Minnesota Statewide
Highway Systems Operation Plan
Executive Summary

HSOP

MINNESOTA DEPARTMENT OF TRANSPORTATION

April 2005

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Minnesota Department of Transportation

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Minnesota Department of Transportation
395 John Ireland Boulevard
Saint Paul, Minnesota 55155
General Phone: 651-296-3000
Toll Free: 1-800-657-3774
TTY: 1-800-657-3994
Web Site: www.dot.state.mn

Introduction

Welcome to the first Minnesota Statewide *Highway Systems Operation Plan* (HSOP). This plan has been prepared by the Minnesota Department of Transportation (Mn/DOT) to support the Department's Strategic Directions and Transportation Polices and to provide a framework for managing key maintenance activities throughout Minnesota. This operations plan is a significant first step to assessing the challenges of preserving and maintaining the State's transportation infrastructure at a time when the competition for resources is intense and the need for services is increasing in parallel with population and economic growth.

This planning effort is intended to complement Mn/DOT's Statewide Transportation Plan from a maintenance-operations perspective. It is also intended to compliment other strategic planning efforts such as the Mn/DOT District Plans which focus more on capital infrastructure needs. Mn/DOT has six main objectives for this *Highway Systems Operation Plan*:

1. Document major trends and key factors that directly affect and/or influence maintenance operations work activities.

2. Identify linkages between maintenance operations activities and Minnesota's Statewide Transportation Plan and District 20-year Plans.

3. Identify performance measures in the operations maintenance area, and gather supporting data for tracking Mn/DOT's progress toward achieving the performance measures.

4. Based on identified trends and present performance levels, identify funding gaps and/or changes in maintenance operations activities to meet performance measures.

5. Based on different levels of investment, identify, if possible, level of service changes and/or priorities for various maintenance operations work activities.

6. Provide guidance and strategies to Mn/DOT Districts and Offices for implementation of the plan.

Plan Development Process

The HSOP plan was developed in a year long process that included a significant amount of participation from Mn/DOT's District Operations Staff, Office of Investment Management (OIM), and specialized groups such as bridge, pavement management, pavement marking, fleet management, building management, Metro Electrical Services Unit and the Regional Traffic Management Center.
The plan development was led by a Project Management Team. Six committees were

Source: Mn/DOT Office of Maintenance

formed to investigate and develop maintenance performance measures, service levels, best management practices, benchmarks and/or performance standards for areas listed below.

1. Safety
2. Mobility
3. Snow and Ice
4. Bridge Maintenance
5. Supporting Infrastructure
6. Pavement Maintenance

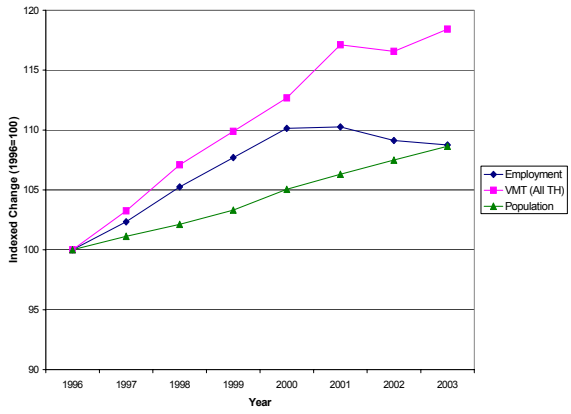
Individual committees met numerous times to review and discuss information. Information was funneled through a consultant who was responsible for reviewing, organizing and writing the plan. The overall process, findings and recommendations were reviewed and approved by the study's Steering Committee and the Commissioner of Transportation.

Major Trends and Influencing Factors

Maintenance activities are influenced by numerous factors, from costs of raw materials, fuel, traffic levels to weather, regulatory and customer expectations. Key trends and factors that influence maintenance activities were categorized into four main areas. A brief summary of these trends is described below:

System Usage Trends: *Due to demographic and economic trends, the use of Minnesota's transportation system is increasing – this has resulted in greater maintenance needs and also changes in the way maintenance work activities are planned, designed and accomplished.*

System Growth Trends: *Minnesota's transportation system is increasing: more travel lanes, bridges, interchanges, signals, signs and street lights are constructed or placed – this requires additional resources to maintain them.*



Source: Minnesota Statewide Transportation Plan 2003

Economic Trends: *Costs of labor, equipment and materials is increasing while financial resources have been decreasing in terms of real purchasing power.*

Customer/User Trends: *Users of the system have consistently expressed their desire for safe and efficient transportation facilities, and prompt snow and ice removal. There is an increased emphasis on minimizing impacts of work activities on road users, establishing performance measures and targets, to ensure resources are used effectively and reducing impacts to environment.*

Performance Categories

Five performance categories have been identified for the HSOP based on user expectations and policy direction. These performance measure categories are:

I. *Infrastructure Maintenance and Preservation*

This area covers many of the typical maintenance activities including maintenance of bridges, pavements, signals, and lighting.

II. *Supporting Infrastructure Management*

This area focuses on maintenance of infrastructure and equipment that is needed to support other core Mn/DOT work activities. For example, equipment and buildings need to be maintained and repaired so that they can serve their intended function. Also, electronic communications services are needed to conduct daily operations for many state agencies.

Source: Mn/DOT Office of Maintenance

III. *User Mobility and Travel Time Reliability*

Activities in this area focus on maintaining user mobility and travel reliability on the Twin Cities' 320-mile Metropolitan Urban Freeway System (MUFS). User mobility and travel reliability is enhanced by managing peak freeway traffic flows, responding to and clearing incidents quickly, and by minimizing lane closures or other capacity restrictions. In addition, this area also includes management and operations of 630 signalized intersections within the Twin Cities Metropolitan Area.

IV. *Snow and Ice Management*

Mn/DOT market research has shown that snow and ice is one of the highest priority services. Minnesota receives significant snow, freezing rain, and ice during a seven-month period between October and April each year. This activity involves the work associated with clearing snow and ice on over 12,000 miles of state highways throughout Minnesota.

V. *Safety*

Maintaining striping and signing is important to user safety throughout the transportation system, and guardrail and barrier repair protects motorists should their vehicle leave the roadway in a hazardous location.

These performance measure categories are tied to Mn/DOT's Strategic Directions and Statewide Transportation Plan policies (Table 1). The table shows that the relationship between the two plans is direct. It should be noted that HSOP Category III – User Mobility/Travel Reliability, and HSOP Category IV – Snow and Ice Management are tied together, because snow and ice

Table 1
Linkage between HSOP Performance Categories and Measures and Statewide Transportation Plan Policies

	Statewide Plan Policies	HSOP Performance Categories and Measures
Strategic Direction 1 "Safeguard What Exists"	**Policy 1** Preserve Essential Elements of Existing Transportation Systems	I. Infrastructure Maintenance and Preservation 1. Preventive Bridge Maintenance 2. Pavement Preventive Maintenance 3. Pavement Patching 4. Signal and Lighting Maintenance
		II. Supporting Infrastructure Management 1. Building Maintenance 2. Building Functional Adequacy 3. Fleet Management Life-Cycle/Utilization 4. Electronic Communications Coverage 5. Electronic Communications Management 6. IT Infrastructure Preservation
	Policy 3 Effectively Manage the Operation of Existing Transportation Systems to Provide Maximum Service to Customers	III. User Mobility and Travel Time Reliability 1. Regional Transportation Management Center - Coverage 2. Incident Removal 3. Planned Lane closures 4. Unplanned Lane Closures 5. Signal Performance on Arterials IV. Snow and Ice Management 1. Time to Bare Pavement by Road Type
Strategic Direction 2 "Make Network Work Better"	**Policy 7** Increase the Safety and Security of Transportation Systems and their Users	V. Safety 1. Striping 2. Signing 3. Guardrail

management affects user mobility and reliability of travel. Similarly, there is a connection between HSOP Category V – Safety and most of the other performance measure categories. For example, snow and ice removal affects safety just as well as pavement maintenance and signal operations affect safety.

Maintenance Performance Measures

Performance measures were developed for the five maintenance performance areas. These measures, performance targets, and information concerning performance gaps are provided in Table 2. As part of developing these measures and targets, benefit-cost, industry standards and/or benchmarks were utilized where possible. As a result of this review and analysis a number of recommendations and implementation strategies were developed.

Recommendations and Strategies

The findings and recommendations focus on the 2006 to 2009 timeframe; however, a number of the strategies identified provide direction beyond this timeframe. The recommendations and findings are listed below in no particular order of importance.

1. **Manage maintenance work and incidents to minimize impacts to road users.** *As roadways in the metropolitan areas become more congested, the ability to work in traffic during daylight hours will be limited. As a result, Mn/DOT will modify its current work practices and methods to safely conduct work and minimize delays to users. In addition, it will need to improve responses and removal of incidents to minimize delay and improve safety (reduce secondary crashes). These will be accomplished through the following:*

   - ✓ Shift more maintenance work to night crews (Twin Cities Metropolitan Area) to minimize impacts of lane closures during heavy travel times.
   - ✓ Increase instrumented system to full Metropolitan Urban Freeway System (MUFS); this will provide better response and monitoring of heavily used urban freeway system.
   - ✓ Increase FIRST coverage of MUFS to reduce user delays and improve safety.
   - ✓ Continue to explore ways to better coordinate work activities of different maintenance work groups as well as coordination between maintenance and construction to minimize lane closures
   - ✓ Continue to conduct non-essential snow and ice removal operations at night or in non-peak periods to reduce delays to users.

2. **Manage infrastructure assets for lowest life-cycle cost.** *It is critical to maintaining important facilities at the lowest cost. To accomplish this, infrastructure elements need to be monitored so that the right treatment is applied at the right time. In addition, agencies and policy-makers need to be able to pro-actively plan for changes in investment needs based on historic life-cycle patterns (e.g., freeway building era, large number of bridges reaching end of life).*

   - ✓ Continue to facilitate discussion between maintenance and construction to better manage investment allocations to minimize long-term life-cycle costs; better document the need to for investment level modifications to address historic infrastructure aging patterns (e.g., large number of bridges reaching design life).

   - ✓ As funding becomes more complex (mixing of capital and maintenance funds), tracking of costs becomes more difficult. Continue to improve accounting methods and practices so that investments can be tracked by asset (e.g., pavement, bridges, signals, buildings) as well as activity (e.g., preventive maintenance, striping, signing).

   - ✓ Increase preventive maintenance funding across all assets. Continue to develop and monitor performance measures.

3. **Continue to strive for improved efficiency and effectiveness in all maintenance areas.** *Mn/DOT's tools and available resources, as well as the conditions of assets, are constantly changing. As such, managers must periodically adjust maintenance practices and management strategies. To make good decisions, activities must be measured and evaluated with respect to the level of resources that are invested and the benefits received and/or levels of service that are provided for this investment. This process must continue to look at internal and external benchmarks, national standards, and internal best-management practices to improve efficiencies and effectiveness throughout the organization.*

   - ✓ Continue to initiate best management practice (BMP) meetings and peer-group reviews to evaluate efficiency of current practices and maintenance activities (e.g., snow and ice planning sessions and district comparisons, equipment utilization). In addition, Mn/DOT should find ways to implement the best management practices among various groups.

   - ✓ Seek and support technology enhancements that can improve effectiveness and efficiencies of maintenance activities, as well as better track inventories and condition of assets (e.g., sign management, AVL technology, weather systems, electronic time sheets and material usage).

   - ✓ Document efficiencies and develop a process for capturing and reallocating efficiencies gained to highest needs. Recognize achievements where efficiencies have been gained.

Table 2
Summary of HSOP Performance Measures

State Plan Policy	Category/Maintenance Activity		Performance Measure	Current Performance Level	Performance Target	Reasons for Performance Gap	Performance Implications of Closing Gap	Identified Budget Gap for First Biennium (2006-2007)		Identified Budget Gap for Second Biennium (2008-2009)	
								Capital	Operating	Capital	Operating
Policy 1 Preserve Essential Elements of Existing Transportation Systems	**3.1 Infrastructure Maintenance and Preservation**										
	3.1.1	Bridge Preventive Maintenance	Percentage of identified bridge preventive maintenance activities completed - Joint Repair (Strip and Poured Seals) - Deck Crack Sealing - Concrete Sealing (Deck and Railing Seals) - Flushing	94 percent - Strip Seals 72 percent - Poured Seals 86 percent - Deck Crack Sealing - Deck and Railing Seals[1] - Flushing[1]	96 percent - Strip Seals 77 percent - Poured Seals 80 percent - Deck Crack Sealing 74 percent - Deck and Railing Seals 87 percent - Flushing	- Bridge preventive maintenance has been low priority activity (minimal investments have been made in this activity)	- Expect a 4:1 return on investment		$6.6 million[2]		$6.6 million[2]
	3.1.2.1	Pavement Preventive Maintenance	-[3]	Not Applicable	Not Applicable	- Pavement preventive maintenance based on achieving minimum of 70% good pavement and 2% of poor pavement condition; performance varies depending on dollar investments in pavement preservation.	- Lower life-cycle cost - Increased Remaining Service Life - 8 to 1 return	$36.3 million[4]		$0 million[5]	
	3.1.2.2	Pavement Patching	Percentage of yearly dollars budgeted for patching that are spent.	$11 million spent in 2003; maintenance staff estimate that another 50 percent was needed.	To Be Developed	- Not enough investment in Capital Pavement Preservation - Funds diverted to Snow and Ice control	- Smoother Roads - Customer satisfaction		$11.0 million[6]		$11.0 million[6]
	3.1.3	Traffic Signal and Lighting Maintenance	Percentage of Priority 1 calls - repairs to begin within 20 minutes; Priority 2 and 3 calls - repairs to be completed within 1 to 3 days for signals and 1 to 3 weeks for lighting; Priority 4 and 5 calls to be repaired within four months.	To be Developed	To Be Developed	- Complexity of systems are increasing - Age of system is increasing - Two Electrician vacancies - Growth in number of lights (system) - Increase in power costs - Gopher One call peaks	- Fewer signal malfunctions - Less delay for drivers - More signal preventive work - Better response times to signal work - Fewer lighting outages - Replace knockdowns (per performance lighting goals)		$1.1 million[7]		$0.8 million[7]
	3.2 Supporting Infrastructure Maintenance and Management										
	3.2.1	Building Maintenance	Percentage of building replacement cost for annual maintenance.	1.5 percent	2.5 percent[8]	- Based on difference in spending as compared to State Facility Management Group standard (2.5% of facility value)	- Facilities meet design life - Lower life-cycle cost		$7.2 million[8]		$7.2 million[8]
		Building Functional Adequacy	Percentage of buildings (administrative and industrial) meeting functional needs.	78 percent	80 percent	- Large equipment and safety standards require upgrades - Gap based on physical and functional evaluation of building	- Reduce life-cycle cost	$25.0 million[9]		$25.0 million[9]	
	3.2.2	Fleet Management	Percentage of units within life-cycle. Percentage of units meeting utilization rate goals.	75 percent (life-cycle) 67 percent (utilization)	90 percent of units within life-cycle 95 percent units meeting utilization goals	- $1.7 Million budget reduction 2003-04 - Inadequate funding over a number of years has resulted in an older fleet; this will take time and more investment dollars to bring fleet back into efficient life-cycle.	- Reduce/optimize replacement/repair costs - Less demand on equipment maintenance and repair resources - Reduced fleet downtime and increased productivity	$5.8 million[10]		$5.8 million[10]	
	3.2.3	Electronic Communications Coverage	Measures statewide geographic coverage of communications systems (composite score)	77 percent	100 percent	- Industry trends toward digital technology - Lack of investment to keep current with technology migration - Need to maintain dual systems until conversion is complete	- Meet interim performance Targets - Increased system coverage	-$2.3 million[11]		$6.8 million	
		Electronic Communications Maintenance	Measures system reliability in terms of maintenance and repair activity	44 percent	94 percent	- Maintenance of multi-agency system	- Meet performance targets - Increased system reliability		$1.5 million		$1.3 million
	3.2.4	Information Technology (IT) Infrastructure Preservation	Percentage of servers and routers within industry recommended service life.	Servers - 54 percent Routers - 18 percent	90 percent of servers within service life 90 percent of routers within service life	- Reduced IT Funding - Lack of Budgeted Replacement Cycle - Server/Network expansions over the years - Previous replacement strategy not efficient	- Create consistent budget expectations - Maintain server performance - Maintain network uptime performance - Performance levels and feature needs met related to convergence		$1.2 million		$1.2 million
Policy 3 Effectively Manage the Operation of Existing Transportation Systems to Provide Maximum Service to Customers	**3.3 User Mobility and Travel Time Reliability** (primarily in the Twin Cities Metropolitan Area)										
	3.3.1.1	Freeway Incident Management (Travel Time Reliability)	Percentage of the Metropolitan Urban Freeway System that is instrumented with cameras and pavement sensors.	82 percent[12]	100 percent	- Increasing congestion on more freeway miles will drive need to manage more freeway miles for greater number of hours - Traffic volumes expected to increase, incidents expected to take longer to clear due to increase in number and reduction of staff for response/clearance	Improved incident clearance, better traveler information to allow more efficient use of road network	$7.3 million[12]	$0.5 million[12]	$2.6 million	$1.2 million
	3.3.1.2	Incident Response and Removal	Percentage of the instrumented MUFS that is covered by a FIRST team.	70 percent	100 percent	FIRST staff levels have not grown to meet expanding need for incident response, State Patrol staff levels have declined as need has grown, RTMC Staff for maintenance, operations, and integration has declined	Improved safety, reduced congestion		$0.7 million[13]		$1.3 million
	3.3.2.1	Planned Lane Closures	Percentage of all planned lane closures done at night as part of normal maintenance operations activities.	To Be Developed	To Be Developed	- As volumes rise, more miles are subject to night-time work, which is more costly but has less impacts on users. - Planned maintenance lane closures in the Twin Cities Metropolitan Area are done primarily at night by night maintenance crews and are causing the addition more night maintenance crews.	Provides flexibility to perform needed infrastructure repairs on Metro area roadways where the LCM prohibits daytime lane closures. Also maintains safety of roadway appurtenances for motoring public.		$0.6 million[14]		$0.9 million[14]

Table 2 Continued
Summary of HSOP Performance Measures

State Plan Policy		Category/Maintenance Activity	Performance Measure	Current Performance Level	Performance Target	Reasons for Performance Gap	Performance Implications of Closing Gap	Identified Budget Gap for First Biennium (2006-2007)		Identified Budget Gap for Second Biennium (2008-2009)	
								Capital	Operating	Capital	Operating
Policy 3 Effectively Manage the Operation of Existing Transportation Systems to Provide Maximum Service to Customers	**3.3 User Mobility and Travel Time Reliability - Continued** (primarily in the Twin Cities Metropolitan Area)										
	3.3.2.2	Unplanned Lane Closures	Identify, respond and clear unplanned lane blockages within two hours.	To Be Developed	To Be Developed	Many incidents (blow ups, barrier hits, flooding, truck overturns, etc) occur during a year on Metro area roadways. These require short term, emergency lane closures to maintain safety for the motorists. Have not authorized overtime for the purposes of responding to incidents, however, some weather/pavement conditions allow for reasonable anticipation of incidents occurring and data collected over the past several years shows us the likely locations.	Ability to respond to and repair emergency lane restrictions is enhanced and lane closure time is minimized (anticipated 1 hour time savings/incident).		$0.2 million[15]		$0.1 million[15]
	3.3.3	Signal Performance on Arterials	Average length of time between signal retiming evaluations	16 years	Four years	- Lack of capacity on freeways means arterials need to carry more traffic - Need better timing plans and system optimization - Better timing plans can reduce delays 10-15%	- Minimize congestion and delay - Reduced Maintenance costs - High benefit-cost ratio of 30:1		$0.5 million[16]		$0.5 million[16]
	3.4 Snow and Ice Management										
	3.4	Time to Bare Pavement by Route Type	Number of hours to achieve bare lanes after a weather event ends.	2.2 hrs Super Commuter 5.0 hrs Urban Commuter 7.0 hrs Rural Commuter 9.2 hrs Primary Collector 18.1 hrs Secondary Collector	1 to 3 hrs Super Commuter 2 to 5.0 hrs Urban Commuter 4 to 9 hrs Rural Commuter 6 to 12 hrs Primary Collector 9 to 36 hrs Secondary Collector	- New lane-miles - Increased number of lane miles in higher roadway categories - Labor intensive activity - increased labor costs - Inflationary pressures fuel, salt, steel (cutting edges) - Customer expectations have increased and it's a high priority for public	- Minimize budget impacts to other maintenance activity areas		$12.2 million[17]		$23.1 million[17]
Policy 7 Increase the Safety and Security of Transportation Systems and their Users	**3.5 Safety**										
	3.5.1	Striping	Percentage of pavement stripes that meet the minimum retro-reflectivity requirements.	95 percent	100 percent	- Thinner lines, less beads (03) - Move to more durable products	- Reflectivity targets will be met - Improved retro reflectivity and safety	$3.0 million[18] (6 inch stripe)	$2.4 million[19]	$3.0 million[18] (6 inch stripe)	$0 million[19]
	3.5.2	Signing	Percentage of signs replaced to meet the 12-year sign life-cycle.	85 percent	100 percent	- Meeting retro reflectivity standards - Growth in system size - District sign crews are being reduced. Insufficient capital dollars for interstate. - Backlog due to inadequate funding	No automated sign management system. Longer lasting VIP sheeting. Extend the cycle to 13-14 years and do a nighttime survey.	$3.4 million[20]	$4.2 million[20]	$0 million[20]	
	3.5.3	Guardrail	To Be Developed	To Be Developed	To Be Developed	- Growth in the number of installations, an increase in traffic volumes and a decreasing budget. - Lack of resources, the cost of materials, labor are increasing - No formal program to address/replace elements - just repair - Insufficient capital funds to replace existing deteriorated items	- Majority of backlog in Metro Area. - Guardrail is typically repaired and safety is maintained. - Guardrail is in place, functioning and provides necessary protection to drivers from roadside appurtenances.	$0.7 million Backlog	$0.8 million	$0.7 million Backlog	$0.8 million
							Total (in millions) =	**$77.88[18]**	**$50.68**	**$42.59[18]**	**$56.02**

Notes for HSOP

1 Due to limited data, current needs for these measures have not been established.

2 Based on seven preventive maintenance treatments with different life-cycles. Cost is $4.1 million per year with additional $134,000 per year catch-up.

3 This performance measure is a spending or input measure. The outcome to be achieved is a smooth pavement measured in District and Statewide Plans.

4 Pavement preventive investment levels are based on Mn/DOT's previous $40 million per year spending target. Current preventive levels of investment for 2006-07 are $43.7 million. Therefore, the funding gap is $80-$43.7 million = $36.3 million

5 Spending levels for 2008-09 biennium are identified and fully funded in District Long-range Transportation Plans.

6 Budget gap based on maintenance staff judgment that budget should be 50 percent more in order to address patching needs ($5.5 million per year).

7 Cost are based on needs for the major components of signal and lighting systems, and traffic management systems (signal poles and equipment - $100,000, signal cabinets - $390,000, lighting poles - $200,000, and Greater Minnesota ITS maintenance - $320,000). In the first biennium, the District Plan does not account for lighting pole needs.

8 The Statewide Facilities Management Group initially made a recommendation for 2.5 percent of replacement value or $11.3 million annually. The Legislature initially funded this at 2 percent of replacement value as part of 1996 legislation. This was later reduced to 1 percent in 2003. The national standard is 2.7 percent based on Building Owners and Managers Association (BOMA). This analysis includes buildings at rest areas.

9 Budget estimate is based on what is feasible to replace given current staff, not based on need (functional problems). These capital needs are not considered part of the District Long-range Plans. Budget split: $10 million capital operating and $15 million capital construction per biennium.

10 Budget gap based upon maintaining life-cycle targets for most predominant vehicle types.

11 Analog to digital conversion costs for the 2006-07 biennium were estimated at $7.7 million. $5 million per year was funded through state road construction funds from FY 2006 to 2008 for the microwave conversion project. Therefore, there is an excess of $2.3 million ($7.7 - $10 million) in the first biennium.

12 Assumes 25 miles constructed in 2005; based on instrumenting the remaining miles of the urban freeway system. Additional staff required to maintain and repair system ($225,000 per year).

13 Two additional FIRST routes 2006 and one additional route in 2007. The cost is $150,000 per additional route.

14 Includes conversion of day to night crews -$133,200 for labor costs and $336,500 in one time equipment costs (per crew basis).

15 Overtime for approximately 20 incidents per year ($50,000) and one time equipment start-up (better distribution of equipment throughout region)

16 Signal retiming includes one additional staff person and $160,000 for signal retiming studies for a total of $250,000 annually. This would result in a 4-year signal retiming frequency.

17 A portion of the snow and ice gap is based on equipment cost. The depreciation cost is also included in the fleet measure. These need to be reconciled.

18 Costs for conversion of 4 inch edgeline stripe to 6 inch edgeline stripe is not included in overall HSOP cost totals.

19 Striping needs for 2008-09 are identified and funded in District Long-range Plans ($4.85 million excluding metro).

20 $3.4 million capital (interstate signs plus sign materials for system growth and backlog); $4.2 operating for installation of backlog and system growth. In 2008-09 needs are included in District Plans.

Grand Totals for 2006-09 (in millions)	
Capital =	**$120.46**
Operating =	**$106.71**

4. **Continually improve reliability and credibility of performance measures**. *The credibility of the measures is important in managing the asset and communicating the needs to the public and policy-makers. It is imperative that good, reliable measures are developed and that data is tracked over time to establish historic patterns. This data can be used to evaluate current practices as well as predict impacts of changing investment levels or resources.*

   - ✓ Continually improve data collection and methodology for performance measures (e.g., pavement patching, guardrail, signing, and preventive bridge maintenance). As part of this process, consider independent review and verification of data.
   - ✓ Track historic data trends and report measures over time. Build trend-line data sets.
   - ✓ Forecast future performance and budget needs based on historic data.
   - ✓ Work to better define "winter severity" index and relationship of index to overall snow and ice removal cost. Track information over time to better compare snow and ice cost changes.
   - ✓ Compare standards and/or performance targets with applicable national standards from other available operations and maintenance plans.
   - ✓ Establish periodic audits of HSOP performance measures encompassing both performance and financial data.

5. **Continually improve knowledge of transportation factors (indicators) that affect maintenance activities, costs and performance levels**. *Maintenance of the 12,000-mile trunk highway system is a very complex business. There are numerous factors that affect the ability to control costs and performance. Tracking these factors over time will provide better knowledge of external impacts on performance levels and costs.*

   - ✓ Identify and document budgetary shifts and their effects to activity levels and performance. Snow storms, tornados, crashes that damage lights or signals, pavement blow-ups, wind storms, or the amount of flooding that may cause unusual shifts in investments in a particular year. As these events occur, priorities may have to shift to respond to these events. In addition, as time goes on, public perceptions and priorities can change. Mn/DOT needs to have some flexibility to respond to these activities, but should track their impact on other budget areas.
   - ✓ Monitor inflationary impacts (cost of materials and equipment) on maintenance activities, budgets and performance levels.
   - ✓ Track changes in size of the system and number of maintenance activities (e.g., number of lane miles, signals, signs, lights, bridges, guardrails, interchanges; events or work orders).

- ✓ Track influences of increasing traffic volumes on maintenance activities, budgets and performance levels.

- ✓ Document and monitor impacts of regulatory requirements and/or mandates that change maintenance practices, and costs.

- ✓ Track labor component of activities – consider impact of retiming workforce and training needs.

6. **Continue to develop strategies for improving individual maintenance activity areas.** *As part of the development of the plan, strategies were identified for individual performance measures.* The key strategies are summarized below and are described in more detail in Table 3:

   - ✓ ***Bridge Preventive Maintenance*** – Focus bridge preventive maintenance investments on activities that provide highest benefit-cost with respect to extending bridge life (i.e., joint repairs, flushing, crack sealing, and concrete seals). Develop better consistency for preventive bridge programs statewide and continue to institute sharing of best practices and performance between Districts.

   - ✓ ***Pavement Maintenance*** – Beginning in 2008, pavement strategies and investment levels will be data driven and guided by the pavement management system.

   - ✓ ***Traffic Signal and Lighting Maintenance*** – Begin to track preventive maintenance work orders; correct chronic maintenance intersections (remove signal heads to back of poles); try and improve restitution recovery percentage.

   - ✓ ***Buildings (Facility) Maintenance*** – Continue current inspection and prioritization process; current building maintenance practices and strategies to ensure that the most cost-effective practices are being employed; increase preventive maintenance to 2.5 percent.

   - ✓ ***Building Functional Adequacy*** – Look for ways to improve partnering with local officials and other state agencies (consider building revolving loan fund).

   - ✓ ***Fleet Management*** – Continue to institute management strategies and best management practices to increase equipment utilization and equipment within life-cycle.

   - ✓ ***Electronic Communications*** – Continue working with other state and local agencies to develop a statewide shared digital system at lowest life-cycle costs. Continue to provide clear message of benefits and rationale for conversion from analog to digital systems. Continue to monitor and track performance measures and provide frequent updates to agencies.

Table 3
HSOP Performance Measures Implementation Strategies

State Plan Policy	Category/Maintenance Activity		Short-Term Strategies (1 -year)	Mid-Term and Long-Term Strategies	Data Collection Issues	Implementation Issues	Performance Measure Implementation Responsibilities	Department Level Measure Reporting Mechanism[1]	Responsibility for Implementation of Strategies and Actions
Policy 1 Preserve Essential Elements of Existing Transportation Systems	**3.1 Infrastructure Maintenance and Preservation**								
	3.1.1	Bridge Preventive Maintenance	Develop methods for tracking preventive work and reporting performance; Develop implementation strategies (address traffic control/lane blockage issues) based on funding received. Investigate ways to develop bridge management program (counter part to pavement manage) that could help define fixes and manage overall structure investments.	Track costs for each activity; compare to original estimates and re-evaluate b-c benefits. Set-up research comparisons with similar structures (leave some structures with no preventive maintenance); track conditions and maintenance/rehab costs over time on these two groups. Continue to develop preventive maintenance cost-benefit information and adjust practice accordingly.	How to track and report. PONTIS?	Feasibility of work in metro due to high volumes. Difficulty in keeping money in preventive programs where impact or benefits are long-term (more pressing issues siphon off funding)	**Data Collection/Reporting–**Office of Bridges and Structures **Measure Review/Concurrence**–MBMT **Implementation Group**–Bridge, MBMT, OIM, and Finance	1. Annual Highway System Performance Report to Commissioner Staff 2. Annual Maintenance Performance Report to Commissioner Staff 3. Annual District Operations Bridge Report	District Operations Division
	3.1.2.1	Pavement Preventive Maintenance	Use pavement management system to determine timing and appropriate treatments. Focus investments towards lowest life-cycle costs. Have to verify theoretical information with field reviews.	Refine strategies and treatments as materials and knowledge of treatments change.		Difficultly in keeping money in preventive programs where impact or benefits are long-term (more pressing issues siphon off funding)	**Data Collection/Reporting–**Office of Materials **Measure Review/Concurrence–**Office of Materials **Implementation Group–**Materials, MBMT, OIM, and Finance	1. Annual Highway System Performance Report to Commissioner Staff 2. Annual Maintenance Performance Report to Commissioner Staff 3. Annual District Operations Pavement Report	
	3.1.2.2	Pavement Patching	Develop better way to measure patching need; potential to tie to amount and severity of pavement distresses.		Little data; need to develop better methodology to assess need.	Defining need? Tracking work? Track changes to budget or - Tracking work is the easiest of the three.	**Data Collection/Reporting–**Office of Materials **Measure Review/Concurrence–**MBMT **Implementation Group–**Materials, MBMT, OIM, and Finance	Report to District Operations-Frequency TBD	
	3.1.3	Traffic Signal and Lighting Maintenance	Continue to evaluate relamping work (group contracts, better lamps to reduce frequency); Develop standards of practice with design group for location of light poles in areas less likely to be hit; define chronic maintenance issues and develop schedule for resolution; Define preventive maintenance program for signal systems (set-up control group to assess preventive benefits over time); Define criteria for signal life-cycle replacement program different levels of replacement (whole system, heads, wiring, etc.)	Continue to track elements affecting service levels and costs (material costs, labor costs by work type, work orders, backlogs). Develop internal benchmarks to identify performance standards (how long does it take to do different repairs, average response times). Track these over time. Determine potential strategies for increasing restitution ($ captured from vehicle damage). Establish group to investigate efficiencies and best practices for this area. Work to increase use of tower lighting and reduce placement of light poles in areas that are susceptible to knockdowns. Evaluate benefits of preventive treatments vs. no preventive treatments (over time).	Need to report performance, include work orders for preventive work.	Many different layers - MESU, CESU, RESU; organizational issues - who is responsible and owns assets? Review business model?	**Data Collection/Reporting–**Office of Traffic, Security and Operations (OTSO) **Measure Review/Concurrence–**OTSO **Implementation Group–**OTSO, Metro Traffic Engineering, OIM, and Finance	1. Report to District Operations-Frequency TBD 2. Report to Metro Traffic and Maintenance Operations and Safety-Frequency TBD	
	3.2 Supporting Infrastructure Maintenance and Management								
	3.2.1	Building Maintenance	Define targets for additional preventive maintenance dollars (where should this be focused). Investigate security issues; define what is needed.	Document where additional dollars were spent and how this helped extend building life (show that dollars were well spent). Divest of properties not used any longer.		Bridge crews do much of work; staffing may be an issue with greater bridge preventive maintenance work.	**Data Collection/Reporting–**Office of Maintenance **Measure Review/Concurrence–**Office of Maintenance **Implementation Group–**Maintenance, MBMT, OIM, and Finance	1. Annual Maintenance Performance Report to Commissioner Staff 2. Annual Report to District Operations	Operations, Safety and Technology Division
		Building Functional Adequacy	Continue to document building conditions and replacement needs. Investigate the issues and legislation required to establish building revolving loan fund. Consider reallocating or changing the way building funds are allocated to encourage good decision-making about space and facility needs. Continue monitoring of environmental regulations to anticipate influences or requirements that affect maintenance and building functional use.			Dollars limited by staff resources.			
	3.2.2	Fleet Management	Work with Equipment Utilization task force to look at measures and targets, define best practices and implementation strategies. Define timing and responsibilities for these strategies. Review methods and accounting practices for charging equipment costs to other activities (how should this be done).	Track progress towards utilization and life-cycle goals, monitor costs and regulatory issues that are affecting costs. Meet at least annually among districts to discuss best practices for equipment utilization.		Better utilization of equipment by sharing. Reconcile vehicle depreciation with snow and ice measure.	**Data Collection/Reporting–**Office of Maintenance **Measure Review/Concurrence–**MBMT **Implementation Group–**Maintenance, MBMT, OIM, and Finance	1. Annual Maintenance Performance Report to Commissioner Staff 2. Quarterly Fleet Report to District Operations	
	3.2.3	Electronic Communications Coverage	Continue to convert system over time. Monitor and track performance measures and provide frequent updates to agencies. Continue to provide clear message of benefits and rationale for conversion. Investigate security issues of facilities - define needs.	Define accounting methods and practices so that implementation costs and budget shifts can be tracked to this asset. Is there a way to simply track different agencies contributions as well as costs for supporting specialized applications. Agencies will ultimately want to know how their cost share was arrived at. Monitor changing technologies, look for ways to get competitive pricing for communications hardware.		Multi-agency system; different needs by different users will be challenge.	**Data Collection/Reporting–**Office of Electronic Communications (OEC) **Measure Review/Concurrence–**O**EC** **Implementation Group–**OEC, OIM, and Finance	1. Report to Mn/DOT Upper Management and Legislature as part of the Biennial Budget process 2. Annual report to customers (DOT, DPS, and DNR) as a component of annual capitol improvement plan	
		Electronic Communications Maintenance	Work on developing partnerships with local agencies to spread costs and benefits to larger group of users. Need to document costs and potential savings. Is there a way to establish a baseline of costs under old system?	Staff recommendations; significant increase in infrastructure suggest need for more staff. Monitor changing technologies, look for ways to get competitive pricing for communications software.		How does one capture savings to users of system? In five years, legislature will probably need reminding why consolidation of systems occurred? Impact to Mn/DOT budget is greater than other agencies.		Report to Mn/DOT Upper Management and Legislature as part of the Biennial Budget process	
	3.2.4	Information Technology (IT) Infrastructure Preservation	Continue to monitor network availability/capacity and implement the proposed replacement cycle on routers and servers. Track server/router downtime and issues similar to existing network availability measures. Limit expansion of applications and best utilize existing infrastructure.	Continue to consolidate number of servers. Support the Drive to Excellence initiative to move towards networks and servers managed as a State Enterprise resource.			**Data Collection/Reporting–**Office of Information Technology (OIT) **Measure Review/Concurrence–**OIT **Implementation Group–**OIT, OIM, and Finance	Annual IT Performance Report to Commissioner's staff in October	

Table 3 Continued
HSOP Performance Measures Implementation Strategies

State Plan Policy	Category/Maintenance Activity		Short-Term Strategies (1 -year)	Mid-Term and Long-Term Strategies	Data Collection Issues	Implementation Issues	Performance Measure Implementation Responsibilities	Department Level Measure Reporting Mechanism[1]	Responsibility for Implementation of Strategies and Actions
Policy 3 Effectively Manage the Operation of Existing Transportation Systems to Provide Maximum Service to Customers	**3.3 User Mobility and Travel Time Reliability** (primarily in the Twin Cities Metropolitan Area)								
	3.3.1.1	Freeway Incident Management (Travel Time Reliability)	Continue to monitor changes in congestion on system to define needs. Better define and quantify benefits of monitored system versus unmonitored system. Develop performance/benchmarks for maintenance staff (staff required)	Complete instrumentation of MUFS	Need better data on ability of this type of system to clear incidents faster; benefits to public.	Unpopular with some legislators.	**Data Collection/Reporting–**Office of Traffic, Security and Operations (OTSO) **Measure Review/Concurrence–**OTSO **Implementation Group–**OTSO, OIM, and Finance	Annual Highway System Performance Report to Commissioner Staff	District Operations Division
	3.3.1.2	Incident Response and Removal	Investigate sponsorship of FIRST units. Continue to track events or responses to incidents, benefits of units, letters of or customer response to units. Continue to work with DPS to identify and pursue strategies to reduce incident response and removal time.	Track and/or monitor factors that affect cost of FIRST units, size of system, hours of operation, labor costs, equipment costs. Complete full monitoring of FIRST routes.	Continue to log all responses. Track events on an hourly basis and on monthly basis to help determine staffing levels. Also look at activity levels with respect to weather events.				Operations, Safety and Technology Division
	3.3.2.1	Planned Lane Closures	Continue to monitor changes in congestion on system to define implementation schedule and needs. Continue to develop implementation strategies for coordinating work between day and night crews.	Monitor and evaluate effectiveness of work crew activities. Document amount of work that has been moved to non-peak travel times (number of hours or percentage of maintenance etc).	Continue to track traffic issues as well as night crew-vs.-day crew costs and efficiencies.	Need to work within labor agreements-semi dependent on hiring ability.	**Data Collection/Reporting–**Metro District Office of Maintenance Operations **Measure Review/Concurrence–**Metro Maintenance Operations **Implementation Group–**Metro Maintenance Operations, OTSO, OIM, and Finance	Report to Metro Management Team (MMT)	District Operations Division
	3.3.2.2	Unplanned Lane Closures	Identify characteristics for pavement blowups (days when crews would be held over). Test methodology (number of correct days - effectiveness of methodology). Refine and use as best practice. Better define response time savings of this practice.	Monitor and evaluate effectiveness of work crew activities. Document benefits of better response times to traveling public.	Time savings and benefit-cost not well documented.	Relatively low-cost activity.			
	3.3.3	Signal Performance on Arterials	Identify locations for signal timing upgrades. Document benefits of retiming (user efficiencies)	As program re-evaluates intersections for a second time, evaluate to see if benefits are at same magnitude (adjust accordingly).		Need to focus on growth areas; volumes or pattern changes.			
	3.4 Snow and Ice Management								
	3.4	Time to Bare Lanes by Route Type	Solidify miles in each plowing classification; Track system changes; Improve and/or confirm winter severity index by capturing Mn/DOT effort (hrs/cost) by storm event. Continue to develop and drive best management practices through organization; resolve discrepancies between WMS and costing systems.	Continue to track elements affecting service levels and costs (material costs, labor costs, equipment costs, system changes, and volume increases). Develop efficiency goals (pursue AVL, anti-icing, and pre-wetting).	Improve consistency of cost data and ability to compare between winters. Reconcile vehicle depreciation issue with fleet measure.	How to quickly drive "best practices" through whole organization is a function of dollars and training and acceptance.	**Data Collection/Reporting–**Office of Maintenance **Measure Review/Concurrence–**MBMT **Implementation Group–**Maintenance, MBMT, OIM, and Finance	1. Annual Maintenance Performance Report to Commissioner Staff 2. Mid-year and end of year reports to District Operations 3. Monthly Electronic reports	District Operations Division
Policy 7 Increase the Safety and Security of Transportation Systems and their Users	**3.5 Safety**								
	3.5.1	Striping	Define impacts of reduced line thickness and less beads on life-cycle. Better monitor and track construction striping. Continue to track and monitor new products, technology, and costs and efficiencies of striping crews.	Continue to investigate advantages (life-cycle) of new products and how they will impact retro-reflectivity.	Better accounting of construction lines in striping assessment.		**Data Collection/Reporting–**Office of Traffic, Security, and Operations **Measure Review/Concurrence–**MBMT **Implementation Group–**OTSO, Maintenance, MBMT, OIM, and Finance	1. Annual Maintenance Performance Report to Commissioner staff 2. Annual Striping report to District Operations	District Operations Division
	3.5.2	Signing	Investigate the potential costs, technologies, and implementation issues of a sign management system for state; continue to evaluate sign life-cycle based on reflectivity measures (determine if there should be a shift to 15 year cycle).	Implement sign inventory system or method for better tracking replacements	Need better inventory - field sign management system. No inventory; longer sign life complicates replacement process.	Concern about sign management system implementation cost; usability for crews, especially in metro.		1. Annual Maintenance Performance Report to Commissioner staff 2. Annual Signing report to District Operations	
	3.5.3	Guardrail	Investigate the potential costs and methods for establishing a guardrail inventory to better define needs and replacement timeframes. Look at opportunities to reduce the number of types of guardrail used (reduce parts inventory and training issues). Expand performance measure to include cable median barrier maintenance and repair.	Document material cost increases, and frequency of repairs (number of incidents). Can this be correlated to traffic volumes or changes in location.	No inventory; no systematic replacement program.	Size of exiting infrastructure is large.	**Data Collection/Reporting–**Office of Maintenance **Measure Review/Concurrence–**MBMT **Implementation Group–**Maintenance, OTSO, MBMT, OIM, and Finance	Annual Guardrail Report to District Operations (proposed)	

Notes

[1] Teams should report on measures, measure development, data, and strategies being pursued to achieve targets.

- ✓ ***Information Technology Infrastructure Preservation*** – Continue to develop performance measure and data, track user impacts of server and/or router problems. Consider adding switches to measure for next HSOP plan.

- ✓ ***Freeway Incident Management (Travel Time Reliability)*** – Evaluate expansion of instrumented MUFS system; track benefits of instrumentation; provide more information using electronic message boards to motorists; and identify potential funding sources to expand the system.

- ✓ ***Incident Response and Removal*** – Continue to pursue sponsorships to fund FIRST expansion; and track workloads, response times and responses per vehicle or route to provide a cost-effective service. Continue to work with DPS to provide coordinated incident response and removal services.

- ✓ ***Planned Lane Closures*** – To minimize user impacts, shift more maintenance work to night crews (track increasing traffic volumes on MUFS, document limited time periods for work using Lane Closure Manual).

- ✓ ***Unplanned Lane Closures*** – Track historic pavement blow-up areas, response, times to clear blow-ups, weather characteristics, and preparation of equipment, to evaluate ability to reduce user delays. Investigate ways to limit future pavement blow-ups or other emergency repairs that are necessary.

- ✓ ***Signal Performance on Arterial Routes*** – Increase frequency of signal retiming studies to three to four years, versus nine years today; document benefit-cost of timing studies.

- ✓ ***Snow and Ice Maintenance*** – Continue tracking of snow and ice costs; labor, equipment, materials versus regain time; correlate costs and regain time with severity index; increase efficiency efforts through pre-wetting, anti-icing, equipment modifications, and AVL technology. Continue to refine Winter Severity Index methodology.

- ✓ ***Pavement Striping*** – Continue to track striping costs for both epoxy and latex (overall costs per foot as well as component costs for labor, equipment, and materials), crew efficiency measures (cost per foot), initial retro reflectivity, and life-cycle of materials to reduce overall costs and increase efficiency.

- ✓ ***Signing*** – Develop an automated sign inventory system to track repair, maintenance, and replacement of signs to efficiently manage the system as well as ensure that signs are being replaced at the end of their useful life. Continue to correlate sign reflectivity and legibility with sign age as a proxy for sign replacement.

- ✓ ***Guardrail*** – Develop inventory of potentially deficient guardrail areas and incorporate these areas into ongoing life-cycle replacement programs and/or adjacent projects.

7. **HSOP Implementation.** *While roles and responsibilities for individual performance measures have been outlined in the implementation matrix (Table 5-1), overall strategic guidance and management are critical to the success of the plan. The figure below illustrates the relationships of Mn/DOT Divisions, Districts and functional areas to the plan.*

- ✓ ***District Operations Division*** is responsible for HSOP oversight. Duties include assuring that implementation assignments are carried out in a timely fashion, results are communicated to decision makers, and processes are put in place to secure and focus resources to areas that require them.

- ✓ ***Expert Offices*** will supply technical knowledge, data analysis, ongoing performance measure support, and data maintenance.

- ✓ ***Maintenance Business Management Team (MBMT)*** will act as the link between the plan itself and ongoing maintenance and operations activities as well as providing operational experience and feedback on current and proposed measures, including performance targets, data integrity and analysis, and best practices.

- ✓ ***Metro District Maintenance Operations*** will play a similar role to that of the expert office but for those measures specific to the Metro District (planned lane closures, unplanned lane closures, and signal performance on arterials).

- ✓ ***Office of Finance*** will assist in assuring financial consistency in the plan. The HSOP relied on various systems to analyze costs and report financial needs. Financial consistency is essential to the plan's success.

- ✓ ***Office of Investment Management*** will coordinate the HSOP with other planning and programming activities, and offer measurement reporting assistance and guidance.

- ✓ ***Other Functional Groups (PCMG, OMG, TEO, etc.)*** can review HSOP products, supply members to implementation groups, and communicate HSOP priorities and principles to their membership.

8. Issues to be addressed in future plans or requiring additional investigation. *Listed below are a few important maintenance and operations issues confronting Mn/DOT that were not fully addressed in this plan. The impacts of these issues are not entirely known at this time, but are likely to require substantial investigation and evaluation. It is recommended that Mn/DOT continue to work on these areas to assess potential impacts of these issues.*

- ✓ ***Develop performance measures for maintenance and operations activities not included in this initial plan*** – Mn/DOT conducts many maintenance and operations activities. Not all could be included in this plan. Listed below are current activities identified by Mn/DOT to be pursued in future plans.

  - Bridge Inspection
  - Bridge Repair
  - Shoulder and Edge Drain Maintenance
  - Traffic Information
  - Maintenance Project Work Zone Management
  - Construction Staging
  - Traffic Demand Management
  - Permitting
  - Snow Removal from Park & Ride Lots
  - Work Zone Management (mobility)
  - Work Zone Safety
  - Roadside Clear Zones
  - Roadway Sweeping
  - Edge Drain Cleaning and Repair
  - Noise wall Repair and Maintenance
  - Roadsides – Native Species
  - Clean Fuels

- ✓ ***Homeland Security*** (security issues were not thoroughly included in the HSOP analysis) – They were identified as part of building/site and other infrastructure discussions. These need to be further explored and separate investments need to be allocated towards these needs.

- ✓ ***Environmental*** – There are significant environmental regulatory issues that will impact Mn/DOT's operations. These regulations will affect storm water management (NPDES – Phase III), highway maintenance, and a number of building maintenance issues such as water re-use (wash bays). In addition, new diesel engine requirements are expected to add significant costs to diesel trucks in coming years. These elements need to be investigated and evaluated with respect to funding and impacts on operations.

- ✓ ***Roadsides*** – Historically, roadside maintenance has a limited affect on safety, mobility, and preservation of infrastructure assets. Also, from user perspective, roadside maintenance has been a low-priority when compared with safety, mobility, and preservation activities. On the other hand, cleanliness is important to the user as it affects the quality of their trip. The trade-off of providing increased roadside maintenance with respect to costs of this activity should be evaluated further during the budgeting process.

- ✓ ***Rest Areas*** – Rest areas are another component of the transportation system that Mn/DOT is responsible for in terms of infrastructure condition as well as operations. Building maintenance was covered under measure 3.2.1 "Building Maintenance," however, the replacement or adequacy of these facilities was not addressed. Future HSOP plans should analyze the rest area program to assess the performance levels and investment needs to meet customer expectations.

- ✓ ***Partnerships*** – Greater efficiency may be realized through continued and expanded use of shared facilities and fleet (e.g., Hutchinson Area Transportation facility). Mn/DOT should continue to investigate and pursue maintenance and operations partnerships with other public agencies, including DNR and DPS.

- ✓ ***Administrative Plan*** – Mn/DOT will consider developing a performance based plan to address administration and overhead activities not encompassed by either the District Long-Range plans or the Highway Systems Operation Plan.

9. HSOP Plan Update. *It is recommended that this plan be updated every two years to coincide with biennial budget discussions. The next update should include updates to data including financial numbers, performance measures and targets. In addition it should consider developing measures for areas identified in eight above.*