U.S. Department of Transportation  
Research and Innovative Technology Administration  
University Transportation Center Grant Agreement  

Grant No. DTRT12-G-UTC08  
Mountain-Plains Consortium, North Dakota State University  
Denver Tolliver, Director  
Denver.tolliver@ndsu.edu  
(701)231-7190  

July 31, 2015  

DUNS: 803882299 and EIN: 45-6002439  

North Dakota State University  
Upper Great Plains Transportation Institute  
NDSU Dept. 2880, P.O. Box 6050  
Fargo, ND 58108-6050  


Reporting Period End Date:  June 30, 2015  
Semi-Annual PPPR#7  

Denver D. Tolliver  

Director, Mountain-Plains Consortium North Dakota State University
1. **Accomplishments: What was done? What was learned?**

**a. What are the major goals of the program?**

The overall objectives are to: (1) conduct basic and applied research, the products of which are judged by peers or other experts in the field of transportation to advance the body of knowledge in transportation; (2) offer an education program in transportation that includes multidisciplinary coursework and participation in research; (3) conduct workforce development activities and programs to expand the workforce of transportation professionals; (4) provide an ongoing program of technology transfer to make transportation research results available to potential users in a form that can be readily used; and (5) provide planning and technical assistance to Native American tribes, especially those heavily impacted by energy development. Other program goals are to select projects and activities using peer review principles and procedures and client input that: (1) address the Secretary’s strategic goals, and (2) leverage UTC funds with matching funds from state and local governments and private industry. The chief operational goals for grant DTRT12-G-UTC08 is to make important contributions to research and technology transfer in key areas related to the Secretary’s goals of State of Good Repair, Safety, and Economic Competiveness, while addressing critical issues of the region and stakeholder groups—especially issues in the rapidly growing Bakken oil production region.

**b. What was accomplished under these goals?**

**i. Project Selection and Peer Review**

Under grant DTRT12-G-UTC08, 87 research projects have been selected from federal fiscal year (FY) 2012 and 2013 funds. All projects have been selected through a peer review process that reflects substantial input and matching resources from state departments of transportation and other transportation agencies in the region. The projects selected under grant DTRT12-G-UTC08 are listed in Tables 1-7, under the primary strategic goal addressed by the project. Please note that many of the projects address several goals simultaneously. In particular, many projects that address State of Good Repair have potential Safety and Economic Competiveness benefits.

**Table 1: MPC Research Projects Most Directly Correlated with Sustainability**

| 1. | MPC-354: Geotechnical Limit to Scour at Spill-through Abutments (Year 2) |
| 2. | MPC-361: Building a Framework for Transportation Resiliency and Evaluating the Resiliency Benefits of Light Rail Transit in Denver, Colorado |
| 4. | MPC-390: Design and Construction Monitoring of Surcharged Embankment |
| 5. | MPC-392: Evaluation of Spliced Sleeve Connections for Precast Reinforced Concrete Bridge Piers |
| 6. | MPC-393: Traffic Modeling of Transit Oriented Development |
| 7. | MPC-396: Extent, Severity, and Location of Chip Seal Loss on the South Dakota State Road Network |

**Table 2: MPC Research Projects Most Directly Correlated with Safety**

| 1. | MPC-354: Geotechnical Limit to Scour at Spill-through Abutments (Year 2) |
| 2. | MPC-366: Structural Health Monitoring of Highway Bridges Subjected to Overweight Trucks, Phase I – Instrumentation Development and Validation |
| 3. | MPC-367: Developing Statistical Models for Crash Severity Comparing Statewide, County and Indian Reservation Roads |
| 4. | MPC-368: Teen Drivers: Crash Factor Analysis |
| 5. | MPC-373: Damage Assessment, Characterization, and Modeling for Enhanced Design of Concrete Bridge Decks in Cold Regions |
| 6. | MPC-375: Small Railroad Capital Investment Needs and Financial Options |
| 7. | MPC-378: MEMS Sensors for Transportation Structures |
8. MPC-380: Investigation of Interactions Between Traffic Law Enforcement and Driving Behavior on Rural Highways in Colorado
9. MPC-381: Performance-based Interaction Analysis of Damage on Bridge Expansion Joints and Heavy Traffic
10. MPC-382: Seismic Behavior of Steel Bridges with Fatigue-prone Details
11. MPC-386: Use of Travel Time, Travel Time Reliability, and Winter Condition Index Information for Improved Operation of Rural Interstates
12. MPC-397: Evaluation and Mitigation of Vehicle Impact Hazard for Overpass Bridges in South Dakota
13. MPC-386: Use of Travel Time, Travel Time Reliability, and Winter Condition Index Information for Improved Operation of Rural Interstates
14. MPC-397: Evaluation and Mitigation of Vehicle Impact Hazard for Overpass Bridges in South Dakota
15. MPC-402: Seismic Performance of SCC Bridge Columns
16. MPC-406: Risk- and Reliability-Based Approaches to Analyzing Road Geometric Design Criteria
17. MPC-407: The Effect of Multi-tasking on Self-Assessments of Driving Performance Center for the Prevention of Distracted Driving
18. MPC-408: Exploring Unique Plastic-Reinforced Bridge Decks: Phase I
19. MPC-409: Identification of Low-Risk Adjusted Work Schedules Designed to Manage Fatigue During Peak Service Demand Periods in the Short line Railroad Industry
20. MPC-416: Development and Testing of Crashworthy Ipe Bridge Rails
21. MPC-418: 400 South Corridor Assessment
22. MPC-425: Building a Sustainable GIS Framework for Supporting a Tribal Transportation Program
23. MPC-431: Connected Vehicle Weather Data for Operation of Rural Variable Speed Limit Corridors
24. MPC-433: Real-Time Traffic Management to Maximize Throughput of Automated Vehicles
25. MPC-434: A Bicycle Network Analysis Tool for Planning Applications in Small Communities
27. MPC-438: Calibration of HSM Predictive Methods on Rural State and Local Highways

Table 3: MPC Research Projects Most Directly Correlated with State of Good Repair

1. MPC-354: Geotechnical Limit to Scour at Spill-through Abutments (Year 2)
2. MPC-366: Structural Health Monitoring of Highway Bridges Subjected to Overweight Trucks, Phase I – Instrumentation Development and Validation
3. MPC-373: Damage Assessment, Characterization, and Modeling for Enhanced Design of Concrete Bridge Decks in Cold Regions
4. MPC-375: Small Railroad Capital Investment Needs and Financial Options
5. MPC-378: MEMS Sensors for Transportation Structures
6. MPC-379: Plastic-Aluminum Composites in Transportation Infrastructure
7. MPC-382: Seismic Behavior of Steel Bridges with Fatigue-prone Details
8. MPC-383: Seismic Performance of Highway Embankments
9. MPC-387: Comprehensive GIS-Based Rural Regional Transportation Planning Models
10. MPC-390: Design and Construction Monitoring of Surcharged Embankment
11. MPC-394: Quantifying Uncertainty in Nondestructive Bridge Inspection Methods for use in Performance Based Inspection
12. MPC-394: Quantifying Uncertainty in Nondestructive Bridge Inspection Methods for use in Performance Based Inspection
14. MPC-396: Extent, Severity, and Location of Chip Seal Loss on the South Dakota State Road Network
15. MPC-397: Evaluation and Mitigation of Vehicle Impact Hazard for Overpass Bridges in South Dakota
16. MPC-400: Evaluation of Ice Loads on Bridge Piers in South Dakota (Years 2 & 3)
17. MPC-402: Seismic Performance of SCC Bridge Columns
18. MPC-404: Seismic Performance of Concrete Filled Steel Tube (CFST) Bridge Columns for Accelerated
Bridge Construction
19. MPC-405: Seismic Retrofit of Spliced Sleeve Connections for Precast Bridge Piers
20. MPC-406: Risk- and Reliability-Based Approaches to Analyzing Road Geometric Design Criteria
22. MPC-410: Predicting Fatigue Service Life Extension of RC Bridges with Externally Bonded CFRP Repairs
23. MPC-411: Re-Use of Mine Waste Materials Amended with Fly Ash in Transportation Earthwork Projects
24. MPC-412: Fatigue Strength of CFRP-repaired Reinforced Concrete Bridge Girders under Service Temperature
25. MPC-414: Quantifying Sustainability Metrics for Trunkline Bridges in the Mountain Plains Region
26. MPC-415: Framework of Performance-Based Earthquake Design of Curved and Skewed Bridges
27. MPC-419: Experimental and Numerical Study for the Debonding Interface between an Existing Pavement and a New Concrete Overlay
28. MPC-421: Seismic Rehabilitation of Skewed and Curved Bridges Using a New Generation of Bulking Restrained Braces
29. MPC-422: Highway Structures Supported on Expanded Polystyrene (EPS) Embankment without Deep Foundations
30. MPC-425: Building a Sustainable GIS Framework for Supporting a Tribal Transportation Program
31. MPC-427: Fire Performance of Bridge Members Retrofitted with Near-Surface-Mounted Carbon Fiber Reinforced Polymer Composites
32. MPC-428: Using Recycled Concrete Aggregate in New Concrete Construction
33. MPC-429: A Methodology for Developing a Replacement Strategy for County/City Owned Bridges
34. MPC-430: Implementation of Intelligent Compaction Technologies for Road Constructions in Wyoming
35. MPC-434: A Bicycle Network Analysis Tool for Planning Applications in Small Communities
36. MPC-437: Fiber Reinforced Concrete for Structure Component
37. MPC-439: Precast Bridge Girder Details for Improved Performance
38. MPC-440: Tolerances for Placement of Tie Bars in Portland Cement Concrete Pavements
39. MPC-441: Developing a Pavement Management System for Small Communities
40. MPC-442: Improving Rural Emergency Medical Services (EMS) through Transportation System Enhancements, Phase II
41. MPC-443: Bridge Structure Alternatives for Local Roads
42. MPC-444: Data-driven Freeway Performance Evaluation Framework for Project Prioritization and Decision Making
43. MPC-445: A Sensor Fusion Approach to Assess Pavement Condition and Maintenance Effectiveness

Table 4: MPC Research Projects Most Directly Correlated with Economic Competitiveness

<table>
<thead>
<tr>
<th>MPC Project Code</th>
<th>Project Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. MPC-354</td>
<td>Geotechnical Limit to Scour at Spill-through Abutments (Year 2)</td>
</tr>
<tr>
<td>3. MPC-366</td>
<td>Structural Health Monitoring of Highway Bridges Subjected to Overweight Trucks, Phase I – Instrumentation Development and Validation</td>
</tr>
<tr>
<td>4. MPC-375</td>
<td>Small Railroad Capital Investment Needs and Financial Options</td>
</tr>
<tr>
<td>5. MPC-379</td>
<td>Plastic-Aluminum Composites in Transportation Infrastructure</td>
</tr>
<tr>
<td>6. MPC-380</td>
<td>Investigation of Interactions Between Traffic Law Enforcement and Driving Behavior on Rural Highways in Colorado</td>
</tr>
<tr>
<td>7. MPC-381</td>
<td>Performance-based Interaction Analysis of Damage on Bridge Expansion Joints and Heavy Traffic</td>
</tr>
<tr>
<td>8. MPC-382</td>
<td>Seismic Behavior of Steel Bridges with Fatigue-prone Details</td>
</tr>
<tr>
<td>9. MPC-384</td>
<td>Understanding Public Perceptions of Different Revenue Generation Systems for Highway Construction and Maintenance</td>
</tr>
<tr>
<td>10. MPC-387</td>
<td>Comprehensive GIS-Based Rural Regional Transportation Planning Models</td>
</tr>
<tr>
<td>11. MPC-395</td>
<td>Accelerated Bridge Construction in South Dakota: Pilot Study for Implementation Strategy</td>
</tr>
</tbody>
</table>
12. MPC-396: Extent, Severity, and Location of Chip Seal Loss on the South Dakota State Road Network  
13. MPC-397: Evaluation and Mitigation of Vehicle Impact Hazard for Overpass Bridges in South Dakota  
14. MPC-402: Seismic Performance of SCC Bridge Columns  
15. MPC-408: Exploring Unique Plastic-Reinforced Bridge Decks: Phase I  
16. MPC-418: 400 South Corridor Assessment  
17. MPC-422: Highway Structures Supported on Expanded Polystyrene (EPS) Embankment without Deep Foundations  
18. MPC-425: Building a Sustainable GIS Framework for Supporting a Tribal Transportation Program  
19. MPC-426: Does the Livability of a Residential Street Depend on the Characteristics of the Neighboring Street Network?  
20. MPC-427: Fire Performance of Bridge Members Retrofitted with Near-Surface-Mounted Carbon Fiber Reinforced Polymer Composites  
22. MPC-435: Realization of a Coarse Position Verification System for an Automated Highway System  
23. MPC-437: Fiber Reinforced Concrete for Structure Component  
24. MPC-439: Precast Bridge Girder Details for Improved Performance  
25. MPC-440: Tolerances for Placement of Tie Bars in Portland Cement Concrete Pavements  
26. MPC-443: Bridge Structure Alternatives for Local Roads  
27. MPC-445: A Sensor Fusion Approach to Assess Pavement Condition and Maintenance Effectiveness  

Table 5: MPC Research Projects Most Directly Correlated with Livable Communities  

<table>
<thead>
<tr>
<th>Project Number</th>
<th>Project Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>MPC-361: Building a Framework for Transportation Resiliency and Evaluating the Resiliency Benefits of Light Rail Transit in Denver, Colorado</td>
</tr>
<tr>
<td>2.</td>
<td>MPC-379: Plastic-Aluminum Composites in Transportation Infrastructure</td>
</tr>
<tr>
<td>3.</td>
<td>MPC-380: Investigation of Interactions Between Traffic Law Enforcement and Driving Behavior on Rural Highways in Colorado</td>
</tr>
<tr>
<td>4.</td>
<td>MPC-381: Performance-based Interaction Analysis of Damage on Bridge Expansion Joints and Heavy Traffic</td>
</tr>
<tr>
<td>5.</td>
<td>MPC-387: Comprehensive GIS-Based Rural Regional Transportation Planning Models</td>
</tr>
<tr>
<td>6.</td>
<td>MPC-392: Evaluation of Spliced Sleeve Connections for Precast Reinforced Concrete Bridge Piers</td>
</tr>
<tr>
<td>7.</td>
<td>MPC-393: Traffic Modeling of Transit Oriented Development</td>
</tr>
<tr>
<td>8.</td>
<td>MPC-408: Exploring Unique Plastic-Reinforced Bridge Decks: Phase I</td>
</tr>
<tr>
<td>9.</td>
<td>MPC-417: Evaluation and Development of Livability and Sustainability Programs for Indian Reservations</td>
</tr>
<tr>
<td>10.</td>
<td>MPC-418: 400 South Corridor Assessment</td>
</tr>
<tr>
<td>11.</td>
<td>MPC-425: Building a Sustainable GIS Framework for Supporting a Tribal Transportation Program</td>
</tr>
<tr>
<td>12.</td>
<td>MPC-426: Does the Livability of a Residential Street Depend on the Characteristics of the Neighboring Street Network?</td>
</tr>
<tr>
<td>13.</td>
<td>MPC-436: Using Flocculation to Reduce Turbidity of Construction Site Runoff</td>
</tr>
<tr>
<td>14.</td>
<td>MPC-438: Calibration of HSM Predictive Methods on Rural State and Local Highways</td>
</tr>
<tr>
<td>15.</td>
<td>MPC-444: Data-driven Freeway Performance Evaluation Framework for Project Prioritization and Decision Making</td>
</tr>
</tbody>
</table>

Table 6: MPC Research Projects Most Directly Correlated with Environmental Sustainability  

<table>
<thead>
<tr>
<th>Project Number</th>
<th>Project Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>MPC-411: Re-Use of Mine Waste Materials Amended with Fly Ash in Transportation Earthwork Projects</td>
</tr>
<tr>
<td>2.</td>
<td>MPC-414: Quantifying Sustainability Metrics for Trunkline Bridges in the Mountain Plains Region</td>
</tr>
<tr>
<td>3.</td>
<td>MPC-416: Development and Testing of Crashworthy Ipe Bridge Rails</td>
</tr>
<tr>
<td>4.</td>
<td>MPC-417: Evaluation and Development of Livability and Sustainability Programs for Indian Reservations</td>
</tr>
<tr>
<td>5.</td>
<td>MPC-418: 400 South Corridor Assessment</td>
</tr>
<tr>
<td>6.</td>
<td>MPC-421: Seismic Rehabilitation of Skewed and Curved Bridges Using a New Generation of Bulking Restrained Braces</td>
</tr>
</tbody>
</table>
7. MPC-428: Using Recycled Concrete Aggregate in New Concrete Construction
8. MPC-436: Using Flocculation to Reduce Turbidity of Construction Site Runoff
9. MPC-441: Developing a Pavement Management System for Small Communities
10. MPC-442: Improving Rural Emergency Medical Services (EMS) through Transportation System Enhancements, Phase II

Table 7: MPC Education Projects

1. MPC-385: Educational and Workforce Development Proposal: STEM Outreach at Colorado State University
2. MPC-403: Web-based Decision Support Tool for Traffic Management and Work Zone Analysis
3. MPC-424: Educational and Workforce Development Proposal: Ethics and Academic Conduct

ii. Educational Accomplishments

The transportation and transportation-related courses offered during Spring and Summer 2015 are listed in Table 8, organized by major subject area. In some cases, courses with the same titles were offered at more than one MPC university. In these cases, the number of courses offered is shown in parenthesis.

Table 8: Transportation and Transportation-Related Courses Offered This Reporting Period

<table>
<thead>
<tr>
<th>Major Subject Area</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering &amp; Design</td>
<td>Advanced Concrete Design</td>
</tr>
<tr>
<td></td>
<td>Advanced Geotechnical Testing and Lab</td>
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<td></td>
<td>Advanced Reinforced Concrete</td>
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<tr>
<td></td>
<td>Advanced Steel Behavior and Design</td>
</tr>
<tr>
<td></td>
<td>Advanced Street &amp; Highway Design</td>
</tr>
<tr>
<td></td>
<td>Bridge Engineering and Hazards</td>
</tr>
<tr>
<td></td>
<td>Concrete Design II Undergraduate</td>
</tr>
<tr>
<td></td>
<td>Concrete Science Graduate</td>
</tr>
<tr>
<td></td>
<td>Design of Reinforced Concrete Structures</td>
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<tr>
<td></td>
<td>Engineering Surveying</td>
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<tr>
<td></td>
<td>Finite Element Method</td>
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<td></td>
<td>Geographic Information Systems for Civil Engineers</td>
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<td></td>
<td>Geometric Design of Highways</td>
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<tr>
<td></td>
<td>Geotechnical Engineering and Lab</td>
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<tr>
<td></td>
<td>GIS in Civil and Environmental Engineering</td>
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<tr>
<td></td>
<td>Highway and Traffic Engineering</td>
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<tr>
<td></td>
<td>Highway Bridge Engineering</td>
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<tr>
<td></td>
<td>Highway Design Undergraduate</td>
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<tr>
<td></td>
<td>Highway Engineering</td>
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<tr>
<td></td>
<td>Hydraulic Engineering</td>
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<tr>
<td></td>
<td>Infrastructure and Utility Management</td>
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<tr>
<td></td>
<td>Introduction to Geotechnical Engineering</td>
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<td></td>
<td>Introduction to Transportation Engineering</td>
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<td></td>
<td>Materials and Lab</td>
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<td></td>
<td>Pavement Materials</td>
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<td></td>
<td>Slope Stability and Retaining Structures</td>
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<tr>
<td></td>
<td>Soil Dynamics Graduate</td>
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<td></td>
<td>Steel Design</td>
</tr>
<tr>
<td>Structural Analysis</td>
<td>Sustainable Materials Undergraduate</td>
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<td>---------------------</td>
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<tr>
<td>Freight &amp; Logistics</td>
<td>Case Studies in Logistics</td>
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<tr>
<td></td>
<td>Freight Transportation Systems</td>
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<tr>
<td></td>
<td>International Logistics Management</td>
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<td></td>
<td>Modeling for Transportation and Logistics Decision Analysis</td>
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<td></td>
<td>Transportation Logistics</td>
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<tr>
<td>Planning &amp; Environment</td>
<td>Context Sensitive Solutions</td>
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<tr>
<td></td>
<td>Enterprise Resource Planning</td>
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<tr>
<td></td>
<td>Form and Formation of Cities</td>
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<tr>
<td></td>
<td>Natural and Built Environments</td>
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<tr>
<td></td>
<td>Planning for Healthy Communities</td>
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<td></td>
<td>Quantitative Tools for Transportation Management</td>
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<td></td>
<td>Spatial Analysis in Transportation</td>
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<td></td>
<td>Transportation and Land Use</td>
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<tr>
<td></td>
<td>Transportation Law and Regulation: Domestic and International</td>
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<tr>
<td></td>
<td>Transportation Management, Leadership, and Values</td>
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<tr>
<td></td>
<td>Transportation Planning Undergraduate</td>
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<tr>
<td></td>
<td>Urban Development</td>
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<tr>
<td>Traffic &amp; Operations</td>
<td>Traffic Impact Assessment</td>
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<td></td>
<td>Transportation Engineering Undergraduate</td>
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<tr>
<td>Transportation Safety</td>
<td>Traffic and Safety Data Analysis</td>
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<td></td>
<td>Transportation Safety</td>
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<tr>
<td>Transportation Systems</td>
<td>Freight Transportation Systems</td>
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<td></td>
<td>Infrastructure and Transportation Systems</td>
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<tr>
<td></td>
<td>Intermodal Transportation Systems</td>
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<tr>
<td></td>
<td>Statistical and Econometric Analysis Graduate</td>
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<tr>
<td></td>
<td>Sustainable Transportation Systems</td>
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<td></td>
<td>Transportation Systems II</td>
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<tr>
<td></td>
<td>Transportation Systems Lab</td>
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<tr>
<td>Public Transportation</td>
<td>Passenger Transportation Systems</td>
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<td></td>
<td>Public Transportation</td>
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<td></td>
<td>Public Transportation II</td>
</tr>
</tbody>
</table>

Altogether, 61 transportation and transportation-related courses have been offered during this reporting period. Altogether, 375 transportation courses have been offered during the grant period thus far. In addition to the courses listed in Table 8, foundational courses in engineering materials, mechanics, structural analysis, and geotechnical engineering have been offered at most of the MPC universities.

### iii. Workforce Development Accomplishments

**Training** events provided for transportation professionals during this reporting period are listed below.

1. 2015 Oil & Gas Producing Counties
2. 3-State Roundtable - Construction Survey & Grade Control
3. 3-State Roundtable - Environmental Process (*CLOSED VC - NOT ON LMS*)
4. 7 Mindsets for Success & Team Building
5. Access Management Training
6. ADA
7. ADA Designing, Constructing, & Maintaining Pedestrian Facilities in the Public Right-Of-Way
8. Asphalt Crack Sealing
9. ATSSA Flagger Certification
10. ATSSA Traffic Control Technician (TCT)
11. Basic Concepts of Pavement Preservation
12. Basic Sign Installation & Maintenance Training
13. Basic Surveying
14. Basic Surveying / Grade Checking
15. Basics of a Good Road
16. Cement Seminar
17. Conflict Management: The Not So Merry-Go-Round of Conflict
18. Construction Project Management/Contract Administration
19. Deciding How to Decide
20. Delivering Leading Edge Customer Service
21. EDC Exchange
22. Full-Depth Reclamation/Cement Stabilization
24. Future Directions in Highway and Street Design and Analysis
25. Gravel Road Maintenance
26. Gravel Roads Academy
27. Guardrail Installation & Inspection
28. Heavy Equipment Operations
29. Heavy Equipment Safety Operations
30. Highway Pipe Installation
31. Highway Pipe Installation - Construction and Inspection
32. Integrated RoadsideVegetation Management
33. Intermodal Transportation Systems
34. Landslides - Slope Stability, Hydrology, Analysis, Repair & Inspection
35. Leading a Successful Change Effort
36. Legal Aspects of Traffic Control on Construction Projects
37. Legal Aspects of Traffic Control on Construction Projects (Tort Liability)
38. Managing Organizational Communication
40. ND Asphalt Conference
41. ND Construction Project Management Cert Training
42. OSHA 10 Hr. - Specifically for the Roadway Construction Industry
43. Pavement Markings for Maintenance Employees
44. PCC Joint Sealing & Resealing Methods
45. PE Review for Civil Engineers
46. Performance-Based Analysis of Geometric Design of Highways and Streets
47. Presentation for Power, Persuasion and Purpose
48. Preventing Runovers & Backovers & Roadway Safety
49. Registered Stormwater Inspector
50. Registered SWPPP Reviewer
51. Roadway Drainage
52. Seal Coat Workshop
53. Sign Truck
54. State of the Guardrail Industry
55. Street Lighting
56. Tree Trimming
57. Trenching and Shoring
58. Truck Weight Education Workshop
59. Using the Right Tools for Systemic Safety Analysis
60. Utah Career Days
61. Western Counties Sign Truck
62. Winter Road Maintenance
63. Workforce Development
64. Workplace, Equipment & Jobsite Safety
65. Workzone Training
66. WYDOT Certification in Aggregate, Asphalt, and Concrete
67. Wyoming Transportation and Safety Congress

iv. Research accomplishments

The following peer reviewed research reports/presentations were published during the period of January – June 2015 from grant DTRT12-G-UTC08 or previous grants.

<table>
<thead>
<tr>
<th>Project #</th>
<th>Title</th>
<th>Date</th>
<th>Report No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>361</td>
<td>Building a Framework for Transportation Resiliency and Evaluating the Resiliency Benefits of Light Rail Transit in Denver, Colorado</td>
<td>March 2015</td>
<td>MPC-279</td>
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<tr>
<td>354</td>
<td>Geotechnical Limit to Scour at Spill-through Bridge Abutments: Laboratory Investigation</td>
<td>March 2015</td>
<td>MPC-280</td>
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<tr>
<td>430</td>
<td>Implementation of Intelligent Compaction Technologies for Road Constructions in Wyoming</td>
<td>March 2015</td>
<td>MPC-281</td>
</tr>
<tr>
<td>374</td>
<td>An Integrated Real-Time Health Monitoring and Impact/Collision Detection System for Bridges in Cold Remote Regions</td>
<td>March 2015</td>
<td>MPC-282</td>
</tr>
<tr>
<td>433</td>
<td>Real-Time Traffic Management to Maximize Throughput of Automated Vehicles</td>
<td>March 2015</td>
<td>MPC-283</td>
</tr>
<tr>
<td>435</td>
<td>Position Verification Systems for an Automated Highway System</td>
<td>March 2015</td>
<td>MPC-284</td>
</tr>
<tr>
<td>434</td>
<td>A Bicycle Network Analysis Tool for Planning Applications in Small Communities</td>
<td>May 2015</td>
<td>MPC-285</td>
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</table>

c. How have the results been disseminated?

The results are being disseminated in a variety of ways, including: (1) workshops and conferences, (2) videoconferences, (3) online modules, (4) presentations at conferences, (5) publications, (6) webpage postings and displays, and (7) Internet-based dissemination media, including broadcast emails and webinars. These accomplishments are summarized under the products section of this report.

d. What do you plan to do during the next reporting period to accomplish the goals/objectives?

(1) Continue to offer the multidisciplinary multimodal catalogue of courses described in the prospectus and teach those courses scheduled during the academic year (2) Continue to deliver extensive programs of technical training, similar to the programs illustrated in b.iii. (3) With the guidance of the recently established North Dakota Transportation Safety Advisory Group, identify a two-year work plan to conduct safety research and technical training that addresses key Bakken-related issues, including motor carrier, railway, and pipeline safety.
(4) In conjunction with tribal partners, develop a two-year plan for tribal transportation research and technical assistance to include: a) the development of an emergency management/response guidebook, b) GIS modeling and technical assistance in traffic forecasting; and c) help in implementing road safety procedures and countermeasures on tribal roads. (5) Continue the strong MPC research programs, which will result in many new publications and journal papers. (6) Participate in conferences and workshops on transportation and energy development. (7) Collaborate with other UTCs to promote greater exchange of information and explore partnering possibilities in railway and waterway transportation. (9) Continue to involve graduate students in MPC research projects.

2. Products: What has the program produced?

a. Publications, conference papers, presentations

i. Participation in key conferences and workshops

- 2015 ASCE Structures Congress, Portland, OR
- 4th International Conference on Material Modeling, Berkeley, CA, USA
- 55th Annual Meeting of the ITE Intermountain Section, Jackson, WY
- 5th International Symposium on Highway Geometric Design, Vancouver, Canada
- American Concrete Institute's Spring 2015 Convention, Kansas City, MO
- American Society of Civil Engineers: EWRI Conference, Austin, TX, May 18-22
- Annual Meeting of the Society for Personality and Social Psychology, Long Beach, CA
- Concrete Spring Symposium, Utah State Capitol Building, Salt Lake City, UT
- Intelligent Compaction Data Management, 2-day Workshop at University of Wyoming, Laramie, WY
- Meeting of AASHTO's Subcommittee on Seismic Design of Bridges, Saratoga Springs, NY
- Meeting of the ASCE Engineering Mechanics Institute, Stanford University
- ND EPSCoR 2015 State Conference, Fargo, ND, April 2015
- Transportation Research Board (TRB) 94th Annual Meeting, Washington, D.C., January 2015
- Transportation Research Board, Low Volume Roads Conference, 2015
- UDOT Research Conference, Salt Lake City, UT
- Utah Department of Transportation Research Workshop (UTRAC), Sandy, Utah
- Western South Dakota Hydrology Meeting, Rapid City, April 15, 2015
- Workshop on Future Directions in Highway and Street Design and Analysis, Vancouver, Canada

ii. Key Journal Articles or Conference Publications

doi.org/10.1061/(ASCE)HY.1943-7900.0000996.

- Kim, M.O. and Bordelon, A. Determination of total fracture energy for fiber-reinforced concrete, American Concrete Institute Special Publication-300CD: (CD-ROM) Fracture Mechanics Applications in Concrete, Editors: C. Gaedicke and A. Bordelon, ACI Committee 446, Farmington Hills, MI, 2015. (no)
- Pei, Shiling, Nadim Wehbe, and Brittnay Kelley: Experimental study on river ice loads in South Dakota. Technical note submitted to Journal of Cold Regions Engineering (under review), MPC support is acknowledged.
- Qin, Xiao, Zhao Shen, and Nadim Wehbe: Analyzing Collision Risk between Trucks and Interstate Overpasses, Journal of Transportation Engineering (under review), MPC support is acknowledged.
- Shea, M.S., Le, T.Q., and Porter, R.J. A combined crash frequency-crash severity evaluation of geometric design decisions: entrance-exit ramp spacing and auxiliary lane presence,” Transportation Research Record: Journal of the Transportation Research Board, accepted. (yes)
- Siriwardanage, T. and Kim, Y.J. Thermomechanical behavior of NSM CFRP-concrete interface, ACI Structural Journal, American Concrete Institute (ACI) (submission number-S-2015-027: accepted)
Tasic, I., Zlatkovic, M., Martin, P.T., and Porter, R.J. Street connectivity versus street widening: enhanced street connectivity on traffic operations in transit-supportive environments, Transportation Research Record: Journal of the Transportation Research Board, accepted. (yes)


Tucker, C. and Ibarra, L. Effects of partial design strength concrete on the seismic performance of concrete-filled tube columns in accelerated bridge construction. ASCE Journal of Bridge Engineering, accepted. (yes)

Wehbe, Nadim and Walker Olson: Experimental Evaluation Of Misaligned Tie Bar Effects On PCC Pavement Longitudinal Joints, The Eighth International Structural Engineering and Construction Conference Sydney, Australia (accepted), MPC support is acknowledged


Zlatkovic, M., Porter, R.J., and Kergaye, C. Performance-based pavement marking warranty contracts: experience and lessons learned in the State of Utah,” Transportation Research Record: Journal of the Transportation Research Board, accepted. (no)

iii. Key Conference Papers


• Kim, M.O., Bordelon, A. “Numerical Study on the Cracking Behavior of Fiber Reinforced Concrete Overlay Subjected to Temperature Loading”, ASCE Cold Regions Engineering Conference July 19-22, 2015 Salt Lake City, UT. (submitted)


iv. Key Presentations
• MPC-442: Improving Rural Emergency Medical Services (EMS) through Transportation System Enhancements, Phase II, Presentation at the South Dakota EMS Annual conference
• Porter, R.J. “Past, Current, and Future Roles of Speed in Highway and Street Design,”


- Qin, X. "Calibrating HSM for South Dakota Rural Highways", Highway Safety Performance (ANB25),Safety Data, Analysis and Evaluation (ANB20),and AASHTO Joint Midyear Meeting, June 10-12, Irvine, CA.


b. Books or other non-periodical, one-time publications

- MPC-378: MEMS Sensors for Transportation Structures, Colorado State University. An additional journal article is nearly completed for submission to JASA.

C. Website(s) or other internet site(s)

Nothing to report at this time.

D. Technologies or Techniques

Nothing to report at this time.

e. Inventions, patent applications, and/or licenses?

Nothing to report at this time.

f. Other

- MPC-442: Improving Rural Emergency Medical Services (EMS) through Transportation System Enhancements, Phase II, North Dakota State University. A proposal was submitted to the Department of Public Safety/Department of Health to perform similar analysis on the cardiac care data for the state of SD.
- MPC-426: Does the Livability of a Residential Street Depend on the Characteristics of the Neighboring Street Network? University of Colorado Denver. This project has informed the design, creation, and adoption of a TRB Task Force on urban arterials and health.
- MPC-354: Geotechnical Limit to Scour at Spill-through Abutments (Year 2), University of Wyoming. An NCHRP Problem Statement: “Scour At Spill-Through Bridge Abutments – A Case For Hydraulic And Geotechnical Collaboration On Failure Modes And Countermeasures”

3. Participants and Other Collaborating Organizations: Who has been involved?

a. What individuals have worked on the program?

The principal investigators, faculty, and administrators participating in MPC project:

Six principal investigators, faculty, and administrators participating in MPC projects at Utah State University are:
Paul Barr, University Program Coordinator, PI, and collaborator; Ryan Bosworth, Co-PI; Michael Thomas, Investigator; Thidapat (Tam) Chantem, PI; Anthony Chen, PI; and Ryan Gerdes, PI. In addition, ten students are participating in MPC research projects at Utah State University: Doctorate Students – Seunkyu Ryu, Ali Soltani Sobh, Donghyung Yook, Ryan Barnes, Ruchir Chauhan; Masters Students – Divya Desiraju, Niranjan Chandrappa; Undergraduate Students – Eric Meissner, Jaque Johansen, and Jacqueline Su.

Nine principal investigators, faculty, and administrators participating in MPC projects at the University of Wyoming are: Khaled Ksaibati, University Program Coordinator, PI, and Co-PI; Robert Ettema, PI; Rhonda Young, PI; Richard J. Schmidt, PI; Kam Ng Co-PI and PI; Jennifer Tanner, PI; Debbie Shinstine, Post Doctorate; Ed Kempema, Lab Director; and James Branscomb, Engineer. Fourteen students participating in MPC research projects at the University of Wyoming: Doctorate Students: Edward Offei, Vijay Sabawat, Promoths Saha; Masters Students - Ram Chakradha, McKenzie Danforth, Darby Hacker, Rebecca Franke, Sanjay Pokharel, Bryce Fiore, Christopher Savan, Wesley Werbelow; Undergraduate Students - Chris Leclerc, and BrittonHammit. Others who participated in the projects at the University of Wyoming: Wendy Perkins, Administrator; Shaun Wulff, Statistics Professor; David Reynaud, NCHRP; Bart Bergendahl, FHWA; Larry Arneson, FHWA; WACERS; WCCA; and WYDOT.

Sixteen principal investigators, faculty, and administrators participating in MPC projects at the University of Utah: Richard J. Porter, University Program Coordinator and PI; David Sanbonmatsu, Co-PI; Peter Martin, PI; Chris P. Pantelides, PI; Lawrence D. Reaveley, Co-PI; Xuesong Zhou, PI; David Strayer, PI; Luis Ibara, PI and Co-PI; Evert Lawton, Co-PI; Cathy Liu, PI; Milan Zlatkovic, Principal Author and PI; Muhammad Farhan, Co-PI; Amanda Bordelon, PI; Jinjin Tang, Researcher and Visiting Professor; Jan Vaslestad Co-PI; and Steven Bartlett, PI. Eighteen graduate students are working on MPC research projects at the University of Utah: Doctorate Students – M.J. Ameli, Ivana Tasic, Tie Shi (visiting student), Jeffrey Taylor, Min Okk Kim, M. Scott Shea, Yuandong Wang, Anusha Musunuru, Arwen Behrends, Ramesh Neupane, Shannon Moore, and Zhuo Chen; Masters Students - Joel Parks, Dylan Brown, Catherine Tucker, Zachary Gibbs, and Anurag Upadhy; Francesco Biondi, visiting student scholar.

Thirteen principal investigators, faculty, and administrators are participating in MPC projects at South Dakota State University: Nadim Wehbe, University Program Coordinator and PI; Allen Jones, PI; Xiao Qin, PI and Co-PI; Guanghui Hua, PI; Haifa Samra, PI; Shiling Pei, PI; Daris Ormesher, Project Manager; Beverly Klein, Lab Staff; Dave Huft, Project Manager; Junwon Seo, Co-PI; Hao Wang, Subcontractor; Chad A. Comes, PE, Project Manager; and Aaron Breyfogle, Project Manager. In addition, fifteen graduate and undergraduate students are working on MPC research projects at South Dakota State University: Masters Students - Zhao Shen, Zhaoxiang He, Jacob Humburg, Micah Underberg, Michael Konrad, Walker Olson, Kofi Oppong, Brett Tigges, Brittney Ahrenstorff, Todd Pauly, Zhi Chen, Md. Razaur Shaon, Nicole Campbell, Melissa Tracy, and Abdullah Boudaqa.

Nine principal investigators, faculty, and administrators are participating in selected projects from Colorado State University: Rebecca Atadero, University Program Coordinator and PI; Paul Heyliger, PI; Suren Chen, PI; Hussam Mahmoud, PI; Mehmet Ozbek, PI; John van de Lindt, PI; Christopher Bareither, PI; Bolivar A. Senior, Co-PI; and Ward Johnson, NIST and Collaborator. In addition, sixteen graduate and undergraduate students are working on MPC research projects at Colorado State University: Doctorate Students - Xiaoxiang Ma, Kristen Peterson, Luke Chen, Akshat Chulahwat, Mehrdad Memari, Huajie Wen, and Mohammad Reza Hassanzadeh Gorakhki; Masters Students – Patrick Sanders, Chris Bright, Sultan Abdulaziz Alhoma, Tyler Sobieck, Vaishak Gopi, Nasser Alberut, Paula Miller, Thomas Wilson, and Robert Lankford.

Altogether, nine principal investigators, faculty, and administrators are participating in selected projects at North Dakota State University: Kimberly Vachal, University Program Coordinator and PI; Dr. Frank Yazdani, PI; Doug Benson, PI; EunSu Lee, Co-PI and PI; Pan Lu, PI; Alan Dybing, Co-PI; Raj Bridgelall, PI; Ying Huang, Co-PI; Denver Tolliver, Director and Co-PI. In addition, eight graduate students are working on MPC projects at North Dakota State University: Doctorate Students- Poyraz Kayabas, Anne Campbell, Elvis Ndemb, Chijioke Ifepe, and
Zhiming Zhang; Masters Students- Ashkan Saboori, Sara Mamani, and Liuqing Hu.

One principal investigator, faculty, and administrator participating in MPC projects at the University of Denver include Patrick Sherry, University Program Coordinator and PI. Four graduate and undergraduate students working on MPC projects at University of Denver include: Doctoral Students - Keaton Zucker and Jessica Mantia; Masters Students- Rachel Mulholland and Wesley Pruitt.

Four principal investigators, faculty, and administrators participating in MPC projects at the University of Colorado Denver include: Wesley Marshall, University Program Coordinator and PI; Jimmy Kim, PI; Carolyn McAndrews, PI; and Bruce Janson, Faculty. Seventeen graduate and undergraduate students working on MPC projects at University of Colorado Denver include: Masters Students - Alejandro Henao, Rachael Bronson, Mahdi Alavizadeh, Greg Colucci, Zachary Heinry, Mayam Karimi, Jenny McGinnis, Abdulaziz Alqurashi, Sarah Rosenberg, Tong Wen, Shile Dong, Thushara Siriwardanage, Laia Mitchell, and Craig Fisher; Undergraduate Students- Ben Johnk and Mat Tostle.

b. What other organizations have been involved as partners?

The timing of match funding and the commitments of collaborators vary widely throughout the life of the grant. During this period, we have the following committed collaborators.

1. AAA Foundation for Traffic Safety
2. AAR John Gray, Frank Hardesty, Shannon Stare
3. Ajou University, Korea
4. ASLRRA Scott Sullivan, Elizabeth Petty, Richard Timmons
5. Association of General Contractors of South Dakota
6. City and County of Denver
7. City of Salt Lake Transportation Division
8. Colorado Department of Transportation
9. Denver Regional Council of Governments
10. Federal Highway Administration (FHWA)
11. Florida Atlantic University
12. Fort Berthold Reservation
13. FRA Administrators
15. Minnesota Department of Transportation
16. MnROAD research facility
17. National Cooperative Highway Research Program
18. National Institute of Standards and Technology, Boulder
19. NCAR
20. North Dakota Department of Transportation
21. Northern Plain TTAP Center
22. Norwegian Public Roads Administration
23. Regional Transportation District
24. South Dakota Department of Transportation
25. South Dakota Office of EMS
26. Tailings and Mine Waste (TMW) Conference Committee
27. Tarek Sayed, University of British Columbia
28. Tegracore, Industrial partner
29. Tom Streicher, Vice President, American Short Line Railroad Association
30. University of Utah Department of City and Metropolitan Planning
31. Utah Department of Transportation
32. Utah Transit Authority
33. WACERS
34. Wasatch Front Regional Council
35. Wind River Indian Reservation
36. Wyoming Department of Transportation
37. Wyoming Division of FHWA

c. Have other collaborators or contacts been involved?

The list of collaborating organizations in 3(b) is complete, as of this grant period.

4. Impact

The impacts of the program will become clearer in future years. The implementation of research findings often lags project selection and completion. However, certain impacts are emerging. The benefits of the program are already being felt in many respects.

1. **Graduate Education.** Collectively, the MPC universities offer one of the most diverse and comprehensive multimodal multidisciplinary graduate education programs in the nation. As shown earlier, 61 courses were offered in the Spring and Summer 2015 and 375 courses have been offered since the inception of the program. The impact of the educational program will increase in future years, as the MPC universities expand the number of courses offered through their existing exchange program, in which students from any MPC university can take courses from other universities. These courses must be placed online for the collaborative exchange to work most effectively. Considerable progress has been made, thus far, in converting classroom courses to online courses and increasing the reach of the program.

2. **Workforce Development.** MPC’s technical training program is having a major impact in the region. Online modules, short courses, webinars, and on site/videoconferencing events are reaching state and local transportation department employees and tribal transportation planners. By harnessing the capabilities of the four LTAP centers located at the MPC universities and the multimedia capabilities of the Transportation Learning Network (which was founded and is partly funded by MPC) more than 30 technical training events were offered in the first half of 2015. These training modules and short courses are critical to transportation agencies that need to improve or renew the skills of engineering technicians and other frontline workers. Many MPC courses or training events result in the certification of workers. Even when certification is not required, TLN’s online learning management systems allow employees and employers to set learning goals and monitor progress towards these goals.

MPC is making another major impact in workforce development. Altogether, 102 graduate students are working on MPC research projects under the tutelage of faculty researchers. These graduate students represent the researchers and technical analysts of tomorrow. Without the MPC program and the stipend funds that it provides, these students may not be specializing in transportation; but, instead would be seeking career opportunities in other fields. The MPC research program allows faculty to mentor graduate students while allowing the students to work on projects for federal and state transportation agencies—thereby, gaining valuable practical experience.

3. **Tribal Transportation Technical Assistance.** The program is already having a major impact in terms of providing tools and assistance for Native American tribes in the region, especially those impacted by energy development in Wyoming and North Dakota. To better coordinate and plan tribal-related activities, NDSU has designated a tribal transportation program coordinator to help the director identify
critical needs and leverage resources to meet those needs. Technical assistance is already being provided in road safety, GIS transportation model building, forecasting heavy truck traffic attributable to energy development, and facilities planning. An emergency response planning guidebook (to help tribes plan for and respond to natural disasters that impact the transportation system and the delivery of life-saving services) is currently under development and will be disseminated within the region and the western United States when completed.

4. Research. During this rating period eight research projects have been completed and final reports published that address critical regional and national issues. Multiple journal articles and conference papers have been derived from each project, increasing their reach and impact. MPC’s strategy of requiring journal articles and presentations at national conferences (such as TRB and the Transportation Research Forum) is greatly magnifying the impacts of the research projects and MPC reports.

5. Leadership. MPC researchers and program administrators are having a major impact through participation in TRB, TRF, ITE, and other national organizations and conferences. Moreover, MPC is a leader in responding to the dynamic and sometimes unprecedented transportation demands and issues posed by shale energy development. MPC research projects in Wyoming and North Dakota are helping impacted states and local/tribal governments develop long-term road and bridge investment strategies. The newly formed North Dakota Transportation Safety Advisory Group (which includes representation from NDOT, North Dakota Highway Patrol, FRA, PHMSA, and FMCSA) is identifying critical research projects for 2015-2016 and leveraging technical assistance and training for transportation operators, emergency responders, and state and local planners. Even though MPC’s primary focus is State of Good Repair, MPC has responded quickly to urgent requests for safety training and research in light of the unprecedented issues associated with the transportation of Bakken crude oil via rail, pipeline, and truck.

5. Changes/Problems - Nothing to report at this time.

5a. Additional Information Regarding Products and Impacts - Nothing to report at this time.

PROGRAM OUTPUTS: Nothing to report at this time.

PROGRAM OUTCOMES: Nothing to report at this time.

PROGRAM IMPACTS: Nothing to report at this time.

6. SPECIAL REPORTING REQUIREMENTS: None