

Evaluating and Communicating the Value of Research

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November 2023

Research Project
Final Report 2023-39



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Technical Report Documentation Page

1. Report No. MN 2023-39	2.	3. Recipients Accession No.	
4. Title and Subtitle Evaluating and Communicating the Value of Research		5. Report Date November 2023	
		6.	
7. Author(s) Rahil Saeedi, Jia Yuan, Scott Drumm, Donald Ludlow, Mary Beth Eddy		8. Performing Organization Report No.	
9. Performing Organization Name and Address CPCS Transcom Inc. 1028 33rd St NW, Washington DC 20007		10. Project/Task/Work Unit No.	
		11. Contract (C) or Grant (G) No. (c) 1049673	
12. Sponsoring Organization Name and Address Minnesota Department of Transportation (MnDOT) Office of Research & Innovation 395 John Ireland Boulevard, MS 330 St. Paul, Minnesota 55155-1899		13. Type of Report and Period Covered Final Report	
		14. Sponsoring Agency Code	
15. Supplementary Notes http://mdl.mndot.gov/			
16. Abstract <p>In FY2022, the MnDOT Office of Research and Innovation managed a total of 215 active and completed projects, of which 75 received partial or full funding from the Local Road Research Board (LRRB). Evaluating the benefits of this research and effectively communicating the benefits to diverse audiences serves several important purposes. It helps both MnDOT and LRRB gain insights into the outcomes of their investments in research and innovation. It also promotes continued exploration and implementation of new knowledge and technology within the field of transportation and aids in prioritizing future research implementation projects.</p> <p>This project involved a comprehensive review of the existing tools and processes used by MnDOT and LRRB for research benefit evaluation and communication and proposed a versatile multi-stage framework that can be adapted for various project types. This framework not only allows for long-term tracking of benefits but can also be integrated into the current research cycle. Furthermore, it incorporates and builds on existing tools, making it a valuable addition to the research and innovation process.</p>			
17. Document Analysis/Descriptors Research projects, Benefits, Benefit cost analysis, Communication		18. Availability Statement No restrictions. Document available from: National Technical Information Services, Alexandria, Virginia 22312	
19. Security Class (this report) Unclassified	20. Security Class (this page) Unclassified	21. No. of Pages 70	22. Price

Evaluating and Communicating the Value of Research

Final Report

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November 2023

Published by:

Minnesota Department of Transportation

Office of Research & Innovation

395 John Ireland Boulevard, MS 330

St. Paul, Minnesota 55155-1899

This report represents the results of research conducted by the authors and does not necessarily represent the views or policies of the Minnesota Department of Transportation or CPCS Transcom Inc. This report does not contain a standard or specified technique.

The authors, the Minnesota Department of Transportation, Local Road Research Board, and CPCS Transcom Inc. do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to this report.

Acknowledgments

The CPCS Team acknowledges and is thankful for the input of those consulted for this project, as well as the guidance and input of the project management team and project Technical Advisory Panel at the Minnesota Department of Transportation Office of Research and Innovation, Local Road Research Board, and the University of Minnesota Center for Transportation Studies, as listed below:

- Jackie Jiran, MnDOT
- Brent Rusco, MnDOT
- Katie Walker, MnDOT
- Kerrie Workman, MnDOT
- Micaela Kranz, MnDOT
- Julie Swiler, MnDOT
- Hafiz Munir, MnDOT
- Jim Foldesi, St. Louis County
- Lou Aune, Marshall County Highway Department
- Kristine Elwood, MnDOT
- Kyle Shelton, University of Minnesota Center for Transportation Studies
- Paul Oehme, City of Lakeville
- Steve Bot, City of St. Michael
- Ben Worel, MnRoad
- Tara Olds, MnDOT

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List of Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
APA	American Psychological Association
CA	California
CEAM	City Engineers Association of Minnesota
CTS	Center for Transportation Studies
DOT	Department of Transportation
FAA	Federal Aviation Administration
FY	Fiscal Year
FL	Florida
LRRB	Local Road Research Board
MCEA	Minnesota County Engineers Association
MN	Minnesota
MnDOT	Minnesota Department of Transportation
MPCA	Minnesota Pollution Control Agency
MRR	Maintenance, Repair, and Replacement
MTFD	Minnesota Transportation Finance Database
mvGLM	Multivariate Generalized Linear Model
NA	Not Assessed
NBIS	National Bridge Inspection Standards
NCHRP	National Cooperative Highway Research Program
ORI	Office of Research and Innovation
PI	Principal Investigator
R&I	Office of Research and Innovation
ROI	Return on Investment
RSC	Research Steering Committee
TAP	Technical Advisory Panel
TL	Technical Liaison
UAS	Unmanned Aircraft Systems

Executive Summary

Why Evaluate and Research the Value of Research?

State departments of transportation (DOTs) and all those who sponsor research, like the Minnesota Department of Transportation (MnDOT) Office of Research and Innovation (R&I), the Local Road Research Board (LRRB), and their research partners can assess the effectiveness of research investment strategies by monitoring the outcomes of research efforts and tracking how research findings are used after a project is completed. Benefit evaluation and communication are also important for promoting further exploration and implementation of new knowledge and technology in transportation, prioritizing future research and implementation projects, sharing knowledge among all research partners in the state, identifying areas of improvement, and ensuring success in achieving the program level research goals and objectives.

This report details the methodology MnDOT and LRRB currently use for research benefit monitoring and communication and provides an enhanced process for the evaluation and communication of the depth, value, and impact of the department and program’s research projects.

What Is the Current Research Lifecycle of MnDOT and LRRB?

The following figure shows the current research lifecycle of MnDOT and LRRB, which starts with research need identification and continues through project execution and implementation and ongoing communication of challenges and benefits at every stage. This cycle already incorporates multiple benefit evaluation activities and tasks, as highlighted in the figure below.



Figure ES. 1: Research Lifecycle of MnDOT and LRRB

Source: CPCS, 2023

What Is the Proposed Benefit Monitoring and Communication Framework?

The proposed framework is built on the existing benefit monitoring and communication tools used by MnDOT and LRRB and is developed based on three guiding principles:

- **Flexibility** as a key to creating a process that can be adapted to different types of projects with various benefit categories and qualitative or quantitative benefit metrics.
- **Trackability** allows revisiting and re-evaluation of the research benefits after project completion, as most research projects will not immediately be ready for application.
- **Integration** ensures the existing tools and processes used by MnDOT, LRRB, and other research partners in the state are leveraged to streamline the application of the process.

The proposed benefit monitoring and communication framework includes two parts:

- 1) **Project type assessment** to determine the level of effort and resources invested in the benefit evaluation and communication process. Projects will be classified into three types based on implementation likelihood and timeline, impact magnitude, level of interest, and assumptions and unknowns for benefit quantification. The project type is flexible and could be adjusted during projects based on their intermediate and final findings.
- 2) **Benefit Evaluation and Communication Form** to identify and record project benefits and other relevant information and disseminate relevant information among interested audiences in various stages of the research lifecycle, namely project development, inception, execution, completion, and post-completion. The form is Excel-based and can be saved in each research project's working file so that all project team members and MnDOT and LRRB staff have access to review and revise as needed and retrieve information for communication with various audiences.

The following table summarizes key benefit monitoring and communication activities for each project phase by project type. Details of the project type assessment and the roles and responsibilities for each benefit monitoring and communication activity are provided in Chapters 2 and 3 of this report.

Table ES. 1: Benefits Monitoring and Communication Workflow

Activity	Project Stage	Responsible Person(s)	Facilitator(s)
► Project Type Assessment			
- Initial type assessment	Project development	RSC & LRRB board members	Champion
- Revisiting type assessment	Project execution	Champion & Project Advisor	Principal Investigator, Technical Liaison, Technical Advisory Panel
► Completion of the Benefit Evaluation & Communication Form			
- Form establishment	Project inception	Champion	Principal Investigator, Technical Liaison, Project Advisor, Technical Advisory Panel
- Identify & document benefit categories, data, & methods	Project inception	Champion	Principal Investigator, Technical Liaison, Technical Advisory Panel
- Review & update benefit categories, data, & methods	Project execution, project completion	Champion & Principal Investigator	Technical Liaison, Technical Advisory Panel
- Identify & document anticipated post-completion benefit categories, data, & methods	Project inception	Champion & Principal Investigator	Technical Liaison, Technical Advisory Panel
- Review & update anticipated post-completion benefit categories, data, & methods	Project execution, completion, post-completion	Champion & Principal Investigator	Technical Liaison, Technical Advisory Panel
- Identify project audiences & communication tools & platforms	Project inception	R&I Communication & Principal Investigator	Champion, Technical Liaison, Technical Advisory Panel
- Review & update the communication information	Project execution, completion, post-completion	Champion & Principal Investigator	Technical Liaison, Technical Advisory Panel, R&I Communication

Source: CPCS, 2023

What are the Next Steps for Implementing the Proposed Research Benefits Monitoring and Communication Framework?

The framework will improve the efficiency and effectiveness of the existing benefit monitoring process and ensure that identified research benefits are incorporated into existing communication and marketing activities. Most importantly, project type assessment can help guide the amount of resources (researchers' level of effort and budget) dedicated to benefit evaluation and communication activities.

Small-scale initial implementation will allow for adaptation. Type assessment can be applied to MnDOT's and LRRB's research project portfolio for next year. This can inform a follow-up pilot on a select set of projects of various types to further refine the proposed framework for full-scale implementation. As a result of the pilot, work plan development guidance can also be adapted to project types and incorporate clear instructions on benefit monitoring and communication activities and staff roles.

Chapter 1: Introduction

Chapter Summary

The recommended framework for benefit monitoring and communication includes two main parts:

- An assessment of the project types according to the potential for implementation, the magnitude of impact, the level of interest, and the unknown factors involved in benefit quantification.
- Use of the Benefit Evaluation and Communication Form to identify and record project benefits and other relevant information and disseminate relevant information among interested audiences in various stages of the research lifecycle.

This framework has been tested through a proof-of-concept pilot and refined based on the findings as well as the inputs shared by the MnDOT/LRRB research and communication teams and other research partners in the state.

1.1 Background & Purpose

The Minnesota Department of Transportation (MnDOT) Office of Research and Innovation (R&I) and Local Road Research Board (LRRB) administer and sponsor research to develop new state and local transportation initiatives, acquire and apply new knowledge, innovate, and explore and implement new technologies in Minnesota. As a follow-up to the LRRB Strategic Plan and the implementation process that began in 2019, MnDOT and LRRB identified the need to develop a methodology to enable the evaluation and communication of the benefits and impact of research projects and the overall research program.

Research benefit monitoring and communication are embedded in the existing research cycle of MnDOT and the LRRB. As Figure 1 shows, the current research cycle uses various benefit evaluation tools and activities, from the research need identification stage to project execution, implementation, and ongoing communication of challenges and benefits at every stage.

This project aims to strengthen this lifecycle by integrating a research benefit monitoring framework that meets the strategic aims of MnDOT, LRRB, and other research programs administered and sponsored by MnDOT.

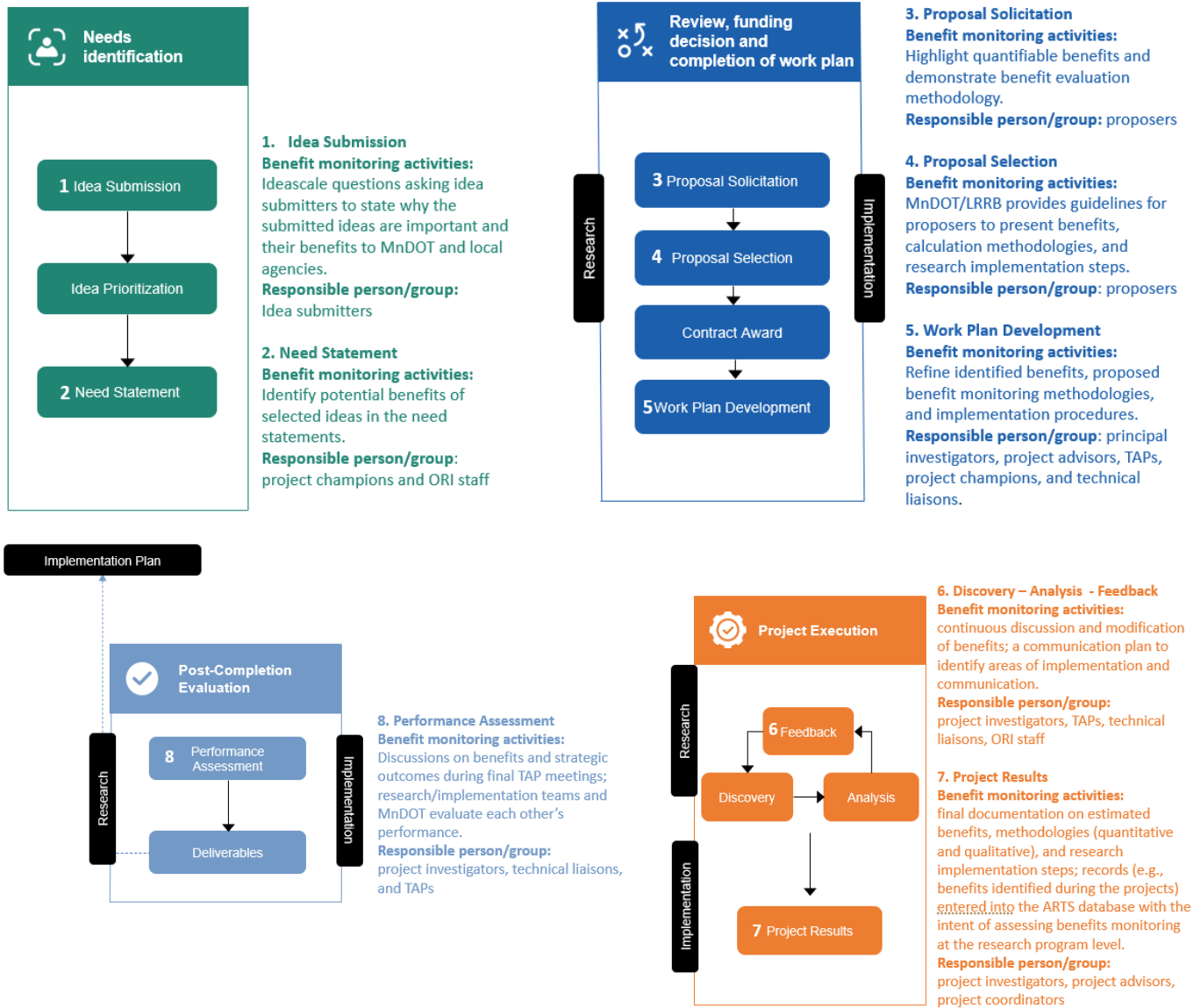


Figure 1: Benefit Monitoring Processes in the Research Cycle

Source: CPCS analysis, 2023

1.2 Methodology

The project team used the following five approaches to assess the current benefit monitoring and communication practices in Minnesota and other states:

Project Team Discussions: The project team actively communicated with the project team members, including the Technical Liaison (TL), Project Coordinator (PC), and the Technical Advisory Panel (TAP) throughout the assessment to get insiders’ perspectives on MnDOT’s and LRRB’s existing benefit evaluation and communication practices and to understand how they fit into LRRB’s research lifecycle. The feedback and insights collected

through this process helped the project team grasp each step of the existing benefit monitoring approaches and tools and enabled the team to provide a comprehensive assessment.

Literature Review: The project team reviewed various literature sources, including MnDOT's and LRRB's previous relevant studies, methods implemented by other state DOTs, and state DOT peer review materials. The objectives of the literature review were to:

- Obtain an understanding of the existing benefit monitoring and communication practices used by MnDOT, LRRB, and their research partners in Minnesota.
- Compile best practices in evaluating and communicating the value of research in other states.
- Summarize benefit monitoring challenges identified by MnDOT, LRRB, and other state DOT research programs.
- Identify gaps and barriers to using the MnDOT Benefit Tracking Tool.
- Inform the approach to communication and outreach (e.g., consultation guide, survey design, etc.).

Consultations with the Transportation Research Community: The project team reached out to 17 individuals involved in research programs in Minnesota and other states and successfully conducted consultations with 12 of them. Those consulted included stakeholders from MnDOT, state DOTs, academia, and city and county engineers in Minnesota. The consultations focused on learning about other state DOTs' benefit evaluation and communication practices, verifying information gathered from the literature review, and understanding common challenges and related solutions.

Strategic Direction Workshops: The team designed workshops to initiate a strategic direction discussion on the research value evaluation and communication among people who actively participate in the MnDOT/LRRB research program and to involve these key stakeholders in the process of enhancing the evaluation and communication practices, respectively. The project team conducted the workshops virtually, during which the participants were presented with takeaways from the review of relevant documents and one-on-one consultations with stakeholders within and outside Minnesota. The participants were also provided with a handout on the proposed concept of evaluation and communication framework to review prior to the workshop. During each workshop, the participants were divided into two groups to engage in discussions about identifying benefit evaluation and communication methods, tools, responsible personnel, and audiences during each step of a research project.

Proof-of-Concept Pilot: In April and May 2023, the MnDOT/LRRB project team members reviewed numerous completed or in-progress projects. A list of candidate projects was then developed for the proof-of-concept pilot, primarily based on a high-level assessment of various factors, including project types, benefit categories, level and areas of impact, and project development stage. This approach was driven by a desire to test and illustrate the flexibility of the proposed benefit evaluation and communication framework and to identify areas in need of improvement.

1.2.1 Review of Existing Benefit Monitoring & Communication Methods

Benefit Monitoring

While research programs inform transportation agencies' decisions regarding the allocation of fiscally constrained funds to various priorities such as safety, system condition, equity, and resilience, continuous benefit monitoring and communication efforts are needed to justify budget and other resource allocations to research. Benefit monitoring is embedded in the existing research cycle of MnDOT and LRRB. The MnDOT/LRRB research cycle consists of five stages:

- 1. Needs Identification:** Research needs and ideas are solicited during the State Aid pre-screening meetings or collected through the Ideascale website. MnDOT and LRRB then prioritize the research ideas based on organizational goals and research strategies, as well as knowledge-building¹ priorities and draft need statements. Benefit forms then allow the proposers to discuss any potential quantitative or qualitative benefits related to the needs statement or to the state.
- 2. Review, Funding Decision, and Completion of Work Plan:** Following the needs statement development, the proposal solicitation and selection stage begins. Proposers are asked to highlight the quantifiable benefits of the project and present any calculation methods and research implementation steps. A work plan must be completed for any research or implementation project before project teams expend any contract funding.
- 3. Project Execution:** A Technical Advisory Panel (TAP) is assigned to every project to provide technical guidance and monitor progress. Benefits are modified throughout the project while an appropriate communication plan is established for identifying areas of implementation and benefit sharing.
- 4. Post-Completion Evaluation:** Project performance is assessed after each project's completion. Performance assessments are done through three methods: qualitative interviews with Principal Investigators (PIs) and TLs; discussion with TAPs; and internal review of the research team. In addition to qualitative discussions with each of these groups, MnDOT and LRRB take advantage of an Excel-based quantitative benefit tracking tool that evaluates benefits based on nine potential benefit categories. Completed research projects may be nominated and selected for implementation.
- 5. Outreach:** The last stage of the research cycle involves knowledge dissemination and feedback collection via MnDOT's and LRRB's social media platforms, newsletter, blog, and other channels.

Prior Quantitative Benefit Tracking Tool and Pilot

MnDOT and LRRB developed a Quantitative Benefit Tracking Tool in 2017 to help streamline the process of calculating quantifiable benefits. A pilot study tested the tool on 11 selected projects with the support of subject matter experts. The tool was well-used, and the results showed a benefit-to-cost ratio of about 34-to-1 over three years. After the pilot, the tool was officially rolled out to all research projects. However, the assessment of the benefits from the 35 completed projects between 2019 and 2020 didn't include strong quantified results, and none of the projects used the benefit tracking tool.

¹ Knowledge building projects encompass research undertaken to improve understanding of concepts through the synthesis of ideas and discussion of objectives and common goals. The final product of a knowledge building project would be intellectual improvements in understanding of critical transportation topics rather than a framework or process that can be implemented later.

Benefit Communication

MnDOT and LRRB make use of multiple communication channels and processes (Figure 2) to disseminate research outcomes and communicate them with a wide range of audiences, including but not limited to city and county engineers, public works directors, state, regional, and local agency staff and decision-makers, and other states.²

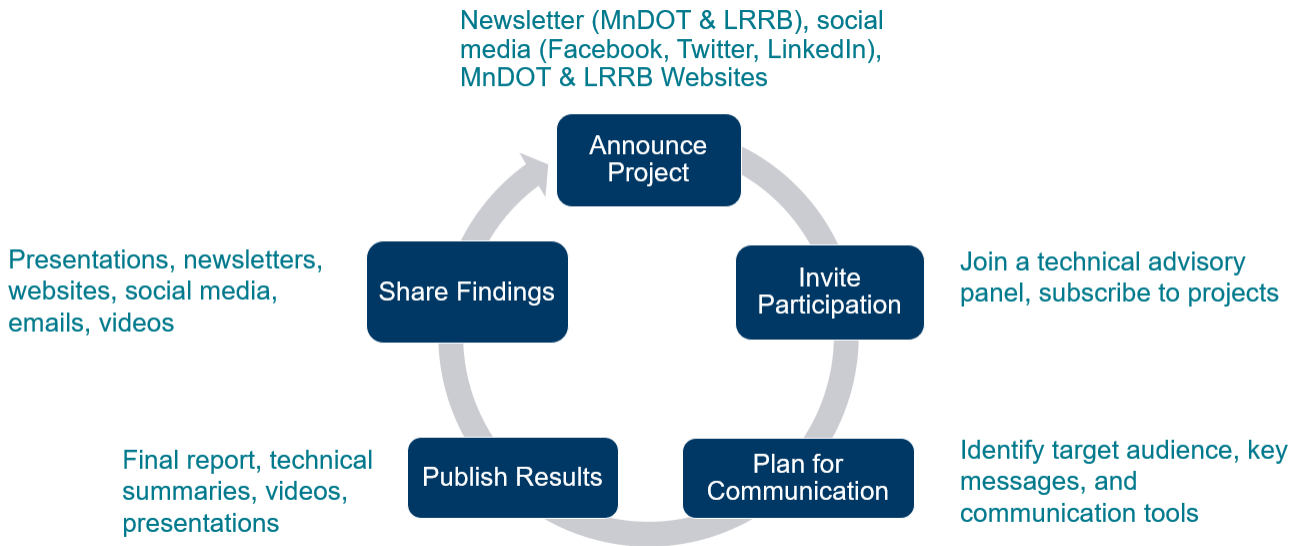


Figure 2: MnDOT and LRRB Research Project Communication Process

Source: MnDOT Office of Research & Innovation¹

The following lists some of MnDOT's and LRRB's frequently used communication tools:

- **Technical summaries** of project final reports
- **E-newsletters** from MnDOT and LRRB
- **Social media** platforms including Twitter, LinkedIn, and Facebook
- MnDOT and LRRB **websites**
- MnDOT's Crossroads **transportation research blog**
- Annual MnDOT and LRRB At-a-Glance **research highlight report**
- The American Association of State Highway and Transportation Officials (AASHTO) High-Value **Research nominations and awards**

² Local Road Research Board Marketing Plan 2021-2023. Minnesota Local Road Research Board. September 2021.

1.2.2 Evaluation of current processes

Table 1 summarizes the strengths and limitations of MnDOT/LRRB’s benefit evaluation process based on consultations with MnDOT staff and literature review. MnDOT/LRRB’s current benefit evaluation process involves all members of project teams — from research investigators to TAPs — and occurs throughout the research lifecycle. Multiple deliverables, such as needs statement forms, proposals, and communication plans, hold project teams accountable for identifying and updating benefits and assessment methodologies.

Table 1: Strengths and Limitations of the Current Benefit Evaluation Process

Strengths	Limitations
<ul style="list-style-type: none"> ● Clear division of responsibilities within each project team ● Benefit identification and evaluation throughout the research lifecycle <ul style="list-style-type: none"> ○ Multiple deliverables require research teams to address project benefits and evaluation methods ○ MnDOT/LRRB continuously engages with research teams throughout research execution. ● A mix of qualitative and quantitative approaches <ul style="list-style-type: none"> ○ Interviews conducted to capture qualitative benefits after project completion ○ The existing Benefit Tracking Tool establishes a seven-step process assessing various quantitative benefit categories. 	<ul style="list-style-type: none"> ● Limited staff and interests ● Lack of an idea clearinghouse ● Difficulties in coming to a consensus on or committing to a set of measures ● Tough to continuously track and evaluate dynamic research outcomes <ul style="list-style-type: none"> ○ Lack of baseline data ○ Staff turnover ● Quantitative analysis doesn’t capture comprehensive values of projects ● Qualitative benefits have been documented but have not been further analyzed to demonstrate valuable program-level value.

Source: CPCS Analysis of Related Literature and Stakeholder Consultations, 2023

Table 2 demonstrates the strengths and limitations of the current benefit communication process based on consultations with MnDOT staff and literature review. In terms of strengths, MnDOT/LRRB takes advantage of multiple platforms — public and internal — to gather feedback on completed projects and generate interest among engineering communities and the public.

Table 2: Strengths and Limitations of the Current Benefit Communication Processes

Strengths	Limitations
<ul style="list-style-type: none"> ● Variety of public and internal platforms to engage interested parties in recent research efforts ● Publish two-page Technical Summaries for each project <ul style="list-style-type: none"> ○ Qualitative values are shared with public ● Utilize AASHTO Research Advisory Committee to amplify research impacts. 	<ul style="list-style-type: none"> ● Limited staff and budget dedicated to marketing, engagement, and outreach ● Communicating findings succinctly for industry use and public knowledge <ul style="list-style-type: none"> ○ Lack of quantified benefits ○ Diverse audience ● Web-based tools or apps <ul style="list-style-type: none"> ○ Unintuitive website design

Source: CPCS Analysis of Related Literature and Stakeholder Consultations, 2023

1.2.3 Summary of Findings Solicited Through Outreach Efforts

Outreach process

In addition to conducting an assessment of MnDOT and LRRB’s own research benefit monitoring and communication methods, the team conducted a literature review and series of stakeholder consultations with state DOTs and national research programs to ascertain what they use to guide project selection and monitoring.

After conducting a literature review and a series of stakeholder consultations, multiple perspectives have been gathered on the benefit monitoring and communication practices for state, DOT, and national research programs. To justify the value and funding of research, many DOTs struggle with similar, if not the same, limitations.

Benefit monitoring

For state DOTs and national programs, benefit monitoring begins at different stages and follows a different set of criteria. For some, systematic project selection ensures that only projects with benefits aligned with agency goals and values are chosen or prioritized. Subject matter experts, multimodal planners, and operations managers within the DOT can all take part in an assessment of stakeholder needs to ensure a holistic approach to selecting valuable research. The National Cooperative Highway Research Program (NCHRP) also recommends a structured set of questions to ask to assess the potential impact of a project, covering the objectives, agencies involved, deliverables, and potential obstacles to implementation. Even if deemed implementable in the selection stage, many DOTs find use in distributing surveys post-project completion to determine the applicability of the research. Often, DOT surveys are sent to a variety of involved staff, including project champions, engineers, and internal research staff, to assess the qualitative and quantitative benefits of the research.

In addition to project selection strategies and post-completion surveys, some DOTs find value in monitoring benefits while research efforts are still active. These strategies often include questions and methods similar to evaluating post-completion surveys but will be conducted at one or multiple points during implementation.

Ohio DOT's (ODOT's) Decision Tree

Looking to improve the regularity of their project benefit monitoring with limited resources, ODOT is currently developing a tool for all stages of their research projects. A three-page spreadsheet asks DOT Project Champions to answer questions regarding implementation stage, successes seen thus far, cost of implementation, any quantifiable benefits, and evaluation of project staff. Based on the project type and potential benefits discussed in the selection stage, these survey questions can be changed to better suit the agency goals or return-on-investment assessment.

The tool will be used once during the project kick-off meeting, once for mid-evaluation, and once post-completion. The tool can be used internally for research staff to monitor the value of research but also as a means of communicating to external stakeholders in non-technical speak the process and benefits of a study.

Source: CPCS Interview with Vicky Fout, ODOT Research Program Manager, February 2023.³

Evaluating the research outcomes of multiple projects with limited resources is difficult for several research programs. As a result, many states take advantage of a more informal word-of-mouth and peer-to-peer communication system to collect feedback on research benefits and implementation progress.

Where agencies vary, the greatest is the type of feedback they look to collect. Some place priority on quantitative outcomes like a cost-benefit ratio for measurable project-to-project comparison. Others find that qualitative feedback allows for more comprehensive accounts of project successes and tells a clearer story of research outcomes.

1.2.4 Benefit communication

Once a review of project benefits has been carried out, multiple platforms can be used to communicate internally and externally the value of conducting research. Multiple state departments of transportation (DOTs) take advantage of multi-media dissemination of research findings and project updates, including platforms like:

- **Webinars** - Hosting regular webinars allows for widespread public engagement and workforce development. Once benefits have been assessed on a closed project, PowerPoints and live Q&A sessions can be developed by the project champion or research panel to showcase successful implementation or changes in department strategies.
- **Research project summary videos** - Rather than communicate the value of selected projects through live webinars, some DOTs require each closed research project to develop Summary Report Videos as part of the deliverables and post them on the DOT YouTube channel and website. These videos are developed in coordination with the project team, addressing the economic benefit and qualitative value of the research that was determined throughout the project.
- **Research briefs** - Many stakeholders also shared that their agencies make use of regular newsletters and research briefs to communicate research benefits succinctly and clearly to internal and external parties. These briefs are often released on a regular basis and can be organized by theme or by individual

project. DOTs prefer to keep these deliverables to one to two pages and include key findings as well as any identifiable benefits. Statistics, quotes from the research team, and comparisons to goals identified at the start of the project are all used by research teams to summarize project outcomes.

- **Conferences and symposiums** - Participating in conferences and symposiums is also an opportunity to generate widespread public engagement with DOT research programs and their completed projects. AASHTO's High-Value Research Awards offer DOTs an opportunity to submit completed projects and receive recognition in a yearly compendium.

Many stakeholders shared an interest in developing communication materials for internal and external use that were more succinct and less technical to generate broader and more regular interest in applied research. Using platforms like webinars and conferences has proven successful for many in engaging internal and external audiences with recent research and getting a wider base of feedback.

Chapter 2: Benefit Monitoring & Communication Framework

Chapter Summary

The recommended framework for benefit monitoring and communication includes two main parts:

- An assessment of the project types according to the potential for implementation, the magnitude of impact, the level of interest, and the unknown factors involved in benefit quantification.
- Use of the Benefit Evaluation and Communication Form to identify and record project benefits and other relevant information and disseminate relevant information among interested audiences in various stages of the research lifecycle.

This framework has been tested through a proof-of-concept pilot and refined based on the findings as well as the inputs shared by the MnDOT/LRRB research and communication teams and other research partners in the state.

2.1 The Proposed Framework

The proposed framework is intended to help MnDOT/LRRB to achieve the following interrelated purposes:

- **Understand how benefits evolve during project development.** The value of research projects often changes or evolves throughout the research cycle. Tracking and accurately understanding project-level benefits can help MnDOT/LRRB better evaluate progress made in achieving program-level goals. Additionally, evaluated benefits also demonstrate outcomes of research implementations and provide practitioners with evidence of the effectiveness of new material, procedure, design, etc.
- **Plan for long-term benefit monitoring and updates for select projects.** Research value takes time to manifest. Like the previous purpose, monitoring and evaluating projects deemed to have long-lasting or delayed impacts supports more holistic program-level benefit evaluation.
- **Share knowledge across the MnDOT, LRRB, and external research communities.** A more comprehensive research benefit evaluation that captures both quantitative and qualitative benefits over a period of time can improve the communication of research value to practitioners in Minnesota, ensuring more research results translate into real-world impacts. Externally, the research benefits can also be shared with other states to promote an active exchange of knowledge.
- **Articulate the value of investing in various research programs.** Research value assessed with a sound methodology can demonstrate good use of research program funding to the state legislature, county boards, and city councils, providing support for receiving future funding.

2.1.1 Guiding Principles

The proposed framework was developed under the guidance of the following three principles:



Flexibility is key to creating a benefit monitoring and communication process that can be adapted to different types of projects with various benefit categories. A flexible process also allows the benefit

categories, metrics, inputs, and methodologies to evolve over time as the project team moves through the various project stages.



Trackability allows revisiting and re-evaluation of the research benefits after project completion. A challenge for researchers and research practitioners is that most research projects will not immediately be ready for application. This is especially true in the case of practices that would require new or revised guidelines, policies, and regulations. Therefore, to facilitate the revisions and creation of new guidelines and policies, the benefit monitoring process should enable the evaluation of long-term outcomes and impacts of such projects.



Integration ensures that the existing tools and processes (such as work plans, the Benefit Tracking Tool, communication plan, etc.) used by MnDOT, LRRB, and other research partners in the state are leveraged so that the new processes can seamlessly fit into the lifecycle of research. An integrated benefit monitoring and communication process also helps reduce confusion around the application of the process.

2.1.2 Framework Components

The proposed framework consists of two parts:

Part 1 – Assign Project Type

Project type categorization determines the level of effort and resources invested in the benefit evaluation and communication process. Projects will be classified into three types based on four criteria – 1) implementation likelihood and timeline, 2) impact magnitude, 3) level of interest, and 4) assumptions and unknowns for benefit quantification, as demonstrated in Table 3. The three project types guide the amount of resources (researchers' level of effort and budget) dedicated to benefit evaluation and communication:

- **Type 1:** This type of project receives the **highest level of investments** for benefit evaluation and the **broadest communication needs**. The outcomes of Type 1 projects have impacts throughout Minnesota and attract the interest of diverse stakeholders on state and national levels. These projects are highly likely to progress directly to implementation and can be easily evaluated using quantitative measures.
- **Type 2:** This type of project requires **moderate efforts in benefit evaluation and communication**. The implementation of these projects may not happen immediately after project completion but will occur within five years or less. The results of these projects should be of high interest to MnDOT but may or may not attract attention from partnering agencies or other state DOTs. This type of project can rely relatively more on qualitative benefit evaluation to supplement benefit quantification.
- **Type 3:** This type of project is suited to **low investments in benefit evaluation and communication**. These projects usually don't have outcomes that point to immediate or near-future implementation. Niche projects that attract the interest of a small audience (e.g., a single office within MnDOT) also fall under this category. Additionally, if the benefit quantification of projects is based on many assumptions or unknowns, the projects are also deemed to be Type 3.

During the funding decision meetings in December, the RSC and LRRB should discuss and classify project types based on each project's needs statement and scope of work in the proposal. Table 4 demonstrates the scoring matrix recommended for the project categorization process. This approach assumes a higher importance for some of the criteria and therefore applies a multiplier weight to reflect this importance on the total score. After project inception, project champions/technical liaisons are responsible for reassessing project type using the scoring approach. If the score of a project changes by three or more, project champions/technical liaisons should work with the boards to adjust project types.

Table 3: Project Type Classification Criteria

	Implementation Likelihood and Timeline	Impact Magnitude	Level of Interest	Assumptions and Unknowns for Benefit Quantification
Type 1	Research products/results are very likely to progress directly to implementation .	Project outcomes are very likely to result in a high magnitude of impacts in areas like transportation system changes, benefits, and/or cost savings. Benefits tend to have positive impacts throughout the State of Minnesota .	Projects are very likely to attract a high level of interest from many stakeholders (e.g., elected officials, the public, transportation system users, etc.) across the state or the nation.	Key benefits of projects can be easily quantified without many assumptions.
Type 2	Research products/results are likely to lead to implementation within the next five years .	Projects generate impacts on transportation planning and engineering in most areas of Minnesota .	Projects are expected to be of higher interest to MnDOT and may attract interest from partnering agencies and other agencies.	Projects have relatively few unknowns and assumptions for benefit quantification.
Type 3	Projects are emerging research anticipating a five-year or greater pathway to implementation (e.g., Knowledge Building Priority projects, disruptive ideas, policy change initiatives).	Projects are about specialized research topics that interest a relatively small audience .	Projects are of interest to a single office or discipline (e.g., changes in specifications or operational methods/procedures, product/material investigations).	Projects have many assumptions and unknowns relative to benefit quantification.

Source: CPCS, 2023

Table 4: Project Type Scoring Matrix

Criteria	Description	Criteria Weight	Score			Total Score
			High (5)	Medium (3)	Low (1)	
Implementation Likelihood	Likelihood that research results will progress directly to real-world implementation	2				
Impact Magnitude	Level of impact based on magnitude of system changes or cost savings	2				
Level of Interest	Number of stakeholders and groups affected	1				
Assumptions and Unknown Benefit Quantification	Projects have easily quantifiable benefits with few assumptions will be granted higher scores	1				
Total Score						

Project type based on total score:

- If total score ≥ 22 the project is Type 1
- If total score ≥ 14 but ≤ 20 the project is Type 2
- If total score ≤ 12 the project is Type 3

Source: CPCS, 2023

Part 2 – Evaluate and Communicate Project Benefits

The research process contains multiple stages of decision-making and analysis and often results in more than one outcome and benefit. Therefore, a multiphase approach is proposed that provides the benefit monitoring and communication activities at multiple points in the research cycle.

After confirming the project types, project team members, including PI, Project Advisors (PA), Project Champion, TL, and TAP members collaborate and follow the benefit evaluation and communication process according to project type and during each project stage.



Project Development: This stage includes activities leading up to contractor selection and project funding announcement, such as **proposal review and presentations** during the Winter Meetings.



Project Inception: This stage starts after the contractor and research team selection. During this phase, research teams work with MnDOT/LRRB to **establish work plans and communication plans**.



Project Execution: This stage comes after the completion of Work Plans and Communication Plans. This is the stage where **researchers conduct technical work and generate results** in response to research questions and needs.



Project Completion: This stage begins after research teams finalize Final Reports. Responsible personnel should **complete the Benefit Evaluation and Communication Form and the benefit evaluation and component in Final Reports**, preparing for hand-off after project completion.







Post-Completion/Post-Implementation: This stage contains any activities that occur after the submission of Final Reports. If long-term benefits or implementation opportunities are identified in the Form, research teams of subsequent project phases or ORI staff should **periodically update the**

Form or as often as necessary.

Table 5 summarizes key benefit evaluation and communication activities for each project phase by project type. Appendix B details all administrative and research activities required throughout research projects by role and demonstrates how the benefit evaluation and communication tasks fit into the research cycle.

The essential activities at each stage as well as the level of effort and resources required to assess and communicate the benefits are also described in Appendix C.

Table 5: Phased Benefits Evaluation & Communication Workflow Overview

 Activity	 Project Stage	 Responsible Person(s)	 Facilitator(s)
▶ Project Type Assessment			
- Initial type assessment	Project development	RSC & LRRB board members	Champion
- Revisiting type assessment	Project execution	Champion & Project Advisor	Principal Investigator, Technical Liaison, Technical Advisory Panel
▶ Completion of the Benefit Evaluation & Communication Form			
- Form establishment	Project inception	Champion	Principal Investigator, Technical Liaison, Project Advisor, Technical Advisory Panel
- Identify & document benefit categories, data, & methods	Project inception	Champion	Principal Investigator, Technical Liaison, Technical Advisory Panel
- Review & update benefit categories, data, & methods	Project execution, project completion	Champion & Principal Investigator	Technical Liaison, Technical Advisory Panel
- Identify & document anticipated post-completion benefit categories, data, & methods	Project inception	Champion & Principal Investigator	Technical Liaison, Technical Advisory Panel
- Review & update anticipated post-completion benefit categories, data, & methods	Project execution, completion, post-completion	Champion & Principal Investigator	Technical Liaison, Technical Advisory Panel
- Identify project audiences & communication tools & platforms	Project inception	R&I Communication & Principal Investigator	Champion, Technical Liaison, Technical Advisory Panel
- Review & update the communication information	Project execution, completion, post-completion	Champion & Principal Investigator	Technical Liaison, Technical Advisory Panel, R&I Communication

Source: CPCS, 2023

2.2 Proof-of-Concept Pilot

2.2.1 Project Selection

A list of candidate projects (Table 6 **Error! Reference source not found.**) was developed by the project team for the proof-of-concept pilot, primarily based on a high-level assessment of various factors, including project types, benefit categories, level and areas of impact, and project development stage.

The purpose of the pilot was to test and refine the proposed benefit monitoring and communication framework. A summary of the pilot process and outcomes also serves as an example for future implementation of the framework. This summary is provided in Appendix D.

Table 6: Selected Pilot Project Overview

Project Type	MnDOT Project ID	Project Name	Sponsor	Implementation Project
1	2019-048	The Impact of Deferred Maintenance in Minnesota	LRRB	No
	2023-016	Understanding Driving Causes of Bridge Replacement	Joint	No
	2019-059	Unmanned Aircraft Systems (UAS) – Metro District Bridge Inspection Implementation	MnDOT	Yes
2	2018-069	Harnessing Solar Energy through Solar Snow Fence: Implementation	MnDOT Implementation	Yes
3	2022-022	Cost-Effective Roadside Revegetation Methods to Support Insect Pollinators	Joint	No
	2018-016	Reuse of Regional Waste in Sustainably-Designed Soils – Part 1	LRRB	No

Source: MnDOT Office of Research and Innovation, 2023

2.2.2 Pilot Project Evaluation

The pilot project evaluation process consists of two steps:

- Filling out the Form using available project documentation
- Conducting interviews with each project’s coordinator, principal investigator, and/or champion.

During Step 1, the consultant team assessed the comprehensiveness of the Form in terms of collecting benefit evaluation and communication information and identified any redundant requirements overlapped with the existing MnDOT/LRRB benefit evaluation tools (e.g., communication form, the initial memo on benefit evaluation, etc.). The Form was then shared with the six project teams, enabling them to familiarize themselves with it and prepare for providing feedback during the Step 2 interviews.

As a part of Step 2, the consultant team interviewed the project coordinators, principal investors, and/or champions of each research team. The research team members were inquired about their experience using the Form, which ultimately inspired the creation of the checklists (included in Appendix A) and other modifications and additions to the framework, as detailed in Section 2.2.3.

2.2.3 Framework Revisions

The proof-of-concept pilot and inputs solicited from the research partners in Minnesota highlighted the nuances, strengths, and limitations of the recommended benefit monitoring and communication framework and resulted in the following revisions to the initially proposed framework:

- MnDOT and LRRB research projects are more than often the result of past experiments and investigations and, in many cases, lead to follow-up study phases to advance or expand research projects and their implementation. Therefore, the Form incorporates information regarding the relevant research efforts and the preceding and succeeding project phases.
- According to MnDOT and LRRB staff and other research partners in Minnesota, project inception, completion, and post-completion are the most important stages for identifying, documenting, and communicating the project benefits. At these stages, the Project Champions, TLs, PIs, and others involved in the research process must
 - Establish benefit categories and metrics to inform goal setting and work plan finalization (inception stage),
 - Finalize benefit evaluation for documentation in the Draft and Final Project Reports (completion stage) or
 - Track project impacts and benefits of its implementation over time (post-completion stage).
- Therefore, benefit monitoring and communication activities during the project execution stage are optional and only recommended for projects with the highest level of interest and magnitude of impact.
- Benefit evaluation and communication roles are assigned to specific research team members based on their project responsibilities and their level of involvement in the flow of research on a specific topic.
- Since intermediate or finalized research outcomes could indicate changes in a project's implementation likelihood, impact magnitude, level of interest, and benefit evaluation assumptions, the project type assessment is made flexible in the Form. Therefore, the project team can revisit and revise the project type during the execution or completion stages.

Chapter 3: Conclusions, Reflections & Next Steps

Research benefit monitoring and communication are embedded in the existing research cycle of MnDOT and the LRRB, from research idea solicitation and proposal review stages to project completion and reporting. Tracking and accurately understanding project-level benefits can help MnDOT and LRRB better evaluate progress made in achieving program-level goals while also demonstrating the outcomes of research implementations and providing practitioners with evidence of the effectiveness of new material, procedure, design, and other findings and outcomes.

This report summarizes the current benefit monitoring and communication processes used by MnDOT and LRRB and establishes an updated benefit monitoring and communication framework. The framework recognizes that benefit monitoring can be a resource-intensive task, and detailed guidance on benefit monitoring steps, tools, and team member roles and responsibilities can significantly improve this process. Also, acknowledging that research value takes time to manifest and benefits can change or evolve throughout the research cycle, the framework establishes a multi-stage approach to allow for benefits evaluation review and refinement at multiple points in the research cycle, from project development to inception, execution, completion, and even a few years after completion.

The proposed framework also integrates many of the existing benefit monitoring and communication tools and activities, therefore enabling a more streamlined assessment of research work, whether they are new projects, in-progress work, or completed projects.

The proposed framework incorporates two main parts:

- 1) An assessment of the project types according to the potential for implementation, the magnitude of impact, the level of interest, and the unknown factors involved in benefit evaluation.
- 2) A Benefit Evaluation and Communication Form to identify and record project benefits and other relevant information and disseminate relevant information among interested audiences in various stages of the research cycle.

This report also provides the timeline for implementing any of the above parts as well as a detailed list of actions, roles, and responsibilities of each research team member for benefit monitoring and evaluation (Appendix A). All these activities are developed according to discussions with project stakeholders and refined and finalized based on a proof-of-concept pilot and feedback from the project's MnDOT/LRRB team and TAP members.

3.1 Next Steps

The following next steps can be considered for further testing and implementation of the proposed benefit monitoring and communication framework:

3.1.1 Benefit monitoring:

- **Implement the project type assessment approach on the next year's research project portfolio:** the project champions can conduct an initial assessment of project types during proposal evaluation and recommend a project type for consideration by the MnDOT Research Steering Committee (RSC) and LRRB boards during the fall and winter meetings.
- **Implement the Benefits Monitoring and Communication Form on a select set of projects:** once the next year's projects are categorized by type, the MnDOT/LRRB staff who led the project can collaborate with the RSC and LRRB boards to identify a select set of projects (of various types) to further test and refine the proposed framework.
- **Tailor Research Work Plan development guidance based on project types:** as a result of the recommended pilot, new instructions on benefit monitoring and communication activities and staff roles can be incorporated into the Research Work Plans. These instructions can distinguish team member roles and the level of effort required for benefit monitoring and communication by project type.
- **Refine the Benefit Monitoring and Communication Framework and develop recommendation steps:** based on the pilot results, the MnDOT/LRRB project team can incorporate any needed refinements and develop recommendations for the next steps.

3.1.2 Benefit communication:

MnDOT and LRRB have mature communication processes and use various tools to announce and communicate research projects and their benefits to various audiences. A number of innovative communication tools can also be added to these processes, including the use of **brief audio recorded statements** from interviews with researchers to disseminate descriptions of research project outcomes and qualitative or quantitative benefits on various platforms. These sound bites can provide clear, concise, and memorable messages on the overall outcomes of the research projects and help highlight the program-level values of investing in research on priority topic areas.

Also, since the Benefits Monitoring and Communication Form already incorporates all the elements of the current template used for MnDOT and LRRB Communication Plans, the **form can replace the Communication Plan** once the proposed benefit monitoring and communication framework is implemented at a large scale.

References

1. MnDOT Office of Research and Innovation, Interview by CPCS, May 2023.
2. LRRB. (2021). *Local Road Research Board Marketing Plan 2021-2023*. Saint Paul, MN: MnDOT Minnesota Local Road Research Board
3. ODOT Research Program Manager Vicky Fout, Interview by CPCS, February 2023.

**Appendix A The Benefit Evaluation and
Communication Form**

Please see Appendix A The Benefit Evaluation and Communication Form.xlsx for the Form. Table A. 1 and Table A. 2 provide screenshots of the Form.

Table A. 1: Screenshot of Project Cover Page

Project Cover Page			
Project Name:	[Enter Project Name Here]	Project Type:	Type X
Form Last Updated: mm/dd/yyyy	Contract Start date: mm/dd/yyyy	Contract Completion Date:	2022-05-27
Principal Investigator:	[Enter Name Here]	Technical Liaison:	[Enter Name Here]
How does this project build upon previous research ?			
Other Relevant Projects' Benefit Evaluation and Communication Forms:			

Table A. 2: Screenshot of the Benefit Evaluation and Communication Form

1. Benefit Assessment										
Project Benefits	Benefit Monitoring Type		Qualitative Benefit Monitoring Details				Quantifiable Benefit Monitoring Details			
	Qualitative	Quantitative	Benefit Metrics	Descriptions	Benefit Metrics	Methodology	Data	Assumptions	Limitations	
Construction Saving										
Decrease Engineering/Administrative Cost										
Decrease Lifecycle Costs										
Environmental Impact										
Increase Lifecycle										
Operation and Maintenance Saving										
Safety										
User Benefits										
Risk Management										
Other (Specify)										

2. Post-Completion/Post-Implementation Benefit Assessment Plan										
Anticipated Benefits	Benefit Monitoring Type		Qualitative Benefit Monitoring Details				Quantifiable Benefit Monitoring Details			
	Qualitative	Quantitative	Benefit Metrics	Descriptions	Benefit Metrics	Methodology	Data Sources	Data Collection Timeline (How long after project completion should the data be collected? Is it a one-time or multi-time collection? How frequent?)	Assumptions	Limitations

3. Communication Requirements					
Communication Goals:					
Key Messages:					
Helpful Resources:					
Phase	Type of Information to Co-Audiences	Medium	Responsibility	Notes	
Project Inception					
Project Execution					
Project Completion					

Appendix B Brochure and Task Checklists

Evaluating and Communicating the Value of Research Brochure and Task Checklists



Why Evaluate and Communicate the Value of Research?

Research benefit evaluation and communication help MnDOT and LRRB understand the outcomes of their investment in research and innovation, promote further exploration and implementation of new knowledge and technology in transportation, and prioritize future research and implementation projects.

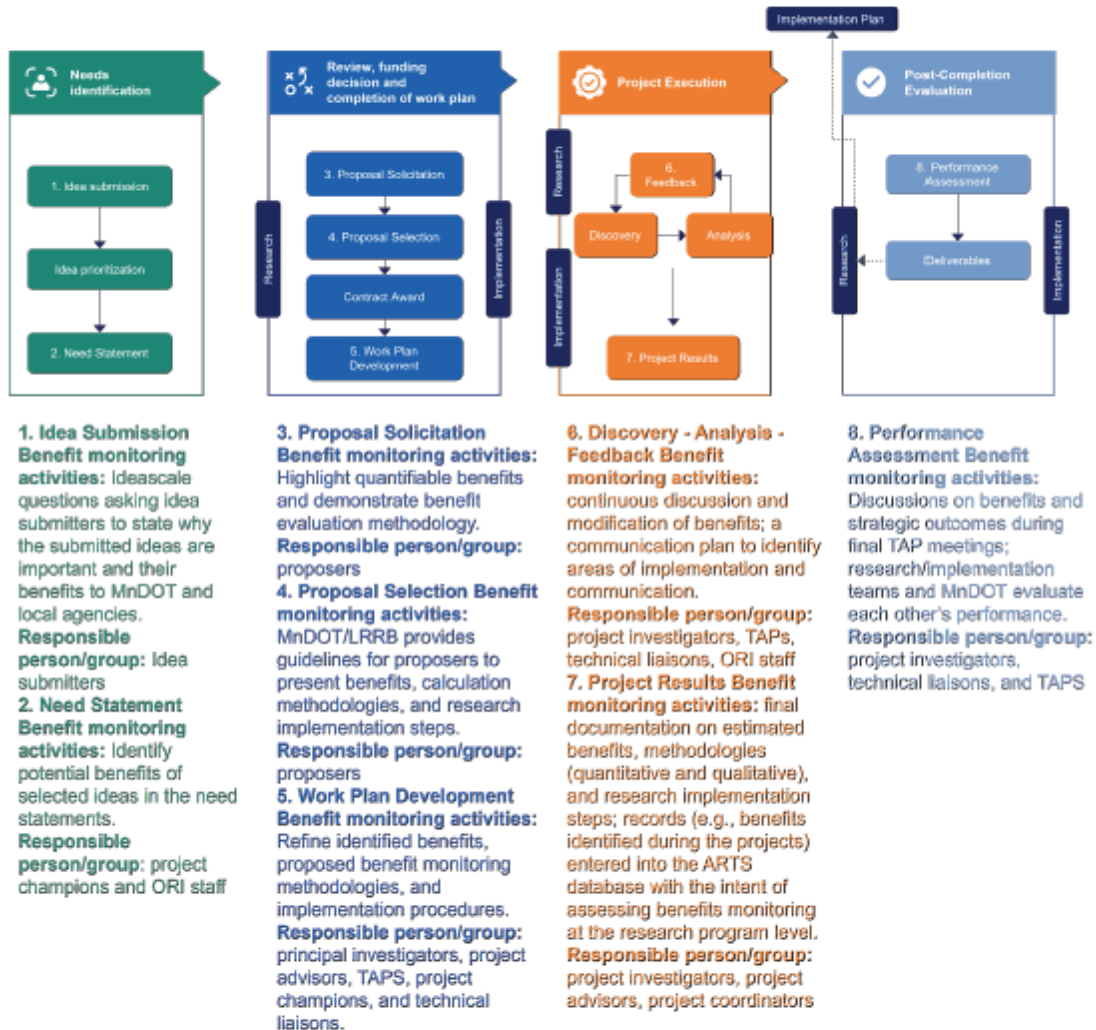


Why Soft-Launch a New Framework for Research Benefits Evaluation and Communication?

The new framework will improve the efficiency and effectiveness of MnDOT's and LRRB's benefit monitoring process and ensure that identified research benefits are incorporated into existing communication and marketing activities

Benefit Monitoring Processes in the Research Cycle of MnDOT and LRRB

The existing research cycle of MnDOT and the LRRB already involves multiple benefit evaluation activities and tasks. The newly adopted framework is built upon these tools and ensures a more streamlined evaluation and communication process.



Multi-Stage Benefit Evaluation and Communication Process

The benefit evaluation and communication framework follows a multi-stage process, aligning with the various stages in the MnDOT/LRRB research cycle. This approach ensures that the assessment and communication of project benefits are integrated seamlessly into the entire lifespan of research and implementation endeavors and requires active collaboration among the research/implementation team members.



Phased Benefits Evaluation & Communication Workflow Overview

The benefit evaluation and communication process will be a collaborative process involving existing research team members:

1

Project Champions / Technical Liaisons are the lead of benefit monitoring efforts. They track the flow of research on a specific topic, oversee completing the Form, and coordinate with other team members to gather benefit evaluation and communication information. They also serve as advocates for research teams during the project type categorization and adjustment discussions with the RSC and LRRB boards.

2

Principal Investigators provide technical expertise on benefit evaluation and communication throughout project lifecycles.

3

Project Advisors (also includes project coordinators) are responsible for the administration tasks in the benefit monitoring and communication process. They oversee the schedule of the process and organize check-in meetings with TAPs. They coordinate with research teams and the boards during project adjustment discussions.

4

Technical Advisory Panel Members provide guidance and feedback to research teams on the benefit evaluation and communication work throughout project lifecycles.

The table on the right summarizes the evaluation and communication activities by role and project stage.

Activity	Project Stage	Responsible Person(s)	Facilitator(s)
Project Type Assessment			
Initial type assessment	Project development	RSC & LRRB board members	Champion
Revisiting type assessment	Project execution	Champion and Technical Liaison & Project Advisor	Principal Investigator, Technical Advisory Panel
Completion of the Benefit Evaluation & Communication Form			
Form establishment	Project inception	Champion and Technical Liaison	Principal Investigator, Project Advisor, Technical Advisory Panel
Identify & document benefit categories, data, & methods	Project inception	Champion and Technical Liaison	Principal Investigator, Technical Advisory Panel
Review & update benefit categories, data, & methods	Project execution, project completion	Champion and Technical Liaison & Principal Investigator	Technical Advisory Panel
Identify & document anticipated post-completion benefit categories, data, & methods	Project inception	Champion and Technical Liaison & Principal Investigator	Technical Advisory Panel
Review & update anticipated post-completion benefit categories, data, & methods	Project execution, completion, post-completion	Champion and Technical Liaison & Principal Investigator	Technical Advisory Panel
Identify project audiences & communication tools & platforms	Project inception	R&I Communication & Principal Investigator	Champion and Technical Liaison, Technical Advisory Panel
Review & update the communication information	Project execution, completion, post-completion	Champion and Technical Liaison & Principal Investigator	Technical Advisory Panel, R&I Communication

Project Type Assessment

Project type categorization determines the level of effort and resources invested in the benefit evaluation and communication process. Projects will be classified into three types based on four criteria – 1) implementation likelihood and timeline, 2) impact magnitude, 3) level of interest, and 4) assumptions and unknowns for benefit quantification. The three project types guide the amount of resources (level of effort and budget) dedicated to benefit evaluation and communication and will be determined by LRRB and RSC boards during their annual winter meetings. The project type is flexible and could be adjusted during projects based on their intermediate and final findings.

	Implementation likelihood and timeline	Impact Magnitude	Level of interest	Assumptions and unknowns for benefits quantification
Type 1	Research products/results are very likely to progress directly to implementation.	Project outcomes are very likely to result in a high magnitude of impacts in areas like transportation system changes, benefits, and/or cost savings. Benefits tend to have positive impacts throughout the state of Minnesota.	Projects are very likely to attract a high level of interest from many stakeholders (e.g., elected officials, the public, transportation system users, etc.) across the state or the nation.	Key benefits of projects can be easily quantified without many assumptions.
Type 2	Research products/results are very likely to lead to implementation within the next five years.	Project generate impacts on transportation planning and engineering in most areas of Minnesota.	Projects are expected to be of higher interest to MnDOT and may attract interest from partnering agencies and other agencies.	Projects have relatively few unknowns and assumptions for benefit quantification.
Type 3	Projects are emerging research anticipating a five year or greater pathway to implementation (e.g., knowledge building priority projects, disruptive ideas, policy changes initiatives).	Projects are about specialized research topics that interest a relatively small audience.	Projects are of interest to a single office or discipline (e.g., changes in specifications or operational methods/procedures, product/material investigations.)	Projects have many assumptions and unknowns relative to benefits quantification.

Project type categorization determines the level of effort and resources invested in the benefit evaluation and communication process. Projects will be classified into three types based on four criteria – 1) implementation likelihood and timeline, 2) impact magnitude, 3) level of interest, and 4) assumptions and unknowns for benefit quantification. The three project types guide the amount of resources (researchers' level of effort and budget) dedicated to benefit evaluation and communication and will be determined by LRRB and RSC boards during their annual winter meetings. The project type is flexible and could be adjusted during projects based on their intermediate and final findings.

Criteria	Criteria Weight	Score			Total Score
		High (5)	Medium (3)	Low (1)	
Implementation Likelihood	2				
Impact Magnitude	2				
Level of Interest	1				
Assumptions and Unknown Benefit Quantification	1				
Total Score					

Project type based on total score:

If total score ≥ 22 the project is Type 1

If total score ≥ 14 but ≤ 20 the project is Type 2

If total score ≤ 12 the project is Type 3

Benefit Evaluation and Communication Activity Checklist



Project Champion / Technical Liaison Task List

Stage	Applicable Project Type			Task	Leads & Facilitators								Relevant Document/Materials	
	1	2	3		PI	PC/TL	PC	TAP	PA	PET	RSC & LR RB	IE		R&I
Project Development	•	•	•	Evaluate submitted proposals for Fast Track eligibility										Submitted proposals; Fast Track criteria
	•	•	•	Assist RSC and LRRB boards in determining project type										Submitted proposals; Project Type Classification Criteria; Project Type Scoring Matrix
Project Inception	•	•	•	Create a new Form and enter general project information and relevant prior projects to the Cover Page sheet										The Benefit Evaluation and Communication Form; Research/Implementation Project Proposals; MnDOT R&I Project Library; MnDOT Library
	•	•	•	Identify the anticipated benefit categories, types, metrics, and methodologies										Needs Statements; Research/Implementation Project Proposals; Work Plans
	•	•	•	Document the benefits and other relevant information in Tables 1 and 2 in the Project Inception tab										The Benefit Evaluation and Communication Form
	•	•	•	Ensure that benefit evaluation tasks (e.g., data collection and evaluation) are included in Work Plans										The Benefit Evaluation and Communication Form; Work Plans
	•	•	•	Identify suitable communication methods, tools, and target audiences										The Benefit Evaluation and Communication Form; Communication Plans
	•	•	•	Fill out Table 3 in the Project Inception tab										The Benefit Evaluation and Communication Form; Communication Plans

PI: Principal Investigator
 TL: Technical Liaison
 PC: Project Coordinator
 PCh: Project Champions

TAP: Technical Advisory Panel
 PA: Project Advisor
 PET: Proposal evaluation teams
 LRRB: Local Road Research Board

RSC: Research Steering Committee
 IE: Implementation Engineers
 R&I: MnDOT Office of Research & Innovation



 Lead  Facilitator

Stage	Applicable Project Type			Task	Leads & Facilitators									Relevant Document/Materials	
	1	2	3		PI	PCh/TL	PC	TAP	PA	PET	RSC & LRRB	IE	R&I		
Project Execution	•			Review benefit categories, types, metrics, and methodologies	Lead	Facilitator		Facilitator							The Benefit Evaluation and Communication Form; Initial Memo on Research Benefits (Task 1)
	•			Update benefit categories, types, metrics, and methodologies, if needed, in Tables 1 and 2 in the Project Execution tab.	Facilitator	Facilitator	Lead								The Benefit Evaluation and Communication Form; Initial Memo on Research Benefits (Task 1)
	•			Review project type and bring suggestions to PAs and TAPs for further discussion	Facilitator	Facilitator		Facilitator	Lead						The Benefit Evaluation and Communication Form; Initial Memo on Research Benefits (Task 1); Final Reports; other relevant intermediate research findings
	•			Update Table 3 in the Project Execution tab, if needed	Facilitator	Facilitator	Lead								The Benefit Evaluation and Communication Form; Initial Memo on Research Benefits (Task 1); Communication Plans
	•	•	•	Develop communication materials	Lead	Facilitator								Lead	Intermediate research findings; Communications Plans
	•	•	•	Lead and coordinate the discussion of potential follow-up studies or implementation opportunities, if applicable	Facilitator	Lead		Facilitator	Facilitator						The Benefit Evaluation and Communication Form; Final Reports; other relevant intermediate and final research/implementation results
	•	•	•	Plan for follow-up studies or implementations and submit needs statements, if applicable	Facilitator	Facilitator		Facilitator	Lead				Facilitator		The Benefit Evaluation and Communication Form; Need Statement Template; IdeaScale; Implementation Form

PI: Principal Investigator
 TL: Technical Liaison
 PC: Project Coordinator
 PCh: Project Champions

TAP: Technical Advisory Panel
 PA: Project Advisor
 PET: Proposal evaluation teams
 LRRB: Local Road Research Board

RSC: Research Steering Committee
 IE: Implementation Engineers
 R&I: MnDOT Office of Research & Innovation



 Lead  Facilitator

Stage	Applicable Project Type			Task	Leads & Facilitators								Relevant Document/Materials		
	1	2	3		PI	PCM/TL	PC	TAP	PA	PET	RSC & LR/RR	IE		R&I	
Project Completion	•	•	•	Complete the Contracts Agreements Audit Tracking System Performance Evaluation Details	Lead	Facilitator			Facilitator					Contracts Agreements Audit Tracking System	
	•			Complete Table 3 in the Project Completion tab	Facilitator	Facilitator	Lead						Facilitator	The Benefit Evaluation and Communication Form	
	•	•	•	Develop communication materials	Lead	Facilitator							Facilitator	Final Reports; other relevant intermediate and final research/ implementation results	
	•	•	•	Lead and coordinate the discussion of potential follow-up studies or implementation opportunities, if applicable	Facilitator	Facilitator		Facilitator	Facilitator						The Benefit Evaluation and Communication Form; Final Reports; other relevant intermediate and final research/ implementation results
	•	•	•	Plan for follow-up studies or implementations and submit needs statements, if applicable	Facilitator	Facilitator		Facilitator	Facilitator				Facilitator		The Benefit Evaluation and Communication Form; Need Statement Template; IdeaScale; Implementation Form
Post-Completion / Post-Implementation	•	•		Update Post-Completion/Post-Implementation benefits and relevant information as needed	Facilitator	Facilitator		Facilitator	Facilitator					Final Reports; other relevant intermediate and final research/ implementation results	
	•	•		Document post-completion/ implementation benefits according to the set timeline in Table 3 in the Post-Completion / Post-Implementation tab	Facilitator	Facilitator		Facilitator	Facilitator					The Benefit Evaluation and Communication Form; Final Reports; other relevant intermediate and final research/ implementation results	
	•	•		Update the relevant project links on the Cover Page	Facilitator	Facilitator		Facilitator	Facilitator					The Benefit Evaluation and Communication Form; MnDOT R&I Project Library; MnDOT Library	
	•			Develop communication materials per request		Facilitator							Facilitator	Final Reports; other relevant intermediate and final research/ implementation results	

PI: Principal Investigator
 TL: Technical Liaison
 PC: Project Coordinator
 PCh: Project Champions

TAP: Technical Advisory Panel
 PA: Project Advisor
 PET: Proposal evaluation teams
 LRRB: Local Road Research Board

RSC: Research Steering Committee
 IE: Implementation Engineers
 R&I: MnDOT Office of Research & Innovation.

 Lead  Facilitator

Principal Investigator Task List

Stage	Applicable Project Type			Task	Leads & Facilitators										Relevant Document/Materials
	1	2	3		PI	PC/TL	PC	TAP	PA	PET	RSC & LR RB	IE	R&I		
Project Inception	•	•	•	Provide technical expertise when updating identified benefit categories, types, metrics, and methodologies	Lead	Facilitator	Lead	Facilitator	Facilitator						Needs Statements; Research/Implementation Project Proposals; Work Plans
	•	•	•	Draft and finalize Work Plans and benefit evaluation activities are incorporated into the plans.	Lead	Facilitator			Facilitator						Needs Statements; Research/Implementation Project Proposals; Work Plans; The Benefit Evaluation and Communication Form
	•	•	•	Identify suitable communication methods, tools, and target audiences	Lead	Facilitator							Lead		The Benefit Evaluation and Communication Form; Communication Plans
	•	•	•	Provide the R&I communication team with content for project announcements and Communication Plans.	Facilitator								Lead		The Benefit Evaluation and Communication Form; Work Plans
Project Execution	•			Draft and finalize the Initial Memorandum on Expected Research Benefits and Potential Implementation Steps from Task 1 (Memo 1)	Lead	Facilitator		Facilitator	Facilitator						Initial Memorandum on Expected Research Benefits and Potential Implementation Steps from Task 1
	•			Provide technical expertise when updating identified and anticipated benefit categories, types, metrics, and methodologies	Lead	Facilitator		Facilitator	Facilitator						The Benefit Evaluation and Communication Form; Initial Memo on Research Benefits (Task 1); other relevant intermediate research findings
	•	•	•	Draft and finalize the Final Report and other deliverables outlined in the Work Plans	Lead	Facilitator		Facilitator	Facilitator						The Benefit Evaluation and Communication Form; Final Reports

PI: Principal Investigator
 TL: Technical Liaison
 PC: Project Coordinator
 PCh: Project Champions

TAP: Technical Advisory Panel
 PA: Project Advisor
 PET: Proposal evaluation teams
 LRRB: Local Road Research Board

RSC: Research Steering Committee
 IE: Implementation Engineers
 R&I: MnDOT Office of Research & Innovation.



Stage	Applicable Project Type			Task	Leads & Facilitators										Relevant Document/Materials	
	1	2	3		PI	PC/TL	PC	TAP	PA	PET	RSC & LR/RR	IE	R&I			
Project Completion	•	•	•	Discuss the potential for follow-up studies or implementation opportunities.	Facilitator	Facilitator		Facilitator	Facilitator							The Benefit Evaluation and Communication Form; Final Reports; other relevant intermediate and final research/implementation results
	•	•	•	Provide input and availability on the potential of a fast-tracked follow-up study.	Facilitator	Facilitator		Facilitator	Facilitator							
	•	•	•	Complete the Contracts Agreements Audit Tracking System Performance Evaluation Details	Lead	Facilitator			Facilitator							Contracts Agreements Audit Tracking System
	•	•	•	Provide communication materials to ORI Communication staff upon request.	Facilitator									Lead		The Benefit Evaluation and Communication Form; Final Reports; other relevant research findings/documents

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 Lead

 Facilitator

Project Advisor Task List

Stage	Applicable Project Type			Task	Leads & Facilitators										Relevant Document/Materials
	1	2	3		PI	PC/TL	PC	TAP	PA	PET	RSC & LRRB	IE	R&I		
Project Inception	•	•	•	Establish a timeline and check-in dates for benefit evaluation and communication.											The Benefit Evaluation and Communication Form; Work Plans
	•	•	•	Supervise and ensure submitted work plans reflect benefit evaluation tasks identified in the Form;											Needs Statements; Research/Implementation Project Proposals; Work Plans; The Benefit Evaluation and Communication Form
	•	•	•	Ensure the Form is saved in the correct contract folder.											The Benefit Evaluation and Communication Form
Project Execution	•			Review project type and coordinate with R&I/the Boards and research teams.											The Benefit Evaluation and Communication Form; Initial Memo on Research Benefits (Task 1); Final Reports; other relevant intermediate research findings
	•			Assist research teams with project type adjustment (i.e., file an amendment or plan for a follow-up study)											The Benefit Evaluation and Communication Form; Initial Memo on Research Benefits (Task 1); Final Reports; other relevant intermediate research findings
	•	•	•	Assemble TAP meetings to update TAP members on benefit evaluation progress.											Work Plans
Project Completion	•	•	•	Ensure all tabs in the Form are completed and saved in the correct contract folders.											The Benefit Evaluation and Communication Form

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 Lead

 Facilitator

TAP Member Task List

Stage	Applicable Project Type			Task	Leads & Facilitators								Relevant Document/Materials		
	1	2	3		PI	PCN/TL	PC	TAP	PA	PET	RSC & LR RB	IE		R&I	
Project Inception	•	•	•	Review Work Plans in conjunction with the completed Project Inception tab in the Form.											The Benefit Evaluation and Communication Form; Work Plans
	•			Review Initial Memos and provide feedback.											Initial Memo on Research Benefits (Task 1)
Project Execution	•			Review the completed Project Execution tab in the Form and provide feedback.											The Benefit Evaluation and Communication Form; Initial Memo on Research Benefits (Task 1); Final Reports; other relevant intermediate research findings.
	•	•	•	Review the Final Reports and provide feedback.											Final Reports; other relevant intermediate research findings.
	•	•	•	Revisit and discuss project type adjustments with project teams when applicable.											-
Project Completion	•	•	•	Review the completed Project Completion tab in the Form and provide feedback.											The Benefit Evaluation and Communication Form
	•	•	•	If applicable, provide comments and guidance on the follow-up phases of the research project.											-

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Lead
 Facilitator

Appendix C Communication Manual

	Communication Approach/Platform	Information Required/Content	Audience	Frequency	Key Personnel	Frequency	Level of Effort
1	Research Summary	Key research information from final reports and short interviews with TLs and PIs	MnDOT, Project Subscribers, Crossroads readers, and other parties of interest	By the end of each project	PIs and the research teams	Routine	Medium
2	E-Newsletter: Local Road Research Board E-Newsletter	Newly funded and recently completed research funded by LRRB; research-related events and research funding opportunities	MnDOT, transportation practitioners, academics, and other parties of interest	Bi-monthly	R&I Communication	Routine	Low
3	E-Newsletter: Transportation Research E-Newsletter	Newly funded and recently completed research funded by MnDOT; research-related events and research funding opportunities	MnDOT, transportation practitioners, academics, and other parties of interest	Bi-monthly	R&I Communication	Routine	Low
4	E-Newsletter: MnDOT Innovation Focus E-Newsletter	Updates on MnDOT's innovation program; innovation-related educational resources; innovation-related events in Minnesota and beyond	MnDOT, transportation practitioners, academics, and other parties of interest	Quarterly	R&I Communication	Routine	Medium
5	E-Newsletter: MnDOT Research	Updates on MnDOT Research Program (e.g., new and completed research, research-related events, partner and	MnDOT, transportation practitioners,	Monthly	R&I Communication	Routine	Medium

	Program News E-Newsletter	stakeholder updates related to the MnDOT Research Program)	academics, and other parties of interest				
6	Social Media Platforms: MnDOT Research Facebook	Medium-length news and updates on MnDOT-funded research	MnDOT, transportation practitioners, academics, and other parties of interest. This platform has a wider reach since posts may appear on search engine websites.	100 new posts per year	R&I Communication	Routine	Low
7	Social Media Platforms: MnDOT Research Twitter	Short news and updates on MnDOT-funded research	MnDOT, transportation practitioners, academics, and other parties of interest. This platform has a wider reach since posts may appear on search engine websites.	100 new posts per year	R&I Communication	Routine	Low
8	Social Media Platforms: MnDOT Research LinkedIn	Long news and updates on MnDOT-funded research	MnDOT, transportation practitioners, academics, and other parties of interest. This platform has a wider reach since posts may	100 new posts per year	R&I Communication	Routine	Low

			appear on search engine websites.				
9	Social Media Platforms: LRRB LinkedIn	News and updates on LRRB-funded research	MnDOT, transportation practitioners, academics, and other parties of interest. This platform has a wider reach since posts may appear on search engine websites.	100 new posts per year	R&I Communication	Routine	Low
10	MnDOT and LRRB Website	Completed and active project information, including summary, final deliverables (e.g., final reports and Technical Summaries), related materials (e.g., blog posts, guides, tools, and infographics), and links to other related research.	MnDOT, transportation practitioners, academics, state legislators, and other parties of interest.	Updated daily	R&I Communication	Routine	Medium
11	Crossroads	Technical Summaries of completed projects and other latest news in transportation research	Transportation practitioners, academics, MnDOT, and other parties of interest.	Updated weekly	R&I Communication	Routine	Medium

12	MnDOT R&I and LRRB At-A-Glance	A list of funded research projects and highlights in each of MnDOT's and LRRB's Research Strategic Priorities	MnDOT and LRRB, state legislators; other parties of interest	Annually	R&I Communication and LRRB	Occasional	High
13	AASHTO High-Value Research Nominations	Information about recently completed "high-value" research projects	MnDOT and other state DOTs, transportation practitioners, academics, and other parties of interest. This platform can reach audience beyond MN and create national-level impacts.	Annually	R&I Communication	Occasional	Medium
14	CTS Transportation Research Conference	Project description, benefits, impacts, and other related information.	Transportation practitioners, academics, and other parties of interests	Annually	PIs, the research team, and R&I Communication	Occasional	Medium
15	Minnesota Transportation Conference	Project description, benefits, impacts, and other related information.	Transportation practitioners, academics, and other parties of interests	Annually	PIs, the research team, and R&I Communication	Occasional	Medium

16	Conferences (e.g., CEAM, MCEA, and other conferences)	Project description, benefits, impacts, and other related information.	Transportation practitioners, academics, and other parties of interests	Annually	PIs, the research team, and R&I Communication	Occasional	Medium
17	Infographics/Flyers	Project description, benefits, impacts, and other related information.	General public, MnDOT and other state DOTs, transportation practitioners, academics, and other parties of interest	Depending on projects	PIs, the research team, R&I communication, and consultants	Occasional	High
18	Videos	The content could include interviews with the research teams, demonstration, and other research-related information	MnDOT, transportation practitioners, academics, and other parties of interest. This platform has a wider reach since posts may appear on search engine websites.	Depending on projects	PIs, the research team, R&I communication, and consultants	Occasional	High
19	Press Release	Project description, benefits, impacts, and other related information.	Transportation professionals or the general public	Depending on projects	R&I Communication	Occasional	High

20	Industry/Trade Association Magazines	The content could include interviews with the research teams, demonstration, and other research-related information	Transportation professionals	Depending on projects	R&I Communication	Occasional	High
21	Interactive Resource Guide	Project description, benefits, impacts, and other related information.	MnDOT, transportation practitioners, academics, and other parties of interest.	Depending on projects	R&I Communication	Occasional	High

Appendix D Pilot Project Summary

Project Type 1

2019-048 – The Impact of Deferred Maintenance in Minnesota

Project Description

Background: Highways play a critical role in the social and economic development of the state. While MnDOT and the regional and local transportation agencies in Minnesota are responsible for developing and maintaining the highway system, maintenance projects often must compete with other priorities, such as safety, to secure funds. Like other parts of the country, Minnesota's highways face challenges such as aging infrastructure, rising construction costs, limited funding, and accelerated deterioration due to maintenance projects being postponed because of budgetary problems.

Objective: This research project assesses the impacts of budgetary limitations on maintenance deterrence decisions, with a specific focus on the investment decision-making processes at the local agency level.

Project Type: as shown in the table below, the project is classified as Type 1 due to its statewide impacts and potential for adoption of its findings and recommendations.

Table D. 1: Project Type Assessment – The Impact of Deferred Maintenance in Minnesota

Project Type Classification Criteria	Assessment
Implementation Likelihood and Timeline	The results of the project will support maintenance funding decisions; implementation can lead to the development and adoption of a standard definition for deferred maintenance and a procedure for roadway and bridge condition target setting.
Impact Magnitude	The benefits of this project are expected to have impacts throughout Minnesota.
Level of Interest	This research will generate information that city and county engineers can use in discussions with elected officials to maintain an appropriate and consistent level of funding for maintenance.
Assumptions and Unknowns for Benefit Quantification	The project benefits can be quantified in the context of specific case studies.

(Source: CPCS; based on assessment of summary criteria provided by MnDOT R&I and LRRB, 2023).

Benefit Categories, Types, and Evaluation Findings

The following table provides a summary of benefit categories, types, and metrics evaluated as part of the project.

Table D. 2: Summary of Evaluated Benefits - The Impact of Deferred Maintenance in Minnesota

Benefit Category	Description		
Environmental Aspect	Type	Quantitative	Estimated based on ratios provided in previous research and specific case studies selected for the project.
	Metric	Emission impacts of poor road surface conditions	
Operation and Maintenance Saving	Type	Quantitative	City and county maintenance expenditures are analyzed using the Minnesota Transportation Finance Database (MTFD), MnDOT's statewide funding/expenditure data, and maintenance and construction spending information provided by the case study city and county offices.
	Metric	Road maintenance cost	
Safety	Type	Qualitative	Assessed based on findings from previous relevant work.
	Metric	Likelihood of fatal & injury crashes	

(Source: CPCS analysis, 2023)

Communication Activities

The methodology and findings from this research project can benefit the transportation research and implementation community in Minnesota, including city and county engineers and other local transportation agencies, universities, and other research entities. The project inception was announced with a post on Crossroads, Minnesota's transportation research blog, on September 10, 2020. The needs statement, as well as a summary of the project's objectives and expected outcomes, were also published on the project page on the LRRB and MnDOT R&I websites. After the project was completed, the final research report, a technical summary, and a one-page infographic were added to the project page, and a story about the results was posted on Crossroads.

According to the project coordinator, additional communication activities for this research project (as initially envisioned in the project's communication plan) include a short video or recorded presentation summarizing the importance and impacts of continuous infrastructure maintenance.

Additionally, reporting infrastructure conditions, trends, target achievement, and budgetary needs through an interactive dashboard can be a powerful tool for sharing information with internal and public stakeholders. Such a communication tool, however, would require regular updates and a MnDOT/LRRB champion to guide the process continuously.

Takeaways from Project Review and Consultation

- The qualitative benefits evaluated in this research project were based on findings from other relevant research. While these benefits provide context and highlight the importance of consistent maintenance investment, they are not a good candidate for post-completion benefit evaluation as the results using the same or similar inputs will be the same or close to initial benefit estimations.

- This research project relied on an assessment of nine specific case studies and a follow-up survey of the people representing each of the agencies responsible for road and bridge maintenance decisions in the selected cities and counties. Therefore, the quantifiable benefits of the theories presented in the research were evaluated using case studies, which is a reliable approach for providing an understanding of complex problems. However, generalizing findings and their impacts on other similar cases can be a challenge. The same case study method has to be used for a post-completion benefit evaluation, and the selected cases should encompass all or some of the initial cases for benchmarking purposes.
- Based on the primary audiences of this research project (city and county engineers and elected officials), an emphasis was placed on developing brief and engaging deliverables to communicate the research findings quickly and effectively. The proposed benefit monitoring and communication framework is useful in such projects as it will streamline the resources and level of effort required for tracking and reporting project benefits.

2023-016 – Understanding Driving Causes of Bridge Replacement

Project Description

Background: Various factors can impact decisions regarding bridge maintenance, repair, and replacement (MRR) project investments, including the quality and accuracy of inspection data and thresholds set for classifying the bridge condition ratings. These thresholds are often decided based on the experience and judgment of the bridge inspectors and, as a result, can lead to variations in investment allocations. The purpose of MRR is to extend the useful life of bridges through better design, construction, and management; a process that can highly improve with the support of decision tools can improve financial planning and asset management processes.

Objective: This research project aims to identify the factors contributing to premature bridge replacements in Minnesota and understand the cost impact of replacing bridges sooner than originally planned. The research is expected to inform bridge management efforts and provide input for overall asset management goals and financial planning.

Project Type: as shown in the table below, the project is classified as Type 1 due to its statewide impacts and potential for adoption of its findings and recommendations.

Table D. 3: Project Type Assessment – Understanding Driving Causes of Bridge Replacement

Project Type Classification Criteria	Assessment
Implementation Likelihood and Timeline	The results of the project will support bridge management efforts and inform financial planning for bridge preservation.
Impact Magnitude	The analysis has the potential to provide valuable input to bridge management efforts throughout Minnesota.
Level of Interest	The expected findings and outcomes of this project can inform city and county engineers' decisions regarding bridge maintenance investments in Minnesota and even across the US.

Assumptions and Unknowns for Benefit Quantification	The project benefits are expected to be quantified without reliance on too many assumptions.
-----------------------------------------------------	----------------------------------------------------------------------------------------------

(Source: CPCS; based on assessment of summary criteria provided by MnDOT R&I and LRRB, 2023)

Benefit Categories, Types, and Evaluation Findings

The following table provides a summary of expected benefit categories, types, and metrics that will be evaluated as part of the project.

Table D. 4: Summary of Expected Benefits - Understanding Driving Causes of Bridge Replacement

Benefit Category	Description		
Construction Savings	Type	Quantitative	The project's work plan lists the required data sources and high-level approaches that will be used to evaluate the quantitative metrics. Data sources include bridge condition, bridge removal and replacement data, and project cost information provided by MnDOT. These datasets are expected to be supplemented through site visits, stakeholder consultations, and the assessment of additional historical data such as the National Bridge Inventory database. An economic model will be developed to assess the cost-saving and environmental benefits of a sustainable bridge maintenance program. This study will help show a delayed replacement value that can potentially have sustainability benefits, leading to operations savings. Preservation actions and rehabilitation activities are generally shorter in duration and thus less disruptive to traffic than new construction.
	Metric	Cost savings from reduced materials;	
Decrease Engineering/Administrative Costs	Type	Quantitative	
	Metric	Reduced planning/design costs	
Environmental Aspects	Type	Quantitative	
	Metric	Hazardous Waste Reduction	
Lifecycle	Type	Quantitative	
	Metric	Products with a longer lifespan	
Operations & Maintenance Savings	Type	Qualitative	
	Metric	Delayed replacement value	
User Benefits	Type	Qualitative	
	Metric	Reduce Road User Cost	

(Source: CPCS analysis, 2023)

Communication Activities

The methodology and findings from this research project can benefit the city and county engineers and other assets management staff at local and district offices, as well as the transportation research and implementation community in Minnesota, including universities and other road research entities.

According to the project's work plan, MnDOT R&I will develop a communications plan for the project in collaboration with the TL and Technical Advisory Panel (TAP). R&I's efforts will be supported by the investigative team.

Takeaways from Project Review and Consultation

- This project provides an example of the types of information that can be entered into the Benefit Monitoring and Communication Form (the Form) when the research project is at its inception phase.
- At the project inception phase, the majority of the benefit monitoring data and anticipated communication audiences and tools can be extracted from the project need statement and finalized work plan. Additional details can be added to the form as advised by the Project Champion and/or TL.

2018-016 Unmanned Aircraft Systems (UAS) – Metro District Bridge Inspection Implementation

Project Description

Background: Regular assessment and maintenance of bridges are crucial to ensuring the safety of roadway users and protecting public infrastructure investments. The National Bridge Inspection Standards (NBIS) were written into federal law in 1968 to regulate inspector qualifications, inspection intervals, and inspection procedures. In recent years, the NBIS has been updated and requires parts of bridges that are not visible using standard access methods to be examined.

Prior to this project, MnDOT had already conducted three phases of research to evaluate the feasibility of using UAS technology for bridge inspection and investigate suitable bridge types and configurations for UAS bridge inspection. The results confirmed the feasibility of using UASs for bridge inspection and outlined UAS hardware, processing software, FAA regulations, and methods of implementation. Due to the promising outcome of the three phases of research, MnDOT Metro District purchased the Elio UAS, an indoor drone, to implement drones in bridge inspection in areas with limited space and/or access.

The MnDOT Bridge Office has been working to develop a statewide UAS program for bridge inspection. The program aims to provide necessary means and guidance to state and local agencies to use state-issued UASs in their bridge inspection. The 2018-016 project also created a UAS Safety and Operation Manual to support the statewide UAS program.

Objective: The UAS – Metro District Bridge Inspection Implementation is phase IV of the effort to investigate and implement UAS use in bridge inspection in Minnesota. This phase aims to identify the most suitable situation for UAS use, determine methods and parameters for governing UAS use in bridge inspection, and discuss and plan for the integration of UASs in the standard inspection procedure. The project also developed a UAS Safety and Operation Manual for the MnDOT Bridge Office Statewide UAS Program.

Project Type: This project is a Type 1 project based on the evaluation results shown in Table D.4.

Table D. 5: Project Type Assessment – UAS – Metro District Bridge Inspection Implementation

Criteria	Assessment
Implementation Likelihood and Timeline	The results of the project will support the MnDOT Bridge Office's statewide UAS program for bridge inspection, providing guidance and examples for using UASs for bridge inspection in counties and cities.
Impact Magnitude	This project paves the way for using UASs in bridge inspection throughout Minnesota. It is also expected to have readily quantifiable benefits in maintenance labor savings and safety improvements.
Level of Interest	This project is high-profile, attracting interest from within and outside of the state.
Assumptions and Unknowns for Benefit Quantification	Most of the benefits can be quantified with a limited need for assumptions.

(Source: CPCS; based on assessment of summary criteria provided by MnDOT R&I and LRRB, 2023)

Benefit Categories, Types, and Evaluation Findings

The following table provides a summary of expected benefit categories, types, and metrics that will be evaluated as part of the project.

Table D. 6: Summary of Expected Benefits – UAS – Metro District Bridge Inspection Implementation

Benefit Category	Description		
Increase Lifecycle	Type	Qualitative	Bridge inspections led by UAS are proven to have improved accuracy than traditional inspection approaches.
	Metric	NA	
Operation and Maintenance Saving	Type	Quantitative	UAS helps reduce operation costs by replacing inspection crew members and expediting the inspection process.
	Metric	Operation costs	
Safety	Type	Quantitative	Using UAS can limit the presence of crew members and equipment on public roadways and, therefore, reduce roadway traffic hazards.
	Metric	Traffic incident data adjacent to bridge inspection sites	
Risk Management	Type	Qualitative	UAS-involved bridge inspections produce data with better quality and can help improve bridge repair and replacement cadence.
	Metric	NA	

(Source: CPCS Analysis, 2023)

Communication Activities

Besides routine communication updates at project inception and after project completion, many other communication channels were used for this project, including a YouTube video, interactive activities at conferences, blog posts, social media posts, and a presentation at the CTS Research Conference.

Takeaways from Project Review and Consultation

- **Record Benefits from Previous Phases:** As a Phase IV project, this project was derived from the outcomes of previous efforts. It would help with information organization and tracking if the Form could have a place for documenting the benefits from previous phases or at least a place for links to relevant reports.

Project Type 2

2022-022 Harnessing Solar Energy through Solar Snow Fence: Implementation

Background: The project is built on the outcomes of a previous MnDOT project that planned a 100-foot-long solar fence. During the project, the researchers will test and evaluate the functionality, effectiveness, and reliability of the prototype solar snow fence in real-world conditions. The project consists of two stages:

- **Construction:** The first stage is to construct the solar snow fence.
- **Testing:** The second stage is to test and assess the impacts of the installed solar snow fence in terms of its energy production, reductions in traffic accident occurrence and mortality, changes in drift snow distribution, and service lifespan.

The evaluation results will provide evidence supporting the adoption of standard plans and specifications for solar snow fence installation in other locations.

Objective: The implementation project will check the possible challenges when implementing the newly developed solar snow fences on a large scale and evaluate its net benefits over the years.

Project Type: This project is a Type 2 project based on the evaluation results shown in Table D.7.

Table D. 7: Project Type Assessment – Harnessing Solar Energy

Criteria	Assessment
Implementation Likelihood and Timeline	The project is an implementation project and could lead to expansive installation in the future.
Impact Magnitude	This project continues the previous planning effort and installs a solar snow fence prototype to conduct field testing. Although the eventual impact magnitude is unclear at this point of the project, the solar snow fences have the potential to be implemented throughout Minnesota.
Level of Interest	This project is high-profile, attracting interest from within and potentially outside the state.

**Assumptions and Unknowns
for Benefit Quantification**

More quantifiable benefits could surface as the ongoing project gathers more field results.

(Source: CPCS; based on assessment of summary criteria provided by MnDOT R&I and LRRB, 2023)

Benefit Categories, Types, and Evaluation Findings

The following table provides a summary of expected benefit categories, types, and metrics that will be evaluated as part of the project.

Table D. 8: Summary of Expected Benefits – Harnessing Solar Energy

Benefit Category	Description		
Decrease Lifecycle Costs	Type	Quantitative	The green energy generated from solar snow fences could offset the initial investment of traditional structural snow fences. The potential benefit of lifecycle cost decrease can be calculated by measuring the amount of energy generated. It was estimated that one mile of solar snow fence Implementation could produce 330 kW per mile and could roughly generate 1,300 kWh of energy per mile per day on average.
	Metric	Amount of Energy Generated	
Environmental Aspect	Type	Qualitative	The renewable energy generated from the solar snow fences has less to no negative impact on the environment in comparison to energy produced from traditional resources (e.g., coal and natural gas). The actual benefits could be hard to quantify without conducting additional studies but could be qualitatively stated.
	Metric	No environmental impacts	
Increase Lifecycle	Type	Quantitative	The implementation team will measure the lifecycle of the solar snow panels as a part of the project. Depending on the results, solar snow fences may have a longer service time than traditional snow fences.
	Metric	Lifecycle	
Operation and Maintenance Saving	Type	Quantitative	The solar snow fences could help prevent snow from going over pavements and, therefore, decrease roadway maintenance costs related to snow cleaning. The savings can be estimated based on the amount of snow kept off of the road.
	Metric	Roadway Maintenance Costs	
Safety	Type	Qualitative	Large-scale implementation of snow fences could mitigate snow safety hazards. Given that this project is only testing a solar snow fence prototype, it is unlikely to draw a causal conclusion on the snow fences' positive impact on roadway safety. However, this project paves a path for solar snow panels to be installed on a wider scale and could help reduce the number of snow-related traffic accidents.
	Metric	Number of Traffic Accidents	
Technology Development	Type	Qualitative	This project develops and tests an integrated energy-harvesting solar snow fence system along roadways, which is a new technology. The results from the pilot could potentially enable a more extensive implementation in other regions and states when possible.
	Metric	NA	

(Source: CPCS Analysis, 2023)

Recommended Communication Activities

Besides routine communication updates at project inception and after project completion, many other communication channels are considered for this project, including videos, webinars, Newline story, an infographic, presentations at conferences, and submission to AASHTO's High-Value Research Award.

Takeaways from Project Review and Consultation

- **Re-Evaluate Project Type:** During the consultation, the research team suggested that the project is more qualified as a Type 1 given its implementation, strong legislative support, and potential wide impact. The project has already installed a solar snow fence, and the testing results will inform more extensive implementation in Minnesota. Furthermore, the Minnesota Legislature signed a clean energy bill into law in February 2023, requiring that 100 percent of electricity generated or procured for use in Minnesota be from carbon-free resources by 2040. Against the backdrop of the legislation, the outcomes of the project could attract a higher level of interest.
- **Monitor Evolving Benefits:** The Form reflects the ongoing nature of project benefit evaluation and allows for tracking the updates. The qualitative and quantitative benefits may change as the project progresses. Additionally, the multi-stage benefit assessment framework could help with identifying and tracking impactful projects with promising benefits and streamline the benefit monitoring process.

Project Type 3

2019-059 – Cost-Effective Roadside Revegetation Methods to Support Insect Pollinators

Project Description

Background: Many insects, including pollinators such as bumble bees and butterflies, are declining due to various factors, the most important of which is habitat loss. Roadside areas provide the potential for improving the habitat of insect pollinators. On the other hand, roadside restoration projects are often expensive and rarely evaluated for effectiveness.

Objective: This research project is developed based on the objective of identifying cost-effective roadside vegetation installation and management techniques in order to provide habitat for the rusty-patched bumble bee and other declining pollinators.

Project Type: as shown in the table below, the project is classified as Type 3 due to its niche area of focus and audience.

Table D. 9: Project Type Assessment – The Impact of Deferred Maintenance in Minnesota

Project Type Classification Criteria			Assessment
Implementation Timeline	Likelihood	and	The research provides management suggestions and future research recommendations.
Impact Magnitude			Specialized research project with a specific audience and application.

Level of Interest	Targeted to specific stakeholders.
Assumptions and Unknowns for Benefit Quantification	Benefits are quantified using statistical methods and some assumptions.

(Source: CPCS; based on assessment of summary criteria provided by MnDOT R&I and LRRB, 2023)

Benefit Categories, Types, and Evaluation Findings

The following table provides a summary of benefit categories, types, and metrics evaluated as part of the project.

Table D. 10: Summary of Evaluated Benefits

Benefit Category	Description		
Environmental Aspect	Type	Quantitative	A generalized linear regression model is used to examine the impact of land cover on the pollinator population using various datasets, like the Minnesota Land Cover Classification System, but primarily relying on surveys of plants and pollinators at select sites.
	Metric	No. of pollinator species or species groups at each studied site	
Pollinator-Friendly Land Cover Costs	Type	Quantitative	Classified each species of plant observed as native or introduced using the Minnesota Department of Natural Resources Vascular Plant Checklist and estimated the prevalence of each plant species using model-based analysis of all plant community data and a multivariate generalized linear model (mvGLM) fitted to the abundances of all plants with binomially distributed errors.
	Metric	Pollinator-friendly seed mix costs relative to land cover	

(Source: CPCS analysis, 2023)

Recommended Communication Activities

The methodology and findings from this research project benefit specific research and implementation stakeholders that are focused on roadside vegetation design, implementation, and maintenance. Those include university researchers who focus on biology, ecology, and entomology, among other relevant topics, and engineers and project managers in MnDOT offices who specifically focus on roadside vegetation, landscape maintenance, and turf establishment management.

The project was announced on the project page on the LRRB and MnDOT R&I websites. After the project was completed, the final research report, a technical summary, the project need statement, and links to relevant resources were also added to the project page. In addition to these activities, project findings were published in academic journals, presented at the University of Minnesota Center for Transportation Studies (CTS) Research Conference, and posted in a story on the Crossroads blog.

Takeaways from Project Review and Consultation

- This is an example of a phased research project resulting from previous research on the same topic and leading to additional relevant research (currently a need statement).

- Although the research project resulted in quantified measures to assess cost-effective roadside vegetation methods, post-completion benefit evaluation is recommended to be qualitative, focusing on describing the benefits observed from the adoption of the project's recommendations. This is in line with identifying the project as a Type 3.

2018-069 Use of Regional Waste in Sustainably-Designed Soils – Part 1

Background: Stormwater runoff contains pollutants that threaten the ecosystem and cause flooding, damaging public and private property. The Minnesota Pollution Control Agency (MPCA) issues a stormwater runoff permit, requiring revegetation areas to retain the first inch of stormwater runoff after roadway construction. The amount of vegetation determines how soil can successfully absorb stormwater runoff. However, the residual soil after roadway construction is usually too thin and lacks sufficient organic matter and infiltration capacity to support vegetation growth. The common practice is to add soil and create a friendly environment for plant growth.

Mineral, forestry, and other industries in northeastern Minnesota produce by-products and waste materials that are stored, hauled away, and discarded. This waste generates additional carbon and has other environmental impacts. MnDOT and county engineers see possibilities to reuse these by-products and waste materials for increasing soil quality in revegetation areas. If proven feasible, this sustainable practice could reduce solid waste, reduce carbon emissions, create a financial advantage for local industries, and help vegetation growth to mitigate stormwater runoff.

The project has led a Phase II study to identify and investigate suitable waste materials across Minnesota and create a guide for statewide implementation of resilient and sustainable engineered soil mixes.

Objective: This project identifies by-products and waste materials and tests the possibility of reusing them to decrease stormwater runoff after road construction.

Project Type: This project is a Type 3 project based on the evaluation results shown in Table D.11.

Table D. 11: Project Type Assessment – Reuse of Regional Waste in Sustainably-Designed Soils – Part 1

Criteria	Assessment
Implementation Likelihood and Timeline	Implementation is not likely solely based on results from this research. The project only conducted laboratory testing; real-life experiments and long-term monitoring will be required to better understand the feasibility and benefits of reusing by-products for soil design. Additionally, a design manual is necessary to provide guidance for implementation.
Impact Magnitude	The research focuses on by-products and wastes produced by manufacturers in the northeastern region of Minnesota.
Level of Interest	The project is of interest to mainly MnDOT and MPCA but could be useful for other state DOTs.

Assumptions and Unknowns for Benefit Quantification

Many assumptions are made for benefit quantification, such as the life span of soils, site location, and weight of horticulture materials.

(Source: CPCS; based on assessment of summary criteria provided by MnDOT R&I and LRRB, 2023)

Benefit Categories, Types, and Evaluation Findings

The following table provides a summary of benefit categories, types, and metrics evaluated as part of the project.

Table D. 12: Summary of Evaluated Benefits

Benefit Category	Description		
Environmental Aspect	Type	Qualitative	The results of the project will encourage and inform the recycling or reuse of waste materials. It is worth noting that the study outcomes also suggest that environmental impact varies by material type and material travel distance - the further material is transported, the greater the environmental impact.
	Metric	NA	
Increase Lifecycle	Type	Quantitative	Lifecycle benefits can be estimated by comparing the lifecycle of the studied by-product materials to that of the topsoil.
	Metric	Lifecycle	
Construction Saving	Type	Quantitative	Construction savings can be estimated by comparing the cost of using the studied by-product materials to that of the topsoil. The study took a scenario approach to evaluate potential construction savings.
	Metric	Construction Costs	

(Source: CPCS Analysis, 2023)

Communication Activities

This communication of the project involves all routine communication materials, including a project site update and a blog post, the project inception and research report, and a technical summary at project completion. Additionally, the project was also promoted at transportation conferences and through social media posts and newsletters.

Takeaways from Project Review and Consultation

- Document Relevant Projects: The research team suggested that the Form could add a section to connect each project with previous and future relevant research or implementation. For example, the link to Phase II of this project can be embedded in the Form. By creating connections among projects, project-level benefits could be better monitored, while program-level benefits could be extrapolated more easily.
- Form Organization: Forms could be saved in central folders, such as the contract folders, for easy access and tracking.

- Form Lead: Project Champions and TLs could lead the documentation of benefit monitoring and communication during the project. After project completion, Project Champions could take over most of the responsibility to continue monitoring and recording research benefits.