for a signal group at an intersection by calculating the distance ahead or back from existing nodes with defined X and Y values.

The Recalculate Key Dates Action will populate the key dates field on the top of the History Form by reading the history information established. On the History Form Activity field, you can define specific events as key date triggers. These triggers are then searched for and the most recent chronological date that event occurred becomes the information populated on the history forms key date field.

Reports

Reports Menu

The reports displayed on this menu are your most recently used reports. When you first open your application, the reports shown will be reports that have been shipped with the application.

You can access any predefined reports (reports shipped with the application) or any custom reports you have created and saved using the More Reports Command.

Notes Window

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Report Builder

Create custom reports using the Report Builder.

You have the option of choosing two layout types—tabular or form. A tabular-based report displays data in a standard row and column format similar to a spreadsheet. A form-based report displays data in a format similar to a standard data entry form.

Use the Browse button in the Data Source section to locate the recordset which has the required data. The Choose Recordset dialog appears after choosing the Browse button.

Various details can be set to help you customize your report. More information on those details, such as fields and page setup, are further explained later.

Import/Export

Format Builder

The Format Builder can be accessed through the File Menu. After selecting Format Builder, you will be presented with tabs that have various options for importing and exporting.

The Format tab allows you to select the recordset you wish to import/export.

You also choose the Format Type. If you pick Delimited you will have to choose a Field Separator—the character that tells the computer where one field stops and the next starts.

You can also have String Identifier placed around text fields.

After all of these options have been chosen you will need to determine the fields you want to import/export. It is important when you are importing to make sure the fields are in the same order as the fields in the import file.

Logs

The Application Log tracks the features and functions of the application that have been accessed. This feature can help both CartéGraph and your organization troubleshoot problems if they occur.
Tools

MultiEdit

This feature will aid you significantly when you are editing several fields within multiple records. For instance, you may have entered an incorrect replacement date for over 200 signs in your database. By using MultiEdit you can filter your database for those signs, then change the date for each sign all at the same time.

My Options

The Directories tab allows you to set directories as default areas for storing things such as attachments, forms and filters.

The Variable Directories lets you assign variables to represent directories.

The Working Set tab allows custom filters to filter subsets of records. Default working set filters are included to filter to groups such as in-service or retired signs, however any filter can be used to define a working set.

The Other tab lets you determine if you wish to display the Event Log when you are saving a record. The Event Log helps track changes to the database.

Help File

In the Help Menu you have the option to view the Help File. The Help File contains various information on the application, such as How do I’s, glossaries and descriptions.