2020 ANNUAL REPORT FOR THE MONTANA DEPARTMENT OF TRANSPORTATION RESEARCH PROGRAMS

FHWA/MT-20-005/8010

Annual Report

prepared for
THE STATE OF MONTANA
DEPARTMENT OF TRANSPORTATION

in cooperation with
THE U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

December 2020

prepared by
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Craig Abernathy
Bobbi deMontigny

Montana Department of Transportation
Helena, MT

Vaneza Callejas

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Madison WI

RESEARCH PROGRAMS

MDT

2020 ANNUAL REPORT
FOR THE MONTANA DEPARTMENT OF TRANSPORTATION
RESEARCH PROGRAMS

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16. Abstract

Montana Department of Transportation's (MDT's) Research Programs are internally driven applied research, development, and technology transfer (RD&T) programs necessary in connection with the planning, design, construction, management, and maintenance of highway, public transportation, and intermodal transportation systems. Funding is limited and to keep research relevant to MDT staff, implementable results are the goal. Implementation of research results also helps MDT in meeting its mission of providing a transportation system and services that emphasize quality, safety, cost-effectiveness, economic vitality, and sensitivity to the environment. The purpose of this report is to give a comprehensive description of research, development, and technology transfer activities for federal fiscal year (FFY) 2020 within the Research Programs of MDT. Through these activities, the Research Programs enhance MDT's ability to meet its mission and to deliver efficient and effective transportation services. MDT's Research Programs impact each and every part of MDT's mission. Research projects completed in FFY 2020 yielded results that when fully implemented will improve:

- ★ Efficiency and effectiveness of MDT operations and technology transfer, and the quality of what we do and how we do it, including: improving cost estimating, decreasing overruns, and providing for improved construction portfolio of projects; improved bridge, culvert, and pavement design and processes; improved construction materials and methods; improved support for cities and counties; improved research processes; improved rockfall evaluation and mitigation; improved roadside revegetation; and improved air quality
- ★ Economic vitality
- ★ Sensitivity to the environment, including: improved roadside reclamation materials and methods; improved roadside revegetation; decreased erosion on construction and maintenance projects; improved environmental processes; decreased vehicle–wildlife collisions; improved habitat connectivity; and improved air quality
- ★ Safety, including: improved safety on low-volume roads and in rockfall areas and work zones; reduced vehicle–wildlife collisions; and improved safety culture both within MDT and among the travelling public

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Montana Department of Transportation's (MDT's) Research Programs are internally driven applied research, development, and technology transfer (RD&T) programs necessary in connection with the planning, design, construction, management, and maintenance of highway, public transportation, and intermodal transportation systems. Funding is limited and to keep research relevant to MDT staff, implementable results are the goal.

The purpose of this report is to give a comprehensive description of research, development, and technology transfer activities for federal fiscal year (FFY) 2020 within the Research Programs of MDT. Through these activities the Research Programs enhances MDT's ability to deliver efficient and effective transportation services.

Responsibilities of the MDT Research Programs include:

- Administer the Research portion of the State Planning and Research Program (SPR);
- Lead and participate in cooperative research efforts with other states, universities, industry, and other partners through pooled-fund and other cooperative research, development, and technology transfer efforts;
- Assist MDT staff in identifying and finding ways to meet research needs;
- Provide leadership for research, development, technology, and technology transfer initiatives within MDT;
- Conduct the Research and Experimental Projects Programs, and the Technology Transfer Program;
- Assist with the implementation of research results; and
- Conduct project and program evaluation.

In taking a look back at where we have been, we are given a clearer view of where we are heading, continuously improving as we move forward.

Janus, this Roman God symbolizes change and transition, such as the progression from past to future or of one vision to another.

2 ANNUAL PROGRAMS

2.1 AASHTO TECHNICAL SERVICES PROGRAMS

Project Number:	7831
Start Date:	10/1/19
Completion Date:	9/30/20
Total Cost (100% federal)	$106,434
Total SPR Funds:	$106,434
FFY 2020 MDT Indirect Costs:	$10,434

Objective:

Research funds pay for seven AASHTO Technical Services Programs (TSPs).

AASHTO Innovation Initiative (AII): The purpose of the AII is to identify and champion the implementation or deployment of a select few proven technologies, products, or processes that are likely to yield significant economic or qualitative benefits to the users. The AII works with the Special Committee on Research and Innovation (SCRI) and the Research Advisory Committee (RAC), as well as others to identify new technologies.

AASHTO re:source: AASHTO re:source promotes the quality of testing in construction material laboratories of the AASHTO member departments and others through four activities: the routine assessment of laboratories; the distribution of proficiency test materials; technical support to the AASHTO Committee on Materials and Pavements in the operation of the AASHTO Accreditation Program (AAP); and the development of precision estimates for the AASHTO Committee on Materials and Pavements test methods.

Development of AASHTO Materials Specifications (DAMS): DAMS supports the development of new materials standards and test methods, as well as revisions and updates to current standards, through assistance from independent technical writers. Funding expedites the development of these important documents and allows the Committee on Materials and Pavements to make better use of its volunteer members.

Equipment Management Technical Service Program (EMTSP): EMTSP assists state DOTs in more efficiently managing their equipment fleets with the goal of yielding significant savings as well as improved performance and reliability.

LRFD Bridges and Structures Maintenance (LRFDSM): This program supports maintenance of the LRFD specifications, as well as other related bridge specifications. Funding is also used for special studies on bridge design issues, AASHTO staff support to the Committee on Bridges and Structures, and updates of LRFD design examples.

National Transportation Product Evaluation Program (NTPEP): NTPEP cooperatively tests manufactured transportation products that are of common interest to all member departments and shares the results from these laboratory and field evaluations.

Transportation System Preservation Technical Services Program (TSP2): Participation in the TSP2 program helps the state DOTs preserve their pavements and bridges by helping them develop and implement their own preservation programs. Program staff field questions and provide technical guidance on preservation issues such as pavement and bridge treatments, materials, strategies, and best practices.

Accomplishments:

Champions attended meetings, reviewed progress reporting, and implement results, as appropriate.

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2.2 ADMINISTRATIVE PROJECTS – ADMINISTRATION AND CONDUCT OF RESEARCH PROGRAMS

Project Number:	8010
Start Date:	10/1/19
Completion Date:	9/30/20
Total/FFY 2020 Cost:	$317,605
SPR Total/FFY 2020 (80%) Funds:	$254,084
State/FFY 2020 (20%) Total:	$63,521
FFY 2020 MDT Indirect Costs:	$29,945

Project Number:	8020
Start Date:	10/1/19
Completion Date:	9/30/20
Total/FFY 2020 Cost:	$39,209
SPR Total/FFY 2020 (80%) Funds:	$31,047
State/FFY 2020 (20%) Total:	$8,162
FFY 2020 MDT Indirect Costs:	$3,798

Project Number:	8021
Start Date:	10/1/19
Completion Date:	9/30/20
Total/FFY 2020 Cost:	$80,112
SPR Total/FFY 2020 (80%) Funds:	$64,090
State/FFY 2020 (20%) Total:	$16,022
FFY 2020 MDT Indirect Costs:	$7,646

Objective:

The purpose of these three annual projects is fourfold. The first is to plan and administer the Research Programs and related research activities of MDT to find solutions to existing highway and transportation challenges in Montana. The second objective is to manage, coordinate, and conduct a program to test and properly evaluate new highway materials, products, designs, and/or methods for the ultimate purpose of improving highway performance; decreasing various highway costs; or attempting to solve existing highway construction, rehabilitation, or maintenance problems in Montana. The third objective is to provide funding for MDT staff when working on MDT research or experimental projects, where other federal funds are not appropriate or available. This can include, for example, fieldwork, such as traffic control and coring; and meeting time and travel associated with research or experimental projects. The fourth and final objective is to plan and conduct a program of technology transfer and to develop and maintain knowledge and understanding of the latest highway research projects and programs.

Accomplishments – Research Projects:

For funding beginning FFY 2020, one solicitation cycle (March - April 2019) was completed with 14 submitted research topics, resulting in five topics being moved forward to technical panels.

- ★ Analyze Business Models for Implementation and Operation of a Statewide GNSS Real-Time Network (20-004)
- ★ Development of Deterioration Curves for Bridge Elements in Montana (20-011)

- ★ Economic Benefits of Improving Montana's Transportation Infrastructure (EBIMTTI) (20-007)
- ★ A Feasibility Study of Road Culvert Bridge Deck Icing Using Geothermal Energy (20-008)
- ★ Icy Road Forecast and Alert (IcyRoad): Validation and Refinement Using MDT RWIS Data (20-014)

During FFY 2020, for funding beginning FFY 2021, one solicitation cycle (March - April 2020) was completed, with 18 submitted research topics, resulting in five topics being moved forward to technical panels.

- ★ Artificial Intelligence (AI) based Tool to Estimate Contract Time (21-012)
- ★ Effective Wildlife Fences through Better Functioning Barriers at Access Roads and Jump-Outs (21-011)
- ★ Exploration of UHPC Applications for Montana Bridges (21-014)
- ★ Feasibility of Non-Proprietary Ultra-High Performance Concrete (UHPC) for Use in Highway Bridges in Montana: Implementation (21-016)
- ★ Safety Evaluation of Sinusoidal Centerline Rumble Strips (21-009)

Twenty-nine projects were contracted and active in FFY 2020.

- ★ Alkali-Silica Reactivity in the State of Montana (9577-607)
- ★ Bridge Deck Cracking Evaluation (9696-700)
- ★ Concrete-Filled Steel Tube to Concrete Pile Cap Connections: Further Evaluation/Improvement of Analysis/Design Methodologies (Phase IV-V) (9630-628)
- ★ Developing a Methodology for Safety Improvements on Low-Volume Roads in Montana (9679-699)
- ★ Development of Deterioration Curves for Bridge Elements in Montana (20-011)
- ★ Effective Production Rate Estimation and Activity Sequencing Logics Using Construction Daily Work Report Data: Phase 2 (9344-723)
- ★ Effectiveness of Highway Safety Public Education at Montana Motor Vehicle Division and Vehicle Registration Stations by Streaming Safety Videos (9832-766)
- ★ Evaluation of Thin Polymer Overlays for Bridge Decks (9757-705)
- ★ Feasibility of Non-Proprietary Ultra-High Performance Concrete (UHPC) for Use in Highway Bridges in Montana – Phase 2: Field Application (9578-606)
- ★ A Feasibility Study of Road Culvert Bridge Deck Deicing Using Geothermal Energy (9890-784)
- ★ FFY 2019 Local Technical Assistance Program (LTAP) (2443-037)
- ★ FFY 2020 Local Technical Assistance Program (LTAP) (2434-038)
- ★ Guidelines for Chemically Stabilizing Problematic Soils (9389-522)
- ★ Icy Road Forecast and Alert (IcyRoad): Validation and Refinement Using MDT RWIS Data (20-014)
- ★ Large-Scale Laboratory Testing of Geosynthetics in Roadway Applications (9564-602)
- ★ MDT Consultant Project Management (9529-589)
- ★ MDT Wildlife Accommodations Process: Implementation (5896-423)
- ★ Monitoring Streamflow Using Video Cameras (9790-727)
- ★ Regional Regression Equations Based on Channel-Width Characteristics to Estimate Peak-Flow Frequencies at Ungauged Sites in Montana Using Data through Water Year 2011 (9353-511)
- ★ Testing Wildlife-Friendly Fencing Modifications to Manage Wildlife and Livestock Movements (9596-617)

- ★ Traffic Safety Culture Transportation Pooled Fund (TSC-TPF): Phase 1 - 2015 -2019 FFY (8882-309) and Phase 2 – 2020-2024 FFY (8882-444)
  - FFY 2019 Management Support Contract
  - FFY 2020 Management Support Contract
  - Guidance for Evaluating Traffic Safety Culture Strategies
  - Guidance on Messaging to Avoid Reactance and Moral Disengagement
  - Guidance to Promote Workplace Policies and Family Rules to Reduce Cell Phone Use While Driving and Promote Engaged Driving
  - Key Information for DUIC Policy
  - Proactive Traffic Safety: Empowering Behaviors to Reach our Shared Vision of Zero Deaths and Serious Injuries
  - Traffic Safety Culture Primer
- ★ Use of Fluorescent Orange Delineators in Temporary Traffic Control Work Zones (19-006)

Of the 29 active research projects, six were completed in FFY 2020.

- ★ FFY 2019 Local Technical Assistance Program (LTAP) (2443-036)
- ★ Guidelines for Chemically Stabilizing Problematic Soils (9389-522)
- ★ Traffic Safety Culture Transportation Pooled Fund (TSC-TPF): Phase 1 - 2015 -2019 FFY (8882-309)
  - FFY 2019 Management Support Contract
  - Key Information for DUIC Policy
  - Proactive Traffic Safety: Empowering Behaviors to Reach our Shared Vision of Zero
  - Traffic Safety Culture Primer

A research project close-out questionnaire was sent to all technical panel members at the completion of each project. Results were compiled and disseminated with the ultimate goal of improving the conduct and management of research projects.

In addition, six projects are pending proposal review and approval by the technical panel and RRC, and contracting:

- ★ Analyze Business Models for Implementation and Operation of a Statewide GNSS Real-Time Network (20-004)
- ★ Artificial Intelligence (AI) based Tool to Estimate Contract Time (21-012)
- ★ Effective Wildlife Fences through Better Functioning Barriers at Access Roads and Jump-Outs (21-011)
- ★ Exploration of UHPC Applications for Montana Bridges (21-014)
- ★ Feasibility of Non-Proprietary Ultra-High Performance Concrete (UHPC) for Use in Highway Bridges in Montana: Implementation (21-016)
- ★ Safety Evaluation of Sinusoidal Centerline Rumble Strips (21-009)

Finally, two projects were placed on hold.

- ★ Economic Benefits of Improving Montana's Transportation Infrastructure (EBIMTTI) (20-007)
- ★ Use of Fluorescent Orange Delineators in Temporary Traffic Control Work Zones (19-006)

Funds were contributed for 19 partnering projects:

- AASHTO Equipment Management Technical Services Program (EMTSP)
- AASHTO Innovation Initiative (AII) Technical Services Program
- AASHTO Load and Resistance Factor Design (LRFD) Bridges and Structures Specification Maintenance (LRFDSM) Technical Services Program
- AASHTO National Transportation Product Evaluation Program (NTPEP) Technical Services Program, includes AASHTO Product Evaluation List (APEL)
- AASHTO re:source (formerly AASHTO Materials Reference Laboratory (AMRL) Technical Services Program)
- AASHTO Technical Service Program to Develop AASHTO Materials Standards (DAMS)
- AASHTO Transportation System Preservation Technical Services Program (TSP2)
- AASHTOWare Project Data Analytics (9811-746)
- Clear Roads Phase II (TPF-5(353))
- Comprehensive Field Load Test and Geotechnical Investigation Program for Development of LRFD Recommendations of Driven Piles on Intermediate GeoMaterials (TPF-5(391))
- Improve Pavement Surface Distress and Transverse Profile Data Collection and Analysis, Phase II (TPF-5(399))
- National Cooperative Highway Research Program (NCHRP) (TPF-5(420))
- Northwest Passage Phase #4 (TPF-5(376))
- Technology Transfer Concrete Consortium (FY20-FY24) (TPF-5(437))
- Traffic Control Device (TCD) Consortium (3) (TPF-5(447))
- Transportation Research Board Core Services Support (TPF-5(450))
- Updating U.S. Precipitation Frequency Estimates for the Northwest (TPF-5(454))
- Western Alliance for Quality Transportation Construction (WAQTC) (TPF-5(349))
- Western Maintenance Partnership – Phase 3 (TPF-5(394))

Accomplishments – Experimental Projects:

During FFY 2020, 17 experimental projects were active.

- 3/8" Asphalt Cement (AC) Placement with No Chip Seal (CS)
- Centerline Rumble Strip (CLRS)
- CRS-2P and CHFRS-2P Chip Seal Field Comparison
- Evaluation of Crafco Mastic One® Hot Applied Sealant
- Fiber Reinforced Asphalt Cement (FRAC)
- Fog Seal Chip Retention Evaluation
- Fog Seal Over Chip Seal Evaluation
- High Float vs. Polymer Modified Emulsion Seal and Cover With and Without a Fog Seal
- JOINTBOND Asphalt Joint Stabilizer
- Maintenance Asphalt Surface Treatments
- RoaDrain Geocomposite for Added Subsurface Drainage
- Seal Coat Asphalt Emulsion (or Fog Seal Coating) Over Chip Seal for Improved Chip Retention Evaluation
- Sinusoidal Centerline Rumble Strip (SCLRS)
- SKAPS GT116N Nonwoven Textile Bond Breaker
- Sprayroq-Spraywall Polyurethane Applied Lining for Culvert Rehabilitation

- T15 Base One Soil Stabilization
- TenCate Mirafi MPV400 Polypropylene Nonwoven Geotextile

During FFY 2020, four projects were pending. Pending experimental projects are assigned to a construction or maintenance project and a plan-in-hand meeting has been held.

- Electric Wildlife Deterrent Mat
- Nomaflex Concrete Joint Filler Evaluation
- Reflective Cracking in Cement-Treated Bases Minimization by Microcracking Evaluation
- Surfacing In-Slope Treatment Evaluation

During FFY 2020, six projects were proposed. Proposed projects may or may not have been assigned to a construction or maintenance project, but a plan-in-hand meeting has not been held.

- Expanded Polystyrene Geofoam Blocks as Lightweight Fill Evaluation
- Prefabricated Steel Truss/Bridge Deck System Evaluation
- Roundabout Striping Durability Trials Evaluation
- Texas Underseal with Added Scrub Seal Evaluation
- Weather-Activated Detection System Evaluation
- Yellow-Dyed Concrete Curbing to Replace Epoxy-Applied Curbing Evaluation

Accomplishments – Technology Transfer and Library Services:

Technology transfer and Library-related accomplishments achieved in FFY 2020 include the following:

- Published one research newsletter.
- Updated and promoted OverDrive digital materials for MDT employee professional development.
- Updated in-depth library training classes on the MDT Moodle.
- Provided library marketing through the Interchange.
- Developed and distributed a departmentally targeted weekly library bulletin to keep people in the know of all library resources as they become available.
- Integrated better outreach and remote access options for employees working from home with links to books and webinars sent directly through email and featured on Moodle.
- Converted library appreciation day into a month of remote learning tools and games to help people learn how to better use library services remotely.
- Provided database training for MDT employees.
- Provided catalog training for MDT employees.
- Provided new employee orientation sessions in the library and remotely.
- Expanded new employee orientation library presentation to include experimental projects and research.
- Worked with the Montana State Library on a government document digitization project increasing access to historical documents.
- Provided 387 brief reference (less than five minutes).
- Provided 185 in-depth reference (requiring research).
- Added 12,066 new titles to the library collection.
- Registered 225 patrons.
- Purged library patrons to remove former MDT employees from the library catalog.

- Circulated materials.
- Processed incoming and outgoing interlibrary loans, borrowing materials for patrons and lending materials to other libraries.
- Set in place mail-to-home options for MDT staff working from home.
- Requested free materials offered through the transportation librarian network.
- Purchased new materials in response to patrons' requests.
- Served as the Montana Shared Catalog role of Executive Board Representative for special libraries statewide.
- Served as the Special Library Association role of Chair and Conference Planner for the Transportation Division.
- Developed, organized, and held five events for the Special Library Association Transportation Unit.
- Served on Information and Knowledge Management committee for the Transportation Research Board.
- Completed a VHS digitization project.

Library Services Analysis:

The library services analysis is as follows:

- **12,066 titles cataloged**. This means 12,066 new publications were added to the MDT Library.
- **387 reference questions (brief).** This means 387 questions were answered that were short in nature and, generally, took five or less minutes to answer (for example, how do I check out a book, how long can I keep materials, where are you located, etc.).
- **185 in-depth reference.** This count includes literature searches, where literature was gathered on particular topics and presented to requestors in a report format; surveys to other state departments of transportation; and any in-depth reference, defined as answering customer questions that require more than five minutes to respond.

Library Collection Analysis:

The principal findings of the library collection analysis, as indicated in Table 1 and Figure 1, include the following:

- The MDT Library has a total of 39,912 copies held in the collection.
- The collection holds 32,604 titles. For some of these titles, there is more than one copy in the collection, which is why the total number of copies is greater than the number of titles.
- Of the 32,604 titles, 8,944 titles are held in electronic format only. These include electronic reports and web-only documents. This category is the second largest format type held in the library, after books.

Table 1. Library Collection Analysis by Item Type

Item Type	Number of Items
Book	21,490
CD	396
Digital	8,944
DVD	257
Journal	1,110
Kit	20
Map	5
Media-Equip	10
OverDrive	359
Pamphlet	13
TOTAL	**32,604**

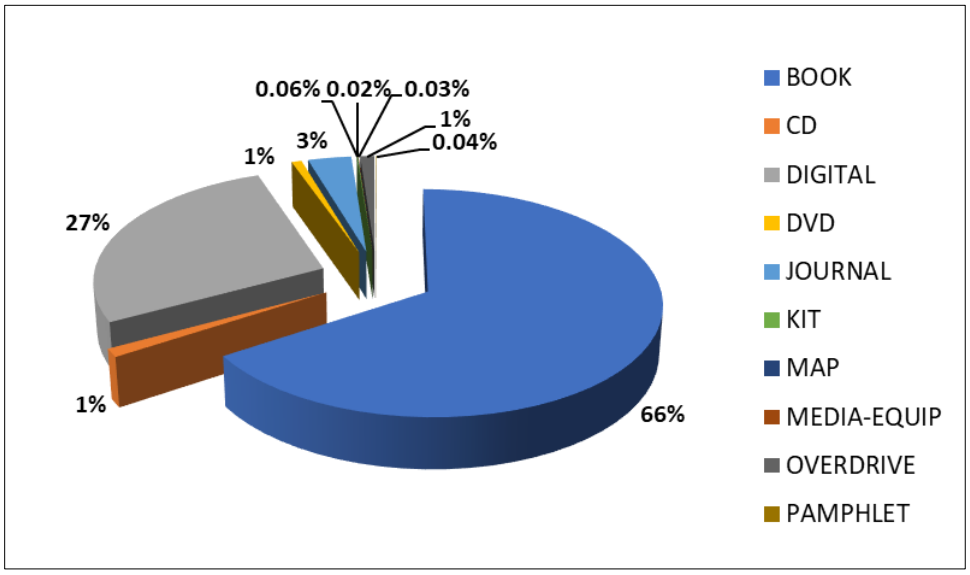

Figure 1. Library Collection Analysis by Item Type

Library Circulation Analysis:

The circulation analysis for FFY 2020, as indicated in Table 2 and Figure 2, include the following:

- OverDrive items were the most heavily circulated items, followed by books.
- There is no circulation information on digital e-resources that are not part of the OverDrive collection, as these titles are not circulated. They are accessed by patrons through the library catalog. The Research and Library website analysis following this section suggests these items are truly the most often accessed by MDT staff.
- 25 interlibrary loans borrowed. This count refers to interlibrary loans that were requested for MDT Library patrons. It includes loans, which means physical items were mailed to the MDT Library for patrons, as well as copies, which means we received electronic copies of materials (usually journal articles) to pass on to MDT Library patrons.

- 7 interlibrary loans lent. This means that, through interlibrary loan, 7 items were lent from the MDT collection to other libraries from around the country.

Table 2. Library Circulation by Item Type

Item Type	Total Circulation
Book	167
CD	16
Interlibrary Loan Borrowed	25
Interlibrary Loan Lent	7
Media Equipment	12
OverDrive Audio & E-Books	283
TOTAL	510

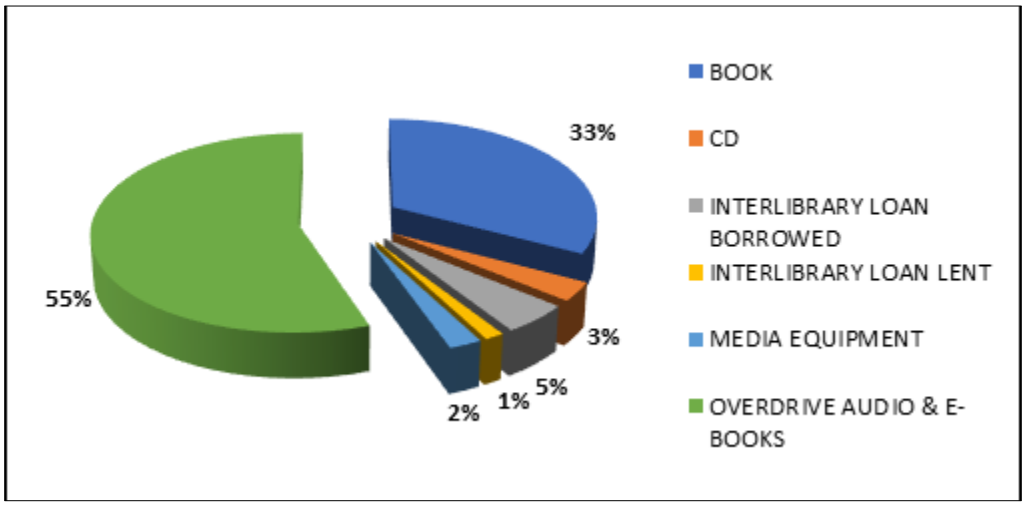

Figure 2. Library Circulation by Item Type

Research and Library Website Analysis:

The principal findings of the Research and Library website analysis includes the following:

- From October 1, 2019, to September 30, 2020, 18,636 visitors accessed the external MDT Research home page; 13,139 of these visitors were new to the site.
- The most commonly visited link on the MDT Research page was the Montana Transportation and Land Use page (https://www.mdt.mt.gov/research/toolkit/m1/ftools/fd/rlot.shtml) at 2,438 users, followed by the main research landing page at 2,035 users.
- The MDT Library catalog was visited 1,114 times by 887 unique users. During those visits, 887 unique users performed 2,065 searches; 203 of those users logged into their MDT Library accounts during those searches.
    - The Montana Shared Catalog (https://mtsc.ent.sirsi.net/client/en_US/MT-DOT/) is comprised of public, academic, and special libraries. Among the 131 participating libraries from large public to small agency libraries, the MDT Library catalog was on average the 48th most utilized catalog between October 1, 2019, and September 30, 2020, making our library catalog a well utilized resource.

The MDT Library catalog is the primary access point for electronic resources with access limited to MDT staff. This supports the supposition that electronic resources are the largest circulating portion of MDT Library resources currently.

Reports/Training/Technology Transfer:

- Research and experimental project progress and final reports were published on the Research Programs website (https://www.mdt.mt.gov/research/projects/sub_listing.shtml).
- The Research Review Committee (RRC) met three times throughout the year to discuss research and pooled fund projects.
- The Research Programs Manager attended the following meetings:
  - AASHTO Research Advisory Committee (RAC) Virtual summer (in July 2020) and winter (at the TRB Annual Meeting) meetings
  - TRB Annual Meeting
- The Research Programs Manager attended periodic online meetings for the following AASHTO and TRB committees:
  - AASHTO and TRB Knowledge Management Committees
  - AASHTO RAC Coordination and Collaboration Task Force
  - AASHTO RAC Implementation Working Group
  - AASHTO RAC Performance Measures Working Group
  - AASHTO RAC Program Management and Quality Task Force
  - AASHTO RAC Research Program and Project Management Content and Marketing Working Group
  - AASHTO RAC Value of Research Task Force
  - AASHTO RAC Website Working Group
  - AASHTO Region 4 RAC
  - TRB Committee Research Coordinator's Council
  - TRB Executive Management Issues Section
  - TRB Research Innovation Implementation Management Committee
- The Librarian attended the following meetings:
  - AASHTO RAC Virtual summer (in July 2020) and winter (at the TRB Annual Meeting) meetings
  - TRB Annual Meeting
- The Librarian attended the following periodic online meetings throughout the year:
  - AASHTO RAC Region 4 meetings
  - AASHTO RAC Website Working Group meetings
  - Montana Shared Catalog member and Executive Board meetings
  - Montana State librarian's quarterly roundtable meeting
  - Special Library Association meetings
  - Transportation Librarian Roundtable meetings
  - TRB Information and Knowledge Management Committee meetings
  - National Transportation Knowledge Network

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2.3 MDT CONSULTANT PROJECT MANAGEMENT

Project Number:	9529-589
Start Date:	6/1/19
Completion Date:	6/30/20
Total Cost[1]:	$148,374
Total SPR Funds:	$148,374
SPR Funds (80%) Expended:	$118,699
State (20%) Expended:	$29,675
Indirect Costs Expended:	$13,992
Unexpended Funds:	$0
Consultant:	CTC & Associates LLC

[1] This contract is run on a state fiscal year. This information summarizes the work completed in FFY 2020.

Objective:

With the 2017 Montana legislative session, MDT lost nearly 70 positions. Guidance has been to contract out more work. One of the positions lost and being contracted is a research project manager position. An RFP was issued in 2018 and CTC & Associates was hired to provide staff for this work. The consultant project managers serve as an extension of staff and manage projects just as internal staff would.

Progress:

The initial contract concluded in 2019. One-year renewals were enacted in June 2019 and 2020. This contract can be renewed up to a total of seven years, as per Montana state law. The consultant Research Project Manager oversees 21 active research projects and 2 projects that are currently on hold (one of which is contracted), following a research project tasks checklist and guidance by the Research Programs Manager. Fifteen of these projects are currently contracted, 14 remain active, six projects are in scope of work and proposal development stages, and one project was completed in FFY 2020. The completed project has moved into the implementation phase. Additional staff from this consultant provides Research Review Committee meeting notes and annual report preparation.

The Research Programs Manager oversaw 15 projects in FFY 2020, eight of which fall under two pooled fund programs and six of which are annual projects. Nine of these projects were completed in FFY 2020, five of which were annual projects and four of which fall under the pooled fund program. Six remain active. The Librarian/Technology Transfer Specialist is currently managing one project in proposal development.

Reports:

Monthly progress reports are provided with each billing.

MDT Project Manager:
Sue Sillick
406.444.7693
ssillick@mt.gov

Consultant Project Manager:
Chris Kline
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chris.kline@ctcandassociates.com

2.4 MONTANA LOCAL TECHNICAL ASSISTANCE PROGRAM (LTAP)

Project Number:	2443-037
Start Date[1]:	7/1/19
Completion Date:	6/30/20
Total Cost:	$380,000
Total SPR Funds:	$80,000
SPR Funds (80%):	$64,000
Other Federal Funds:	$150,000
State (20%):	$16,000
Other State Funds:	$150,000
Total MDT Indirect Costs[2]:	$0
Unexpended Funds:	$0
Consultant:	Montana State University

URL: https://www.mdt.mt.gov/research/ltap/ltap.shtml

[1] The LTAP program is run on a state fiscal year. Hence, it is run nine months behind the federal fiscal year. FFY 2020 LTAP is currently active, running from 7/1/20 to 6/30/21. Therefore, the FFY 2019/SFY 2020 LTAP Program is presented here.

[2] MDT Indirect Costs have been waived for LTAP.

Objective:

The mission of the national Local Technical Assistance Program (LTAP) is to foster a safe, efficient, and environmentally sound transportation system by improving skills and knowledge of local transportation providers through training, technical assistance, and technology transfer. LTAP centers enable counties, parishes, townships, cities, and towns to improve their roads and bridges by supplying them with a variety of training programs, an information clearinghouse, new and existing technology updates, personalized technical assistance, and newsletters. Through these core services, LTAP centers provide access to training and information that may not have otherwise been available. Centers are able to provide local road departments with work force development services; resources to enhance safety and security; solutions to environmental, congestion, capacity, and other issues; technical publications; and training videos and materials.

Montana has more than 70,000 miles of roads in over 185 jurisdictions including towns, cities, counties, and highway districts. Montana LTAP has focused on assisting state and county road offices and city street departments in road and bridge maintenance and repair. By sharing technical information and improving the distribution of this information, the program promotes efficient use of local transportation agencies' scarce resources. Specific LTAP tasks in FFY 2019/SFY 2020 included: compile and maintain a mailing list; maintain class completion and Road Scholar program database; publish a regular newsletter; provide technology transfer materials; provide information and on-site technical assistance; conduct or arrange seminars/training sessions; and conduct program evaluation/reporting.

Progress:

Two newsletters were published and distributed electronically to a large listserv via email, with numerous digital contacts (via email, website contacts and social media/Facebook) with customers regarding upcoming trainings, classes, and updates on technical assists. Technical assists included on-

site visits, emails, reports, and analysis, as well as information distributed and responded to through phone calls, faxes, personal contact at workshops, conferences, and email. Local, state of Montana, and Federal Highway Administration (FHWA) initiatives were highlighted in the LTAP newsletters.

Montana LTAP worked with FHWA to promote the "Every Day Counts" (EDC) initiatives, including the Local Road Safety Plans Development Process, which identify, analyze, and prioritize safety improvements and strategies for local roads. The Montana LTAP Director was also recently involved directly with the FHWA Safety Resource Center staff in developing film footage for a new video released this spring in support of the EDC-5 focus on reducing rural roadway departures (FoRRRwD) initiative.

A few examples of LTAP efforts include:

- Administered Road Scholar program as educational incentive and recognition program for training participants statewide.
- Organized numerous safety and operations trainings within the Road Scholar class framework.
- Provided numerous on-site technical assists from sign placement assistance to guardrail evaluations.
- Provided winter maintenance and safety trainings at many locations around the state.
- LTAP renewed the forklift/skid steer certification program and has worked with several local agencies to renew their training certifications and internal training programs.
- LTAP provides administration of the Montana Work Zone Flagger Certification program, training and certifying numerous flaggers every year.

Since 2017, LTAP has experienced an approximately over 40% increase in program content delivery, and the 2019 Program Assessment Report shows further growth including increased content in local trainings. Technical assists have also improved and expanded. At any given time, we are frequently working on over a dozen technical assists of varying complexity and duration.

Due to COVID-19 restrictions, spring and summer 2020 were challenging for program delivery. LTAP adjusted by offering more digital content delivery, virtual options, increasing focus on direct one-on-one technical assistance when appropriate, and keeping class sizes small, venues large and maintaining social distance and mask use requirements.

Reports:

Four quarterly progress reports were submitted, reviewed, and published on the project website at the above URL. Much more detail of LTAP's activity is included in these reports.

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Consultant Project Manager:
Matt Ulberg
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2.5 TRANSPORTATION RESEARCH BOARD SUPPORT

Project Name: TRB Core Services
Project Number: TPF-5(450)
Start Date: 10/1/2019
Completion Date: 9/30/2020
Total Cost: $109,301
SPR Funds – B (100%): $109,301
URL: http://www.trb.org/Main/Home.aspx

Project Name: NCHRP
Project Number: TPF-5(420)
Start Date: 10/1/2019
Completion Date: 9/30/2020
Total Cost: $492,789
SPR Funds – A (100%): $246,394
SPR Funds – B (100%): $246,395
URL: http://www.trb.org/NCHRP/NCHRP.aspx

TRB Core Services Support:

TRB was founded in 1919 to convene experts—from the public, private, and academic sectors, across transportation modes and disciplines—to advance the knowledge and practice of transportation in an open and non-partisan setting. These experts identify research needs, share the latest ideas and innovations, oversee cooperatively funded research, and provide independent advice on policy issues that entail significant and technical aspects.

The partnership of TRB and the state transportation research community has been in place since 1920, with states providing direct financial support beginning in the 1940s. This TRB/state partnership promotes the development and implementation of innovations that save countless lives, improve mobility and access, and vastly increase the cost-effectiveness of materials, designs, construction practices, and operations.

TRB provides an information infrastructure that is designed to serve the nation's highly decentralized transportation system in which no single organization dominates. Indeed, the cooperation that TRB encourages among transportation agencies at all levels is the envy of other sectors that are similarly decentralized but do not have a mechanism like TRB to facilitate interactions among practitioners and researchers in an independent setting.

MDT invests in TRB's Core Program, which provides a forum for state DOT employees to collaborate with transportation professionals from other organizations to share information on research and issues of interest.

MDT's investment leverages a considerable return. As part of the independent institution, The National Academy of Sciences, Engineering, and Medicine (NASEM), TRB has earned a national and international reputation for objective, high-quality products.

With MDT's financial contribution, MDT employees are involved in the following activities:

- Selecting and providing oversight to projects in TRB's National Cooperative Highway Research Program.
- Serving on panels for other TRB cooperative research programs in the areas of transit, airports, behavioral traffic safety, freight, and hazardous materials.
- Providing input to TRB's Technical Activities Division, which functions as a research clearinghouse and facilitates collaboration among the states, transportation organizations, academia, and individual researchers and practitioners.

- Serving on National Research Council-appointed committees that develop, refine, or offer direction on national transportation issues, often based on a request for advice from a public or private agency.

This investment in TRB and the pooled funding it represents is mission-critical, enabling MDT to:

- Have a voice in setting national research priorities and agendas;
- Continue to have access to the user-oriented research;
- Avoid duplication of research efforts;
- Demonstrate a return on investment of taxpayers' dollars;
- Support the uniform, practical, and common-sense application of transportation research results;
- Continue to develop a more enlightened and informed workforce;
- Improve our customers' experience by accelerating the development and implementation of solutions to problems that affect transportation planning, design, construction, operation, and maintenance; and
- Retain employees by offering them stimulating and professionally rewarding opportunities to participate in efforts that will help improve the nation as a whole.

Tangible Benefits:

MDT receives the following tangible benefits.

- Complimentary registration to the TRB Annual Meeting. The face-to-face meetings and interactions that take place at the Annual Meeting generate ideas, products, and partnerships from which MDT benefits. The Annual Meeting provides an unparalleled opportunity for MDT staff to share knowledge and perspectives with over 13,000 colleagues and to learn about the latest in transportation research, policy, and practice. This sense of community also offers a significant morale boost during tough economic times.
- To address budget restrictions within states, TRB offers activities that not only save states money, but push traditional conference type-information out to state employees who are not able to travel. Examples include the following:
  - **Complimentary access to Annual Meeting papers, extended abstracts, and speaker visual aids through the TRB Annual Meeting Online portal, or AMOnline for short.** Speaker visual aids are from lectern and poster sessions, workshops, and peer-reviewed papers at committee meetings. Non-TRB sponsors are charged $20 per paper/presentation.
  - **Complimentary, unlimited participation in TRB Webinars.** These webinars also provide continuing education credits for MDT employees who attended webinars. This provides MDT with a flexible and extremely economical way to ensure that our employees' professional licenses and certifications remain current.
- **Complimentary copies of TRB publications.** TRB fulfills all individual "over the counter" publication requests from state employees on a complimentary basis. (Note: Most states are now moving to all-electronic distribution. This number refers to printed publications.)
- **Complimentary, electronic access to the TRR Journal Online**, which includes more than 13,900 peer-reviewed papers that have been published as part of the *Transportation Research Record: Journal of the Transportation Research Board* (TRR Journal) series since 1996.
- **Reduced fees to TRB-sponsored specialty conferences**. This discount is about 25% below the general registration fee for the more than 25 specialty conferences TRB conducts each year.

- **Reimbursement for State Representative Meeting Travel**. TRB reimburses the costs for lodging for TRB State Representatives to attend the State Representatives annual meeting, which is held in conjunction with the AASHTO Research Advisory Committee meeting. The reimbursement and reduction in travel cost savings associated with the dual scheduling of these events amounts to a value of approximately $1,800 per year.

Intangible Benefits:

- **Access to research collaboration tools** such as the Research Needs Statements (RNS) and Research in Progress (RiP), which were built and are maintained by TRB in part by the Department's contribution to TRB.
- **Access to the Transport Research International Documentation (TRID) database.** TRID is an integrated database that combines the records from TRB's Transportation Research Information Services (TRIS) Database and the Organisation for Economic Co-operation and Development's Joint Transport Research Centre's International Transport Research Documentation (ITRD) Database. TRID provides access to more than one million records of transportation research worldwide. TRID is maintained by TRB in part by the Department's contribution to TRB.
- **Weekly notices on TRB Activities** via TRB E-Newsletter. The weekly electronic service is designed to keep individuals up-to-date on TRB activities and to highlight selected transportation research-related activities taking place at the federal and state levels, and within the academic and international transportation communities.
- **In-state, periodic access to TRB staff**. Not all of our staff can participate in TRB, so TRB comes to us. TRB's field visit program is designed to keep TRB aware of and responsive to our needs. TRB's last visit to Montana was in 2019**.**

National Cooperative Highway Research Program (NCHRP):

- A portion of MDT's federal State Planning and Research funds is invested in and is the primary source of funding for TRB's National Cooperative Highway Research Program (NCHRP), which conducts and delivers research in acute problem areas that affect state DOT highway planning, design, construction, operation, and maintenance nationwide.
- Our state's contribution to that total was $492,789, which means we leverage approximately $93 in research-related activity for every $1 we invest in TRB's NCHRP activities.
- MDT participates in NCHRP by:
  - Submitting problem statements
  - Rating problem statements
  - Participating on and chairing NCHRP panels. TRB reimburses state employees for travel and lodging expenses related to participation in panel meetings.
- MDT benefits by implementing research results developed through NCHRP. In addition to conducting research on specific problems identified by practitioners and selected by the AASHTO Special Committee on Research and innovation, NCHRP through its 20-24 project series addresses issues selected by state CEOs in the areas of resource development, decision support, and financial management and through its 20-123 series addresses issues selected by AASHTO committees.
- NCHRP's Impact on Practice series, available at http://www.trb.org/NCHRP/NCHRPImpactsonPractice.aspx, highlights how transportation agencies have put NCHRP research results to use.

Other TRB Research Programs:
In addition to TRB's NCHRP, TRB also manages a variety of other programs that are not directly supported by the states, but from which MDT benefits. These programs are authorized by Congress and funded through various administrations within the U.S. Department of Transportation. The programs include the following:

- **Airport Cooperative Research Program (ACRP).** ACRP is an industry-driven, applied research program that develops near-term, practical solutions to problems faced by airport operators.
- **Behavioral Traffic Safety Cooperative Research Program (BTSCRP).** BTSCRP is a forum for coordinated and collaborative research to address issues integral to the Governors Highway Safety Association (GHSA), the National Highway Traffic Safety Administration (NHTSA), and traffic safety professionals at all levels of government and the private sector.
- **Transit Cooperative Research Program (TCRP).** TCRP is an applied, contract research program that develops near-term, practical solutions to problems facing transit agencies.

Leadership within TRB:

MDT's employees help provide direct leadership on TRB activities by participating in TRB committees and panels. Their direct involvement enables MDT to affect national transportation research agendas and activities and provides direct information to MDT on the latest information from other states and countries.

Visit the following address to see a list of MDT's employees who help provide direct leadership on TRB activities: https://www.mytrb.org/CompanyDetails.aspx?CID=6744.

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3 RESEARCH PROJECTS

3.1 OVERVIEW

Once a year, the Research Programs Manager solicits research ideas from as wide a variety of individuals as possible. This open solicitation enhances the possibility of receiving a diverse spectrum of research suggestions.

The solicitation process begins with the Stage 1: Research Idea form (https://www.mdt.mt.gov/research/unique/solicit.shtml). This simple form is due each March 31st and contains four components: title, idea description, and submitter and champion information. A champion is any MDT staff with a vested interest in the research, and is willing to chair the technical panel if the research should move forward to that stage and make presentations to the Research Review Committee (RRC) at various stages in the life of the project. In doing this, the champion asserts there is a research need and this need is important to MDT. The champion information is optional. If an idea is submitted by MDT staff, that person or their designee is the champion. If an idea is submitted by someone other than MDT staff and they do not include a champion, Research staff will attempt to secure a champion. If one is not secured, the idea does not move forward.

For all ideas that have a champion, the MDT librarian conducts a literature search on the topic and shares this information with the champion, who determines, based on the results of this literature search, if the idea should move forward to the Stage 2: Research Topic Statement (https://www.mdt.mt.gov/research/unique/solicit.shtml). The Stage 2 form is due each April 30th and contains the following fields: title; topic statement; related research summary; research proposed; research period; IT component; feasibility, probability of success, and risk; urgency, importance, and expected benefits/payoff; implementability, implementation plan, and responsibility; MDT priority focus areas; total cost estimate; funding source(s); funding match source and amount (if any); funding partners; potential technical panel members; and submitter, champion, and sponsor information. A sponsor is MDT staff at or above the District and Division Administrator level. Sponsors agree each topic is consistent with MDT needs and goals, should be considered by a technical panel, and to ensure implementation, as applicable. A sponsor is required for each topic statement before it can be prioritized.

The champions for each topic statement present their topic to the RRC and District Administrators in May of each year. Between May and July, based on available funding, the RRC and District Administrators then select the topics that will move forward to the technical panel stage for funding beginning October 1st of each year. These topics are chosen because they address actual concerns of the Department.

Following the selection of these high-priority topics, Research Programs staff forms a technical panel for each topic. Technical panels are formed to follow research projects from inception through implementation and are typically composed of three to 10 people with knowledge or expertise and interest in the specific area of research. See Appendix A for Technical Panel Roles and Responsibilities and for more information on the RRC. Panel members are drawn from MDT's Division and District offices, as well as from outside the Department. FHWA is invited to appoint staff to each technical panel. The technical panel's responsibility begins with a review of the literature to determine the need for research, if any, and continues with the development of a scope of work (SOW), which is developed on the SOW form (Appendix B) and includes the following fields:

- Project Title
- Project Background
- Benefits/Business Case/Impact
- Objectives
- Tasks
- Acceptance Criteria
- Cooperators/Stakeholders/Partners
- Communications Considerations
- Data Requirements
- IT Components
- Intellectual Property Considerations
- MDT Involvement
- Deliverables, especially those that facilitate implementation
- Risks
- Implementation Considerations, including barriers and any attempts to reduce or eliminate the barriers
- Performance Measures Considerations

The SOW is used by consultants to prepare a proposal. The champion presents the proposal recommended by the technical panel to the RRC for funding approval.

During the research, the Research Programs representative on each technical panel serves as MDT's project manager and liaison between the technical panel and the consultant. The technical panel monitors research progress by reviewing monthly or quarterly, annual, task, final, project summary, implementation, and performance measures reports, and any other reports and deliverables produced.

When a contract is executed for each project, the Research Project Manager completes Part A of the Implementation Planning and Documentation form. The Research Project Manager completes Parts B-D when the research is concluded. Part D is the sign off by the project champion and sponsor. Also at this time, the champion presents the research results and implementation plan to the RRC. The Implementation Planning and Documentation form provides a living implementation plan to track implementation activities until all are fully implemented or it is clear that no additional implementation will follow.

The research projects process as detailed above is shown in Figure 3 on page 24. In addition to the solicitation process (as described above), there are a number of other methods to initiate research projects that require funding outside of the annual funding process described above; these include the following: Montana Partnership for the Advancement of Research in Transportation (MPART Small Projects); other partnership projects such as pooled funds and AASHTO Technical Services Programs TSP); and Administration High Priority topics (Figure 3). In these cases, a champion identifies a sponsor, and presents the need and why it cannot wait until the next funding cycle to the RRC. Champions and sponsors are required for all projects; these roles may be filled by the same person if that person meets the requirements for a sponsor as described above.

MDT has contracts in place with the Montana University System for small projects (<$50,000 and 1 year) under the MPART Small Projects agreement. If there is a need for a small project, such as a synthesis project, which includes a review of the literature and a survey of the state of the practice, similar to NCHRP synthesis projects, the steps below are followed:

- ★ Champion notifies Research Programs of need
- ★ Technical panel is formed
- ★ Proposal is obtained
- ★ Technical panel recommends proposal for funding to RRC through the champion
- ★ RRC approves or denies funding request

For pooled fund projects and AASHTO TSPs, a technical panel is not required. The champion requests funding from the RRC via the Partnering Project Funding Request form (Appendix C), justifying the need for the expense and why it cannot wait until the next funding cycle. Each partnering project champion must prepare the Partnering Project Annual Evaluation form (Appendix D) and present it to the RRC in May of each year. When a partnering project is concluded, the Champion completes the Partnering Project Close-Out Evaluation form (Appendix E) and presents to the RRC the results and implementation activities stemming from the project.

Finally, if MDT Administration identifies a research need that requires immediate attention, the Research Programs Manager is informed, a technical panel is formed, and a proposal(s) is obtained and approved either by the RRC or Administration.

More details on the research project identification, prioritization, and selection process can be found in Appendix F and more details on the implementation process can be found in Appendix G.

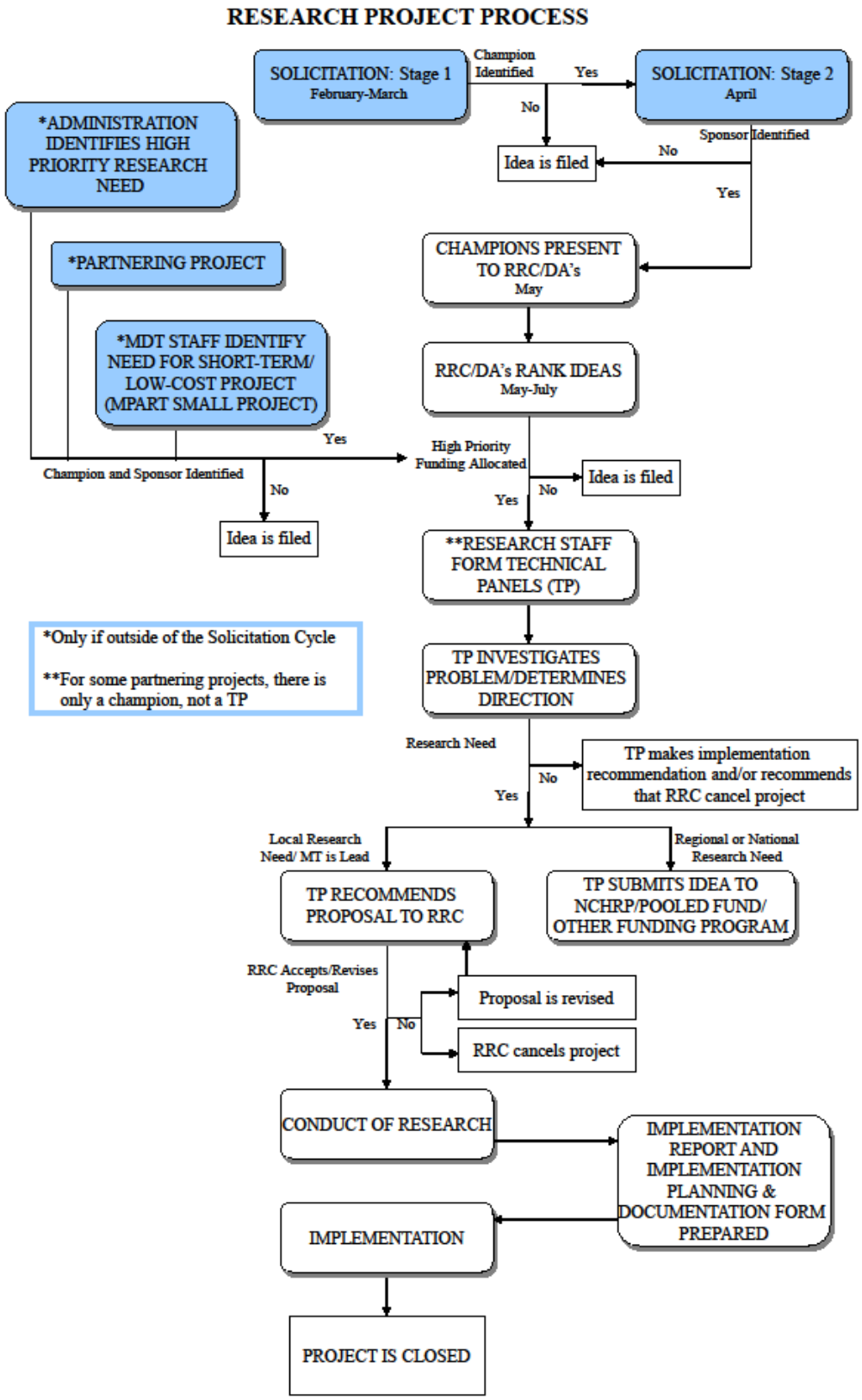

Figure 3: Research Project Process

3.2 BRIDGE AND HYDRAULICS RESEARCH PROJECTS

3.2.1 Active Projects

3.2.1.1 Bridge Deck Cracking Evaluation

Project Number:	9696-700
Start Date:	8/6/19
Completion Date:	12/31/20
Total Cost:	$226,977
Total SPR Funds:	$226,977
Total SPR Funds (80%):	$181,582
Total State Funds (20%)	$45,395
Total MDT Indirect Costs:	$22,339
Total FFY 2020 Expended:	$185,092
Total SPR FFY 2020 Expended:	$185,092
FFY 2020 SPR Funds (80%) Expended:	$148,074
FFY 2020 State Funds (20%) Expended:	$37,018
FFY 2020 MDT Indirect Costs:	$17,553
Consultant:	Wiss, Janney, Elstner and Associates

URL: https://www.mdt.mt.gov/research/projects/const/deckcracking.shtml

Objective:

In the spring of 2016, MDT noted severe cracking on two bridge decks in the Missoula District which led to holes in these decks after small sections of concrete fell through. MDT hired Wiss, Janney, Elstner and Associates (WJE) to investigate the cause of these cracks and provide recommendations. The report by WJE was published in April 2017 and some, but not all, of the recommendations were implemented and proved successful in reducing early age cracking in new bridge decks. Although MDT had success with implementation, documentation of actual in-field procedures was not sufficient and there was not a clear understanding of which of the recommendations implemented were causing the success. The purpose of this project is to determine a better way to document in-field procedures and specification enforcement as well as identifying which recommendations are the main cause of the success and which ones may not be proving beneficial.

Progress:

Work on the literature review (Task 4.1), data accumulation (Task 4.2) and data evaluation (Task 4.3) was completed. Interim reports for bridge deck inspections (Task 4.4a) and bridge instrumentation and monitoring (Task 4.4b) were provided for review.

Reports:

Twelve progress reports were received. Project information can be viewed on the project website at the above URL.

MDT Project Manager:
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802.546.0217
vcallejas@mt.gov

Consultant Project Manager:
Todd Nelson
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3.2.1.2 Concrete-Filled Steel Tube to Concrete Pile Cap Connections: Further Evaluation/Improvement of Analysis/Design Methodologies (Phase IV-V)

Project Number:	9630-628
Start Date:	7/10/18
Completion Date:	9/30/22
Total Cost:	$256,000
Total SPR Funds:	$241,000
Total SPR Funds (80%):	$192,800
Total State Funds (20%)	$48,200
Total Consultant Cost Share:	$15,000
Total MDT Indirect Costs:	$23,595
Total FFY 2020 Expended:	$30,986
Total SPR FFY 2020 Expended:	$29,336
FFY 2020 SPR Funds (80%) Expended:	$23,469
FFY 2020 State Funds (20%) Expended:	$5,867
Total Consultant Cost Share FFY 2020 Expended:	$1,527
FFY 2020 MDT Indirect Costs:	$2,836
Consultant:	Montana State University

URL: https://www.mdt.mt.gov/research/projects/structures/seismic.shtml

Objective:

MDT has found concrete-filled steel tube (CFST) piles connected at the top by a concrete pile cap to be a very cost-effective support system for short- and medium-span bridges. This type of system offers low initial cost, short construction time, low maintenance requirements, and a long service life. While the gravity load performance of these systems is well understood, their strength and ductility under extreme lateral loads (e.g., seismic events) is more difficult to reliably predict using conventional design procedures. The research aims to further develop newly established design and analysis methodologies, and to ultimately ensure the desired bridge performance.

The primary objective of the research is to further validate/improve MDT's CFST to concrete pile cap connection design/analysis methodologies, and to ensure the efficacy of these methodologies for a wide variety of potential design configurations. Work will begin by identifying potential gaps in the existing design/modeling strategies, and then designing tests that will help close these gaps. Physical tests will

then be conducted and analyzed, with the results being used to develop recommendations as appropriate to improve the analysis and design methodologies.

Progress:
Work on the literature review (Task 1) was completed and a draft report was submitted for review. Work on identification of potential gaps in current design/analysis methodology (Task 2) and experimental design (Task 3) continued in 2020.

Reports:
Two progress reports were received. Project information can be viewed on the project website at the above URL.

MDT Project Manager:
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vcallejas@mt.gov

Consultant Project Manager:
Mike Berry
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3.2.1.3 Development of Deterioration Curves for Bridge Elements in Montana

Project Number:	9831-765
Start Date:	8/5/19
Completion Date:	1/31/22
Total Cost:	$83,000
Total SPR Funds:	$83,000
Total SPR Funds (80%):	$66,400
Total State Funds (20%)	$16,600
Total MDT Indirect Costs:	$8,396
Total FFY 2020 Expended:	$22,595
Total SPR FFY 2020 Expended:	$22,595
FFY 2020 SPR Funds (80%) Expended:	$18,076
FFY 2020 State Funds (20%) Expended:	$4,519
FFY 2020 MDT Indirect Costs:	$1,485
Consultant:	Montana State University

URL: https://www.mdt.mt.gov/research/projects/structures/deterioration-curves.shtml

Objective:

This proposed research is in response to FHWA's objective of implementing a transportation management plan for the National Highway System (NHS). One of the standards that state departments of transportation must meet is the development and operation of a bridge management system that includes deterioration forecasting for all NHS bridge assets. MDT uses two analysis programs for this purpose: FHWA's National Bridge Investment Analysis System (NBIAS) and the Bridge Data Analytics Tool, which is currently under development. Both of these tools require deterioration curves for different bridge elements (bridge deck, superstructure, and substructure). The objective of the proposed research is to 1) develop deterioration models specific to Montana's five transportation districts using inspection data related to time-dependent element deterioration, operation practices and annual average daily traffic; 2) identify existing or new data that could be used to improve the accuracy of the deterioration curves; and 3) compare the results from Montana-specific data with data from the National Bridge Inventory to identify similarities and differences in the deterioration models.

Progress:

The literature review was completed (Task 1). Work also continued on site selection and the analysis plan (Task 2).

Reports:

Two progress reports were received. Project information and reports can be viewed on the project website at the above URL.

MDT Project Manager:
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Consultant Project Manager:
Damon R. Fick
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3.2.1.4 Evaluation of Thin Polymer Overlays for Bridge Decks

Project Number:	9757-705
Start Date:	1/22/20
Completion Date:	3/31/23
Total Cost:	$83,000
Total SPR Funds:	$83,000
Total SPR Funds (80%):	$66,400
Total State Funds (20%)	$16,600
Total MDT Indirect Costs:	$8,396
Total FFY 2020 Expended:	$40,601
Total SPR FFY 2020 Expended:	$40,601
FFY 2020 SPR Funds (80%) Expended:	$32,481
FFY 2020 State Funds (20%) Expended:	$8,120
FFY 2020 MDT Indirect Costs:	$3,511
Consultant:	Wiss, Janney, Elstner and Associates

URL: https://www.mdt.mt.gov/research/projects/const/evaluation.shtml

Objective:

Thin composite polymer overlays are a cost-effective method for extending the service life and serviceability of concrete bridge decks by filling concrete cracks and increasing skid resistance. The overlay is a thin (1/4 to 1/2 inch) layer of polymer that seals existing cracks and is embedded with aggregate for wear and skid resistance. MDT has recently observed varying performance of two different polymer overlay systems applied to four different bridge decks across the state. This research will assess the performance of thin polymer overlays on concrete bridge decks in Montana.

The project includes a literature review, a review of the polymer systems on MDT's qualified product list and recent skid resistance data for two of these materials. The project also includes the implementation of an expanded and focused field investigation to measure skid resistance and durability of selected polymer systems. The anticipated product of this research will be an updated process for selecting and utilizing thin polymer overlays to increase the service life of bridge decks in Montana.

Progress:

Work continued on the literature review (Task 4.1). Work also started on the analysis of DOT polymer practice survey results (Task 4.1). Data and samples were collected for analysis and the first year of monitoring (Task 4.4) was completed.

Reports:

Five progress reports were received. Project information can be viewed on the project website at the above URL.

MDT Project Manager:
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Consultant Project Manager:
Paul Krauss
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3.2.1.5 Feasibility of Non-Proprietary Ultra-High Performance Concrete (UHPC) for Use in Highway Bridges in Montana – Phase 2: Field Application

Project Number:	9578-606
Start Date:	3/20/18
Completion Date:	12/31/20
Total Cost:	$162,000
Total SPR Funds:	$162,000
Total SPR Funds (80%):	$124,965
Total State Funds (20%)	$31,241
Total Other State Funds:	$5,794
Total MDT Indirect Costs:	$16,332
Total FFY 2020 Expended:	$30,545
Total SPR FFY 2020 Expended:	$30,545
FFY 2020 SPR Funds (80%) Expended:	$24,436
FFY 2020 State Funds (20%) Expended:	$6,109
FFY 2020 MDT Indirect Costs:	$2,880
Consultant:	Montana State University

URL: https://www.mdt.mt.gov/research/projects/mat/high_performance_concrete.shtml

Objective:

Ultra-high performance concrete (UHPC) has mechanical and durability properties that far exceed those of conventional concrete. However, using UHPC in conventional concrete applications has been cost prohibitive, with commercially available/proprietary mixes costing approximately 30 times more than conventional concrete. Previous research conducted at Montana State University resulted in non-proprietary UHPC mixes made with materials readily available in Montana. These mixes are significantly less expensive than commercially available UHPC mixes, thus opening the door for their use in construction projects in the state. The MDT Bridge Bureau is interested in using UHPC in field-cast joints between precast concrete deck panels. The use of UHPC in this application will reduce development lengths, and subsequently reduce the requisite spacing between the decks and improve the overall performance of the bridge. The research will build on the non-proprietary UHPC research completed in Phase 1 of this project and focus on ensuring the successful application of this material in these field-cast joints. Specifically, this research will investigate several items related to the field batching of these mixes, and the potential variability in performance related to differences in constituent materials. Further, rebar bond strength and the subsequent effect this has on development length will be investigated.

Progress:

Work on the literature review (Task 1), material sensitivity (Task 2), field batching/mixing (Task 3) and bond/development length characterization (Task 4) was completed. An additional mixer was purchased and further testing using a third fiber source was conducted. The final report is being drafted.

Reports:

Four progress reports were received. Project information and reports can be viewed on the project website at the above URL.

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3.2.1.6 A Feasibility Study of Road Culvert Bridge Deck Deicing Using Geothermal Energy

Project Number:	9890-784
Start Date:	7/13/20
Completion Date:	12/31/23
Total Cost:	$235,000
Total SPR Funds:	$235,000
Total SPR Funds (80%):	$188,000
Total State Funds (20%)	$47,000
Total MDT Indirect Costs:	$24,299
Total FFY 2020 Expended:	$2,310
Total SPR FFY 2020 Expended:	$2,310
FFY 2020 SPR Funds (80%) Expended:	$1,848
FFY 2020 State Funds (20%) Expended:	$462
FFY 2020 MDT Indirect Costs:	$229
Consultant:	Montana State University

URL: https://www.mdt.mt.gov/research/projects/deicing-geothermal.shtml

Objective:

Adverse winter weather conditions have a significant impact on the safety, operation and maintenance of transportation infrastructure. Snow accumulation on roads and bridges reduces their capacity, decreases safety and increases travel delays. Ice accumulation in and around culverts may adversely affect fish movement and causes flooding and extensive economic losses. Ice accumulation can also lead to propagation of the freezing front into the soil around the culvert and increase the risk of frost heave in the frost-susceptible subsoil in road sections adjacent to the culvert. Therefore, deicing bridge decks and culverts is a major maintenance concern in areas with extreme cold weather. Reduction of ice and snow on bridges also leads to safer roadways and enhanced winter traffic mobility. The research project will investigate the feasibility of using a ground-coupled system that utilizes heat energy harvested from the ground as an alternative for deicing bridges and culverts. The ground-coupled system relies on the circulation of water through pipes placed underground (either vertically or horizontally) to utilize the natural heat retained by the earth.

Progress:

The project kick-off meeting was held in July 2020. The principal investigator began working on the literature review.

Reports:

Project information can be viewed on the project website at the above URL.

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3.2.1.7 Monitoring Streamflow Using Video Cameras

Project Number:	9790-727
Start Date:	8/5/19
Completion Date:	1/31/22
Total Cost:	$153,600
Total SPR Funds:	$96,000
Total SPR Funds (80%):	$76,800
Total Other Federal Funds:	$57,600
Total State Funds (20%)	$19,200
Total MDT Indirect Costs:	$9,600
Total FFY 2020 Expended:	$46,255
Total SPR FFY 2020 Expended:	$28,678
FFY 2020 SPR Funds (80%) Expended:	$22,942
FFY 2020 Other Federal Funds Expended:	$17,114
FFY 2020 State Funds (20%) Expended:	$5,736
FFY 2020 MDT Indirect Costs:	$2,778
Consultant:	United States Geological Survey

URL: https://www.mdt.mt.gov/research/projects/hyd/streamflow.shtml

Objective:

Stream velocity information is critical for triggering site visits or other action by MDT personnel for scour-critical bridges in response to floods. Large-scale particle image velocimetry (LSPIV) installations might provide valuable data for MDT's plans of action (POAs) for such sites. LSPIV installations also could provide data on ice jam formation and breakup, and on debris buildup at bridges. LSPIV installations include a video camera, surveyed reference marks, and small computer. LSPIV installations can provide stream velocity information and, when used along with channel cross sections and other field data, stream discharge data.

But LSPIV is relatively new, and the U.S. Geological Survey (USGS) is just beginning to test the technology in select locations across the United States.

The objectives of this project are threefold: 1) investigate the effectiveness and limitations of LSPIV for measuring velocity magnitude and direction related to bridge scour, for detecting changes in a channel thalweg, for POAs for scour-critical bridges and for bridge scour modeling and assessment; 2) investigate the potential for providing real-time information from LSPIV installations using live-stream video, or

periodic photographs or data delivery; and 3) investigate best practices for data processing and distribution, especially for transferring data from the sites to both USGS and MDT personnel.

Progress:

Work continued on site selection (Task 1). Work began on the LSPIV equipment installation and operation (Task 2), as well as the downloading and processing of the LSPIV data (Task 3).

Reports:

Four progress reports were received. Project information can be viewed on the project website at the above URL.

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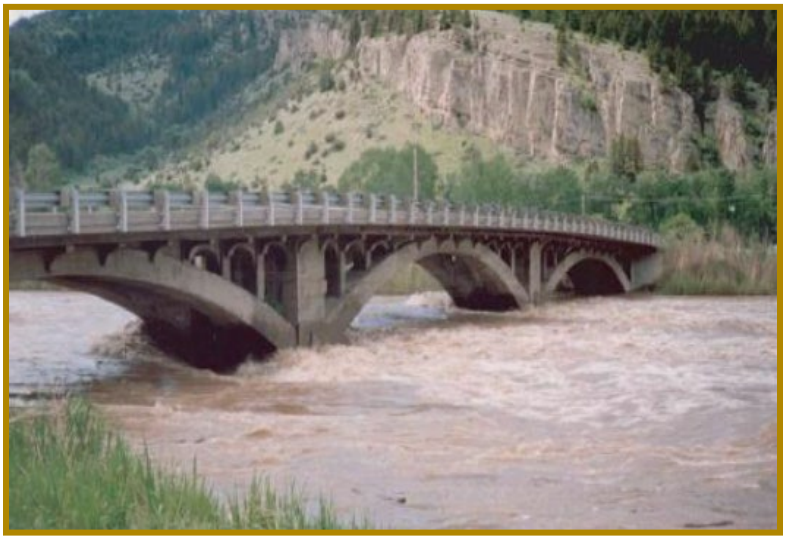
3.2.1.8 Regional Regression Equations Based on Channel-Width Characteristics to Estimate Peak-Flow Frequencies at Ungauged Sites in Montana Using Data Through Water Year 2011

Project Number:	9353-511
Start Date:	2/1/17
Completion Date:	5/28/21
Total Cost:	$240,000
Total SPR Funds:	$150,000
Total SPR Funds (80%):	$120,000
Total Other Federal Funds:	$90,000
Total State Funds (20%)	$30,000
Total MDT Indirect Costs:	$15,000
Total FFY 2020 Expended:	$0
Total SPR FFY 2020 Expended:	$0
FFY 2020 SPR Funds (80%) Expended:	$0
FFY 2020 Other Federal Funds Expended:	$0
FFY 2020 State Funds (20%) Expended:	$0
FFY 2020 MDT Indirect Costs:	$0
Consultant:	United States Geological Survey

URL: https://www.mdt.mt.gov/research/projects/hyd/peak_flow.shtml

Objective:



MDT uses peak-flow frequency data (i.e., 100-year flood) to design highway infrastructure, secure floodplain permits, and perform stream restoration activities. The United States Geological Survey (USGS), in cooperation with MDT, will develop regression equations which use channel width as a predictor to provide peak-flow frequency estimates to MDT. The research will develop channel width-based regression equations that could increase accuracy and reduce uncertainty when determining flood magnitudes and frequencies. Channel width measurements are commonly obtained through on-site surveys. This project will evaluate the use of aerial photography and other remote measurement methods to quickly estimate channel widths to reduce the need for on-site surveys.

Progress:

Work on regional regression equations (Task 3) was completed. The final deliverables, including the Network Analysis Report and USGS Scientific Investigations Report are being finalized for publication.

Reports:

Two progress reports were received. Project information can be viewed on the project website at the above URL.

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3.2.2 Proposed Projects

3.2.2.1 Exploration of UHPC Applications for Montana Bridges

URL: https://www.mdt.mt.gov/research/projects/uhpc.shtml

Topic Statement:

Ultra-high performance concrete (UHPC) has mechanical and durability properties that far exceed those of conventional concrete. However, using UHPC in conventional concrete applications has been cost prohibitive, with commercially available/proprietary mixes costing approximately 30 times more than conventional concrete. Previous research conducted at Montana State University (MSU) has focused on the development and evaluation of non-proprietary UHPC mixes made with materials readily available in Montana. These mixes are significantly less expensive than commercially available UHPC mixes, thus opening the door for their use in construction projects in the state. Building on the success of this previous research, the focus of the project proposed herein is to investigate further uses of this novel material in MDT bridge projects.

Related Research:

Previous research conducted at MSU has included 1) the development of non-proprietary UHPC mixes that are significantly less expensive than commercially available mixes and are made with materials readily available in Montana; 2) an investigation into several items related to the field batching of these mixes; 3) an exploration into the potential variability in performance related to differences in constituent materials; and 4) the investigation of rebar bond strength and the subsequent effect this has on development length. The MDT Bridge Bureau is interested in using UHPC in field-cast joints between precast concrete deck panels to reduce congestion and the requisite spacing between the decks, and ultimately improve the overall performance of the bridge. Currently, another research project is being proposed that will focus on the successful implementation of UHPC in this application. There is significant potential for the use of UHPC in other applications that will improve the performance of Montana bridges; however, before the mixes can be used in other field applications, further research must be conducted to ensure performance in the desired application(s).

Research Proposed:

Bridge deterioration (including decks and other members) is a problem across Montana, and UHPC overlays/patching may be a viable solution to rehabilitate these bridges instead of replacing. Specifically, the research proposed herein will focus on exploring the following applications: 1) thin-bonded overlays for bridge decks, 2) patching, and 3) reinforcing/replacing deteriorating members. Confidence in the use of UHPC as a strengthening material will require the exploration of surface preparation/treatments and bonding between UHPC and standard concrete. Experiments will be performed including stiffness and strength testing of both small slab sections with UHPC overlays, and damaged beams with UHPC

patches. Fatigue testing of smaller-scale specimens may also be warranted. This project is a required step to fully understand and capitalize on the benefits of using UHPC to increase the lifespan of Montana's existing concrete infrastructure.

Urgency and Expected Benefits:

Aging infrastructure and limited budgets require robust and proven bridge construction, rehabilitation and replacement strategies that are cost-effective and efficient. The non-proprietary fiber-reinforced UHPC mixes developed in the Phase I/II research are significantly less expensive than proprietary mixes, costing $1,000 per cubic yard, compared to $2,500-3,500 per cubic yard from commercial suppliers. If these mixes are found to be viable for other applications, Montana can take advantage of the cost savings of the non-proprietary mixes and ultimately improve the performance and durability of its bridges. If successful, using UHPC for field-cast joints and other applications could potentially turn a $50 million bridge replacement into a $10 million rehabilitation.

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3.2.2.2 Feasibility of Non-Proprietary Ultra-High Performance Concrete (UHPC) for Use in Highway Bridges in Montana: Implementation

URL: https://www.mdt.mt.gov/research/projects/mat/high_performance_concrete.shtml

Topic Statement:

Ultra-high performance concrete (UHPC) has mechanical and durability properties that far exceed those of conventional concrete. However, using UHPC in conventional concrete applications has been cost prohibitive, with commercially available/proprietary mixes costing approximately 30 times more than conventional concrete. Previous research conducted at Montana State University (MSU) has focused on the development and evaluation of non-proprietary UHPC mixes made with materials readily available in Montana. These mixes are significantly less expensive than commercially available UHPC mixes, thus opening the door for their use in construction projects in the state. The focus of the proposed project is on taking this material beyond the laboratory, and successfully use it on a bridge project in Montana, specifically for field-cast joints. This project is a required step to fully understand and capitalize on the benefits of using UHPC for this application and increase the performance, durability, and efficiency of Montana bridges.

Related Research:

Previous research conducted at MSU has included 1) the development of non-proprietary UHPC mixes that are significantly less expensive than commercially available mixes and are made with materials readily available in Montana; 2) an investigation into several items related to the field batching of these mixes; 3) an exploration into the potential variability in performance related to differences in constituent materials; and 4) the investigation of rebar bond strength and the subsequent effect this has on development length. This previous research has been successful and has clearly demonstrated the feasibility of using UHPC in Montana bridge projects. Specifically, this research demonstrated that its use in field-cast joints between adjacent precast deck panels could be particularly useful. In this application, UHPC can reduce congestion and the requisite spacing between the panels, and ultimately improve the overall performance of the bridge. However, this research also demonstrated the need for experience with this material in order to ensure its successful application.

Research Proposed:

The focus of the proposed research is on the implementation of this newly developed non-proprietary UHPC in closure pours on an actual bridge project in Montana. The scope of this project would include: 1) closing any minor research gaps that may prohibit UHPC use in the desired application (e.g., testing epoxy coated rebar in bar pullout tests); 2) the development of specifications for this material documenting mix proportions and batching/mixing instructions; 3) working with MDT to identify a potential bridge project that would be suitable for UHPC closure pours; 4) working with the selected contractor to conduct and test several trial batches/pours to ensure proper mixing/curing/finishing

procedures; 5) assisting the contractor on the bridge project and preparing specimens for quality control tests; and 6) monitoring the performance of the deck after completion.

Urgency and Expected Benefits:

Aging infrastructure and limited budgets require robust and proven bridge construction, rehabilitation and replacement strategies that are cost-effective and efficient. The non-proprietary fiber-reinforced UHPC mixes developed in the Phase I/II research are significantly less expensive than proprietary mixes, costing $1,000 per cubic yard, compared to $2,500-3,500 per cubic yard from commercial suppliers. Upon completion of this project, Montana can take advantage of the cost savings of this non-proprietary UHPC and ultimately improve the performance and durability of its bridges.

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3.3 CONSTRUCTION RESEARCH PROJECTS

3.3.1 Active Projects

3.3.1.1 Effective Production Rate Estimation and Activity Sequencing Logics Using Construction Daily Work Report Data: Phase 2

Project Number:	9344-723
Start Date:	6/7/19
Completion Date:	12/31/20
Total Cost:	$50,000
Total SPR Funds:	$50,000
Total SPR Funds (80%):	$40,000
Total State Funds (20%)	$10,000
Total MDT Indirect Costs:	$5,000
Total FFY 2020 Expended:	$39,880
Total SPR FFY 2020 Expended:	$39,880
FFY 2020 SPR Funds (80%) Expended:	$31,904
FFY 2020 State Funds (20%) Expended:	$7,976
FFY 2020 MDT Indirect Costs:	$3,760
Consultant:	Texas Transportation Institute

URL: https://www.mdt.mt.gov/research/projects/const/production_rates.shtml

Objective:

A production rate is a quantity of production accomplished over a specific period of time and realistic production rates are the key in determining reasonable contract times for construction projects. The production rates of major construction activities are important for planning resources and tracking project progress as these activities typically fall in the critical path of the project schedule. Therefore, the accuracy and reliability of the estimated production rates is an effective contract administration tool. The goal of Phase 1 (9344-504) was to enhance MDT's current contract time determination procedures by developing a historical data-driven production rate estimation system using data available in construction daily work reports. This second phase will address activity sequence logics for different types of projects based on historical data. These new tools are expected to significantly improve the accuracy and reliability of MDT's contract time determination.

Progress:

All work was completed and all draft deliverables were provided in FFY 2020. The final report, construction activity sequence logics, and the project poster were all completed in FFY 2020 and posted to the project page. The project summary and implementation reports will be completed after the implementation meeting and posted to the project website in FFY 2021.

Reports:

Two quarterly progress reports and a Tasks 1-3 report were submitted in FFY 2020, along with all of the final products.

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3.3.2 Proposed Projects

3.3.2.1 Artificial Intelligence (AI) based Tool to Estimate Contract Time

URL: https://www.mdt.mt.gov/research/projects/const/ai_based_contracting_tool.shtml

Topic Statement:

MDT is required by federal regulations to have a procedure and tools for contract time determination. The contract time drives much of the contractor's approach to bidding a specific project. If MDT sets a period that is shorter than the construction industry's estimate, bids will go up across the board as competing contractors bid the cost to accelerate the project. If the period is longer than the industry's estimate of time, the bids also go up as contractors bid the additional costs to remain mobilized. Either way, the public loses due to inaccurate and sometimes arbitrary contract completion times. Emerging artificial intelligence (AI) algorithms have power to process various types of data and learn the hidden patterns and make a reasonable prediction with reliable accuracy. This research project will use one of the promising AI algorithms, namely, the neural network algorithm to quickly estimate the most likely contract time for a highway project. The principal idea is to use key project characteristics that may include work type, project location, major controlling work items and their quantities of work as input variables, and then the neural network algorithm will estimate the most likely project duration or contract time of a new project by analyzing the data of the historical MDT highway projects. One of the major challenges that MDT schedulers face is the short period of time allowed for contract time determination. Thus, a quick and effective contract time determination tool that produces high-quality results in a more reliable and defensible manner will serve as a great supporting tool for improving work efficiency.

Related Research:

According to 23 Code of Federal Regulations 635.12, state transportation agencies should have adequate written procedures for the determination of contract time. Current practices of DOTs, including MDT, are typically based on a rule of thumb to determine the contract time or manual development of a bar chart schedule to compute project completion time. The current MDT Contract Time Determination (CDT) manual suggests the following process: a) identify work activities, b) estimate production rates, c) determine each activity's duration, d) develop a sequence logic, and e) create a bar chart to compute the project duration. Studies indicated that by analyzing historical project documents, strong correlation patterns can be found between key project characteristics and project duration that can be used to develop models as a robust alternative tool for estimating project duration of a highway project. Some DOTs including Kentucky Transportation Cabinet, Ohio DOT, and Colorado DOT applied this idea and developed data-driven statistical models for contract time determination. They identified key project characteristics to estimate the most probable project duration including engineer's estimate, work item quantities, project type, road type, project location (urban/rural), terrain type, traffic control, and project starting season. Kentucky Transportation Cabinet was able to increase their contract time estimation accuracy by almost five times when they switched from traditional bar chart-based methods to a data-driven statistical model. Many of the previous research studies used multivariate regression analysis to develop their models. The rise of AI algorithms in the last decade has proven that AI algorithms such as an artificial neural network (ANN) can perform better than multivariate regression models in term of its performance, accuracy and reliability. This research will obtain and analyze MDT historical project data and use the ANN as a robust technique to develop a model that can estimate the contract time of a new project with a reliable accuracy. MDT contract time developers can enhance their CTD process by using the information obtained from this model to calibrate their initial contract time

estimate and the information can be used as another defensible document for justifying the contract time of a project.

Research Proposed:

The research goal of this study is to provide MDT with a robust decision support tool that can estimate the project duration or contract time with a reliable accuracy for a new highway project. To accomplish the goal, the following key tasks will be performed: I) examine the currently accessible MDT historical data of project documents to extract key project characteristics that may affect contract time. Some of the potential characteristics include project type, project location, major controlling work items, and their quantities of work to be used as input variables; II) collect and analyze historical MDT highway project data that include major project characteristics; III) develop an ANN model that takes key project characteristics as input values and estimates the most likely project duration and contract time for a new project; IV) develop a user-friendly Excel tool based on the ANN model. The tool will be designed to easily capture and store input variables from MDT and help users to quickly estimate the project duration of a project when key project data are entered. The most likely project duration will be estimated with a confidence level so that the information about the scheduling risk or uncertainty is known; V) develop a guidebook and a user's manual for MDT; and VI) provide a training session for MDT engineers for immediate implementation of the tool.

Urgency and Expected Benefits:

Federal regulations require that each DOT must have a well-structured contract time determination procedure and tools. Inaccurate estimating of contract time will result in additionally required budget, project delay, and inconvenience to the public. This research study will provide a data-driven AI model that estimates project duration with a reliable level of accuracy. The deliverable from this project is expected to significantly help MDT meet the federal regulations and avoid budget overruns and project delays.

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3.4 ENVIRONMENTAL RESEARCH PROJECTS

3.4.1 Active Projects

3.4.1.1 Testing Wildlife-Friendly Fencing Modifications to Manage Wildlife and Livestock Movements

Project Number:	9596-617
Start Date:	6/19/18
Completion Date:	2/28/21
Total Cost:	$247,259
Total SPR Funds:	$63,803
Total SPR Funds (80%):	$51,043
Total State Funds (20%)	$12,761
Total Consultant/Other Cost Share:	$183,456
Total MDT Indirect Costs:	$6,915
Total FFY 2020 Expended:	$19,312
Total SPR FFY 2020 Expended:	$19,312
FFY 2020 SPR Funds (80%) Expended:	$15,450
FFY 2020 State Funds (20%) Expended:	$3,862
FFY 2020 Consultant/Other Cost Share Expended:	$0
FFY 2020 MDT Indirect Costs:	$1,436
Consultant:	University of Montana

URL: https://www.mdt.mt.gov/research/projects/env/wildlife_fence_mods.shtml

Objective:

Fences along roadways serve as safety measures to protect humans from vehicular collisions with wildlife and livestock by containing animals in appropriate pastures and keeping them off roadways. Fences can act as semi-permeable or complete barriers to wildlife movement. As a consequence, through landscape fragmentation, fences reduce landscape connectivity, impede resource selection, and are a direct cause of mortality in ungulates (e.g., pronghorn, elk, deer) and other species (e.g., greater sage-grouse). To combat these effects on wildlife, multiple fence modifications have been recommended by management agencies using the best available science to either facilitate or deter wildlife and/or livestock from crossing fences.

Progress:

The final deliverables are being finalized.

Reports:

Project information can be viewed on the project website at the above URL.

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3.4.2 Implementation Projects

3.4.2.1 MDT Wildlife Accommodations Process

Project Number: 5896-423
Start Date: 2/14/19
Completion Date: 10/31/24
Total Cost: $0
URL: https://www.mdt.mt.gov/research/projects/env/wap.shtml

Objective:

MDT has accommodated a variety of wildlife species in the last two decades in a number of different ways. However, the processes, justification, and criteria used for recommending and implementing accommodations have varied just as the technology and practices in the field have rapidly evolved. This project investigated how to establish a process to incorporate these features into construction projects by a documented justification process to determine the appropriateness of including wildlife accommodations in project development and design. The overall objective is to implement a wildlife accommodations process specifically tailored to meet MDT's project development processes, Montana wildlife, and evaluate needs as well as feasibility.

Progress:

In FFY 2020, the implementation plan was regularly reviewed. Completed implementation tasks include the following:

1. Develop training (Moodle). Develop a Q&A forum; test and distribute training.
2. Populate Wildlife Accommodation Process (WAP) tracking spreadsheet with all projects using the Wildlife Accommodations Process (i.e., every project that has a Wildlife Accommodations Recommendations Memo (WARM)). This task in ongoing.

Tasks pending implementation include the following:

1. Develop a survey to determine performance measures.
2. Implement survey.
3. Annual process review: Download survey (assuming use of SurveyMonkey), format survey results if necessary, schedule technical panel meeting, and send results of survey and tracking spreadsheet to technical panel.
4. Technical panel meeting to discuss survey results and tracking spreadsheet. Environmental will develop process review summary report with specific action items to include possible process changes, etc. Environmental will send document to the technical panel for review and revision. Environmental will revise and finalize document for distribution.
5. Implement tasks from #4 immediately above.

Previously completed tasks include the following:

1. Update construction project milestone report templates.
2. Discuss implementation plan at an Engineering Bureau Chiefs meeting.
3. Discuss implementation plan at Preconstruction meeting with headquarter and district staff.

4. Modify MDT WARM and Wildlife Accommodations Decision Report (WADR) so that they can be used by consultants as well. Post on website. Archive files.
5. Prepare Scope of Work (SOW) activity descriptions (128, 214, 415, and 566) to include the WADR language, and precursors and successors.
6. Determine activity durations and man-hours (214, 415, 566, 706, and 707): 60 days for 706 (BRR/PBA - MDT).
7. Update flowcharts and add activity description for activities 109 and 707 (WARM).
8. Discuss implementation at seven regional Fish, Wildlife and Parks (FWP) meetings.
9. Make all activities (109, 128, 182, 214, 415, 566, 706, and 707) and flowcharts, WARM, and WADR live.
10. Determine and announce go live date.
11. Develop and implement tracking spreadsheet; implementation will occur beginning on the go live date.

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3.4.3 Proposed Projects

3.4.3.1 Effective Wildlife Fences through Better Functioning Barriers at Access Roads and Jump-Outs

URL: https://www.mdt.mt.gov/research/projects/admin/wildlife-jumpouts.shtml

Topic Statement:

Wildlife fences in combination with wildlife crossing structures are the most effective and robust measure to improve human safety through reducing collisions with large mammals, and to provide safe crossing opportunities for wildlife. However, in multifunctional landscapes, access roads for agriculture, dispersed housing, and other roads result in openings in the fence. Along US Hwy 93 North on the Flathead Indian Reservation, wildlife guards (similar to cattle guards) at access roads have proven to be a substantial barrier to deer species (about 80% to nearly 100% barrier), but unfortunately they are quite permeable to species with paws, including bear species (about 50% to nearly 100% permeable). In addition, animals that do end up in the fenced road corridor must be able to escape quickly. Earthen mounds built up against the fence allow animals to jump down to the safe side of the fence. However, deer use of these wildlife jump-outs has been low (only about 32% use by mule deer, only about 7% use by white-tailed deer). This means that these animals spend more time inside the fenced road corridor before they exit, either at one of the jump-outs or at a fence-end. To further improve human safety, and to reduce direct road mortality of wildlife, including grizzly bears, additional measures are needed at access roads, and deer species need to use the jump-outs more readily.

Related Research:

Electrified barriers have been implemented to keep large wild mammals out of fenced road corridors. These barriers have been mostly at high-volume access roads and at fence-ends along main highways (e.g., Gagnon et al, 2010; Huijser et al., 2015). Historically, one-way escape gates have been implemented to allow large wild mammals to escape fenced road corridors (see review in Huijser et al., 2015). However, one-way gates are now rarely implemented because of low effectiveness, animal intrusions into the fenced road corridor, and injuries and death of animals using the one-way gates (see review in Huijser et al., 2015). Wildlife jump-outs or “escape ramps” are now widely used instead. There is little information available on the appropriate height of jump-outs for different species. Nonetheless, a height of about 5-5½ ft seems advisable for white-tailed deer and mule deer (review in Huijser et al., 2015). This is lower than the height of most of the jump-outs along US Hwy 93N (Huijser et al., 2016b). Unfortunately, lower jump-outs can also result in more animals jumping up into the fenced road corridor. A jump-out can be made to appear higher for animals that may be interested in jumping up into the fenced road corridor by adding a metal bar or wooden plank about 18 inches above the ground, close to the edge of the jump-out (Siemers et al., 2013).

Research Proposed:

Relatively inexpensive electrified barriers (e.g., up to several thousands of dollars per location) may be suitable for such low traffic volume and low traffic speed access roads. These low-cost barriers must still be effective in keeping large mammals, including bear species, out of the fenced road corridor. The focus of this portion of the research project is on electrified barriers that are relatively low cost and appear suited for low traffic volume and low traffic speed locations.

The jump-outs should be low enough for the target species to readily jump down to the safe side of the fence. At the same time, the jump-outs should be high enough to discourage animals that are on the safe side of the fence to jump up into the fenced road corridor. There is very little information available on the appropriate height of jump-outs for different species. This research will be investigating jump-outs at a height of about 5-5½ ft, advisable for white-tailed deer and mule deer (review in Huijser et al., 2015). This is lower than the height of most of the jump-outs along US Hwy 93N (Huijser et al., 2016b). Unfortunately, lower jump-outs can also result in more animals jumping up into the fenced road corridor. A jump-out can be made to appear higher for animals that may be interested in jumping up into the fenced road corridor by adding a metal bar or wooden plank about 18 inches above the ground, close to the edge of the jump-out (Siemers et al., 2013). The focus of this portion of the research project is on the effectiveness of jump-outs that are about 5-5½ ft tall in combination with a bar or plank on top.

Urgency and Expected Benefits:

The results of this project will provide information on how to improve human safety and how to reduce direct mortality of wildlife within fenced road sections. The research focuses on how to better keep wildlife, specifically carnivores, out of fenced road corridors through electrified barriers at access roads, and on how to improve wildlife use, specifically deer, of jump-outs, should the animals still end up inside the fenced road corridor. Depending on the results of the project, and implementation of the recommendations, the improvements to the mitigation measures are expected to lead to fewer large wild animals on fenced roads, and reduced time spent by these animals inside fenced road corridors. This in turn is expected to improve human safety through a reduction in collisions with large wild mammals. At the same time, reduced collisions with wildlife would also result in reduced unnatural direct wildlife mortality. This not only relates to common ungulates such as white-tailed deer and mule deer, but also to carnivore species such as black bear and grizzly bear. The knowledge gained on the effectiveness of the mitigation measures associated with wildlife fences and modifications to these mitigation measures, is expected to have wide application for highways for which wildlife fences are considered.

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3.5 FINANCE/REVENUE RESEARCH PROJECTS

3.5.1 Proposed Projects

3.5.1.1 Economic Benefits of Improving Montana's Transportation Infrastructure (EBIMTTI)

URL: https://www.mdt.mt.gov/research/projects/admin/eco-benefits.shtml

Topic Statement:

Promoting economic vitality is one mission of MDT. There are several avenues to quantify this mission. First is the primary impact of MDT activities on Montana's economy as measured by income, employment and other indicators. Second are the impacts on state revenues, including the General Fund and other taxes and fees. And third is the impact of an efficient transportation system on increasing overall productivity which enhances returns to households and private and public firms. The overall research will quantify all three avenues with the goal of estimating the economic gains to Montana of improving infrastructure to raise the state's ASCE grade from a C- to a B. These findings may be used by MDT to inform policy-makers, stakeholder about the economic impacts associated with MDT infrastructure improvement.

Related Research:

What are the economic and general fund impacts of current projected transportation infrastructure funding? And what would the impacts look like if funding increased to improve the state of Montana's road and bridge infrastructure? Montana's bridges and road system received grades of C and C- respectively according the American Society of Civil Engineers (ASCE) "Infrastructure Report Card" published in 2017. What would be the net economic impact to the state if there were additional infrastructure expenditures sufficient to raise the grades to a B? Just maintaining the status quo would require about $15 billion over the next 10 years, according to MDT. The Bureau of Business and Economic Research (BBER) would work with MDT to derive the cost estimates to raise the grade to B and then estimate the economic impacts and contributions to the state's general fund under three different scenarios over a 10-20 year time horizon: 1) with current projected funding (33% of the $15 billion required to maintain); 2) maintaining the status quo; and 3) additional impacts of raising the ASCE grade to a B. This research would provide insights into the economic impacts of improving the state's transportation network and fit within the "Mobility and Economic Vitality" component of the 20-year TranPlan MT program. The economic impacts will be estimated using a dynamic mathematical/empirical model of the Montana economy and MDT regions. This approach is "state of the art" in that it includes contemporaneous direct and indirect impacts. It also includes social returns to public investment, such as a lower transportation, congestion, and health costs of an efficient transportation system. BBER has been conducting economic analysis about Montana's state and local economies for more than 70 years. Housed on the Missoula campus of the University of Montana, the bureau is the research and public service branch of the College of Business.

Research Proposed:

Two different methods will be used to identify and calculate the economic benefits of additional Montana highway infrastructure investments:

- The first method will utilize the economic models prepared by Regional Economic Models Incorporated (REMI) and IMPLAN (Impact Analysis for Planning). The REMI model will be used to identify and estimate the total economic impact on statewide income and employment of the additional out-of-state revenues and associated additional infrastructure expenditures. The IMPLAN model will be used to corroborate the REMI estimates and provide additional details for certain items. The statewide totals will be disaggregated into estimates for each MDT region.
- The second method estimates the total rate of return and the productivity gains of additional roadway investment and maintenance over a 10-year period. Previous research has identified the significant returns to national and state incomes from infrastructure investment. For example, one research report stated, "Over the period 1950 to 1989, U.S. industries realized production cost savings averaging 18 cents annually for each dollar invested in the road system" (Federal Highway Administration, "Productivity and the Highway Network," 1996).

There are several approaches to estimate the rate of return and productivity gains. A variety of publications describing the methods used to derive these estimates and results at the state and national level are available. For example, Florida estimated the rate of return on investment. FHWA/USDOT and others use production and cost regressions to estimate the returns on investment. Whichever approach is chosen, estimates will be presented for different types of roadways to identify differences between them.

In summary, this portion of the research will provide "observable" economic impacts for increased income and employment as well as less quantifiable returns to increased infrastructure due to gains in productivity and returns to investment. Both the "observable" and less quantifiable estimates are part of MDT's mission to provide services that emphasize "economic vitality" and "cost-effectiveness."

Several factors will be observed throughout the research:

1. The analysis will clearly distinguish between all roads and bridges (73,000) and those under MDT management. Estimates for MDT-managed roads and bridges will be presented separately.
2. The researchers will closely coordinate with MDT and ASCE to determine the methodology the ASCE used to identify roads that fall into the "poor" or "fair" categories and reconcile the differences when conducting economic analyses.

Lastly, the proposed study will update the impact of MDT on Montana state revenues last analyzed in the 2002 MDT research project "The Revenue Contribution of Montana Department of Transportation Expenditures to the Montana General Fund" (FHWA/MT-02-012/8170).

Urgency and Expected Benefits:

This research will assist MDT in meeting its mission to serve the public by providing a transportation system and services that emphasize quality, safety, cost-effectiveness, economic vitality and/or sensitivity to the environment. Specifically, the findings will aid MDT in presenting the economic impacts of transportation system expenditures to elected officials, decision-makers, the media, the federal government and the public. The economic impacts will be calculated on a regional basis so that the users will be able to identify the specific local impacts that are important to them. The users may have confidence in their accuracy because the impacts will be calculated using a sophisticated modern

methodology. The more information users have on the direct and indirect features of a project, the more likely they will approve and support the projects.

The practical and concrete economic focus of this research will assist in raising the public's knowledge and interest in MDT's role of providing infrastructure. The Tranplan21 survey of Montanans (also conducted by the BBER) reported a roughly 40% item nonresponse rate for questions regarding infrastructure. This hesitancy to respond suggests a very low level of knowledge among respondents. The findings of this research will be reported in terms of jobs and income, concepts that are readily understandable to the layperson.

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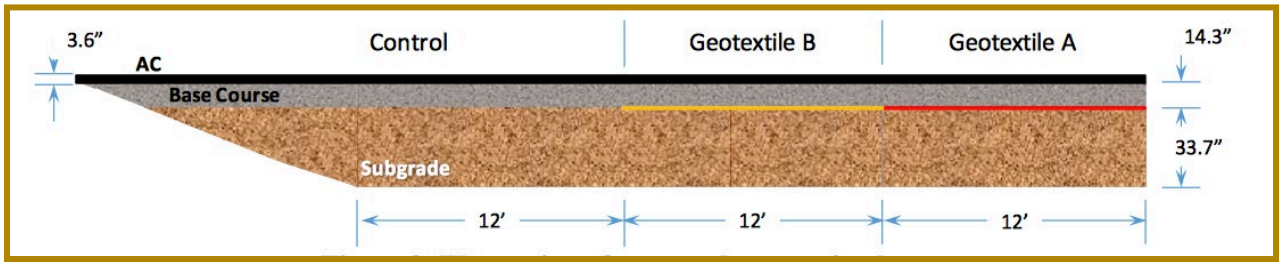
3.6 GEOTECHNICAL RESEARCH PROJECTS

3.6.1 Active Projects

3.6.1.1 Large-Scale Laboratory Testing of Geosynthetics in Roadway Applications

Project Number:	9564-602
Start Date:	2/21/18
Completion Date:	12/31/20
Total Cost:	$450,073
Total SPR Funds:	$450,073
Total SPR Funds (80%):	$360,058
Total State Funds (20%)	$90,015
Total MDT Indirect Costs:	$43,330
Total FFY 2020 Expended:	$150,801
Total SPR FFY 2020 Expended:	$150,801
FFY 2020 SPR Funds (80%) Expended:	$120,641
FFY 2020 State Funds (20%) Expended:	$30,160
FFY 2020 MDT Indirect Costs:	$14,460
Consultant:	Montana State University

URL: http://www.mdt.mt.gov/research/projects/geotech/lab_testing.shtml



Objective:

The main objective of this project is to characterize the performance of geosynthetic-reinforced test sections when compared to an unreinforced case to assess benefit in terms of a reduction in the base course thickness, an extension of the life of the pavement, or the strengthening of the individual pavement layers. This objective will be achieved through the construction of a single test track containing three test sections, a detailed analysis and synthesis of the results, and the evaluation of an analytical design tool to be used by pavement engineers to design geosynthetic-reinforced pavements.

Progress:

Test section construction and trafficking (Task 3) were completed. Analysis and synthesis of results (Task 4) were initiated. An annual presentation on the research progress to date was presented to the technical panel in September 2020.

Reports:

Four progress reports were received. Project information, reports and the annual presentation can be viewed at the above URL.

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3.6.2 Completed Projects

3.6.2.1 Guidelines for Chemically Stabilizing Problematic Soils

Project Number:	9389-522
Start Date:	4/21/17
Completion Date:	2/29/20
Total Cost:	$168,808
Total SPR Funds:	$168,808
Total SPR Funds (80%):	$135,046
Total State Funds (20%)	$33,762
Total MDT Indirect Costs:	$16,215
Total FFY 2020 Expended:	$23,552
Total SPR FFY 2020 Expended:	$23,552
FFY 2020 SPR Funds (80%) Expended:	$18,842
FFY 2020 State Funds (20%) Expended:	$4,710
FFY 2020 MDT Indirect Costs:	$2,221
Consultant:	Boise State University

URL: https://www.mdt.mt.gov/research/projects/geotech/chemical_stablize.shtml

Objective:

This project established protocols to help evaluate the utilization of chemical stabilization methods to potentially improve the engineering behavior of problematic soils, with and without soluble sulfates, within the state of Montana. In addition, construction life cycle cost analyses were used to compare existing approaches used by MDT versus chemical stabilization alternatives for problematic soils. The additional resources and time required to incorporate chemical stabilization were not included in the life cycle cost analysis.

Progress:

All research is complete.

Reports:

A detailed implementation plan, including performance measures, was drafted and implementation is in progress (see related implementation project).

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3.6.3 Implementation Projects

3.6.3.1 Guidelines for Chemically Stabilizing Problematic Soils

Project Number: 9389-522
Start Date: 5/21/20
Completion Date: 3/1/22
Total Cost: $0
URL: https://www.mdt.mt.gov/research/projects/geotech/chemical_stablize.shtml

Objective:

This project established protocols to help evaluate the utilization of chemical stabilization methods to potentially improve the engineering behavior of problematic soils, with and without soluble sulfates, within the state of Montana. In addition, construction life cycle cost analyses were used to compare existing approaches used by MDT versus chemical stabilization alternatives for problematic soils. The additional resources and time required to incorporate chemical stabilization were not included in the life cycle cost analysis.

Progress:

In FFY 2020, the implementation plan was developed, covering a period of 15 months.

Tasks pending implementation include the following:

1. Develop training materials (presentation and short accompanying document).
2. Provide training to higher level construction personnel and project crews.
3. Evaluate appropriate projects where chemical stabilization might be utilized. This is an ongoing activity.
4. Develop a spreadsheet to track projects that have been evaluated.

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3.7 INFORMATION SERVICES RESEARCH PROJECTS

3.7.1 Proposed Projects

3.7.1.1 Analyze Business Models for Implementation and Operation of a Statewide GNSS Real-Time Network

URL: https://www.mdt.mt.gov/research/projects/planning/gnss.shtml

Topic Statement:

MDT and the State Library are leading an effort to develop a Statewide GNSS (Global Navigation Satellite System) Real-Time Network (RTN). A statewide RTN benefits multiple public and private entities that utilize Global Positioning System (GPS) survey and geographic information system mapping services. Users can realize reduced equipment and field man-hours performing field surveys. Infrastructure and assets can be efficiently inventoried and mapped. GPS automated machine control is supported. Data across all users of a network can be connected.

The goal is to provide a statewide RTN covering most of the Montana geographical area that 1) provides survey grade RTN survey and mapping services minimally to public and private network partners and preferably offered as a public service to subscribers as well; and 2) is a fiscally sustainable business operation. MDT and the State Library are collaborating in a planning effort to identify and resolve technical planning and design issues for implementation and operation. MDT completed a gap analysis identifying multiple RTN operation and maintenance business models for further investigation including multiple system access variations of the business models. Further research and investigation into the feasibility of different business models for sustainable operation and maintenance of a statewide RTN accessible minimally to network partners is necessary to make sound decisions regarding access to network services and ownership, operation, maintenance and repair of RTN components including CORS (continuously operating reference stations), CPC (central processing center) and network communications.

Related Research:

The research summary provided insight to assist defining project goals, developing a planning strategy and narrowing the focus of research needs. The literature search did not reveal current research relevant to the focus of investigating multiple business models considering system access and RTN ownership, operation, maintenance and repair.

Research Proposed:

Research the feasibility of different business models for a statewide RTN supportive and accessible minimally to multiple public and private partners and preferably with additional services offered to subscribers. Research should identify feasibility of different business models with considerations for 1) system access variations (e.g., public partners, private partners, public fee subscriptions, free public services, etc.); 2) roles and responsibilities variations for ownership, maintenance and repair of RTN components (i.e., CORS, CPC and communications); 3) network administration requirements; and 4) relative state laws and policies. The research should deliver a feasibility report aligned with Montana's RTN goals and the considerations stated above that details and summarizes evaluated business models and includes estimated costs and revenues, resource requirements, advantages, disadvantages and recommendations.

Urgency and Expected Benefits:

Potential partners are actively being engaged and have expressed interest in participating in developing a statewide RTN. As previously stated, timing of this research is a risk. MDT and the State Library are actively pursuing means to assume operation of a pilot network in MT Mobile Subscriber Roaming Number (MSRN) beginning fall of 2019. A business model should be adopted before formal agreements are executed among network partners. Development of a statewide RTN has significant implications for multiple public agencies and private industries supported by survey, mapping, automated machine control, navigation, emergency management and response, and infrastructure and asset inventory. Survey operations alone can realize substantial reductions in field man-hours and equipment required. A statewide RTN also supports data sharing and collaboration across different public and private agencies. Development of a statewide RTN is an opportunity to demonstrate effective public-private collaboration on a large scale impacting multiple agencies and industries.

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3.8 MATERIALS RESEARCH PROJECTS

3.8.1 Active Projects

3.8.1.1 Alkali-Silica Reactivity in the State of Montana

Project Number:	9577-607
Start Date:	4/6/18
Completion Date:	1/31/21
Total Cost:	$109,000
Total SPR Funds:	$74,000
Total SPR Funds (80%):	$59,200
Total State Funds (20%)	$14,800
Total Cost Share:	$35,000
Total MDT Indirect Costs:	$11,374
Total FFY 2020 Expended:	$84,275
Total SPR FFY 2020 Expended:	$63,975
FFY 2020 SPR Funds (80%) Expended:	$51,180
FFY 2020 State Funds (20%) Expended:	$12,795
FFY 2020 Cost Share Expended:	$20,300
FFY 2020 MDT Indirect Costs:	$2,779
Consultant:	Montana State University

URL: https://www.mdt.mt.gov/research/projects/mat/alkali_silica.shtml

Objective:

Concrete can be susceptible to expansive reactions between alkalis in the Portland cement and reactive forms of silica in the aggregates, which can ultimately reduce the lifespan of the concrete resulting in costly repairs or even replacement. While alkali-silica reactivity (ASR) has been documented as an issue in many states, little work has been conducted to determine the presence/potential of ASR in Montana.

The primary objectives of the proposed research are to evaluate the potential for deleterious ASR in the state of Montana, and to develop a testing protocol for identifying potential reactive aggregates. This research will also identify/document existing ASR damage in the state and investigate the potential underlying geological features that may contribute to the presence of reactive aggregates. Finally, this research will explore the efficacy of potential mitigation techniques employed to limit the effect of ASR.

Progress:

The Task 2 report (testing protocol development) was completed. Completion of work on identifying and documenting cases of ASR (Task 3) was impacted by COVID-19 delays.

Reports:

Three progress reports were received. Project information and reports can be viewed on the project website at the above URL.

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3.9 SAFETY RESEARCH PROJECTS

3.9.1 Active Projects

3.9.1.1 Developing a Methodology for Safety Improvements on Low-Volume Roads in Montana

Project Number:	9679-699
Start Date:	2/15/19
Completion Date:	3/31/21
Total Cost:	$134,877
Total SPR Funds:	$70,990
Total SPR Funds (80%):	$56,792
Total State Funds (20%)	$14,198
Total MDT Indirect Costs:	$7,489
Total Consultant Cost Share:	$63,887
Total FFY 2020 Expended:	$29,086
Total SPR FFY 2020 Expended:	$15,309
FFY 2020 SPR Funds (80%) Expended:	$12,247
FFY 2020 State Funds (20%) Expended:	$3,062
Total Consultant Cost Share FFY 2020 Expended:	$13,777
FFY 2020 MDT Indirect Costs:	$1,443
Consultant:	Montana State University

URL: https://www.mdt.mt.gov/research/projects/planning/lvr-safety.shtml

Objective:

Maintaining safety on the highway system has been a top priority for most highway agencies in the U.S. given the heavy toll in deaths and casualties associated with traffic crashes. The limited funds available to highway agencies for safety improvements require a careful consideration of sites that are more promising in improving safety at the network level. Therefore, highway agencies systemically screen the network to identify those sites that are expected to yield greater safety benefits, thus deserving more consideration for safety improvement funds. While this process has been successfully implemented by many agencies for urban and well-traveled major rural highways, it may prove difficult on rural low-volume roads including local county roads. The low traffic exposure on these roads and consequently the low number of crashes occurring may preclude the possibility of using crash data alone in identifying and

ranking candidate sites for safety improvement projects. The proposed research attempts to address this issue by providing a much-needed guidance on how to systemically screen the network and rank sites on low-volume roads that are most deserving of safety improvements funds.

Progress:

Research on Task 4 (state of practice in local roads safety improvement site prioritization), Task 5 (assessment of existing methodologies) and Task 6 (develop a Montana-specific methodology for selecting safety improvement sites on local roads) was completed. A draft of the Task 7 (assessing benefits of proposed methodology) report was submitted to the technical panel for review.

Reports:

Three progress reports were received. Project information and reports can be viewed on the project website at the above URL.

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3.9.1.2 Effectiveness of Highway Safety Public Education at Montana Motor Vehicle Registration Stations by Streaming a Variety of Safety Content

Project Number:	9832-766
Start Date:	3/15/20
Completion Date:	10/31/21
Total Cost:	$240,656
Total SPR Funds:	$166,000
Total SPR Funds (80%):	$132,800
Total State Funds (20%)	$33,200
Total Consultant Cost Share:	$74,656
Total MDT Indirect Costs:	$16,000
Total FFY 2020 Expended:	$27,072
Total SPR FFY 2020 Expended:	$20,662
FFY 2020 SPR Funds (80%) Expended:	$16,530
FFY 2020 State Funds (20%) Expended:	$4,132
Total Consultant Cost Share FFY 2020 Expended:	$6,410
FFY 2020 MDT Indirect Costs:	$1,674
Consultant:	Montana State University

URL: https://www.mdt.mt.gov/research/projects/safety/safetyvideos.shtml

Objective:

There is a need to educate Montanans about highway safety, the consequences of exhibiting risky behaviors while driving such as texting while driving, driving while impaired or distracted, driving unbuckled, and the benefits of proven innovative road safety countermeasures such as roundabouts and rumble strips installed by public transportation agencies. There is an opportunity to install video equipment at select Motor Vehicle Division licensing and vehicle registration stations around the state to continuously play highway safety video clips. At many of these locations, the public has waiting times of five minutes or longer. This is enough time for people to give their attention to a video screen playing safety messages.

Progress:

The project kick-off meeting was held in March 2020. The principal investigator began working on Task 2 (pre-deployment planning) activities for securing additional video content from other DOTs, identifying potential deployment locations, equipment identification and storyboard creation. A draft of the Task 2 report was submitted to the technical panel for review.

Reports:

Two progress reports were received. Project information can be viewed on the project website at the above URL.

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3.9.1.3 Icy Road Forecast and Alert (IcyRoad): Validation and Refinement Using MDT RWIS Data

Project Number:	9891-785
Start Date:	7/13/20
Completion Date:	3/31/22
Total Cost:	$84,000
Total SPR Funds:	$84,000
Total SPR Funds (80%):	$67,200
Total State Funds (20%)	$16,800
Total MDT Indirect Costs:	$9,631
Total FFY 2020 Expended:	$14,919
Total SPR FFY 2020 Expended:	$14,919
FFY 2020 SPR Funds (80%) Expended:	$11,935
FFY 2020 State Funds (20%) Expended:	$2,984
FFY 2020 MDT Indirect Costs:	$2,517
Consultant:	University of Montana

URL: https://www.mdt.mt.gov/research/projects/safety/icy-road-rwis.shtml

Objective:

Drivers need reliable forecasts and alerts for icy road conditions, particularly the presence of black ice, to reduce winter driving risks. MDT currently has 73 road weather information system (RWIS) stations throughout the state, which are used to measure road surface temperature, subsurface temperature, air temperature, humidity, dew point, pressure, wind speed and precipitation type and occurrence. Select sites (six or fewer) have advanced precipitation sensors, visibility sensors or infrared illuminators for nighttime camera images. This data makes it possible to study geospatial distribution of black ice formation and identify different mechanisms of black ice for various orographic and surrounding environmental conditions. Consequently, it advances the capability to forecast black ice. Icy Road Forecast and Alert (IcyRoad) is a technology based on weather forecasts, remote sensing observations, cloud computing and data mining. The purpose of this proposed project is to validate and refine the IcyRoad scientific algorithm, particularly the black ice algorithm, using MDT RWIS ground observations to develop a black-ice forecast scheme.

Progress:

The project kick-off meeting was held in July 2020. The principal investigator began working on the analysis of MDT RWIS data for Task 1 (evaluation for validation and refinement). An experimental plan,

for use in the Subzero Research Laboratory at Montana State University, was developed for Task 2 (evaluation for unmanned aerial vehicles (UAVs) and the mobile vehicle-based RWIS sensors).

Reports:

Project information can be viewed on the project website at the above URL.

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3.9.1.4 Traffic Safety Culture Transportation Pooled Fund (TSC-TPF) Program – Phase 1

Project Number:	8882-309
Start Date:	10/1/14
Completion Date:	9/30/22
Total Cost:	$1,194,000
Total SPR Funds (100%):	$80,000
Total Other Federal Funds:	$954,000
Total State Funds (100%)	$160,000
Total MDT Indirect Costs:	$121,913
Total FFY 2020 Expended:	$156,841
FFY 2020 SPR Funds (100%) Expended:	$10,508
FFY 2020 Other Federal Funds (100%) Expended:	$123,315
FFY 2020 Other State Funds (100%) Expended:	$21,017
FFY 2020 MDT Indirect Costs:	$15,832
Consultant:	Montana State University

MDT URL: https://www.mdt.mt.gov/research/projects/trafficsafety.shtml

Phase 1 Pooled Fund URL: https://www.pooledfund.org/Details/Study/558

Objective:

MDT initiated a multiyear pooled fund program in partnership with the Center for Health and Safety Culture (CHSC) within the Western Transportation Institute (WTI) at Montana State University. This program is a cooperative effort of participating state DOTs and other organizations vested in traffic safety. The purpose of this effort is to accelerate the development and delivery of tools and services to transform traffic safety culture. The goal of this transformation is to support the Toward Zero Deaths (TZD) vision with sustainable traffic safety solutions.

The Toward Zero Deaths (TZD): National Strategy on Highway Safety is a cooperative and coordinated effort among state highway safety agencies and stakeholders. The transformation of the traffic safety culture is a primary element of the TZD strategy. Only through the growth of a positive safety culture can significant and sustainable reductions in crash fatalities and serious injuries be achieved. Such transformation would not only support traffic safety goals by reducing risky behaviors and increasing protective behaviors, it would also increase public acceptance of other forms of effective safety programs.

Progress and Reports:

There are a total of 16 projects (including annual management support renewals) under the Phase 1 pooled fund program umbrella. A follow-on pooled fund program for an additional five years was initiated.

Management Support:

This project provides project management assistance, including meeting support (web conference set-up, in-person meeting logistics and travel reimbursement, agenda input, post-meeting follow-up, and

meeting notes), quarterly progress reporting, support for outreach and awareness activities, and support for work plan and project development.

This is an annual contract renewed each year of the pooled fund, for a total of five annual projects. For FFY 2020, all tasks were completed and four quarterly progress reports were received; they can be viewed at https://www.pooledfund.org/Details/Study/558.

Driving After Cannabis Use:

The purpose of this project was to develop a better understanding of the traffic safety culture (i.e., shared values, beliefs, and attitudes) of driving under the influence of cannabis (DUIC). A survey was developed based on an augmented integrated model of behavior and was implemented using mailed and internet-based methods. Adults age 18 and older from the U.S. responded. Two states with legalized recreational use of cannabis (Colorado and Washington) were oversampled. The survey measured DUIC behavior, intention, willingness, attitudes, behavioral beliefs, perceived norms, and perceived control. About half of the individuals who had used cannabis in the past 12 months reported driving within four hours of use. Partial correlation coefficients showed that many components of the model correlated with willingness to DUIC. Significant differences in attitudes and beliefs were found between nonusers of cannabis, users of cannabis, and those who DUIC. No differences in beliefs or attitudes were found between states with and without legalized recreational use laws nor between states with legalized medical use laws. Recommendations for strategies to reduce DUIC are provided.

This project was completed prior to FFY 2020. The final deliverables, which include final and project summary reports, and a webinar recording, can be viewed at https://www.mdt.mt.gov/research/projects/cannabis-use.shtml.

Exploring Traffic Safety Citizenship:

The purpose of this project was to develop a better understanding of the values, beliefs, and attitudes regarding engagement in behaviors that impact the traffic safety of others, informing agencies and others how to grow these beliefs in communities—thereby creating a culture that achieves greater improvements in traffic safety. A survey was developed based on an augmented integrated model of behavior and was implemented with adults age 18 and older from the U.S. using mailed and internet-based methods. About half of the people who responded to the survey indicated they had been in a situation in the past 12 months when someone was not wearing a seat belt or was reading or texting while driving. Of those who indicated they were in a situation to intervene, more than half did. They were more likely to intervene with others who were socially closer to them (e.g., family and friends) than with those more socially distant (e.g., acquaintances or strangers). Most people had favorable attitudes and beliefs about intervening. Analysis revealed that the perception of whether most people do intervene (e.g., the perceived descriptive norm) was strongly correlated with intervening behavior. Similarly, most people who responded to the survey had favorable attitudes about strategies involving policy or rules to increase seat belt use or decrease reading or typing on a cell phone while driving. Recommendations for growing intervening behaviors are provided.

This project was completed prior to FFY 2020. The final deliverables, which include final and project summary reports, and a webinar recording, can be viewed at https://www.mdt.mt.gov/research/projects/trafficsafety-citizenship.shtml.

Traffic Safety Cultures and the Safe Systems Approach:

This project brought together expertise in engineering (vehicle safety, road building, and traffic system planning) as well as in the sciences of human action (psychology, sociology, and anthropology) in order to develop a comprehensive framework of traffic safety culture that is useful for practical work in road safety as well as for academic research. Knowledge exchange was a core element of the project, not only via the researchers that are seconded between partner organizations but also through a knowledge platform created for the partners as well as for the public. The project also included data from naturalistic driving studies that has not been used in the context of cultural analysis before. A major focus was on factors that can be changed comparatively easy under given cultural conditions in order to contribute to road safety work in practice.

This project was completed in FFY 2019. More information can be found at https://www.mdt.mt.gov/research/projects/trafficsafety-ss-approach.shtml.

Understanding Law Enforcement Attitudes and Beliefs About Traffic Safety:

Law enforcement plays a critical role in traffic safety. However, traffic safety is one of many issues that law enforcement agencies must address. A variety of factors including budget limitations, political support, and agency culture can influence engagement in traffic safety. A decrease in law enforcement's engagement in traffic safety could make a reduction in fatalities and serious injuries less likely.

Recently, some traffic safety professionals have noted a change in the prioritization of traffic safety among law enforcement. It is difficult to determine whether this perception is accurate or not and the reasons and nature of this possible change. Therefore, understanding the attitudes and beliefs of law enforcement leaders and officers regarding traffic safety is critical to growing a positive traffic safety culture and ultimately achieving a goal of zero deaths on the nation's roadways.

The objectives of this case study were to understand:

- How law enforcement leaders and officers within the agencies selected prioritize traffic safety relative to other public safety issues;
- Self-reported attitudes, beliefs, and enforcement behaviors;
- Law enforcement's perceptions of how traffic safety enforcement behaviors have changed in recent years; and
- How prioritization of traffic safety; attitudes, beliefs, and enforcement; and perceptions of change vary between leaders and officers, agency types, and urban and rural settings.

Furthermore, the project proposed methods of increasing engagement in traffic safety efforts based on the beliefs identified in this study.

To support these objectives, this project included the development and implementation of interviews and a survey to measure the beliefs and attitudes among law enforcement that influence traffic safety enforcement.

This project was completed in FFY 2019. Products include a final report, project summary report, dialog guide and speaking points, and a webinar recording and presentations These reports and additional information can be found at https://www.mdt.mt.gov/research/projects/trafficsafety-attitudes.shtml.

Key Information for DUIC Policy:

There is growing concern about driving under the influence of cannabis (DUIC), especially as more states change laws around cannabis possession and use. This concern is often exacerbated by the inaccessibility of key information regarding the role of cannabis in crash risk. To rectify this situation, this synthesis project captured the key information for the critical issues that affect policy decisions with DUIC. The synthesis focused on the usability of information to garner stakeholder support and inform rational policy making.

This project provided a set of tools to educate and engage stakeholders (e.g., enforcement agencies, traffic safety agencies, public health departments, etc.) to inform decision-making about effective DUIC policy and counter measures. These tools included several products:

- **Concise information summary** that integrates current research on the key issues involved in the debate surrounding DUIC crash risk (e.g., methodological limitations of measuring DUIC crash risk, evidence of THC impairment on driver behavior, relationship of THC per se limits with crash risk, interactions with alcohol).
- **Compilation infographic** that summarizes the key points from the information summary. This included a **revision of infographics** for the existing pooled fund DUIC project that captures the essence of this project within the theoretical framework upon which the study was designed.
- **Talking points** (based on the information summary and referencing the infographic) which can be used by practitioners to discuss DUIC with stakeholders to garner support for effective DUIC strategies.
- **Poster design and PowerPoint presentation** was created for traffic safety professionals to use to disseminate information in a traffic safety poster session.

This project was completed in FFY 2020. The above final products were posted to the project website and include the following: final report, Driving Under the Influence of Cannabis (DUIC): Key Information for DUIC Policy presentation, Talking Points for Driving After Using Cannabis, The Effect of Legalization of Recreational Cannabis on Crash Risk poster, Effects of Cannabis on Traffic Safety infographic, Cultural Factors that Predict the Frequency of Driving within 4 Hours of Using Cannabis in the Past 12 Months Infographic and a project webinar. These deliverables can be found at https://www.mdt.mt.gov/research/projects/trafficsafety-duic.shtml.

Proactive Traffic Safety: Empowering Behaviors to Reach Our Shared Vision of Zero Deaths and Serious Injuries:

Growing traffic safety citizenship is a novel approach that strategically shifts our focus to the engagement of the larger majority of safe road users to influence the behaviors of the smaller group engaging in risky behaviors. Previous research sponsored by the Traffic Safety Culture Pooled Fund to understand traffic safety citizenship revealed a variety of opportunities to bolster traffic safety citizenship behaviors to reduce traffic crashes and fatalities. However, in order for state highway safety agencies and stakeholders to embrace this strategic approach, information learned from research must be translated to practice. Communication tools that make traffic safety citizenship easier to understand and integrate into existing traffic safety efforts are needed.

The objective of this project was to create meaningful communication tools for state and local traffic safety professionals that can be implemented immediately to build the capacity of critical stakeholders about traffic safety citizenship as a strategy to improve traffic safety.

To support this objective, this project resulted in the development of communication tools:

- **Traffic Safety Citizenship Primer** – This tool introduces traffic safety professionals and stakeholders to the concept of traffic safety citizenship. Sections within the Traffic Safety Citizenship Primer will include a) what traffic safety citizenship is; b) the origin and background; c) the state of the science; d) examples of safety citizenship; e) talking points to introduce the concept to other professionals, stakeholders, and the community; and f) examples of traffic safety citizenship activities that can be readily implemented.
- **Traffic Safety Citizenship PowerPoint Presentation** – This tool was created for traffic safety professionals and stakeholders to introduce Traffic Safety Citizenship to other professionals, stakeholders, and the community.
- **Conversation Guide** – This tool was created to support traffic safety professionals' efforts to engage their staff or coworkers about Traffic Safety Citizenship as a strategy to improve traffic safety. This will be a stand-alone document that can be printed and shared with others.
- **Poster** – This tool was created for traffic safety professionals to use to disseminate information in a traffic safety poster session.

This project was completed in FFY 2020. All final deliverables were accepted and posted to the project website (https://www.mdt.mt.gov/research/projects/trafficsafety-cc-tools.shtml). They include the following: final report, primer, poster, conversation guide, a presentation, and a webinar.

Traffic Safety Culture Primer:

There is growing interest in "traffic safety culture" as a key factor to manage and sustain safe roadway transportation systems, especially as more jurisdictions adopt targets of zero traffic fatalities and serious injuries. However, the theory, terminology, and methods involved in addressing traffic safety culture come from human and social science disciplines that are not typically included in traditional traffic safety, engineering, or other behavioral change agencies (e.g., departments of transportation, driver's licensing, motor vehicles records, etc.). The lack of shared language and understanding about traffic safety culture limits the ability of agencies to explore this topic and engage new stakeholders. Additionally, the variation in the interpretation and implementation of strategies to improve traffic safety has resulted in no consensus about best practices. Communication tools that develop shared language and understanding about traffic safety culture and its relationship to vision zero goals are needed.

The objective of this project was to provide a multimedia primer about traffic safety culture and how a cultural perspective can support vision zero goals. The purpose of this primer is to foster shared language and understanding about traffic safety culture—thus "priming" stakeholders for new and constructive dialogue and thinking about this complex topic. The materials include readily accessible definitions, insights, and examples of how traffic safety culture influences behaviors and questions to guide dialogue among stakeholders to make meaning of these ideas and expand their thinking.

To support this objective, this project included:

- **A Traffic Safety Culture Primer** – A brief document was created that can be readily printed by stakeholders. The primer includes sections addressing:
  - what is traffic safety culture;
  - how does traffic safety culture influence behavior;
  - issues about measuring traffic safety culture; and
  - how a cultural perspective expands approaches to improve traffic safety.

  The format of the primer is concise text intended for traffic safety practitioners and other stakeholders. The text is augmented with infographics. The materials are professionally laid out as an "electronic book" suitable for viewing and printing.
- **Series of PowerPoint Slides** – Each of the primer sections have a set of accompanying PowerPoint slides with talking points that practitioners can use to communicate to other stakeholders. There is also a brief overview suitable for a 20-minute presentation.
- **Animated Video** – A short, animated video was developed to introduce the key topics. The video can be easily shared and used to increase awareness and use of the primer.
- **Webinar** – A webinar was created and presented to introduce the primer to the traffic safety community. The webinar highlights key features of the tools and promotes their use.
- **Poster** – A high-resolution graphic was created that is suitable for printing on a large poster for use in a conference poster session for traffic safety professionals to use to disseminate a summary of the primer and the tools.

This project was completed in FFY 2020. The following deliverables were completed and posted to the project website (https://www.mdt.mt.gov/research/projects/trafficsafety-primer.shtml): final report, primer, poster, presentation, animated video and webinar.

Guidance for Evaluating Traffic Safety Culture Strategies:

In an effort to reduce the number of traffic crashes and resulting injuries and fatalities, traffic safety agencies are developing and implementing new intervention strategies aimed at changing road user culture. However, systematic evaluations of the implementation and impacts of these new programs are not advancing as rapidly as the programs themselves. At this point, there are neither well-developed summative/outcome evaluations nor formative/process evaluations of most existing programs. Compounding this lack of systematic evaluation is an underlying lack of consensus about or development of the sorts of evaluation designs capable of yielding results that researchers and program managers can be confident in to support future programming and resource allocation decisions.

To address the lack of generally accepted formative and summative evaluation designs and the resulting lack of available outcome and process data, this research will:

- Conduct a comprehensive systematic review of available evaluations of traffic safety culture initiatives in order to catalog and assess both their designs and findings. This will result in a better understanding of the state of the field with respect to what is known about the effectiveness of existing culture-focused interventions and countermeasures and will identify, catalog, and assess the evaluation designs including their associated impact indicators and measures.
- Conduct a parallel examination of what is known about formative and summative designs used to evaluate culture change initiatives in other fields including organization development, community development, and community health. An examination of these related fields will yield additional information about both the effectiveness and rigor of the evaluation designs as well as any knowledge generated about the effectiveness and operation of culture change programs in those fields.
- Provide guidance for practitioners on best practices to evaluate traffic culture strategies.

To support this objective, this project will create:

- **Summary Guidance on Best Practices to Evaluate Traffic Safety Culture Strategies** – A brief document will be created that can be readily used by traffic safety professionals and stakeholders.
- **Journal Article** – An academic journal article will be written and submitted for publication to a peer-reviewed journal in the traffic safety field. This article will help move the field of study forward and provide researchers with guidance on how to evaluate culturally based strategies in the future.

- **Webinar** – A webinar will be created to summarize guidance for the traffic safety community. The webinar will highlight how program managers can use this guidance to select intervention strategies.
- **Poster** – A high-resolution graphic will be created that is suitable for printing on a large poster for use in a conference poster session for traffic safety professionals to use to disseminate a summary of guidance on the evaluation of traffic safety culture strategies. A handout with talking points will also be created.

This project was initiated in FFY 2019. Quarterly progress reports and the Task 2 (journal article) report were submitted in FFY 2020. This project will be completed in FFY 2021. More information can be found at https://www.mdt.mt.gov/research/projects/trafficsafety-strategies.shtml.

Guidance on Messaging to Avoid Reactance and Moral Disengagement:

Not wearing a seat belt and speeding are two significant contributing factors to motor vehicle-related fatalities. Significant efforts, including messaging, have sought to increase seat belt use and decrease speeding. These efforts have been largely successful as the majority of adults wear a seat belt and do not speed. However, traditional messaging may not be as effective with the small minority of individuals still engaging in these risky behaviors because of two psychological phenomena: psychological reactance and moral disengagement. This project seeks to better understand if these two phenomena are more prevalent among individuals still engaging in these risky behaviors and how messaging might be adjusted to mitigate these phenomena.

The objectives of this research project are to:

- Determine if the prevalence of psychological reactance and moral disengagement are higher among adult drivers who never or rarely wear their seat belts or who drive aggressively (i.e., speed, follow too closely, and pass excessively) compared to adults who do not engage in these risky behaviors; and
- Identify potential messaging to minimize reactance and overcome moral disengagement regarding seat belt use and aggressive driving.

This project was initiated in FFY 2019, with quarterly progress reports and the Task 2 (survey development) report being submitted and finalized in FFY 2020. This project will be completed in FFY 2021. More information can be found at https://www.mdt.mt.gov/research/projects/trafficsafety-reactance.shtml.

Guidance to Promote Workplace Policies and Family Rules to Reduce Cell Phone Use While Driving and Promote Engaged Driving:

Distraction while driving is a significant cause of crashes resulting in fatalities and serious injuries. Distracted driving may be more prevalent among young drivers who are already at greater risk for crashes due to novice driving skills. One source of distraction is using a cell phone. Communication (both spoken and typed) is a primary function of cell phones, and such communication is distracting because it takes the driver's eyes off the road and pulls their attention from the driving task. Safe driving requires the driver to be engaged in the driving task. The family and workplace contexts offer two important opportunities to address cell phone use while driving and promote engaged driving. Families can establish rules about never using a cell phone while driving and never communicating using a phone with a family member who is driving. Workplaces can establish similar policies. Guidance to reach families and workplaces is needed for traffic safety practitioners to promote engaged driving—driving free of distractions like cell phones.

The objectives of this project are to identify strategies for families and workplaces that foster engaged driving (i.e., practices that promote engagement by the driver in the driving task). Specifically, the project will seek to answer the following questions:

- How do expectations within families and workplaces influence cell phone use while driving?
- What beliefs and attitudes need to shift to change these expectations and increase engaged driving?
- What are potentially effective strategies (and associated messages) to promote engaged driving within families and workplaces to reduce cell phone use?

This project was initiated in FFY 2019 with quarterly progress reports and the Task 1 Report (literature review) being submitted and finalized in FFY 2020. This project will be completed in FFY 2021. More information can be found at https://www.mdt.mt.gov/research/projects/trafficsafety-engaged.shtml.

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3.9.1.5 Traffic Safety Culture Transportation Pooled Fund (TSC-TPF) Program – Phase 2

Project Number:	8882-444
Start Date:	10/1/19
Completion Date:	9/30/24
Total Cost:	$1,430,000
Total SPR Funds (100%):	$125,000
Total Other Federal Funds:	$1,180,000
Total Other State Funds (100%)	$125,000
Total MDT Indirect Costs:	$153,010
Total FFY 2020 Expended:	$27,083
FFY 2020 SPR Funds (100%) Expended:	$2,356
FFY 2020 Other Federal Funds (100%) Expended:	$22,371
FFY 2020 Other State Funds (100%) Expended:	$2,356
FFY 2020 MDT Indirect Costs:	$1,545
Consultant:	Montana State University

MDT URL: https://www.mdt.mt.gov/research/projects/trafficsafety.shtml

Phase 2 Pooled Fund URL: https://www.pooledfund.org/Details/Study/668

Objective:

MDT initiated a multiyear pooled fund program in partnership with the Center for Health and Safety Culture (CHSC) within the Western Transportation Institute (WTI) at Montana State University. This program is a cooperative effort of participating state DOTs and other organizations vested in traffic safety. The purpose of this effort is to accelerate the development and delivery of tools and services to transform traffic safety culture. The goal of this transformation is to support the Toward Zero Deaths (TZD) vision with sustainable traffic safety solutions.

The Toward Zero Deaths (TZD): National Strategy on Highway Safety is a cooperative and coordinated effort among state highway safety agencies and stakeholders. The transformation of the traffic safety culture is a primary element of the TZD strategy. Only through the growth of a positive safety culture can significant and sustainable reductions in crash fatalities and serious injuries be achieved. Such transformation would not only support traffic safety goals by reducing risky behaviors and increasing protective behaviors, it would also increase public acceptance of other forms of effective safety programs.

Progress and Reports:

Currently, there is only one project under the Phase 2 pooled fund program umbrella.

Management Support:

This project provides project management assistance, including meeting support (web conference set-up, in-person meeting logistics and travel reimbursement, agenda input, post-meeting follow-up, and meeting notes), quarterly progress reporting, support for outreach and awareness activities, and support for work plan and project development.

This is an annual contract renewed each year of the pooled fund, for a total of five annual projects. For FFY 2020, all tasks were completed and four quarterly progress reports were received; they can be viewed at https://www.pooledfund.org/Details/Study/668.

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3.9.1.6 Use of Fluorescent Orange Delineators in Temporary Traffic Control Work Zones

Project Number:	9833-767
Start Date:	4/1/20
Completion Date:	6/15/22
Total Cost:	$205,320
Total SPR Funds:	$89,996
Total SPR Funds (80%):	$71,997
Total State Funds (20%)	$17,999
Total Consultant Funds	$115,325
Total MDT Indirect Costs:	$9,987
Total FFY 2020 Expended:	$0
Total SPR FFY 2020 Expended:	$0
FFY 2020 SPR Funds (80%) Expended:	$0
FFY 2020 State Funds (20%) Expended:	$0
FFY 2020 Consultant Funds Expended:	$0
FFY 2020 MDT Indirect Costs:	$0
Consultant:	Montana State University

URL: https://www.mdt.mt.gov/research/projects/safety/delineators.shtml

Objective:

Road maintenance and reconstruction often present serious safety challenges to highway agencies due to the dynamic and variable work environment which may well be inconsistent with drivers' expectations. As such, proper delineation of travel path through work zones is critical for safe and efficient work zone operations. Currently the Manual on Uniform Traffic Control Devices (MUTCD) only allows white and yellow delineators within temporary traffic control work zones (Section 6F.80, MUTCD 2009). Field observations suggest that using the conventional white and yellow delineation may not be adequate to effectively delineate traffic through work zones.

Progress:

The project kick-off meeting was held in April 2020. As a result of COVID-19 and traffic volumes having dropped by 30-50% of normal on the selected projects for this research, it was decided to postpone the research for 12 months.

Reports:

Project information can be viewed on the project website at the above URL.

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3.9.2 Proposed Projects

3.9.2.1 Safety Evaluation of Sinusoidal Centerline Rumble Strips

URL: https://www.mdt.mt.gov/research/projects/sclrs-safety-eval.shtml

Topic Statement:

Centerline rumble strips (CLRS) are a proven safety feature to reduce high severity cross-over type crashes on rural and suburban roadways. Although the primary crash types reduced are head-on and sideswipe opposite direction crashes, studies have shown a reduction for all crash types. When traversed, conventional CLRS create significant additional traffic noise which can travel several hundred feet and create a nuisance to nearby residents. Previous studies show a quieter CLRS option is the sinusoidal centerline rumble strip (SCLRS). Currently there are no studies to quantify the crash reduction effects of the SCLRS. This proposed project will investigate the effectiveness of sinusoidal centerline rumble strips in lowering the number of observed crashes.

Related Research:

CLRS are nationally recognized as a cost-effective tool for reducing lane departure crashes. While conventional CLRS are effective, they can produce what is perceived as excessive exterior noise, particularly in areas with frequently used passing zones adjacent to residences. Many states have explored the use of modified rumble strips, also known as sinusoidal rumble strips, to lessen exterior noise impacts. A number of studies have shown sinusoidal rumble strips provide for significantly reduced exterior noise levels. Studies have also quantified changes to interior noise and vibration levels of sinusoidal rumble strips with the assumption that these would correlate with changes to driver response. Real-world performance testing using actual crash data has not yet been conducted for sinusoidal rumble strips. MDT proposes to use two planned CLRS projects to conduct a before-and-after crash comparison for approximately 600 miles of SCLRS on highways in western Montana.

Research Proposed:

The proposed research will analyze two SCLRS projects using safety performance function (SPF) modeling with empirical Bayes methodology. This will aid in determining the effectiveness of SCLRS on a variety of roadway for multiple crash types. The type of roadways to be studied are rural flat and rolling two-lane undivided highways, and rural mountainous two-lane undivided highways. Crash types to be analyzed include total crashes, injury crashes, single vehicle run-off-road total and injury crashes, and head-on and sideswipe opposite direction total and injury crashes. Achieving the objective of the research will be a three-part process. First, SPFs will be created and calibrated for the specific roadway and crash types. Five years of pre-installation crash data along with three to five years of post-installation data will then be collected at the identified sites. Finally, utilizing the specific SPFs, the before-installation crash rate will be compared to the after-installation crash rate. The research plan will include having the research team on board during construction so they can note any issues or anomalies

that could skew the data. The plan will also include documenting any issues during or after construction such as issues with centerline pavement joints.

Urgency and Expected Benefits:

Improved safety of the traveling public is a high priority for MDT and critical to achieving the goals of Vision Zero. This proposed research project will provide MDT and other states important information on the use of an alternative rumble strip option. Favorable crash reduction may allow the installation of centerline rumble strips in noise-sensitive areas deemed infeasible for conventional rumble strips which would further reduce crashes and save lives.

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4 EXPERIMENTAL PROJECTS

4.1 Overview

The experimental features program is a FHWA-sponsored program that allows incorporation of experimental features into a project (e.g., construction, maintenance, and safety projects) and provides a vital field evaluation of new materials and methods. This evaluation, if performed well and scientifically based, allows MDT to evaluate specifications and to determine the implementation value in terms of performance and cost-effectiveness of these innovative practices.

FHWA defines an experimental feature as *a material, process, method, equipment item, or other feature that has not been sufficiently tested under actual service conditions or has been accepted but requires comparison with alternative acceptable features to determine their relative merits* (https://www.fhwa.dot.gov/programadmin/contracts/expermnt.cfm). This means that a material, process, method, equipment item, or other feature has not been sufficiently tested or requires comparison with alternative acceptable features in Montana.

Experimental features are identified by MDT staff (not Research staff) through the standard project process. The champion notifies the Experimental Projects Manager (ExPM) of the proposed experimental feature. The ExPM then attends all project meetings. Also, prior to developing a work plan, the ExPM may conduct a survey of other states and search TRB's TRID database to determine previous documented performance of an experimental feature, which may result in cancelling the proposed experimental feature.

4.1.1 Work Plan

Prior to construction, the ExPM writes a formal work plan. FHWA has delegated authority to MDT to proceed with experimental features without FHWA approval; however, every work plan is sent to FHWA for their information. This work plan includes the following information:

- Project location
- Project name
- Construction project number
- Experimental project number
- Project type/experimental feature
- Principal investigator
- Technical contact/champion
- Expected construction year
- Statement of objectives
- Experimental design
- Estimated quantities and costs (if applicable)
- Evaluation schedule
- Reporting requirements

This work plan is important as it yields two additional benefits:

- FHWA will participate in the original construction, as appropriate, and repair, if the project should fail prematurely, at the percent funded during construction.

- Proprietary features may be specified without a public interest finding as otherwise required by FHWA. Also, in terms of state procurement laws and regulations, proprietary features can be sole sourced.

The ExPM may visit the project site prior to construction to document site conditions and delineate test and control sections.

4.1.2 Construction Report

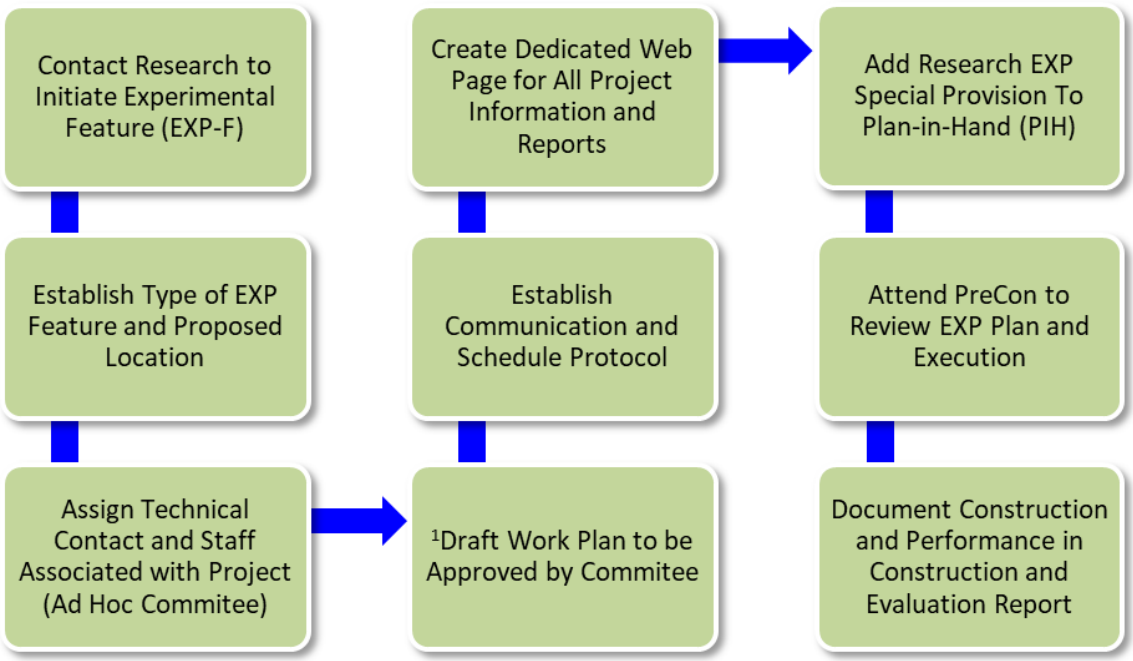
The ExPM will be present during construction of each experimental feature to observe construction practices, especially those that may have an effect on performance. Following the construction of an experimental feature, the ExPM prepares a construction report to document construction practices and baseline conditions. All reports are distributed to MDT statewide, via listserv, and posted on the experimental projects website (https://www.mdt.mt.gov/research/projects/exp_sub_listing.shtml). This report includes the following information:

- Project location
- Project name
- Construction project number
- Experimental project number
- Project type/experimental feature
- Principal investigator
- Technical contact/champion
- Construction year
- Statement of objectives
- Experimental design
- Summary of materials and methods
- Quantity and cost of experimental feature
- Construction details
- Construction problems and a statement of how these problems might have been alleviated

4.1.3 Progress and Final Reports

Performance is evaluated as per the work plan, usually annually for a minimum of five years, unless otherwise indicated by the type of feature. Sometimes evaluations continue beyond the initial five-year evaluation if needed to allow enough data to be collected to distinguish performance among the various test and control sections. Progress and final performance evaluations are documented and appended to the construction report. This process is documented in Figure 4. Annually, progress and final project results are presented to FHWA and MDT staff from Maintenance, Design, Construction, Materials, and District offices, including the Field Research Coordinators and the District Construction Services Supervisors. This helps to ensure all parties are kept in the loop with performance of the experimental features and creates a feedback loop from design to construction to maintenance and then back to design.

Finally, experimental projects are conducted in association with the Department's Product Acceptance Program. A related AASHTO Technical Services Program is the National Transportation Product Evaluation Program (NTPEP).



[1] The work plan contains project location, description, and extent of the experimental feature, how the EXP-F will be evaluated, schedule of installation, on-site evaluations, and reporting requirements. As a rule, all EXP projects should have a work plan.

Figure 4. Experimental Process Summary

Visit the MDT Research Programs website for additional information and current project reports available at http://www.mdt.mt.gov/research/.

4.2 Active Projects

4.2.1 3/8” Asphalt Cement (AC) Placement with No Chip Seal (CS)

Location: Great Falls District, Cascade County, Interstate 15 (C000015), Approximate RP 282-283 (NB Lane Only)
Project Name: Emerson Junction - Manchester
Project Number: IM 15-5(124)282
Project Type: Asphalt Concrete Pavement Evaluation
Principal Investigator: Craig Abernathy, Experimental Project Manager
Construction Year: 2017
Inspection Dates: Nov. 2017, May 2018, Jan. 2019, Oct. 2019, and May 2020
Project End Date: 2022
URL: https://www.mdt.mt.gov/research/projects/asphalt-cement.shtml

Description:

The purpose of this project is to determine how a 3/8" asphalt cement (AC) mix design performs without a chip seal compared to a 3/4" AC with conventional chip seal.

The two main measures of effectiveness of this project are 1) visual distress of the pavement over time, and 2) the texture characteristics of the pavement. The Department’s Pavement Management section will conduct skid testing on both the 3/8" non-chipped and 3/4" chipped sections of the interstate for comparison annually. That data will be added to the report when available.

Analysis to Date:

No visual distress to report.

The Great Falls District has reported the results of Hamburg rut tests were peripheral with several of the samples marginally passing and several with signs of rutting.

Although test results did not initiate any rework on the project (possible pavement replacement), there may be potential for reduced service life of the AC pavement structure.

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4.2.2 Centerline Rumble Strip (CLRS)

Location: Missoula District, Lincoln County, US 2; RP 0.0-13.75
Project Name: 508 E/W
Project Number: N/A
Experimental Project Number: MT-17-04
Project Type: Centerline Rumble Strip
Principal Investigator: Craig Abernathy, Experimental Project Manager
Technical Contact: Justun Juelfs, Kalispell Maintenance Chief
Construction Year: 2017
Inspection Dates: Apr. 2018, Sep. 2018, Apr. 2019, and Apr. 2020
Project End Date: 2023
URL: https://www.mdt.mt.gov/research/projects/rumblestrip.shtml

Description:

This project is a centerline rumble strip (CLRS) longitudinal joint performance evaluation located in Lincoln County on US Highway 2 (C000001/N1), Missoula District, reference point 0.0 to 13.75. The 2016 annual average daily traffic through this corridor is 1,539.

A CLRS is a longitudinal safety feature installed at or near the centerline of a paved roadway. On this project, the strip is a series of rectangular milled indents intended to alert distracted drivers (through vibration and sound) that their vehicles have left the travel lane.

Asphalt pavements are typically constructed with a longitudinal joint (or meet line) along the center of the road. Degradation over time may allow the entry of water, leading to early pavement deterioration. Rumble strips provide another potential reservoir to hold water and could accelerate this joint deterioration. Traffic and environmental characteristics may also affect joint performance.

This project has a test section of CLRS (TS1) adjacent to a control section on non-CLRS (CS2) to compare performance. TS1 begins at reference point (RP) 0.0 on the Idaho/Montana border and runs east to the section transition CS2 at RP 8.2, which continues to RP 13.75 just east on the entrance to the township of Troy. TS1 pavement treatment was a mill and fill with CS2, a standard overlay.

Analysis to Date:

No issues at this time.

MDT Project Manager:
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4.2.3 CRS-2P and CHFRS-2P Chip Seal Field Comparison

Location:	Missoula District, Sanders County, Montana Highway 200 (P-6), RP 98.7-116.1
Project Name:	Dixon-West – Dixon-Ravalli
Project Number:	STPP 6-1(156)99/STPP 6-1(154)109
Experimental Project Number:	MT-19-02
Project Type:	Chip Seal (CS) Performance
Principal Investigator:	Craig Abernathy, Experimental Project Manager
Technical Contact:	Joshua Dold, Missoula District Design Supervisor
Construction Year:	2019
Inspection Dates:	Apr. 2020
Project End Date:	TBD

URL: https://www.mdt.mt.gov/research/projects/chip_seal_emulsion.shtml

Description:

The project was initiated to compare the performance of two asphalt cement (AC) emulsions in an application of a conventional chip seal using Type I chips; no added fog seal was applied.

The chosen emulsions are cationic high-float rapid set (CHFRS-2P) and cationic rapid set (CRS-2P). The Dixon-Ravalli project will utilize CHFRS-2P (for the project length, full roadway width); the Dixon-West project will utilize CRS-2P (for the project length, full roadway width).

Annual average daily traffic for both project sections is approximately 1,921.

Analysis to Date:

No construction issue was reported that may affect future performance of the chip seals. No visible distress to report. The next scheduled inspection will be in the spring of 2021.

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4.2.4 Evaluation of Crafco Mastic One® Hot Applied Sealant

Location: Great Falls District, Pondera County, Interstate-15 and Secondary 218
Project Name: Brady N and S (NB) and Conrad-East
Project Number: IM 15-6(43)323 and STPS 218-1(11)0
Experimental Project Number: MT-18-03
Project Type: Crack Seal and Pavement Repair
Principal Investigator: Craig Abernathy, Experimental Project Manager
Construction Year: 2020
Project End Date: TBD
URL: https://www.mdt.mt.gov/research/projects/crafco.shtml

Objective:

Crafco Mastic One is a hot-applied, single component, pourable, aggregate-filled, polymer modified asphalt mastic used for maintenance, repair, and preservation of pavement and bridge surfaces.

Mastic One is used for sealing, filling, and repairing many distresses in both asphalt concrete and Portland cement concrete pavements that are larger than those typically repaired by crack or joint sealing, but smaller than repairs requiring remove and replace patching procedures.

This application of Mastic One will primarily be used for transverse cracks.

Status:

Project is constructed and the construction report is pending.

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4.2.5 Fiber Reinforced Asphalt Cement (FRAC)

Location: Billings District, Yellowstone County-Billings, Division St. and 6th Ave N (27th to 32nd)
Project Name: Division St.-Billings and 6th Ave. N-27th to 32nd
Project Number: UPPIP 1017(2)7/UPPIP 1029(4)
Experimental Project Number: MT-18-03
Project Type: Sasobit-Aramid Fiber Reinforced Asphalt Cement
Principal Investigator: Craig Abernathy, Experimental Project Manager
Construction Year: 2018
Inspection Dates: Apr. 2019 and Apr. 2020
Project End Date: 2023
URL: https://www.mdt.mt.gov/research/projects/fiber-rac.shtml

Description:

The Billings District incorporated synthetic fibers as an additive to improve asphalt cement (AC) properties. This is the first trial in the state that has used AC fiber reinforcement in a pavement preservation application. The intent of this chosen admixture is to improve resistance to cracking and rutting, increase dynamic modulus, and increase service life.

Surface Tech is the chosen vendor to supply Ace Fiber (pretreated aramid fibers coated with Sasobit wax) used in the production of fiber reinforced asphalt cement (FRAC). Surface Tech was on site to monitor the inclusion of the Ace Fiber during AC production. Surface Tech also furnished the Ace Fiber Line-Vac delivery system, which is the device that introduces the fibers into the drum mixer. Over 18 million Aramid fibers are dispersed for each ton of mix to provide three-dimensional reinforcement.

Because untreated aramid fiber is a very lightweight material and difficult to work with, the fibers are soaked in a wax binder. This pretreatment adds weight to the fiber clips and prevents them from blowing away or clumping during the delivery and feeding process.

Analysis to Date:

No issues were reported in connection with the Ace Fiber addition at the AC production plant. The FRAC paving went well and to date no visible pavement distress is reported. The AC fiber production phase was conducted in July 2018.

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4.2.6 Fog Seal Chip Retention Evaluation

Location:	Butte District, Gallatin County, Targhee Pass-West Yellowstone, State Highway 20 (N-12) – Reference Point 0.0-9.4
Project Name:	Targhee Pass-West Yellowstone
Project Number:	NH 12-1(20)0, UPN 8762000
Experimental Project Number:	MT-15-01
Project Type:	Fog Seal on Chip Seal
Principal Investigator:	Craig Abernathy, Experimental Project Manager
Construction Year:	2017
Inspection Dates:	Apr. 2018, Oct. 2018, May 2019, and May 2020
Project End Date:	2022

URL: https://www.mdt.mt.gov/research/projects/seal_coat.shtml

Description:

The project was nominated to determine if the performance of a fog seal over the top of a chip seal (FSCS) will extend the service life (chip retention) of the pavement treatment compared to that of a conventional chip seal (seal and cover).

The area selected is a mountainous (average project elevation of 6,800 ft.) section of state (secondary) highway with extreme weather conditions that maximize maintenance activities and has severely limited the effectiveness of past pavement preservation treatments.

The FSCS test section encompasses the westbound lane for the length of the project, with the eastbound lane serving as the conventional chip seal control section.

The level of objective relief (the visual appearance of the ratio of binder to the exposed vertical area of the aggregate) of the chip seal as compared to the level of an additional binder layer for an enhanced embedment of chip may show the FSCS creates a tighter bond with the aggregate. The level of texture is not an indicator of friction coefficient. The second objective is to ascertain the level of chip loss between the sections over time.

Analysis to Date:

Both lane treatments displayed good visual condition during the spring 2020 inspection.

The next site inspection will be in the spring of 2021.

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4.2.7 Fog Seal Over Chip Seal Evaluation

Location:	Missoula District, Mineral County, Interstate Highway 90 (C-000090), RP 5.7-23.3
Project Name:	Exit 5 – East – CN 8954000
Project Number:	IM 90-1(220)6
Experimental Project Number:	MT-18-02
Project Type:	Fog Seal on Chip Seal
Principal Investigator:	Craig Abernathy, Experimental Project Manager
Construction Year:	2017
Inspection Dates:	Oct. 2017, Apr. 2018, Oct. 2018, May 2019, and May 2020
Project End Date:	2022

URL: https://www.mdt.mt.gov/research/projects/seal_coat.shtml

Description:

This project was implemented to determine the performance of an applied fog seal to chip seal (FSCS), which may extend the service life of the pavement treatment (chip retention) compared to the conventional practice of a chip seal (seal and cover).

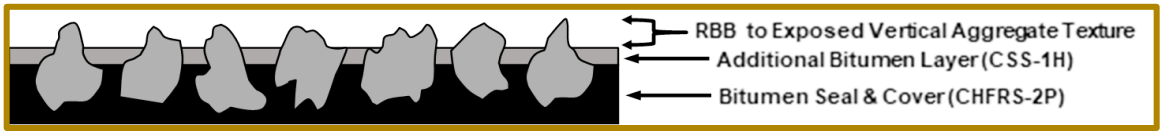
The area selected is a high mountain (average project elevation of 6,800 ft.) section of state (secondary) highway with extreme weather conditions that maximize maintenance activities and has severely limited the effectiveness of past pavement preservation treatments.

The FSCS section encompasses both the westbound and eastbound lanes of the interstate.

The objective of the project is to determine if the selected emulsion (CSS-1H) will add additional reinforcement of the embedded Type III chip (within the conventional seal using CHFRS-2P) to enhance the residual bitumen binder (RBB) on the FSCS section. The level of objective relief (the visual appearance of the ratio of binder to the exposed vertical area of the aggregate (as seen in the diagram below) may offer a tighter bond with the RBB (the level of texture is not an indicator of friction coefficient).

Analysis to Date:

Next (informal) site inspection will be in the spring of 2021.



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4.2.8 High Float vs. Polymer Modified Emulsion Seal and Cover With and Without a Fog Seal

Location: Great Falls District, Hill County, US 2 (N-1)
Project Name: Gilford-East
Project Number: NH 1-6(123)355
Experimental Project Number: MT-18-05
Project Type: Fog Seal/Chip Seal Emulsion Comparison
Principal Investigator: Craig Abernathy, Experimental Project Manager
Construction Year: 2020
Project End Date: TBD
URL: https://www.mdt.mt.gov/research/projects/seal_coat.shtml

Objective:

The purpose of this project is to compare two emulsions with and without a fog seal, determining the short- and long-term performance benefits of each application including cost-effectiveness, long-term durability, and/or potential chip retention benefits. The two emulsions are Cationic High Float Rapid-Set High Viscosity Polymer (CHFRS-2P) and Cationic Rapid Set High-Viscosity Polymer (CRS-2P). The former will be placed with a chip seal only. The latter will be placed with a chip seal and with a Cationic Slow-Set Low Viscosity Hard-Base (CSS-1H/diluted 50%) fog seal treatment. Maintenance is routinely using the CHRFS-2P chip seal oil. Benefits of fog seal on a new chip seal have been noted, but formal documentation of the benefits is lacking.

Status:

Project was constructed in the summer of 2020.

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4.2.9 JOINTBOND Asphalt Joint Stabilizer

Location:	Butte District, Gallatin County, Bridger Canyon Rd.; Montana Highway 86 (P-86), RP 11-13.8
Project Name:	Bridger Canyon
Project Number:	STPP86-1(55)10
Experimental Project Number:	MT-19-03
Project Type:	Centerline Joint Stabilizer Treatment
Principal Investigator:	Craig Abernathy, Experimental Project Manager
Technical Contact:	Tyrell Murfitt, Helena Road Design
Construction Year:	2019
Inspection Dates:	Spring 2020
Project End Date:	TBD

URL: https://www.mdt.mt.gov/research/projects/jointbond.shtml

Description:

JOINTBOND longitudinal joint stabilizer was developed to inhibit the premature deterioration of construction joints by penetrating the asphalt pavement and combining with the existing asphalt binder.

As a polymerized maltene-based emulsion, JOINTBOND stabilizer may extend the service life of longitudinal joints and adjacent areas in two ways:

- Improving the chemistry of the in-place asphalt binder
- Adding a physical in-depth seal to the construction joint, thereby sealing the joint and surrounding area against intrusion by air, water and salt brine

Annual average daily traffic for the project is approximately 1,980.

Analysis to Date:

No construction issues were reported during the application of the joint sealer. No performance issues to date. The next scheduled inspection will be in the spring of 2021.

MDT Project Manager:

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4.2.10 Maintenance Asphalt Surface Treatments

Location:	Great Falls District, Lewis & Clark, Teton, Pondera, and Glacier Counties, Highways US 89 and 287
Project Name:	Augustus North/SE of Dupuyer/US 89 N of Dupuyer
Project Number:	STPP-NHTSA 3-3(23)6/STPP 9-1(20)40/Maintenance Project
Project Type:	Pavement Surface Treatments
Principal Investigator:	Craig Abernathy, Experimental Project Manager
Technical Contact:	Justun Juelfs, Kalispell Maintenance Chief
Construction Year:	2014
Inspection Dates:	Sep. 2014, Jun. 2015, Jun. 2016, Jun. 2017, May 2018, Apr. 2019, and Apr. 2020
Project End Date:	2021

URL: https://www.mdt.mt.gov/research/projects/seal_coat.shtml

Description:

The purpose of this project is to compare the following three types of surface applications under similar environmental and traffic conditions over time to determine the benefits of each treatment:

- Chip seal
- Fog seal over chip seal
- Microsurfacing

The Experimental Program will prepare long-term documentation on the installations in an attempt to establish performance with the surface applications and to ascertain applicable comparisons between the three projects and any other measurable outcomes.

Analysis to Date:

All sections performing well. The final project inspection will be in the spring of 2021.

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4.2.11 RoaDrain Geocomposite for Added Subsurface Drainage

Location:	Butte District, Gallatin County, State Highway 287 (P-87), R.P. 6.81-6.95
Project Name:	Jct. Raynolds Pass - Quake Lake
Project Number:	STPP 87-1(11)0
Experimental Project Number:	MT-15-02
Project Type:	Geocomposite Application
Principal Investigator:	Craig Abernathy, Experimental Project Manager
Construction Year:	2016
Inspection Dates:	Apr. 2017, Aug. 2017, Apr. 2018, Oct. 2018, Apr. 2019, and Apr. 2020
Project End Date:	2022

URL: https://www.mdt.mt.gov/research/projects/roadrain.shtml

Description:

This project is located on US 287 (P-87) in Gallatin County, from the junction with Montana Highway 87 (P-13) approximately 7.0 miles to southbound, toward West Yellowstone. Work to be performed includes cold milling, plant mix surfacing, seal and cover, guardrail installation, dig-outs, and signing and pavement marking.

As of four years ago, prior to the new construction, the section of Highway 287 in question (R.P. 6.81-6.95) had deteriorated to the point a dig-out was performed and treated using usual methods of rehabilitation (geotextile, special borrow, crushed aggregate course, PMS). The section has since failed, and the Department has installed a synthetic subsurface drainage layer (SSDL) under the assumption that water retention within the pavement layers deteriorated the structural base course, contributing to the premature failure of the pavement.

The Department elected to install Tensar RoaDrain 5 (RD-5) as an experimental feature in this project.

Analysis to Date:

A small section of frost heave was detected in 2019 and field marked for future reference.

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4.2.12 Seal Coat Asphalt Emulsion (or Fog Seal Coating) Over Chip Seal for Improved Chip Retention Evaluation

Location:	Mineral County, Interstate 90 (C000090)
Project Name:	Taft-West
Project Number:	IM 90-1(215)0
Project Type:	Work Type: 183 – Resurfacing – Seal and Cover
Principal Investigator:	Craig Abernathy, Experimental Project Manager
Construction Year:	2015
Inspection Dates:	Jun. 2016, Apr. 2017, Apr. 2018, Jul. 2019*, and Jul. 2020*
Project End Date:	2021

URL: https://www.mdt.mt.gov/research/projects/seal_coat.shtml

***** Informal site inspections. District personnel asked Research to conduct informal site inspections since it is in the vicinity of other experimental projects. However, 2021 will be the last inspection of the site to close out the project.

Description:

The purpose of this project is to determine the effectiveness and added durability of applying a fog seal (SS1 asphalt emulsion) to a chip seal (CS). The goal is to reduce aggregate loss and maximize surface friction in an environment of extreme fluctuations in temperature and numerous snow removal activities.

The project will compare a conventional chip seal procedure to a fog seal over chip seal (FSCS) application on a section of Interstate 90 beginning at reference point 0.0 (Idaho border) east to approximate reference point 5.7 (Taft Area interchange). The project will use Type 2 cover material (1/2" chip). Traffic (2015 data) puts an annual average daily traffic at approximately 7,600 with a 30% calculated commercial load.

Analysis to Date:

The main measure of effectiveness is the average texture of embedded chip within the residual bitumen binder on each of the test sections as compared to the control in an area that, historically, is difficult to maintain an effective chip seal. The project area will be reviewed semiannually with reporting once per year.

District staff reported a high level of plow passes during the 2015/16 and 2016/17 winter seasons. Even with the additional application of emulsion to the chip seal, aggregate loss was almost identical to the conventional CS sections.

Conversely, there are intact sections of CS and FSCS on the project as well. Most of the distress observed is at the higher elevation portions of the project and where roadway curves are present. With almost 23

lanes miles on the project, it is difficult to ascertain the percentage of distress areas of pavement to those still intact.

Overall, the addition of the fog seal appeared to perform comparably to the control. The majority of the distress observed was located in the travel lane, which indicates traffic factors as an indicator of performance. That effect, combined with the severe environment and substantial snowplow miles this corridor receives, may result in the additional benefit of the FSCS being only marginal.

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4.2.13 Sinusoidal Centerline Rumble Strip (SCLRS)

Location: Glendive District, Rosebud County, MT-39; RP 31-32.4
Project Name: Sinusoidal CLRS-Colstrip
Project Number: UPN 9370
Experimental Project Number: MT-18-02
Project Type: Centerline Sinusoidal Rumble Strip
Principal Investigator: Craig Abernathy, Experimental Project Manager
Construction Year: 2018
Inspection Dates: Apr. 2019, Feb. 2020, and May 2020
Project End Date: 2023
URL: https://www.mdt.mt.gov/research/projects/sclrs.shtml

Description:

The purpose of this project is to demonstrate the application of a sinusoidal centerline rumble strip (SCLRS) and evaluate performance. The 2017 annual average daily traffic through this corridor is 1,235.

Centerline rumble strips are extremely effective in reducing severe roadway departure crashes at a low cost. Rumble strips use both noise and vibration to alert a driver that their vehicle is leaving the travel path. To be effective, the noise generated inside the vehicle must rouse a drowsy driver or grab the attention of a distracted driver. Since there is a wide range of "drowsiness" and "distraction" inside the vehicle compartment, more noise is typically better.

Conversely, the noise generated outside the vehicle can be disruptive to residents or businesses in the area, and the goal is to produce as little sound as possible broadcast outside the vehicle and still maintain the needed noise level for safety. The focus of this project is to document the method of installation and equipment used to apply this feature and to compare the current noise level of the conventional strips the Department now deploys to the sinusoidal rumble strips on this project.

The following indicates the SCLRS design parameters:

- ★ Design S1: 14" longitudinal frequency, 12" wide, 1/8" to 1/2" depth frequency
- ★ Design S2: 24" longitudinal frequency, 12" wide, 1/8" to 1/2" depth frequency
- ★ Design S3: 14" longitudinal frequency, 14" wide tapered, 1/8" to 1/2" depth frequency
- ★ Design S3A: 24" longitudinal frequency, 14" wide tapered, 1/8" to 1/2" depth frequency

Analysis to Date:

No visible distress to the strip sections to date. On-site decibel testing was conducted in September 2019. That report has been submitted and is available to review at the project's webpage.

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4.2.14 SKAPS GT116N Nonwoven Textile Bond Breaker

Location:	Glendive District, Richland County, Township of Fairview-Montana 200/P-20
Project Name:	MT 200-Fairview
Project Number:	STPP 20-2(31)62
Experimental Project Number:	MT-20-03
Project Type:	Nonwoven Textile Bond Breaker CTB/PCCP
Principal Investigator:	Jeremy Schneidt, Experimental Project Manager
Construction Year:	2020
Project End Date:	TBD
URL:	Pending

Objective:

The purpose of this project is to rehabilitate the existing surfacing and to provide a smoother and safer roadway to meet the demand of increased traffic the pavement will be milled to the level of cement-treated base (CTB) with a nonwoven fabric interlayer to minimize potential reflective cracking to the Portland cement concrete pavement (PCCP) overlay.

Status:

Project is constructed with construction report pending.

MDT Project Manager:
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4.2.15 Sprayroq-SprayWall Polyurethane Applied Lining for Culvert Rehabilitation

Location:	Missoula District, Mineral County, Interstate 90, Reference Point (RP) 59, Nemote Creek Crossing
Project Name:	I-90 Nemote Creek Culvert
Project Number:	IM 90-1(205)59 – Work Type 312: Structure Safety
Experimental Project Number:	MT-13-14
Project Type:	Culvert Rehabilitation
Principal Investigator:	Craig Abernathy, Experimental Project Manager
Construction Year:	2017
Inspection Dates:	Apr. 2017, Apr. 2018, Jan. 2019, and Jan. 2020
Project End Date:	2022

URL: https://www.mdt.mt.gov/research/projects/spraywall.shtml

Description:

This project is located at the crossing of Nemote Creek on Interstate 90, at RP 59.0 ±; approximately two miles west/north of the Tarkio Loop Road interchange, and 1.3 miles east/south of the Quartz Flats westbound rest area. The eight (8) gauge steel plate pipe culvert (SPPC) is 242 linear feet and has an interior radius of 12 ft.

Bulging and sagging of the steel-plated panels located near the east end of the culvert were noted in 2006 and remedial action was recommended in May 2013. Maximum deflection within areas of deformation was roughly estimated to be 6 inches located in the upper plates of the pipe. The purpose of the rehabilitation effort is to improve the structural capacity of the pipe to reduce the chance of a culvert failure that would impact the I-90 roadway.

Due to site constraints and apparent minimal change in the areas of deformation over the past seven years, the Department used a cure-in-place-pipe (CIPP) process to provide structural enhancement and corrosion resistance.

The selected product is Sprayroq's catalyzed, two-component coatings, SprayWall. SprayWall is a procedure using self-priming, spray-applied structural polyurethane coating as the lining medium. The manufacturer states the lining allows return to active service within an hour of application.

The extent of the treatment encompassed the culvert inlet to approximately 30 ft. down flow into the culvert with a 360° SprayWall application. Areas of the apparent deformation received a thicker application of SprayWall.

Analysis to Date:

The SprayWall treatment appears to be intact with no visual evidence of separation or cracking.

During the April 2017 inspection, it was noted that areas of the steel plate seams and bolt connections received an additional (apparently hand-applied) application of SprayWall most likely applied soon after installation.

Information from District staff states the issue of moisture seepage (a condition evident in the culvert preparation phase) was observed after the initial SprayWall application was completed and required spot patching to eliminate the migration of moisture. Although the contractor attempted to check the leaks through the use of expanding sealants, 100% containment was not possible. On the January 2020 inspection, plate connections had icicles forming.

The representative will visit the site during the winter of 2020/21 to inspect and seal apparent holes and cracks.

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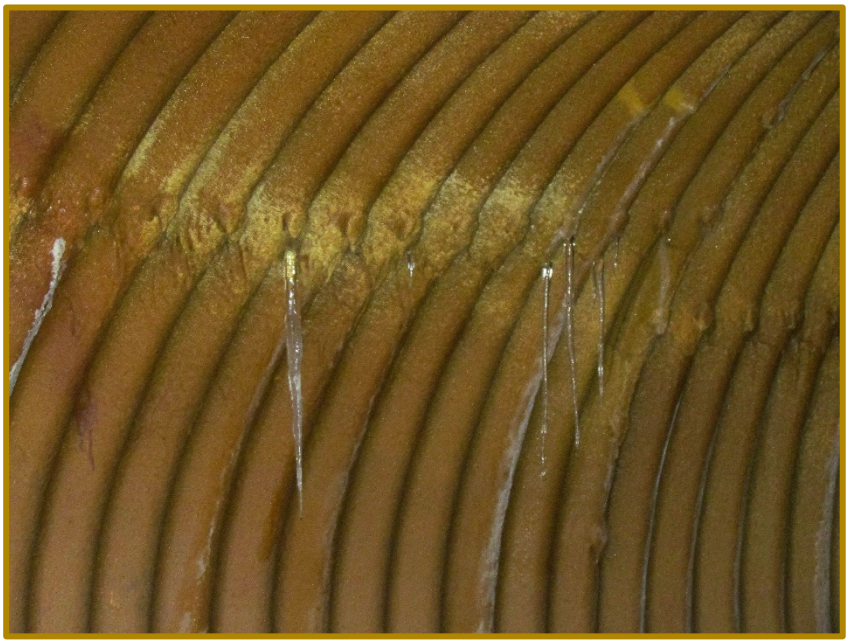

4.2.16 T15 Base One Soil Stabilization

Location:	Glendive District, Valley County-City of Nashua, Montana Route 117 (P-17)
Project Name:	Milk River – North
Project Number:	STPP 17-1(10)11
Experimental Project Number:	MT-18-05
Project Type:	Full-Reclamation Chemical Soil Stabilization
Principal Investigator:	Craig Abernathy, Experimental Project Manager
Construction Year:	2018
Inspection Dates:	May 2019 and May 2020
Project End Date:	2023

URL: https://www.mdt.mt.gov/research/projects/t5baseone.shtml

Description:

The project is located on Montana Route 117 (P-17) in Valley County from the north end of the Milk River bridge extending north approximately 1.91 miles to the new alignment and intersection of MT 117 and (NHS/NI) US2. Test sections also include the old stretch of MT 117 through the town of Nashua (Front and Sargent streets).

The pavement sections located on this project were in variable condition with significant cracking, large partial and full-width patched sections, and isolated repaired potholes. The pavement was generally considered to be in poor to fair condition. It was decided that full-depth reclamation was needed to restore the efficacy of the pavement and to employ a soil stabilizer to enforce the integrity of the pavement structure.

The chosen soil stabilizer (SS) is Team Labs T15 Base One, a proprietary blend of silicic acid and sodium salt. Six (6) test sections were installed on the project. A road reclaimer was used for pavement reclamation and for the homogeneous mixing/injection of the SS. The SS application rate was set at 0.005 (0.5%) gallons per square yard per inch of reclamation depth.

A Tetra Tech representative, one of the subcontractors on the project, was on hand to assist with and monitor the reclamation and application phases of the Base One soil stabilizer.

Analysis to Date:

The 2020 inspection revealed no pavement distress to date. The next inspection will be in the spring of 2021.

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4.2.17 TenCate Mirafi MPV400 Polypropylene Nonwoven Geotextile

Location:	Great Falls District, Cascade County, U-5201; Smelter Ave. NW – 5th St. NW to 1st St. NW
Project Name:	Smelter-1st to 5th St NW
Project Number:	8978000 UPP 5201(24)
Experimental Project Number:	MT-17-03
Project Type:	Milled Overlay with Paving Fabric
Principal Investigator:	Craig Abernathy, Experimental Project Manager
Construction Year:	2017
Inspection Date:	Apr. 2018, Apr. 2019, and Apr. 2020
Project End Date:	2022

URL: https://www.mdt.mt.gov/research/projects/tencate-mirifi-mpv400.shtml

Description:

The project is located in Cascade County within the township of Great Falls on Route U-5201 (C005201), Smelter Ave. NW, beginning at RP 2.5, at 5th St NW and extending approximately 0.4 miles east ending at RP 3.0, 1st St NW. This is a pavement preservation project involving a cold mill, overlay and added paving fabric.

The purpose of adding the designated paving fabric on the prepared milled surface is to aid in extending the service life of the pavement. As claimed by the manufacturer, TenCate Mirafi MPV400 nonwoven asphalt overlay fabric forms a membrane that minimizes surface water from penetrating pavement systems and provides a stress relief interlayer that inhibits the growth of reflective cracks. Produced from polypropylene staple fibers, TenCate Mirafi is heat-set to provide a waterproofing barrier.

Analysis to Date:

No issues to report since installation. No visible pavement distress documented to date.

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4.3 PENDING PROJECTS

4.3.1 Electric Wildlife Deterrent Mat

Location:	Butte District, Broadwater County, MT Route 287/12 (N-8) Missoula District, Sanders County, MT Route 200 (P-6)
Project Name:	Toston Structure East of Thompson River – East
Project Number:	NHIP-NHPBIP 8-4(66)86 STPP 6-1(126)57
Experimental Project Number:	NHIP-NHPBIP 8-4(66)86 MT-14-01
Project Type:	Wildlife Crossing Structure
Principal Investigator:	Craig Abernathy, Experimental Project Manager
Construction Year:	2020

URL: https://www.mdt.mt.gov/research/projects/electmat.shtml

Objective:

Generically known as electric mats, these structures are crossing deterrents to discourage animals from entering an area deemed necessary to be "animal free" to mitigate conflicts with travelling motorists. These mats incorporate a mild electric shock when a hooved animal attempts to enter the crossing.

The electric wildlife deterrent mat units are embedded directly in the pavement (concrete and metal fiber or rubberized composite material) in a full-width roadway application. Electric mats serve as an alternative to cattle guards and other non-electric crossing structures to manage ungulate movements.

The information gathered and analyzed from this project may result in a better understanding of how existing roadways may be utilized as wildlife barrier structures. In addition to gaining a better understanding of how "funnel" fencing can be used on existing and future projects, the goal is a roadway system that is safer for motorists and wildlife.

Status:

This project is slated for installation in late fall 2020.

MDT Project Manager:
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4.3.2 Nomaflex Concrete Joint Filler Evaluation

Location:	Butte District, Gallatin County, Rouse Ave-Bozeman
Project Name:	Nomaflex Concrete Expansion Joint
Project Number:	STPP 86-1(27)0
Experimental Project Number:	MT-17-05
Project Type:	Concrete Expansion Joint
Principal Investigator:	Craig Abernathy, Experimental Project Manager
Construction Year:	Pending 2021
URL:	Pending

Objective:

Nomaco Nomaflex is a closed-cell polypropylene foam used as a preformed expansion joint in concrete sidewalk applications. This product does not require the use of a bond breaker commonly used with other conventional expansion joints (i.e., asphalt saturated fiber). This product is also recyclable.

The manufacturer's information states that it extends the service life of concrete by reducing the amount of incompressible materials that may enter the joint over time and accelerate cracking or spalling.

Crews will install 3000 linear feet of Nomaflex from reference point (RP) 0.0 (Main Street) to RP 0.85 (Oak Street).

Status:

Project was slated for installation in the summer of 2018. Due to a scheduling conflict this project is now pending for the summer of 2021.

MDT Project Manager:
Craig Abernathy
406.444.6269
cabernathy@mt.gov

4.3.3 Reflective Cracking in Cement-Treated Bases Minimization by Microcracking Evaluation

Location:	Glendive District, Sheridan County, Westby
Project Name:	Westby West
Project Number:	UPN 7953
Experimental Project Number:	MT-18-07
Project Type:	Cement Treated Base
Principal Investigator:	Craig Abernathy, Experimental Project Manager
Construction Year:	Pending 2021
URL:	Pending

Objective:

This project will focus on evaluating the effectiveness of the microcracking concept for reducing shrinkage cracking in cement-treated bases. Microcracking can be defined as the application of several vibratory roller passes to the cement-treated base at a short curing stage, typically after one to three days, to create a fine network of cracks to potentially minimize reflective cracking after paving course is applied.

Status:

This project was initially scheduled for 2019 but is currently slated for 2021 construction.

MDT Project Manager:
Craig Abernathy
406.444.6269
cabernathy@mt.gov

4.3.4 Surfacing In-Slope Treatment Evaluation

Location: Glendive District, Dawson County, I-94
Project Name: Bad Route Interchange – NE
Project Number: IM 94-6(59)193
Experimental Project Number: MT-18-06
Project Type: Topsoil Surfacing Comparison
Principal Investigator: Jeremy Schneidt, Experimental Project Manager
Construction Year: Pending 2021

Objective:

A section of Interstate 94 near the township of Glendive has deteriorated to the point that a reconstruct is necessary. The primary cause of the subgrade failure exhibited on this project is heave action on the frost susceptible subgrade soils.

When drainage of the surfacing section is hindered, the susceptibility to freeze/thaw action increases significantly. By not topsoiling the new crushed aggregate course surfacing in-slope there may be a better chance of the surfacing section being able to drain during the fall, spring, and winter seasons when the presence of moisture, combined with freeze/thaw action, is most prevalent. Two separate design changes to the roadway in-slope will be constructed to compare efficacy of the treatments as compared to the current practice of topsoil placement.

Status:

Project was slated for installation in the fall of 2019 but has been delayed until 2021.

MDT Project Manager:
Jeremy Schneidt
406.233.3626
jschneidt@mt.gov

4.4 PROPOSED PROJECTS

Expanded Polystyrene Geofoam Blocks as Lightweight Fill
Swamp Creek East/NH 1-1(29) 45 F – Section 1304

Prefabricated Steel Truss/Bridge Deck System
Conly Ave. Bridge-Deer Lodge/STPB 9039(43)

Roundabout Striping Durability Trials
Project Review in Billings and Poplar, Montana

Texas Underseal with Added Scrub Seal
Lewistown, Montana/UPP 7105(4)

Weather-Activated Detection System
Granite Powell Safety Project/HSIP-G STWD(538)

Yellow-Dyed Concrete Curbing to Replace Epoxy-Applied Curbing
Project Currently Under Consideration in Billings, Montana

5 PARTNERING PROJECTS AND POOLED FUND STUDIES

MDT contributed funds to the following partnering and pooled fund studies in FFY 2020 (Table 3). Click on the project links to view project information.

Table 3. FFY 2020 Partnering and Pooled Fund Contributions

Number	Name	Funding Level
N/A	AASHTO Equipment Management Technical Services Program (EMTSP)	$5,000
N/A	AASHTO Innovation Initiative (AII) Technical Services Program	$6,000
N/A	AASHTO Load and Resistance Factor Design (LRFD) Bridges and Structures Specification Maintenance (LRFDSM)Technical Services Program	$15,000
N/A	AASHTO National Transportation Product Evaluation Program (NTPEP) Technical Services Program, includes AASHTO Product Evaluation List (APEL)	$20,000
N/A	AASHTO re:source (formerly AASHTO Materials Reference Laboratory (AMRL) Technical Services Program)	$20,000
N/A	AASHTO Technical Service Program to Develop AASHTO Materials Standards (DAMS)	$10,000
N/A	AASHTO Transportation System Preservation Technical Services Program (TSP2)	$20,000
9811-746	AASHTOWare Project Data Analytics	$277,475
TPF-5(349)	Western Alliance for Quality Transportation Construction (WAQTC)	$12,000
TPF-5(353)	Clear Roads Phase II	$25,000
TPF-5(376)	Northwest Passage Phase #4	$25,000
TPF-5(391)	Comprehensive Field Load Test and Geotechnical Investigation Program for Development of LRFD Recommendations of Driven Piles on Intermediate GeoMaterials	$15,000
TPF-5(394)	Western Maintenance Partnership – Phase 3	$5,000
TPF-5(399)	Improve Pavement Surface Distress and Transverse Profile Data Collection and Analysis, Phase II	$15,000
TPF-5(420)	National Cooperative Highway Research Program (NCHRP)	$246,395
TPF-5(437)	Technology Transfer Concrete Consortium (FY20-FY24)	$12,000
TPF-5(447)	Traffic Control Device (TCD) Consortium (3)	$10,000
TPF-5(450)	Transportation Research Board Cores Services Support	$109,301
TPF-5(454)	Updating U.S. Precipitation Frequency Estimates for the Northwest	$133,520
	TOTAL	**$981,691**

6 SUMMARY

6.1 GENERAL

MDT's mission is to serve the public by providing a transportation system and services that emphasize quality, safety, cost-effectiveness, economic vitality, and sensitivity to the environment. MDT's Research Programs impact each and every part of MDT's mission.

Research projects completed in FFY 2020 yielded results that when fully implemented will improve:

- ★ Efficiency and effectiveness of MDT operations and technology transfer, including:
  - Improved cost estimating, decreasing overruns and providing for improved construction portfolio of projects
  - Improved construction contracting
  - Improved bridge, culvert, pavement, and geotechnical design and processes
  - Increased bridge, culvert and roadway design life
  - Improved construction materials and methods
  - Improved construction practices
  - Improved support for cities and counties
  - Improved maintenance
- ★ Economic vitality: Understanding the economic benefits of Montana's transportation infrastructure
- ★ Sensitivity to the environment, including:
  - Improved environmental processes
  - Decreased vehicle-wildlife collisions
  - Improved habitat connectivity
- ★ Safety, including:
  - Improved bridge, culvert, and pavement design and processes
  - Improved safety on roads and bridges
  - Reduced animal-vehicle collisions
  - Improved safety culture both within MDT and among the travelling public
  - Improved safety in work zones
  - Improved winter maintenance
- ★ Quality of what we do and how we do it, including:
  - Improved cost estimating, decreasing overruns and providing for improved construction portfolio of projects
  - Improved construction contracting
  - Improved bridge, culvert, and pavement design and processes
  - Increased bridge, culvert and roadway design life
  - Improved construction materials and methods
  - Improved construction practices
  - Improved support for cities and counties
  - Improved maintenance
  - Improved equipment management
  - Improved construction practices

6.2 FISCAL

Research Programs expenditures occurred through research projects, AASHTO Technical Services Programs (TSP), Local Transportation Assistance Program (LTAP), pooled fund studies, NCHRP and TRB Core Services support, and program administration (Figure 5). Figures 6 and 7 show these expenditures categorized by subject. Figure 8 shows indirect costs, as well as overhead costs, as compared to total project expenditures, including projects such as pooled fund studies that are not charged indirect costs by MDT. The program administration category not only includes MDT staff support, including travel, but also includes a contract for research project management services. MDT, as of July 2007, is required to charge indirect costs. The indirect cost rates are revised each state fiscal year. From July 2019 to June 2020, the indirect cost rate charged to each expenditure was 10.41% and from July 2020 to June 2021, the indirect cost rate charged to each expenditure is 10.99%. Figure 9 shows total funding for all active research projects by funding source. Figures 10 and 11 show funding for in-state and out-of-state researchers. Figures 12 and 13 show funding by public and private consultants. Figures 14 and 15 show funding by university and non-university researchers. Finally, for every Research dollar expended in FFY 2020, $1.19 in other funds were expended.

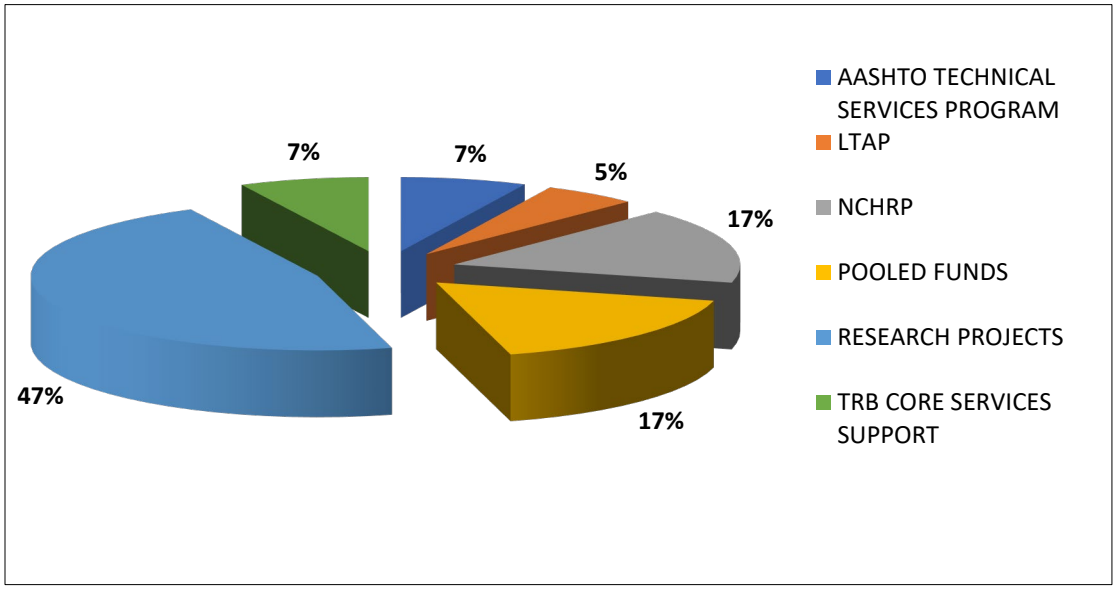

Figure 5. FFY 2020 Percent of Research Programs Expenditures by Project Type

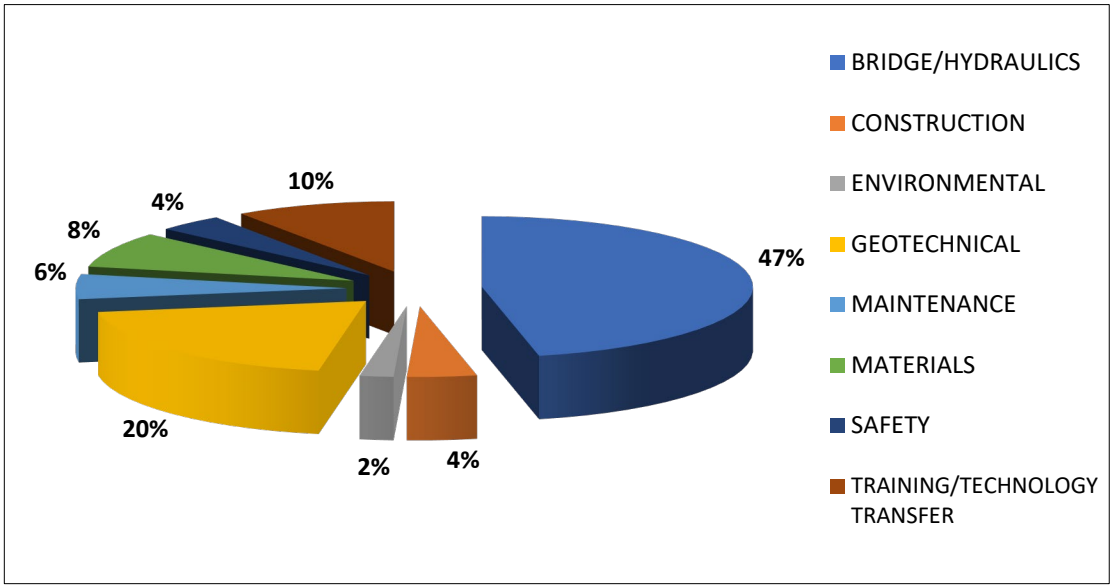

Figure 6. FFY 2020 Percent of Research Project Expenditures by Subject

Note: The data presented in Figure 6 includes pooled fund studies.

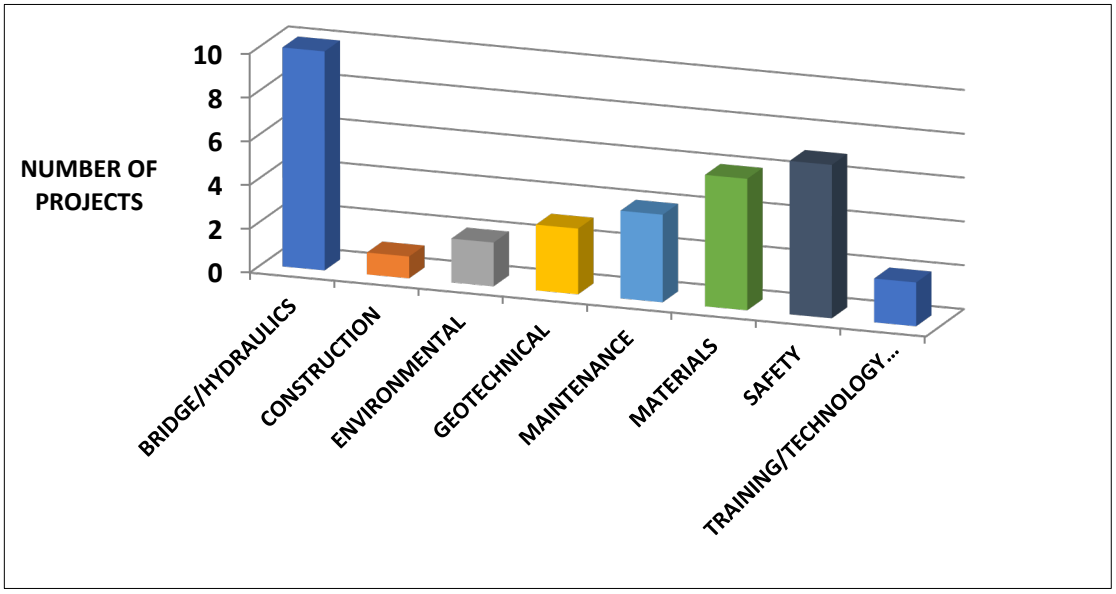

Figure 7. FFY 2020 Number of Research Project Expenditures by Subject

Note: The data presented in Figure 7 includes pooled fund studies.

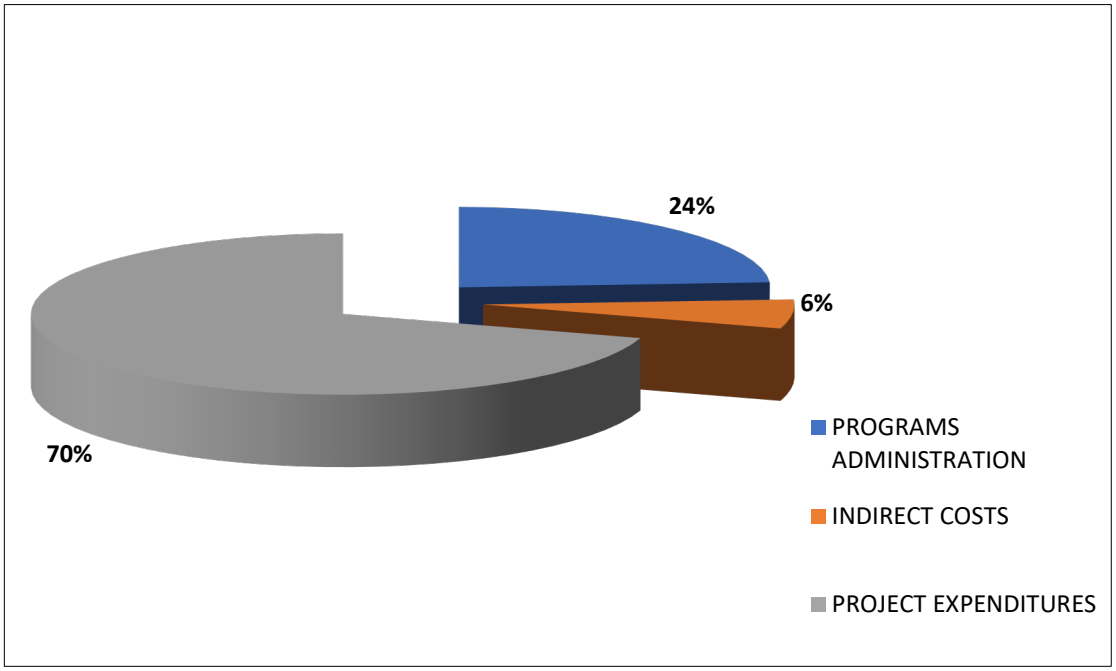

Figure 8. FFY 2020 Research Programs Overhead and Indirect Expenditures as Compared to Other Expenditures

Note: The data presented in Figure 8 includes pooled fund studies.

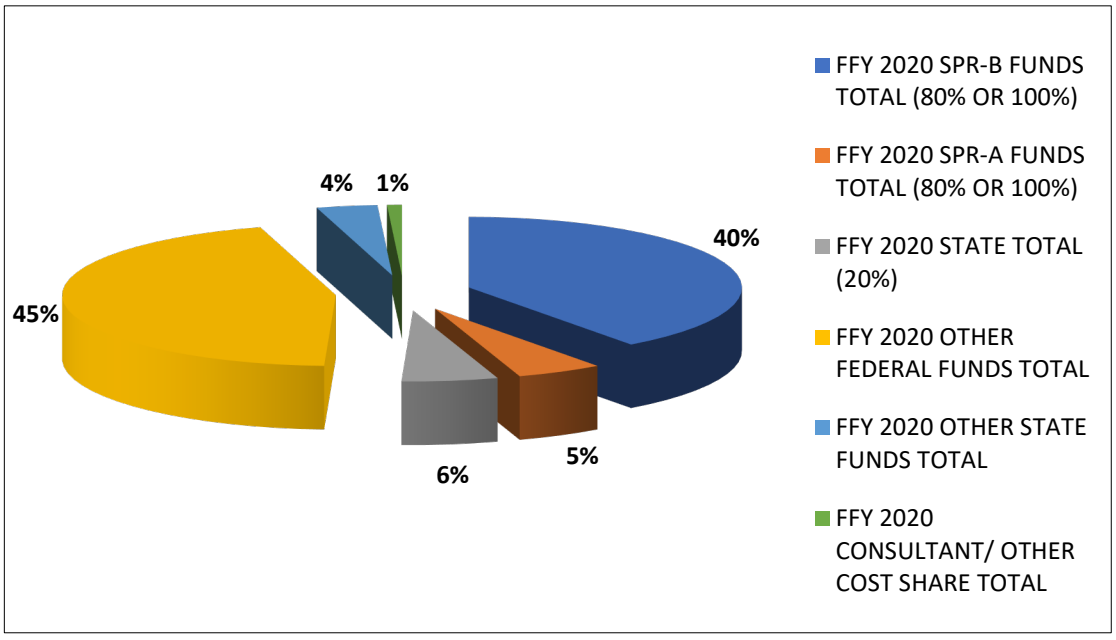

Figure 9. FFY 2020 Research Program Expenditures by Funding Source

Note: The data presented in Figure 9 includes pooled fund studies.

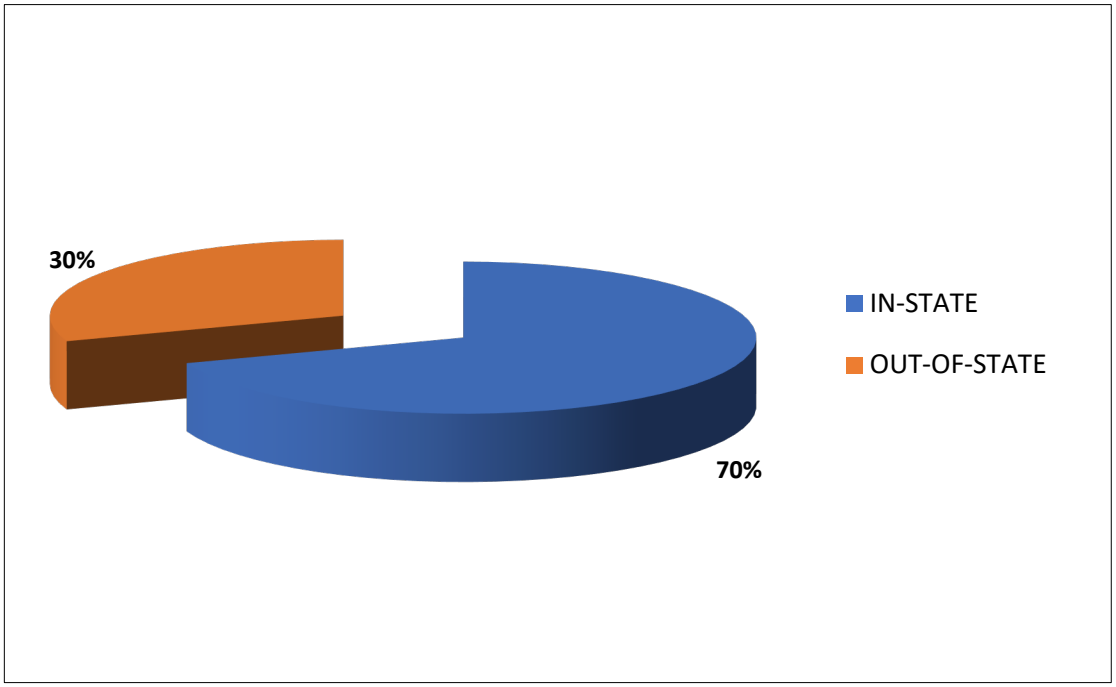

Figure 10. FFY 2020 Research Project Expenditures by Researcher Location

Note: The data presented in Figure 10 does not include non-MDT led pooled fund studies.

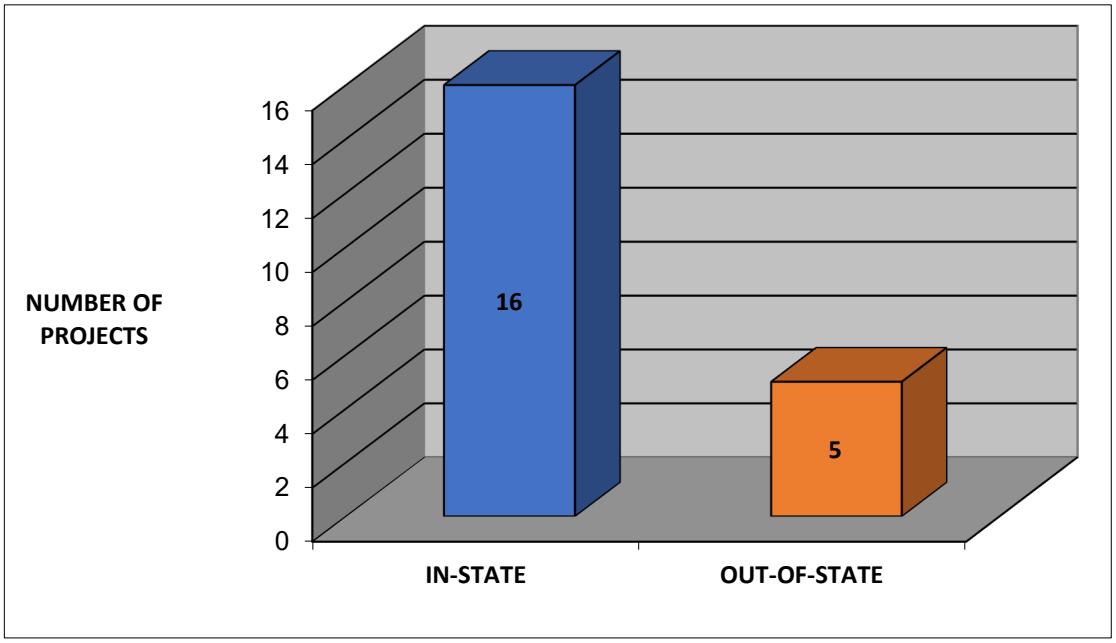

Figure 11. FFY 2020 Number of Research Projects by Researcher Location

Note: The data presented in Figure 11 does not include non-MDT led pooled fund studies.

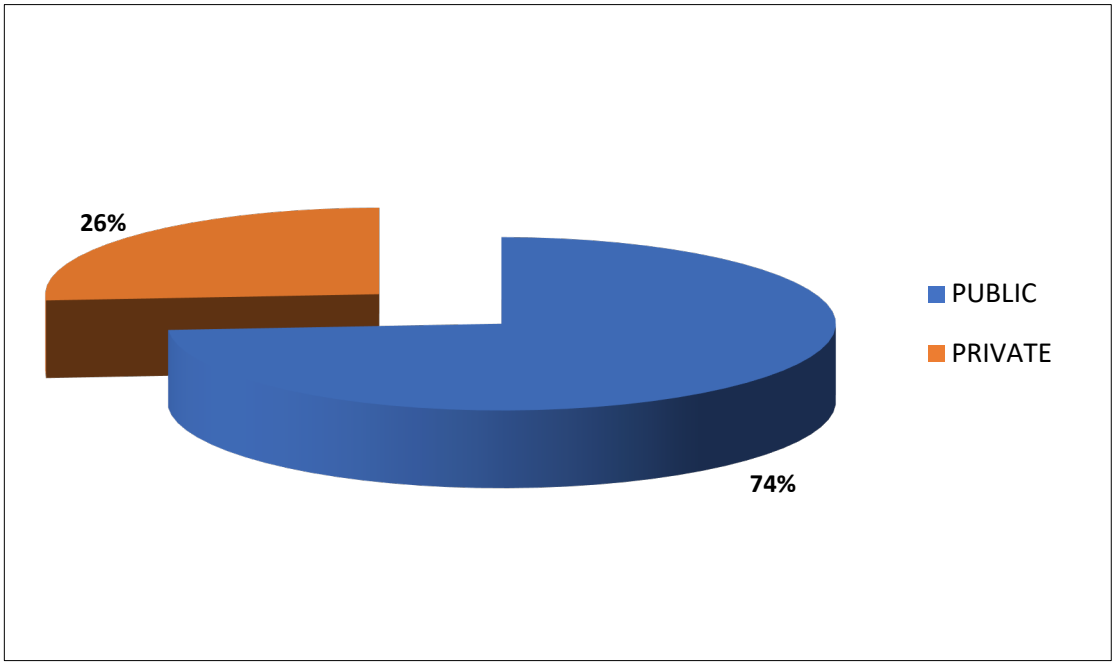

Figure 12. FFY 2020 Research Project Expenditures by Sector

Note: The data presented in Figure 12 does not include non-MDT led pooled fund studies.

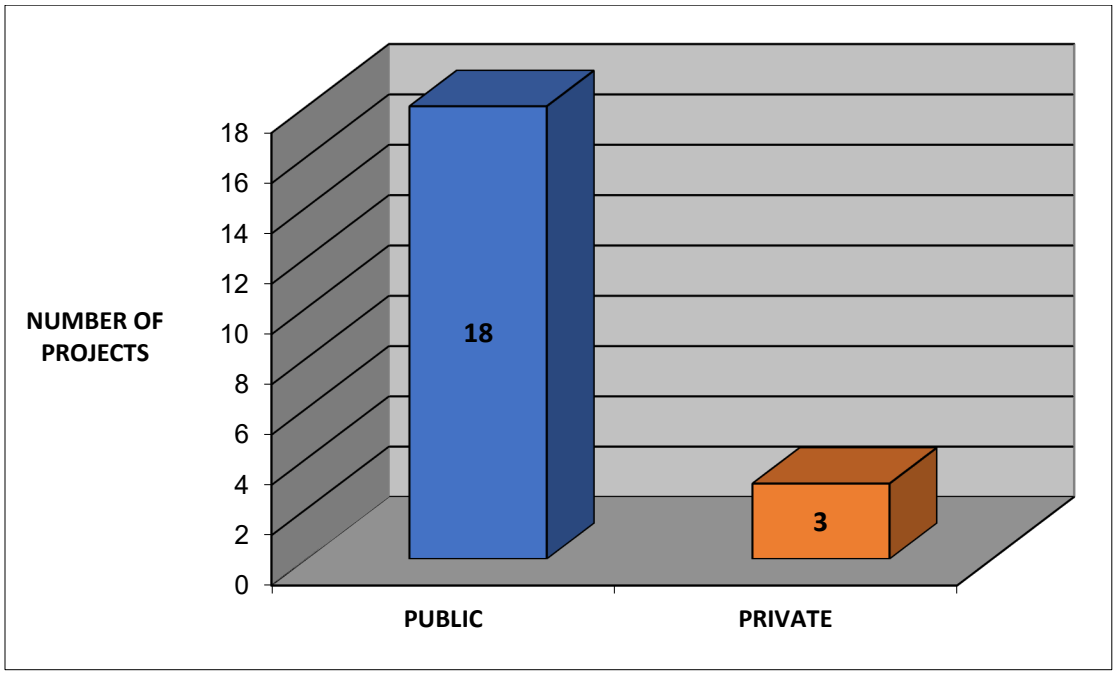

Figure 13. FFY 2020 Number of Research Projects by Sector

Note: The data presented in Figure 13 does not include non-MDT led pooled fund studies.

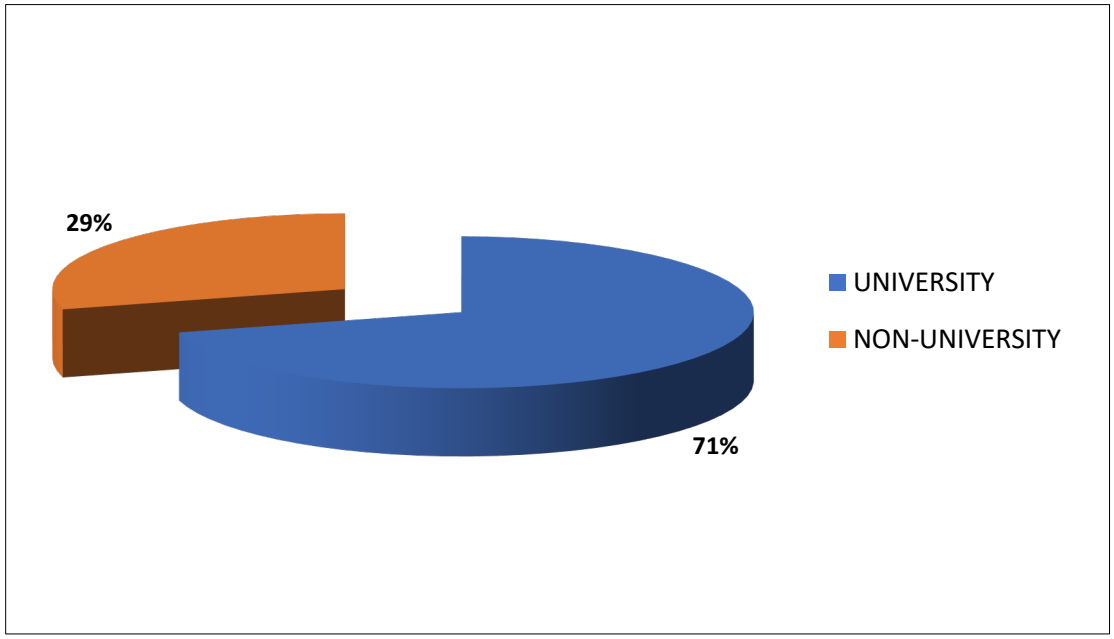

Figure 14. FFY 2020 Research Project Expenditures by Researcher Type

Note: The data presented in Figure 14 does not include non-MDT led pooled fund studies.

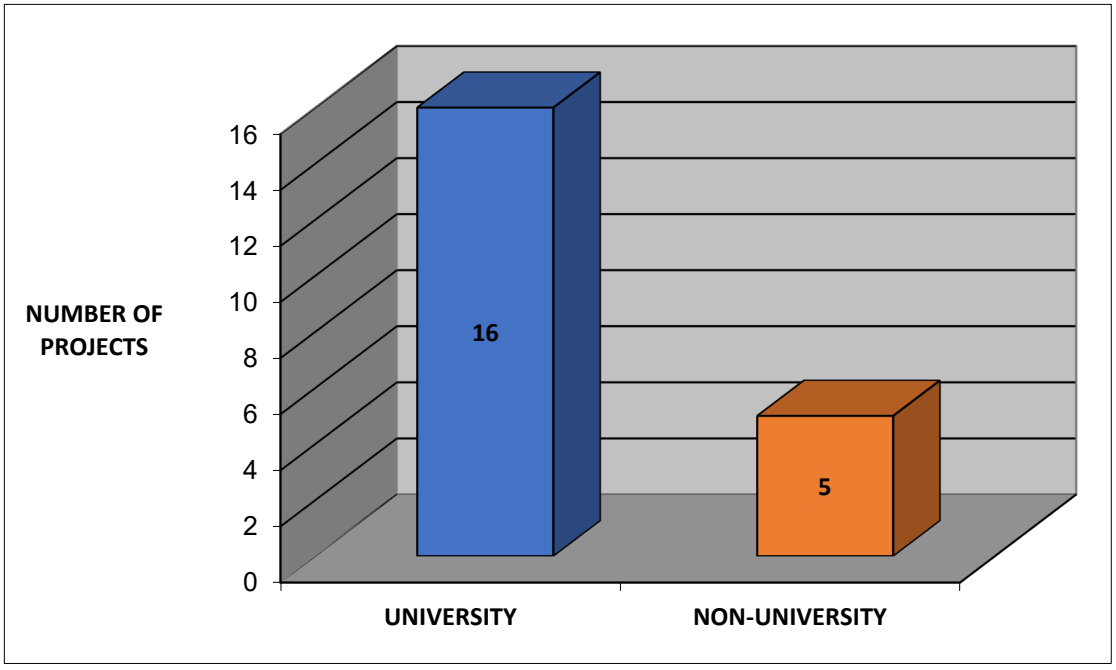

Figure 15. FFY 2020 Number of Research Projects by Researcher Type

Note: The data presented in Figure 15 does not include non-MDT led pooled fund studies.

Appendix A: Research Project Technical Panel Roles and Responsibilities

MONTANA MDT DEPARTMENT OF TRANSPORTATION

RESEARCH PROGRAMS

RESEARCH REVIEW COMMITTEE AND RESEARCH PROJECT TECHNICAL PANEL ROLES AND RESPONSIBILITIES

GENERAL

Research Review Committee

The Research Review Committee (RRC) oversees the Research Projects Program. This committee:

- Along with the District Administrators, determines which research topics submitted during the annual research solicitation move forward to the technical panel stage based on champion presentation, ranking (criteria listed below), and funding availability.
  - Priority research focus areas (e.g., TranPlanMT focus areas that lend themselves to research);
  - Scope, budget, and timeline are appropriate for available resources (limited funds need to be allocated to highest priorities) and timeliness/urgency of topic;
  - Importance (e.g., federal or state initiative or compliance);
  - Benefits and pay-off (including as they relate to MDT's mission and "strategic plan"; e.g., return on investment, cost/lives savings, etc.);
  - Implementability; and
  - Feasibility/probability of success/risk (What is success?)

- Identifies need for and approves administration high priority research topics, partnership projects, and small projects;
- Identifies additional technical panel members;
- Reviews technical panel recommendations (e.g., cancel, fund, implement) for each research project;
- Reviews and approves scopes of work for those research projects where an RFP is to be issued, the cost of the project has increased by the percentage shown in the below table or more, or if there was any contention within the RRC when the project was approved to move forward to the technical panel stage;

Project Cost	Percent Increase in Project Cost
$50,000 or less	N/A
$50,001 to $100,000	30%
$100,001 to $500,000	25%
Greater than $500,000	15%

- Approves funding for all MDT research projects based on the project proposal and technical panel recommendation;
- Approves funding for pooled-fund studies, based on the scope of work and staff recommendation;
- Reviews project progress, as desired; and
- Reviews and makes implementation recommendations.

The RRC consists of a FHWA and WTI representative, and the following MDT positions:

- Director,
- Deputy Director,
- Administrators (except HR), and
- Research Manager.

The RRC meets at most monthly (typically last Wednesday of the month from 9 am to 12 pm). Agenda items must be prepared and final approximately 2 weeks prior to each RRC meeting.

Technical Panels

Technical Panels (TP) oversee all MDT research projects. They are formed at the beginning of each project and members are chosen with careful consideration since the success of a project hinges on the Technical Panel and its oversight. **This is your project, not Research's; the project can only deliver the products the technical panel wants if there is appropriate technical panel oversight.** There is a different technical panel for each project, usually consisting of three to ten individuals from both inside and outside of MDT, with knowledge and a vested interest in the research topic, results, and implementation. FHWA and MDT Research Staff are on all technical panels. Individuals on panels should adequately represent the breadth of the issue at hand and be balanced with respect to viewpoint and representation. Each panel member is chosen to represent the needs of their respective division, department, organization, and/or constituencies.

Benefits

The benefits of serving on a technical panel are many and varied. Some are listed below.

1. Obtain answers to questions and solve problems.
2. Help MDT to meet its mission by improving quality, safety, cost effectiveness, economic vitality, and sensitivity to the environment.
3. Help to guide the future direction of MDT.

4. Help to improve operations within your area.
5. Communicate, coordinate, and collaborate within a team environment.
6. Contribute to your professional development.

Roles

1. Technical Panel Member
2. MDT Research Project Manager
3. Technical Panel Chair

Responsibilities

Note: All tasks must be performed in a timely manner.

1. Technical Panel Members, including Research staff (MDT Research Project Manager) and panel chair, who is usually the project champion
    a. Determine if others need to participate on the technical panel.
    b. Oversee project from inception through implementation. Implementation (i.e., products necessary, identification of barriers, mitigation of barriers) should be considered from the very first panel meeting.
    c. Determine if research need exists by a literature search and completing the research project statement form and, then, the best method to proceed (cancel project; implement available results; or secure funding from local/MDT, regional, or national research programs).
    d. If it is determined a project is necessary and should be funded at the local/MDT level, develop a scope of work (SOW), based on the research project statement. Otherwise, work within the appropriate venue to submit research topic. It is critical that a clear, complete, and concise SOW is developed, as the proposal, which is a part of the project contract, is developed from this SOW.
        i. *Items e. through i. pertain to projects funded at by MDT*.
    e. Determine if RFP should be issued or a governmental agency would be the best entity to conduct research. Review proposal(s) and recommend to the RRC a proposal for funding. Proposals are based on the SOW.
    f. Meet with consultant in project kick-off meeting and other meetings, as determined by the project proposal and/or technical panel.
    g. Carefully review all project products for completeness and accuracy. It is especially critical for technical panel members to review the Task Reports (TR). The TR will provide detailed information on each task, including what was done, how it was done, and the results. The TRs can be combined to form much of the final report.
    h. Ensure the project stays on scope and delivers desired products by reviewing project deliverables (i.e., progress reports, task reports, other interim products, final report and other final products) and communicating issues with contractor through the MDT Research Project Manager. This is critical for project success.
    i. Keep supervisor(s), organizations, and/or constituencies informed of all progress and products of the project.
    j. Make implementation recommendations for MDT.
2. MDT Research Project Manager

a. Identifies technical panel members and forms technical panels.
b. The Research staff on each technical panel serves as the project manager.
c. The project manager is the direct liaison between the technical panel and contractor, communicating panel decisions to the contractor.
d. Serves as a conduit for all information flowing between the technical panel as a whole or individual technical panel members, and the contractor.
e. Ensures project stays within scope and budget, and issues are addressed in a timely fashion.
f. Takes meeting notes prior to contracting and for those meetings not attended by the contractor. Contractor takes meeting notes after contract is in place for those meetings contractor attends.
g. Manages contractual compliance.

3. Technical Panel Chair
    a. Identifies technical panel members and makes sure they have the time and are willing and able to serve on the technical panel.
    b. Presents scope of work and business case information to RRC for approval-in-concept as described in the Research Review Committee Section on page 1.
    c. Presents business case for project and proposal technical panel recommends for funding to RRC for funding approval.
    d. Chairs, schedules, and moderates all technical panel meetings.
    e. Encourages active participation by all panel members.
    f. Helps the panel reach consensus.

Time Commitment

1. Scope and business case development – 2-8 hours.
2. Proposal review – 1-5 days if an RFP is issued; 2-4 hours if not.
3. Meetings and review of progress and interim products. – varies depending on length of project, about 1-2 hours per month.
4. Final Product Review – 1-2 days

Time commitment varies with each project.

Appendix B: On Developing a Research Project Scope of Work

RESEARCH PROGRAMS

On Developing a Research Project Scope of Work

June 2018

Updated: January 2020

Scope of Work Background and Description

MDT's Research Programs are internally driven applied research, development, and technology transfer (RD&T) programs necessary in connection with the planning, design, construction, management, and maintenance of highway, public transportation, and intermodal transportation systems. Funding is limited and to keep research relevant to MDT staff, implementable results are the goal. Implementation of research results also helps MDT in meeting its mission of providing a transportation system and services that emphasize quality, safety, cost effectiveness, economic vitality, and sensitivity to the environment. As defined by MDT, implementation means the widespread use of research results and innovations.

A well-written scope of work (SOW) is critical for the success of a project and successful implementation of research results. Researchers use the scope of work to develop a proposal, which becomes a part of the contract and describes the details of performance, providing the yardstick to which performance is measured. A good SOW is clear, complete, concise, and logical enough to be understood by researchers, technical panels, and research project managers. A SOW describes the work to be performed or the services to be provided; the goal of the research and the application of the results; the benefits and impact, including who may be impacted by the use of research results. However, it does not describe every detail of the work to be conducted, rather it specifies the required elements. This leaves the methods and details of the research approach to the expertise of the researchers and provides a mechanism to select the best research approach.

Scope of Work Content

- **Maximum Project Cost:** This is the cost identified in the Stage 2: Research Topic Statement form. This is just what it is stated to be – the maximum project cost. If a proposal comes in higher than this amount, the project may be delayed until the next year's cycle or cancelled. If a proposal comes in higher than this amount through the RFP process, it will be deemed to not meet the RFP requirements and will not be considered for funding, as meeting or beating this cost in the proposal is a pass/fail condition of the RFP.
- **Title:** The title should briefly and immediately convey to the reader what the proposed study is about. It does not have to capture every element, nuance, and expected task of the research problem. It is like the title of a book—it should attract your attention, quickly convey the subject, draw you in, and make you want to read what's inside. A good title is like a good sound bite—people will remember it.

Hint: Look at every word in your title and ask yourself if it's necessary.

- **Background:** This section sets the stage for the research. It describes the issue and indicates why we care and why we are seeking to fund the research in the first place.

- **Benefits/Business Case/ Impact:** Address urgency, timeliness, and importance of the research. Identify if the research is required for any federal or state initiative or compliance. This section must include a description of how this research will help to meet MDT's mission (i.e., serve the public by providing a transportation system and services that emphasize quality, safety, cost effectiveness, economic vitality and/or sensitivity to the environment). It should also indicate the expected outcomes, such as cost savings, improvements in safety, user benefits, and process improvements.

- **Objectives:** Describe in very brief terms the expected product(s) of the research. The objective should be short, concise, and accurate. Don't put details in the objective related to how the study will be done unless some new or innovative research methodology is the key element of the research. The details will be in the research plan and reflected in the final product. If your objective is "to produce a new fuel-efficient vehicle," say so. Don't say that the objective is "to produce a new fuel-efficient vehicle, including the design, construction, testing, and installation of all necessary components including body, frame, power train, tires, wheels, seats, mirrors, and other appurtenances to be determined through a survey of user needs, performance measures, and financial constraints." If those things need to be done to accomplish the objective, put them in task statements.

  Hint: Go back and read the advice above on titling your research statement. A very reasonable objective statement is "…to develop (insert your title).

- **Tasks:** If you have identified specific tasks that absolutely have to be part of the project work plan, include them in the SOW. However, don't let your own biases determine the research plan. Focus your attention on providing a full and accurate description of the final product(s). To the extent possible, give the proposing research team the flexibility to describe a research plan that they feel will accomplish the project objectives.

  Hint: The more detail you include in the task statements, the less opportunity a researcher has to show initiative and innovation, and the more every proposal will come in looking the same. Don't be prescriptive.

- **Acceptance:** As appropriate and only as required, establish milestones or management control points in the sequence of events where actions for review, approval, acceptance, or rejection are required.

- **Collaborators, Partners, and Stakeholders:** Identify individuals and/or organizations that need to be brought into the fold to create buy-in and acceptance of the results; review results; and/or participate in communications, decisions, and/or deployment. Specify the relationship and roles.

- **Communications:** Identify any communication needs, including technology/knowledge transfer, marketing, and training. Consider such factors as the target audience, end users, communication methods, events, responsible person/area, required approvals, and efforts needed for full implementation. Timing for communications should also be considered.

- **Data Requirements:** Identify available data that may be helpful in conducting the research. Include the limits of the data, such as fields and date ranges. Identify the format, such as Excel spreadsheet or hardcopy documents. Indicate what MDT can provide to the consultant and how.

- **IT:** Identify if the project involves software, hardware, data management, or technology devices, including maintenance, that may require coordination with ISD and/or SITSD.

- **Intellectual Property:** Describe any potential intellectual property issues.

- **MDT and Technical Panel Involvement:** As much as is known at this point, identify all MDT and consultant participation needed for the project, as well as the nature and extent of this participation. For example, MDT will provide gravel samples, traffic control, core samples to the consultant. The consultant may need to provide the time frame and required quantities. Another example may be that the consultant is required to visit MDT to review project hardcopy files or the consultant is required to provide specific equipment for use during the project.

- **Deliverables:** It is critical to identify deliverables needed to implement the results of the research. Final reports, while required, cannot typically be implemented. Determine the products that will facilitate implementation. To achieve a significant impact, products must be well specified, well matched to the needs of the users, implemented in a deliberate and adaptive manner, and supported by a hospitable environment and learning processes.

- **Risks:** Identify risks to budget, resources, schedule, and scope. Identify potential mitigation measures, forewarning indicators, and contingencies. Determine impact and probability. Rate risks as high, medium, and low. Develop a plan to mitigate risks.

- **Implementation:** As much as is possible at this point, describe how the results will be implemented, who will implement the results, and any barriers to implementation and how these barriers might be reduce or eliminated. Define/describe successful implementation and activities necessary for successful implementation. Describe the criteria for judging the progress and consequences of implementation.

- **Performance Measures:** The research to be conducted should include both qualitative and quantitative performance measures if at all possible. Performance measures include such improvements as cost and time savings; improved process, safety, environmental considerations, efficiency, quality, and service; and user benefits. As much as possible, these benefits need to be quantified. This is an indication of the value of the research. Consideration needs to be given to the data that will need to be collected to report performance measures. The proposal must describe how performance measures will be quantified.

- **Timeliness:** Add a timeliness statement to all SOWs, “Time is of the essence. The proposal must be submitted (original and revised), research conducted, and deliverables submitted as detailed in the proposal and the resulting contract.”

MONTANA MDT DEPARTMENT OF TRANSPORTATION

RESEARCH PROGRAMS

Scope of Work

Date: Click to enter a date.	**Champion:** Click to enter name.	**Technical Panel Members:** Click to enter names & areas.
Solicitation Number: Click to enter # (e.g., 19-020)	**Sponsor:** Click to enter name.	
Project Number: Click to enter #.	**Research Project Manager:** Click to enter name.	
Maximum Project Cost: Click to enter $.		
Project Title: Click to enter project title.		
Project URL: Click to enter project URL.		
Project Background: Click to enter text.		
Benefits/Business Case/Impact: Click to enter text.		
Objectives: Click to enter text.		
Tasks: Click to enter text.		
Acceptance: Click to enter text.		
Cooperators, Stakeholders, Partners: Click to enter name, org and role.		
Communications: Click to enter text.		
Data Requirements: Click to enter text.		
IT: Click to enter text.		
Intellectual Property: Click to enter text.		
MDT and /technical Panel Involvement: Click to enter text.		
Deliverables: Click to enter text.		
Risks: Click to enter text.		
Implementation: Click to enter text.		
Performance Measures: Click to enter text.		

Appendix C: Research Partnering Project Funding Request

Montana Department of Transportation
Research Partnering Project Funding Request

2701 Prospect Avenue
PO Box 201001
Helena, MT 59620-1001
www.mdt.mt.gov

Print Form

RESEARCH PROGRAMS

INSTRUCTIONS:

Complete this form to request funding for research projects and programs where MDT will not be the lead and will not contribute all funds for the project/program, such as AASHTO pooled fund programs/projects (TPF) and Technical Service Programs (TSP). Send completed form to the Research Programs Manager.

Part A: General Project/Program Information			
Date:	**Solicitation or Project Number:**		**Lead Entity:**
Title:			
Project/Program URL:			
Project/Program Duration:	**years**	**months**	**Project/Program Begin Date:**
Total Cost:	**Total Cost to MDT:**		**Annual Cost to MDT:**

Part B: For Bureau Chief	
	will be the Technical Representative for this project/program.
☐ **Yes** ☐ **No**	**This employee will be encouraged to request travel approval to attend panel meetings in-person, as funded by the project/program.**
☐ **Yes** ☐ **No**	**If the employee is not granted travel approval, employee will be allowed to attend via conference call or web meeting, as provided through the project/program.**
☐ **Yes** ☐ **No**	**I will annually review MDT's participation in this project/program to determine value to MDT.**
☐ **Yes** ☐ **No**	**If this project/program is funded, but becomes no longer of significant value to MDT, I will alert the Research Programs Manager.**

Part C: For Technical Representative	
☐ **Yes** ☐ **No**	**I will attend project/program meetings, as funded by the project/program.**
☐ **Yes** ☐ **No**	**If I cannot attend in-person, I will attend via conference call or web meeting, as provided**
☐ **Yes** ☐ **No**	**I will review documents and deliverables, determining their value to MDT.**
☐ **Yes** ☐ **No**	**I will complete an annual evaluation form, for this project/program, and provide comprehensive feedback on its value to MDT.**
☐ **Yes** ☐ **No**	**If this project/program is no longer of value to MDT, I will alert my Bureau Chief and the Research Programs Manager.**

Montana Department of Transportation
Research Partnering Project Funding Request

2701 Prospect Avenue
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Helena, MT 59620-1001
www.mdt.mt.gov

Print Form

Part D: MDT Benefits

Please explain the benefits MDT is expected to achieve through participation in this project/program.

Part E: Approval (Technical Representative and Bureau Chief Sections are to be completed prior to submitting form)

	☐ Yes ☐ No	
Technical Representative Name	**Technical Representative Approval**	**Date**
	☐ Yes ☐ No	
Bureau Chief Name	**Bureau Chief Approval**	**Date**
RRC Approval	☐ Yes ☐ No	**Date**

Appendix D: Research Partnering Project Annual Evaluation

Montana Department of Transportation
Research Partnering Project Annual Evaluation

2701 Prospect Avenue
PO Box 201001
Helena, MT 59620-1001
www.mdt.mt.gov

Print Form

RESEARCH PROGRAMS

INSTRUCTIONS:

Complete this form by April 30th of each year to provide an annual evaluation of your partnering project. Send completed form to the Research Programs Manager.

Part A: General Project/Program Information			
Date:	**Solicitation or Project Number:**	**Lead Entity:**	
Technical Representative:			
Title:			
Project/Program URL:			
Project/Program Begin Date:		**Project/Program End Date:**	
Annual MDT Contribution:	**Number of Years for Annual Contribution:**	**Total Contributed:**	**Total Yet to Contribute:**

Part B: Evaluation–Technical Representative		
Evaluation		
Is this project/program making progress toward stated goals?	☐ **Yes**	☐ **No**
If yes, please describe.		
If no, please explain why.		
What knowledge and/or deliverables has MDT received to date from participation in this project/program?		
Do you anticipate that any results of this project/program will be implemented/used at MDT?	☐ **Yes**	☐ **No**
If yes, please describe.		
If no, please explain why.		
Communications		
How often are meetings held?		
Are you able to attend?	☐ **Yes**	☐ **No**
Do you at least receive quarterly progress reports?	☐ **Yes**	☐ **No**
If no, please explain.		
Should MDT continue to contribute?	☐ **Yes**	☐ **No**
If yes, please explain.		
If no, please explain why.		

Montana Department of Transportation
Research Partnering Project Annual Evaluation

2701 Prospect Avenue
PO Box 201001
Helena, MT 59620-1001
www.mdt.mt.gov

Print Form

Part C: Evaluation –Bureau Chief

What benefits has participation had on your bureau, staff, and/or on MDT?		
Should MDT continue to contribute?	☐ **Yes**	☐ **No**
If yes, please explain.		
If no, please explain why.		

Part D: Approval

	☐ **Yes** ☐ **No**	
Technical Representative Name	**Technical Representative Approval**	**Date**
	☐ **Yes** ☐ **No**	
Bureau Chief Name	**Bureau Chief Approval**	**Date**

Appendix E: Research Partnering Project Close-Out Evaluation

Montana Department of Transportation
Research Partnering Project Close-Out Evaluation

2701 Prospect Avenue
PO Box 201001
Helena, MT 59620-1001
www.mdt.mt.gov

Print Form

RESEARCH PROGRAMS

INSTRUCTIONS:

Complete this form when your partnering project is complete. Send completed form to Research Programs Manager.

Part A: General Project/Program Information		
Date:	**Solicitation or Project Number:**	**Lead Entity:**
Technical Representative:		
Title:		
Project/Program Begin Date:	**Project/Program End Date:**	**Total Cost to MDT:**

Part B: Close-Out Evaluation–Technical Representative		
What Knowledge and/or deliverables did MDT receive from this project/program?		
Do you anticipate that any results of this study will be implemented at MDT?	☐ **Yes**	☐ **No**
If yes, please describe implementation activities..		
If no, please explain why.		
What value did MDT receive from participation in this project/program?		
What value did you receive from participating in this project//program?		

What benefits did participation have on your Bureau and/or MDT?

	☐ **Yes** ☐ **No**	
Technical Representative Name	**Technical Representative Approval**	**Date**
	☐ **Yes** ☐ **No**	
Bureau Chief Name	**Bureau Chief Approval**	**Date**

Appendix F: Research Project Identification, Prioritization, and Selection

MONTANA MDT DEPARTMENT OF TRANSPORTATION

RESEARCH PROGRAMS

Research Project Identification, Prioritization, & Selection

July 2019

The Research Review Committee (RRC) is the governing committee for all research conducted for MDT, regardless of funding source.

MDT's Research Programs are internally-driven applied research, development, and technology transfer (RD&T) programs necessary in connection with the planning, design, construction, management, and maintenance of highway, public transportation, and intermodal transportation systems. Funding is limited and to keep research relevant to MDT staff, implementable results are required.

Definitions of Research

- **Research** means a systematic study directed toward fuller scientific knowledge or understanding of the subject studied. It can be formally defined as a systematic controlled inquiry involving analytical and experimental activities that primarily seek to increase the understanding of underlying phenomena. Research can be basic or applied.
- **Applied Research** means the study of phenomena to gain knowledge or understanding necessary for determining the means by which a recognized need may be met. Applied research serves to answer questions or solve problems. This research tends to respond to specific problems, providing realistic solutions, with lower risk and a short-term focus. **Applied Research is a focus of MDT's Research Programs.**
- **Basic Research** means the study of phenomena, and of observable facts, without specific applications towards processes or products in mind. Basic research serves to increase knowledge and lays the foundation for advancements in knowledge that may lead to applied gains in the future. This research seeks comprehensive understanding and tends to be higher risk, with a long-term focus. In the transportation field, for the most part, basic research is conducted by the federal government, universities, and the private sector. **MDT does not conduct basic research; however, basic research can be a component of a research project if there are matching funds to conduct this research.**
- **Experimental Feature** is any material, method, and/or process that is deployed in the field through an MDT project (e.g., construction, maintenance, or safety) for the purpose of evaluating the material, method, and/or process. **Experimental Feature deployment is a focus of MDT's Research Programs.**
- **Development** means the systematic use of the knowledge or understanding gained from research and innovations, directed toward the production of useful materials, devices, systems or methods, including design and development of prototypes and processes. It includes the delivery, application,

demonstration, or assessment of products, such as through the Experimental Features Program, that have the potential to be implemented by research customers. Development tends to turn research results and innovations into useable materials, devices, systems, and methods. **Development is a focus of MDT's Research Programs.**

- **Technology or Knowledge Transfer** means the communication of knowledge with users and involves the dissemination, demonstration, training, and other activities that can lead to the adoption of a new technique or product by users and eventual implementation and innovation. It can occur at any time in the research cycle. **Technology Transfer is a focus of MDT's Research Programs.**
- **Implementation** means the widespread use of research results and innovations. Implementation activities can occur throughout the research process. While implementation itself is not an SPR-eligible activity, efforts to facilitate implementation are for the most part SPR-eligible. **Facilitating the implementation of research results and innovations is a focus on MDT's Research Programs, translating research results and innovations into practice and making MDT Research relevant to MDT staff.**

What Research is not: While research may involve some of the below activities, they are not the main component of research.

- Data collection
- Implementation of operational changes (e.g. computerizing existing processes)
- Routine testing
- Training
- IT development
- Routine and/or periodic updates of plans, data, surveys, etc.

Applicable federal regulation & law, and other resources:

- 23 CFR 420.203
- 23 USC 505
- NCHRP Synthesis Report 355: Transportation Technology Transfer: Successes, Challenges, and Needs (pages 7-8)
- NCHRP Synthesis Report 461: Accelerating Implementation of Transportation Research Results (pages 6-7)
- NCHRP Synthesis Report 768: Guide to Accelerating New Technology Adoption through Directed Technology Transfer (page 6)

Project Types

All projects, regardless of type, require a champion and sponsor; these roles may be filled by the same person if that person meets requirements for a sponsor as defined in the following text. The champion must be an MDT employee with a vested interest in the results and implementation of those results. This person typically chairs the project technical panel (TP), if one is formed (Note: Not all partnering projects will have a technical panel overseeing each project), and makes requests of and presentations

to the MDT Research Review Committee (RRC). See MDT's Research Project Technical Panel Roles and Responsibilities document in Appendix A. The sponsor is a high-level MDT manager, division or district administrator, or higher. This person agrees the topic is consistent with Department needs and goals, should be considered by a technical panel, if one is formed, and commits to ensuring implementation occurs, as appropriate. The project types are described below.

- **Administration High Priority:** Any project which the Administrative Staff deems necessary and funding is needed prior to the next annual research project funding cycle.
- **Partnering Projects/Pooled Fund Projects:** Any project where MDT will not be the sole contributor of funds, is not the lead for the project, and, funding is needed prior to the next annual research project funding cycle. Pooled fund projects (TPF) and AASHTO Technical Services Programs (TSP) are examples of partnering projects.
- **Quick Response/Small Projects:** Any project low in cost and short in duration, as defined by the latest Montana Partnership for the Advancement of Research in Transportation (MPART) agreement, and funding is needed prior to the next annual research project funding cycle. Contracts with MSU-Bozeman, Montana Tech, and UM-Missoula are executed every seven years to facilitate rapid initiation of these projects. In addition to these contracted small projects, research staff conducts quick response activities, such as literature searches and surveys of other entities.
- **Standard Research Projects:** Any project that does not qualify as any of the above.

Research Topic Solicitation

Research ideas can be submitted by anyone at any time on any research topic, as defined above; however, they may only be considered annually, unless they fall outside of the standard research project as described in the previous section. Also, as previously mentioned, all research topics require an internal champion and sponsor.

The RRC may want to identify priority research focus areas annually or on some other basis. If so, these areas are advertised when research ideas are requested. Research ideas will still be accepted on any topic; however, those addressing a priority research focus area may be ranked higher.

Submittal of research ideas and topic statements is a two-stage process. Stage 1: Anyone submits a Research Idea form (http://www.mdt.mt.gov/research/unique/solicit.shtml) by March 31st of each year. A Champion is identified in the Research Idea Form or Research staff attempt to secure a Champion for the idea. If a Champion is not identified, the idea does not move forward. If a Champion is identified, the Champion works with the MDT librarian to conduct a literature search on the topic to identify related ongoing and completed research. If research is ongoing on the topic, the Champion may wish to wait until the research is complete to identify any additional related research topics or to initiate an implementation process and/or project (Stage 2). If research on the topic is complete, the Champion will evaluate the research to determine if it meets the specific need. If so, the Champion may want to initiate an implementation process and/or project (Stage 2). If completed research does not meet the specific need, the Champion can initiate Stage 2. Implementation of research results can be a research project in and of itself; in this case, the implementation project will move forward to Stage 2. Stage 2: A Research Topic Statement form (http://www.mdt.mt.gov/research/unique/solicit.shtml) will be submitted by April 30th of each year to be considered in May to August of that same year for funding in the next federal fiscal year. Champions present their research topics to the RRC in May of each year.

It must be realized that the cost and research period estimates are only that, as the final cost and research period will be based on the chosen research methods as described in the final proposal and approved by the RRC. However, if the cost is higher than originally estimated, the project may be delayed.

MDT staff is encouraged to reach out to research staff, university staff, and others to discuss problems, rather than research needs. Once these problems are identified, potential for research solution(s) can be identified. Likewise, individuals interested in conducting research for MDT should make connections with MDT staff in their area of expertise to discuss MDT issues and the potential for research solution(s), matching researcher areas of expertise to MDT research needs. However, Research Topic Statements become the property of MDT and no entity is guaranteed to receive research contracts for their topic statements. Technical panels choose to contract directly with a public entity, issue an RFP, or to submit to another research program, such as the National Cooperative Highway Research Program (NCHRP). If a topic statement is submitted by a public entity, the panel will consider recommending the funding for the public entity first.

Topic statement champions will present their topic to the RRC and District Administrators annually at the May RRC meeting.

Research Topic Prioritization and Selection for Standard Research Projects

Who: RRC and District Administrators

When: Annually in June, July, or August, after champions present at the May RRC meeting

How: The process is described below.

The RRC and District Administrators will rank the topic statements after the champion presentations in May, but by the deadline set for receipt of June, July, or August RRC meeting agenda items. Items to be considered in the ranking include:

- Priority research focus areas (e.g., TranPlanMT focus areas that lend themselves to research);
- Scope, budget, and timeline are appropriate for available resources (limited funds need to be allocated to highest priorities) and timeliness/urgency of topic;
- Importance (e.g., federal or state initiative or compliance);
- Benefits and pay-off (including as they relate to MDT's mission and "strategic plan"; e.g., return on investment, cost/lives savings, etc.);
- Implementability; and
- Feasibility/probability of success/risk (What is success?)

Also, the RRC and District Administrators should identify additional technical panel members by naming individuals and/or stakeholder groups/entities. In addition, they should identify topic statements where they feel the requested funding is insufficient and identify an amount they feel is sufficient. Finally, rankers should identify any topic statements which they feel should not move forward.

Research staff will compile the rankings, projects identified for potentially not moving forward, proposed technical panel members, and funding level changes, along with changes to estimated ICAP. This information will be discussed at the June, July, or August RRC meeting. The results of which will be a

final ranking, identification of panel members, funding level, and identification of topic statements that will not be moved forward.

At the June, July, or August RRC meeting, funding will be assigned to research topics based on their ranking, final estimated cost, and funding source(s), until all estimated available funds for research projects have been committed. Partial funding for projects will not be considered, unless, it makes sense to phase the project or it is a partnering project and the project is entirely funding by all of the partners. While funding is allocated to projects at this point, funding is not approved. Final funding approval occurs when each project proposal is presented to the RRC.

A 15%, of total available funds, contingency should be held back to cover potential project costs higher than the original estimate and other needs that arise, such as Administration High Priority Projects, as described below.

Research Topic Development and Proposal Solicitation for Standard Research Projects

Technical panels will be formed for the projects approved in June, July, or August.

Technical panels will continue to fulfill their role, as identified in Appendix A, and as amended. Champions will review ongoing and completed research identified in Stage 1 with panel members. Technical panels will determine the specific research need (i.e., fine-tuning the Stage 2 Research Topic Statement into a scope of work (SOW); see Appendix B). Panels will determine the most appropriate venue for research (e.g., MDT funded research, pooled fund study, or NCHRP project). Panels may determine the need for research does not exist or the research should be submitted to another research program, in these cases, the panel will recommend the RRC cancel the project. If the technical panel recommends a project be cancelled and the RRC approves cancellation, the estimated cost is returned as available funds.

This will all be documented in the Research Project Scope of Work form (Appendix B).

Sometimes, after discussion amongst technical panel members, the scope of the project changes from the original research topic statement. When the scope changes substantially (i.e., the SOW changes from the original intent; e.g., a different champion is required), the SOW will be presented to the RRC prior to requesting proposals. Also, if the estimated cost increases by the percentage shown in the below table or more (projects estimated to cost $50,000 or less do not need additional approval), or there was any contention when the research topic statement was moved forward to a technical panel, the SOW will be presented to the RRC. Finally, the SOW for which an RFP will be issued will be presented to the RRC. Technical panels have the authority to fine-tune the SOW without RRC approval if the original intent does not substantially change, the estimated cost does not increase by the percentage shown in the below table or more, and if an RFP will not be issued.

Project Cost	Percent Increase in Project Cost
$50,000 or less	N/A
$50,001 to $100,000	30%
$100,001 to $500,000	25%
Greater than $500,000	15%

The SOW will be used to solicit a proposal(s) in one of two ways: one or more public entities may be asked to submit a proposal, or an RFP will be issued. The time for proposal development can be quite varied depending on the topic, the method for obtaining each proposal, panel availability, and other factors.

Research Project Funding

Unless stated otherwise, funding is from federal appropriations or other sources and does not refer to state budget authority. State Planning and Research (SPR) funds are legislated as a 2% set aside of the apportionments MDT receives from the Interstate Maintenance, National Highway System, Surface Transportation, Highway Bridge, Congestion Mitigation and air Quality Improvement, and Equity Bonus programs. Legislation also mandates a minimum 25% of SPR funds be allocated to RD&T activities.

The champion will present the proposal selected by the technical panel to the RRC for funding approval. The RRC may approve or reject the proposal, request clarification, or cancel the project.

If the proposed funding for a project is not more than the percentage shown in the below table greater than identified in the Stage 2: Research Topic Statement (excluding ICAP) and the proposal is approved by the RRC, the project will be contracted.

Amount of Final Proposal	Percent Over Estimate
$50,000 or less	N/A
$50,001 to $100,000	30%
$100,001 to $500,000	25%
Greater than $500,000	15%

If the proposed funding for a project is more than that identified in the above table greater than identified in the Stage 2: Research Topic Statement (excluding ICAP) and the proposal is approved by the RRC, the RRC will evaluate the availability of funds and determine if the project can be contracted at the current time. Note: Contracting for projects resulting through an RFP must occur within a specified timeframe (currently, within 6 months of the original RFP posting date), or the RFP needs to be readvertised.

Projects that don't rank high enough to receive funding in the initial cut can be disposed of in a couple of ways, as determined by the RRC: 1) Any funding assigned to projects that are later cancelled can be reassigned to the next highest ranked project(s) and technical panels can be formed for these projects or 2) Champions can resubmit these Research Topic Statements to request funding in a future federal fiscal year.

The estimated ICAP will be updated as soon as the ICAP rate is known for each successive state fiscal year (SFY), during which each project is active. If the ICAP rate increases, it will result in less funds available for non-standard research projects and/or funds available for the next cycle.

Funds will be set aside for the following projects:

- Administration of research activities by Research staff (8010 and 8020);
- MDT staff participation in research activities (8021);
- LTAP SPR (2443) (Note: LTAP is exempt from ICAP);
- NCHRP (Note: This expense is treated as a pooled fund and is exempt from ICAP);
- TRB Core Services Support (Note: This expense is treated as a pooled fund and is exempt from ICAP);
- AASHTO Technical Services Programs (TSP);
- Activities mandated ad/or to support Research, such as peer exchanges.
- WAQTC Pooled Fund (Note: This expense is exempt from ICAP)

Non-Standard Research Projects

Administration High Priority Projects

These projects are deemed high priority by Administrative Staff and funding is needed prior to the next annual solicitation for research topics. These projects are assigned technical panel oversight. As soon as projects are identified, funds are diverted to these projects.

Partnering Projects/Pooled Fund Projects

These projects are any project where MDT will not be the sole contributor of funds, MDT is not the lead, and funding is needed prior to the next annual research project funding cycle. Pooled fund projects (TPF) and AASHTO Technical Services Programs (TSP) are examples of partnering projects. Most partnering projects are assigned only a champion, as opposed to a full technical panel. TPFs are typically approved by FHWA for use of 100% SPR funds and they are not charged ICAP. However, some pooled funds are more planning in nature and do not fit the definition of research as documented above. The RRC will discuss funding these as the situations arise. Many AASHTO TSPs are approved by FHWA for use of 100% SPR funds; however, they are charged ICAP.

Funding request, annual evaluation, and close-out forms for these projects are found in Appendices C, D and E, respectively.

For multi-year partnering projects, funding may be approved for a maximum of three years and funding commitments will be made. However, it will be noted, participation in future years for which commitments have been made is dependent on the results of the annual evaluation and presentation as described above. Champions will be required to present annual progress to confirm the next year's commitment, if applicable, at the May RRC meeting. Funding decisions will be made at the June, July, or August RRC meeting.

Annual limits should be developed by the June, July, or August RRC meeting to allow contribution for current commitments and to additional partnering projects as they arise. Funding for partnering projects, will be approved on a first come, first serve basis, until the funding set aside is exhausted.

Quick Response/Small Projects

Quick Response/Small projects are any project low in cost and short in duration, as defined by the latest Montana Partnership for the Advancement of Research in Transportation (MPART) agreement, and funding is needed prior to the next annual research project funding cycle. Contracts with MSU-Bozeman, Montana Tech, and UM-Missoula are executed every seven years to facilitate rapid initiation of these projects. In addition to these contracted small projects, research staff conducts quick response activities, such as literature searches and surveys of other entities.

Annual limits should be developed by the June, July, or August RRC meeting to allow contribution for current commitments and to additional quick response/small projects as they arise. Funding for quick response/small projects, will be approved on a first come, first serve basis, until the funding set aside is exhausted.

Work Plan Development

The Research portion of the SPR work plan will be developed and approved by FHWA annually in August and September for the FFY that begins in October. All RD&T activities planned for a particular year will be included in that annual work plan. If actual costs are unknown, estimates will be included.

Appendix G: Implementation of Research Results

MONTANA MDT DEPARTMENT OF TRANSPORTATION

RESEARCH PROGRAMS

Implementation of Research Results and Innovations – Begin with the End in Mind

July 2019

Introduction

MDT's Research Programs are internally-driven applied research, development, and technology transfer (RD&T) programs necessary in connection with the planning, design, construction, management, and maintenance of highway, public transportation, and intermodal transportation systems. Funding is limited and to keep research relevant to MDT staff, implementable results are the goal. Implementation of research results also helps MDT in meeting its mission of providing a transportation system and services that emphasize quality, safety, cost effectiveness, economic vitality, and sensitivity to the environment. As defined by MDT, implementation means the widespread use of research results and innovations. While implementation itself is the responsibility of research customers and is not an SPR-B-eligible activity, Research provides support to facilitate implementation and tracks this implementation.

To enhance the chance of successful implementation, it should be considered as a driving force, an integral component of the research process serving as a constant reminder for the conduct of the research. It is a process, not an event, and must be considered from the beginning and throughout each research project, with consideration to the three key implementation drivers: competency, organization, and leadership. The competency to implement the results and sustain them must be present or developed. MDT, as an organization, must be ready for the required changes. There must be leadership buy-in and support to effect any change. A culture of implementation needs to be encouraged within the philosophy and processes of an organization.

Implementation Integration in the Research Process

Implementation is first considered in MDT's research process with the submittal of the Stage 2: Research Topic Statement form (https://www.mdt.mt.gov/research/unique/solicit.shtml), with the following directions.

- Describe how the project will address the need
- Address the implementability of the expected results from the proposed project.
- Identify products that will facilitate implementation and how these products may be used.
- Identify any known implementation barriers and how these barriers might be eliminated or reduced.
- Identify MDT office or entity outside of MDT responsible for implementation.
- Describe initial implementation plan, include timeframe for implementation.

The topic statement also requires a Champion, who is involved in the daily aspects of the research project, and a Sponsor, who is ultimately responsible for the implementation of research results. The 15 people who can sponsor research are the Division and District Administrators, the Deputy Director, and the Director. These individuals are also members of MDT's high-level Research Review Committee, which determines which Research Topic Statements will be moved forward to technical panels. Stakeholders, including potential implementers, are included on each technical panel. This helps to ensure that the process seamlessly flows from project idea through implementation, performance measurement, and determining the value of the research.

Implementation is next considered at the first technical panel meeting, through scope of work (see Appendix B) development and in Part A of the Implementation Planning and Documentation form (Appendix H), with the following considerations.

- Linking of objectives and tasks to deliverables
- Describing how the research will address the need
- Identifying key decision-makers
- Identifying the area(s) responsible for implementation
- Identifying other cooperators, stakeholders, and partners
- Identifying barriers to implementation and the actions necessary to reduce or eliminate these barriers
- Describing how the results will be implemented
- Defining successful implementation
- Identifying the benefits of implementation
- Identifying the products necessary for implementation (including any technology/knowledge transfer, marketing, and/or training activities).

  Technology/Knowledge Transfer means those activities that can lead to the adoption of a new technique or product by users and involves dissemination, demonstration, training, and other activities that may lead to eventual implementation.

  Marketing is directed towards a larger, general audience. Products can include such things as newspaper, radio, and TV outreach.

The scope of work is developed and the Implementation Planning and Documentation form is completed by the research project manager for each project. The latter begins as a planning document, with the assumption that the research will be successful and that results of the research will be implementable and is updated as new information is available. Early implementation efforts, those occurring prior to project completion, are documented as well.

It is critical that implementation requirements are included in the scope of work as it the basis for proposal development. The proposal becomes a part of the project contract and is the standard to which consultants are held. Also, demonstrating the benefits of implementation will significantly increase the chances of successful deployment.

Implementation barriers, both internal and external, are considered early on so that the barriers can be eliminated or at least reduced. Considering these barriers early on in a project greatly increases the chances for a successful project and implementation. Also, providing the researchers with the knowledge of these obstacles may influence proposal development.

Typically, final reports are not implementable. Without engaged thought and a targeted deployment strategy, the research report will often die on the shelf or in the cyber world. Therefore, products necessary for implementation are identified so that these products can be added as deliverables in the project scope, proposal, and contract. If, as the research proceeds or as it is completed, there is a need for different or additional implementation products, the contract will be amended to include the appropriate and necessary deliverables, or a separate implementation assistance contract will be executed. To achieve a significant impact, products must be well specified, well matched to the needs of the users, implemented in a deliberate and adaptive manner, and supported by a hospitable environment and learning processes.

Implementation is next considered in the project proposal (https://www.mdt.mt.gov/other/webdata/external/research/docs/proposal.pdf), with directions to describe how research results can be applied, including the following, to the extent possible.

- Describe how the research will address the need.
- Describe the form in which the findings may be reported, such as a mathematical model, a laboratory test procedure, or a design technique. Describe these results in terms of the user (e.g., practicing engineer, administrator).
- Link the objectives and tasks to deliverables and successful implementation.
- Describe activities necessary for successful implementation.
- Identify who would logically be responsible for applying the research results, such as the American Association of State Highway and Transportation Officials (AASHTO), FHWA, MDT, or a particular office within MDT.
- Identify specific standards or practices that might be affected by the research findings, such as AASHTO or MDT specifications, MDT policies and procedures, legislation, or fiscal requirements.
- Submit an implementation plan tied to performance measures describing how to implement the results. If an IT component is part of the implementation submit a work plan for update and maintenance.
- Provide an estimate of the costs of implementation.
- Identify the long-term implementation activities and costs.
- Identify barriers of implementation and how these barriers might be reduced or eliminated.
- Describe the criteria for judging the progress and consequences of implementation.
- Describe the benefits of implementation
- If the findings of a study are not suitable for immediate application in practice, the proposal should specify additional steps needed before application can occur (e.g., additional research, field testing, changes in policy, etc.).

The proposal instructions continue with the following text: *It is understood the research may produce unanticipated findings, making changes in the implementation plan necessary. This is acceptable. The proposal selection, however, will be greatly influenced by the practicality and direction of the implementation plan presented in the proposal.*

As each research project progresses, from the project kick-off meeting through the conduct of research, the Implementation Planning and Documentation form (Appendix H) is updated. The following items are discussed at the project kick-off meeting.

- Research project process
- Key contractual requirements
- Research objectives, and link to tasks and deliverables
- Research approach to meet objectives
- Data requirements
- IT requirements
- Researcher needs of the technical panel
- Implementation barriers and actions to reduce or eliminate barriers
- Products, including those necessary for implementation
- Implementation process, including key players
- Benefits and impact of research (Both qualitative and quantitative performance measures will be captured and documented in the Performance Measures Report)
- Research performance measures
- Research timeline

Also, as research results are available, implementation can occur at any time in the research process and early implementation is enhanced with the requirement of project task reports. However, implementation recommendations and an implementation plan defining the procedure to introduce the results into practice are documented in final deliverables.

These recommendations are discussed at the project implementation meeting, along with MDT's response to each recommendation. This information is summarized in the implementation report, which requires a review and approval by the technical panel and the Sponsor. The final researcher presentation to the technical panel is also given at this meeting.

This triggers the completion of Part C in the Implementation Planning and Documentation form (Appendix H), which includes the following information for each implementation activity.

- Implementation Activity Description
- Required Resources, including an itemized cost for implementation, source of funds, tools, and any approvals needed
- Continuing Barriers, Planned Resolution, and Results
- Individual Responsible for Activity
- Begin Date
- Deadline

- Follow-up Schedule
- Updated Date
- Update Description
- Implementation Status
- Comments

Implementation Categories are listed below. These categories are not mutually exclusive and are updated with each update to the Implementation Planning and Documentation form (Appendix H).

- Change in practice (e.g., business practice, design, methods, plan, policies, procedures, process, regulation, rule, specification, standard)
- Current Practice Validation
- Data Collection and/or Processing
- Decision Support Tool, Simulation, Model, or Algorithm: New or Improved
- Demonstration
- Developmental: The research produces a new or modified material, method, device, system, or technology, including design and development of prototypes and processes.
- Equipment, Technology, or Tool: New or Improved
- Feasibility/Proof of Concept
- Field Guide, Guidelines, Handbook, or Manual: New or Improved
- Further Work Needed
- Information-Only/Knowledge Gained
- Information Dissemination/Training: New or Improved
- Product Evaluation

The implementation stages or statuses are listed below; these statuses are mutually exclusive and are updated with each update to the Implementation Planning and Documentation form (Appendix H).

- **Further Work Needed:** Further research, such as another phase or an Experimental Features project, and/or further preparation, such as an organizational change, are needed before implementation can begin.
- **Implementation Pending:** Implementation is planned but has not yet begun.
- **Implementation in Progress:** Implementation is actively proceeding.
- **Partially Implemented:** The implementation activity is not and will not be fully implemented.
- **Fully Implemented:** The implementation activity is complete as described or modified and is in wide use.
- **Not Implemented:** The implementation activity will not proceed to implementation.
- **Not Applicable for Implementation:** The project did not produce an implementable activity.

Research results indicating the current situation is the best alternative should be considered as implemented. Also, projects initiated to only provide information to staff are also considered implemented when the information is provided.

At this time, the champion presents the research, results, and planned implementation to MDT's high-level Research Review Committee.

Implementation for each research project is tracked as described in the Implementation Planning and Documentation form (Appendix H) until all implementation activities are complete or it is clear there will be no additional implementation. At this point this form is finalized, with a sign-off by the project champion and sponsor.

Beyond MDT Research: Implementing the Research Results and Innovations of Others

In addition to the implementation of MDT research results, MDT Research makes a deliberate and focused effort to identify the implementation of innovations from MDT staff and the innovations and research results from other organizations and programs, such as the AASHTO Innovation Initiative (AII), FHWA Accelerated Innovation Deployment (AID), FHWA Every Day Counts (EDC), FHWA Exploratory Advanced Research (EAR), TRB Innovations Deserving Exploratory Analysis (IDEA) programs and other research programs, that can either directly or with some additional work be implemented within MDT. There is no need to reinvent the wheel. In many cases, the research results and innovations from other entities can be directly implemented or implemented with little additional effort. MDT Research documents and quantifies the value of doing so as they result in a large cost savings to MDT, leveraging the funds from others. There are a number of key questions related to this implementation, including the following:

- Is the innovation implementation ready or does additional work need to be conducted to make it so? Is it feasible to deploy within MDT's environment?
- What are the qualitative and quantitative impacts of this implementation? Is data available or can it be generated to quantify the benefits?
- How does the innovation apply to MDT's mission, strategic goals, and performance measures?
- How is the innovation an improvement over the as is condition?
- What is the timeframe for implementation?
- What resources are required for implementation and to sustain the implementation of the innovation?
- How broadly does the innovation apply to MDT?
- What are the barriers to implementation and how can they be overcome?
- What are the risks?

There are a number of efforts to capture this information on research results and innovations that can be implemented by MDT.

- On a continuing basis, MDT Research identifies the implementation of innovations. For those innovations that can be quantified, data is collected to calculate value such as benefit/cost and return on investment. This ongoing effort is supplemented with an annual survey.
- When customers request literature searches from library staff, they are asked if they found that which they were seeking. If so and results will be implemented, implementation is documented,

and performance measures identified, documented, and those quantitative performance measures are calculated.

- When MDT staff participate on panels for pooled fund and TRB Cooperative Research Programs, such as NCHRP, they are required to complete a Partnering Project Close-Out form (Appendix E) to identify MDT implementation efforts that will follow, from which performance measures are identified, documented, and those quantitative performance measures calculated. Also, staff are notified of the NCHRP Implementation Support Program, which provides funds to facilitate the implementation of the results of NCHRP projects.
- As external research reports are distributed to staff, staff are asked if they plan to implement any of the results. In addition to research final reports, many funding programs also publish implementation reports, successes, and other documents, such as TRB's Paths to Practice and Ready Results, which can facilitate implementing the results of research. If staff are planning to implement research results and innovations, implementation will be documented, and performance measures identified, documented, and those quantitative performance measures will be calculated. Also, staff are notified of the NCHRP Implementation Support Program, which provides funds to facilitate the implementation of the results of NCHRP projects.

A concerted effort is made to identify and document the implementation of research results and innovations, from both internal and external sources, to communicate and facilitate the practical use of these results and innovations, and to determine the value of this implementation value.

Implementation Funding

Implementation in itself is not an SPR-B-eligible activity. However, SPR-B funds can be used to facilitate implementation. SPR-B funds are the most common funds available for these activities. However, there are other sources of funds, such as the NCHRP Implementation Support Program, AASHTO Innovation Initiative (AII), FHWA Accelerated Innovation Deployment (AID), FHWA Every Day Counts (EDC), FHWA Exploratory Advanced Research (EAR), TRB Innovations Deserving Exploratory Analysis (IDEA) programs, and the State Transportation Innovation Councils (STIC).

Implementation Tracking

Implementation program-wide is also tracked and is an aggregation of project (both MDT Research and non-MDT Research) implementation. Implementation is tracked by project as detailed in the Implementation Planning and Documentation form for each project. It is aggregated annually in the MDT Research Annual Report.

Implementation Reporting

Implementation plans and results are reported in a number of documents, including: Project Summary, Implementation, Implementation Planning and Documentation, and Annual Research Reports.