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, 2014

DUNS: 803882299 and EIN: 45-6002439

North Dakota State University
Upper Great Plains Transportation Institute NDSU Dept. 2880,
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Reporting Period End Date: June 30, 2014 Semi-Annual
PPPR#5

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 are 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 Competitiveness, while addressing critical issues of the region and stakeholder groups—especially issues in the rapidly growing Bakken oil production region. Under grant DTRT13-G-UTC38, the focus will shift more toward State of Good Repair. However, some safety emphasis is still necessary, given the issues posed by the transportation of Bakken crude oil by rail and truck.

b. What was accomplished under these goals?

i. Project Selection and Peer Review

Under grant DTRT12-G-UTC08, 47 research projects have been selected from federal fiscal year (FY) 2011 funds—which were received in 2012. An additional 37 research projects have been selected from FY 2012 funds—which were received in 2013. 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 1-6, 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 Competitiveness benefits.

Table 1: 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: Effectiveness of Advisory Letter in Preventing At-Risk Teen DriverCrashes: Pilot Project |
| 5. MPC-369: ND Motor Crash Analysis and Rider Assessment for ImprovedConspicuity |
| 6. MPC-370: Anticipatory Guidance for Older Drivers |
| 7. MPC-371: Decision Support for Strategic Truck Safety and Weight Enforcement Planning |
| 8. MPC-373: Damage Assessment, Characterization, and Modeling for Enhanced Design of Concrete Bridge Decks in Cold Regions |
| 10. MPC-375: Small Railroad Capital Investment Needs and Financial Options |
| 11. MPC-378: MEMS Sensors for Transportation Structures |
| 12. MPC-380: Investigation of Interactions between Traffic Law Enforcement and Driving Behavior on Rural Highways in Colorado |
| 13. MPC-381: Performance-based Interaction Analysis of Damage on Bridge Expansion Joints and Heavy Traf |
14. MPC-382: Seismic Behavior of Steel Bridges with Fatigue-prone Details
15. MPC-386: Use of Travel Time, Travel Time Reliability, and Winter Condition Index Information for Improved Operation of Rural Interstates
16. MPC-397: Evaluation and Mitigation of Vehicle Impact Hazard for Overpass Bridges in South Dakota
17. MPC-401: Review of Road User Costs (RUC) and Methods
18. MPC-402: Seismic Performance of SCC Bridge Columns
19. MPC-406: Risk- and Reliability-Based Approaches to Analyzing Road Geometric Design Criteria
20. MPC-407: The Effect of Multi-tasking on Self-Assessments of Driving Performance Center for the Prevention of Distracted Driving
22. MPC-416: Development and Testing of Crashworthy Ipe Bridge Rails
23. MPC-418: 400 South Corridor Assessment
24. MPC-423: Impact of Energy Sector Growth on Perceived Transportation Safety in the Seventeen County Oil Region of Western North Dakota: A Longitudinal Analysis
25. MPC-425: Building a Sustainable GIS Framework for Supporting a Tribal Transportation Program
26. MPC-431: Connected Vehicle Weather Data for Operation of Rural Variable Speed Limit Corridors
27. MPC-438: Calibration of HSM Predictive Methods on Rural State and Local Highways

Table 2: MPC Research Projects Most Directly Correlated with State of Good Repair

<table>
<thead>
<tr>
<th>Project Code</th>
<th>Project Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPC-354</td>
<td>Geotechnical Limit to Scour at Spill-through Abutments (Year 2)</td>
</tr>
<tr>
<td>MPC-365</td>
<td>Improved Understanding of Pavement Impacts and Cost-Effective Designs Based on Mechanistic Empirical Methods</td>
</tr>
<tr>
<td>MPC-366</td>
<td>Structural Health Monitoring of Highway Bridges Subjected to Overweight Trucks, Phase I – Instrumentation Development and Validation</td>
</tr>
<tr>
<td>MPC-371</td>
<td>Decision Support for Strategic Truck Safety and Weight Enforcement Planning</td>
</tr>
<tr>
<td>MPC-372</td>
<td>A Novel Methodology for Quantifying the Performance of Constructed Bridges in Cold Regions: Development, Assessment, and Repair</td>
</tr>
<tr>
<td>MPC-373</td>
<td>Damage Assessment, Characterization, and Modeling for Enhanced Design of Concrete Bridge Decks in Cold Regions</td>
</tr>
<tr>
<td>MPC-374</td>
<td>An Integrated Real-Time Health Monitoring and Impact/Collision Detection System for Bridges in Cold Remote Regions</td>
</tr>
<tr>
<td>MPC-375</td>
<td>Small Railroad Capital Investment Needs and Financial Options</td>
</tr>
<tr>
<td>MPC-376</td>
<td>Improved Understanding of Pavement Impacts and Cost-Effective Designs Based on Mechanistic-Empirical Methods</td>
</tr>
<tr>
<td>MPC-378</td>
<td>MEMS Sensors for Transportation Structures</td>
</tr>
<tr>
<td>MPC-379</td>
<td>Plastic-Aluminum Composites in Transportation Infrastructure</td>
</tr>
<tr>
<td>MPC-382</td>
<td>Seismic Behavior of Steel Bridges with Fatigue-prone Details</td>
</tr>
<tr>
<td>MPC-383</td>
<td>Seismic Performance of Highway Embankments</td>
</tr>
<tr>
<td>MPC-387</td>
<td>Comprehensive GIS-Based Rural Regional Transportation Planning Models</td>
</tr>
<tr>
<td>MPC-390</td>
<td>Design and Construction Monitoring of Surcharged Embankment</td>
</tr>
<tr>
<td>MPC-391</td>
<td>Implementation of Low Temperature Test for Asphalt Mixtures to Improve the Longevity of Road Surfaces</td>
</tr>
<tr>
<td>MPC-395</td>
<td>Accelerated Bridge Construction in South Dakota: Pilot Study for Implementation Strategy</td>
</tr>
<tr>
<td>MPC-394</td>
<td>Quantifying Uncertainty in Nondestructive Bridge Inspection Methods for use in P B I</td>
</tr>
<tr>
<td>MPC-396</td>
<td>Extent, Severity, and Location of Chip Seal Loss on the South Dakota State Road Network</td>
</tr>
<tr>
<td>MPC-397</td>
<td>Evaluation and Mitigation of Vehicle Impact Hazard for Overpass Bridges in South Dakota</td>
</tr>
<tr>
<td>MPC-398</td>
<td>Selection of Discount Rates for Infrastructure Investment</td>
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<tr>
<td>MPC-400</td>
<td>Evaluation of Ice Loads on Bridge Piers in South Dakota (Years 2 &amp; 3)</td>
</tr>
<tr>
<td>MPC-401</td>
<td>Review of Road User Costs (RUC) and Methods</td>
</tr>
<tr>
<td>MPC-402</td>
<td>Seismic Performance of SCC Bridge Columns</td>
</tr>
</tbody>
</table>
25. MPC-404: Seismic Performance of Concrete Filled Steel Tube (CFST) Bridge Columns For Accelerated Bridge Construction
26. MPC-405: Seismic Retrofit of Spliced Sleeve Connections for Precast Bridge Piers
27. MPC-406: Risk- and Reliability-Based Approaches to Analyzing Road Geometric Design Criteria
28. MPC-410: Predicting Fatigue Service Life Extension of RC Bridges with Externally Bonded CFRP Repairs
29. MPC-411: Re-Use of Mine Waste Materials Amended with Fly Ash in Transportation Earthwork Projects
30. MPC-412: Fatigue Strength of CFRP-repaired Reinforced Concrete Bridge Girders under Service Temperature
31. MPC-413: A Pilot Case Study to Evaluate the Potential Impact and Benefit of adopting and Implementing BIM on Bridge and Infrastructure Projects
32. MPC-414: Quantifying Sustainability Metrics for Trunkline Bridges in the Mountain Plains Region
33. MPC-415: Framework of Performance-Based Earthquake Design of Curved and Skewed Bridges
34. MPC-419: Experimental and Numerical Study for the Debonding Interface Between an Existing Pavement and a New Concrete Overlay
35. MPC-421: Seismic Rehabilitation of Skewed and Curved Bridges Using a New Generation of Bulking Restrained Braces
36. MPC-422: Highway Structures Supported on Expanded Polystyrene (EPS) Embankment without Deep Foundations
37. MPC-423: Impact of Energy Sector Growth on Perceived Transportation Safety in the Seventeen County Oil Region of Western North Dakota: A Longitudinal Analysis
38. MPC-425: Building a Sustainable GIS Framework for Supporting a Tribal Transportation Program
39. MPC-427: Fire Performance of Bridge Members Retrofitted with Near-Surface-Mounted Carbon Fiber Reinforced Polymer Composites
40. MPC-428: Using Recycled Concrete Aggregate in New Concrete Construction
41. MPC-429: A Methodology for Developing a Replacement Strategy for County/City Owned Bridges
42. MPC-430: Implementation of Intelligent Compaction Technologies for Road Constructions in Wyoming
43. MPC-437: Fiber Reinforced Concrete for Structure Component
44. MPC-439: Precast Bridge Girder Details for Improved Performance
45. MPC-440: Tolerances for Placement of Tie Bars in Portland Cement Concrete Pavements
46. MPC-441: Developing a Pavement Management System for Small Communities
47. MPC-442: Improving Rural Emergency Medical Services (EMS) through Transportation System Enhancements, Phase II
48. MPC-443: Bridge Structure Alternatives for Local Roads
49. MPC-444: Data-Driven Freeway Performance Evaluation Framework for Project Prioritization and Decision Making
50. MPC-445: A Sensor Fusion Approach to Assess Pavement Condition and Maintenance Effectiveness

Table 3: MPC Research Projects Most Directly Correlated with Economic Competitiveness

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-375: Small Railroad Capital Investment Needs and Financial Options
4. MPC-379: Plastic-Aluminum Composites in Transportation Infrastructure
5. MPC-380: Investigation of Interactions Between Traffic Law Enforcement and Driving Behavior on Rural Highways in Colorado
6. MPC-381: Performance-based Interaction Analysis of Damage on Bridge Expansion Joints and Heavy Traffic
7. MPC-382: Seismic Behavior of Steel Bridges with Fatigue-prone Details
8. MPC-384: Understanding Public Perceptions of Different Revenue Generation Systems for Highway Construction and Maintenance
9. MPC-387: Comprehensive GIS-Based Rural Regional Transportation Planning Models
11. MPC-396: Extent, Severity, and Location of Chip Seal Loss on the South Dakota State Road Network
12. MPC-397: Evaluation and Mitigation of Vehicle Impact Hazard for Overpass Bridges in South Dakota
13. MPC-398: Selection of Discount Rates for Infrastructure Investment
14. MPC-401: Review of Road User Costs (RUC) and Methods
15. MPC-402: Seismic Performance of SCC Bridge Columns
16. MPC-408: Exploring Unique Plastic-Reinforced Bridge Decks: Phase I
17. MPC-418: 400 South Corridor Assessment
18. MPC-422: Highway Structures Supported on Expanded Polystyrene (EPS) Embankment without Deep Foundations
19. MPC-425: Building a Sustainable GIS Framework for Supporting a Tribal Transportation Program
20. MPC-426: Does the Livability of a Residential Street Depend on the Characteristics of the Neighboring Street Network?
21. MPC-427: Fire Performance of Bridge Members Retrofit with Near-Surface-Mounted Carbon Fiber Reinforced Polymer Composites
22. MPC-437: Fiber Reinforced Concrete for Structure Component
23. MPC-439: Precast Bridge Girder Details for Improved Performance
24. MPC-440: Tolerances for Placement of Tie Bars in Portland Cement Concrete Pavements
25. MPC-443: Bridge Structure Alternatives for Local Roads

Table 4: 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>MPC-361</td>
<td>Building a Framework for Transportation Resiliency and Evaluating the Resiliency Benefits of Light Rail Transit in Denver, Colorado</td>
</tr>
<tr>
<td>MPC-376</td>
<td>Improved Understanding of Pavements Impacts and Cost-Effective Designs Based on Mechanistic-Empirical Methods</td>
</tr>
<tr>
<td>MPC-379</td>
<td>Plastic-Aluminum Composites in Transportation Infrastructure</td>
</tr>
<tr>
<td>MPC-380</td>
<td>Investigation of Interactions between Traffic Law Enforcement and Driving Behavior on Rural Highways in Colorado</td>
</tr>
<tr>
<td>MPC-381</td>
<td>Performance-based Interaction Analysis of Damage on Bridge Expansion Joints and Heavy Traffic</td>
</tr>
<tr>
<td>MPC-387</td>
<td>Comprehensive GIS-Based Rural Regional Transportation Planning Models</td>
</tr>
<tr>
<td>MPC-392</td>
<td>Evaluation of Spliced Sleeve Connections for Precast Reinforced Concrete Bridge Piers</td>
</tr>
<tr>
<td>MPC-393</td>
<td>Traffic Modeling of Transit Oriented Development</td>
</tr>
<tr>
<td>MPC-399</td>
<td>Improving Rural Emergency Medical Services (EMS) through Transportation System Enhancements</td>
</tr>
<tr>
<td>MPC-408</td>
<td>Exploring Unique Plastic-Reinforced Bridge Decks: Phase I</td>
</tr>
<tr>
<td>MPC-417</td>
<td>Evaluation and Development of Livability and Sustainability Programs for Indian Reservations</td>
</tr>
<tr>
<td>MPC-418</td>
<td>400 South Corridor Assessment</td>
</tr>
<tr>
<td>MPC-425</td>
<td>Building a Sustainable GIS Framework for Supporting a Tribal Transportation Program</td>
</tr>
<tr>
<td>MPC-426</td>
<td>Does the Livability of a Residential Street Depend on the Characteristics of the Neighboring Street Network?</td>
</tr>
<tr>
<td>MPC-436</td>
<td>Using Flocculation to Reduce Turbidity of Construction Site Runoff</td>
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<tr>
<td>MPC-438</td>
<td>Calibration of HSM Predictive Methods on Rural State and Local Highways</td>
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<tr>
<td>MPC-444</td>
<td>Data-Driven Freeway Performance Evaluation Framework for Project Prioritization and Decision Making</td>
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Table 5: MPC Research Projects Most Directly Correlated with Environmental Sustainability

<table>
<thead>
<tr>
<th>Project Number</th>
<th>Project Title</th>
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</thead>
<tbody>
<tr>
<td>MPC-411</td>
<td>Re-Use of Mine Waste Materials Amended with Fly Ash in Transportation Earthwork Proj</td>
</tr>
</tbody>
</table>
2. MPC-414: Quantifying Sustainability Metrics for Trunkline Bridges in the Mountain Plains Region
3. MPC-416: Development and Testing of Crashworthy Ipe Bridge Rails
4. MPC-417: Evaluation and Development of Livability and Sustainability Programs for Indian Reservations
5. MPC-418: 400 South Corridor Assessment
6. MPC-421: Seismic Rehabilitation of Skewed and Curved Bridges Using a New Generation of Bulking Restained Braces
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 6: 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: Ethics and Academic Conduct

ii. Educational Accomplishments

The transportation and transportation-related courses offered during Spring & Summer 2014 are listed in Table 7, 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 7: Transportation and Transportation-Related Courses Offered This Reporting Period

<table>
<thead>
<tr>
<th>Major Subject Area</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>Engineering &amp; Design</td>
<td>Advanced Concrete Design</td>
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<td></td>
<td>Advanced Foundation Engineering</td>
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<td></td>
<td>Advanced Steel Behavior and Design</td>
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<td></td>
<td>Advanced Street and Highway Design</td>
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<td></td>
<td>Concrete Science</td>
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<td></td>
<td>Design of Timber Structures</td>
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<td>Finite Element Method</td>
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<td></td>
<td>Geotechnical Engineering and Lab</td>
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<td></td>
<td>GIS in Civil and Environmental Engineering</td>
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<tr>
<td></td>
<td>Highway Design</td>
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<td></td>
<td>Highway Engineering (2)</td>
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<td></td>
<td>Hydraulics Engineering</td>
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<td></td>
<td>Pavement Design</td>
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<td></td>
<td>Prestressed Concrete</td>
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<td></td>
<td>Soils</td>
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<td></td>
<td>Steel Design</td>
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<td>Structural Dynamics</td>
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<td></td>
<td>Structural Earthquake Engineering</td>
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<tr>
<td>Freight &amp; Logistics</td>
<td>Adaptive Planning/Logistics Systems</td>
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<td></td>
<td>Advanced Supply Chain Planning/Enterpr</td>
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<td>Logistics Decision Analysis</td>
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<td>Supply Chain Strategy</td>
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<thead>
<tr>
<th>Planning &amp; Environment</th>
<th>Context Sensitive Solutions</th>
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<tr>
<td></td>
<td>Crisis Analysis/Homeless Security</td>
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<td></td>
<td>Form and Formation of Cities</td>
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<td>Natural and Built Environments</td>
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<td>Planning for Healthy Communities</td>
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<td>Spatial Analysis/Transportation</td>
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<td>Sustainable Materials</td>
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<td>Transportation and Land Use</td>
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<td>Transportation Planning</td>
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<td>Transportation Systems Modeling</td>
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<td>Urban Development</td>
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<td>Urban Planning and Site Impact Development</td>
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<tr>
<th>Traffic &amp; Operations</th>
<th>Highway and Traffic Engineering</th>
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<tr>
<td></td>
<td>Quantitative Tools for Transportation Management</td>
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<td>Traffic Impact Assessment</td>
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<td>Traffic Operation</td>
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<td>Transportation Management</td>
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<thead>
<tr>
<th>Transportation Safety</th>
<th>Cognitive Psychology</th>
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<tbody>
<tr>
<td></td>
<td>Human Performance and Engineering</td>
</tr>
<tr>
<td></td>
<td>Traffic and Safety Data Analysis</td>
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<td>Transportation Safety</td>
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<tr>
<th>Transportation Systems</th>
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<tr>
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<td>Infrastructure and Transportation Systems</td>
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<td>Passenger Transportation Systems</td>
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<td>Sustainable Transportation Systems</td>
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<td>Transportation Finance</td>
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<td>Transportation Law and Regulation: Domestic and International</td>
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<td>Transportation Marketing and Sales Tools</td>
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<td>Transportation Systems II</td>
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<td>Transportation Systems Lab</td>
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Altogether, 52 transportation and transportation-related courses have been offered during this reporting period. Altogether, 255 transportation courses have been offered during the grant period thus far. In addition to the courses listed in Table 7, 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. Access Management (Webinar)
2. Ethics in the Workplace, Community Transportation Association of America
3. ADA - Designing, Constructing & Maintaining Pedestrian Facilities in the Public Right-of-Way
4. Aggregate Testing Certification (2)
iv. Research accomplishments
The following peer reviewed research reports/presentations were published in 2014 from grant DTRT12-G-UTC08 or previous grants.

<table>
<thead>
<tr>
<th>Project #</th>
<th>Title</th>
<th>Date</th>
<th>Report No.</th>
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</thead>
<tbody>
<tr>
<td>330</td>
<td>Integrate Supply Chain Model in Urban Freight Planning</td>
<td>Dec 2013</td>
<td>MPC 13-259</td>
</tr>
<tr>
<td>335</td>
<td>Misinformation Contributing to Safety Issues in Vehicle Restraints for Children</td>
<td>Dec 2013</td>
<td>MPC 13-264</td>
</tr>
</tbody>
</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 4 or more 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
   - 2014 TRB 93rd Annual Conference
   - 10th National Conference on Earthquake Engineering (NCEE)
   - 2014 ASCE Geocongress
• 2014 Intermountain GIS Conference
• 2014 ITE Utah Chapter Annual Conference
• 2nd T&DI Congress of the American Society of Civil Engineers
• ACI 2014 Spring Convention
• ACI Spring Convention
• American Society of Civil Engineers Annual Structures Congress
• Annual Meeting of the American Psychological Science Association
• ASCE T&DI Congress 2014
• ASCE-EWRI Water-Resources & Environment Conference
• Association of Logistics and Supply Chain Management
• Community Transportation Association of America
• Congress for the New Urbanism Annual Meeting
• Federal Highway Administration’s Massive Data Convening Panel
• FHWA: Intelligent Compaction Data Management Workshop
• Future Concrete Institute (ACI) 2014
• Geo-Congress 2014, Geo-Characterization and Modeling for Sustainability, Geo-Institute of the American Society of Civil Engineers
• Global Waste Management Symposium
• ITE Colorado-Wyoming Section Transportation Symposium
• ITE Intermountain Section 54th Annual Meeting
• ITE Western District Annual Meeting 2014
• IX International Conference on Structural Dynamics
• Law Enforcement Summit
• ND Motor Carrier Association Annual Meeting
• Non-Destructive Surface Analysis of Composites and Polymers by Handheld FTIR (Webinar)
• North Dakota Strategic Highway Safety Plan Conference
• SPIE: Sensors and Smart Structures Technologies for Civil, Mechanical, and Aerospace Systems, Smart Structures/ NDE 2014
• Traffic Modeling of Transit Oriented Development
• Utah Asphalt conference
• Utah Society of Professional Engineers Annual Conference
• Wind River Indian Reservation: Livability Stakeholders Meeting
• Wind River Indian Reservation: Safety Fair
• Women in Transportation Workshop

ii. Key Journal Articles or Conference Publications
• Al Wakeel, S., Kim, Y.J., Deng, Y.J. Performance of bridge decks in a cold region and a high-fidelity sensing system for damage detection, American Concrete Institute (ACI) Special Publication on Advanced Materials and Sensors toward Smart Concrete Bridges: Concept, Performance, Evaluation, and Repair, 187-206, 2014
• Clevenger, C., Fanning, B., Ozbek, M.E., Mahmoud, H.N. "Implementing BIM on Infrastructure: A Comparison of Two Bridge Construction Projects" has been accepted for publication by ASCE's Practice Periodical on Structural Design and Construction.
• Ettema, Robert, Kam Ng, Ram Chakradhar, Joshua Fuller, and Edward W. Kempema. Failure of Spill-through Bridge Abutments during Scour: Flume and Field observations. ASCE Journal of Hydraulic Engineering.
• Kubas, Andrew and Kimberly Vachal. Oil County Traffic Safety: A Perspective of Western North Dakota Residents. Transportation Research Record. Accepted. 2014.
• Musunuru, A. and Porter, R.J. A Reliability-Based Geometric Design Approach for Selecting the Basic Number of Freeway Lanes, Transportation Research Record, Journal of the Transportation Research Board, 2014, accepted for publication.
• Namrou, A.R. and Kim, Y.J. An experimental investigation into the behavior of concrete elements retrofitted with NSM composite strips at elevated temperatures, American Concrete Institute (ACI) Special Publication on Advanced Materials and Sensors toward Smart Concrete Bridges: Concept, Performance, Evaluation, and Repair, 225-239, 2014.

iii. Key Conference Papers
- Kim, Y.J., Hyun, S.W., Yoshitake, I., Kang, J.-Y, and Seo, J. A composite-bonded steel substrate with silyl-modified polymer exposed to thermal distress, Probabilistic Safety Assessment and Management (PSAM 12), Honolulu, HI, 2014.
iv. Key Presentations

- Debbie Shinstine and Khaled Ksaibati "Safety Improvement Programs for Indian Reservations", Advisory Board Meeting for the Northern Plain TTAP Center, Fort Morgan, SD. South Dakota Tribal Safety Summit, May 21, 2014.
- Debbie Shinstine and Khaled Ksaibati "Safety Improvement Programs for Indian Reservations", Advisory Board Meeting for the Northern Plain TTAP Center, Fort Morgan, SD. South Dakota Tribal Safety Summit, May 21, 2014.
- Kim, Y.J., Hyun, S.W., Yoshitake, I., Kang, J.-Y, and Seo, J. A composite-bonded steel substrate with silyl-modified polymer exposed to thermal distress, Probabilistic Safety Assessment and Management (PSAM 12), Honolulu, HI, 2014.
- Kubas, Andrew and Kimberly Vachal. "Oil County Traffic Safety: A Perspective of Western North Dakota Residents." 93rd annual meeting of the Transportation Research Board,


- McMullen, M., Pei, S., and Wehbe, N. "Accelerated Bridge Construction in South Dakota: Pilot Study for Implementation Strategy." Final presentation of the research results has been presented to the SDDOT Research Review Board.


- Porter, R.J. Hitting the Ground Running: Choosing and Navigating a Successful Transportation Career Path in Academia, Session 107 of the 93rd Annual Meeting of the Transportation Research Board, Washington, D.C., January 12, 2014.


- Tasic, I., Musunuru, A., and Porter, R.J. Quantifying Accessibility of Non-Motorized Transportation Modes in Recreational Areas: Case Study of Mill Creek Canyon, Utah, Session

- Wehbe, N. and Pauly, T. "Square SCC Bridge Columns under High Lateral Drifts," American Concrete Institute (ACI) 2014 Spring Convention. Reno, NV.

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


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

- The MPC website is fully operational at: http://www.mountain-plains.org/
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-375(Small Railroad Capital Investment Needs and Financial Options) provided small railroad data to FRA; advice FRA on report to OST and Congress
- MPC-390(Design and Construction Monitoring of Surcharged Embankment) held interim technical advisory committee meeting with UDOT
- MPC-422(Highway Structures Supported on Expanded Plystyrene (EPS) Embankment without Deep Foundations) developed software (analytical) model to evaluate the seismic stability
- MPC-354(Geotechnical Limit to Scour at Spill-through Abutments (Year 2), Ram Chakradhar. "Laboratory Investigation of Geotechnical and Hydraulic Processes in Abutment Scour." MS Thesis, University of Wyoming and produced a NCHRP-AASHTO Problem Statement that was included in the SCOR list of such statements.
- MPC-367(Developing Statistical Models for Crash Severity Comparing Statewide, County, and Indian Reservation Roads) developed models which were presented in a seminar at the University of Wyoming, December 1, 2013
- MPC-428(Using Recycled Concrete Aggregate in New Concrete Construction) thesis published by Mr. Darby Hacker
- MPC-430(Implementation of Intelligent Compaction Technologies for Road Construction in Wyoming) produced WYT2 Newsletter, Issue 2, 2013

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: Kevin Heaslip, University Program Coordinator and PI; Anthony Chen, PI; Ryan Bosworth, Co-PI; Michael Thomas, PI; Rebecca Winstead, TIMELab Administrator; Patricia Cramer, PI; and Thidapat (Tam) Chantem, PI. In addition, nine students are participating in MPC research projects at Utah State University: Doctorate Students - Ali Soltani Sobh, Donghyung Yook, Sarawut Jansuwan, Seunkyu Ryu, Masters Students - Joseph Flower, Divya Desiraju, Nirajan Chandrappa, Undergraduate Students - Eric Meissner and Jaque Johansen. Others participating in MPC projects at Utah State University include Hugh Boyle (a consultant).

Nine principal investigators, faculty, and administrators participating in MPC projects at the University of Wyoming are: Khaled Ksaibati, University Program Coordinator and PI; Robert Ettema, PI; Rhonda Young, PI; Richard J. Schmidt, PI; Kam Ng, Co-PI; Jennifer Tanner, PI; Debbie Shinstine, Post Doctorate; Ed Kempema, Lab Director; and James Branscomb, Engineer. Thirteen students participating in MPC research projects at the University of Wyoming: Doctorate Students: Edward Ofet, Vijay Sabawat, Promoths Saha, Zhuo Chen; Masters Students - Ram Chakradha, Mike Jung, McKenzie Danforth, Darby Hacker, Nicholas Owen, Christopher Savan; Undergraduate Students - Chris Leclerc, Mingde Lin, and Britton Hammit.
Sixteen principal investigators, faculty, and administrators participating in MPC projects at the University of Utah: Richard Porter, University Program Coordinator and PI; Steven Bartlett, PI; Peter Martin, PI; Chris Pantelides, PI; Lawrence Reaveley, Co-PI; Pedro Romero, PI; Xuesong Zhou, PI; David Strayer, PI; Luis Ibara, PI; Evert Lawton, PI; Ivana Tasic, PI; Cathy Liu, PI; Milan Zlatkovic, PI; Muhammad Farhan, PI; Amanda Bordelon, PI; and Jan Vaslestad, Co-PI. Twenty graduate and undergraduate students are working on MPC research projects at the University of Utah: Doctorate Students – M.J. Ameli, Ivana Tasic, Tie Shi, Ramesh Newpane, Min Ok Kim, M. Scott Shea; Masters Students - Crystal R. Clendennen-Pierce, Joel Parks, Dylan Brown, Jonna Turrill, Anush Musunuru, Catherine Tucker, Jeffrey Taylor, James Coleman, Arwen Behrends, Shannon Moore, Anurag Upadhay, Zach Gibbs, and Francesco Biondi, Visiting Scholar; Undergraduate Students- Dillon Lee

Seven 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; Zhiguang Wang, PI; Guanghui Hua, PI; Junwon Seo, Co-PI; and Seyed Ardakani, Co-PI. In addition, sixteen graduate and undergraduate students are working on MPC research projects at South Dakota State University: Masters Students - Brittney Ahrenstorff, Chase Cutler, Todd Pauly, Kai Wang, Zhao Shen, Zhaoxiang He, Jacob Humburg, Micah Underberg, Zhi Chen, Md. Michael Konrad, Walker Olson, and Kofi Oppong, Melissa McMullen, Brett Tigges, Abdullah Boudaqa, Kofi Oppong and Md. Razaur Rahman Shaon.

Ten 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; Caroline Clevenger, PI; John vande Lindt, PI; Ward Johnson, NIST, Collaborator; Christopher Bareither, PI; and Bolivar A. Senior, PI. In addition, fourteen graduate and undergraduate students are working on MPC research projects at Colorado State University: Doctorate Students Xiaoxiang Ma, Kristen Peterson, Luke Chen; Masters Students – Patrick Sanders, Chris Bright, Mohammad Reza Hassanzadeh Gorakhi, Sultan Abdulaziz Alhommair, Sherona Simpson, Tyler Sobieck, Nasser Alberuti, Blaine Fanning, Thomas Wilson, and Robert Lankford; Undergraduate Students - Vaishak Gopi.

Altogether, sixteen principal investigators, faculty, and administrators are participating in selected projects at North Dakota State University: Kimberly Vachal, University Program Coordinator and PI; Andrea Huseth, PI; Andrew Bratlien, Co-PI; Brenda Lantz, PI; Frank Yazdani, PI; Mijia Yang, PI; Doug Benson, PI; EunSu Lee, PI; Pan Lu, PI; Alan Dybing, Co-PI; Raj Bridgelall, PI; Ying Huang, Co-PI; Denver Tolliver, Director; Donald Malchose, Project Researcher; Laurel Benson, Research Specialists; Andrew Kubas, Ph.D. In addition, twenty-five graduate and undergraduate students are working on MPC projects at North Dakota State University: Doctorate Students- Oz Khan, Mohammad Molla, Poyraz Kayabas, Anne Campbell, Elvis Ndembe, Jaesung Choi, Qianli He, Nimish Dhamadhikari, Zijian Zheng, Yolanda Carson, Vu Dang, Chris DeHaan, Fesheha Gebremikael, Luke Holt, Chijioke Ifepe, Maher Itani, Yasaman Kazemi, Dilip Mistry, Ju Dong Park, Yong Shin Park, Azadeh Jaberi (CE), Niloy Saha (CE), Saeed Ahmari (CE), Debbie Shinstine (Univ of Wyoming); Masters Students- Mike Telste.

One principal investigators, faculty, and administrators participating in MPC projects at the University of Denver include Patrick Sherry, University Program Coordinator and PI. Three graduate and undergraduate students working on MPC projects at University of Denver include: Doctoral Students - Keaton Zucker; Masters Students Rachel Mulholland and Yifan Shi.

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, PI. Seven graduate and undergraduate students working on MPC projects at University of Colorado Denver include: Doctorate Students- Shahlaa AlWakeel Masters Students - Alejandro Henao, Rachael Bronson, Abdul Namrou, Thushara Siriprachen, Laia Mitchell, and Craig Fisher.
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. American Short Line Railroad Association
4. ASLRRRA; Scott Sullivan, Elizabeth Petty, Richard Timmons
5. City and County of Denver
6. City of Madison, South Dakota
7. City of Salt Lake Transportation Division
8. Colorado DOT
9. Denver Regional Council of Governments
10. Denver Regional Transportation District
11. Department of Public Safety, Sanford Trauma
12. Florida Atlantic University, Boca Raton, FL
13. Fort Berthold Reservation
14. FRA Administrators
15. Metrolink; Los Angeles, SCARRA
16. Mineta Transportation Institute
17. Minnesota DOT
18. MnROAD Research Facility
19. National Cooperative Highway Research Program
20. National Institute of Standards and Technology, Boulder
21. NCAR
22. NCHRP
23. North Dakota Highway Patrol
24. North Dakota DOT
25. Northern Plain TTAP Center
26. Norwegian Public Roads Administration
27. Regional Transportation District
28. Sean Vonfeldt, Triunity
29. South Dakota DOT
30. Tailings and Mine Waste (TMW) Conference Committee
31. Tegracore, Industrial Partner
32. Utah DOT
33. Utah Transit Authority
34. Wasatch Front Regional Council
35. Wind River Indian Reservation
36. Wyoming Division of FHWA
37. Wyoming DOT

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, 52 courses were offered in the spring & summer 2014 and 255 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. The Master of Transportation and Urban Systems degree is offered fully online at NDSU.

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 45 technical training events were offered in the first half of 2014. 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, 107 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.** Twenty-three research projects have been completed thus far 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 NDDOT, North Dakota Highway Patrol, FRA, PHMSA, and FMCSA) is identifying critical
research projects for 2014-2015 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