APPENDIX B - TAMP RISK REGISTER

Figure B-1: Pavement Asset Risk Register, 1 of 2

RISK CODE	RISK CATEGORY	RISK	CURRENT MITIGATION STRATEGY	GAP	IDEAL MITIGATION STRATEGY	RESOURCES NEEDED
1P	Aging Infrastructure	Premature deterioration of pavements (e.g., construction issues, increase in traffic, higher equivalent single axle loads (ESALs) and snow and ice removal methods)	Improve asphalt and concrete mixes. Improvement in ice removal practices. Use of HPMA in decision-making for projects. Have tested use of salt alternatives and practices that reduce the amount of salt needed. Improve traffic modeling for more accurate ESAL data. Apply PM. VMT reduction targets	Funding trade-offs. Technology transfer. Inconsistencies across department. Lack of expertise of construction inspectors in the industry.	Better training for construction inspectors. Change design (or over-design) according to better projections (e.g., VMT, HCVMT, ESALs, environmental factors)	Use tech certification program to implement better training. Address rutting problems of automated vehicles. Focus on reducing HCVMT, as trucks result in the most damage or change in how we plan for truck/freight travel. Over-designing to account for unknowns requires additional funding to reduce this risk
2P	Funding	Inability to manage to the lowest life cycle cost	Better understanding of impact and more implementation of PM. Improved products/materials used for PM. Improved options for fixes in all work types. Improved LCP analysis to better understand LCC scenarios	Funding constraints. Current programming practices limit our ability to follow lowest LCC. Decline in reconstruction of rural pavements (doing more rehab instead). Political pressure prioritizes projects outside of an ideal LCP strategy. Other competing priorities (ex major bridge projects)	Use various tools to communicate the need/ benefit of following the lowest LCP strategy by implementing a regular pavement management schedule	Use different overall network strategy for different roads (ex. low vs high volume roads). Use new health indicators that are being developed. Increase in pavement funding needed
3P	Funding	Significant reduction in funding over time	Investment scenario planning. Trying to be more efficient by using more optimization strategies. Applying shorter-term fixes. Improving specifications, design, etc. Advanced understanding of what the reduction will be to better plan projects	Don't correctly tell the story the impact of reduced funding has on the condition of our system. Change in vehicle design has changed public perception of pavement condition	Identify alternative revenue sources due to reductions from various sources resulting from technological changes. Continue to research how to optimize MnDOT's dollars	Good leadership and industry support (already doing well). Annual report to legislature to communicate pavement condition/need. Maintain research and implementation funding
4P	Data Management/ Lack of Data/ Quality of Data	Low prioritization of ancillary pavements (e.g., frontage roads, ramps, auxiliary lanes and rest areas)	N/A (Ancillary pavement condition using satellite imagery project.) Rest areas are addressed differently: collected condition of rest area pavements and included in MnSHIP investment need. some rest areas have been funded through freight program for site improvements	Lack of inventory and condition data for ancillary pavements. Have collected this data in the past, but a big need for this data has not been identified. Treat them differently when addressing mainline project	Study cost-benefit of treating ancillary pavements as separate assets independent of mainline using different measures, deterioration modeling, data collection, etc	Identify potential turn-backs. Rest areas to use different metric than other ancillary pavements. Identify need early enough in scoping to be able to include in need. Treat them as standalone projects and include in budget trade-offs. Collect data, develop deterioration models, etc. (may not be worthwhile). We currently focus on mainline, and likely won't address these until those are addressed
5P	Infrastructure Resilience	Significant damage to the asset through human-made or natural events	Preventive maintenance. Federal ER requirement (analysis to see if there are locations with repeat damage due to extreme weather events). Districts have BARC funds which may be used to address emergencies. Climate change studies. Maintenance fixes quickly after an event to reduce system disruption. Slope vulnerability project	Risks addressed during projects but need more focus on more proactive understanding system-wide. Implementation of slope vulnerability model	Include potential needs in scoping (climate models, slope vulnerability analysis, emergency response history, etc.). Identify a separate pot of money to address reactive needs. Better study these events and learn how to mitigate them. Study more resilient designs	Training on available tools. Look at historic spending on reactive activities to predict future needs, and increase BARC funds accordingly. Recommend using climate modeling when completing an ER project to build a more resilient system rather than replacing in-kind. Research proposals

Figure B-1: Pavement Asset Risk Register, 2 of 2

RISK CODE	RISK CATEGORY	RISK	CURRENT MITIGATION STRATEGY	GAP	IDEAL MITIGATION STRATEGY	RESOURCES NEEDED
6P	Succession Planning	Losing construction experience through attrition	Aggressive training program for new techs. Centralized federally required technician certification program using adult learning techniques. Hired additional staff for plant monitoring. Plan to hire more staff for construction	Lack of expertise of construction inspectors in the industry. Takes many years to develop necessary expertise. TW (transportation worker) staff series has limited our ability to get qualified applications. No vocational program for highway technicians	Create a vocational program for highway technicians. Improve tech certification program by working with industry to improve outreach	Work with staff we hired to develop outreach program. Need more help from MMB for outreach to underrepresented groups. Highway technician testing Raise pay of technicians and engineers in the industry to incentivize interest in the field. Education that this field exists. MnDOT to increase STEM outreach (ex through ASCE)
7P	Competing Stakeholder Expectations	Not meeting public expectations for pavement quality/ condition (state, district and local levels)	Increased percent of pavements in good condition	Understanding expectations of the public	Educate the public on what it takes to maintain the roads. (e.g., surface rating vs. the structure itself, what it takes to maintain roads and what jurisdiction is responsible)	Used to have a market research staff, could hire another continue to survey the public to understand their expectations use creative techniques (ex. Minnesota GO stickers to scan and go to informational video, short videos, interactive displays, infographics, roadway condition simulator, etc.) Work with lobbying groups/advocates (Mn Transportation Alliance, LRRB, etc)

Figure B-2: Bridge Asset Risk Register, 1 of 2

RISK CODE	RISK CATEGORY	RISK	CURRENT MITIGATION STRATEGY	GAP	IDEAL MITIGATION STRATEGY	RESOURCES NEEDED
1B	Aging Infrastructure	Premature deterioration of the asset (e.g., service lives that are 10% to 20% shorter than expected, material defects, quality of initial construction)	Quality assurance training for bridge construction inspectors. Implementing innovative best practices into standards. Best Practices and training for maintenance activities. Developed sub-committee to help implement best practices to track trials (look at different types of materials, performance, processes, etc.) Existing related research projects	Inexperienced construction inspectors, lack of understanding of what contributes to premature deterioration, material defects	Improve design and construction practices	Bring maintenance perspective into structural standards review committee. Invite maintenance staff into construction project reviews and involve maintenance into project decision concerns that may impact long-term performance. Better understanding of deterioration. Greater emphasis on workmanship before opening up to traffic.
2B	Data Management/ Lack of Data/ Quality of Data	Poor inspection data, improper data stewardship and software limitations	Created business plan to identify need to develop an improved bridge asset management process (plan to develop new health index, etc.). State-aid staff provide inspection QA on local system	Don't have the plan developed yet for how we will execute a new bridge asset management process	Dedicate full-time inspectors and staff with proper training.	Readjusting workload, position descriptions, and organization structure of existing staff. Hard to attract inspection staff when they are required to also plow snow.
3B	Funding	Lack of, deferred, or inconsistency of funding (e.g., unexpected budget cuts)	Transparency with project selection. Financial scenario planning in place. Selecting high benefit to cost ratio projects. We identify shelf-projects that we would address with more funding	Working toward a more automated scenario planning process. Improvement needed of communicating funding needs to legislature and stakeholders.	Expand practices to identify more shelf-projects that can be addressed with more funding. Lobby for more funding and better communicate funding needs. Tie expansion projects to maintenance budgets	Need more staff to manage to lowest life cycle cost, especially as we expand our system.
4B	Multimodal Safety	Requests or the ability to widen bridges to accommodate multimodal transportation	Practical based performance design to come up with most efficient compromise. outreach to talk to other stakeholders to understand variety of needs.	Not maximizing trade-offs. prioritizing locations that most benefit public and quantifying that benefit. understanding needs early on in project development process. trade-off of increased service vs preservation	If premature replacement due to widening is necessary, communicate loss of service life costs and how it impacts projections	Communicate to all stakeholders. Quantify maintenance impact (ex. closing lanes, safety, user impact, etc.). Trade-off analysis

Figure B-2: Bridge Asset Risk Register, 2 of 2

RISK CODE	RISK CATEGORY	RISK	CURRENT MITIGATION STRATEGY	GAP	IDEAL MITIGATION STRATEGY	RESOURCES NEEDED
5B	Infrastructure Resilience	Unanticipated service interruption due to natural event (e.g., flood, earthquake, adverse weather)	Bridges rated for scour. If they are scour critical, they have a plan of action. BRIM uses scour in the risk prioritization score. Scour protection in place through operational plans. Research on impacts of climate change	Uncertainty of climate change	Identify and prioritize bridges in need of debris removal. Use flood vulnerability model output to prioritize areas in need of further checking criticality/loss of structure. Implement Bridge Watch, a GIS-based predictive program for rain events and how they impact existing infrastructure. Bridge Watch sends alerts to maintenance crews to identify bridges that may be impacted	Crews understand bridges/ bridge culverts that often require debris removal and prioritize them, but many locations that need debris removal are postponed. Flood vulnerability model is not yet complete (additional consultant work is needed) Pursuing a grant to purchase Bridge Watch
6B	Continuity of Operations	Shortage of workforce, lack of qualified replacement candidates (e.g., early retirements and hiring freezes)	STEM outreach, better recruitment, mobilities for cross-training, internship opportunities, TROPS (training opportunities) and bridge maintenance academy	Still not reaching all audiences, recruitment communication, pay inequities compared to general industry, lack of communicating additional benefits beyond pay. Pay inequity	Improve recruiting practices, change job requirements for certain positions and improve cross-training	Make job postings more widely available. Change hiring practices to not require snow plowing with certain maintenance and operations positions. Improve cross-training (mobilities, etc.). Provide clear paths for advancement (mostly, TS)
7B	Infrastructure Resilience	Unanticipated service interruption due to asset condition	Compliant with all FHWA bridge inspection metric requirements. Consistent staff training on inspection process. Increased inspection frequency on poor condition bridges. Increased Program Administrator review process (review and approve inspection reports - can identify critical areas sooner to eliminate service interruption)	Inexperienced inspection staff. Limited access	Identify critical elements, increase the inspection/monitoring frequency, including better access for equipment and traffic control	Consider access for inspection and maintenance throughout entire design process. Understanding critical elements, which are vulnerable, and allocate more money towards them
8B	Infrastructure Resilience	Unanticipated service interruption due to human-caused events (e.g., crashes, damage from construction activities)	Developing standards around repair projects to improve safety requirements. Thorough process for after-incident responsibilities. Raise high-risk assets that have had multiple hits in the past. Meeting standards when assets are replaced: redundancy, safety barrier, and proper vertical and horizontal clearance. Install warning systems for certain construction projects	Unpredictability in behavior of the traveling public. Not enough funding to upgrade bridge assets to current safety design standards	Identify which assets have had repeat hits and are considered high-risk. Install warning systems and cameras at high-risk locations (lower cost option than replacements) OR Meet standards for high-risk locations before planning replacements	Develop tracking system for bridge hits, and regularly update. Also, study adjacent bridges. Identify if there is a pattern or random occurrences. Document findings as a tool for decision-making. Quickly respond to incidents to reduce system interruption times
9B	Response to Disruptive Transportation Technologies	Autonomous trucking legislation and an increase in truckload capacity may increase the design load for bridges	Research for truck weight legislation. improving communication to legislature for impact of truck weight statute changes	Uncertainty of future technology or direction of autonomous vehicles. Lack of understanding by trucking industry of bridge capacity understanding	Understand proposals, identify what challenges they pose and make changes accordingly	Unclear now what will be needed in terms of resources. Contingent on legislation
10B	Competing Stakeholder Expectations	Not meeting federal condition targets	Using sound asset management approach for funding projects, implementing TAMP	Changing project selection process from worst-first approach to optimized life-cycle strategy. Developing more appropriate targets	Receive adequate funding to fully implement the current mitigation strategy. Base federal targets on an element-level approach	Additional funding
11B	Integration	Inability to manage assets to the lowest life-cycle cost (e.g., preventive activities not performed on a timely basis)	Moving toward a bridge health index to provide better planning scenarios. Improved Life Cycle Planning analysis provides better data behind LCP scenarios. Robust bridge management system. Developing preventive maintenance performance measures	Need to develop performance targets that better allow us to follow a lowest life cycle management decisions	Fully implement using element-level based bridge performance measures and preventive maintenance performance measures	Implementing other risk mitigation strategies would reduce this risk. Use existing staff time, additional funding to implement is needed. Other trade-offs are prioritized that limit our ability to follow lowest LC strategy

Figure B-3: Buildings Asset Risk Register

RISK CODE	RISK CATEGORY	RISK	CURRENT MITIGATION STRATEGY	GAP	IDEAL MITIGATION STRATEGY	RESOURCES NEEDED
1BLDG	Aging Infrastructure	Temporary or permanent building closures	Assessing conditions of buildings as well as engineering studies. Performing PM activities. Investing more into capital projects	Advanced deterioration (brine solution wears away at materials more than salt does). Age causes buildings to become functionally obsolete. Not managing to optimal life cycle management strategy	Develop a plan for data collection and maintenance	Use salt alternative to slow deterioration. Data would help us better understand remaining service life, so we can be more proactive before a building becomes functionally obsolete
2BLDG	Infrastructure Resilience	Efficient building management	Project selection criteria based on several factors to prioritize. Focus on habitable buildings/ those that impact the traveling public.	Missing ADA assessment information which should be included in project selection criteria. Gaps in site and facility functionality - have developed criteria but have not yet implemented. Still need complete site information. Lack of communication and training between functional groups (maint, ops, admin, etc.) which affects our work.	*Rest areas and headquarters:* Include Americans with Disabilities Act assessment information in project selection criteria. *All buildings:* Identify communication gaps and find a way to address them	All Buildings: Need better communication. Once program manager is identified, include this as part of the facilities AMP implementation
3BLDG	Data Management/ Lack of Data/ Quality of Data	Lack of data on equipment and components	We have a data management system in place to store data	Do not have install dates of all components. Lack of quality amongst data. Shortcoming on IT support. Lack of staff to enter and maintain data	Develop a plan for data collection and maintenance	Need additional personnel and mobile data collection equipment. Need one-time push to get up to date, then need continuous upkeep of data. Could add this into BIM contract for new buildings (current as built process does not include internal components). Department of Admin includes language - should integrate this into our language as well
4BLDG	Funding	Lack of dedicated capital, operations and maintenance funding	Developed a Facilities Asset Management Plan to communicate funding needs.	Different funding buckets limit our flexibility in how funds are allocated (we used to have flexibility, but this has changed). Staffing varies by districts.	Implement the Facilities Asset Management Plan	Follow the Facilities Asset Management Plan
5BLDG	Competing Stakeholder Expectations	Competing stakeholder expectations	To varying degrees, districts are using building assessments to address most high priority items - better prioritization	Competing with other priorities for funding. Competing between districts for equipment. District spending maintenance money for competing issues (adding to the system rather than maintaining existing system)	Implement the Facilities Asset Management Plan	Follow the Facilities Asset Management Plan
6BLDG	Continuity of Operations	Increasing maintenance equipment and material sizes (e.g., including tow plows, tandems, tanks, brine)	Updating truck stations standards manual. Established fleet liaison to communicate equipment size changes between fleet and buildings	Building may be in good condition, but space does not accommodate larger equipment sizes.	Design based on truck station standards manual	Need to complete the manual. Design teams then need to follow the standards. Frequent discussions with fleet and operation staff about trends in equipment sizes and usages
7BLDG	Response to Disruptive Transportation Technologies	Unforeseen changes in regulatory requirements, travel demands or technology	Working reactively rather than proactively limits our ability to mitigate	Building experts are not always involved in discussions of potential mitigation strategies. Uncertainties with changes with electric vehicles, etc. Executive orders issued and building functional areas notified after the fact. We are reactive rather than proactive	Identify communication gaps and address them	Need better communication. Once program manager is identified, include this as part of the facilities AMP implementation

Figure B-4: Highway Culverts and Deep Stormwater Tunnels Asset Risk Register

RISK CODE	RISK CATEGORY	RISK	CURRENT MITIGATION STRATEGY	GAP	IDEAL MITIGATION STRATEGY	RESOURCES NEEDED
1HCDST	Data Management/ Lack of Data/ Quality of Data	Difficulty in getting inspections done by local agencies on shared tunnel system	MnDOT hired consultants to do inspections	Should be a shared expense, but local agencies often unwilling to provide funding or resources. Then, MnDOT covers the work/ cost	Inspect tunnels according to inspection schedules (local jurisdictions conduct inspections on tunnels with shared water)	Arranging for local agencies to do inspections
2HCDST	Aging Infrastructure	Failure/collapse of culvert due to age or lack of maintenance	Inspection performance measure which is continuously monitored. Annual condition report monitors the risk. Regular communication with district hydraulics engineers	In current investment, culvert system condition is declining each year.Need for continued inspections and increased investments	Rehab culverts before failure occurs and make permanent fixes during future pavement projects	Develop more detailed LCP strategies for different culvert types and features and follow them. Use flow chart for work planning. Consider capacity needs.
3HCDST	Aging Infrastructure	Inability to manage culverts to lowest life cycle cost	During pavement projects, look at poor and very poor conditions rather than only very poor. Standalone culvert rehab projects provide a longer service life and do not impact pavement	Dependent on pavement projects. Deterioration of culverts is complex and is difficult to model. Do not have construction date	Better model and research deterioration. Address culvert needs earlier in pavement project scoping—(e.g., during STIP/CHIP development)	Input more data into TAMS (at a minimum, subset of year built, design data, etc.) to track deterioration over time. Using a subset of typical assets would help inform and may be a good foundation for a research project to analyze deterioration. Better understand additional attributes that contribute to asset deterioration. District hydraulics engineers look at mapped STIP and CHIP projects
4HCDST	Aging Infrastructure	Failure/collapse of tunnel due to age or lack of maintenance	Significant repair of tunnels to get to 0% poor	Need for continued inspections and investments in repairs	Perform regular inspections and invest in recommended repairs (follow ideal LCP strategy)	Local support for those that are maintained by local agencies. Additional funding needed
5HCDST	Data Management/ Lack of Data/ Quality of Data	Lack of statewide location and inspection data for storm drains causes issues with drainage system and affects the roadway	Collected LiDAR data of structure location, which is going into TAMS. Through scoping process, districts are collecting more of the storm drain inventory. Making advances in more affordable technology	LiDAR does not provide pipe data. Funding not allocated. Harder to collect inventory and condition data due to high cost and additional equipment needed	Collect statewide location inventory and inspection data of storm drains	Use existing staff for ongoing needs, hire consultant for up front collection. Video collection, equipment, training, check plans, etc. Better technology in the future may be more cost-effective
6HCDST	Funding	Availability of funds or inconsistency in culvert investments	Districts have detailed scoping process that identifies culverts and includes them in cost estimates	Culverts identified after initial scoping process are difficult to add to project. Funding restrictions limit the number of culvert replacements/ repairs regardless of need	Communicate funding needs (e.g., it's more cost-effective to align culvert replacement with pavement projects; emphasize this approach as an optimization strategy)	Maintain data in TAMS. Ensure project-scoping inspection to catch any needs and update in TAMS
7HCDST	Infrastructure Resilience	Flooding and deterioration due to lack of culvert capacity, resulting in adverse impacts to properties and roadway user safety	Some districts are upsizing or providing storage when culverts are replaced. Check hydraulic capacity of existing culvert when deciding whether to line it	Current scoping processes do not focus on culvert capacity. Some permitting agencies restrict upsizing	Formalize the process of checking hydraulic capacity and the availability of existing culvert storage when deciding whether to line it. Keep track of culverts in areas with flooding problems to determine if they need repair	Run culvert model analysis (ex: hydroCAD for storage). Use flood vulnerability tool, historical flood data, and TAMS work orders. Consult with maintenance to identify areas that have flooding issues. Both: develop database to track this data
8HCDST	Infrastructure Resilience	Flooding and deterioration due to a lack of tunnel capacity, resulting in adverse impacts to property and roadway user safety	Provided cost estimates for increasing capacity. Installed a stormwater storage facility	Tunnels are tied into other systems owned by other jurisdictions, so we have limited control over other systems	Add recommended tunnel capacity	Funding and support from local cities, MnDOT owns tunnels, but local agencies have a greater share of water within our tunnel systems - local agencies help maintain those with shared water.Understand capacity needs for some tunnels, but not all
9HCDST	Infrastructure Resilience	Significant damage to culverts through human-caused events	Full inventory of locations. Work with other stakeholders to provide maps of drainage infrastructure for those working on ROW or adjacent developments	Highway culverts have a least one side located statewide, but do not have elevations or location of both pipe ends for all culverts	Complete location inventory, continue current inspections and identify damage and repair needs	Work with other utilities and permits to make sure our assets are known (partially implemented but need to expand statewide). Ensure this data is included in MnDOT project plans. Place physical markers on culverts so others know they are there

Figure B-5: Intelligent Transportation Systems Asset Risk Register

RISK CODE	RISK CATEGORY	RISK	CURRENT MITIGATION STRATEGY	GAP	IDEAL MITIGATION STRATEGY	RESOURCES NEEDED
1ITS	Funding	Inconsistent operations/ maintenance, funding for staff, equipment and construction	We have used one-time funds to purchase equipment	Not sustainable and does not meet all needs. Unreliability limits our ability to plan and implement	Communicate funding needs. Develop and track uptime performance measures	IRIS provides communication data to show which assets are functional. Feed that data into DJANGO to identify work needs (not available for all devices - additional tools may be needed. Research best practices on this topic). TAMS may be an alternative for tracking work order completions
2ITS	Infrastructure Resilience	Standardization in system design, construction issues or system flaws	Update standards in design manual	Unable to conduct face-to-face training due to COVID restrictions	Update standards in design manual and provide training on standards. Create a construction manual, provide certification training	Continuous effort needed in the long term to keep the manuals up-to-date and provide training. Include contractors in training
3ITS	Succession Planning	Staff turnover and lack of documentation	Changes are documented and added to SharePoint to keep others informed (knowledge books, continuity manuals)	Want to better document procedures and what these systems are. Cannot have staffing overlap with cross-training before staff leaves	Update standards in the design manual and provide training on standards. Create a construction manual, provide certification training. Create an operations and maintenance manual, provide training	Continuous effort needed in the long term to keep the manuals up-to-date and provide training. Include contractors in training
4ITS	Integration	Not identifying an appropriate responsible party for maintenance/ operations	None	Identified that this is a risk that requires mitigation and are in initial discussions but have not fully addressed yet.	Develop workflows	Committee to determine what the responsibilities are
5ITS	Continuity of Operations	Issues with vendor skills, ability and availability to provide support	Tightened specifications, awarded multiple contracts	Dependent on health of the company.	Add more details into RFPs to ensure support and reliability of potential vendors for selection	Internal staff
6ITS	Response to Disruptive Transportation Technologies	Technology shift/ obsolescence	Use technology independent equipment, multi-year contracts, approved products list, use experimental products in small test cases	Inability to replace technology when vendor no longer manufactures or supports equipment due to lack of staffing and resources. Inadequate replacement cycles to keep up to changing technologies	Create plans to address potential obsolescence	Data tracking, research upcoming trends
7ITS	Response to Disruptive Transportation Technologies	Supply availability, equipment shortages and shipping disruptions	Stocking up on products - MnDOT purchases equipment in advance of contracts and furnishes it to vendors (applies to some projects)	Don't have a large enough stock of products (can be an issue if we stock too much of old equipment). Underutilized warranties. Have to meet certain criteria	Standardize certain materials rather than customizing based on location	Staff time, and potentially additional consultant time

Figure B-6: Noise Walls Asset Risk Register

RISK CODE	RISK CATEGORY	RISK	CURRENT MITIGATION STRATEGY	GAP	IDEAL MITIGATION STRATEGY	RESOURCES NEEDED
1NW	Data Management	Not keeping asset inventory and condition data current and consistent in TAMS	As-builts are a contract pay item that provides survey data with high accuracy. If as-built data is not provided, then MnDOT staff provide field data collection	We are transitioning to a new rating system, which may cause confusion in what condition data is reported. Limited ways to get data into TAMS. Changes in TAMS are not more widely distributed to other systems	Annually collect asset inventory and condition data using LiDAR. Maintain a regular inspection schedule to collect data that LiDAR cannot capture. Inspect noise walls at appropriate frequencies to promptly address fixes	Develop more flexibility in making adjustments in TAMS. Need additional staff for inspections and data processing. LiDAR would not have all the data we would need, so we would need staff to fill in the gaps. Inspections would still be needed because of limitations with what LiDAR can collect
2NW	Funding	Noise walls may lack prioritization in funding allocation decisions	In metro, we are using a portion of standalone maintenance program setaside towards noise wall maintenance using a consent agreement	We developed a substantially complete risk rating per wall, but not yet used in prioritization. no standard funding for roadside infrastructure maintenance	Consider noise walls earlier in scoping process to include them in project costs	Use Noise Wall's risk tool to understand and prioritize needs - the tool needs additional work to finalize it. Education to project managers to check wall condition as part of projects
3NW	Aging Infrastructure	Not managing noise walls to optimize the life cycle management strategy	Recommended new installations to be concrete which require lowest life cycle cost strategy	Maintenance activities are more reactive than proactive	Set up work plans for walls based on their age and condition	Implement TAMS planning tool. Need inventory and condition data to inform the work plan. Consultant contracts to conduct preventive maintenance (MnDOT staff would continue to address reactive maintenance)
4NW	Integration	Inconsistent application of existing data for capital and preventive maintenance decision making	Capital found ways to use existing data to program repair projects as funding becomes available. Noise Walls condition scoping worksheet to use in project scoping	Do not have the same mitigation strategies for maintenance. Maintenance work is primarily reactive, rather than proactive using TAMS data	Set cyclical repair either as part of the inspection process or from TAMS recommendations	Educate project managers on availability of data
5NW	Competing Stakeholder Expectations	Poor aesthetics of noise walls are a visual issue for neighbors, whereas structural condition is MnDOT's priority	For paint issue: developed a performance-based paint spec for wood noise walls using a specialist. MnDOT's Highway Sponsorship program: other entities can be involved in funding aesthetics	Trade-off of choosing local partnership (aesthetic-focused) over structural issues. Unable to evaluate this. Complaint-driven prioritization. Issues with previous paint types. finding a solution to repainting	Fund aesthetics based on performance-based paint specifications (alternatively, MnDOT will prioritize additional funding through other means unless there is dedicated aesthetic funding)	Potentially use the highway sponsorship program for additional public/private partnerships to seek funding from others for aesthetics

Figure B-7: Overhead Signs Asset Risk Register, 1 of 2

RISK CODE	RISK CATEGORY	RISK	CURRENT MITIGATION STRATEGY	GAP	IDEAL MITIGATION STRATEGY	RESOURCES NEEDED
1OS	Aging Infrastructure	Premature deterioration of the asset (e.g., salt corrosion, loose nuts)	Inspections, nut tightening	Not enough inspection. Research needed to better understand factors that result in premature deterioration. lack of funding to tighten nuts results in foundation replacement	Inspect every five years using a standard inspection form to identify overhead signs that may require more frequent inspections. Revise standards (e.g., MnDOT previously used grout but found it led to premature deterioration)	Use inspections to develop work plan that prioritizes assets with more severe deterioration. For those with recurring or more severe issues, recommend a more frequent inspection cycle. Note: most districts do inspections. One does "some", but all do not have dedicated resources for inspection. Identify elements with issues across entire inventory. Use consistency with entering inspection data - Use signs committee to communicate need of consistency
2OS	Infrastructure Resilience	Structure design is inadequate for increasing panel sizes	Ask for data from supplier	Look at monotube structures proactively. missing data such as structure measurements. (Panel sizes may increase due to increase in text or changes in requirements of text sizes, etc.)	Identify when sign panel sizes are outside of standards. Verify with engineer the use of current design specifications in standard plans	Track requests and responses (may use metro's process of tracking in ProjectWise).

Figure B-7: Overhead Signs Asset Risk Register, 2 of 2

RISK CODE	RISK CATEGORY	RISK	CURRENT MITIGATION STRATEGY	GAP	IDEAL MITIGATION STRATEGY	RESOURCES NEEDED
3OS	Integration or Infrastructure Resilience	Poor construction and/ or installation (e.g., post tilt and loose nuts)	Training of new specification. new installation practices with checklist and documentation. Various related research	Foundation issues	Train installers and certify inspectors. Ensure construction inspections are done correctly and any construction flaws are fixed	Develop handbook. Develop MnDOT inspection certification program. Use TAMS during construction to capture initial asset inspection data, noting any installation issues. Communicate problems so installers can address installation flaws
4OS	Infrastructure Resilience	Significant damage to asset or structural failure due to natural events	Rapid response to incidents with engineering analysis. Built to standard	Don't have documentation on response process	Develop a new response process and ensure it is understood by all parties. (Continue to focus on response due to an inability to predict these events)	Use new design types with more redundancy. Ensure certified staff are responding to hits
5OS	Succession Planning or Continuity of Operations	Shortage of workforce, retirements and documentation	Create documentation and staffing responsibilities	Ability of concurrent training, ability to staff at appropriate position classification	Train and hire staffing concurrently. Fostering consistent documentation standards across districts	Generate a knowledge book (like what bridge is doing). Use signs committee to communicate need of consistency. Need a replacement planning strategy. May use pro-plan to aid in knowledge transfer
6OS	Response to Disruptive Transportation Technologies	Unforeseen changes in regulatory requirements, travel demands or technology	Proactive to understanding which changes are needed and build in enough time to adapt to changes - update policies and standards accordingly. Develop standards to adapt	lack of expertise in understanding uncertainties	Pilot new technology with experimental projects before widespread implementation	Use existing staff along with potential consultant contract to conduct pilots

Figure B-8: Pedestrian Infrastructure Asset Risk Register, 1 of 2

RISK CODE	RISK CATEGORY	RISK	CURRENT MITIGATION STRATEGY	GAP	IDEAL MITIGATION STRATEGY	RESOURCES NEEDED
1PED	Data Management/ Lack of Data/ Quality of Data	Current approach to collecting inventory and condition data is labor intensive and the data cycle is 10 years	Building the inventory and condition is the mitigation strategy. Current data collection approach is labor intensive and the data cycle is currently ten years.	Incomplete baseline inventory. (This should support a data driven decision making process.) Lack of functional data tools (web maps, spatial, etc.) to help scoping and implementation	Collect pedestrian assets using mobile LiDAR	Build capacity with post processing data collected from mobile lidar (asset grade accuracy)
2PED	Aging Infrastructure	Not meeting federal ADA compliance or its intent	The maintenance throughout the lifecycle is minimal, compliant driven. No oversight of community contracts	The maintenance throughout the lifecycle is minimal, compliant driven. No oversight of community contracts	Develop and pilot performance measures for maintaining pedestrian facilities in partnership with local jurisdictions. Identify consistent maintenance approaches to better define responsibilities included in maintenance agreements under cooperative agreements and in master maintenance agreements	Full implementation of TAMS and external partner/consultant documentation. The Master Maintenance Agreement efforts are moving slowly. There are 4 pilot counties working on this with MnDOT, being facilitated by a consultant. That contract is about $100,000 and there may not be even one MMA in place at the end of that contract. It will take years to fully implement and will be at least a couple million dollars
3PED	Aging Infrastructure	Difficulty following a life cycle management strategy	Using the TAMP to help inform lifecycle planning scenarios	limited funding, limited ability to move away from a reactive management strategy due to existing business process, uncoordinated, and limited baseline inventory and condition data. Needs district advocates to help implement strategies	Fully integrate assets into TAMS work order process. Develop MnDOT guidance on best practices for maintenance of pedestrian assets	Staff adhere to MnDOT standards and ADA tech memo for design and construction. And develop best practices for maintenance
4PED	Succession Planning	Staff turnover limits the ADA program's ability to address liability, essential services and ADA planning at the district and project level	ADA Transition Plan and conversations with Operation Division Leadership	There is no succession planning for staff within the ADA unit. There is also no ADA staff at the district level to provide redundancy and accountability	Increase capacity among existing staff and hire additional staff at the district level	Training current staff on everything ADA

Figure B-8: Pedestrian Infrastructure Asset Risk Register, 1 of 2

RISK CODE	RISK CATEGORY	RISK	CURRENT MITIGATION STRATEGY	GAP	IDEAL MITIGATION STRATEGY	RESOURCES NEEDED
5PED	Infrastructure Resilience	Poor planning, design and/or construction	Construction inspection, ADA compliance, field walks, plan reviews, sidewalk evaluation	Lack of funding and staff to fully implement existing strategies and to comply with Complete Streets policy and Ped Plan	Continue current control and mitigation strategies. Incorporate 3D modeling to improve planning, design and construction	Work with Todd Berglin's group to ensure that one of the district's pilot projects include pedestrian assets in the 3D modeling. Complete the baseline for the inspection data to become the data of record...incorporate into the TAMS ultimately (TAMs Work Manager--includes work orders, inspection frequency)
6PED	Continuity of Operations	Not receiving local consent/agreement resulting in a lack of operations/ maintenance and oversight that leads to premature deterioration	Developing master maintenance agreements with counties.	Inconsistent oversight and enforcement of agreements. If issues come up, MnDOT is responsible. County master maintenance agreements do not fully mitigate this risk	Implement the master maintenance agreements	Full implementation of TAMS and external partner/consultant documentation. The Master Maintenance Agreement efforts are moving slowly. There are 4 pilot counties working on this with MnDOT, being facilitated by a consultant. That contract is about $100,000 and there may not be even one MMA in place at the end of that contract. It will take years to fully implement and will be at least a couple million dollars
7PED	Competing Stakeholder Expectations	Not meeting the needs of system users	Addressing user complaints with existing plans and maintenance requests within a reasonable timeframe	Taking a reactive compliant driven approach. Underutilizing the TAMS infrastructure to accommodate maintenance requests.	Develop performance measures based on location, type of repair and response timeframe to address complaints. Identify trends to support a more proactive approach	Full implementation of TAMs

Figure B-9: Traffic Signals, Lighting and High-Mast Light Towers Asset Risk Register, 1 of 2

RISK CODE	RISK CATEGORY	RISK	CURRENT MITIGATION STRATEGY	GAP	IDEAL MITIGATION STRATEGY	RESOURCES NEEDED
1SLHMT	Aging Infrastructure	Not managing assets appropriately resulting in poor asset condition, which impacts the safety of the traveling public	Developing a more formal/ standardized structural inspection. Utilizing TAMS to program. Signals and lighting considered when scoping pavement projects	Not able to perform regular structural inspection and PM due to lack of staffing and funding. Life cycle replacement program not in place for standalone projects. Often times, local agencies do not contribute their share of funding for replacements	Ensure adequate staffing for structural inspection throughout asset life cycle. Develop life cycle replacement or preservation program for standalone projects	Group component replacements and/or upgrades - we often have one-time funding where we do a lot at once, which means they will become due all at once and no dedicated funding to address. Document programs and needs for if/when there is staff turnover. Finish gathering condition data
2SLHMT	Funding	Lack of consistent dedicated funding/ staffing limits the ability to effectively manage and operate existing assets	Contract out some work using district SRC funds. Identified staffing gaps, one-time funding need to address gaps, and annual funding need. MnSHIP looks specifically at signals/lighting and performance levels based on various funding scenarios. Use TAMS to develop funding needs	Have not received money that the program has identified as a need. Also, have not received necessary staffing levels. Lighting receives leftover funding at the end of the year, but not the case for signals	Document and communicate needs (e.g., business plans)	Identify gaps to come up with need
3SLHMT	Infrastructure Resilience	Premature deterioration due to extreme weather or environmental factors	Do PM inspections. Specification changes - now using galvanized signal poles. Also, using better quality lighting poles. In Process: Using AASHTO standards. Working with manufacturers on issues with new poles. Working on design changes for materials that are more resilient	Many signal poles are not galvanized - limited ability to replace due to financial constraints	Continue to follow through and fully implement "in-process" mitigation strategies	Need support from manufacturers on requested changes. Enhance installation checklist to include new standards. Ensure that issues are being reported. Have staff do regular PM checks, including training and applying PM activities

Figure B-9: Traffic Signals, Lighting and High-Mast Light Towers Asset Risk Register, 2 of 2

RISK CODE	RISK CATEGORY	RISK	CURRENT MITIGATION STRATEGY	GAP	IDEAL MITIGATION STRATEGY	RESOURCES NEEDED
4SLHMT	Infrastructure Resilience	Damage due to hits by traveling public	Added requirements for location placements	Inability to predict hits, as they may be due to drivers under the influence, unpredictable crashes, etc.	Increase resources to respond to incidents more quickly (there are several options for prevention, but none that are based on competing factors)	Dedicated lighting crew in metro. Additional trained personnel and equipment (pole setter, lane control, etc.)
5SLHMT	Response to Disruptive Transportation Technologies	Cybersecurity breaches or hardware/software incompatibility and upgrades	Firmware upgrades tracked in share point site. Network management (firewalls, device configurations, segmentation, etc.). Updated laptops and devices to be able to program devices remotely and view with cameras to make sure they are functioning	Currently, anyone can purchase a cabinet key and manipulate the system. Mostly affects signals. Obsolescence is an issue - no longer supported by manufacturer requires a replacement. Firmware upgrades. Lack of funding and personnel to upgrade the system. No procedure or policy identifying responsibility. Lack of communication between IT and functional area (ex: IT shut down servers without notification)	Use more secure passwords (Cybersecurity mitigation provided through MNIT). Add locks to cabinets, mostly done through vendors	Create a system for tracking passwords
6SLHMT	Infrastructure Resilience	Poor construction, installation, design specifications or fabrication	Require contractors to be certified (MnDOT's signal and lighting certification). Specification changes and product improvements (nut tightening, galvanizing, etc.). Construction spec checklist. Workmanship warranties. Inspectors specialize in signals and lighting	We have a gap of dedicated staff to get out to sites for inspection	Need dedicated statewide construction inspectors trained in signals and lighting (e.g., electrical components)	Need additional dedicated inspection staff - minimum 2-4 for greater MN (have 4 in metro already)
7SLHMT	Continuity of Operations	Power outages result in a non-operational system	Some signals have battery backup (but very small amount - prioritized by critical locations and does not provide enough benefit to do this system-wide). Some tunnels have dual power feed. Place stop signs at locations where outage will likely not be quickly repaired	Need to modernize tunnel lighting (LED) to provide backup power system	Modernize tunnel lighting by providing backup power systems (focus on tunnels due to more critical safety risks). Communicate to the traveling public when systems are out of operation	Modernize: install a backup power system.Communication: notifications on DMS, radio stations, news outlets, 511, navigational map applications, etc. (some being done already). Public education on what it means when a signal is out. Technicians available on-call to quickly respond
8SLHMT	Multimodal Safety	Signal inoperability results in decreased safety benefits to the traveling public and negative perceptions of how MnDOT manages assets	Signals that go into flash. Different types of PM for signals. Replacing outdated electronics (MMUs). Spec and design changes (connectors, etc.). Those connected to central system allow us to identify outages and respond more quickly. Determining if signals are still required and sometimes replacing with roundabouts or alternative stop control. There is a 24/7 call system for the public to report outages, which minimizes downtime	Few signals are not connected to central system. Limited resources to do more evaluations of whether systems are still warranted. Local agencies are responsible for some maintenance activities - often they are not responsive, and we keep systems operational on their behalf	Continue to upgrade equipment to the central system. Follow life cycle management strategy on all equipment to minimize failures	Include ideal life cycle planning strategy in business plans. Make sure to define strategies for components of the system. Make agreement with manufacturers on service life. Upgrade Maxview (central system)
9SLHMT	Multimodal Safety	Lighting inoperability results in decreased safety benefits to the traveling public and negative perceptions of how MnDOT manages assets	Replacing with LED bulbs (most of the system has been replaced). There is a 24/7 call system for the public to report outages, which minimizes downtime (Webpage lists contacts for reporting as well)	No traffic management cameras to view device status. No regular PM program due to lack of funding. No fiber optic communication between device and software system	Follow life cycle management strategy on all equipment to minimize failures	Include ideal life cycle planning strategy in business plans. Make sure to define strategies for components of the system. Make agreement with manufacturers on service life
10SLHMT	Response to Disruptive Transportation Technologies	Poor traffic signal timing results in increased user delay and crashes	Developed a signal timing shared service	Need funding to implement signal timing shared service. Competing district work priorities result in signal timing not being addressed	Implement signal timing performance measure (e.g., retime on-demand as needed)	It will be much easier when we upgrade our central system, as we will have the necessary tools to implement. Additional staff time or consultant time needed