- AGENDA -

2016 RESEARCH WORKSHOP

Organized by the UDOT Research Division

Salt Lake Community College – Miller Campus
9750 South 300 West, Sandy, Utah

Monday, March 28, 2016

Registration (KGMC main foyer):
7:30 – 8:30 am  Workshop Registration & Light Breakfast

General Session (KGMC):
8:30 – 9:30 am  Welcome – Tom Hales, Research Project Manager
Research Program – Cameron Kergaye, Research Director
Keynote Introduction – Nathan Lee, Director Program Development
Keynote Address – Mayor Mike Caldwell, Ogden City

First Breakout Session by Subject Area (MPDC classrooms):
9:30 am – 12:00 pm  Problem Statement discussion
Prioritization voting, Workshop feedback

Featured Subject Areas: (see map for room assignments)
1. Materials & Pavements
2. Maintenance
3. Traffic Management & Safety
4. Preconstruction
5. Planning
6. Public Transportation

Workshop Sponsored Lunch (KGMC):
12:00 – 1:00 pm  Lunch

Presentation of Trailblazer Award by: Scott Andrus, State Engineer for Materials

Second Breakout Session by Subject Area (MPDC classrooms):
1:00 – 3:00 pm  Problem Statement discussion and refinement
Prioritization voting, Workshop feedback

Adjourn Workshop:  3:00 pm
Karen G. Miller
Conference Center (KGMC)
First Floor

Miller Professional
Development Center (MPDC)
Second Floor
## BREAKOUT SESSION CONTACTS

### GROUP 1: Materials & Pavements
- **Subject Leader:** Scott Andrus, scottandrus@utah.gov, 801-965-4859
- **Research Contact:** David Stevens, davidstevens@utah.gov, 801-589-8340

### GROUP 2: Maintenance
- **Subject Leader:** Kevin Griffin, kgriffin@utah.gov, 801-965-4120
- **Research Contact:** Jason Richins, jtrichins@utah.gov, 801-360-4985

### GROUP 3: Traffic Management & Safety
- **Subject Leader:** Robert Miles, robertmiles@utah.gov, 801-965-4273
- **Research Contact:** Cameron Kergaye, ckergaye@utah.gov, 801-965-2576

### GROUP 4: Preconstruction
- **Subject Leader:** Jim Golden, jimgolden@utah.gov, 801-360-0052
- **Research Contact:** Tom Hales, tahales@utah.gov, 801-633-6226

### GROUP 5: Planning
- **Subject Leader:** Jeff Harris, jeffharris@utah.gov, 801-965-4354
- **Research Contact:** Kevin Nichol, knichol@utah.gov, 801-870-4033

### GROUP 6: Public Transportation
- **Subject Leader:** Hal Johnson, hjohnson@rideuta.com, 801-237-1905
- **Research Contact:** Tim Boschert, tboschert@utah.gov, 801-964-4508

*Updated 2/23/16*
# 2016 Research Workshop Problem Statement List

**GROUP:** 1 MATERIALS & PAVEMENTS

**Subject Leader:** Scott Andrus  
**Research Contact:** David Stevens

<table>
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<tr>
<th>Prob No.</th>
<th>Problem Title</th>
<th>Submitted By</th>
<th>Suggested Champion</th>
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<th>UDOT Cost</th>
<th>Other/Matching Funds</th>
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<td>16.01.01</td>
<td>Field Data for Low Temperature Cracking</td>
<td>Pedro Romero</td>
<td>Howard Anderson, Scott Andrus, Steve Anderson, Lonnie Merchant</td>
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<td>Cold In Place Recycle Emulsion Qualification with the Forced Cone Penetration Test</td>
<td>Kevin VanFrank</td>
<td>Howard Anderson, Scott Andrus</td>
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<td>SemiCircular Bending Test Phase III Existing Mix Valadation</td>
<td>Kevin VanFrank</td>
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<td>SemiCircular Bending Ruggedness Study</td>
<td>Tim Biel</td>
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<td>Improvement of Asphalt Recycle</td>
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<td>Photoluminescent Markings Development</td>
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<td>Inverted Base Pavement - Pooled Fund Participation</td>
<td>Jason Richins</td>
<td>Scott Andrus, Jason Richins &amp; Georgia DOT</td>
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<td>16.01.08</td>
<td>Review and Specification for Shrinkage Cracks of Bridge Decks Phase II</td>
<td>Amanda Bordelon</td>
<td>Bryan Lee, Scott Strader, or Tom Hales</td>
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<td>Development of Highly Modified Asphalt (HMA)</td>
<td>Prabhat Gupta</td>
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<td>UDOT Concrete Sustainability Calculator</td>
<td>Marc Maguire</td>
<td>Bryan Lee, Tom Hales</td>
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<td>Feasibility of Instrumenting and Monitoring Designated Roadway Sections in Utah</td>
<td>David Stevens</td>
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<td>Chris Pantelides</td>
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<td>Efficiency of Nox Air Pollution Reduction with TIO2 Coatings</td>
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<td>Jason Richins</td>
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<td>$60,000</td>
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<td>Mobile Data Collection Device</td>
<td>Reuel Alder</td>
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<td>Recommended Snow Plow Blade Use due to Various Factors</td>
<td>Eric Chaston</td>
<td>Todd Richins, Jack Mason, Roger Frantz</td>
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<td>Filter Systems to Produce Industrial Use Water for UDOT Maintenance Stations</td>
<td>Kevin Griffin</td>
<td>Kevin Griffin</td>
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<td>A Data Fusion Approach for Extracting Highway Maintenance Features</td>
<td>Ziqi Song</td>
<td>Rukhsana Lindsey</td>
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<td>Snow Plow Equipment Lighting - Best Practice Recommendation</td>
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<td>Smart Work Zones using End of Queue Detection Warning Systems</td>
<td>Troy C. Torgersen</td>
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<td>Developing a Method to Identify Horizontal Curves Segments with Worst Crash Histories Using the HAF Algorithm</td>
<td>Mitsuru Saito &amp; Grant G. Schultz</td>
<td>Scott Jones</td>
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<td>Effects of Converting Express Lanes from Restricted to Continuous Access on Safety and Operation</td>
<td>Mitsuru Saito &amp; Grant G. Schultz</td>
<td>Rob Clayton</td>
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<td>Analysis of Left-turn Warrants in Utah</td>
<td>Grant G. Schultz &amp; Mitsuru Saito</td>
<td>Mark Taylor/Jesse Sweeten</td>
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<td>Data Based Testing &amp; Decision Process for Traffic Signal Steel Replacement</td>
<td>Mark Taylor</td>
<td>Mark Taylor/Jesse Sweeten</td>
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<td>Connected Vehicle Dilemma Zone Awareness</td>
<td>Daniel Fagnant</td>
<td>Blaine Leonard, Scott Jones</td>
<td>14 months</td>
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<td>Assessing Prevalence and Countermeasures for Motorcycle Crashes in Utah</td>
<td>Daniel Fagnant</td>
<td>Scott Jones</td>
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<td>Index of Model Ordinances Promoting Pedestrian Safety</td>
<td>Shaunna K. Burbidge</td>
<td>Robert Miles</td>
<td>15 months</td>
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<td>Pedestrian Safety Toolbox for Elected Officials</td>
<td>Shaunna K. Burbidge</td>
<td>Robert Miles</td>
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<td>Risk Assessment of Non-Motorized Access to Rail Transit Stations</td>
<td>Shaunnna K. Burbidge</td>
<td>Robert Miles</td>
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<td>Utilizing Vehicle-To-Infrastructure Connectivity For Increased Safety</td>
<td>Spencer Taylor</td>
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<td>Evaluation of InSync Adaptive Traffic Control on Fort Union Boulevard</td>
<td>Milan Zlatkovic, Steve Laner and Joe Perrin</td>
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<td>16.03.13</td>
<td>Roadway and Roadside-Related Crash Causes in Urban Areas</td>
<td>Milan Zlatkovic</td>
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<td>Decreasing Road Failities by Using Flashlight Signs in Specific Areas</td>
<td>Yanguo Ma</td>
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<td>Traffic Ticker</td>
<td>Darcy Bullock</td>
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### 2016 RESEARCH WORKSHOP PROBLEM STATEMENT LIST

**Date Updated:** 21-Mar-16  
**GROUP:** 4 PRECONSTRUCTION

**Subject Leader:** Jim Golden  
**Research Contact:** Tom Hales

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<th>Prob No.</th>
<th>Problem Title</th>
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<td>16.04.01</td>
<td>Project Management in Transportation Engineering - National Best Practices</td>
<td>Jim Golden</td>
<td>Jim Golden</td>
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<td>16.04.02</td>
<td>Efficiency of Nox Air Pollution Reduction with TIO2 Coatings</td>
<td>Amanda Bordelon</td>
<td>Jason Richins</td>
<td>2 years</td>
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<td>Investigation of iPhone APP &quot;Traffic Control on the Fly&quot;</td>
<td>Sara Colosimo</td>
<td>Rob Wight, PJ Roubinet, Shawn Lambert</td>
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## 2016 RESEARCH WORKSHOP PROBLEM STATEMENT LIST

**Date Updated:** 21-Mar-16  
**GROUP:** 5 PLANNING  
**Subject Leader:** Jeff Harris  
**Research Contact:** Kevin Nichol

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<td>Analysis of Bicycle Infrastructure in Utah</td>
<td>Grant G. Schultz and Shaunna Burbidge</td>
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<td>Trip and Parking Generation by TODs Phase II</td>
<td>Reid Ewing</td>
<td>Jeff Harris</td>
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<td>Does Compact Development Increase or Reduce Traffic Congestion?</td>
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<td>Daniel Fagnant</td>
<td>Jeff Harris/Angelo Papastamos</td>
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<td>Incorporating Reliability Performance Measures into Transportation Planning</td>
<td>Cathy Liu</td>
<td>Jeff Harris</td>
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<td>Improving Long-term Passing Lane Needs Identification on Rural Utah Highway</td>
<td>Charles Allen</td>
<td>Walt Steinworth</td>
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<td>Using EERPAT to Model Disruptive Technologies in Utah</td>
<td>Kordel Braley</td>
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<td>Coping with Traffic: How Different Residential Locations Affect Personal Travel and Emissions</td>
<td>Douglas Eisinger</td>
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<td>Ran Wei</td>
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<td>An Intrastate Passenger Rail System for Utah Using Existing Tracks</td>
<td>Mike Christensen</td>
<td>Jeff Harris</td>
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<td>Analysis of a Connector-Feeder Shared Autonomous Vehicle System</td>
<td>Daniel Fagnant</td>
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<td>Understanding Transit Ridership: Using Regression Analysis to Generate Ridership Forecasts for Better Performance Measurement of Transit Agencies</td>
<td>Torrey Lyons</td>
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<td>Quantifying Effects of Spatial Coverage and Temporal Frequency of Transit Service on Ridership</td>
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<td>Optimal Deployment of Wireless Charging Facilities for an Electric Bus System</td>
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<td>Development of Methodologies and Algorithms for Adaptive Transit Signal Priority</td>
<td>Milan Zlatkovic</td>
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<td>Traffic Impact Analysis of Downtown SLC Streetcar Deployment</td>
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<td>Return on Investment for Bus Stop Investments</td>
<td>Keith Bartholomew &amp; Heidi Goedhart</td>
<td>Jeff Harris &amp; Jake Splan (UTA)</td>
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<td>Economic Viability and Architecture Optimization of Wireless Power Transfer for Public Trans.</td>
<td>Jason Quinn</td>
<td>Hal Johnson</td>
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<td>The Effect of Air Quality on Transit Ridership Patterns and Associated Vehicle Emissions</td>
<td>John Lin</td>
<td>Hal Johnson</td>
<td>16 months</td>
<td>$20,000</td>
<td>$25,000</td>
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<td>16.06.12</td>
<td>Electric Bus Advanced Battery Management System</td>
<td>Regan Zane</td>
<td>Hal Johnson</td>
<td>13 months</td>
<td>$50,000</td>
<td>$70,000</td>
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Title: Smart Work Zones using End of Queue Detection Warning Systems

Submitted By: Troy C. Torgersen
Email: ttorgersen@utah.gov

Organization: Region Four - UDOT
Phone: 435-896-1303

1. Describe the problem to be addressed.
   For years we, as a Department have struggled with using technology to make our Work Zones Smarter. One of the systems that other states are using is an End of Queue Warning System. This is something that could reduce or prevent rear end crashes while reducing the injuries resulting from them.

2. Explain why this research is important.
   Had two fatalities over the last two years because motorists were not aware of the end of queue.

3. List the research objective(s):
   1. Determine existing systems that currently are being used.
   2. Evaluate and come up with specifications and standards for the implementation of End of Queue Systems on UDOT Construction Zones.

4. List the major tasks:
   1. Research of existing systems
   2. Development of specifications and standards
   3. Working with either procurement or other means to make them available for use on projects

5. List the expected results:
   1. Standards and Specifications
   2. Ability to select the option of using the system on projects

6. Describe how this research will be implemented.
   Hopefully we can implement EOQ systems on our projects in the near future.

7. Requested from UDOT: $ Other/Matching Funds: $ Total Cost: $

8. Outline the proposed schedule, including start and major event dates.
   Start asap and get something in place for implementation next construction season.
1. Describe the problem to be addressed.
As part of the Traffic Safety Data Research 2014-2015 funded by UDOT, an algorithm to identify horizontal curves, their beginning and ending points and their radii, named the Horizontal Alignment Finder (HAF), was developed (Cook, Saito and Schultz 2015). This algorithm takes advantage of the horizontal alignment data provided by UDOT’s LiDAR-based asset management program. Horizontal curve data provided by the contractor of the program were so segmented and were not ready to be used for crash prediction model development of the study. To deal with this inaccuracy in horizontal curve data and provide horizontal alignment data necessary for crash prediction modeling, the HAF algorithm was developed. Properly identifying the beginning and ending points and radius is the most important step to use such data in crash prediction modeling and curve segment hot spots.

For that past several years, BYU researchers have worked on development of Bayesian-based crash prediction models, including the Utah Crash Prediction Model (UCPM) and the Utah Crash Severity Model (UCSM), which reflect uncertainty in the identification and prioritization of hot spots. These models will help the safety engineer rank the hot spots of crash occurrence using the advanced statistical concept. At the moment, however, there is no automated or semi-automated method to identify whether such hot spots identified by the models are part of curve segments of highways. The HAF algorithm can help the safety engineers to identify horizontal curve segments with high crash histories on state highways.

However, the HAF algorithm was originally developed for rural two-way two-lane highways. Hence, it is necessary to test the robustness of the HAF for other highway types, both rural and urban areas. The accuracy of the current HAF algorithm is approximately 85 percent and how to deal with the 15 percent error is an issue when it is directly applied to the entire state highway systems. At the moment, in order to identify beginning and ending points and radii of curved segments, the current HAF requires human intervention to make sure the algorithm has correctly identified the horizontal curve segments.

In this proposed study, we develop an efficient and effective method that will incorporate the outcome of the UCPM and UCSM, which will help the user to deal with the issue of 15 percent error rate of the current HAF algorithm. At the same time, we investigate ways to improve the HAF algorithm to increase its accuracy and make it more robust to be applied to any types of highways, such as multi-lane highways and freeways both in rural and urban highways.

Reference:

2. Explain why this research is important.
Impact of horizontal curves on crash occurrence can be finally analyzed due to the availability of LiDAR-based asset management survey data that UDOT periodically conducts. The methodology developed in this research will be an added feature to UCPM and UCSM. When a listing of horizontal curve segments with worst crash histories needs to be prepared, say annually, the methodology developed by this proposed study can be used. The results of this study will help UDOT safety engineers to prepare a listing of curve segments with high crash occurrence histories and help them program safety related improvements.

3. List the research objective(s):
1. Develop a methodology to identify curved segments of state highways with worst crash histories using the HAF algorithm.
2. Improve the accuracy of the HAF algorithm and make it useable for other highways other than rural two-lane two-way highway.
3. List horizontal curve segments of state highways with worst crash histories identified using the current or improved version along with their radii, superelevation, lane width, shoulder width, and any other data pertinent to curve segment safety analysis.
4. List the major tasks:
   1. Convene kickoff meeting and discuss general directions of conducting the study given the conditions used for developing the current HAF algorithm.
   2. Conduct literature review on curve identification algorithms – any new methods that have been developed and published since the development of the current version of HAF algorithm (to prepare the research assistant to become familiar with the research objectives) will be identified.
   3. Review the coding of the HAF algorithm that was originally developed to analyze rural two-way, two-lane highways to evaluate if the current HAF algorithm can be applied to freeways and multiple highways without any modifications. If yes, conduct Task 5, followed by Task 6; if not, conduct Task 4 first followed by Task 5, followed by Task 6.
   4. Make necessary modifications to the HAF algorithm to make it other types of state highways in both rural and urban areas than rural two-way two-lane highways and at the same time develop steps to improve the accuracy of the HAF algorithm. Once this has been completed, conduct Task 5, followed by Task 6.
   5. Develop a method to identify curved segments of highways with worst crash histories given the outcome of the UCPM and UCSM using the HAF algorithm.
   6. Execute the method developed in Task 5 to identify and list curve segments with worst crash histories.
   7. Prepare a list of curved segments of the highways with worst crash histories for the given crash data years.
   8. Preparation the final report

5. List the expected results:
   1. List of curved segments with worst crash histories by highway class with their radiuses, based on the outcomes of hotspots identified by the current HAF algorithm.
   2. An improved HAF algorithm and the methodology to identify curved highway segments with worst crash histories.
   3. Final report and technical papers.

6. Describe how this research will be implemented.
The product of this research can be immediately implemented. For the given crash data, the research provide UDOT with a list of curved segments with worst crash histories. The method developed in this research can be applied in the future for the next set of crash data, every time such listing of curved segments with worst crash histories is needed in the future. This method will be an additional feature of the UCPM or UCSM. The research also provides insight in the effect of horizontal curvature on crash occurrence trends.

7. Requested from UDOT: $60,000
   Other/Matching Funds: $
   Total Cost: $60,000

8. Outline the proposed schedule, including start and major event dates.
It is recommended that this project begin in September 2016 with the initial tasks of finalizing the project scope of work and detailed cost estimates, followed with the literature review. It is anticipated that the project would take 16 to 18 months, including a 4-month report review period.
1. Describe the problem to be addressed.

High Occupancy Toll (HOT) lanes were first introduced by the Utah Department of Transportation (UDOT) in September 2006. At that time Single Occupancy Vehicles (SOVs) were allowed to use the lane by paying a flat monthly fee of $50 per month. Since this time, the HOT lanes have evolved into the current 63 miles of Express lanes, the longest managed lane system in the United States. The primary purpose for the Express lanes was to provide a system wherein users could pay a toll to experience higher travel time reliability as the lanes were expected to operate at speeds at, or above, 55 mph 90% of the time. Although this goal has been met the majority of the time, recent research has identified that there are times where this goal is not met on the entire corridor. During these times of congestion, when the speeds are below 55 mph, the research has also shown that the Express Lanes generally do not operate more than 10-15 mph faster than the General Purpose (GP) lanes. Experience has also shown that although it is relatively easy to enter the Express lane during the peak period, exiting from the Express lane during the peak period is much more difficult to do within the restricted access points because it is difficult to find safe gaps in the GP lane closest to the Express lane. In such cases the drivers exiting the Express lane have two options: 1) slowdown in the Express lane to find a safe gap (knowingly or unknowingly) or 2) take a shorter-than-usual safe gap they accept, thus creating both safety and operational dilemmas for both Express lane users and those in the GP lane next to the Express lane and at the same time potentially lowering the speed of vehicles in the Express lane.

Washington State Department of Transportation (WSDOT) representatives were facing with a similar problem that existed for the SR 167 HOT lanes. They had thought that they could improve safety and operation of the HOT lanes by restricting the entry/exit of the HOT lane to limited access points; however, the reality has not been always true. Recently, WSDOT acquired federal funding to test this theory in the field by converting restricted access points on SR 167 to continuous access. Access rules for the study section changed in August 2014 and the test was completed in 2015. A WSDOT representative (Patty Rubstello) and the researchers of University of Washington (Mark Hallenbeck and John Ishimaru) made a presentation during the 2016 Annual TRB Meeting to report their final findings. They reported the customers generally approved of the access rule change (65%), felt the HOT lanes are now easier to use (75%), and felt the HOT lanes were safer (54% felt safer vs. 27% less safer) according to their motorist survey with 4,000 participants. They reported that travel times increased in both HOT and GP lanes, especially in the first 5 month of operation but they mentioned that the overall trend was towards increasing travel time in the area; so, this increase may not necessary be caused by the change in HOV lane access rule. Other findings included: (1) HOT lane speeds appear to be more affected by GP lane speeds now, and (2) As GP lanes’ speeds slow down, neighboring HOT lane speeds tend to slow down faster than previously. Also found was that transit operators liked the access rule change because of ease of entry to and exit from the HOT lane. Based on these findings, WSDOT decided to keep open access to the study sites.

Considering the current performance level of the Express lane on I-15 and the findings from WSDOT’s field experiments, it is recommended to conduct a study to evaluate the effects of access rule changes to I-15 Express Lanes on its safety and operational benefits. The concept of continuous HOV lane is not new. The Highway Capacity Manual 6th edition that will be published in summer 2016 contains the capacity analysis of managed lanes, one of them being an HOV lane with continuous access. The purpose of this research is to compare the benefits of converting limited access points to continuous access to the Express lane on I-15 to the users of both the Express lane and of the GP lanes using simulation modeling to study the performance and the use of the Surrogate Safety Analysis Model (SSAM), a free software program developed and provided by FHWA to study the safety aspects of the proposed change (or, any other method that can be used to meet the goal of the study) as well as the evaluation of crash records at and near the off-ramps to which exit guidance is given by a sign for the study areas that will be selected for the study.

2. Explain why this research is important.

This research will evaluate the safety and operational benefits of converting restricted access to continuous access to the Express lane on I-15. Limited access forces Express lane users to weave in a short distance and this arrangement may be creating a potentially hazardous environment for Express lane users as well as users of the fast lane of the GP lanes, especially when GP lanes are...
congested. In recent years, some state DOTs have converted limited access to continuous access to Express lanes or HOV lanes because of the overall benefits of continuous access. The study will provide UDOT with the safety and operational data to consider as they ponder how to improve the performance of the Express lane.

3. List the research objective(s):
   1. Survey Express lane users’ experiences and desires, both paid users and other users such as car poolers, public transit drivers and motor cyclists.
   2. Analyze crash potentials near the current limited access openings
   3. Compare the safety benefits of converting restricted access to continuous access
   4. Compare the operational benefits of converting restricted access to continuous access

4. List the major tasks:
   1. Kickoff meeting
   2. Literature review
   3. Develop a user survey regarding Express lane users’ experience in the restricted entry/exit segments of the Express Lane
   4. Crash analysis at and near the access points of the Express lane to identify potential contribution of restricted access points at the selected study sites
   5. Evaluation and selection of simulation software to meet the goal of the study and a segment of I-15 for simulation analysis (most likely VISSIM)
   6. Simulation model building of the selected segment of I-15: with restricted access points and with continuous access (at present, the proposers of this study consider three cases: (1) entry and exit restricted, (2) entry restricted but exit continuously free, and (3) entry and exit continuous access.
   7. Analysis of conflicts in two cases using the SSAM (Surrogate Safety Analysis Model, a free software program developed and provided by FHWA) or any other appropriate simulation method that will be explored as part of literature review
   8. Comparison of benefits of converting restricted access to continuous access to the Express Lane
   9. Identification of issues concerning the conversion from restricted access to continuous access
   10. Preparation of final report

5. List the expected results:
   1. Survey results of Express lane users regarding their experience at restricted access points and their view on continuous access to the Express lane and results of statistical analyses of crashes that took place near or on access points to the Express lane
   2. Effects of converting restricted access to continuous access on safety and performance of Express lane and general purpose lanes.

6. Describe how this research will be implemented.
The results of this study will help UDOT to determine whether they should continue the policy of restricting entry to and exit from the Express lane to restricted access points or change the policy to convert entry/exit from restricted points to continuous access.

7. Requested from UDOT: $69,000
   Other/Matching Funds: $0
   Total Cost: $69,000
   (or UTA for Public Transportation)

8. Outline the proposed schedule, including start and major event dates.
It is recommended that this project begin in later summer or early Fall 2016 with the initial tasks of finalizing the project scope of work and detailed cost estimates, followed with the literature review. It is anticipated that the project would take 16 to 18 months, including a 4-month report review period.
2016 UDOT RESEARCH PROBLEM STATEMENT

Title: Analysis of Left-Turn Warrants in Utah

Submitted By: Grant G. Schultz and Mitsuru Saito

Email: gschultz@byu.edu, msaito@byu.edu

Organization: Brigham Young University

Phone: 801-422-6326, 801-422-6326

UDOT Champion (suggested): Mark Taylor/Jesse Sweeten

Select One Subject Area

☐ Materials/Pavements
☐ Maintenance
☒ Traffic Mgmt/Safety
☐ Preconstruction
☐ Planning
☐ Public Transportation

No. (office use): 16.03.04

*** Problem statement deadline is March 14, 2016. Submit statements to Tom Hales at tahales@utah.gov. ***

1. Describe the problem to be addressed.
   The Utah Department of Transportation (UDOT) has established guidelines for left-turn phases at signalized intersections. The most recent (updated November 13, 2014) guidelines provide a detailed flow-chart as criteria for recommending left-turn phasing at signalized intersections. According to the guidelines a left-turn phase may be installed with left-turn volumes as low as 100 veh/hr (assuming there is a history of severe left-turn crashes), while the more common installations would occur with volumes greater than 100 veh/hour and four or more opposing through lanes and/or speed limit of 60 mph or higher. The left-turn phase is recommended “after less restrictive measures to reduce delay, congestion, and crashes have been considered. The overall signalized corridor/network operations should be considered when evaluating the impacts of left-turn phasing. Even if the criteria in the flowchart are met for left-turn phasing, engineering judgment should be used to determine whether left-turn phasing is implemented.” Additional guidelines are provided for installation of dual left-turn lanes. Based on the current left-turn warrant guidelines, the number of left-turn phasing installations and signal upgrades has been increasing as traffic volumes increase across the state. The costs associated with the installation of the left-turn phases are increasing with this, especially in those instances when conduit is either not available, or is in a poor state of repair and must be replaced.

   The purpose of this research is to evaluate the current left-turn warrant process for UDOT in an effort to determine if the current warranting procedure may be too liberal for the current driver population in the state. Anecdotal evidence would suggest that the number of sneaker on low volume left-turn movements has increased over the years and that more left-turns are being accommodated safely than anticipated within the changing (yellow) and clearance (all red) intervals. As the number of sneakers depends on the volume of traffic in the opposing direction and the behaviors of the drivers in the opposing direction, several locations and volume scenarios would need to be evaluated. To meet the purpose of the research, the research team would complete a literature review to gain insight and understanding on changes that have been made at both the state and national level on left-turn warranting including dual left-turns and permissive dual left-turns, perform a synthesis of practice for left-turn warrants across the nation to determine best practices for left-turn warrants, complete an in-field “sneaker” study to evaluate left-turn practices in the state, perform simulation in Synchro to compare delay at intersections with and without left-turn phasing, and make limited recommendations on the current Utah policy based on these tasks.

2. Explain why this research is important.
   UDOT will benefit from this research by gaining an understanding of the left-turn warranting process across the nation in comparison to the current left-turn warranting process in Utah. The results of the research will help to identify possible changes and new recommendations on left-turn warrant alternatives that would help to improve safety and operations on arterials across the state.

3. List the research objective(s):
   1. Identify state of the practice for left-turn warranting across the nation.
   2. Evaluate current left-turn operations in the state through a “sneaker” study and simulation of selected intersections with and without left-turn phasing.
   3. Develop limited recommendations for left-turn warrant alternatives in the state.

4. List the major tasks:
   1. Develop a project scope of work and detailed cost estimate.
   2. Conduct kickoff meeting.
   3. Perform literature review on safety and operations benefits of left-turn phasing warrants and operations, including dual left-
turns and permissive dual left-turn options.

4. Conduct a synthesis of practice for left-turn warrant procedures across the nation.

5. Conduct a “sneaker” study across the state to determine driver behavior for left-turn movements without left-turn phasing.

6. Perform a sensitivity analysis at selected locations in Synchro to compare delay with and without left-turn phasing.

7. Provide limited recommendations on left-turn warrant alternatives and evaluate the effect any proposed changes in warrant criteria would have made on left-turn warrants already completed across the state over the past several years.

8. Report results to UDOT in the form of a written report.

5. List the expected results:
   1. Engineering report documenting the literature review and research results.
   2. Understanding of left-turn warrant and phasing procedures across the nation.
   3. Understanding of left-turn driver behavior in the state and comparison of delay with and without left-turn phasing.
   4. Limited recommendations on left-turn warrant alternatives.

6. Describe how this research will be implemented.
   This research would be implemented jointly by the UDOT Traffic & Safety Division and the Traffic Operations Center to improve the left-turn phasing warrants across the state. The results of this research would assist UDOT in future decisions on left-turn warranting procedures in the state.

7. Requested from UDOT: $60,000    Other/Matching Funds: $    Total Cost: $60,000
   (or UTA for Public Transportation)

8. Outline the proposed schedule, including start and major event dates.
   It is recommended that this project begin late summer/early Fall 2016 with the project scope of work and detailed cost estimate, followed with the literature review. The work will continue with the remaining tasks as outlined. The results of the research will then be reported to UDOT in the form of a written report. The research is anticipated to take 12-16 months.
Title: Data Based Testing & Decision Process for Traffic Signal Steel Replacement

Submitted By: Mark Taylor
Email: marktaylor@utah.gov

Organization: UDOT
Phone: 801-887-3714

UDOT Champion (suggested): Mark Taylor & Jesse Sweeten

Select One Subject Area
- Materials/Pavements
- Preconstruction
- Maintenance
- Planning
- Traffic Mgmt/Safety
- Public Transportation

1. Describe the problem to be addressed.

Many current, in-use signalized intersections in Utah were constructed during the 1970s and 1980s, making the steel mast poles and arms 30-40 years old. Recent crashes where signal steel was struck and in some form or another ‘failed’, have highlighted the need for UDOT to be more proactive in testing older steel elements for fatigue, micro-fracturing, and corrosion. There is currently no testing procedure or data-driven approach in Utah regarding when signal steel needs to be replaced. The need is to prevent a catastrophic failure where a mast arm or pole collapses over live traffic due to stress induced by device loading, wind, etc.

2. Explain why this research is important.

UDOT will benefit from this research by defining testing protocols for aging steel and thresholds for when steel elements need to be replaced in the interest of safety and preserving infrastructure.

3. List the research objective(s):

1. Identify state of the practice currently in place across the nation and in other countries.
2. Produce a procedure and policy – based on empirical data and best practices of other agencies that would define testing protocols for aging steel and thresholds for when steel elements need to be replaced in the interest of safety and preserving infrastructure.

4. List the major tasks:

1. Develop a project scope of work and detailed cost estimate.
2. Conduct kickoff meeting.
3. Conduct a best-practices survey and literature review to identify similar programs currently in place in other States or Countries, and summarize the results of this research.
4. Conduct a historical review of incidents – in Utah or otherwise – involving signal steel failure from the past 25 years, and
summarize this information for reference, identifying any notable trends or causalities.

5. Identify non-destructive testing procedures that are cost effective for evaluating steel condition at existing, aged traffic signals currently in operation.

6. Perform the recommended testing procedure(s) at a sample of locations around the State, of variable age, to produce a scatterplot of data points that relate steel age to steel condition.

7. Based on the empirical data and the best practices research above, develop a recommended testing policy for signals across the state – how often, at what age it is required, and expected data results with thresholds for ‘failure’ clearly defined.

8. Based on these same items above, develop a simple, data-based series of thresholds for the following events;
   a. When testing should begin at a given site (age, other contributing factors like wind, salt, etc.).
   b. How often testing should be conducted.
   c. A formulaic or data based decision matrix for when steel should be considered to fall into one of the following categories, such as: (A – Like New), (B – Worn), or (C – Risk of Failure, Replace).

5. List the expected results:

   1. A modest report summarizing best practices, the literature review, and historical incidents.
   2. A recommended testing procedure/policy, with costs per unit and expected results.
   3. A recommended set of thresholds, based on data and/or age, defining when testing should begin and how often it should be conducted.
   4. A decision matrix that can be used to categorize signal steel as grade A, B or C as defined above.

6. Describe how this research will be implemented.

This research would be implemented jointly by the UDOT Traffic Management Division and the UDOT Traffic & Safety in better defining a plan when to replace aging steel at signalized intersections. The results of this research would assist UDOT in future decisions and budget forecasting when to replace aging steel at signalized intersections.

7. Requested from UDOT: $60,000  Other/Matching Funds: $  Total Cost: $60,000
   (or UTA for Public Transportation)

8. Outline the proposed schedule, including start and major event dates.

   It is recommended that this project begin summer or early fall 2016 with the project scope of work and detailed cost estimate, followed with the literature review. The work will continue with the remaining tasks as outlined. The results of the research will then be reported to UDOT in the form of a written report. The research is anticipated to take 12-16 months.
# 2016 UDOT RESEARCH PROBLEM STATEMENT

**Problem statement deadline is March 14, 2016. Submit statements to Tom Hales at tahales@utah.gov.**

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<tr>
<th>Submitted By</th>
<th>Daniel J. Fagnant</th>
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<tr>
<td>Email</td>
<td><a href="mailto:dan.fagnant@utah.edu">dan.fagnant@utah.edu</a></td>
</tr>
<tr>
<td>Organization</td>
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</tr>
<tr>
<td>Phone</td>
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| UDOT Champion (suggested) | Blaine Leonard, Scott Jones |

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## 1. Describe the problem to be addressed.

When approaching signalized intersections, motorists oftentimes find themselves within a dilemma zone at the time of the phase change from yellow to green – an area where the driver must make a non-obvious decision between continuing through the intersection, or to begin braking. Due to the imprecise nature of driver behavior (e.g., reaction times, time-speed-distance assessment, yellow time estimation, degree of driving aggressiveness, etc.) individual drivers behave quite differently when faced with the same decision. Without external information to support these decisions, this can lead to red light running or hesitation before hard braking, ultimately resulting in angle and rear-end collisions stemming from such misjudgments. To address this problem, this research proposes to examine driver behavioral responses to a connected vehicle dilemma zone awareness (CVDZA) application through the use of the University of Utah’s driving simulator, in order to assess the potential effectiveness of such systems. This application will consist of two main components, examining the potential effectiveness, limitations and risks of (1) a red light warning application (to recommend that drivers brake), and (2) an optional added intersection clearance application (to recommend that drivers proceed with caution).

## 2. Explain why this research is important.

Angle and rear-end collisions are some of the most common crash types observed at signalized intersections, and injury outcomes can oftentimes be severe, particularly for angle collisions. Many of these crashes stem from driver misjudgments as to whether to brake or continue through the intersection when the signal indication changes from green to yellow. While it will soon be possible to assist drivers in making these braking or proceeding decisions through new connected vehicle and connected infrastructure systems, the potential effectiveness of such applications are broadly unknown. Existing research to date has focused on how to apply red light warning systems and when to target individual vehicles based on distance from an intersection, vehicle speed, and signal timing parameters. Ultimately, however, the breadth and speed of deployment of such systems should depend on the effectiveness of the application, which this research work will seek to investigate.

## 3. List the research objective(s):

1. Identify how best to implement a CVDZA application.
2. Estimate the effectiveness of CVDZA applications on reaction times, hard braking, driver compliance (avoidance of red light running) and other factors influencing intersection safety, across multiple intersection contexts.

## 4. List the major tasks:

1. Synthesize literature. Identify, review, and critically synthesize relevant published literature regarding red light running warning applications, connected vehicle driving simulation methodologies, and other relevant literature to the research topic.
2. Scenario design and development. Design a set of driving simulator scenarios, with the consideration of key simulation factors such as communication method (audible, heads-up in-vehicle display, etc.), application settings (red light warning only, or combined with intersection clearance option), roadway speeds, congestion levels, and surrounding vehicle behavior, as well as other study design factors such as number of participants, simulation duration, and number of intersections that each participant will drive through. The scenarios will include intersections with and without the connected vehicle dilemma zone application. After consultation with the Technical Advisory Committee (TAC), selected driving simulator scenarios will be developed in detail and thoroughly tested.
3. Participant recruiting and simulation. Driving simulator participants will be recruited to partake in the developed scenarios. A small monetary incentive (e.g., $20 per participant) will be used to assist with recruiting. Limited screening will be used as necessary to ensure a reasonable distribution of participant ages and gender in the overall sample. Participants will drive through developed scenarios using the University of Utah’s driving simulator, while research team members record vehicle
operation. Coordination with the University of Utah’s Institutional Review Board (IRB) will help ensure that all human subject research conducted in this study is in compliance with federal standards and regulations.

4. Analysis and evaluation of results. Collected simulation data will be reviewed and compared to default (non-connected) intersection settings. Using this information, the research team will estimate the impact of CVDZA applications on driver compliance (red light running avoidance), hard braking, reaction times, and other factors influencing intersection safety. If present, differences in effectiveness across intersection contexts (e.g., number of lanes, speed, traffic volumes, etc.) will be identified.

5. Final reporting. A Final Report will be prepared and submitted that documents the entire research effort, including preliminary literature synthesis, scenario design, development, application, and evaluation, and participant recruiting process, while also incorporating feedback received from the TAC. Task 5 activities will follow UDOT Research Division’s Final Report Process.

5. List the expected results:
   1. Assessment of CVDZA application effectiveness, across metrics noted in Task 4, and across tested intersection settings.
   2. Identification of preferred CVDZA implementation, (e.g., whether to include the intersection clearance application, and the effectiveness of audible vs. in-vehicle heads-up display messages).

6. Describe how this research will be implemented.
   Findings will be presented to UDOT transportation safety and operations staff. These individuals may use the information stemming from this research in order to better anticipate how and where such CV dilemma zone awareness systems might be best implemented, as well as the anticipated effectiveness of such systems which could have an impact on the speed and breadth of such deployments. Research findings will also be shared with automotive manufacturers through the PI’s contacts, such as Toyota and Ford.

7. Requested from UDOT: $50K Other/Matching Funds: $40K* Total Cost: $90K
   *A proposal for the $40K in matching funds will be submitted to the Mountain Plains Consortium, the U.S. DOT Regional University Transportation Center for Federal Region 8, which shall be used to supplement scenario evaluation activities.
   (or UTA for Public Transportation)

8. Outline the proposed schedule, including start and major event dates.
   - Task 2 Scenario design and development (5 months): Nov. 1, 2016 – March 31, 2017
     - Meeting with TAC around Dec. 15
     - Technical memorandum detailing outcomes of first two tasks March 31
   - Task 3 Participant recruiting and simulation (2 months): April 1, 2017 – May 31, 2017
   - Task 4 Analysis and evaluation of results (3 months): June 1, 2017 – Aug. 31, 2017
     - Meeting with TAC around July 15
     - Technical memorandum detailing outcomes of Tasks 3 and 4, Aug. 31
1. Describe the problem to be addressed.
Motorcycle crashes are rare events with severe outcomes. This makes future motorcycle collisions frustratingly hard to pinpoint with hot-spot analysis utilizing historical crash data. Moreover, since riders comprise different portions of the traffic stream at different locations, a fixed share of an overall crash rate obtained from a safety performance functions will likely result in marginally accurate results. While much existing work has been conducted surrounding the topic of motorcycle crash severity estimation, much less has focused on the problem of frequency. Furthermore, the models developed in such existing studies (e.g., Schneider et al.’s evaluation of curves on rural 2-lane highways in Ohio) may not be appropriate for direct application in Utah, given Utah’s mountainous terrain and high attractiveness of many scenic riding routes. Therefore, this research proposes to develop methods to identify locations in Utah where motorcyclists are at increased crash risk, and to recommend proposed countermeasures to address such risks.

2. Explain why this research is important.
In 2014 motorcyclists made up 17.5% of Utah road fatalities, with total crashes increasing 52% from the average across the prior 8 years. While the total number of fatal motorcycle crashes fell 20% in 2015 (accounting for 14% of all fatal crashes that year), this remains a troubling trend. Data for where motorcyclists are crashing is currently available from motor vehicle collision reports, but predicting future collisions can be quite difficult due to the rare and semi-random nature of crashes, low share of motorcyclists as a proportion of the total traffic stream, and lack of motorcycle count data. Reducing the number of motorcycle crashes has been identified as a safety priority for the state of Utah.

3. List the research objective(s):
1. Identify characteristics of roadways in Utah associated with high crash rates.
2. Identify locations in Utah where expected motorcycle crash rates appear excessively high.
3. Identify motorcycle crash countermeasures, and propose prioritization for countermeasure implementation.

4. List the major tasks:
1. Literature synthesis. Identify, review, and critically synthesize relevant published literature regarding motorcycle crash prediction estimation, as well as estimation methods used for other sparse collision data (e.g., pedestrians, cyclists). The literature review will also include an assessment of motorcycle crash countermeasures, and how they might be applied by UDOT and/or the Utah Highway Safety Office.
2. Preliminary motorcycle crash data assessment. Identify key settings where raw numbers indicate that motorcycle crashes are over-represented (e.g., rural 2-lane road segments, urban signalized intersections, etc.) With consultation of the Technical Advisory Committee (TAC), select one or two key settings for further detailed analysis.
3. Development of statistical models to identify risk factors. One or more crash count estimation models will be developed in order to estimate the motorcycle crash likelihood in the key settings previously selected in Task 2.
4. Application of risk factor estimation to selected locations. The crash likelihood model(s) developed in Task 3 will be applied broadly across regions or facilities where motorcycle crashes appear over-represented. Using these models, segments and/or intersections may be identified that appear at higher risk to experience future motorcycle collisions.
5. Identification of potential countermeasures. Relevant countermeasures identified in Task 1 will be paired with high-risk motorcycle crash locations identified in Task 4. Application of countermeasure-location pairings will be prioritized and ranked in terms of estimated location risk, anticipated cost, and expected countermeasure effectiveness.
6. Submit final report. A Final Report will be prepared and submitted that documents the entire research effort, including literature synthesis, preliminary crash data assessment, development and application of statistical models, identification of counter measures. This work shall also incorporate feedback received from the TAC prior to submittal. Task 6 activities will follow UDOT Research Division’s Final Report Process.

5. List the expected results:

1. Assessment of expected motorcycle crash rates on key setting types in Utah. This may be disaggregated by crash type (e.g., total, multi-vehicle, angle, run-off-road, etc.) and will likely be realized in the form of one or more safety performance functions.

2. Application the motorcycle crash rates across Utah in regions with high overall motorcycle collision rates.

3. Identification of locations with high expected future motorcycle crash rates, and prioritization of possible countermeasures for such locations.

6. Describe how this research will be implemented.

Findings will be presented to UDOT transportation safety staff, as well as potentially staff from the Utah Highway Safety Office. These individuals may use the information stemming from this research in order to understand which areas may be at higher risk of motorcycle crashes, and potential countermeasures to address them.

7. Requested from UDOT: $50K  
Other/Matching Funds: $40K*  
Total Cost: $90K*

A proposal for the $40K in matching funds will be submitted to the Mountain Plains Consortium, the U.S. DOT Regional University Transportation Center for Federal Region 8, which shall be used to supplement this work through motorcycle count estimation activities.

(or UTA for Public Transportation)

8. Outline the proposed schedule, including start and major event dates.

The proposed timeline will begin Sept. 1, 2016 and end Dec. 31, 2017, with major tasks as follows:

  - Meeting with TAC around Dec. 15
  - Technical memorandum detailing outcomes of first two tasks, Dec. 31
  - Meeting with TAC around Jan. 1
  - Technical memorandum detailing outcomes through Task 2, Jan. 31
- Task 3 Development of statistical models to identify risk factors (4 months): Jan. 1, 2017 – April 31, 2017
  - Meeting with TAC around July 1
  - Technical memorandum detailing outcomes through Task 3, July 31
- Task 4 Application of risk factor estimation to selected locations (3 months): May 1, 2017 – July 31, 2017
  - Meeting with TAC around Aug. 1
  - Technical memorandum detailing outcomes through Task 4, Aug. 31
**2016 UDOT RESEARCH PROBLEM STATEMENT**

### Problem statement deadline is March 14, 2016. Submit statements to Tom Hales at tahales@utah.gov.***

<table>
<thead>
<tr>
<th>Title: Index of Model Ordinances Promoting Pedestrian Safety</th>
<th>No. (office use): 16.03.08</th>
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</thead>
<tbody>
<tr>
<td>Submitted By: Shaunna K. Burbidge</td>
<td>Organization: Active Planning</td>
</tr>
<tr>
<td>Email: <a href="mailto:burbridge@walkbikeplan.com">burbridge@walkbikeplan.com</a></td>
<td>Phone: 801-336-7991</td>
</tr>
</tbody>
</table>

**UDOT Champion (suggested):** Robert Miles

#### 1. Describe the problem to be addressed.
In early March 2016 the Utah Department of Transportation and the Utah Department of Public Safety’s Highway Safety Office adopted the Utah Pedestrian Safety Action Plan. This plan was created as the culmination of a comprehensive effort by a diverse stakeholder committee to address and reduce the high number of pedestrian fatalities in Utah. Within that plan, goals and tasks are outlined. Goal 7.1 Task 3 is to “create an index of model ordinances and policies for local governments promoting pedestrian safety.”

Currently, the promotion of pedestrian safety is not a main focus within Utah municipalities. While many cities do have existing ordinances on their books that aim to promote pedestrian safety, their implementation and enforcement is limited or in many cases nonexistent. This research will conduct a comprehensive review to identify effective policies and ordinances from jurisdictions both locally and nationally that have been proven to improve and promote pedestrian safety. A working group of representatives will be convened to review these model policies and ordinances to identify which are appropriate and feasible for implementation in Utah, as well as the best way to incorporate these ideas at the local level. A resource will be compiled that provides information on each type of policy as well as sample language for incorporating these concepts into existing code. Additionally, this resource will provide information on implementation and enforcement techniques to assist in institutionalizing appropriate methods.

#### 2. Explain why this research is important.
UDOT has committed to accomplish all tasks assigned to the agency in the Pedestrian Safety Action Plan. Completion of this task will fulfill the requirements of Goal 7.1 Task 3. Additionally, this project will allow local jurisdictions to have input and ownership over the identification of appropriate policies which will lead to an increase in interagency cooperation and a higher likelihood of implementation.

#### 3. List the research objective(s):
1. Identify effective policies and ordinances that will promote pedestrian safety and decrease pedestrian fatalities.
2. Work with local jurisdictions to create a resource that will encourage the adoption and implementation of these policies/ordinances.

#### 4. List the major tasks:
1. Develop a project scope of work and cost estimate and identify appropriate TAC members.
2. Conduct a project kick-off meeting with the TAC.
3. Conduct a comprehensive review of local and national policies and ordinances aimed at promoting pedestrian safety or the improvement of the pedestrian environment, and identify their proven effectiveness where possible.
4. Work with representatives from local jurisdictions (through the COGs, Utah League of Cities and Towns, MPOs, etc.) to identify recommendations for which would be most appropriate for local implementation.
5. Create a resource for local municipalities that 1) identifies effective policies and ordinances, 2) includes sample language for incorporating them into existing code, and 3) provides information on implementation and enforcement techniques.
6. Report results to UDOT in a final written report.

#### 5. List the expected results:
1. Technical memo outlining the findings of the literature review.

2. Recommendations of appropriate policies and ordinances for promoting pedestrian safety and reducing pedestrian fatalities.

3. Creation of a comprehensive resource outlining appropriate policies and ordinances for local jurisdictions.

6. Describe how this research will be implemented.
   This research will be disseminated by UDOT and DPS to promote pedestrian safety statewide through encouraged local implementation.

7. Requested from UDOT: $45,000  Other/Matching Funds: $0  Total Cost: $45,000

8. Outline the proposed schedule, including start and major event dates.
Project will kick-off in Fall 2016. The comprehensive literature review and efficacy analysis will be conducted through the winter (Q4 2016-Q1 2017). During this time a working group of representatives from local jurisdictions will also be assembled. Recommendations from the working group will be gathered by the end of Q2-2017. Based on those recommendations the final resource will be created in the form of a document, guidebook, or interactive webpage (to be determined by the working group) during Q3-2017. A final written report will then be submitted to UDOT. This research is anticipated to be completed within 12-15 months.
# 2016 UDOT RESEARCH PROBLEM STATEMENT

*** Problem statement deadline is March 14, 2016. Submit statements to Tom Hales at tahales@utah.gov. ***

<table>
<thead>
<tr>
<th>Title: Pedestrian Safety Toolbox for Elected Officials</th>
<th>No. (office use):</th>
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<tr>
<td>Submitted By: Shauna K. Burbidge</td>
<td>Organization:</td>
<td>Active Planning</td>
</tr>
<tr>
<td>Email: <a href="mailto:burbridge@walkbikeplan.com">burbridge@walkbikeplan.com</a></td>
<td>Phone:</td>
<td>801-336-7991</td>
</tr>
<tr>
<td>UDOT Champion (suggested): Robert Miles</td>
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<tr>
<th>Select One Subject Area</th>
<th>Materials/Pavements</th>
<th>Maintenance</th>
<th>Traffic Mgmt/Safety</th>
<th>Preconstruction</th>
<th>Planning</th>
</tr>
</thead>
</table>

1. **Describe the problem to be addressed.**
   
   In early March 2016 the Utah Department of Transportation and the Utah Department of Public Safety’s Highway Safety Office adopted the Utah Pedestrian Safety Action Plan. This plan was created as the culmination of a comprehensive effort by a diverse stakeholder committee to address and reduce the high number of pedestrian fatalities in Utah. Within that plan, goals and tasks are outlined. Goal 5.3 Task 1 is to “create a toolbox on pedestrian safety initiatives, infrastructure improvements, and programs to be disseminated to elected officials across the state.”

   This project will compile appropriate information and resources into a document or web interface that can be advertised and disseminated to elected officials statewide to fulfill this task. Informing local elected officials of available pedestrian safety resources will encourage and increase the likelihood of local implementation, resulting in improved pedestrian safety and reduced pedestrian fatalities.

2. **Explain why this research is important.**
   
   UDOT has committed to accomplish all tasks assigned to the agency in the Pedestrian Safety Action Plan. Completion of this task will fulfill the requirements of Goal 5.3 Task 1.

3. **List the research objective(s):**
   
   1. Compile all existing resources regarding local pedestrian safety initiatives, appropriate and effective infrastructure improvements, and existing safety programs into a single resource for elected officials.
   
   2. Advertise and disseminate this resource statewide.

4. **List the major tasks:**
   
   1. Develop a project scope of work and cost estimate and identify appropriate TAC members.
   
   2. Conduct a project kick-off meeting with the TAC.
   
   3. Conduct a comprehensive review of existing local pedestrian safety initiatives and state programs, and compile an inventory of appropriate infrastructure improvements.
   
   4. Create a document or web-based resource to disseminate to local elected officials, statewide.
   
   5. Report results to UDOT in a final written report.

5. **List the expected results:**
   
   1. Document or web-based resource cataloguing all available pedestrian safety resources.
   
   2. Recommendations for advertisement and dissemination to elected officials.

6. **Describe how this research will be implemented.**
   
   This research will be disseminated by UDOT and DPS to promote knowledge of pedestrian safety resources to elected officials.
| 7. Requested from UDOT: | $15,000-$20,000* | Other/Matching Funds: | $0 | Total Cost: | $15,000-$20,000* |

8. **Outline the proposed schedule, including start and major event dates.**

Project will kick-off in Fall 2016. The comprehensive review of existing local pedestrian safety initiatives and state programs, and an inventory of appropriate infrastructure improvements will be conducted through the winter (Q4 2016-Q1 2017). All resources will be compiled into a resource document or web-based interface during Q3-2017. A final written report will then be submitted to UDOT. This research is anticipated to be completed within 12 months.

*Cost will be determined based on the scope and final output. A document portfolio will cost less than creating a web-interface.*
Title: Risk Assessment of Non-Motorized Access to Rail Transit Stations

Submitted By: Shauna K. Burbidge
Email: burbridge@walkbikeplan.com

Organization: Active Planning
Phone: 801-336-7991

UDOT Champion (suggested): Robert Miles

Select One Subject Area
- [ ] Materials/Pavements
- [ ] Maintenance
- [x] Traffic Mgmt/Safety
- [ ] Preconstruction
- [ ] Planning

1. Describe the problem to be addressed.
Pedestrian and bicycle safety has become an important priority area for UDOT over the past five years. The agency has undertaken multiple efforts to better understand the various components that contribute to safety for these vulnerable road users. This has included analysis of: characteristics of the built environment that make it safe or dangerous for pedestrians and cyclists; the detailed circumstances surrounding pedestrian fatalities; and pedestrian and cyclist crossing behaviors and an examination of how vehicles interact with these modes at intersection crossings. One major destination that attracts a large number of pedestrians and cyclists is transit stations. In fact all transit riders are pedestrians at some point in their journey, making it even more important to promote safe access to and from transit stations or stops. This travel is often overlooked by the DOT because it is typically classified as part of a transit trip. However, most transit riders access the stations and stops via UDOT roadways which puts a portion of pedestrian and cyclist transit access under UDOT’s jurisdiction.

According to Congress for New Urbanism, “the Salt Lake City area has the fastest growth of rail transit comparing with any American city” (Eckerson, 2013). With this incredible growth comes a responsibility to understand and promote user safety. This research will build upon prior UDOT bicycle and pedestrian intersection safety research, as well as the UTA First and Last Mile Study to comprehensively analyze non-motorized safety in accessing fixed rail transit stations.


2. Explain why this research is important.
Although UDOT is not directly responsible for conditions at fixed rail stations, their jurisdiction does typically encompass rail crossings and roadways surrounding the rail stations. Because this infrastructure is used in accessing the stations it is important that it promotes safety, visibility, and ease of use. This research will specifically identify any geometric design or built-environment characteristics that may inadvertently be inhibiting pedestrian and cyclist safety in accessing or exiting the areas surrounding rail transit stations, focusing on Salt Lake County, UT.

3. List the research objective(s):
1. Analyze a comprehensive database of site characteristics within a set distance of rail transit stations in Salt Lake County, Utah.
2. Identify characteristics that are correlated to an increase or decrease in crash risk for pedestrians and cyclists.
3. Provide recommendations for improving safety.

4. List the major tasks:
1. Develop a project scope of work and cost estimate and identify appropriate TAC members.
2. Conduct a project kick-off meeting with the TAC.
3. Conduct a literature review of safety issues surrounding approximately 50 fixed rail transit stations in Salt Lake County.
4. Compile a comprehensive database of transportation system, and built/natural environment characteristics surrounding the fixed rail stations.
5. Analyze crash data surrounding each station and identify significant variables/characteristics.
6. Create recommendations for improving pedestrian and cyclist access in areas surrounding fixed rail transit stations.
7. Report results to UDOT in a final written report.
5. List the expected results:
   1. Technical memo outlining the findings of the literature review.
   2. Identification of significant hazards or impediments to pedestrian and cyclist safety in accessing transit stations.

6. Describe how this research will be implemented.
   UDOT will be able to coordinate with UTA to address safety hazards near transit stations and along surrounding corridors in order to promote safety and reduce crash or accident risks. UDOT will provide guidance to local regions regarding site specific treatments or corridor/access improvements.

7. Requested from UDOT: $95,000  Other/Matching Funds: $  Total Cost: $95,000

8. Outline the proposed schedule, including start and major event dates.
   Project will kick-off in Fall 2016. The comprehensive literature review will be conducted through the winter (Q4 2016-Q1 2017). A site inventory for each of the sample rail stations will be gathered from Q2-Q3 2017, and analysis will be conducted against crash and non-motorized incident data. Findings and recommendations will be compiled in the form of a final written report which will be submitted to UDOT and UTA. This research is anticipated to be completed within 12-15 months.
Title: Utilizing Vehicle-To-Infrastructure Connectivity For Increased Safety

Submitted By: Spencer Taylor
Email: staylor@avenueconsultants.com
Organization: Avenue Consultants
Phone: 801-716-2438

UDOT Champion (suggested):
Select One Subject Area
- Materials/Pavements
- Preconstruction
- Maintenance
- Planning
- Traffic Mgmt/Safety

1. Describe the problem to be addressed.
   To find the best way to adapt existing infrastructure to leverage the most safety benefits from the increasing number of “smart” vehicles on Utah roads. Vehicle-to-infrastructure connectivity (V2I).

2. Explain why this research is important.
   Vehicle communication and autonomous systems are quickly being implemented into newly available automobiles. Safety improvements and benefits from these improved vehicles is greatly exploited only when they can communicate with existing traffic and community infrastructure. Connecting existing infrastructure with even a few of these improved vehicles on the road could significantly improve overall driving safety and data flow.

3. List the research objective(s):
   1. Select several existing systems that could best provide or utilize useful information from connected vehicles.
   2. Outline plans for scaling this system as the number of connected vehicles increases on UDOT roads. (Including uses for the USDOT and FCC dedicated vehicle communication bandwidths).

4. List the major tasks:
   1. Identify existing systems that could provide or utilize useful information from connected vehicles.
   2. Identify options for scaling this system as the number of connected vehicles increases on UDOT roads and dedicated vehicle communication becomes more common.
   3. Select three priorities that could be most beneficial for vehicle-to-infrastructure communication.

5. List the expected results:
   1. List of priority infrastructure to utilize for maximum safety benefits.
   2. Three priority applications selected and one priority fully pursued to preliminary test phase.

6. Describe how this research will be implemented.
   A research matrix will be followed to document and record all work.
   - Each priority will be pursued individually to identify needs, feasibility, safety benefits, and obstacles limiting connected vehicle communication within each.
   - This research will seek to coordinate with current related UDOT ITS research as much as possible.
   - Vehicle communication systems, types, availability, etc. will be reviewed and used to further determine greatest safety benefits and feasibility.
   - Coordination needs will be identified and communicated with involved parties for the particular priorities identified.
   - Regulations and options will be reviewed concerning the federally designated vehicle communication bandwidth.
   - The ongoing USDOT SmartCities Challenge initiatives and outlines will also be reviewed and followed for national
recommendations, updates, and conclusions concerning connected-vehicle and infrastructure communications.

- The best priority selected from the review process and research matrix criteria will then be pursued as far as possible to prepare for preliminary testing and implementation as determined from the research steps.

<table>
<thead>
<tr>
<th>7. Requested from UDOT:</th>
<th>$15000</th>
<th>Other/Matching Funds:</th>
<th>$</th>
<th>Total Cost:</th>
<th>$15000</th>
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8. Outline the proposed schedule, including start and major event dates.

April 1  - Start Research Project

April 15  - Research matrix and scope identified
- Begin research of selected applications

July 1   - Narrow research to single application

Aug. 15  - Provide research overview and next steps for preliminary test
- End Research
Title: Evaluation of InSync Adaptive Traffic Control on Fort Union Boulevard

Submitted By: Milan Zlatkovic, Steve Laner and Joe Perrin
Organization: University of Utah, Rhythm Engineering and A-Trans Engineering, LLC

Email: milan@trafficlab.utah.edu; steve.laner@rhythmtraffic.com; atrans@comcast.net
Phone: 801-819-5925; 303-589-7969; 801-949-0348

1. Describe the problem to be addressed.
Fort Union Boulevard is a Minor Urban Arterial in Cottonwood Heights, and is characterized by high traffic volumes throughout the day, as well as significant fluctuations in traffic during different periods. A large shopping mall that spawns for several blocks is located on the south side of this corridor, and I-215 freeway with ramps on Union Park Ave and Highland Drive is on the north side. It also serves as a transition route that leads to the Canyon roads on the east. Delays at signalized intersections can be significant at certain times during day. The shopping mall is a major traffic generator/attractor and adds additional complexity to this corridor, especially during “shopping seasons”. A need for a better management of traffic signals along this corridor has been recognized and a study of an adaptive traffic control system, InSync, is proposed in this research.

2. Explain why this research is important.
This research will estimate the effectiveness of InSync adaptive traffic control system along selected sections of Fort Union Boulevard and 1300 E (Figure 1). It will assess the performance of the systems for different conditions that are expected along these corridors, such as high demand in peak hours, fluctuations in traffic demand due to the shopping mall, and during adverse winter weather conditions. InSync has the ability to adapt to different traffic conditions in real time, and has already been successfully deployed at more than 2,300 intersections in 31 states in the U.S. This research would represent a first evaluation of InSync in Utah. The evaluation will be performed in traffic microsimulation and will complement a potential field deployment of InSync.

Figure 1: Proposed InSync Deployment on Fort Union and 1300 E Corridors
3. **List the research objective(s):**
   1. Review current state of art and practice in adaptive signal control, with a focus on InSync deployments
   2. Collect traffic data along selected sections of Fort Union Boulevard (intersection counts, travel times, vehicular delays, fluctuations in traffic demand etc.)
   3. Develop, calibrate and validate a base microsimulation model in VISSIM
   4. Create different scenarios for evaluation of InSync vs. Time-of-Day (TOD) plans (peak demand, off-peak demand, demand fluctuations, adverse winter weather conditions)
   5. Evaluate the effectiveness of InSync and TOD plans under different conditions
   6. Report findings

4. **List the major tasks:**
   1. Literature review of adaptive signal control and InSync deployments
   2. Field data collection and analysis
   3. Development of microsimulation models for different scenarios
   4. Analysis of InSync effectiveness

5. **List the expected results:**
   1. Analysis of traffic conditions along Fort Union Boulevard
   2. Identification of critical sections and intersections
   3. Effectiveness of InSync adaptive and TOD actuated signal control

6. **Describe how this research will be implemented.**
   This research will supplement a potential field deployment of InSync along Fort Union Boulevard. It will provide detailed insights into its operation and comparison with actuated TOD plans under different conditions that are occurring along this corridor. This research will also provide ideas for future similar studies on adaptive traffic control in Utah.

   The University of Utah will apply for additional funds from the Mountain Plains Consortium (MPC), a University Transportation Center, and if the funds are approved, the researchers will work with the UDOT TAC to develop an additional scope that would supplement the work presented in this proposal.

7. **Requested from UDOT:** $75,000 (or UTA for Public Transportation)  
    **Other/Matching Funds:** $TBA  
    **Total Cost:** $TBA

8. **Outline the proposed schedule, including start and major event dates.**

   The proposed project duration is eighteen months, as follows:

   Start: Summer 2016

   Completion by project phases:
   - Phase 1: Literature review and data collection
   - Phase 2: Data analysis and model development
   - Phase 3: Scenario development, comparison and analysis
   - Phase 4: Finalize analysis, recommendation and provide final report
2016 UDOT RESEARCH PROBLEM STATEMENT

*** Problem statement deadline is March 14, 2016. Submit statements to Tom Hales at tahales@utah.gov. ***

Title: Roadway and Roadside-Related Crash Causes in Urban Areas

Submitted By: Milan Zlatkovic
Email: milan@trafficlab.utah.edu

Organization: University of Utah
Phone: 801-819-5925

UDOT Champion (suggested): TBA

1. Describe the problem to be addressed.
This research will look into the possible causes for crashes which are related to the roadway or the roadside. It will aim to identify locations where frequent crashes of different types occur, and look into the possible causes for those crashes that can be attributed to the roadway or roadside (insufficient sight distance, insufficient clear zone, too wide or narrow travel lanes, auxiliary lanes, bike lanes, shoulders, medians, signage, pavement markings and similar). The research will also look into potential solutions for improving safety performance.

2. Explain why this research is important.
The research is directly related to UDOT’s strategic goals, primarily zero fatalities, injuries and crashes. A portion of crashes has causes in the roadway and roadside environment, and most of the time this can be prevented by minor improvements. This research will look into the possible causes for crashes which can be attributed to roadway or roadside design. It will also try to address some of the problems by exploring potential solutions (which in most cases can be low-cost safety improvements), in order to reduce the crashes and their severity. The research would look into the urban area crashes in this phase, roughly identified as urban corridors inside the I-215 ring.

3. List the research objective(s):
1. Review literature related to roadway and roadside crashes and possible remedies
2. Obtain crash data for multiple years
3. Perform temporal and spatial analysis of crash data with identified causes and harmful events
4. Geo-locate the crashes and look for connection in crash causes, with a special attention to roadway and roadside
5. Perform field visits of identified locations and collect available data, including measurements, photographs, videos and similar
6. Identify potential roadway and roadside related causes
7. Explore potential improvements for identified locations

4. List the major tasks:
1. Literature review of crash causes, with special attention to roadway and roadside related crash causes
2. Data collection and analysis, including UDOT’s crash databases and field data collection
3. Identification of critical locations with roadway and roadside related crash causes
4. Explore potential improvements at critical locations
5. Report findings

5. List the expected results:
1. Crash data analysis
2. Critical locations with respect to roadway and roadside crash contributing factors
3. Potential improvements at critical locations
4. Report
6. Describe how this research will be implemented.
   The research will look into possible improvements (with a focus on low-cost safety improvements) that can be implemented within the urban roadway or roadside in order to reduce the number of crashes and their severity. It will also provide crash data analysis that can be used for other purposes.

   The University of Utah will apply for additional funds from the Mountain Plains Consortium (MPC), a University Transportation Center, and if the funds are approved, the researchers will work with the UDOT TAC to develop an additional scope that would supplement the work presented in this proposal.

7. Requested from UDOT: $20,000   Other/Matching Funds: $TBA   Total Cost: $TBA
   (or UTA for Public Transportation)

8. Outline the proposed schedule, including start and major event dates.
   The proposed project duration is one year, as follows:

   Start: Summer 2016

   Completion by project phases:
   Phase 1: Literature review and data collection: 3 months after project start
   Phase 2: Data analysis and locations identification: 6 months after project start
   Phase 3: Field visits and recommendations for improvement: 9 months after project start
   Phase 4: Finalize data analysis, recommendation and provide final report: 12 months after project start
## Title: Decreasing road fatalities by using flashlight signs in specific areas

### Submitted By: Yanguo Ma
Email: yanguo@cmtlaboratories.com

### Organization: CMT Engineering Laboratories
Phone: 801 9085859

### UDOT Champion (suggested):

#### Select One Subject Area
- [ ] Materials/Pavements
- [ ] Maintenance
- [X] Traffic Mgmt/Safety
- [ ] Preconstruction
- [ ] Planning
- [ ] Public Transportation

### 1. Describe the problem to be addressed.
Road fatalities number is increasing in recent two years.

### 2. Explain why this research is important.
The proposed research will help to decrease the road fatality number.

### 3. List the research objective(s):
1. Map specific areas for road crash and install new flashlight signs.

### 4. List the major tasks:
1. Map crash areas on Utah local and state roads.
2. Design new flash light signs
3. Monitor the crash numbers.

### 5. List the expected results:
1. Utah road crash areas will be mapped and some new designed flash light signs will be installed and monitored.

### 6. Describe how this research will be implemented.
We will work with UDOT to map crash areas and flash light design as well as monitoring those areas.

### 7. Requested from UDOT: $45,000
Other/Matching Funds: $
Total Cost: $45,000
8. Outline the proposed schedule, including start and major event dates.
   Month 1-3: Mapping Utah road crash areas.
   Month 2: Design new flash light signs
   Month 3-11: Install the signs and automatic monitor those areas.
   Month 12: write a report
# 2016 UDOT RESEARCH PROBLEM STATEMENT

*** Problem statement deadline is March 14, 2016. Submit statements to Tom Hales at tahales@utah.gov. ***

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<th>Submitted By: Darcy Bullock</th>
<th>Organization: Purdue University</th>
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<tr>
<td>Email: <a href="mailto:darcy@purdue.edu">darcy@purdue.edu</a></td>
<td>Phone: 765 494 2226</td>
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<tr>
<th>Select One Subject Area</th>
<th>Materials/Pavements</th>
<th>Maintenance</th>
<th>Traffic Mgmt/Safety</th>
<th>Preconstruction</th>
<th>Planning</th>
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1. **Describe the problem to be addressed.**
   Development dashboard to characterize the performance of freeways and signalized arterials.

2. **Explain why this research is important.**
   With over a thousand miles of freeway and hundreds of signalized intersections, it is important to have high level dashboards to assess the relative impact of special events, winter weather, and recurring congestion.

3. **List the research objective(s):**
   1. Develop consensus on appropriate performance measure to be track with a signal system ticker (perhaps split failure)
   2. Develop consensus on appropriate performance measures to track with a freeway system ticker (perhaps miles<45mph, or speed profiles)

4. **List the major tasks:**
   1. Engage with stakeholders on a recurring basis.
   2. Refine performance measures
   3. Refine visualization graphics

5. **List the expected results:**
   1. Traffic Signal Ticker
   2. Freeway Ticker

6. **Describe how this research will be implemented.**
   Collaborate with UDOT TMC Team to incorporate into there dashboards

7. **Requested from UDOT:** $50,000-$100,000
   **Other/Matching Funds:** $
   **Total Cost:** $

8. **Outline the proposed schedule, including start and major event dates.**
2016 UDOT RESEARCH PROBLEM STATEMENT

*** Problem statement deadline is March 14, 2016. Submit statements to Tom Hales at tahales@utah.gov. ***

<table>
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<tr>
<th>Title: Streamlined Traffic Impact Studies for Conditional Access Permits</th>
<th>No. (office use): 16.03.16</th>
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<tr>
<td>Submitted By: Tony Lau, Blake Unguren</td>
<td>Organization: UDOT</td>
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<tr>
<td>Email: <a href="mailto:tlau@utah.gov">tlau@utah.gov</a></td>
<td>Phone: 801-887-3717</td>
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UDOT Champion (suggested): Tony Lau, Rod McDaniels, Eric Rasband

Select One Subject Area

- [ ] Materials/Pavements
- [ ] Maintenance
- [x] Traffic Mgmt/Safety
- [ ] Preconstruction
- [ ] Planning

1. **Describe the problem to be addressed.**

Developers are required to obtain permits from UDOT to change access to their property. As part of the permitting process, they are required to perform a Traffic Impact Study (TIS), which takes time and money. The Department has authority to waive the TIS for smaller applications at the Engineer’s discretion. Applicants struggle to understand when a TIS is required and when it will provide value to a development. These unknowns drive up the cost of development and can potentially kill potential development.

2. **Explain why this research is important.**

The results of this research will increase the efficiency of the permitting process, reduce the number of access permits requiring a TIS, and save developers time, money, and risk of the unknown due to the UDOT permitting process when planning developments. The results and recommendations of this study are intended to be “ready to implement” by design so that the research can provide immediate value to the Department. This will provide new information about the TIS and when it may be waived so that the Department can reduce the time to permit an access and improve Department transparency.

3. **List the research objective(s):**

1. Develop a semi-automated process (using a spreadsheet) that will aid the decision making process for waiving a TIS.
2. Protect UDOT’s interest to maintain or improve traffic flow and the safety of the State’s roadways.
3. Recommend changes to UDOT’s process or rules based on national best practices and latest research.

4. **List the major tasks:**

1. **Problem Identification**
   - Identify the key objective criteria in the permitting process that would allow developers to independently demonstrate whether or not a TIS is required for their access.
   - Summarize questions/answers UDOT is discussing with developers.
   - Gather data on current permitting practices to identify measures of effectiveness that can be used to determine the success of the streamlining efforts implemented as a result of this effort.
   - Research best practices for a TIS that can be applied in Utah.

2. **Process Development**

   **Flowchart**

   Recognizing the variability in development access needs, we will create a draft flowchart of the process a developer would use to determine if a TIS is required based on the criteria identified in the previous task. We will include criteria thresholds that will be used to screen out projects that will not require a TIS.

   **Spreadsheet**

   We will then utilize the flowchart to create a simple-to-use spreadsheet that will incorporate the criteria and thresholds to determine whether or not a TIS is required. As part of this process we will perform a series of tests by running various examples through the process to “debug”, update and optimize the spreadsheet.

   **TIS Guidelines**

   TIS guidelines based on national best practices and the flowchart and spreadsheet will be developed to guide traffic
engineering professionals to know and understand what information must be included in a traffic impact study.

Process/Rule Change Recommendations
This research will also make process and rule change recommendations to further streamline the UDOT conditional access permit program to make the process more efficient and transparent.

5. List the expected results:
   1. The results will include a flowchart and spreadsheet that will be used by developers to determine if a TIS is required for their access change.
   2. Develop “publish ready” TIS guidelines that clearly communicate to a consultant Traffic Engineer what a TIS needs to contain for various levels of intensity of development.
   3. Recommendation of changes to current practice that will streamline processes with respect to a TIS.

6. Describe how this research will be implemented.
   - The spreadsheet will be published on UDOT’s Statewide Access Management website.
   - Recommendations will be given to the UDOT permitting team for implementation guidelines
   - We will present the results at UDOT Conference.
   - We will present the results at a conference targeted to Access Management Professionals to share with a larger audience

7. Requested from UDOT: $50000 Other/Matching Funds: $10000 Total Cost: $60000

8. Outline the proposed schedule, including start and major event dates.
   From NTP (obligation of funding)
   - Task 1: 2 months
   - Task 2:
     Flowchart – 2 months
     Spreadsheet – 3 months
     Development of Guidelines and recommendations – 2 months
     Testing – 1 month
   - Total Schedule – 10 months
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