Chapter 5

RISK MANAGEMENT ANALYSIS: SUPPLEMENTAL INFORMATION

RISK MANAGEMENT ANALYSIS: SUPPLEMENTAL INFORMATION

Overview

This chapter provides a detailed description of the various processes involved in identifying and prioritizing the risks and mitigation strategies described in the TAMP. MnDOT's approach to Enterprise Risk Management is presented in this chapter, along with the steps involved in determining the undermanaged risks presented in the TAMP. The risk management analysis efforts resulted in the production of risk registers specific to each asset category considered in this TAMP. The summarized core content of these risk registers is provided as an attachment at the end of the chapter, along with additional information compiled by each asset Work Group.

Process

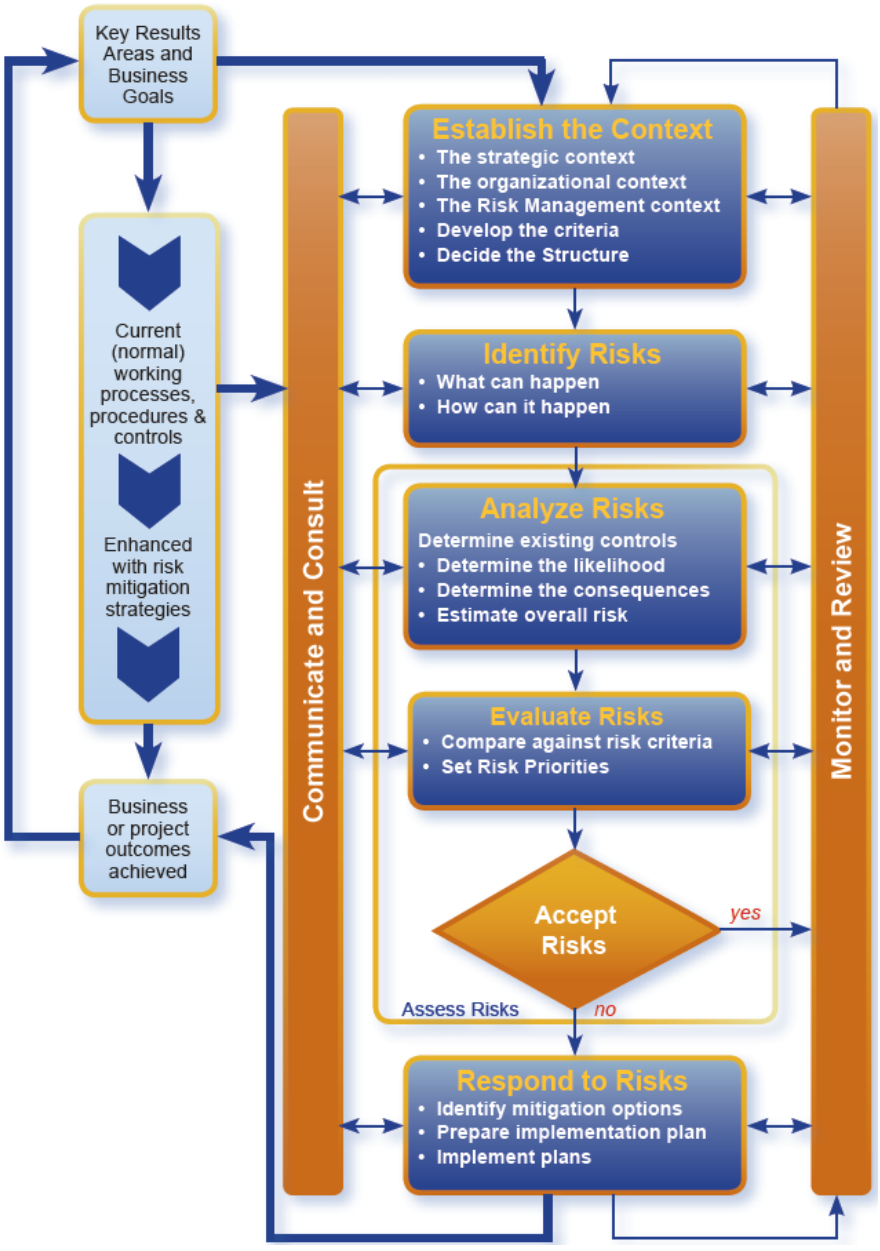
MnDOT's Enterprise Risk Management (ERM) framework – which is used to assess, prioritize, and manage strategic/global risks across the department – is discussed in this section, followed by a discussion of the step-by-step process used in identifying, prioritizing and costing the undermanaged risk opportunities.

ENTERPRISE RISK MANAGEMENT FRAMEWORK

MnDOT has implemented an ERM framework as an integral part of its business processes (illustrated in Figure 5-1[1]). The framework begins with identification of Key Results Areas, which are the MnDOT's priority business and investment objectives. Business planning for these Key Results Areas includes an assessment of strategic risks by senior executives. Business line management groups then assess strategic and business line risks affecting the achievement of their objectives and the delivery of their products and services. At an even more detailed level, project managers identify the risks that threaten project objectives such as scope, schedule, and cost.

Supporting these risk assessment processes, MnDOT maintains a risk register[2], reflecting at any given point in time the current status of strategic and business line risks, including relevant performance measures. The integrated risk register discusses the likelihood and consequences of strategic risks, along with potential impacts in the following areas:

Figure 5-1: MnDOT's Enterprise Risk Management Framework



[1] Source: *MnDOT Enterprise Risk Management Framework and Guidance* (2013).
[2] http://www.dot.state.mn.us/riskmanagement/pdf/july_2013-strategic_risk_register_report.pdf

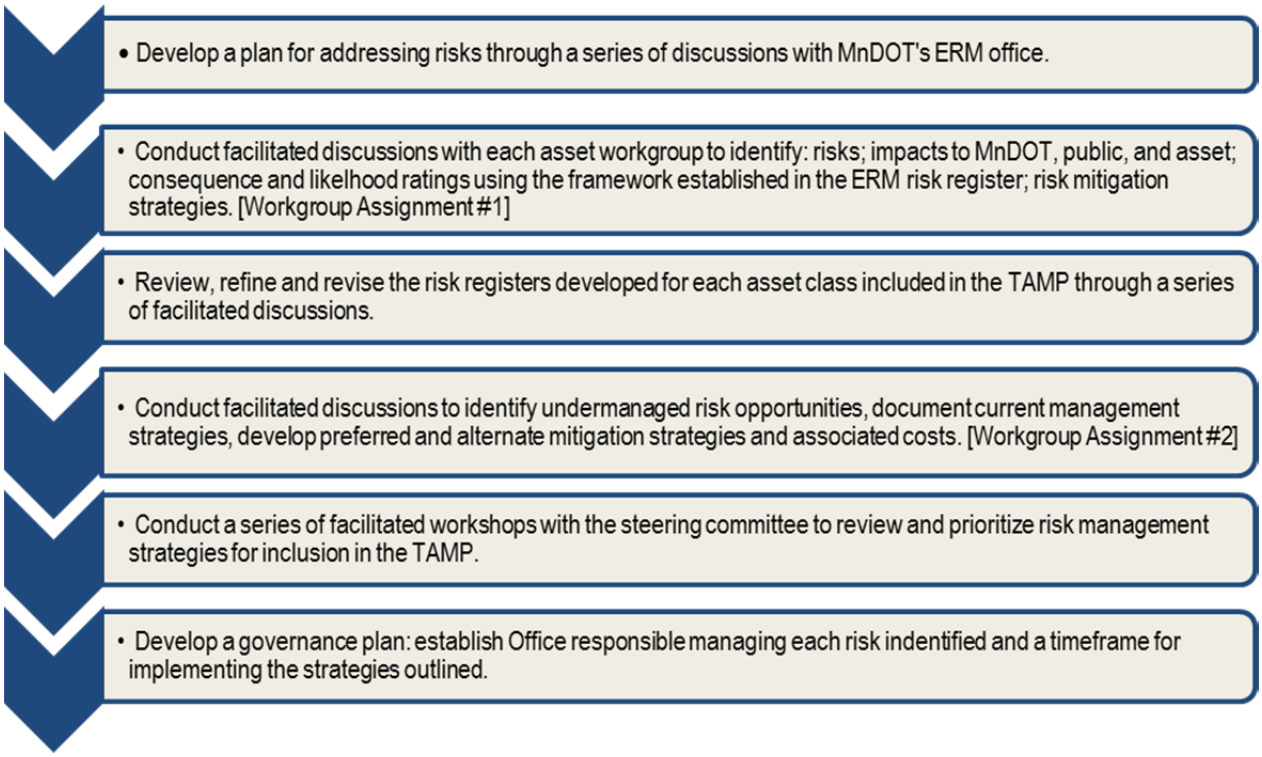
- Agency reputation
- Business performance and capability
- Finance
- Security of assets
- Management effort
- Environment
- Legal and compliance
- Health and safety
- Quality
- Stakeholder engagement

The risk register also provides a risk mitigation plan and a governance structure that indicates the division responsible to manage a particular risk. Since the global/strategic risks (e.g. natural hazards, accidents and crashes, traffic congestion) are already handled effectively through the ERM process, the TAMP focuses on undermanaged risks and opportunities to management/mitigate those risks though process changes and/or capital investments. This procedure is discussed in further detail in the following sections.

RISK MANAGEMENT ANALYSIS PROCEDURE USED IN THE TAMP

The step-by-step approach used in identifying the undermanaged risks is illustrated in Figure 5-2.

Figure 5-2: TAMP Risk Management Analysis Process



WORK GROUP ASSIGNMENT #1: IDENTIFY BROAD RISKS AND IMPACTS (AUGUST/SEPTEMBER 2013)

The first assignment completed by each asset Work Group included the determination of the broad list of risks relevant to each asset class included in the TAMP and the impact of the risk on the asset, the public, and MnDOT. The Work Groups also documented existing control/mitigation strategies being used, gaps in existing business protocols that are preventing MnDOT from managing the risks effectively and the ideal mitigation strategy for the risk identified.

Figure 5-3 summarizes the comprehensive list of risks identified by the asset Work Groups. These lists were discussed among the Work Group participants and those risks that were considered to be undermanaged are shown in italics. The remaining risks (not identified as being undermanaged) are either being addressed through the current management practices and protocols in place for each asset or they are already addressed through the ERM framework (discussed earlier). The undermanaged risks were reviewed in further detail during the development of the strategies for mitigating/managing these risks, identified during the second Work Group assignment. The complete set of documentation developed by the asset Work Groups as a part of the Work Group Assignment #1 is provided as an attachment at the end of this chapter.

Figure 5-3: Risks Identified by Asset Work Groups

PAVEMENTS	BRIDGES
• *Not meeting public expectations for pavement quality/condition at the state/district/local levels* • *Inappropriately managing or not managing pavements such as frontage roads, ramps, and auxiliary lanes* • Inability to meet federal requirements (such as MAP-21, GASB, etc.) • Inability to appropriately manage to lowest life-cycle cost • Premature deterioration of pavements • Significant reduction in funding • Occurrence of an unanticipated event such as a natural disaster	• *Lack of or deferred funding* • *Inability to manage to lowest life-cycle cost* • Occurrence of an unanticipated natural event • Catastrophic failure of the asset • Significant damage to the asset through manmade events • *Premature deterioration of the asset* • Shortage of workforce
HIGHWAY CULVERTS AND DEEP STORMWATER TUNNELS	**OVERHEAD SIGN STRUCTURES AND HIGH-MAST LIGHT TOWER STRUCTURES**
• *Failure/collapse of tunnel/culvert* • *Flooding and deterioration due lack of tunnel capacity* • *Lack of culvert capacity* • *Inability to appropriately manage culverts* • Inability to appropriately manage tunnels • Inappropriately distributing funds or inconsistency in culvert investments • Significant damage to culverts through manmade events	• Lack of having a mandated process for inspection • *Poor contract execution* • *Inability to manage to lowest life-cycle cost* • Significant damage to asset through manmade events • Premature deterioration of the asset • Unforeseen changes in regulatory requirements, travel demands, or technology • *Shortage of workforce*

RISK WORKSHOP #1: VALIDATION OF UNDERMANAGED RISKS AND STRATEGY IDENTIFICATION FOR TOP UNDERMANAGED RISKS (SEPTEMBER 2013)

During this workshop, representatives from MnDOT's ERM office provided a brief overview of MnDOT's approach to risk management and how the agency's standardized risk assessment process aligns with the preliminary risks identified by each asset Work Group (shown in Table 5-1). The presentation, which involved members of the Steering Committee as well as Work Group participants, further discussed the proposed plan to focus the TAMP on undermanaged risks. The participants agreed to the approach and participated in a facilitated discussion to identify general mitigation/management strategies for the top undermanaged risks.

Following this workshop, a meeting was held with TAMP Project Management team (on September 26, 2013) to discuss the results of the risk assessment workshop and the next steps. At the conclusion of this meeting, the asset Work Groups, in conjunction with the representatives of MnDOT's ERM office, were tasked with developing comprehensive risk statements that could be used to develop strategies that would help control/mitigate the highest risks. In order to finalize the risk management analysis section of the TAMP, another assignment, which focused on reviewing the undermanaged risks identified in closer detail and developing specific mitigation strategies, was undertaken by the Work Groups (discussed in the next section).

WORK GROUP ASSIGNMENT #2: REVIEW UNDERMANAGED RISKS AND DEVELOP PREFERRED AND ALTERNATE MITIGATION STRATEGIES (OCTOBER/NOVEMBER 2013)

The second assignment completed by the asset Work Groups built on the previous information but specifically focused on the undermanaged risks. The step-by-step procedure followed by the Work Groups to complete this assignment is summarized below:

- Step 1: Define preferred mitigation strategy for addressing the risk identified.
- Step 2: Identify data, resources, tools, and/or training required to enact the strategy.
- Step 3: Describe whether the strategy will reduce the likelihood of another identified risk.
- Step 4: Estimate the approximate cost of implementing the preferred mitigation strategy.
- Step 5: Identify whether an alternate strategy might be available that doesn't fully mitigate the risk but lowers the overall likelihood or consequence associated with the risk.
- Step 6: Estimate the cost associated with the alternate strategy.
- Step 7: For both strategies developed, identify the impact on likelihood and consequence of the original risk should either of the strategies be adopted.

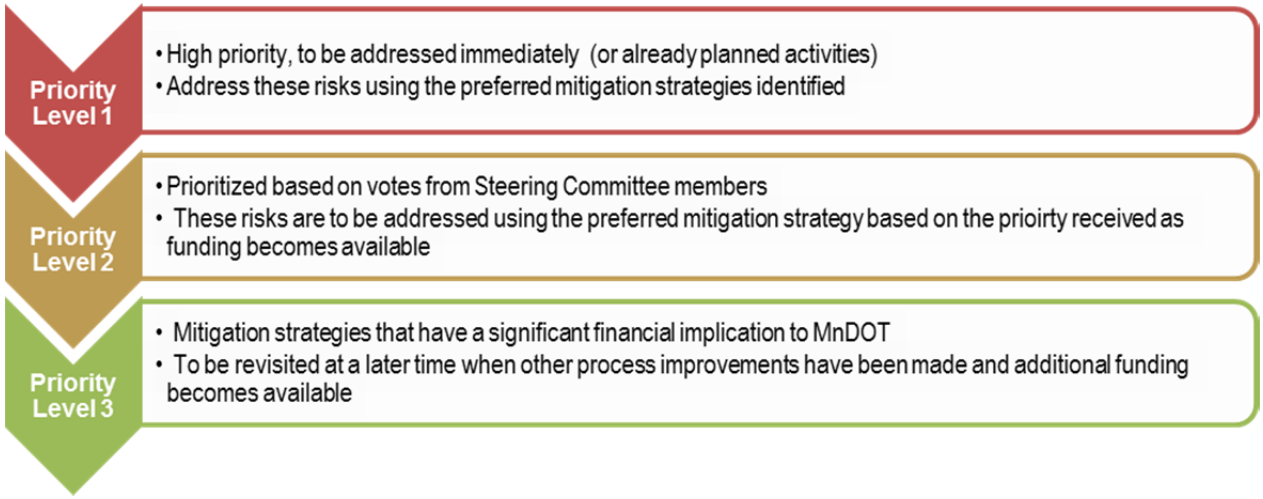
A detailed version of the guidance provided to the Work Groups on Assignment #2 and the results are provided as attachments at the end of this chapter.

RISK WORKSHOP #2: PRIORITIZATION OF RISK MITIGATION STRATEGIES (NOVEMBER 2013)

The undermanaged risks developed by the Work Groups were organized into one of two broad categories: "Capital Investments" or "Process Improvements". Those risks that were considered to be process improvements were ranked by the workshop participants. Strategies that involved capital investments were not included in the prioritization process because those risks would likely be addressed elsewhere within MnDOT. Also, process improvement initiatives that were considered to be very low-cost activities that provided a high return on investment were excluded from the prioritization process because they were clearly high priorities and most of them were already underway. Based on votes from the Steering Committee members, the risk mitigation strategies associated with bridge process improvements received the highest priority, followed by process improvements for highway culverts, deep stormwater tunnels, pavements, and overhead sign structures / high-mast light tower structures.

The results of the Risk Workshop #2 were then used to develop final priorities for the TAMP using the general process summarized in Figure 5-4. (Results of this process are summarized in Figure 5-7 of the main TAMP document).

Figure 5-4: Prioritization Strategy for Risks to be Managed by MnDOT



Supporting Data and Documentation

As discussed in the previous sections, a number of documents were prepared as part of the risk management analysis efforts undertaken by the asset Work Groups. These include:

- Results of Work Group Assignment #1: Identify Broad Risks and Impacts
- Results of Work Group Assignment #2: Review Undermanaged Risks and Develop Preferred and Alternate Mitigation Strategies and Costs

The key findings related to the undermanaged risks (from Work Group Assignments #1 and #2) are summarized in this section, and detailed worksheets prepared by the Work Groups as supporting documentation and detailed instructions are provided at the end of the chapter.

SUMMARY OF FINDINGS FROM THE RISK MANAGEMENT ANALYSIS WORK GROUP EFFORTS

The Work Group process was iterative and extended over two formal workshops, with opportunities between workshops to modify certain aspects of the product. Participants took advantage of the process to learn about the risks, assess the ability of existing information systems to quantify risks and costs, and reach consensus on priorities and approaches for future improvements. Undermanaged risks identified in the TAMP are summarized in the following sections.

PAVEMENTS

The Pavements Work Group developed two risk statements and a set of mitigation strategies and risk ratings for each of them. Figure 5-5 summarizes the risk management analysis performed by the Work Group.

Figure 5-5: Pavement Risk Management Analysis Summary

Risk Statement (#1) Mitigation Strategies, Impacts on Other Risks, and Costs

Risk Statement #1:

Non-Attainment of Objectives: If public expectations for pavement quality or condition are not met, especially at the local/corridor level, then the agency's reputation may suffer, service delays and unsafe conditions may increase and the cost of maintenance may grow.

- Current control/mitigation strategies: Using money to manage to lowest life-cycle cost including routine maintenance; money distributed statewide based on need; implementation of performance measures and targets; balanced funding across entire system; MAP-21 direction to allocate funding to the National Highway System; staging of more timely and appropriate treatments; and multiple fixes at each location or on each corridor.
- Previously identified mitigation strategies: More timely and appropriate staging of treatments; multiple fixes at location or on corridor (only if LCC treatment intervals modified); more systematic and standardized statewide approach to fixes.

Preferred Mitigation Strategy, Resources, and Costs:

Annually track, monitor and identify roadway segments that have been in Poor condition greater than five years, and consistently consider this information when programming at the district level. The cost would be eight hours of staff time to run a report and coordinate with districts during annual programming activities. (*Process Improvement Strategy*)

Effect on Other Risks: May reduce the risk of failing to comply with GASB Statement 34 requirements.

Alternate Mitigation Strategy and Costs:

Jurisdictional realignments, to divest maintenance responsibility onto other agencies. Divestiture could cost $200,000 per mile to bring roads up to a standard necessary for acceptance by another agency. An outreach plan and communication strategy – at a possible cost of $25,000 – may reduce the potential loss of reputation if the MnDOT fails to meet objectives.

Likelihood and Consequence of Adverse Impacts

	Consequence	Likelihood	Risk Rating
Original Risk Rating	Major	Likely	High
Preferred Strategy	Major	Possible	Medium
Alternate Strategy	Moderate	Likely	Medium

Risk Statement (#2), Mitigation Strategies, Impacts on Other Risks, and Costs

Risk Statement #2:

Exclusion of Auxiliary Roads: If MnDOT does not include ramps, access roads, auxiliary lanes and frontage roads in its pavement inventory and use their condition in its pavement model, then these assets will not be included in pavement management decisions and cannot be managed to achieve the lowest life-cycle cost for all highway pavements.

- Current control/mitigation strategies: None.
- Previously identified mitigation strategies: Increased indefinite-quantity or blanket-type projects to address localized distresses, with better tracking of deterioration and condition.

Preferred Mitigation Strategy, Resources, and Costs:

1. Collect additional data in the Metro District with the use of the old Material Office pavement van, at an estimated cost of $100 per mile. (*Process Improvement Strategy*)
2. Build a stand-alone database that will house pavement data and allow for better tracking, with a cost range of $2,000 to $20,000. (*Process Improvement Strategy*)

Alternate Mitigation Strategy and Costs:

Collect data in Greater Minnesota districts by hand, using maintenance staff. Visually collect images through video capture or windshield survey. These would cost around $100/mile to collect data and additional cost/time to enter information into the database.

Likelihood and Consequence of Adverse Impacts

	Consequence	Likelihood	Risk Rating
Original Risk Rating	Minor	Possible	Low
Preferred Strategy	Minor	Unlikely	Low
Alternate Strategy	Minor	Unlikely	Low

BRIDGES

Figure 5-6 summarizes the bridge risk management analysis performed by the Bridge Work Group. The Work Group developed two risk statements, an integrated set of mitigation strategies, and associated risk ratings.

Figure 5-6: Bridge Risk Management Analysis Summary

Risk Statements (#1 & #2) Mitigation Strategies, Impacts on Other Risks, and Costs

Risk Statement #1:

Life-Cycle Cost: If bridge inspection data, bridge model sophistication, and bridge deterioration models are not accurate or complete, then it may be difficult to determine the lowest life-cycle cost strategy for bridges.

- Current control/mitigation strategies: BRIM (Bridge Replacement and Improvement Management) system; SIMS (Structure Information Management System); performance measures.
- Previously identified mitigation strategies: Link BRIM, SIMS, Swift (MnDOT financial management system), contract preservation costs and AASHTOWare Bridge Management 5.2 (bridge management system) in order to make appropriate management decisions; develop a preventive maintenance performance measure; improve knowledge of deterioration curves.

Risk Statement #2:

Premature Deterioration: If one or more bridges deteriorate prematurely, then maintenance costs may be higher than expected and there may be unanticipated risks to structural integrity.

- Current control/mitigation strategies: Inspection and maintenance tracking to try to anticipate needs; ability to track and prioritize work.
- Previously identified mitigation strategies: Better inspection and maintenance tracking; better knowledge of deterioration curves; implementation of the AASHTOWare Bridge Management 5.2 system.

Preferred Mitigation Strategy, Resources, and Costs (Process Improvement Strategy:

1. Finish development of SIMS Maintenance Module.
   - This system is currently in development. MnDOT has in-depth maintenance data back to 2009 which needs to be migrated into the SIMS Maintenance Module.
   - Requires 50 Trainees and 2 instructors for eight 4-hour training sessions located around the state, plus curriculum development and data migration. The total effort is about 400 hours.
2. Develop the Preventive Maintenance (PM) Program, including a performance measure to verify that PM is performed at the right time. This will require collaboration with MnDOT districts, including annual meetings.
3. Develop a Business Intelligence reporting tool to link SIMS and Swift.
   - This is currently in the data discovery phase, and no cost estimate has yet been prepared.
   - Training for three power users with one instructor for two full-day sessions would total 64 hours. Training for 29 regular users with one instructor for one full-day session would total 240 hours.
4. Migrate inspection and maintenance data to AASHTOWare Bridge Management 5.2 (when completed), create and utilize the deterioration curves. As part of this step, existing bridge element condition data will need to be converted according to upcoming Federal requirements and AASHTO specifications.
   - Multi-state collaboration for AASHTOWare development costs $50,000 per year for five years (29 states are participating).
   - MnDOT will need resources and equipment to test and implement the BrM 5.2 system. MnDOT will need to develop deterioration curves and cost models from Minnesota data.
5. Link Construction Costs with Maintenance costs in the new Business Intelligence reporting tool.
6. Link BRIM and AASHTOWare BrM 5.2, which will allow future bridge data and models to participate in the BRIM risk analysis.
7. Compare cost, age, and performance trends of the bridge system to determine effectiveness of management strategy, and adjust accordingly.
8. Research to further identify lowest life-cycle cost (e.g. deterioration models, effectiveness of maintenance activities, products, etc.)
   - Deck deterioration and National Bridge Element research is currently in progress.
   - Other research may be needed.

Approximate Cost of Preferred Mitigation Strategy: $2 million. This represents a one-time implementation cost. Following implementation, this will be a low-cost strategy to maintain annually.

Effect on Other Risks: The preferred strategy will mitigate both of the risks identified in this exercise (manage to lowest life-cycle cost and premature deterioration) as well as help to mitigate the lack or deferral of funding.

Alternate Mitigation Strategy and Costs:

1. Finish development of SIMS Maintenance Module (already in progress).
2. Develop the Preventive Maintenance (PM) program and performance measure (in progress) to verify that PM is performed at the right time.
3. Cost accounting tracking through existing systems (WOM, Financial Reports). These systems are not tied with maintenance data in SIMS.
4. Migrate inspection and maintenance data to AASHTOWare BrM 5.2 (when completed) and create/utilize the deterioration curves. As part of this step, existing bridge element condition data will need to be converted according to upcoming Federal requirements and AASHTO specifications.

Under this alternate strategy, the Business Intelligence reporting tool would not be used and BRIM would not be linked to future bridge inspection data.

Approximate Cost of Alternate Mitigation Strategy: $1.4 million. This represents a one-time implementation cost. Following implementation, this will be a low-cost strategy to maintain annually.

Likelihood and Consequence of Adverse Impacts

	Consequence	Likelihood	Risk Rating
Original Risk Rating	Moderate	Likely	Medium
Preferred Strategy	Minor	Likely	Medium
Alternate Strategy	Moderate	Likely	Medium

HIGHWAY CULVERTS

Figure 5-7 summarizes the highway culvert risk management analysis performed by the Hydraulics Work Group.

Figure 5-7: Highway Culvert Risk Management Analysis Summary

Risk Statement, Mitigation Strategies, Impacts on Other Risks, and Costs

Risk Statement:

Inability to manage culverts: If highway culverts are not managed effectively, then the risk of failure and the life-cycle cost of ownership may increase.

- Current control/mitigation strategies: MnDOT (partially) inventories and inspects highway culverts and the information is used to plan maintenance work and project scoping activities. Highway culvert failures are repaired when they occur.
- Previously identified mitigation strategies: Additional funding to be able to implement a systematic management approach based on targeted work, complete life-cycle cost understanding, data provided, shared and used by design, construction, maintenance.

Preferred Mitigation Strategy, Resources, and Costs:

1. Adopt a system condition performance measure, and set performance targets. This will need about 200 hours of staff time. (*Process Improvement Strategy*)
2. Implement the proposed Asset Management System and gather data that will support life-cycle cost analysis (*Process Improvement Strategy*). This will require:
   - Funds to purchase and implement Transportation Asset Management System – at least $1 million and 1000 hours of staff time.
   - Staff and consultant resources to develop business rules – roughly $50,000 in costs and 500 hours of staff time.
   - Staff and consultant resources to collect data for the asset management system. This is estimated to require 16,000 hours per year.
3. Repair or replace highway culverts in accordance with Asset Management System recommendations through capital

projects and maintenance work. This is estimated to require $40 million per year. (*Capital Investment Strategy*)

Effect on Other Risks: The preferred strategy will reduce the likelihood of road failure, interruption of service, lack of adequate capacity, and land owner drainage complaints. The strategy will also reduce the risk of not being able to support the HydInfra information system currently used for culvert data.

Alternate Mitigation Strategy and Costs:

Stand-alone construction projects to repair or replace Poor and Very Poor highway culverts. This would entail $1.25 million to implement the Transportation Asset Management System (does not include life-cycle cost functionality) and 800 staff hours. The cost to repair or replace culverts would need to be significantly more than the current $30 million per year and likely more than the $40 million in the preferred strategy, to clear the existing backlog and stabilize future performance.

Likelihood and Consequence of Adverse Impacts

	Consequence	Likelihood	Risk Rating
Original Risk Rating	Moderate	Almost Certain	High
Preferred Strategy	Moderate	Possible	Medium
Alternate Strategy	Moderate	Likely	Medium

DEEP STORMWATER TUNNELS

The Hydraulics Work Group developed two deep stormwater tunnel risk statements and a set of mitigation strategies and risk ratings for each. Figure 5-8 summarizes the risk management analysis performed by the Work Group.

Figure 5-8: Deep Stormwater Tunnel Risk Management Analysis Summary

Risk Statement (#1) Mitigation Strategies, Impacts on Other Risks, and Costs

Risk Statement #1:

Capacity: If stormwater tunnel capacity is not adequate for a major rain event and resulting pressurization is too great, then the tunnel will be damaged or collapse, local flooding may occur, property may be damaged, and people may be killed or injured.

- Current control/mitigation strategies: None.
- Previously identified mitigation strategies: Provide a new tunnel system and back charge City of Minneapolis; City to separate its water (as much as possible); downsize new/modified system as much as possible to save costs

Preferred Mitigation Strategy, Resources, and Costs:

1. Complete research on underground storage options, including the exploration of shallow cavern storage options for South (I-35W) tunnel. The estimated cost is $30,000. Then build the I-35W South underground storage cavern, at a cost of $50 million. (*Process Improvement Strategy*)
2. Develop and implement emergency response plan for business, residential, and freeway areas along the flood-prone I-35W South tunnel. The estimated cost is $15,000. (*Process Improvement Strategy*)

Effect on Other Risks: May reduce the risk of failing to comply with GASB Statement 34 requirements.

Alternate Mitigation Strategy and Costs:

Build the I-35W South underground storage cavern, at a cost of $50 million.

Likelihood and Consequence of Adverse Impacts

	Consequence	Likelihood	Risk Rating
Original Risk Rating	Catastrophic	Likely	Extreme
Preferred Strategy	Catastrophic	Rare	High
Alternate Strategy	Catastrophic	Rare	High

Risk Statement (#2), Mitigation Strategies, Impacts on Other Risks, and Costs

Risk Statement #2:

Disrepair: If the needed maintenance repairs are not made in a timely manner, then tunnels may collapse in a major rain event, and significant property damage, loss of life, or extensive service disruption may occur and significant reconstruction costs may be necessary.

- Current control/mitigation strategies: Tunnels, with the exception of one, have been thoroughly inspected once to gauge baseline condition. Repairs have been prioritized.
- Previously identified mitigation strategies: MnDOT and communities prioritize construction funding. Establish detour routes

in advance; map extent of possible flooding; increase funding for rehabilitation, perform data collection and inspection to determine life-cycle costs and deterioration rates; work with Cities to redefine management of tunnels to more of a coordinated effort.

Preferred Mitigation Strategy, Resources, and Costs:

1. Inspect the one remaining uninspected tunnel at a cost of $50,000. (*Process Improvement Strategy*)
2. Install pressure transducers in tunnels to measure pressurization. Cost undetermined. (*Process Improvement Strategy*)
3. Design and implement a mandated inspection frequency (1-5 years) based on tunnel/segment condition rating, at an average cost of $250,000 per inspection. (*Process Improvement Strategy*)
4. Include tunnels in the bridge inventory. This will require cooperative work with district offices and the Central Office bridge group, and may require consultant assistance. (*Process Improvement Strategy*)
5. Prepare plans and implement all repairs needed on the South I-35W tunnel system at MnDOT cost, with City of Minneapolis funding used for all other known repairs on all other tunnels. This may require transportation bond financing of $12 million, which has already been allocated by MnDOT. (*Capital Investment Strategy*)

Effect on Other Risks: This work will improve MnDOT credibility in the event of a failure. It will strategically fix the worst tunnel repair needs. It may reduce the likelihood of failure by having increased information on tunnel condition – as long as funding is available for repairs when conditions warrant it.

Alternate Mitigation Strategy and Costs:

1. Staff from MnDOT (likely Metro Bridge Maintenance), trained on inspections, complete them on select tunnel segments after major rain events.
2. MnDOT hires a consultant to complete inspections on each tunnel, as identified by mandated inspection guidelines.
3. Begin repairs incrementally and withhold funding to cities on other projects if proposed repair schedules are not met. This is estimated to cost an average of $3.5 million per segment.

Likelihood and Consequence of Adverse Impacts

	Consequence	Likelihood	Risk Rating
Original Risk Rating	Catastrophic	Possible	High
Preferred Strategy	Catastrophic	Possible	High
Alternate Strategy	Catastrophic	Rare	Medium

OVERHEAD SIGN STRUCTURES AND HIGH-MAST LIGHT TOWER STRUCTURES

The Overhead Sign Structures / High-Mast Light Tower Structures Work Group developed three risk statements and a set of correlating mitigation strategies. Figure 5-9 summarizes the risk management analysis performed by the Work Group.

Figure 5-9: Overhead Sign Structures and High-Mast Light Tower Structures Risk Management Analysis Summary

Risk Statement (#1) Mitigation Strategies, Impacts on Other Risks, and Costs

Risk Statement #1:

Construction Defects: If overhead sign structures and high-mast light tower structures are not properly installed as part of a construction project, then they may deteriorate more rapidly, requiring more subsequent maintenance.

- Current control/mitigation strategies: None.
- Previously identified mitigation strategies: Better quality controls (e.g. MnDOT inspections) of construction work outside of edge-of-pavement-to-edge-of-pavement; better checklist to include roadside infrastructure; routine/mandatory workshops at end of each construction project.

Preferred Mitigation Strategy, Resources, and Costs:

1. Change construction specifications to require torque threshold dye washers. This would entail a one-time investment of 40 hours of staff time, and an increased annual cost of $20,000 per year. (*Process Improvement Strategy*)
2. Communicate punch list and specifications with companies that install structures and with construction inspectors. This might increase staff time requirements by 200 hours per year. (*Process Improvement Strategy*)

Effect on Other Risks: Reducing the risk of poor contract execution should extend the life of the structure and reduce maintenance costs, thus reducing life-cycle costs.

Alternate Mitigation Strategy and Costs:

MnDOT Maintenance will tighten the nuts on all new structures. A one-time cost of $40,000 would be needed to purchase additional machinery necessary to secure the structures, plus an increased annual cost of $2,000 for additional staff and equipment.

Likelihood and Consequence of Adverse Impacts

Likelihood and Consequence of Adverse Impacts			
	Consequence	Likelihood	Risk Rating
Original Risk Rating	Minor	Likely	Medium
Preferred Strategy	Minor	Rare	Low
Alternate Strategy	Minor	Rare	Low

Risk Statement (#2) Mitigation Strategies, Impacts on Other Risks, and Costs

Risk Statement #2:

Life-Cycle Cost: If overhead sign structure and high-mast light tower structure inspection data and deterioration models are not accurate or complete, then it may be difficult to determine the lowest life-cycle cost for these assets.

- Current control/mitigation strategies: Bridge Office Structural Metals and Bridge Inspection Engineer notify Electrical Services after pole is inspected as to what repairs are required for each pole.
- Previously identified mitigation strategies: Develop an enterprise asset management system for better tracking of asset status and better assignment of responsibility for condition and work accomplishment information.

Preferred Mitigation Strategy, Resources, and Costs:

1. Adopt a MnDOT policy/technical memo requiring a five-year inspection frequency for all overhead structures (approx. 40 staff hours). (*Process Improvement Strategy*)
2. Report annually on inspection frequency results (approx. 40 hours per year). (*Process Improvement Strategy*)
3. Create a training program for inspecting and maintaining structures, develop inspection forms, develop clear condition rating criteria. This would require a one-time cost of 320 hours, plus about 80 hours per year. (*Process Improvement Strategy*)
4. Gain efficiencies by using mobile technology in the field, at a cost of about $10,000 per year. (*Process Improvement Strategy*)

Alternate Mitigation Strategy and Costs:

Use consultants to perform the work, and/or increase inspection intervals. An average of $800 per structure was previously paid for external inspection. Internal inspections cost roughly $100 per structure.

Likelihood and Consequence of Adverse Impacts

	Consequence	Likelihood	Risk Rating
Original Risk Rating	Minor	Likely	Medium
Preferred Strategy	Minor	Rare	Low
Alternate Strategy	Minor	Likely	Medium

Risk Statement (#3), Mitigation Strategies, Impacts on Other Risks, and Costs

Risk Statement #3:

Labor Shortage: If MnDOT is unable to provide a sufficient number of workers to maintain high-mast light tower structures or overhead sign structures, then inspections, maintenance, repairs and replacement may fall short of service standards.

- Current control/mitigation strategies: None.
- Determine risk to public if MnDOT staff is decreased; cross training of staff (redundancy in knowledge).

Preferred Mitigation Strategy, Resources, and Costs:

1. Implement the proposed Transportation Asset Management System to include a work order, resource, and materials cost tracking module. This would entail a one-time cost of $250,000 and annual costs of $100,000 for software maintenance and usage costs. (*Process Improvement Strategy*)
2. Report annually on life-cycle cost and identify and implement refined/additional strategies to reduce costs, at a cost of 80 staff hours per year. (*Process Improvement Strategy*)

Alternate Mitigation Strategy and Costs:

1. Maintain status quo with replacement cycle of 40-50 years.
2. When an overhead sign structure or high-mast light tower structure are due for replacement, remove and replace with 6-8 standard lights or ground mount overhead.
3. Conduct research that will better define/determine deterioration rates and collect additional information.

Likelihood and Consequence of Adverse Impacts

	Consequence	Likelihood	Risk Rating
Original Risk Rating	Minor	Possible	Low
Preferred Strategy	Minor	Rare	Low
Alternate Strategy	Minor	Rare	Low

Work Group Assignment #1: Identification of Pavement Risks (including undermanaged)

Column 1	*Column 2*	*Column 3*	*Column 4*	*Column 5*	*Column 6*	*Column 7*	*Column 8*	*Column 9*	*Column 10*	
Risks:	**Impact of not managing the risk effectively to: (you do not have to have impacts in all three areas for each risk)**			**Has MnDOT been managing this risk effectively?**			**What is the risk rating?**			**Most Undermanaged Risk**
				If Yes, List control/mitigation strategies used	**If No:**		**Consequence of Risk Occurring**	**Likelihood of Risk Occurring**	**Overall Risk Rating**	
	Asset	**Public**	**MnDOT**		**List gaps in current business protocols preventing MnDOT from managing the risk effectively**	**Ideal Mitigation Strategy(ies)**				
Not Meeting Public Expectations for Pavement Quality/Condition	Strain on Rest of System; Economy; Lower Quality of Life; Traveler Safety; Higher Maintenance Costs	Economy (commodities); Lower Quality of Life; Traveler Safety; Service Delays for Traveling Public;	Reputation Higher Maintenance Cost, and other asset maintenance is deferred.	Using money to manage to lowest lifecycle cost including routine maintenance; money distributed statewide based on need, measures & targets; balanced across entire system; MAP-21 direction (allocates $ on NHS); staging of treatments (more timely & appropriate treatments); multiple fixes at location or on corridor		Staging of treatments (more timely & appropriate treatments); multiple fixes at location or on corridor (IF LCC TREATMENT INTERVALS MODIFIED)	Moderate	Possible	Low	x
Statewide							Moderate	Possible	Low	
District Level						Small portion of DRMP is condition based	Moderate	Likely	Medium	
Local Level - Corridor (predicted or premature)						Manage expectations	Major	Likely	High	
Inappropriately Managing or Not Managing Pavements Such as Frontage Roads, Ramps, Auxiliary Lanes, etc.						Increased IDIQ or BARC type projects to address localized distresses	Minor	Possible	Low	x
Federal MAP-21 and GASB Requirements	Shorter/Wrong Fixes (e.g. Medium Mill & Overlay vs. Major Rehab./Construction)	Traveler Safety	Federal Funds withheld, bond rating impacted.	Same as above	Funding assigned to pavement has been too low, leading to low RQI, now it's difficult to catch up.	Provide funding to actually exceed targets, so that we could endure occasional budget shortfalls.	Major	Rare	Low	
Inability to Appropriately Manage Lowest LCC for Pavements	Project Deferrals/Delays or Shorter Term Fixes; Increased Operations Costs. Construction costs go up as conditions worsen. Missing Data and/or Hidden Costs (scope creep)	More Poor Roads; Traveler Safety. More auto repairs, more money spent on gas, risk of tax increases.	Additional Strain on MnDOT Maint./Operations Staff; Additional Funding Needed for Fixes	Same as above		Consistency on types of fixes statewide; managed system-wide (balance between project, district or statewide LCC - all three different); better coordination across offices and jurisdictions (e.g. pavement, safety, bridge, hydraulics, etc.) - think all inclusive corridor investments. Inventory and include all pavement in Pavement Management System.	Moderate	Possible	Medium	
Premature Deterioration of Pavements	Project Deferrals/Delays or Shorter Term Fixes; Increased Operations Costs	More Poor Roads; Traveler Safety	Additional Strain on MnDOT Maint./Operations Staff	Same as above		District Risk Management Program (DRMP) changes to align with shifts in pavement condition; Begin to document	Moderate	Possible	Medium	
Funding Being A Lot Less than Expected	More Poor Roads	More Poor Roads; Traveler Safety	Reputation	Same as above		Invest only in roads with ADT above a certain number (e.g. 2000 ADT)	Minor	Possible	Low	
Occurrence of an unanticipated event, natural disaster	Assets unusable	Service Delays, Traveler safety	Additional funding needed for fixes			Invest network-wide when unforeseen costs occur, stretch funding	Major	Rare	low	

Work Group Assignment #1: Identification of Bridge Risks (including undermanaged)

Column 1	*Column 2*	*Column 3*	*Column 4*	*Column 5*	*Column 6*	*Column 7*	*Column 8*	*Column 9*	*Column 10*			
Risk of:	**Impact of not managing the risk effectively to: (you do not have to have impacts in all three areas for each risk)**			**Has MnDOT been managing this risk effectively?**			**What is the risk rating?**					**Most Undermanaged Risks**
				If Yes, List control/mitigation strategies used	**If No:**		**Consequence of Risk Occurring**	**Likelihood of Risk Occurring**	**Overall Risk Rating**	**Discussion Comments**		**Validation**
	Asset	**Public**	**MnDOT**		**List gaps in current business protocols preventing MnDOT from managing the risk effectively**	**Ideal Mitigation Strategy**						
Lack of or deferred funding (e.g., unexpected budget cuts)	Highest needs first; more reactive maintenance; low cost preservation to limp assets along; more frequent inspections	Potential for unsafe driving conditions; increased service interruptions; decreased public confidence; bridge or route restrictions	Do not meet performance targets; defer non-critical repairs; unmanageable growth of bridge needs; increased operations resource needs	BRIM (Bridge Replacement and Improvement Management); SIMS (Structure Information Management System)	SIMS Maintenance Module (in progress); linking costs to maintenance tasks (Swift, SIMS and BI); SIMS, BRIM and construction cost data not linked; implementation and use of a multi-objective optimization tool in BrM 5.2 (in development)	Link BRIM, SIMS, Swift, contract preservation costs and BrM 5.2 in order to make appropriate management decisions	Moderate	Possible	Medium	Does the likelihood of this risk concur with OCPPM?	x	The management programs (and links between the management programs) are not in place to be able to manage from an "entire system" asset management and life cycle cost approach.
Inability to manage to lowest life-cycle cost (e.g., preventive activities not performed on a timely basis)	Deteriorates faster (reduced bridge service life); more reactive maintenance; higher life cycle cost; manage highest needs first	Increased duration and frequency of service interruptions; decreased public confidence; bridge or route restrictions	More bridges falling into lower service conditions faster; do not meet performance targets; increased operations resource needs	BRIM; SIMS; Performance Measures	SIMS Maintenance Module (in progress); linking costs to maintenance tasks (Swift, SIMS and BI); SIMS, BRIM and construction cost data not linked; Preventive Maintenance Performance Measure still in development; Deterioration Curves; implementation and use of the multi-objective optimization tool in BrM 5.2 (in development)	Link BRIM, SIMS, Swift, contract preservation costs and BrM 5.2 in order to make appropriate management decisions; Preventive Maintenance Performance Measure; Deterioration Curves	Minor to Moderate	Likely	Medium	We could have a >$5M risk potential.	x	The management programs (and links between the management programs) are not in place to be able to manage from an "entire system" asset management and life cycle cost approach.
Occurrence of an unanticipated natural event (e.g. flood, earthquake, adverse weather)	Unexpected need - more resources assigned to that asset; scheduled bridge investments are deferred	Safety; increased service interruptions; detours; congestion	Changed maintenance program: top needs are redefined; unanticipated resources assigned to a single asset and other priorities are deferred	Design preventive measures; regular scour monitoring for scour critical bridges; debris removal; having resources available to react; ability to track and prioritize work	Maintenance resource and scheduling still in development (SIMS Maintenance Module); Up to date emergency response plan or critical infrastructure plan	Preventive Measures; Emergency Response Plan; Resource and Scheduling to reallocate resources	Major Moderate Minor	Rare to Unlikely Possible Likely	Low to Medium Medium Medium	Is this a major event? Are we looking at this from a statewide perspective or a local perspective? This could have three different answers for consequence and likelihood depending on the severity of the event and the perspective.		
Catastrophic failure of the asset (e.g., unexpected bridge collapse)	Unexpected need - more resources assigned to that asset; scheduled bridge investments are deferred	Safety; increased service interruptions; detours; congestion; decreased public confidence	Changed maintenance program: top needs are redefined; unanticipated resources assigned to a single asset and other priorities are deferred; management strategy and policies are investigated and redefined	Inspection frequency and best practices; performing required maintenance; having resources available to react; designing resilient bridges	Comprehensive Inspection Manual (in progress); Up to date emergency response plan or critical infrastructure plan	Inspection and Maintenance; Emergency Response Plan	Catastrophic	Rare	Medium			
Significant damage to the asset through man made events (e.g., crashes, damage from construction activities etc.)	Unexpected need - more resources assigned to that asset; scheduled bridge investments are deferred	Safety; increased service interruptions; detours; congestion	Changed maintenance program: top needs are redefined; unanticipated resources assigned to a single asset and other priorities are deferred	Having resources available to react; ability to track and prioritize work; inspection, permitting and restitution processes; preventive measures; designing resilient bridges	Up to date emergency response plan for at risk bridges; Maintenance resource and scheduling still in development (SIMS Maintenance Module); Restitution tracking; Linking Costs to Maintenance Tasks	Preventive Measures; Emergency Response Plan; Resource and Scheduling to reallocate resources; Inspection; Permitting process; Restitution	Major	Unlikely	Medium	Are we only looking at significant damage? Bridge hits and accidents happen more often than "unlikely" represents, but they do not all result in "significant" damage. What percentage of the bridge system is actually affected? This may be more of a localized risk.		
Premature deterioration of the asset (e.g., service lives 10 to 20 percent shorter than expected)	Unanticipated reactive maintenance or major investments required sooner; reduced service life	Increased duration and frequency of service interruptions; bridge or route restrictions; safety; decreased public confidence	Do not meet performance targets; changed maintenance program; increased operations resource needs	Inspection and maintenance tracking to try to anticipate needs; ability to track and prioritize work	SIMS Maintenance Module (in progress); Deterioration curves; implementation and use of the multi-objective optimization tool in BrM 5.2 (in development)	Inspection and Maintenance tracking; Deterioration curves; BrM 5.2	Moderate to Major	Unlikely	Medium	Is this from a "whole system" perspective or from an individual bridge perspective? This will affect the consequence and likelihood values.	x	The management programs (and links between the management programs) are not in place to be able to manage from an "entire system" asset management and life cycle cost approach. Need improved deterioration models for our bridges.
Shortage of workforce (e.g., early retirements and hiring freezes)	Maintenance not performed when needed; impacts to design, scoping, estimates, load rating, data management, etc.	Decreased public confidence; increased service interruptions	Not enough resources to perform the work and lack of knowledgeable and experienced workers to perform the work efficiently and effectively.	Bridge training program; Bridge Maintenance Academy training; technology; Consultant Contracts	Performance and Efficiency Measures for performing all tasks (design, load rating, scoping, estimates, inspection and actual maintenance on the structure) as well as the link between the measures	Training; Measures; Consultant Contracts	Minor to Moderate	Possible	Low to Medium	What is the magnitude of this event? Depending on the magnitude, a shortage of workforce could be considered a moderate consequence as far as financial impact, service interruptions, and significantly impacted programs (design, construction, load ratings, maintenance, inspection etc).		

Work Group Assignment #1: Identification of Hydraulic Structures Risks (including undermanaged)

Column 1	*Column 2*	*Column 3*	*Column 4*	*Column 5*	*Column 6*	*Column 7*	*Column 8*	*Column 9*	*Column 10*	
Risks:	**Impact of not managing the risk effectively to: (you do not have to have impacts in all three areas for each risk)**			**Has MnDOT been managing this risk effectively?**			**What is the risk rating?**			**Most Undermanaged Risk**
				If Yes, List control/mitigation strategies used	**If No:**		**Consequence of Risk Occurring**	**Likelihood of Risk Occurring**	**Overall Risk Rating**	
	Asset	**Public**	**MnDOT**		**List gaps in current business protocols preventing MnDOT from managing the risk effectively**	**Ideal Mitigation Strategy(ies)**				
Tunnel Failure/Collapse	Strain on Rest of Tunnel System	Trauma or Death to Traveling Public and or Residents; Increased Congestion on Other Arterials and Local System; Service Delays for Traveling Public; Increased Flooding on Roadway & Adjacent Business/Residential	Highways Closures; Loss of Public Trust/Reputation; Large, Short-Term, Immediate Financial Impacts	No	Funding for Repairs and Maintenance. Not a high priority for agency; Inspection/maint. of tunnels done by Cities (need more of a joint process, merge of priorities)	MnDOT and Communities prioritize construction funding. Detour routes established in advance; map extent of possible flooding; increase funding for rehab., data collection & inspection (determine LCC & deterioration); work with Cities to redefine management of tunnels to more of a coordinated effort	Catastrophic	Likely	Extreme	2nd Highest Tunnel Risk
Flooding and Deterioration due to lack of tunnel capacity	Increased Rate of Deterioration; Deterioration of Sandstone Layer Adjacent Tunnel Lining From Pressurized Water	Increased Flooding on Roadway & Adjacent Business/Residential; Loss of Commerce; Tunnel Failure/Collapse	Increased Flooding on Roadway; Deterioration of Tunnels & Other Assets; Loss of Public Trust; Loss of Commerce; Increased Cost to Replace at a Later Time	No	Shared water with City of Minneapolis; Based on maintenance agreement, City of Minneapolis would have cost share and have said they do not have the money	Provide new system & back charge City; City to separate its' water (as much as possible); Downsize new/modified system as much as possible to save costs	Catastrophic	Possible	High	Highest Tunnel Risk
Inability to Appropriately Manage Tunnels (i.e. lack of data, no LCC or deterioration rates; adequate inspection, etc.)	Increased Risk of Failure	Increased Travel Delays	Increased Risk of Failure; Financial Impact to Repair Over Life of Asset	Inspections	Shared maintenance agreements with City of Minneapolis; Shared water with City of Minneapolis; Minneapolis tunnels in worse condition; Frequency of inspections	MnDOT pays and charges Minneapolis interest and/or reduces funding on other projects that City wants; Put information in bridge inventory, not just HydInfra; pressure transducer; installation and monitoring	Moderate	Likely	Medium	
Culvert Failure/Collapse	Requires roadway reconstruction or repair with culvert replacement	Safety of Traveling Public (e.g. car damage, injury or death/fatalities); Service Delay; Emergency Service Disruptions; Flooding to Adjacent Properties	Considerable impact to MnDOT's reputation if fatalities would occur. Higher cost of emergency repairs compared to maintenance.	Partially, have implemented inventory and inspection program to identify bad culverts and begun repairing some pipes. Should minimize surprise failures.	Insufficient funding for adequate maintenance and repairs. Not all culverts needing repaired are fixed during construction projects. MnDOT Maintenance staffing inadequate to address drainage needs.	Culverts identified as in poor or very poor condition are fixed by MnDOT maintenance or in construction projects. Culverts identified as very poor are fixed before failures cause major repair impacts.	Major	Likely	High	Highest Culvert Risk
Lack of Culvert Capacity	Culvert and road failure (e.g. caused by high head, road overtopping, scour or piping)	Detours, delays or property damage (e.g. Flooding to Adjacent Properties)	Staff and funding needed to address problems (e.g. law suits, flood damage, road and culvert repairs and detours)	No	Insufficient resources to upsize culverts and concerns of passing additional water downstream. (e.g. permitting requirements, environmental, ROW impacts, liability)	Parties causing upsize need participate financially. Evaluations done on case by case basis but more resources will be needed. May require designing more storage and investing in flood easements. Watershed coordination.	Minor	almost certain	Medium	3rd Highest Culvert Risk
Inability to Appropriately Manage Culverts (i.e. lack of data, no LCC or deterioration rates; age, adequate inspection, etc.)	Greater likelihood of culvert failure. Higher life cycle cost.	Pays more for drainage infrastructure maintenance; potential traffic impacts, exposure to culvert failure risk. Lack of Ability/Time to Work with Partners to Actually Improve Hydraulics serving constituents.	MnDOT pays more over life cycle, more for emergency repairs, may suffer impacts to trust and confidence. May be investing inefficiently (e.g. Under or Over Investing; Inability to Leverage Appropriate Funding to Meet Targets)	Partially; MnDOT has invested heavily in inventory and condition data collection, a rigorous drainage performance measure remains to be selected. A department wide measure would result in more systematic management of the system.	Selection of a repair measure and target, and corresponding funding. Missing data in HydInfra (i.e. date built, construction as-built, repair records). Robust LCC methodology.	Funding to be able to implement a systematic maintenance approach based on targeted work , complete LCC understanding, data provided and shared by design, construction, maintenance.	Moderate	Possible	Medium	2nd Highest Culvert Risk
Inappropriately Distributing Funds or Inconsistency on Investing in Culverts	Higher likelihood of localized failures	Potential inconsistent levels of service geographically; Potentially differing risks in Safety of Traveling Public (e.g. car damage, injury or death); Service Delay; Emergency Service Disruptions; Flooding to Adjacent Properties	Districts need to make hard decisions about where to spent limited funds, backlogs of needed maintenance or repair could develop.	Unknown	Lack of funds and ability to manage culverts in a cost effective manner	More funds, better information to manage culverts with less money.	Minor	Possible	Low	
Significant Damage to Culvert Through Man-Made Event(s)	Culverts are damaged (e.g. utility installation, vehicle hits apron, damage from fire)	Bears costs ($'s, Inconvenience etc).	Costs to repair culverts.	Unknown	Difficult to predict or prevent.	Respond when event happens.	Insignificant	Likely	Low	

Work Group Assignment #1: Identification of Overhead Sign Structures & High-Mast Light Tower Structures Risks (including undermanaged)

Column 1	*Column 2*	*Column 3*	*Column 4*	*Column 5*	*Column 6*	*Column 7*	*Column 8*	*Column 9*	*Column 10*	
Risk of:	**Impact of not managing the risk effectively to: (you do not have to have impacts in all three areas for each risk)**			**Has MnDOT been managing this risk effectively?**			**What is the risk rating?**			**Most Undermanaged Risk**
				If Yes, List control/mitigation strategies used	**If No:**		**Consequence of Risk Occurring**	**Likelihood of Risk Occurring**	**Overall Risk Rating**	
	Asset	**Public**	**MnDOT**		**List gaps in current business protocols preventing MnDOT from managing the risk effectively**	**Ideal Mitigation Strategy**				
Lack of having a mandated process for inspection	Lower Asset Quality (Not a priority for agency so work (i.e. inspection/fixes) doesn't get completed in a timely manner	increased risk of safety and/or damage to public property (vehicles), increase in cost to public if external resources are used	Staffing; lack of public trust to know the condition of the asset	Bridge Office Structural Metals and Bridge Inspection Engineer performs inspections per technical memorandum on all TL.	Management deciding inspection is a priority. Determining which offices/functional areas will perform and be accountable for the inspections	tech memo. (similar to tower lighting); mandatory 5-year inspection cycle (this is probably a measure and/or target)	Minor	Possible	Low	
Poor contract execution (e.g., inappropriate construction installation)	Poor quality product; deteriorate at a higher rate; increased reactive maintenance.	Safety; decreased public confidence; increased service interruptions.	Staffing; Reputation; More Costs and/or Less Funding; Ability to Scope with Project	No.	Project Engineer relies on contractor to perform installation correctly. There is no understanding of the cost to repair because of poor asset installation	better quality controls (e.g. MnDOT checks) of construction work outside of edge-of-pavement-to-edge-of-pavement; better checklist to include roadside infrastructure; workshops at end of construction project	Minor	Likely	Medium	Highest OSS/TL Risk
Inability to manage to lowest life-cycle cost (e.g., preventive activities not performed on a timely basis)	Deteriorates faster (reduced service life); more reactive maintenance; higher life cycle cost.	Increased duration and frequency of service interruptions; decreased public confidence.	Lower service conditions; does not meet AASHTO light levels; increased operations resource needs	Bridge Office Structural Metals and Bridge Inspection Engineer notifies Electrical Services after pole is inspected as to what repairs are required for each pole.	Funding is rotated to where needs are to try and maintain balance; lack of data on what is optimal lowest LCC	Having an enterprise asset management system in place will help track status of asset (e.g. inspection of asset is completed by maintenance which is part of Engineering Services and fixes are performed by electrical services which is part of Operations Division. There is not a direct and clear connection to notify maint. when fixes are performed.	Minor	Likely	Medium	2nd Highest OSS/TL Risk
Significant damage to the asset through man made events (e.g., crashes, damage from construction activities etc.)	Faster deterioration due to damage to elements; decrease in life of structure	increased risk of safety and/or damage to public property (vehicles)	Increase in tort claims, increase in public complaints	MnDOT monitors roadway cameras and responds to asset damage due to crashes in timely manner; MnDOT pursues restitution with insurance companies to recoup costs		Not sure what factor of safety is being used for structural design?	Minor	Likely	Medium	
Premature deterioration of the asset	Unexpected need- more resources assigned to that asset; other preservation projects are deferred.	Safety; Potential for unsafe driving conditions.	Changed maintenance program: top needs are redefined; unanticipated resources assigned to a single asset and other priorities are deferred.	Inspections of TL keep the premature for failure of the asset to a minimum.	lack of data on what deterioration rates for OSS/TL are		Minor	Likely	Medium	
Unforeseen changes in regulatory requirements, travel demands, or technology (e.g., significant industrial growth in one region of the state, availability of new technology for conducting inspections more efficiently)	Increase in the number of structures, larger structures being built because of additional weight (larger or more elements); more complex structures due to complex traffic control devices	Increase in cost to maintain and build structures	Inquired costs because of new requirements/specs, increase in personnel time to inspect more structures, increase in technical knowledge to perform inspections		communicating hard costs when regulatory requirements are implemented; being able to determine if an additional structure is a "need" or just a "want"	Adding maintenance and inspection costs to capital costs (life cycle costs) when making planning/design decisions	Moderate	Rare	Low	
Shortage of workforce (e.g., early retirements/hiring freezes or need for additional staff to complete work tasks in a timely manner)	decrease in life of structure due to lack of inspections and maintenance	increased risk of safety and/or damage to public property (vehicles)	Inspection intervals increased or not accomplished; maintenance response time slower or not able to accomplish			Determine risk to public if MnDOT staff is decreased.	Minor	Possible	Low	3rd Highest OSS/TL Risk

Work Group Assignment #1 Results: Identified Most Undermanaged Risks

Risks:	Impact of not managing the risk effectively to: (you do not have to have impacts in all three areas for each risk)			Has MnDOT been managing this risk effectively?		
				If Yes, List control/mitigation strategies used	If No:	
	Asset	Public	MnDOT		List gaps in current business protocols preventing MnDOT from managing the risk effectively	Ideal Mitigation Strategy(ies)
Pavement						
Not meeting public expectations for pavement quality/condition, specifically at the local/corridor level	Strain on rest of system; economic impacts; traveler safety; higher maintenance costs	Economic (commodities) impacts; lower quality of life; traveler safety; service delays for traveling public	Reputation; higher maintenance costs; other asset maintenance is deferred.	Using money to manage to lowest lifecycle cost including routine maintenance; money distributed statewide based on need; measures & targets; balanced across entire system; MAP-21 direction (allocates $ on NHS); staging of treatments (more timely & appropriate treatments); multiple fixes at location or on corridor		More timely and appropriate staging of treatments; multiple fixes at location or on corridor (only if LCC treatment intervals modified); more systemmatic and standardized statewide approach to fixes
Local Level - Corridor (predicted or premature) NOT STATE OR DISTRICT						Better manage expectations
Inappropriately managing or not managing pavements such as frontage roads, ramps, and auxilary lanes						Increased IDIQ or BARC type projects to address localized distresses; better tracking of deterioration and condition
Bridge						
Inability to manage to lowest life-cycle cost for bridges (corollary risk: lack of or deferred funding)	Deteriorates faster (reduced bridge service life); more reactive maintenance; higher life cycle cost; manage highest needs first	Increased duration and frequency of service interruptions; decreased public confidence; bridge or route restrictions	More bridges falling into lower service conditions faster; do not meet performance targets; increased operations resource needs	BRIM; SIMS; performance measures	SIMS Maintenance Module (in progress); linking costs to maintenance tasks (Swift, SIMS and BI); SIMS, BRIM and construction cost data not linked; Preventive Maintenance Performance Measure still in development; deterioration curves; implementation and use of the multi-objective optimization tool in BrM 5.2 (in development)	Link BRIM, SIMS, Swift, contract preservation costs and BrM 5.2 in order to make appropriate management decisions; preventive maintenance performance measure; better knowledge of deterioration curves
Premature deterioration of a bridge	Unanticipated reactive maintenance or major investments required sooner; reduced service life	Increased duration and frequency of service interruptions; bridge or route restrictions; safety; decreased public confidence	Do not meet performance targets; changed maintenance program; increased operations resource needs	Inspection and maintenance tracking to try to anticipate needs; ability to track and prioritize work	SIMS Maintenance Module (in progress); deterioration curves; implementation and use of the multi-objective optimization tool in BrM 5.2 (in development)	Better inspection and maintenance tracking; better knowledge of deterioration curves; BrM 5.2
Highway Culverts						
Culvert failure/collapse	Requires roadway reconstruction or repair with culvert replacement	Safety of traveling public (e.g. car damage, injury or death/fatalities); service delay; emergency service disruptions; flooding to adjacent properties	Considerable impact to MnDOT's reputation if fatalities occur; higher cost of emergency repairs compared to maintenance.	Partially, have implemented inventory and inspection program to identify bad culverts and begun repairing some pipes. Should minimize surprise failures.	Insufficient funding for adequate maintenance and repairs. Not all culverts needing repaired are fixed during construction projects.	Culverts identified as in poor or very poor condition are fixed by MnDOT maintenance or during construction projects. Culverts identified as very poor are fixed before failures cause major repair impacts. Need a better coordinated process for fixes.
Inability to appropriately manage culverts	Greater likelihood of culvert failure; higher life cycle cost	Pays more for drainage infrastructure maintenance; potential traffic impacts, exposure to culvert failure risk; lack of ability/time to work with partners to improve hydraulics for constituents	Pay more over life cycle; higher costs for emergency repairs: impacts to trust and confidence; investing inefficiently (e.g. under or over investing; inability to leverage appropriate funding to meet targets)	Partially; MnDOT has invested heavily in inventory and condition data collection, a rigorous drainage performance measure remains to be selected. A department-wide measure would result in more systematic management of the system.	Selection of a repair measure and target, and corresponding funding. Missing data in HydInfra (i.e. date built, construction as-built, repair records). Robust LCC methodology.	Additional funding to be able to implement a systematic maintenance approach based on targeted work, complete LCC understanding, data provided and shared by design, construction, maintenance.
Lack of culvert capacity	Culvert and road failure (e.g. caused by high head, road overtopping, scour or piping)	Detours, delays or property damage (e.g. flooding to adjacent properties)	Staff and funding needed to address problems (e.g. law suits, flood damage, road and culvert repairs and detours)	No	Insufficient resources to upsize culverts and concerns of passing additional water downstream. (e.g. permitting requirements, environmental, ROW impacts, liability)	Parties causing upsize need to participate financially; evaluations could be done on case by case basis which would require more resources; may require designing more storage and investing in flood easements; watershed coordination.
Deep Stormwater Tunnels						
Flooding and deterioration due to lack of tunnel capacity	Increased rate of deterioration; deterioration of sandstone layer adjacent tunnel lining from pressurized water	Increased flooding on roadway & adjacent business/residential; loss of commerce; tunnel failure/collapse; service delays	Increased flooding on roadway; deterioration of tunnels & other assets; loss of public trust/reputation; loss of commerce; increased cost to replace at a later time	No	Shared water with City of Minneapolis; based on maintenance agreement, City of Minneapolis would have cost share and have said they do not have the money	Provide new system & back charge City; City to separate its' water (as much as possible); downsize new/modified system as much as possible to save costs
Tunnel failure/collapse because of not managing and mismanagement	Strain on rest of tunnel system	Trauma or death to traveling public and or residents; increased congestion on other arterials and local system; Service delays for traveling public; increased flooding on roadway & adjacent business/residential	Highways closures; loss of public trust/reputation; Large, short-term, immediate financial impacts	No	No funding for repairs and maintenance. Not a high priority for agency; inspection/maint. of tunnels done by Cities (need more of a joint process, merge of priorities)	MnDOT and communities prioritize construction funding. detour routes established in advance; map extent of possible flooding; increase funding for rehab., data collection & inspection (determine LCC & deterioration); work with Cities to redefine management of tunnels to more of a coordinated effort
Overhead Sign Structure & Tower Lighting						
Poor contract execution for installation of overhead sign structures and tower lighting	Poor quality product; deteriorate at a higher rate; increased reactive maintenance	Safety; decreased public confidence; increased service interruptions	Staffing; reputation; more costs and/or less funding; ability to scope with project	No.	Project Engineer relies on contractor to perform installation correctly - lack of oversight on project-by-project case; lack of understanding of costs to repair because of poor asset installation	Better quality controls (e.g. MnDOT checks) of construction work outside of edge-of-pavement-to-edge-of-pavement; better checklist to include roadside infrastructure; routine/mandatory workshops at end of construction project
Inability to manage to lowest life-cycle cost for overhead sign structures and tower lighting	Deteriorates faster (reduced service life); more reactive maintenance; higher life cycle cost	Increased duration and frequency of service interruptions; decreased public confidence	Lower service conditions; does not meet AASHTO light levels; increased operations resource needs	Bridge Office Structural Metals and Bridge Inspection Engineer notifies Electrical Services after pole is inspected as to what repairs are required for each pole.	Funding is rotated to where needs are to try and maintain balance; lack of data on what is optimal lowest LCC	Enterprise asset management system for better tracking asset status (e.g. inspection of asset is completed by maintenance which is part of Engineering Services and fixes are performed by Electrical Services which is part of Operations Division. There is not a direct and clear connection to notify maint. when fixes are performed.
Shortage of workforce for overhead sign structures and tower lighting	Decrease in life of structure due to lack of inspections and maintenance	Increased risk of safety and/or damage to public property (vehicles)	Inspection intervals increased or not accomplished; maintenance response time slower or not able to accomplish			Determine risk to public if MnDOT staff is decreased; cross training of staff (redundancy in knowledge)

Work Group Assignment #2 Detailed Instructions

During your work on identifying and prioritizing undermanaged risks, your group identified mitigation strategies that would enable MnDOT to better manage these risks. The objective of this exercise is to explore those risk mitigation strategies in more detail to help us estimate the overall return on the investment. You will do that by reviewing your risk statements and identifying costs associated with one or two mitigation strategies for each of your asset group's most undermanaged risks (as previously identified – see Excel spreadsheet). The results of this activity will be used in a workshop on November 15, 2013.

Step 1: Define your preferred mitigation strategy for addressing the risk. Be specific as to what needs to be done to better manage risk. For example, instead of saying "better manage customer expectations," it would be more specific to suggest activities such as "develop a press package to help customers set more realistic pavement performance expectations based on the fiscally-constrained environment." Your mitigation strategy should clearly convey to an outsider what will be done to reduce or eliminate the risk.

Step 2: Identify the data, resources, tools, and/or training required to enact your strategy. Without getting too hung up in the details of what will be required, prepare an estimate of the types and quantities of resources that might be needed to implement your strategy, including work force impacts, equipment purchases, software tools, and so on. For example, will you need a 2-person survey crew for 2 months of the year? Do you need an analysis tool to be able to predict asset performance? For the example given in Step 1, the response might look like this:

[Example Response: Requires a Public Information Office employee to develop a campaign using data provided from the pavement management system. Once the campaign materials are developed, the materials must be distributed via appropriate channels and future customer expectations must be monitored every other year.]

Step 3: Describe whether your strategy will reduce the likelihood of another risk identified by your group. For example, a more formal process for managing culverts should reduce the likelihood that unexpected failures will occur.

Step 4: Estimate the approximate cost of implementing the preferred mitigation strategy. Again, do not worry too much about getting your cost estimate exact. If you can adequately estimate the relative magnitude of the strategy cost, that should be close enough. In other words, we would like to know if this is a $20,000 strategy or a $200,000 strategy. Use readily available information to prepare your estimate and document how you arrived at the total cost. For calculating work force salary costs, please use an hourly unit cost of $25/hour. If it is too difficult to estimate the costs associated with your strategy, at least indicate whether your preferred strategy is a low-cost strategy (i.e. less than $250,000 annually to implement), moderate-cost strategy (i.e. between $250,000 and $800,000 annually), or a high-cost strategy (i.e. more than $800,000 annually)

Step 5: Identify whether an alternate strategy might be available that doesn't fully mitigate the risk, but lowers the overall likelihood or consequence associated with the risk. Think about alternate approaches that might not be as effective at reducing the risk, but might cost the agency less than the preferred strategy. For example, the preferred strategy for managing culverts might be to repair all culverts in poor or very poor condition. An alternate strategy might include monitoring all culverts in poor or very poor condition on a quarterly basis to track changes in conditions and to prioritize repairs. This approach won't eliminate unexpected culvert failures, but will provide a way of prioritizing the culverts that are at greatest risk.

Step 6: Estimate the cost associated with the alternate strategy. As in step 4, we are not looking for a detailed estimate, but want you to think about the resources, equipment, or tools that might be needed to implement the alternate strategy.

Step 7: For both of the strategies you've identified, identify the impact on the likelihood and consequence of the original risk should either of the strategies be adopted. This information will allow us to estimate the return on investment associated with each of the two strategies. You can use the chart below to record the changes in likelihood and consequence.

Risk 1:	**Original Risk Rating**	**Risk Ratings for Preferred Strategy** (From Step 1)	**Risk Ratings for Alternate Strategy** (From Step 6)
Likelihood of Event (Select from: Rare, Unlikely, Possible, Likely, or Almost Certain)			
Consequence of Event (Select from: Insignificant, Minor, Moderate, Major, or Catastrophic)			

Risk 2:	**Original Risk Rating**	**Risk Ratings for Preferred Strategy** (From Step 1)	**Risk Ratings for Alternate Strategy** (From Step 6)
Likelihood of Event			
Consequence of Event			

Risk 3:	**Original Risk Rating**	**Risk Ratings for Preferred Strategy** (From Step 1)	**Risk Ratings for Alternate Strategy** (From Step 6)
Likelihood of Event			
Consequence of Event			

Work Group Assignment #2: Identification of Pavement Undermanaged Risk Mitigation Strategies and Costs

Undermanaged Opportunity	Current Control/Mitigation Strategy(ies)	Previously Identified Mitigation Strategy(ies)	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7		
			Preferred Mitigation Strategy(ies)	Data, Tools Resources and/or Training Required to Make Strategy Reality	Describe if Strategy Will Reduce Likelihood of Another Risk	Estimate Approximate Cost of Preferred Mitigation Strategy(ies)	Alternate Mitigation Strategy	Estimate Approximate Cost of Alternate Strategy	Estimate Likelihood & Consequence of Strategy		
									Original Risk Rating	Preferred Strategy Rating	Alternate Strategy Rating
Pavement											
If public expectations for pavement quality or condition are not met, especially at the local/corridor level, then the agency's reputation may suffer, service delays and unsafe conditions may increase and the cost of maintenance may grow.	Using money to manage to lowest lifecycle cost including routine maintenance; money distributed statewide based on need; measures & targets; balanced across entire system; MAP-21 direction (allocates $ on NHS); staging of treatments (more timely & appropriate treatments); multiple fixes at location or on corridor	More timely and appropriate staging of treatments; multiple fixes at location or on corridor (only if LCC treatment intervals modified); more systemmatic and standardized statewide approach to fixes	1. Annually track, monitor and identify roadway segments that have been in poor condition greater than 5 years, and consistently consider when programming at the District level	Query out miles by poor with no treatments within last 5-years or some extended period of time.	Strategy will not reduce likelihood of the 2nd risk but may reduce the previous risk (likelihood) of meeting GASB 34 (previously identified risk - not under-managed)	1. 8 hours of staff time to run report and coordinate with districts during annual programming activities.	3. Turnbacks (jurisditional realignment) 4. Outreach plan or communication tool	3. $200k per mile to bring roads up to standard for realignment 4. $25k	C: Major L: Likely	C: Major L: Possible	C: Moderate L: Likely
If MnDOT does not include ramps, access roads, auxiliary lanes and frontage roads in its pavement inventory and use their condition in its pavement model, then these assets will not be included in pavement management decisions and cannot be managed to achieve the lowest lifecycle cost for all highway pavements.	No	Increased IDIQ or BARC type projects to address localized distresses; better tracking of deterioration and condition	1. Collect additional information/data in the Metro District with the use of old Material Office pavement van. 2. Build a stand alone database that will house information/data and allow for better tracking.	Use old Material Office pavement van, MS Excel or Access software for database	Strategy will not reduce likelihood of the 1st risk.	1. $100/mile 2. $2000-4000. Rough cost to put database together and communicate to districts. Cost might be more toward $10-20k if a consultant was hired.	3a. Collect data in Greater MN districts by hand, using maintenance staff. 3b. Visually collect images through video capture or windshield survey.	3a/3b. $100/mile to collect data and additional cost/time to enter information into database. This time and cost would be determined by the data (# of facilities, collection detail, etc.)	C: Minor L: Possible	C: Minor L: Unlikely	C: Minor L: Unlikely

Work Group Assignment #2: Identification of Bridge Undermanaged Risk Mitigation Strategies and Costs

Undermanaged Opportunity	Current Control/Mitigation Strategy(ies)	Previously Identified Mitigation Strategy(ies)	Step 1 Preferred Mitigation Strategy	Step 2 Data, Tools Resources and/or Training Required to Make Strategy Reality	Step 3 Describe if Strategy Will Reduce Likelihood of Another Risk	Step 4 Estimate Approximate Cost of Preferred Mitigation Strategy	Step 5 Alternate Mitigation Strategy	Step 6 Estimate Approximate Cost of Alternate Strategy	Step 7 Estimate Likelihood & Consequence of Strategy Original Risk Rating	Preferred Strategy Rating	Alternate Strategy Rating
Bridge											
If bridge inspection data, bridge model sophistication and bridge deterioration models are not accurate or complete, then it may be difficult to determine the lowest lifecycle cost strategy for bridges. AND If one or more bridges deteriorate prematurely, then maintenance costs may be higher than expected and there may be unanticipated risks to structural integrity.	BRIM; SIMS; performance measures Inspection and maintenance tracking to try to anticipate needs; ability to track and prioritize work	Link BRIM, SIMS, Swift, contract preservation costs and BrM 5.2 in order to make appropriate management decisions; preventive maintenance performance measure; better knowledge of deterioration curves Better inspection and maintenance tracking; better knowledge of deterioration curves; BrM 5.2	1. Finish development of SIMS Maintenance Module 2. Develop the Preventive Maintenance (PM) Program/Performance Measure (in progress) to verify that PM is performed at the right time. 3. Develop BI reporting tool to link SIMS and Swift (in discovery phase now). 4. Migrate inspection (and maintenance?) data to BrM 5.2 (BrM 5.2 is still in development) and create/utilize the deterioration curves. As part of this step, the CORE AASHTO elements need to be translated to the new AASHTO National Bridge Elements (NBE). 5. Link Construction Costs with Maintenance costs in BI 6. Link BRIM and BrM 5.2 7. Compare cost, age and performance trends of the bridge system to determine effectiveness of management strategy and adjust accordingly 8. Research to further identify lowest lifecycle cost (i.e. deterioration models, effectiveness of maintenance activities, products etc.)	1a. SIMS Maintenance Module is currently in development with Bentley. We have in depth maintenance data back to 2009 which needs to be migrated into the SIMS Maintenance Module. 1b. Training Required (50 Trainees + 2 instructors for 8 4-hour training sessions located around the state + curriculum development and data migration = 400 hours total) 2. Need to develop the measure. Also need collaboration from the Districts (Annual Meetings between Bridge Office Staff and District Staff) 3a. BI Bridge Maintenance tool is currently in the data discovery phase. We do not have a project assigned yet and therefore do not have any associated costs. All costs included in this strategy are estimates and may actually be higher or lower given many factors. 3b. Training (Power Users: 3 Trainees + 1 instructor for 2 full day sessions = 64 hours total; Regular Users: 29 Trainees + 1 instructor for 1 full day session = 240 hours total) 4a. Multi-state collaboration for development. $50,000 per year for 5 years for BrM 5.2 development (29 states participate) 4b. Need resources and equipment to test and implement the BrM 5.2 system. Need to develop deterioration curves from Minnesota data. 5. Need to develop a plan on how to link Construction Costs to the BI reporting tool. 6a. BRIM Development 6b. Need to develop a plan on how to integrate BRIM risk analysis into BrM 5.2. 7. Development 8a. Deck Deterioration and NBE Research is currently in progress. 8b. Other Research may be needed.	This strategy will mitigate both of the risks identified in this exercise (manage to lowest lifecycle cost and premature deterioration) as well as help to mitigate the lack of or deferred funding.	$2 Million (This represents a one time implementation cost. Following implementation, this will be a low cost strategy to maintain annually)	1. Finish development of SIMS Maintenance Module (already in progress). 2. Develop the Preventive Maintenance (PM) Program/Performance Measure (in progress) to verify that PM is performed at the right time. 3. Cost accounting tracking through existing systems (WOM, Financial Reports). These systems are not tied with maintenance data in SIMS. 4. Migrate inspection (and maintenance?) data to BrM 5.2 (BrM 5.2 is still in development) and create/utilize the deterioration curves. As part of this step, the CORE AASHTO elements need to be translated to the new AASHTO National Bridge Elements (NBE). 5. Not included in alternate mitigation strategy. 6. Use BRIM as currently developed. 7. Not included in alternate mitigation strategy. 8. Current Research	$1.4 Million (This represents a one time implementation cost. Following implementation, this will be a low cost strategy to maintain annually)	C: Moderate L: Likely	C: Minor L: Likely	C: Moderate L: Likely

Work Group Assignment #2: Identification of Hydraulic Undermanaged Risk Mitigation Strategies and Costs

Undermanaged Opportunity	Current Control/Mitigation Strategy(ies)	Previously Identified Mitigation Strategy(ies)	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7		
			Preferred Mitigation Strategy(ies)	Data, Tools Resources and/or Training Required to Make Strategy Reality	Describe if Strategy Will Reduce Likelihood of Another Risk	Estimate Approximate Cost of Preferred Mitigation Strategy(ies)	Alternate Mitigation Strategy	Estimate Approximate Cost of Alternate Strategy	Estimate Likelihood & Consequence of Strategy		
									Original Risk Rating	Preferred Strategy Rating	Alternate Strategy Rating
Highway Culverts											
Inability to manage highway culverts increases risk of failure and the life cycle cost (LCC).	Partially, MnDOT inventories and inspects highway culverts and the information is used to plan maintenance work and project scoping activities. Culvert failues are repaired when they occur.	Additional funding to be able to implement a systematic management approach based on targeted work, complete LCC understanding, data provided, shared and used by design, construction, maintenance.	1. Adopt System Condition Performance Measure (including defining target, etc.) 2. Implement Asset Management System and Data that will support LCC 3. Repair or replace Highway Culverts in accordance with Asset Management System Recommendations through Captial Projects and Maintenance work.	1. Staff time to develop and implement performance measures 2a. Funds to purchase and implement Transportation Asset Management System 2b. Staff & consultant resources to develop LCC business rules 2c. Staff & consultant resources to collect data for asset management system 3. Funding for capital and maintenance work needs to repair and replace culverts	Strategy will reduce the likelihood of road failure, interruption of service, lack of adequate capacity, and land owner drainage complaints. Strategy will also reduce the risk of not being able to support HydInfra system.	1. 200 hours staff time 2a. >$1M for software, consultant, and equipment purchase. 1000 hours staff time. 2b. $50,000 Research or consultant project. 500 hours staff time for internal rule development and training. 2c. 16,000 hours per year for highway culverts (assume around 12,000 hours currently, estimate extra 3000 hours/per year for unknown condition culverts, plus 1000 hours per year to meet inspection targets) 3. $40M per year (approximate $30M current investment, and additional $10M per year to repair or replace poor and very poor highway culverts).	Stand-alone construction projects to repair or replace poor and very poor highway culverts.	1. NA 2a. $1.25 M to implement Transportation Asset Management system (does not include LCC functionality) and 800 staff hours. 2b. NA 2c. 16,000 hours/year (no change) 3. $30M current investment + funding for additional stand-alone construction projects	C: Moderate L: Almost Certain HIGH	C: Moderate L: Possible MEDIUM	C: Moderate L: Likely MEDIUM
Deep Stormwater Tunnels											
If stormwater tunnel capacity is not adequate for a major rain event and resulting pressurization is too great, then the tunnel will be damaged or collapse, local flooding may occur, property may be damaged, and people may be killed or injured.	No	Provide new system & back charge City; City to separate its' water (as much as possible); downsize new/modified system as much as possible to save costs	1. Complete research on underground storage options, including the exploration of shallow cavern storage options for south (I-35W) tunnel. 2. Develop & implement emergency response plan for business, residential, and freeway area along floodprone I-35W south tunnel.	Consultants and funding needed	If #1 is installed, then risk will be mitigated; #2 only deals with event when it occurs.	1. $30,000 2. $15,000	1. Build I-35W south underground storage cavern.	1. $50 M	C: Catastrophic L: Likely	C. Catastrophic L. Possible Improved Credability and may lead to lower cost solution than a parallel tunnel	C. Catastrophic L. Rare
If the suggested maintenance repairs are not made in a timely manner, then the tunnels may collapse in a major rain event, and significant property damage, loss of life, or extensive service disruption may occur and significant reconstruction costs may be necessary.	Tunnels, with exception of one, have been throughly inspected once to gauge baseline condition. Repairs have been prioritized.	MnDOT and communities prioritize construction funding. detour routes established in advance; map extent of possible flooding; increase funding for rehab., data collection & inspection (determine LCC & deterioration); work with Cities to redefine management of tunnels to more of a coordinated effort	1. Inspect one remaining tunnel. 2. Put pressure tranducers in tunnels to measure pressurization. 3. Put together and implement a mandated inspection frequency (1-5 yrs.) based on tunnel/segment condition rating. 4. Include tunnels in bridge inventory. 5. Prepare plans and implement all repairs needed on south I-35W tunnel system at MnDOT cost and city to fully fund all other known repairs on all other tunnels.	Staff, priorities, funding for consultants, TH bond funding for repairs	This work will improve our credability in the event of a failure. It will strategically fix the worst tunnels repair needs. It may reduce the event of a failure by having increased information on tunnel condition - as long as funding is available for repairs when conditions warrant it.	1. $50,000 2. Estimate is being obtained. 3. $250,000 per inspection (basic walk through). 4. Process for approval would come from Metro Maintenance and CO Bridge Office Directors. Metro WRE MS4 staff would work with Metro Bridge Maintenance and CO Bridge to transfer info to forms. May need consultant assistance. 5. TH Bond funds $12 M.	1. Staff from MnDOT (likely Metro Bridge Maintenance) trained on inspections to complete them on select tunnel segments after major rain events. 2. MnDOT hires a consultant to complete inspections on each tunnel, as identified by mandated inspection guidelines. 3. Begin repairs incrementally and withhold funding to cities on other projects if proposed repair schedules are not met.	1. Training cost and inspection time required. 2. Political acceptance? Roughly $3.5 M per segment.	C: Catastrophic L: Possible	C: Catastrophic L: Possible Improved Credability	C. Catastrophic L. Rare

Work Group Assignment #2: Identification of Other Traffic Structures Undermanaged Risk Mitigation Strategies and Costs

Undermanaged Opportunity	Current Control/Mitigation Strategy(ies)	Previously Identified Mitigation Strategy(ies)	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7		
			Preferred Mitigation Strategy(ies)	Data, Tools Resources and/or Training Required to Make Strategy Reality	Describe if Strategy Will Reduce Likelihood of Another Risk	Estimate Approximate Cost of Preferred Mitigation Strategy(ies)	Alternate Mitigation Strategy	Estimate Approximate Cost of Alternate Strategy	Estimate Likelihood & Consequence of Strategy		
									Original Risk Rating	Preferred Strategy Rating	Alternate Strategy Rating
Overhead Sign Structure & High-Mast Light Tower Structures											
If tower lights and overhead sign structures are not properly installed as part of a construction project, then they may deteriorate more rapidly, and will require more subsequent maintenance.	No	Better quality controls (e.g. MnDOT checks) of construction work outside of edge-of-pavement-to-edge-of-pavement; better checklist to include roadside infrastructure; routine/mandatory workshops at end of construction project	1. Change construction specifications to require torque threshold dye washers 2. Communicate punchlist and specifications with companies that install structures and with construction inspectors.	1. Additional staff time to write the specification and update detail plan sheets; change in element used during construction. 2. Additional staff time.	Reducing the risk of poor contract execution should extend the life of the structure and reduce maintenance costs (Risk 2), thus reducing life-cycle costs.	1. One-time fee of $1000 (40 hours of staff time). Increased annual cost of $20,000/year (if additional $1000/structure @ 20 structures/year to add dye washers). 2. Increased annual cost of $5000/year (4 hours inspection per structure and 20 structures/year is 80 hours of inspection; and 120 hours of additional communication)	MnDOT Maintenance will tighten the nuts on all new structures.	One-time fee of $40,000 to purchase an additional wrench. Increased annual cost of $2000 additional staff and equipment ($100/structure at 20 structures).	C: Minor L: Likely	C: Minor L: Rare	C: Minor L: Rare
If light tower and sign structure inspection data and deterioration models are not accurate or complete, then it may be difficult to determine the lowest life-cycle cost for these assets.	Bridge Office Structural Metals and Bridge Inspection Engineer notifies Electrical Services after pole is inspected as to what repairs are required for each pole.	Enterprise asset management system for better tracking asset status (e.g. inspection of asset is completed by maintenance which is part of Engineering Services and fixes are performed by Electrical Services which is part of Operations Division. There is not a direct and clear connection to notify maint. when fixes are performed.	1. Implement TAMS that includes a work order, resource, and materials cost tracking module. 2. Report annually on life-cycle cost and identify and implement refined/additional strategies to reduce costs.	1. Additional staff and/or consultant time to implement new software system. 2. Additional staff time to report annual performance.	Managing OSS/TL structures to lowest LCC cannot occur if Risk 1 is not mitigated.	1. One-time fee of $250,000 to add structures data into TAMS software (staff time). Increased annual maintenance and user costs of $100,000/year for software. 2. Increased annual cost of $2000/year (80 staff hours).	1. Maintain status quo with replacement cycle for OSS/TL, which is 40-50 years. 2. When OSS/TL due for replacement, remove and replace with 6-8 standard lights or ground mount overhead. 3. Conduct research that will better define/determine deterioration rates and collect other addtional info.	Overhead structure life cycles could be doubled; thereby reducing costs. Amount unknown.	C: Minor L: Likely	C: Minor L: Rare	C: Minor L: Likely
If MnDOT is unable to provide a sufficient number of workers to maintain high-mast light tower structures or overhead sign structures, then inspections, maintenance, repairs and replacement may fall short of service standards.		Determine risk to public if MnDOT staff is decreased; cross training of staff (redundancy in knowledge)	1. Adopt a MnDOT policy/technical memo requiring a 5-year inspection frequency for all overhead structures. 2. Report annually on inspection frequency results. 3. Create a training program for inspecting and maintaining structures, develop inspection forms, develop clear condition rating criteria. 4. Gain efficiencies by using mobile technology in the field	1-3. Additional staff time. 4. Additional equipment expense.	Adopting a policy/technical memo of inspecting and reporting will help mitigate Risk 1.	1. One-time cost of $1000 (40 hours staff time) to write policy. 2. Increased annual cost of $1000 (40 hours/year staff time) to report on performance. 3. One-time cost of $8000 (320 staff hours). Increased annual cost of $2000/year (80 hours/year staff time) to train. 4. Increased annual cost of $10,000/year to use mobile handheld devices.	1. Use consultants to perform work. 2. Increase inspection intervals (Strategies can be either/or/both)	An average of $800/structure was previously paid for external inspection. Internal inspections cost roughly $100/structure.	C: Minor L: Possible	C: Minor L: Rare	C:Minor L: Rare